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Source control SUDS Strategic Directions

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This document was produced by:

Alison Duffy, Brian D'Arcy, Neil Berwick, Rebecca Wade and Roshni Jose,

Urban Water Technology Centre, University of Abertay Dundee,

Kydd Building, Bell St, Dundee, DD1 1HG.

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The uptake or transition from traditional drainage to sustainable drainage (SUDS) in Scotland has happened in a relatively short timescale (less than fifteen years) with site and regional control drainage structures such as ponds and basins now considered 'business as usual'. This rapid transition to SUDS has been facilitated by a stakeholder platform called the Sustainable Urban Drainage Scottish Working Party (SUDSWP) which has promoted their use since 1997. This has subsequently led to Scotland being regarded as a frontrunner in SUDS implementation in the UK. However the uptake of source control as part of a stormwater treatment train is less routine than expected. With the aforementioned in mind, this Phase Three Report seeks to answer the question 'How can the national uptake of source control be encouraged and influenced by the SUDS Working Party and whether they should recast their remit'?

Objectives of research

Phase One of this research looked at the background to the evolution of source control in Scotland providing preliminary insight into the enabling factors and obstacles for uptake of the systems since inception in the mid 1990's. Phase Two appraised source control delivery on a global scale providing insight to enabling factors out with Scotland and appraising current delivery in Scotland by responsible organisations. The transition pathway from traditional drainage to source control SUDS was mapped out to highlight what the key enabling (and disabling) factors were to realise the transition to date. This phase of the research, Phase Three defines the next steps including comment on optimal source control and further considerations and recommendations. This involved analysis and consolidation of the findings from Phases one and two, a workshop delivered to SUDSWP and two surveys delivered online and via telephone interviews with professionals involved in source control SUDS. These findings are used to define barriers and opportunities to inform the development of a strategy to support and encourage implementation of source control within SUDSWP remit.

Key findings and recommendations

Key findings and recommendations for the SUDS Working Party are grouped according to transition management cluster activities:

- **Transition Arena:** Strengthen links with internal members and external stakeholders who have a stake in source control SUDS and develop an integrated long-term vision.
- **Transition Agenda:** Develop a shared strategic plan which considers aligning agendas with other infrastructure initiatives and enforcement / inspection policies to ensure cost effective, fit for purpose measures particularly in the areas of unit plot, local streets and regeneration areas.
- **Transition Experiments / case studies:** Encourage research partnerships to validate techniques in the source control toolkit not yet applied in Scotland and showcase case studies.
- **Transition Monitoring / evaluation:** undertake a baseline assessment to gauge source control uptake and performance, revise existing guidance and encourage capacity building programmes.

Key words Scotland, SUDS Working Party, Source control SUDS, Stormwater treatment train, Transition management.

1.0 INTRODUCTION

The uptake or transition from traditional drainage to sustainable drainage (SUDS) in Scotland has happened in a relatively short timescale (less than fifteen years) with site and regional control drainage structures now considered 'business as usual' (Wild et al. 2002, Duffy et al. 2012). This rapid transition to SUDS has been facilitated by a stakeholder platform called the SUDS Working Party (SUDSWP) which has promoted their use since 1997. This subsequently led to Scotland being regarded as a frontrunner in SUDS implementation in the UK (Duffy *et al.* 2013, NCE 2013). However the uptake of source control as part of a stormwater treatment train is much less advanced than other forms of SUDS.

Transitions are long-term processes that generally occur in excess of thirty years. They occur due to the co-evolution of several societal, economic (market driven) and technological processes. Transition management is a process which attempts to accelerate the uptake of innovative systems and practices which are more sustainable by guiding or influencing activities that encourage wide acceptance.

This phase of the research, Phase Three, informs the development of a strategy to support and encourage the next steps in the SUDS journey by SUDSWP within their remit. Using the transition management concept, a SUDSWP Source Control SUDS Transition Framework has been developed to focus, orientate and guide activities for the realisation of the end goal - furthering the implementation of optimal source control SUDS in Scotland.

Using the framework, the next steps have been defined which outline pathways or activities which could be taken by SUDSWP to influence the delivery of optimal source control SUDS in Scotland. Recommendations are based upon Phase One and Phase Two outputs combined with an analysis of an online and telephone survey results and a workshop delivered to the SUDSWP. Based on these findings and existing transition strengths within the SUDSWP, strengths which can be developed further to encourage enabling activities are defined. Finally solutions, strategic directions, and recommendations are provided to facilitate moving forwards with the source control SUDS journey.

2.0 SUDS WORKING PARTY WORKSHOP AND SURVEY FINDINGS

Part of the phase three outputs were the findings from a workshop delivered to the SUDSWPand invited experts. The workshop considered how to progress the implementation of optimal source control in Scotland. To add value to these findings, two surveys were conducted with professionals in the field via an online survey and telephone interviews.

2.1 SUDS WORKING PARTY DESIGN WORKSHOP 27TH FEBRUARY 2013

The rationale behind the design workshop was to determine if there is an appetite for furthering the implementation of source control and to investigate preferences for source control techniques from diverse decision making / professional backgrounds. Key barriers to furthering the uptake of source control were identified and potential solutions explored.

2.1.1 Format of the Workshop

The workshop participants were encouraged to collaborate to deliver a sustainable solution for a given scenario. The scenario was the Spateston Burn catchment in Johnstone near Paisley. This area was studied in detail for SUDS retrofitting opportunities during the Interreg IIIB project 'Urban Water' (Jefferies *et al,* 2008). The drainage issues presented at this location are considered to be

representative of many urban areas in Scotland: mixed existing (with some regeneration funding available at one location) and new housing development plus new commercial development potential; partly combined sewer, and otherwise separate (**Figure 1**). The Spateston Burn catchment has subsequently been studied by the Glasgow and Clyde Valley Green Network Partnership (GCVGNP) resulting in a design study which built on the Interreg research (Barber, (Ed) 2010).

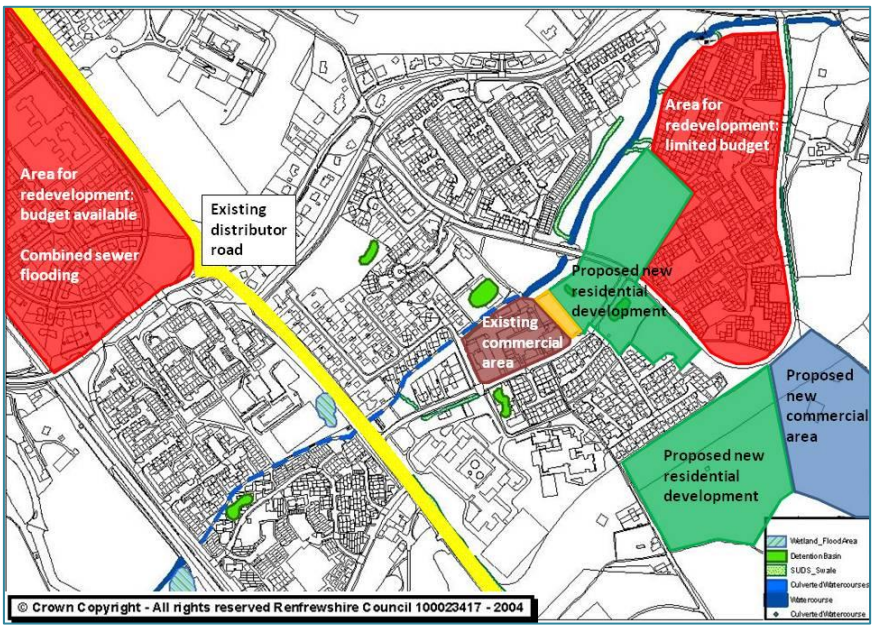


Figure 1 The Spateston Burn Catchment

Three groups (Table 1), with a mix of professional backgrounds, each jointly developed a masterplan for the implementation of source control. The teams were asked to draw on knowledge gained through Phases 1 and 2 of this study. Brief presentations were delivered regarding the evolution of source control SUDS in Scotland. Different techniques and applications of source control techniques were presented and preliminary outputs from the online survey were discussed.

Table 1 Group composition

Expert	Group 1	Group 2	Group 3
Developer	X		
SEPA	X	X	X
Scottish Water	X		
Government - Building Standards		X	
Government - Transport		X	X
Government - Planning			X
Local Authority		X	X
Consultant	XX		
Commercial Supplier	X		
Academic		X	
Landscape Architect			X
British Water		X	

The baseline principle which the teams were asked to take into account was: design a drainage system for an existing large area prone to flooding by considering source control at every location and level, rather than by using traditional drainage solutions (decentralisation of all stormwater). The teams were also asked to consider global and local challenges such as: population growth;

climate change; water quality initiatives and pollution of water sources (receiving water and groundwater).

