SuDS asset register and mapping

Review of current status and recommendations

MAR5930-RT001-R04-00

February 2019

Document information

Document permissions	Confidential – client
Project number	MAR5930
Project name	SuDS asset register and mapping
Report title	Review of current status and recommendations
Report number	RT001
Release number	R04-00
Report date	February 2019
Client	Water UK
Client representative	Brian Smith / Phil Reaney
Project manager	Bridget Woods Ballard
Project director	Richard Kellagher

Document authorisation

Prepared	Approved	Authorised

Document history

Date	Release	Prepared	Approved	Authorised	Notes
01 Feb 2019	04-00	RBBK	BAW	BAW	
29 Jan 2019	03-00	RBBK	BAW	BAW	
21 Dec 2018	02-00	RBBK	BAW	BAW	
07 Sep 2018	01-00	RBBK	BAW	BAW	Unauthorised release

Summary

This project started as an UKWIR research project on SuDS symbols and data model in 2015 which had to be stopped prior to completion. The objectives of this Water UK project reflect those set for the UKWIR project in:

- Defining the data model and the data attributes that should be stored for recording SuDS information which ensures all relevant information can be provided to all UK stakeholders; and
- Considering the representation of SuDS on drainage mapping and sewer plans.

This project also considers any significant changes in SuDS policy and practice that have occurred since 2015.

This project has been primarily driven by the need to provide Sewerage Undertakers (SUs) with the information to enable a consistent industry wide approach for the recording of SuDS as part of their asset data information. However there are many other organisations who own their own drainage systems which will include SuDS units (examples include Highways Authorities, Highways England (HE), SABs in Wales and others), as well as organisations who have interest in drainage details even if they do not own them (LLFAs, Environment Agency etc.). The need to collect, record and share data for drainage assets was a recommendation of the Pitt Review in 2008 and was accepted in the Government's response to that review (Defra, 2008). It was carried through into the Flood and Water Management Act, 2010, and is one of the key commitments set out in the document 'Surface Water Management: An Action Plan' (Defra, 2018). Progress, however, has been limited (Committee on Climate Change, 2018), due to the lack of capacity and resources in local authorities and the lack of statutory responsibilities for SuDS adoption. The objective is therefore to provide a generic approach which can be applied across the UK that is flexible enough to fit in with current practices carried out by all organisations.

This report reviews and summarises the original UKWIR project work, considers any relevant new information or activities that have happened since 2015 and provides detailed proposals for meeting the objectives of the project. Recommendations have been specifically made on:

- The referencing of SuDS assets based on a variation of using STC25 for minimising changes to the water industry, and in particular sewerage undertaker practice;
- Symbols for representation of SuDS on sewer maps;
- The data model schema for storing data and transferring SuDS data between stakeholders;
- The SuDS attribute information that should be recorded;
- An implementation strategy for effective take up of recording of SuDS assets;
- The benefits of having a web-based data portal tool to facilitate data collection.

Consultative questionnaires were issued and followed up by a workshop held in London. Presentations were made on the recommended approach in dealing with the collection of SuDS assets and related issues with discussion taking place on every aspect. This report takes all the feedback into consideration and presents all the information, conclusions and recommendations for achieving effective SuDS data collection in the future.

Conclusions and Recommendations

SuDS ownership

A sewer for Adoption 8 (pre-implementation version - Water UK, 2018) provides the mechanisms by which sewerage undertakers (SUs) can secure the adoption of a wide range of SuDS components. However it may not mean that SUs become the default adopting body for all SuDS for the following reasons:

- The most cost effective drainage design may include non-adoptable SuDS (e.g. pervious pavements);
- Drainage designs that combine the management of highway runoff and runoff from other impervious surfaces may not be adoptable by SUs, but may be the most efficient in terms of space for a development;
- Drainage designs that deliver high value landscaping and environmental benefits (but which may mean they are considered to receive land drainage) may not be adoptable by SUs;
- If some SuDS components are not adoptable by SUs, then it may be more cost-effective for a developer to transfer the entire system to a management company for adoption or long-term management;
- Some developers may consider that specific management companies are more suited to deliver high value landscape management (that promotes the image of the developer) than SUs and therefore may elect not to request SU adoption of SuDS assets.

Therefore the proliferation of SuDS adoption bodies and the associated need for collecting and sharing consistent datasets between stakeholders is likely to remain.

SuDS mapping symbols

It is recommended that a limited set of simple symbols should be used for mapping SuDS components and this report does not therefore recommend a specific detailed set of images. All that needs to be achieved is to differentiate SuDS drainage assets from other assets already shown on sewer mapping.