The round up session reviewed group discussions and final masterplans (**Table 2**), all of which highlighted common issues between the groups in reaching a joined up solution: the identification of opportunities to implement and integrate source control SUDS (particularly next generation source control techniques) into existing infrastructure and the institutional, environmental, socio-economic and technical barriers were deliberated.

Table 2 Masterplan results for implementing Source Control SUDS per group

Group 1	Group 2	Group 3
PP, WB, RG, BR, FD, DB, Sw. Deculvert + natural storage, green network incorporating stormwater treatment train, visitor centre, woodland creation	PP, BS, **BR,** Sw, FD, DB, **RWH,** WB **SUDSButt, GR,** GU, Linear W, hydrobrake. Woodland creation, walkways, street furniture, exceedence using road network, downspout disconnection in combined sewer areas, gravel drives, deculvert, green corridor incorporating stormwater treatment train	PP, WB, **RWH, BR,** RP, **GR,** Sw. Exceedence using road network, disconnection of existing road network and properties in combined sewer areas, central SUDS feature for educational purposes, green corridor/ bridges connecting sites, cycle paths

Abbreviations: BR = Bioretention, BS = Buffer strip, DB = Detention Basin, FD = Filter drain, GU = Geocellular unit, GR = Green roof, PP = Permeable paving, RG = Raingarden, RWH = Rainwater harvesting, RP = Retention pond, Sw = Swale, WB = Waterbutt, W = Wetland. **Red text indicates next generation source control SUDS i.e. not common practice in the UK.**

2.1.2 Workshop results and discussion points

Table 3 outlines pooled comments made during the workshop from the teams as they developed their masterplan and during the question and answer session. These include barriers and potential opportunities for the uptake of source control SUDS. There was recognition amongst participants that different scenarios would require different solutions, e.g. limited budget action on flooding in combined sewer areas where the participants looked for the best cost effective options.

It was also generally recognised that rain gardens / bioretention units could enhance amenity and be a constructive part of regeneration objectives, whilst also gaining local residential interest and understanding of the issues and solutions available i.e. street traffic calming measures provide attractive multi-functional systems in open areas and margins. This would require public sector awareness raising initiatives. Green roofs were similarly attractive options.

Participants generally displayed joined-up thinking on green networks and existing habitat creation / enhancement, including de-culverting and using source control to link green areas for achieving more attractive and ecologically diverse urban landscapes. Schools to be closed and redeveloped offer land to accommodate regional or site control SUDS features. Existing schools in regeneration zones offer opportunities for open water SUDS features, where children can learn about water safety, see wild flowers and amphibians and other wildlife in their own community.

Table 3 SUDSWP Wokshop findings - Barriers and Opportunities for implementing Source Control

Barriers	Opportunities
Cost - too expensive	Public engagement in regeneration areas
Local resident interest and understanding	Attractive multi-functional features
Rainwater harvesting a desirable solution but additional SUDS benefits unclear	Novel treatment train options i.e. Green roof to permeable paving car park
Lack of incentives (as found in US and Germany)	Joined up thinking to deliver attractive and

including water charges	ecologically diverse urban landscapes
Finalising Section 7 agreements	Next generation techniques at the unit plot level
Developer (especially SMEs) and traditional consultant education	Economic drivers for house builders to discourage overuse of site / regional controls
Policy, specifically source control	Aligning with the green infrastructure agenda
Planning and existing statutes (GBRs) do notencourage source control	Use opportunities to educate schoolchildren in regeneration areas
Interpretation of source control and the need for it by regulator	Use open areas and margins adjacent to local roads and buildings where possible
Clarity - treatment train implementation / functionality of features	Recognition of proprietary products for use in retrofit / regeneration areas
Adequate and effective guidance	New developments need full benefit SUDS
Maintenance by owners of unit plot features	Disconnection of surface water
Need simplified terminology that does not confuse (rain garden or bioretention?)	De-culverting to provide additional storage and deliver green networks
Confidence in the technology - especially performance (frontier and proprietary)	
No formal pre/post inspection regimes to ensure the systems are fit for purpose.	

Participants generally recognised that open drainage offers an effective approach to prevent wrong connections or other pollution risks being realised. Some participants recognised the potential for disconnecting existing housing into a redeveloped permeable pavement car park nearby, if adequate additional storage capacity was provided. It was suggested that economic drivers are needed for housebuilders to provide source control. There were a variety of practical comments on swales and different proprietary products from a performance perspective.

All teams included several next generation or emerging techniques as part of an integrated solution. The most common features were green roofs, rainwater harvesting and raingardens for unit plots and bioretention units implemented in local streets.

2.1.3 Question and answer session

Following a rapid assessment of the masterplans, a question and answer session gave an opportunity for the facilitators to ask questions and discuss aspects not covered in the surveys or workshop. The key question put to the workshop delegates was 'ok – it is obvious that there is an appetite and the technical knowledge is evident for implementing source control SUDS so why is it not happening?' The initial response was 'cost' but further discussion identified a lack of confidence and consensus across professionals regarding performance (in terms of operation and performance) of source control systems. In Scotland there are limited documented flagship or exemplar schemes; there are many feasibility or design studies, however few of these have become a practical reality. The surface water management plan for Glasgow City Centre has the potential to deliver source control SUDS flagship schemes once implementation begins (see section 3.2.4 for more details).

It is also apparent that there is some confusion regarding the concepts of source control and levels of treatment in the stormwater management treatment train. This issue continues to be problematic as some participants were unclear on the full performance of certain types of SUDS feature, and were unclear on whether some of these provided a 'level' of treatment as required under CAR (Controlled Activity Regulations). There appeared to be limited understanding regarding levels of treatment across a development which progressively (or accumulatively) increase pollutant capture

beginning with source control, then site control or conveyance and finally regional control for the most polluted catchment types such as an industrial estate. This issue is discussed in detail in the Phase One report and was highlighted in both surveys. It is obvious that clear guidance is needed to provide clarity on this issue.

2.2 ONLINE AND TELEPHONE SURVEYS

To add value to the appraisal on source control delivery and the results from the SUDSWPworkshop, two types of survey were conducted to obtain anecdotal information from professionals in the field on the nature and extent of source control implementation:

- an online survey distributed through SUDSnet (http://sudsnet.abertay.ac.uk/) with a target audience of professionals and academics interested or involved with source control SUDS implementation such as consultants, local authorities, water authorities, planners and the research community (25% academic).
- semi-structured questionnaires delivered to a small number of professionals (15) covering similar professional backgrounds as the online survey (50% practitioner, 25% public body, 25% academic / research community i.e. CIRIA).

The online survey questions and results including individual responses can be found in Appendix 1 of this report. Telephone interview questions, responses and results are in Appendix 2.

2.2.1 Online Survey Results

Eighty two responses were received from the online survey over a two month period. **Question 1** asked if the respondent was a practitioner or academic, with 75% being practitioners. The next two questions provided insight into not just the extent of source control implementation in the UK but also experience with implementation of the systems. **Question 2** asked if respondents had been directly involved in the implementation of source control with a very high number of respondents (80%) answering yes. **Question 3** asked how many source control SUDS projects the respondents had been directly involved with implementing, 67% had implemented 10+ schemes.