SuDS mapped as Nodes

To help keep asset records in line with current SU methods and to ensure simplicity of approach, it is recommended that all SuDS are treated as nodes (rather than links) despite the fact that in many cases SuDS components will also convey flows.

SuDS asset referencing

Sewerage undertakers and Highways England both use versions of STC25 for referencing drainage assets. This will not change and therefore any pre-adoption asset referencing probably needs to be seen as an initial reference which will be over-written by some adopting organisations. Recommendations have therefore been made for two alternatives for initial referencing; a variation of STC25 and a method based on the development and type of drainage asset.

SuDS data attributes

To get a complete understanding of all drainage attributes of SuDS components (i.e. that defines their physical characteristics, hydraulic and water quality functionality, and environmental attributes) requires a considerable amount of data and much of this has been detailed in the report. Due to the need to limit the burden on those providing (or updating) data, a minimum dataset that enables the hydraulic behaviour of the SuDS unit to be understood is recommended.

SuDS data model and transfer

There is little need for a complex data model to be defined (as it is likely that each SU will develop code to extract and format the relevant datasets they require for their internal asset management, mapping and modelling systems). A simple approach to recording data is therefore recommended that incorporates spatial information, numeric and descriptive text.

An XML data transfer based protocol is proposed for ensuring ease of communication between stakeholders.

Implementation of SuDS data recording

The recording of a consistent set of data for all SuDS assets should be a mandatory requirement as a condition of planning. This would benefit from the support (in policy) from central government for the above requirements as well as agreement between all the main stakeholders with an interest in either planning or the ownership of drainage systems. Urgent action is required to manage the current risks associated with an incomplete and inadequate record of surface water management assets.

The development of a web based tool to facilitate the input of consistent data information is also recommended.

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1. Introduction

This work has been undertaken by HR Wallingford for Water UK. It completes and extends a project which started originally as an UKWIR research project in 2015. The objectives of the project are:

- To define a standard data model for the recording and storage of SuDS asset data to facilitate data sharing between UK stakeholders;
- To consider the representation of SuDS on sewer plans;
- To consult with stakeholders; and
- To report on the findings.

Although this study was commissioned by organisations which represent Sewerage Undertakers (via Water UK and previously UKWIR), the objectives of this study are to consider the universal countrywide requirements for collecting and recording SuDS information - not just limiting it to its application to Sewerage Undertakers. However representation on mapping and referencing is focused specifically at Sewerage undertakers and their legal obligations to provide sewerage information, though similar referencing protocols to those used by Sewerage Undertakers are also used by other organisations.

The UKWIR project “SuDS symbology and data model” which began in 2015 was put on hold by UKWIR before it was completed. Following publication of the pre-implementation version of Sewers for Adoption 8 (Water UK, 2018), Water UK identified this work as being of strategic importance and therefore commissioned its completion, taking into account any SuDS related policy and practices that have occurred since 2015.

This report reviews and summarises the original work, considers any relevant new information or activities that have happened since 2015, and provides recommendations for meeting the objectives of the project.

The specific issues addressed in this report are:

- Changes in SuDS policy and practice since 2015 that may impact on the proposed approach;
- The referencing of SuDS assets (i.e. unique asset identification);
- The representation of SuDS on sewer maps;
- The data model schema for recording and transferring SuDS data between stakeholders;
- The content of the SuDS information that should be recorded;
- An implementation strategy for effective take up of recording of SuDS assets; and
- Recommendations for the development of a web-based data portal tool to facilitate the acquisition of data.

2. Stakeholder consultation

Consultation with all potential stakeholder groups involved in the creation, storage and use of SuDS asset data was undertaken using:

a. A suite of questionnaires focussed at the stakeholder groups (local authorities, sewerage undertakers, developers and property management companies);

b. A follow-up workshop (that took place on 13th November 2018.

A summary of the questionnaire responses and a write-up of the discussion at the workshop are included in full as Appendix B. The outcomes and views from these sources have been taken into account in making recommendations in this report.

3. The importance of recording surface water management assets

There is a need to ensure that the UK has a complete inventory of surface water drainage infrastructure into the future, and that details of each of the as-constructed assets and their functionality are available. This aspiration is very much in line with the current drive of the 21st Century project led by Water UK and supported by Defra in providing a national picture of the performance of sewerage systems.