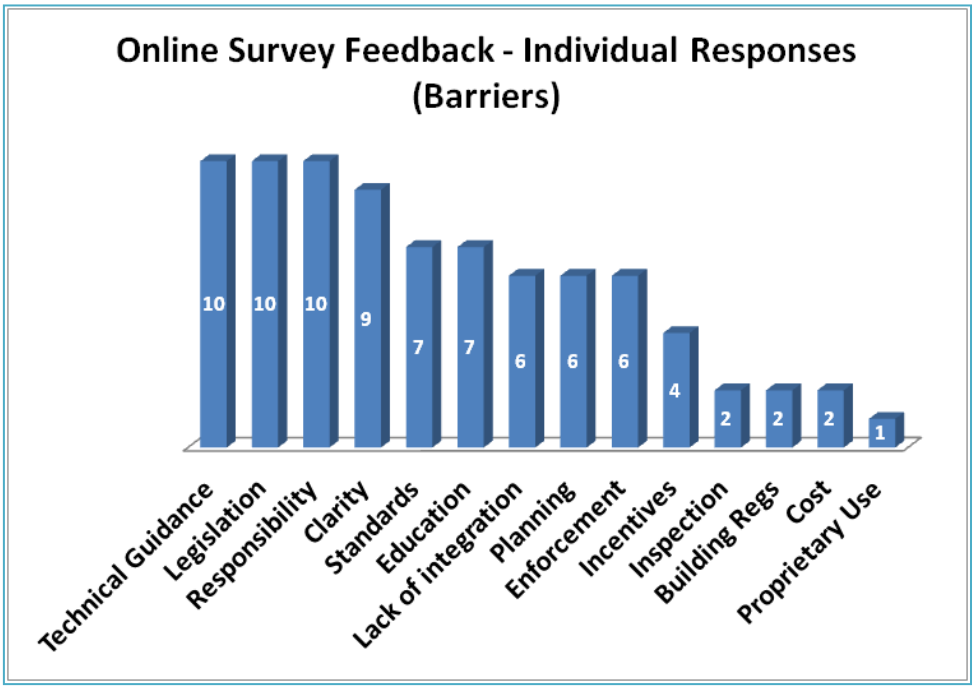
Question number 4 asked respondents if there was scope for more widespread use with 99% agreeing that yes there was more scope. There was only one respondent who did not agree. The response sums up the issues surrounding different drivers resulting in fragmented agendas / visions at the responsible stakeholder level and ownership responsibilities at the unit plot level *"There are VERY few areas where genuine source control works - an outlet is usually required to cope with flows dictated by statutory authorities. Water and highway authorities are moving further apart with source control related topics, not closer together. Too many source control techniques rely on owner/occupier maintenance which is of questionable long term sustainability".*

During Phase one of the report, fifteen source control SUDS types were identified and **question number 5** asked respondents which type they had been involved with. Permeable pavement, swale and soakaway were the most common types to be implemented with filter drain, filter strip, geocellular and surprisingly rainwater harvesting being the next most common types to be implemented. Green roof, waterbutts, biofiltration, rain gardens and tree planters are less common with natural rain gardens, planted rills, green walls and schotterasen being the least likely type that has been implemented.

Question number 6 asked respondents if they thought that legislation was adequate from the key responsible bodies involved with regulating drainage infrastructure: a) building regulations; b) planning applications; c) highways and drainage approvals; d) environmental regulation. All questions received less than 50% positive (yes) responses. Environmental regulation received the highest response with 42% agreeing that environmental regulation was adequate. Highway drainage approvals received 36%, planning approvals received 33% with the lowest being building regulations at 31%. The role which building regulations play in implementing and enforcing source control SUDS was also raised during the workshop and telephone interviews.

The **final question** was an open ended question which asked respondents if they had any further comments. All of the responses (45%) bar one offered insights into what they perceived as barriers to the implementation of source control SUDS (**Chart 1)**.

Chart 1 Q7 Any further comments? Individual response results regarding barriers to source control



Lack of technical guidance, legislation, responsibility (ownership / maintenance issues) and clarity surrounding the concept and function of source control SUDS (as opposed to SUDS in general) were considered the biggest barriers to source control SUDS implementation. "*In Scotland - too much confusion regarding ownership and maintenance. Developers need more clarity before they will take the risk of implementing*". Lack of technical standards, education, integration, planning guidelines, enforcement and incentives were also considered significant barriers to source control SUDS implementation. *"Although regulation consistently stipulates source control should be considered as a first choice SUDS measure, there are no minimum standards or requirements. Perhaps regulation, or greater encouragement, could drive forward uptake".*

Finally, issues which were surprisingly considered the least for facilitating source control SUDS implementation included system inspection and cost. This contrasts with the workshop and the telephone survey findings. The provision of building regulations to encourage implementation and combining the use of proprietary products to enable implementation of source control SUDS were also considered to be least facilitating barriers. However respondents had already answered a question regarding adequacy of building regulations therefore the importance of this comment is

that it reinforces the feedback gained in question 6. *"Local Authorities should get funding to better enforce and police SuDS, and follow up on front gardens being paved over without appropriate permission".*

2.2.2 Telephone Survey Results

The telephone survey involved a qualitative research methodology with open ended questions to elicit comprehensive answers from respondents (Bryman 2001). This meant that respondents could explain any important opinions in detail if they wished as opposed to the online questionnaire structure which did not allow personal expressions until the end of the survey.

The **first question** asked respondents what in their opinion they considered source control to be. This was probably the most difficult question and the one which respondents deliberated over the most. However, the results show that there is a high level of understanding of the concept; with 57% describing it as management of rainfall at source, 14% believing it to be pollution prevention and 29% describing it as rainfall management at source combined with pollution prevention.

Question 2 was designed to gauge respondents' deeper understanding of the source control concept by asking what benefits the techniques offered. Findings were grouped under sixteen main headings. Decreased pollutant loading and flood mitigation (15%) was considered to be the main benefit. Other benefits which were suggested such as 'interception of small events' (9%), 'easier to manage' (7%) and 'reduces traditional infrastructure' (4%) indicate the level of understanding surrounding overall technical and holistic advantages. The high result obtained (9%) for attributing source control to reduction in surface water entering sewers is indicative of respondents who have been involved in retrofit / regeneration projects, a factor which has already been identified during phase one of this research as a key opportunity for encouraging uptake of the techniques.

Question 3 'what are the barriers to source control implementation': results are provided in The barriers to source control implementation were many and varied with seventeen barriers identified. Cost was considered to be the biggest barrier (16%). This is in line with findings from the SUDSWPWorkshop but contradictory to the online survey findings where costs were considered to be the lowest barrier (2%). This is surprising as 67% of respondents from the online survey had direct experience with implementing source control techniques whereas only 47% of respondents of the telephone survey had direct experience. This would imply that this is a 'perceived' barrier by the telephone survey respondents and SUDS Working Party (who had less direct experience) and not an actual barrier as indicated by the online survey respondents. Perceived barriers however are significant issues and should not be ignored.

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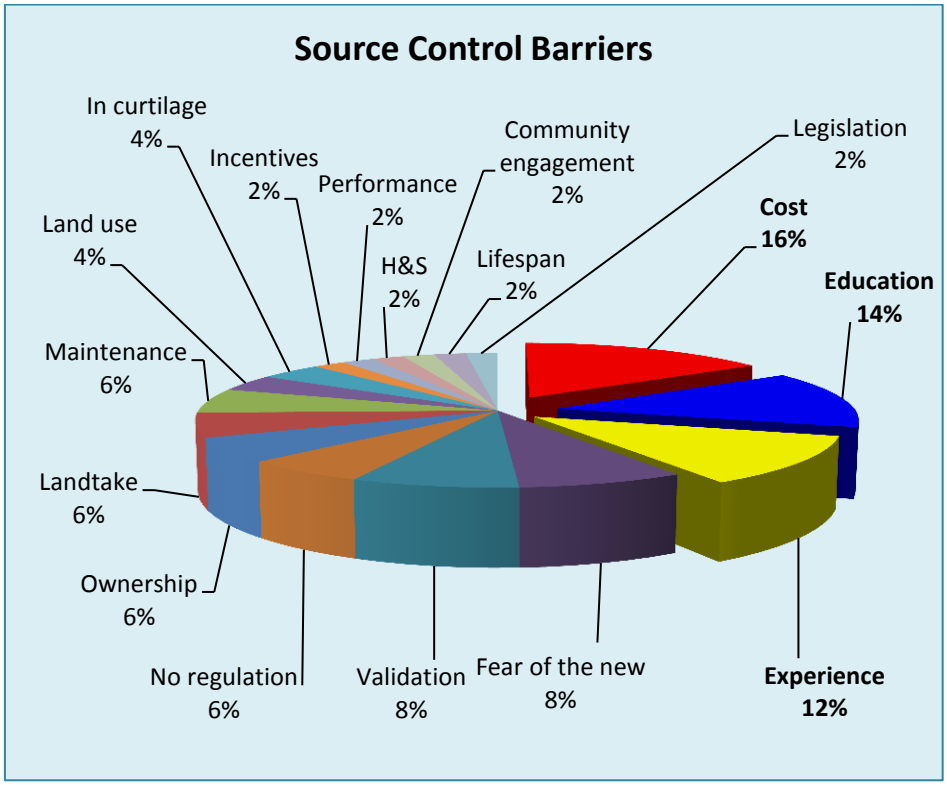
Chart 2 Q3 What are the barriers to source control implementation?