This is of fundamental importance to effective drainage and sewerage asset management because:

- There is no single body responsible for the adoption and management of SuDS, therefore owner records (where these exist) are likely to remain with individual organisations – potentially without assurance that records are retained for the lifetime of the development and without data sharing agreements in place with relevant authorities.
- Sewerage Undertakers are likely to only adopt certain elements of the complete surface water management system with property owners, highway authorities and others adopting upstream, adjacent or downstream components. Without access to complete system information, Sewerage Undertakers and other authorities with drainage responsibilities will not have the ability to understand, predict or evaluate the performance of their adopted assets.
- SuDS can be designed to facilitate the introduction of surface water runoff into the ground via infiltration. This may be an important consideration for the performance of sewers in areas where new development or re-development takes place.
- SuDS may be designed as multi-functional systems e.g. pervious parking or recreational/amenity space; and may be in public or private land. It may not be obvious that they are performing a surface water management function, and there may therefore be a risk that they are subsequently built over or damaged. This could increase flood risk downstream.
- SuDS are designed to capture and retain pollutants. This functionality requires awareness, long-term protection, monitoring and management.
- SuDS are also important green and blue infrastructure assets and can make a significant contribution to natural capital which may be important to evaluate for local authorities.

The benefits to Sewerage Undertakers of access to a complete record of the surface water management system (rather than just their own assets) - including a picture of what runoff does or does not enter the system at different points - allows an effective understanding to be gained of the sewer system performance downstream. A good illustration of Sewerage Undertakers trying to reduce sewer system performance uncertainty when managing conventional sewerage infrastructure is the use of drainage area surveys to assess what proportion of properties are or are not served by soakaways (which are often unknown). Although soakaways are all private drainage systems, an assessment of the level of service provided by downstream sewerage systems can only be determined by making an accurate assessment of the extent of the use of soakaways in individual areas. Knowledge about soakaways is also needed to support reduced billing for customers not directly connected to the surface water drainage network.

Research undertaken by JBA for the Committee on Climate Change, Adaptation Sub-Committee (July, 2018) found that it was not currently possible to compile a set of populated metrics that could be used to measure the progress in management of surface water flood risk because:

- The data is not currently collected; and
- The lack of compatible standards results in an inconsistency in reporting between the various drainage Authorities.

The report concludes that '*there is very little consistent data available at a local level that provides a detailed understanding of the interactions between drainage systems owned and maintained by different authorities and 3rd parties and hence there is not a shared understanding of local flood risk on which to make informed decisions in partnership. This is important because the performance of one part of the drainage network is often dependent on another e.g. water floods from highway gullies because the receiving sewer is at capacity*.'

The report also included the following strategic recommendation: '*organisations need to be clearly tasked with (and if appropriate, funded for) data collection and collating progress on a national level, beyond the mechanisms and metrics that currently exist*'. Securing consistent asset registers would provide important supporting evidence to government adaptation evaluations. It would allow wider evaluations of the contribution SuDS implementation is making to surface water / local / catchment / national flood risk; and would provide key contributory material to water industry or local authority natural capital assessments.

A review of the application and effectiveness of planning policy for Sustainable Drainage Systems published by MHCLG (August 2018) found that it was unclear in 70% of the planning applications that included SuDS as to who was responsible for maintaining the system in the long term. The report acknowledges that this may not necessarily mean that no organisation was taking on the maintenance, but that maintenance responsibility had not been recorded and documents / records on planning websites were incomplete or out of date.

4. Earlier UKWIR project (incomplete, 2015)

The UKWIR project "SuDS symbology and data model" was commissioned in 2015, but the contract was terminated before the work was completed. An interim report was issued in November 2015 which stated what actions had taken place and what had been achieved.

4.1. Brief

The UKWIR project brief was effectively much the same as that required by this project.

4.2. Project activities

The project tasks that were carried out included:

- A review of standards relating to component design and construction;
- A review of symbols used in software for representation of SuDS;
- A review of symbols used for sewer maps;
- A review of SuDS physical and other characteristics required for storing SuDS data.

These are discussed in the following sections.

4.2.1. Standards review

A review was carried out into whether there were standards associated with SuDS component design and construction. There is an extensive amount of literature on the technical aspects of SuDS and guidance documents associated with using them, and there are (currently non-statutory) standards on design criteria for SuDS systems, but there are no formalised design and construction standards for the full suite of SuDS components. Design and construction standards or codes of practice do exist for some standard manufactured drainage products such as rainwater harvesting and oil separators, permeable block pavements and geocellular crate storage systems. Landscape SuDS design is non-prescriptive and schemes are influenced by the specific requirements and arrangements of individual development sites and therefore standards for vegetative SuDS would be difficult to develop.

4.2.2. Software review

The project carried out an extensive review of software packages which include SuDS design and analysis. Meetings were also held with software suppliers.

Two packages stood out in terms of their inclusion of SuDS in 2015; MicroDrainage (XP Solution, now Innovyze) and MUSIC (eWater). In the case of the former the focus is purely hydraulic and representation of their effectiveness for treatment or for time series rainfall in achieving runoff volume loss is minimal. In the case of MUSIC the emphasis is much more on the treatment effectiveness of the drainage components with limited representation of hydraulic functionality.

A package called ‘Storm’ is used by a consultant in Germany which has detailed representation of SuDS units for hydraulic representation which is probably the most detailed of all drainage software, but this is believed to be unavailable commercially.

In addition, there are a few bespoke GIS based SuDS tools in use in the UK. These include the Atkins tool SuDS Studio (not available commercially) which is used to assess SuDS opportunities and resulting benefits across an urban area. Similarly JBA has a tool GisMAPP which is an iOS platform location-aware mapping system that can be used to collect asset data on site as well as guiding asset inspections and to manage health and safety risks during site work.

4.2.3. SuDS symbols

SuDS symbology was reviewed within software, asset management systems, and policy documents. The following was found regarding usage of symbols.

Software symbols

Two popular SuDS modelling software packages (MicroDrainage and MUSIC) use symbols in their packages to represent SuDS components. No other packages have been found which use symbols for SuDS. These use images which assist the user in recognising the SuDS component. MicroDrainage also shows the plan area of certain SuDS elements such as pervious pavements. However these image objects are focused at facilitating the use for modellers rather than providing a generic set of images suitable for use for general sewer mapping.

Asset management system symbols

The municipalities in the USA and elsewhere record SuDS with symbols in their GIS systems. There is no uniformity as to the symbols used and they usually do not relate to the sewer networks if they are connected to them. In many cases there is no explicit connection shown with the piped drainage system.

There are currently no agreed symbols for representing SuDS on sewer plans by UK sewerage undertakers.

Symbols defined in policy documentation

During the period when the UK Government was considering enacting Schedule 3 of the Flood and Water Management Act (2015), a working group which included representatives from Sewerage Undertakers was set up by Defra to look into the subject of SuDS symbols which was issued as an interim output in a document called "Draft Process Guidance for SuDS Approval and Adoption". However it is not clear whether these symbols were being produced for sewer mapping, or for local authority flooding asset registers and SABs. These images did not use imagery of SuDS components in the same way as the modelling tools above, but were aimed at using simplified imagery which was illustrative of the SuDS unit and a reflection of their functional characteristics. This resulted in a large number of suggested symbols. The work was not completed when it became clear that Schedule 3 was not going to be enacted.

The symbols developed under the Defra task group were used as the starting point and progressed further by HR Wallingford in the UKWIR project (2015). The resulting large number of symbols (which are shown in the UKWIR 2015 interim report) were similar to the Defra symbols, but with some significant modifications to reflect certain thematic aspects of SuDS.

However it is now felt that this approach of using a large number of symbols which attempt to capture the various characteristics of SuDS (such as treatment, storage, conveyance, etc.) is not appropriate and modified and simplified proposals are made later in this report.

4.2.4. Recording of SuDS data

Pipe and manhole based networks are recorded as line and node systems with a unique node reference being used for each manhole. SuDS have fundamental differences to pipe and manhole systems in that they have a geo-spatial area extent and are often irregular in shape. The following sections detail the information on SuDS characteristics which were highlighted in the previous study on the particular requirements for the recording and representation of SuDS and showing them on sewer plans.

SuDS are generally surface-based systems

This means:

- They have a plan area (and depth) that may be irregular in extent;
- They may have multi-functionality (e.g. car park or public open space as well as a drainage system) Note: this highlights the importance of comprehensive records in order that the drainage functionality is maintained effectively;
- They can contribute runoff to the system as well as manage runoff (e.g. green roofs and pervious pavements).

SuDS components have a wide range of performance functionality

SuDS schemes comprise a mix of component types including:

- Multiple inlets (e.g. continuous edge inflow, pipes and structures);
- Multiple inlets (e.g. complex outlet structure, weir);
- Conveyance (e.g. piped, surface flow, flow through media);

- Storage (e.g. open surface storage, storage within media, closed subsurface storage);
- Treatment (e.g. sedimentation, adsorption, volatilisation).

Each of these aspects of a SuDS unit will define the behaviour of the system.