Question 4 'In your opinion are source control measures effective' was designed to elicit information on the performance of source control SUDS techniques. There were no negative responses, 40% positive and 27% 'most' responses. Respondents who replied 'most' cited examples of system failures and also commented on the use of the techniques for the wrong location type – i.e. non optimal use. There was a further two categories defined from responses to this question – 'if designed well' (27%) and 'if maintained well' (6%) which indicates overall quality control (enforcement / inspection) issues.

Question 5 asked respondents which of the 15 source control types they would recommend. Most respondents explained why they would recommend a particular technique. Many advised that they were unsure of the performance of emerging or next generation techniques such as green roofs and rills as there were no reliable sources of literature available which validated the systems. Overall, swales received the highest ranking (9%) with surprisingly some of the more innovative techniques such as raingardens (8%) also ranking highly. It is interesting to note that the literature review could not find any information to validate planted rills (6%) or tree planters (6%) as 'reliable science' yet these ranked higher than other innovative techniques which have been validated such as rainwater harvesting systems (5%). This may be due to the exposure these systems have recently gained through case studies published via the CIRIA susdrain website.

Question 6 'In your opinion is source control attractive?' was designed to elicit information regarding aesthetic benefits of source control. Again there were no negative responses, 14% positive responses and 86% 'can be' responses. The main reasons attributed to a 'can be' response were poor design, construction and maintenance regimes. This again indicates quality control issues.

Question 7 asked respondents if they had been involved with the implementation of source control SUDS. Only 47% had been directly involved with implementing source control which was a surprisingly low figure considering the respondents were chosen for their activity in the field.

Question 8 asked respondents if they were aware of any case studies, with 6% giving a negative response and almost 70% providing case study examples. Surprisingly 25% of respondents advised that we refer to the susdrain website which is indicative of the usage of this website by professionals.

Question 9 'do you have access to maintenance activity / cost information?' gave almost 60% negative responses. Of the positive responses, 12% had maintenance activity information and 29% had cost information which they could share.

Question 10 asked respondents if there was a place for proprietary SUDS as source control techniques with almost 80% providing a positive response. There were no negative responses with 20% responding 'possibly' – depending on the technique. Proprietary products were generally split into two categories: structural components such as bioretention units and permeable paving and; 'gismos' or sedimentation devices which were not considered SUDS and which are also considered high maintenance techniques.

Question 11 asked respondents 'what guidance documents would you refer to for advice on source control implementation?' CIRIA guidance (42%) was clearly ranked the highest by more than 50% over any other guidance available, with research the second highest at 12%. CIRIA guidance quoted included all guidance related to SUDS and not just the SUDS manual. Local Authority planning guidance, Sewers for Scotland 2nd Edition and SUDS for Roads were also highly ranked.

Question 12 asked respondents 'which public organisations or professional body do you find is the most helpful for providing information / guidance?' CIRIA again was ranked the highest at 35%. Susdrain was also cited as a helpful source of information (10%). Susdrain could have been added to the CIRIA result however it was felt important to distinguish between the two resources. This is because susdrain is a fairly recent resource developed by CIRIA which has gained popularity in a very short timescale indicating the need for resources such as this by professionals in the field. Local Authorities were also cited as useful sources of information (21%) with several respondents citing specific authorities who they considered to be particularly helpful with either advice or published information. SEPA / EA were ranked the third most helpful resource for advice / guidance (17%) and both agencies also received negative responses. SUDSnet and the research community were only referred to by 7% of respondents.

Question 13 At the specific request of the SUDSWPa final question was added towards the end of the telephone survey: 'do you know if there are any checks / sign-offs for source control SUDS implementation – pre or post construction?' Although this was only included in four surveys the answer was 100% negative. One respondent replied: *"No formal checking through planning application but should get picked up through RCC (roads construction consent), however although this happens for roads, this rarely happens formally for the SUDS".* Lack of quality control is not an ideal situation and will account for systems which may not be constructed according to best practice and prone to failure (potential flood risk and regulation breach) and reduced life expectancies.

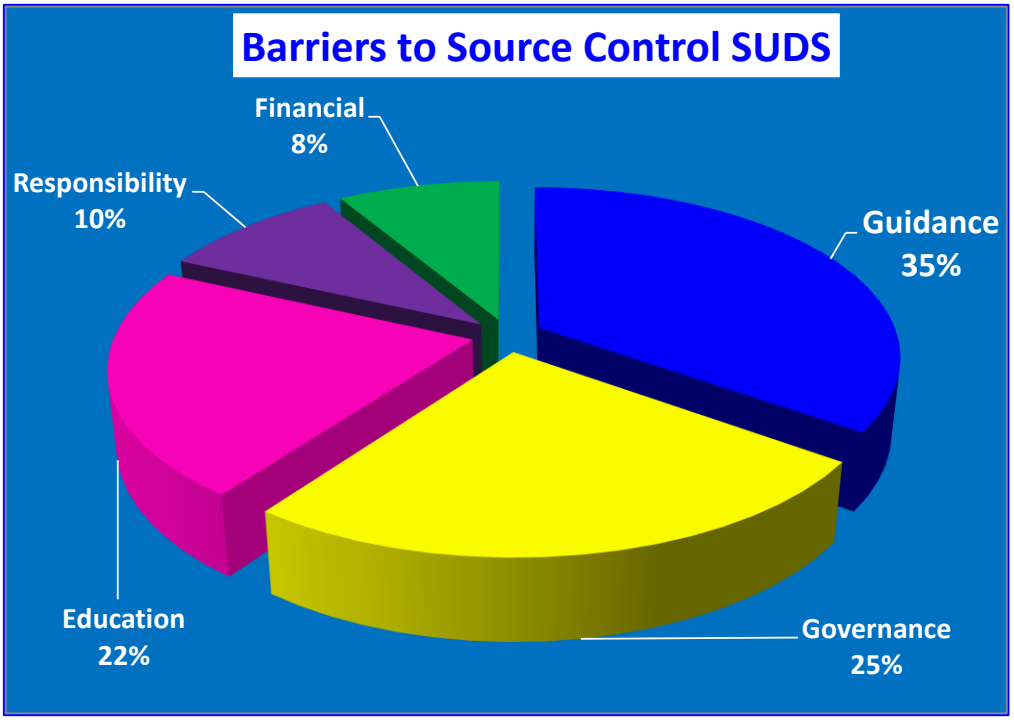
2.3 ANALYSIS OF WORKSHOP AND SURVEYS RESULTS

Findings from the surveys and workshop provided insights into why source control is not being implemented on the scale that it was originally hoped at the beginning of the SUDS journey. Overall survey respondents and workshop delegates suggested twenty three categories which they considered to be barriers to source control implementation (

Table 4). The categories were grouped with relevance of importance under the five generic headings shown in Chart 3 and

Table 4.

Chart 3 Results for barriers to the uptake of source control from Surveys and Workshop.



Guidance is a generic heading which encompasses all issues where clarity is required i.e. technical guidance, levels of treatment (and the placement of source control in the stormwater treatment train) and the lack of understanding regarding the concept, functionality and benefits of the systems. Clarity issues were also highlighted during Phase One of this research. There is obviously a need for clear guidance surrounding technical issues and new policies surrounding optimal implementation and ownership. Terminology was also considered an obstacle. This is mainly with regard to emerging techniques which have several labels for one type of system (i.e. biofilters, bioretention, bioswales, rain garden). This indicates a need to standardise the options available for different catchment types.

Governance encompasses issues related to acts of governing (or lack of) by responsible bodies including enforcement which was mainly cited with regard to legislation and regulation. Quality control by local authorities, SEPA and building standards was cited as a particular issue. Planning issues and lack of inter-agency collaboration are also included under this heading.

Table 4 Combined results for barriers to source control implementation

Individual Barrier Categories	Grouped Barrier Categories
Benefits Technical guidance Functionality Standards Treatment train Terminology	Guidance
Legislation Regulation Building Regulations Enforcement Inspection Planning Inter-agency collaboration	Governance
Community Engagement Best practice case studies Validation Experience Fear of the new	Education
Implementation Land use / take Incentives	Financial
Maintenance In curtilage ownership H&S	Responsibility

Education encompasses issues relating to professional, societal or cultural expectations / experiences and performance issues, particularly fear of the new and lack of exemplar best practice case studies to garner confidence in the systems. During Phase Two of this research it was observed that limited local (Scottish) case studies are available in existing literature, particularly emerging techniques.

Responsibility encompasses maintenance regimes, private ownership of in-curtilage techniques and health and safety issues. **Financial** encompasses not just the cost to implement source control but also the land use context and land taken up by the systems. Land take cost is arguably a perceived issue as additional land is often not purchased to implement source control for many location types.

3.0 SUDS WORKING PARTY SOURCE CONTROL TRANSITION FRAMEWORK

When considering transition management it is useful to consider the multi-phase concept which broadly considers the dynamics of transitions over time as a series of phases. This is a process whereby culture, markets, networks, institutions, technologies, innovations, policies, behaviours and 'trends' evolve together from one relatively stable state to another.

The process can be visualised as an S curve which generally indicates a growth phase (Figure 2). The transition pathway begins with the pre-development phase and the transformation away from the old system. During the take-off and acceleration phases, new generation systems begin to be implemented. This involves interaction between stakeholders and is often a period of rapid development. The stabilisation phase signifies business as usual with the new generation systems. The S curve implies smooth change, whereas this is often a start-stop process, or more

pessimistically, lock-in, backlash or even system breakdown. System lock-in is where an emergent technology becomes path dependent. When this occurs, new opportunities and innovations might become excluded due to, for example, perceptions of increased costs or resistance from stakeholders who fear a change to the existing status quo (Grin *et al.* 2010). Once an institution or community decides not to accept a change, the uptake of new systems can be blocked. This scenario is particularly relevant in the water sector where improvements to infrastructure entail large investments and specialised skills (Jefferies and Duffy 2011). The existing state of play for source control SUDS currently aligns with the system lock-in scenario as both of these situations (cost and fear of the new) have been identified as barriers to implementation, particularly next generation techniques. System backlash occurs when innovation advancement is stifled at a time when the emerging technology is still immature resulting in a loss of momentum. System breakdown occurs when there is insufficient knowledge or stakeholder support for the new technology resulting in system collapse.

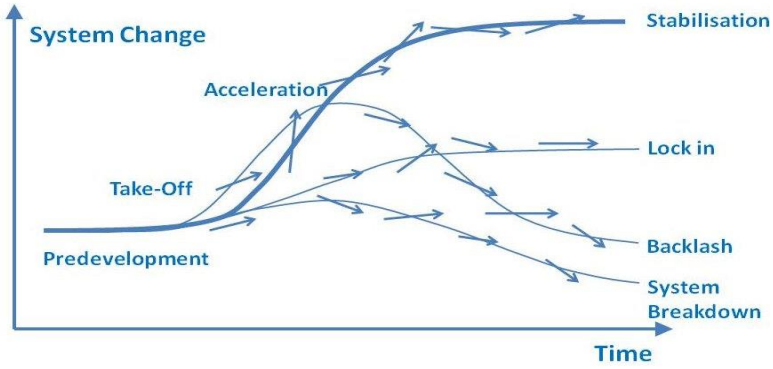


Figure 2 The Multi-Phase Concept after Grin *et al.* (2010)

A transition management (TM) framework (Figure 3) has been developed for the SUDSWPbased on the SWITCH Transition Framework for Urban Water Management (Jefferies and Duffy 2011). This framework has been informed by the findings from all phases of this research.

The framework has been developed with a fifteen year trajectory for SUDSWPto encourage and influence, through member activities, the implementation of optimal source control. The fifteen year timespan is not set in stone and can be adjusted. Transition management activities where existing strengths can be deepened based on experience gained to date, are green circled and TM strengths which can be developed specifically from a source control perspective, red circled.

The core (inner layer) of the framework which outlines transition management activities and clusters has not changed. The ten steps of the TM framework (Dirven *et. al.* 2002) involve long-term planning through small steps based on learning and experimenting. This process consists of four co-evolving activity clusters: Transition Arena – where problem solving and vision development takes place; Transition Agenda - developing the strategic plan; Transition Experiments – initiating and implementing innovations, and; Monitoring, Evaluating, Learning – continuous lesson learning and re-evaluating for adjustments to the vision and agenda closing the loop to make the process cyclical.

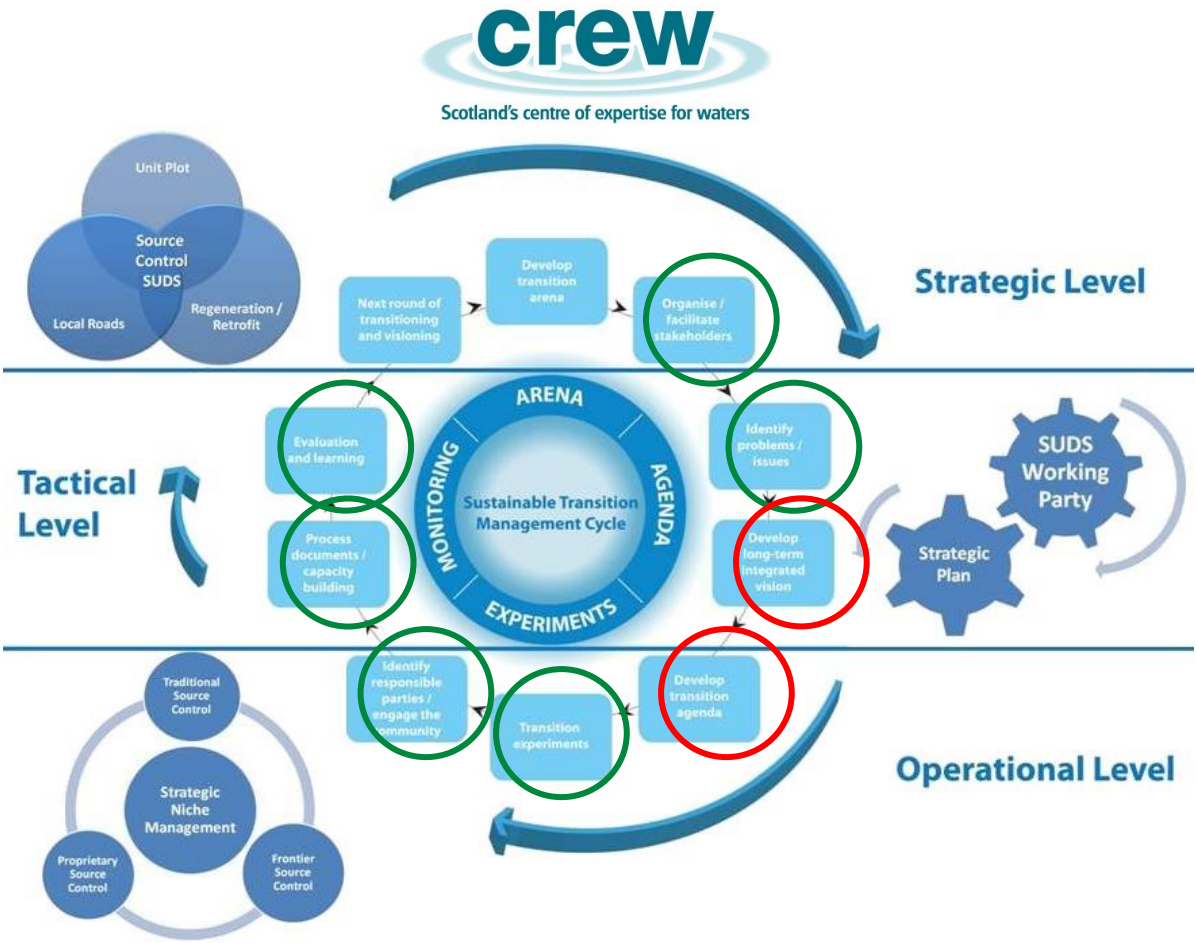


Figure 3 SUDSWPSource Control Transition Framework 2014 – 2030 highlighting where transition strengths can be built upon or developed. Green circle indicates where strengths already exist and can be built upon, red circle indicates where strengths can be developed.

The framework TM levels (strategic, tactical and operational) are forms of governance activities which the SUDSWP is in a position to play a lead role by ensuring that the levels influence each other and provide direction to a source control SUDS implementation strategy / plan (Table 5).

Table 5 Transition management levels (Loorbach 2007)

Management Level	Problem Level	Time Scale	Systems Level
Strategic	Abstract / societal system	Long-term (30yr)	System
Tactical	Institutions / Regime	Short-term (5-15yr)	Sub-system
Operational	Concrete / Projects	Short-term (0-5yr)	Niche / micro-system

3.1 FRAMEWORK INNER CORE – TRANSITION MANAGEMENT CYCLE ACTIVITIES

The following section looks at each of the ten transition management steps highlighting areas where SUDSWP can focus on building transition strengths in order to influence and accelerate the uptake of source control SUDS within their remit. Different coloured headings align with Figure 3 transition strength colours – existing, developing, need to strengthen etc. Recommendations are summarised in Table 6 which also indicates where transition strengths had been gained during the first round of transitioning which introduced and embedded (integrated) SUDS into drainage infrastructure in Scotland. Due to the composition and diverse backgrounds of the stakeholders in the SUDSWP, the group are in a position to facilitate the development of 'common ground' resulting in an integrated guiding function to influence change towards increased uptake of source control SUDS.