SuDS components have a wide range of characteristics

No SuDS scheme will be the same and designs can use a wide range of design features and materials. A comprehensive definition of a component's characteristics may require an extensive number of attributes to be recorded. Fortunately GIS package capabilities are such that this does not present a problem. However, the process of collating such data in a consistent manner poses challenges for the industry in terms of commitment to provide all the relevant information.

4.2.5. Data model

As with any drainage asset information system, a SuDS asset 'model' has to address various aspects to ensure its effective use (Figure 4.1).

Although there are many organisations using GIS systems and databases for recording some SuDS information, there is no SuDS data model in existence which defines the approach for recording and sharing SuDS system data. A draft outline of a data model was produced by the UKWIR 2015 study.

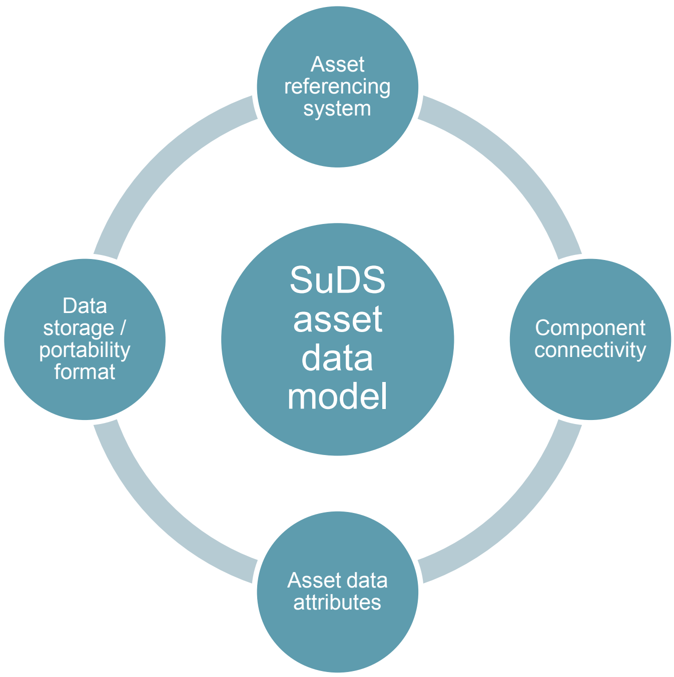

Figure 4.1: Conceptualised model of the requirements of SuDS assets recording system

5. Evolution of SuDS policy and practice (2015-2018)

Drainage is an area where responsibility is devolved across a number of organisations and between the different countries. This means that each country in the United Kingdom has to be referred to in discussing the current approach taken with respect to SuDS policy and practice.

5.1. England

In England:

- SuDS are only required for developments greater than 10 properties (NPPF, MHCLG 2018b).
- The non-statutory SuDS standards are limited to designing for hydraulic control of surface water runoff for extreme events only (Defra, 2015).
- Sewers for Adoption v8 is to be formalised in 2019 which will allow Sewerage Undertakers to adopt types of SuDS that comply with the definition of a sewer.
- There is still a right to connect to the sewer system for any development.
- SuDS not adopted by Sewerage Undertakers will need to be owned and managed either by local authorities (via their highways or public open space functions) or, more commonly, management companies set up for that purpose as there is no legislation in place for the statutory adoption of SuDS. These organisations do not have the same obligations as the Sewerage Undertakers for recording asset information and providing access to this information to the public.
- The Government's 25 year Environment Plan (2018) pledges to clarify SuDS maintenance requirements.
- The Government's Surface Water Management Action Plan (Defra, 2018) makes repeated reference to the need for asset registers for drainage systems.

5.1.1. Policy

Government policy in England includes plans to build a million new homes by 2020. National planning policy supports the use of sustainable drainage systems (SuDS) as a method for reducing flood risk from new development as well as for delivering a range of other benefits. As Schedule 3 of the Flood and Water Management Act 2010 was not implemented; so the NPPF has been used as a mechanism for defining SuDS requirements and approval of SuDS and is the responsibility of the Local Planning Authority via the planning approval process. As part of this process there is a requirement for the developer to arrange viable long-term maintenance of the system. The current policy position on the use of SuDS is that:

- Developments of fewer than 10 properties are not required to include SuDS, but larger developments should use SuDS wherever possible;
- Developers can invoke 'cost' or 'practicality' opt-outs in planning rules as a reason for not implementing SuDS;
- Developers retain an automatic right to connect surface water run-off to Sewerage Undertaker sewers;
- There are no statutory design standards for SuDS;
- There is no formal framework for system ownership and long-term funding of maintenance.