- **The transition arena**. The existing SUDSWParena is well-structured and functioning with many key players in place and which continues to be actively engaged in SUDS issues.
- **Organisation and facilitation of stakeholders.** Is there a potential to engage other responsible / professional organisations in Scotland which have a stake in source control?
- **Identify what the problems and issues are.** This CREW study has identified problems and issues.
- **Develop a long-term integrated vision.** Co-develop a source control vision to act as a framework for action and implementing a strategic plan. Use the TM framework to orientate and guide.
- **Develop the transition agenda.** Co-develop a source control strategic plan (align agendas / drivers) with short term targets. Use CREW Reports and workshop / survey findings to provide solutions.
- **Transition experiments.** Influence and encourage coordination of projects which realise short-term targets of the source control strategic plan and long-term targets of the vision.
- **Identify other responsible parties, engage the public and raise awareness through mass and digital media.** Is there a potential to encourage public sector engagement to empower and increase acceptance of new systems? Mass media is a powerful tool for raising awareness (i.e. update stakeholder websites, local press articles).
- **Capacity building and document the process of change.** Encourage capacity building programmes to ensure education and uptake by professionals and the public. This study provides the basis for process documentation - why and how change occurred.
- **Evaluate progress and learn**. Assess progress through analysis of process documents to ensure short and long-term targets can continue to be met.
- **Next round of transitioning.** Following assessment – is a review of the vision / activities for moving forwards required (i.e. has new knowledge become available)?

Table 6 Transition management steps /activities for encouraging the uptake of source control (SC).

Transition Management Steps	SUDS Implementation 1990's - 2010	Source Control Implementation 2014 - 2030
1. Develop the Arena	SUDSWP	SUDSWP
2. Organise Stakeholders	SUDS Champions	Extend links to external influential source control (SC) champions.
3. Identify problems / issues	SUDS vs traditional drainage	Provide the evidence that SC is less routine than expected (baseline review required). Fragmented vision and agendas. Governance (Legislation, Regulation, Enforcement, Inspection, Building standards). Clarity of SC and treatment train concepts.
4. Develop long-term vision	SUDS in new developments SUDS for roads	Align agenda's. Opportunities for SC - Retrofit, Regeneration, Unit plot, Local streets, Section 7 agreements, Emerging SC techniques.
5. Develop Agenda	Voluntary code for SUDS provision / SEPA Water Environment Controlled Activity Regulations / Scottish Water Sewers for Scotland 2nd Edition.	Policies. Enforcement and inspection. Incentives. Replicate global examples and initiatives. See Table 4 for other potential agenda items.
6. Experiments / Demonstrations	Scottish Universities SUDS monitoring group.	Build on existing research - MGSDP, Arborflow, Heriot Watt, SUDSbutt etc, encourage new studies
7. Identify other responsible parties / Engage the public	CIRIA, SNH, RSPB, DEX comm engagement (limited period),	CIRIA RP992 – update of CIRIA C697 SUDS manual. GCC / MGSDP SWMP. NGO's. Education boards.

(awareness raising)	Wauchope Square.	
8. Capacity Building / Process documentation	CIRIA C521 SUDS Manual / SUDS for Roads manual / Workshops / SUDS Online	Guidance / Conferences / Workshops / University courses / SUDS Online / Stakeholder websites / CREW studies
9. Evaluate and learn	Journal papers. Media articles. Design studies.	National SUDS inspection programme. Scottish case studies - SUDSnet / susdrain.
10. Next transition phase	SC implementation	Re-evaluate vision for next phase.

3.2 FRAMEWORK INNER CORE – TRANSITION MANAGEMENT CLUSTERS

The transition management steps are grouped into TM activity clusters. Clusters are mechanisms for encouraging coordinated, multiple stakeholder processes at the different transition management levels (strategic, tactical and operational) and which drive activities in a shared direction. This is particularly beneficial when attempting to apply pressure or influence policy changes in favour of implementation of source control SUDS. There is no fixed sequence and activities can be carried out partially, in sequence, in parallel or in isolation (Grin *et el.* 2010). The following section discusses barriers and potential solutions relating to each cluster activity which SUDSWP may directly undertake or drive the agenda through collectively influencing policies and practices.

3.2.1 The Transition Arena – SUDS Working Party and Review of Aspirations

The SUDS Working Party transition arena is a platform where problem solving, visions, actions and agendas have been and continue to be developed. It is also where interaction with relevant water policies occurs in order to influence future policies as SUDS practices become more developed. The Phase One report identified how SUDSWP managed the SUDS transition to date and that the previous aspiration for source control implementation has failed to be realised. Actively driving forward Source Control is the next step to embedding SUDS as a drainage methodology. Bringing together all of the stakeholders for the SUDSWP Workshop indicated that there is an appetite to work together to deliver source control SUDS, particularly frontier or emerging techniques. New knowledge has become available from Phases One and Two of this CREW study to assist in developing a new vision for moving forwards: opportunities for implementing SUDS at the unit plot level, in local roads and areas designated for regeneration / retrofit; expansion of the source control SUDS toolkit to include novel techniques and proprietary products which are main stream in other countries but not in Scotland.

Barrier1: No Shared Source Control Vision. Are some aspirations being lost as stakeholders focus on their own needs and priorities resulting in conflicting interests and ultimately holding back implementation? Are all stakeholders with a stake in source control implementation or with parallel infrastructure agendas engaged? The long-term source control future vision is fragmented resulting in missed opportunities for cost effective integrated schemes.

Solution: SUDSWP - Co-develop a long-term integrated vision. Many responsible organisations and other professional groups were identified in the Phase Two report. Develop or strengthen existing links to engage with all parties with a stake in source control SUDS. Part of the challenge in defining a shared vision lies in unpicking the adoption and long-term maintenance issue. Fully documented, transparent and nationally agreed roles and responsibilities are required by the responsible organisation which is best placed to manage the structures depending on location and which asset the SUDS is protecting i.e. Scottish Water, Transport Scotland or Local Authority (or others such as private / commercial / industrial landowners). Scottish Government Planning and Building Standards should set out what should be undertaken by Local Authorities in relation to

approving and checking proposals. This will assist in delivering a more integrated long-term source control vision to help define a phased strategic plan which is implementable (i.e. realistic targets and timeframes) across Scotland. Nurture links with national, catchment and local level initiatives to take advantage of opportunities which encourage intra- and inter-agency coordination for alignment of drivers, visions and funding avenues (i.e. flooding and green infrastructure initiatives). Some specific opportunities to lobby support with other infrastructure initiatives include:

- The Scottish Government have identified that an increase in source control measures will be fundamental to solving diffuse pollution problems in urban areas to assist in the realisation of the Hydro Nation Agenda (see Phase One Report). This also aligns with the CREW Diffuse Pollution study to inform the development of policy supporting recent legislation (see section 3.2.4).
- Scottish Water have identified that source control measures are required for delivering surface water management plans in areas prone to flooding (See Phase 2 Report).
- Designing Streets (Scottish and Local Government) identified next generation source control techniques as appropriate solutions for draining local streets (See Phase 2 Report).
- MGSDP and GCVGNP aspirations for creating / enhancing green networks recommend the implementation of traditional and next generation techniques (See Phase 2 Report).

Other funding avenues could be explored such as: UK research council grants (EPSRC, NERC, etc.); charities and trusts (Carnegie, SNIFFER, Leverhulme etc.); Learned societies / associations (Royal Academy of Engineering, Royal Society of Edinburgh etc.); Government Agencies - Scottish Government i.e. CREW / Sustainable Action Fund etc., Defra, TSB, etc.; and European funding (Horizon 20, Interreg, Life+, ESF, UKRO etc.)

3.2.2 The Transition Agenda – Source Control Implementation Strategic Plan

Prior to developing the strategic plan, problems and issues regarding the low uptake of source control and influences on decision making processes must be identified. By considering the transition management levels approach (**Table 5**), the long-term aims of the vision can be achieved through smaller steps with identifiable and realistic targets for overcoming barriers at the strategic, tactical and operational levels. Many problems and issues have been defined through this CREW Study. This phase of the research provides potential solutions to address several of the key issues raised during Phases One / Two, SUDSWP meetings and the workshop / surveys.