Following a written Ministerial Statement on 6 April 2015, local planning policy and decisions on major developments (10 dwellings or more, or equivalent non-residential or mixed development) are expected to ensure that sustainable drainage systems for the management of run-off are put in place, unless demonstrated to be inappropriate. 'Strengthening' of the NPPF at the same time included the amendment of National Planning Practice Guidance to make the implementation of SuDS (for major developments) a material planning consideration requiring approval by the local planning authority (with support from the LLFA); and the publication by Defra of non-statutory technical standards for the design, maintenance and operation of SuDS to drain surface water against which drainage design applications should be assessed. The non-statutory standards cover a limited suite of design requirements related to hydraulic performance of the drainage system for flood control, but planning authorities can require water quality, amenity and biodiversity benefits as part of supplementary planning conditions. In practice the 10 properties threshold is not applied and SuDS is universally requested by most LPAs.

Developers have the option of either entering into adoption agreements with local authorities or Sewerage Undertakers, or handing them over to management companies. This last option often involves the creation of such companies by developers and the need to have contracts with residents of the development to ensure funding of these companies. With no commissioning requirements, no oversight enforcement body and no publically accountable statutory maintenance bodies, risks to long term operation of these systems include:

- Management companies abnegating their responsibilities in the longer term;
- No requirement for asset records to be maintained and shared;
- No obligatory access for homeowners, or public bodies to data on surface water drainage assets and their functionality;
- The freehold of the land on which the SuDS lie not being transferred to the adoption body, meaning that ensuring right to access and maintain the system in perpetuity is a potential problem.

More recent changes that have occurred include the following:

- A requirement for sustainable drainage systems to be included in all new developments and removal of the automatic right to connect to existing drainage systems were two of several amendments deleted from the final version of the Housing and Planning Bill (May, 2018). The amendments were withdrawn following a government pledge to carry out a review of existing planning policy related to flooding.
- The Government's 25 year Environment Plan (Defra, 2018b) pledges to clarify SuDS maintenance responsibilities and enhance links with water quality management and biodiversity delivery through future changes to planning guidance and policy.
- The Government's Surface Water Management Action Plan (Defra, 2018) makes frequent reference to asset registers for data and ownership of drainage systems and the need for Sewerage Undertakers and LLFAs to coordinate on this.

5.1.2. Guidance

LASOO (the Local Authority SuDS Officer Organisation) published 'practice guidance (2015)' to support stakeholders in delivering the non-statutory SuDS standards This guidance is largely in line with the principles of best practice although there are caveats which weaken the requirements for good practice SuDS design on the basis of limiting development construction costs.

The revised SuDS Manual was published in 2015 (CIRIA, 2015). This is considered to be a comprehensive statement of SuDS design and construction best practice, and is referenced by all recent SuDS policy and practice documents.

In 2018 the ICE, with the support of ACO, produced SuDS route maps as a “Guide to Effective Surface Water Management”. This guide was produced by the ICE SuDS Task Group with the objective of getting SuDS more widely built and adopted.

5.1.3. Adoption

Sewers are designed to industry standards (Sewers for Adoption, WRc) and then offered to the Sewerage Undertaker for adoption and maintenance under Section 104 of the Water Industry Act (WIA) 1991, subject to the payment of fees and charges. Highway gullies and associated drainage are designed to agreed standards with the local Highways Authority and then offered for adoption under Section 38 of the Highways Act 1980, and may require a commuted sum payment for exceptional future costs.

There has been debate amongst water companies regarding whether the statutory definition of a sewer allowed them to build and adopt any type of SuDS as assets. A position statement “Interim Code of Practice for sustainable drainage systems” was produced with CIRIA in 2004 which effectively stated that water companies were in favour of SuDS, but could not adopt them largely because OFWAT would not accord them as being drainage assets.

However work has been on-going by the water industry since then and this has resulted recently in a Water UK initiative which has led to the production of a pre-implementation version of the 8th edition of ‘Sewers for Adoption’ (2018) with the expectation that the document will come into effect in mid 2019 as part of the implementation of the OFWAT Code on Adoption Agreements. The Sewers for Adoption version 8 (2018) document sets out detailed guidance by water companies in England to developers as to which SuDS can be seen as being compliant with the legal definition of a sewer and can be adopted by water companies. A major breakthrough was in the acceptance that infiltration to ground could be considered as an acceptable outfall. Nevertheless there are still a number of constraints which may limit the types of SuDS that can be considered for adoption. One of these is the consideration of the proportion of highway runoff drained by a SuDS (more than 50% contribution may not be adoptable), while another is whether or not the SuDS component is considered to accept ‘land drainage’ (which would not be adoptable). As highway runoff is likely to often comprise the major proportion of runoff contribution, and as surface based systems necessarily need to accept both pervious and impervious runoff, both considerations may cause a significant obstacle to the adoption of SuDS units by the Sewerage Undertakers.

5.2. Scotland

In Scotland:

- Scottish Water has added swales and piped filter drains in Sewers for Scotland v4 (2019) to as the SuDS that they can adopt (previously limited to ponds and basins).
- The hydraulic and water quality design criteria for drainage systems are set out in the Water Assessment and Drainage Assessment Guide (Scottish SuDS Working Party, 2016).

5.2.1. Policy

In Scotland, the Water Environment (Controlled Activities) Regulations have required SuDS for new developments since 2006, and SuDS are routinely installed in new developments. Requirements for water quality treatment are established in the Controlled Activity Regulations. Hydraulic design criteria are non-statutory and established in guidance.

Under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 it is a general* requirement for new developments with surface water drainage systems discharging to the water environment that such discharges will pass through SuDS to get some degree of treatment. All reasonable steps must be taken to ensure protection of the water environment.

* Two exceptions exist to this requirement:

- Where the development is only a single dwelling;
- Where the discharge is directly to coastal waters (this does not including transitional waters).

The Controlled Activities Regulations (CAR) provide regulation for water quality treatment under general binding rules (GBRs) 10 and 11 for SuDS.

5.2.2. Guidance

The Water Assessment and Drainage Assessment Guide was published by the SuDS Scottish Working Party (2016) setting out best practice with respect to water supply and surface water management for new development.

5.2.3. Adoption

Scottish Water has a statutory duty to dispose of waste water. It also has an obligation to accept surface water discharges from drainage systems (e.g. those serving residential properties), although it sets conditions before agreeing to accept new storm drainage from road surfaces.

The Water Environment and Water Services (Scotland) Act 2003 ("the WEWS Act") in its Part 2 introduced new provisions into the Water (Scotland) Act 1980 ("the 1980 Act") and the Sewerage (Scotland) Act 1968 ("the 1968 Act"). The amending provisions deal with construction standards and vesting conditions for the adoption by Scottish Water of privately constructed water or sewerage, including SuDS infrastructure.

The roads authority has the responsibility to drain and maintain public roads and other public areas, such as pedestrian and civic realm spaces.

Sewers for Scotland V4 (Scottish Water, 2019) is the current document which defines what Scottish Water is prepared to adopt. In general Scottish Water are prepared to adopt SuDS storage systems (ponds and basins), but this has been extended to swales and piped filter trench systems. Other forms of SuDS have to be adopted by the local authorities or private management companies. This has, in the past, often resulted in designs focused at providing end of pipe storage systems.

5.3. Wales

In Wales:

- The statutory national SuDS standards and associated guidance (Welsh Government, 2018) is in line with best practice as defined in the SuDS Manual (CIRIA, 2015).
- Enactment of Schedule 3 of the Floods and Water Management Act 2010 occurred on 7th January 2019.
- SuDS Approving Bodies (SABs) will be created and all SuDS will be approved and owned by them.

5.3.1. Policy and adoption

The Welsh Government developed and then issued in 2017 (and updated in 2018) "interim non statutory national standards and guidance for the design, construction, operation and maintenance of SuDS serving new developments in urban or rural areas of more than one house or larger than 300m^2 floor space in Wales".

These Standards and the associated guidance are much more detailed than the equivalent issued elsewhere in the UK and are closely aligned with the SuDS Manual in all respects.

The Welsh Government has now implemented Schedule 3 of the Flood and Water Management Act which has included the creation of SuDS Approval Bodies (SABs) within local authorities.

Each SAB is:

- Responsible for the approval of all SuDS schemes within its authoritative boundary;
- A member of the Lead Local Flood Authority.

This is aimed at minimising differences in approach in the adoption and maintenance of SuDS schemes.

The implementation of Schedule 3 results in:

- Statutory National Standards on the design, construction, operation and maintenance of SuDS schemes published by the Welsh Government;
- SABs approving all SuDS schemes against the National Standards;
- SABs adopting and maintaining all approved SuDS schemes.

5.4. Northern Ireland

In Northern Ireland:

- A number of planning policy guidance documents now encourage the use of SuDS.