Barrier2: Fragmented source control agenda. A key barrier is the existing situation of a fragmented source control agenda due to the differing stakeholder drivers within SUDSWP and the other infrastructure initiatives such as green infrastructure and flooding agendas.

Solution: SUDSWP - Develop a shared source control SUDS agenda or strategic plan. This will consist of guiding principles, goals and short-term targets which provide direction for addressing barriers defined throughout this study. The transition agenda or strategic plan will facilitate realisation of the shared long-term vision of increasing the uptake across Scotland of source control SUDS using the opportunities and toolkit identified in Phases One and Two and incorporated into the vision.

Barrier3: Statutory responsibilities and remits that encompass SUDS. Scotland has a good legislative and regulatory regime. All public bodies in Scotland have a remit to encourage implementation of SUDS in new or re-developments however statutory remits regarding enforcement and inspection programmes in accordance with approved designs are poor. This is a governance issue which is currently being overlooked in Scotland by several responsible

organisations. Enforcement and inspection regimes would also significantly address performance (quality control) issues.

Solution: All public Bodies and Scottish Government - Develop and implement inspection and enforcement policies with targets in line with SUDS remits. In parallel with, and informed by a fixed term Scottish Government project recommended below (see monitoring and evaluation), all public bodies with statutory responsibilities and remits that encompass SUDS should also be encouraged to develop and implement inspection and enforcement policies in line with their specific SUDS remits, as follows:

- **Planning Authorities** – for a sample of approved developments every year, inspect and report on the establishment of features specified in the planning consent. Report also on amenity and compliance with other aspects of SUDS largely out with the remit of the organisations below.
- **Roads Authorities** – ensure policies require assessment of SUDS in the roads appraisal prior to adoption. Report findings.
- **Local Authority Building Standards** - ensure policies require assessment of SUDS in the percentage of developments subject to inspection each year. Report findings.
- **Scottish Water** – continue to undertake pre-adoption inspections and report annually on findings. Report annually on inspections of vested SUDS (all 'public SUDS' as defined in the WEWS Act 2003 in new developments).
- **SEPA (Environmental Regulation)** – inspect a percentage or target a minimum number of SUDS facilities established for new developments each year. Each SEPA pollution control team should have a target number of inspections, but catchments at risk of ecological status failures associated with planned urbanisation will require a greater degree of inspection of the SUDS measures designed to prevent that (i.e. risk based effort).
- **All above (Local Authorities, Scottish Water and SEPA)** should report annually on SUDS in relation to their duties under the Nature Conservation (Scotland) Act 2004.
- **Scottish Government Building Standards Division** – ensure statutory duties are not ignored. Using the SUDS Inspection Panel findings arising from the Scottish Government project recommended below (see monitoring and evaluation), further encourage Local Authority Building Standards and other departments to take a more active role in monitoring the design and development phases by following up with sign-off / inspection programmes.

Barrier4: No Section 7 Agreements in Scotland to date. Section 7 agreements provide an opportunity to bring stakeholders together. Sharing roads and residential drainage responsibilities is particularly beneficial when implementing source control SUDS in regeneration areas which has been identified as an opportunity category in the Phase One report. The main issue with Section 7 agreements is cost allocation between fragmented institutional arrangements reported in Phase 2 of this study: as it is generally feared that costs will be unfairly distributed amongst stakeholders.

Solution: Local Authorities, Scottish Water, Scottish Government - Encourage the progression to completion of Section 7 Agreements. Several Section 7 Memorandums are in existence (Glasgow and West Lothian Councils with Dundee City Council Section 7 Agreement in progress). A timescale should be agreed for the process with fines set (by Scottish Government) if an arbitration process is required. Showcase the agreements which should document the process – why and how the agreement was achieved. This will encourage and provide confidence in the mechanism and speed up agreements in other areas of Scotland.

Barrier5: Explore the option for future amendments to building regulation standards and planning guidance. The findings from the SUDSWP workshop and the surveys indicated that updated building regulations and planning guidance was required to drive forward the uptake of source control. In particular 'unit plot' at the source control level is not an established term in planning guidance. This would support and encourage implementation of source control SUDS which was identified as an opportunity in the Phase One review and implementation of Phase Three strategic level shared vision.

Solution: Scottish Government - establish "unit plot SUDS" as a recognised term in planning guidance. Members of SUDSWP should consider organising discussions and meetings with appropriate Scottish Government departments to take this agenda forward.

3.2.3 Transition Experiments – Research and Case Studies

Following the Phase 2 source control global delivery literature review it was evident that all countries had established good research partnerships and documented findings to further the source control SUDS agenda.

Barrier6: Research Partnerships and case studies. Phase One identified that at the beginning of the SUDS journey Scotland benefitted from such a well-established stakeholder / academic partnership in the form of the Scottish Universities SUDS monitoring project. Phase 2 identified emerging source control techniques and proprietary products which are now in existence in other countries but are not implemented in Scotland. Phase 3 identified that there is a lack of confidence in these emerging technologies as they have not yet been validated as appropriate for the local (Scottish / UK) climate.

Solution: Scottish Government, SUDSWP - Encourage / re-establish research partnerships to validate emerging source control techniques which meet the aspirations and needs of dense developments and retrofit situations. Assess a selection of source control systems which are mainstream in other countries but not in Scotland, as they are implemented, as undertaken at the outset of SUDSWP and the parallel Scottish Universities SUDS Monitoring Project. These findings could feed into revised guidelines and delivery of case studies. The following represents several examples of research currently underway in Scotland to demonstrate feasibility and appropriateness or optimal application for emerging and proprietary source control techniques:

- **Arborflow (SUDS tree pit).** Greenleaf in conjunction with Dundee City Council and Abertay University are undertaking research on the first novel proprietary source control solution which integrates SUDS and green infrastructure. Arborflow is designed for use in urban areas where space is a premium and also realises new national open space regulations. Key benefits include: additional stormwater storage as the tree matures; downstream SUDS footprint reduction; reduced pumping and treatment costs in combined sewer areas. The project investigates water quality, hydrology, and tree growth (Duffy *et al*. 2012b).
- **Experimental study on hydrological performance of a permeable pavement.** Heriot-Watt University laboratory based study funded by the EU investigating permeable pavement performance. The key benefit of the system is the amount of water stored during and released after a storm. Performance parameters investigated include hydrology and runoff percolation rates during a range of rainfall events.
- **CREW 2012/1: Critically review methodologies to identify sources and pathways for urban diffuse pollution and identify measures/treatments with multiple benefits.** A consortium of researchers, commissioned by CREW and led by Abertay University has completed a study into urban diffuse pollution and the multiple benefits that can be gained from mitigation measures. A decision support

tool has been developed and study findings relating can be used in conjunction with this research (Wade *et al*. 2013).

- **Delivering and Evaluating Multiple Flood Risk Benefits in Blue-Green Cities.** Heriot Watt University as part of an EPSRC funding initiative are investigating the functions and dynamics of SUDS and urban watercourses, focusing on debris and sediment transport. SUDS, as part of Blue-Green networks, have the potential to influence flood control, water quality, public amenity and safety within the local urban environment. The project team are currently monitoring SUDS at the JM48 motorway service area.
- **Glasgow City Centre SWMP**. MWH Global and Abertay University have recently delivered a surface water management plan (SWMP) for Glasgow City Centre to safeguard long-term development aspirations. The SWMP funded by Glasgow City Council will fulfil a number of objectives of the Metropolitan Glasgow Strategic Drainage Plan (MGSDP). Source control, including novel systems such as 'rain ladders' in locations with steep gradients are identified as key solutions.

3.2.4 Monitoring and Evaluation – Quality Control, CREW Study and Capacity Building

A quality control issue highlighted by SUDSWP is that many constructed SUDS may not be deemed fit for purpose (SUDSWP 2013). This appears to be backed up by findings from the surveys. A recent Knowledge Transfer Partnership between Scottish Water and Abertay University highlighted that 80% of residential SUDS (site and regional controls) were not performing as per design standards due to poor construction and maintenance regimes. Scottish Water has recently put practices in place to safeguard quality implementation for residential SUDS (ponds and basins) according to their standards (Duffy *et al.* 2012). Lessons could be learned from this process. A very recent survey by Hydro International: SUDS in Scotland – Experience and Opportunity (November 2013) highlighted that 98% of respondents believed that although Scotland were successful in SUDS implementation, quality and optimal use of SUDS in the ground was questionable "***I think Scotland is ahead but I am not seeing quality SUDS appropriate to place coming through yet***". Overall, this indicates a need to provide the evidence base for the current state of play for all SUDS (not just source control) in Scotland.

Phases One and Two from this research are the beginning of process documentation for the implementation of source control SUDS. They outline the historical and current reasons as to why and how the change happened to enable the recommendations for this strategic directions report. There is however no baseline data available for the current situation regarding the uptake of source control SUDS. The last audit undertaken to gain an insight into the numbers of SUDS (which included source control) in Scotland was in 2002 (Wild *et al.* 2002).

Capacity building in the form of guidance manuals, dissemination of knowledge, sector engagement and educational programmes is important for all water users including the public, decision makers and the media in order to embed new concepts (Pagelar, 2009; Duffy et al., 2010). This helps mitigate resistance to switching to more innovative urban water practices such as rain gardens and green roofs. It will also help to overcome issues relating to institutional and technological lock-in (Heslop and Dixon 2008) which this study has identified as a potential scenario for the implementation of source control SUDS.

Barrier7: Process Documents. The first two phases of this study has provided SUDSWP with process documentation regarding the historical enabling and disabling factors and potential opportunities for furthering the implementation of source control. This final phase of the study has provided solutions and recommendations with timescales for moving forwards by responsible bodies.

Solution: SUDSWP - Continue to document the process of change. Periodic review of process documents will ensure that the desired direction continues to reflect changing circumstances as new knowledge becomes available. Undertaking solutions to barriers three and eight (statutory remits / enforcement and quality control / performance issues) will be an important element of process documentation. Determining the existing situation and potential extent of problems related to poorly performing SUDS will provide key information which will assist in guiding and potentially re-adjusting the vision and strategic planning processes. In this regard effective enforcement regimes by responsible bodies and a national SUDS inspection panel are essential.

Barrier8: Performance of source control SUDS. If fundamental changes in the way not just source control but SUDS in general are regulated and enforced then the evidence base must be provided through an audit of existing / established systems. There are primarily two aspects to quality control: suitability of designs; and construction standards. Unit plot and local roads source control SUDS come under the domain of building regulation and local authority planning departments.

Solution: Scottish Government – Encourage the development of asset registers and provision of the performance evidence base. Encourage the establishment of a national SUDS project in recognition of Hydro Nation aspirations and new flood prevention and management requirements which will add a new impetus to the provision of SUDS. A national inspection programme, with detailed development of asset register databases in example pilot local authority areas, would be a significant step forward and is strongly recommended. A short-term (2-5 yrs) SUDS Inspection Programme for existing source control would provide the evidence base against which future actions and improvements can be measured.

Consider assembling a SUDS Inspection Panel (SIP) to inspect and report on SUDS performance across Scotland. The SIP should include individuals who represent all major stakeholders with large assets, legislative bodies, consultants and contractors. Essentially these would be members of SUDSWP with a focus on site inspection, audit and reporting. Working together this group, supported and led by academia (independent), should visit a range of ten to twenty SUDS a year, table an annual findings report, and present to the SUDSWP for action. They would need to seek a mandate, develop guidelines for inspection, and conduct a risk assessment to evaluate appropriate locations. There should be a "no implied criticism mandate" on projects reviewed, while at the same time making useful deductions and recommendations for improvements based on findings. Objectives of the panel would be to investigate performance of a range of SUDS across the stormwater treatment train and provide the evidence base for under-performance if this is the case: i.e. existing situation and extent of the problem. Ideally, this should include hydrological and water quality monitoring alongside technical inspections to validate as-built systems with design details and track maintenance costs where possible.

Barrier9: Capacity Building / Guidance. The findings from surveys and interviews undertaken for this work indicated a need for source control guidance for planners, developers and consultants in Scotland.

Solution: Scottish Government - Review existing guidance based on findings from Scottish pilot case studies and / or using examples from other countries where the techniques have been validated and are now business as usual. The Phase 2 mini-case studies provide several international best practice examples. This report also highlighted issues regarding planning constraints in the UK such as using source control close to buildings which impacts on the implementation of techniques such as rain gardens at the unit plot level. New information is now available regarding this issue (see

Wilson 2012 and EPG *et al.* 2013). Guidance should include: simple terminology; source control definition; clarification of levels of treatment; stormwater treatment train and distributed functionality across a development; different aspirations for combined sewer catchments in comparison with separately sewered ones; exemplification of applications particularly emerging techniques in various types of development; clarity regarding shared source control SUDS features and unit plot measures. Minimum standards should be developed which would be deemed to meet planning and building standards. Any solutions which did not meet these standards would need to be supported by significant performance and maintenance detail.

Barrier10: Capacity Building / Education and Sector Engagement. According to the survey and workshop findings there are limited published best practice Scottish case studies which validate and subsequently provide confidence in the techniques, particularly for application of the more innovative techniques at the unit plot level. Perceptions surrounding costs to construct and maintain source control SUDS were also cited as a barrier. Information and tools are now available as mentioned previously in this report however best practice case studies which provide this information in Scotland are limited. If source control SUDS were to become more common / mandatory then public sector education / awareness raising regarding responsibilities (long-term maintenance practices) would be required.

Solution: SUDSWP - Explore opportunities to promote positive messages and encourage dissemination of information to inform stakeholders, developers, existing (and future) practitioners, and the community at large about the benefits of installing all levels of treatment correctly and managed effectively. It is strongly advised that robust Scottish based best practice case studies are developed which highlight the options for different land use types (residential, roads, industrial etc.) and minimal maintenance regimes. This will be valuable in demonstrating what can be done in Scotland. Consider co-organising conferences and partnering other organisations in their events (e.g. CREW, SNIFFER, Scottish Hydraulics Study Group, SUDSNet, CIWEM Scottish Branch). Bring local and international case studies of long-established sites to the attention of members and a wider stakeholder audience. Collaboration with Universities should be encouraged: many Scottish Universities now deliver modules which include SUDS. Abertay University provides SUDS online training for professionals. Explore opportunities for a broad sector and public awareness raising campaigns to fit with the need for flood asset registers and provision of source control SUDS. Consider the Melbourne Water "10,000 Raingardens – be a part of protecting your water environment" initiative as a practical option for Scotland.

4.0 NEXT STEPS STRATEGIC DIRECTIONS AND RECOMMENDATIONS

Findings from the three phases of this study identified a number of potential strategies and a variety of actions at the strategic, tactical and operational levels. These findings and actions have subsequently been reviewed and agreed by SUDSWP as a way forward to encourage the scaling-up of source control techniques in Scotland in order to progress the SUDS journey. Strategic directions recommendations and priorities for the next steps include:

Strategic Level (strategic discussions, goal setting, long term shared vision)

- Engage with influential responsible players at the national, catchment and local level with a stake in source control SUDS. Strengthen links to assist in the delivery of a more integrated vision and alignment of other infrastructure initiatives and funding avenues.
- Develop a baseline assessment to provide an overview of source control uptake.

- Develop an integrated high level vision which focuses on the opportunities for implementing the source control toolkit: unit plot, local roads and retrofit / regeneration areas.
- Review individual organisational aspirations, particularly needs and priorities. Co-ordinate fragmented agendas and drivers. Agree a co-developed strategic plan which defines the next steps and encourages cross-disciplinary roles.
- Address quality control issues by instigating an inspection and monitoring programme against which future actions and improvements can be measured for source control SUDS.

Tactical Level (strategic planning, policies, inter-institutional networking, financing)

- Lobby support with members to consider amendments to building regulation standards and planning guidance for source control SUDS at the unit plot level.
- Develop guidance which clarifies the treatment train concept and validates different source control measures (particularly emerging and proprietary techniques) for different land uses.
- Encourage capacity building programmes amongst professionals and disseminate findings to deliver clarity and empower implementers, owners and operators. This helps mitigate resistance to new ideas and will help to overcome institutional and technological lock-in issues.

Operational Level (short-term actions such as new practices and research)

- Define and co-ordinate projects to address barriers and explore opportunities. Translate findings into policies and guidance.
- Encourage sector engagement for increasing the acceptance of source control SUDS. Examples which could usefully be replicated in Scotland were provided in phase two of this research.

A final recommendation is to organise a high level meeting with SUDSWP, Government including CREW and a small number of other influential stakeholders to discuss the findings from this research and consider how to fund and actively drive the source control SUDS agenda forward.

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CREW Facilitation Team

James Hutton Institute
Craigiebuckler
Aberdeen AB15 8QH
Scotland UK
Tel: +44 (0) 844 928 5428

Email: enquiries@crew.ac.uk

www.crew.ac.uk

The James Hutton Institute

crew
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