5.4.1. Policy

The latest policy position with respect to SuDS in Northern Ireland is summarised in the points below:

- The Strategic Planning Policy Statement for Northern Ireland (2015) suggests the planning system should help to mitigate and adapt to climate change by working with natural environmental processes, for example through promoting the development of green infrastructure and the use of SuDS to reduce flood risk and improve water quality.

- Planning Policy Statement 15 (PPS 15) – Planning and Flood Risk sets out the planning policy to minimise flood risk to people, property and the environment. The policy states that 'appropriately scaled and supported SuDS can, in the right circumstances, offer developers the opportunity to proceed with developments which would otherwise be refused because of the increased flood risk they would pose.'
- The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003 provides a legal imperative to consider the introduction of measures such as SuDS and water level control to mitigate against floods.
- The Water and Sewerage Services Act (Northern Ireland) 2016) places a statutory duty on developers to demonstrate that they have considered the use of SuDS before requesting a connection to the public drainage network.
- An addendum has been added to Planning Policy Statement 7 (PPS 7) – Safeguarding the Character of Established Residential Areas. Policy LC 3 encourages the use of permeable paving as a SuDS technique as it can contribute to a reduction in the volume and speed of run-off from new residential developments, in turn reducing flood risk.

5.4.2. Adoption

Northern Ireland (NI) Water can adopt hard components of SuDS and can also require the consideration of SuDS as part of the application to connect to the public sewer network. Developers must also engage with NI Water and enter into an Article 161 agreement to have their infrastructure (potentially including SuDS Systems) adopted by NI Water provided that it conforms to their adoption standards.

Guidance for the construction of sewers is in Sewers for Adoption Northern Ireland, 1st Edition (WRc, 2010). An update is planned for 2018. NI Water offers a Pre-development Enquiry service prior to submitting a formal application.

6. SuDS asset referencing

- There is no existing guidance or agreed method for referencing SuDS systems.
- Sewerage Undertakers and Highways England use a node referencing system referred to as STC25 for their standard drainage systems. The systems now in place are an evolution of the original proposal made in 1980 by the technical committee.
- Other organisations (LLFAs and LPAs) do not have an asset recording system based on this data referencing approach and some have very rudimentary methods or none at all.
- It is considered appropriate to record SuDS as Nodes in keeping with current methods even though they have spatial extents (such as a pond) and may also act as a form of conveyance (such as a swale).
- Any reference given to SuDS structures in a new development by developer / consultant / local authority will inevitably be re-referenced by the adopting organisation to fit with their current referencing system. However an agreed initial form of referencing is still considered useful. There are two recommended options proposed; the second of which is thought to be more universally preferred (based on stakeholder feedback):
  a. Create a version of STC25 which is based on the 1m coordinate location of the drainage unit;
  b. Create a system based on the name of the development, the type of SuDS and a simple numeric count.

6.1. Existing sewer asset referencing systems

STC25 is the referencing convention used for referencing sewer node data (manhole and other ancillary sewer items). It was created from work carried out by the Standing Technical Committee on drainage from their Report No. 25 on Sewer and Water Main Records (STC25, 1980). The current approaches used by most Sewerage Undertakers are fairly similar, but are a significant evolution of the original recommendations. The recommendations were made before the digital age but, although computers enable a much more rigorous approach to be applied, the concept of the original STC25 method tends to continue to be used, albeit with some differences across different water companies.

The STC25 system is both a unique ID and also has an approximate location embedded within the value. It is based on the Ordnance Survey cartographic subdivision across the UK and Ireland which uses an alpha-numeric system. Two letters are used to define the 100km x 100km grid point and then 4 numbers – two for northings followed by two for eastings - define the 1km grid, followed by 2 numbers – 1 for the northing and one for the easting – to give the 100m grid. Within each 100m grid every manhole is allocated a unique identifier, a number from 01 to 99 which is not coordinate related. The identifier number is split into two categories with 01 – 49 being foul drainage while 51 to 99 being reserved for surface water systems. The assumption had been made that there would be less than 50 manholes in any 100m grid for any category of sewer and that in general only manholes needed to be recorded in this way. There is no distinction in the ID reference as to whether the unit is a standard manhole or other drainage feature.

What is shown on any sewer map in terms of asset identifier is the last four values of the manhole ID reference; the first two being the 100m coordinate grid location followed by the two digit number of the manhole. The full reference can be determined by using the full map reference followed by the manhole ID. Figure 6.2 shows a typical sewer map which illustrates this and an explanation of the STC25 Reference is shown in Figure 6.1.

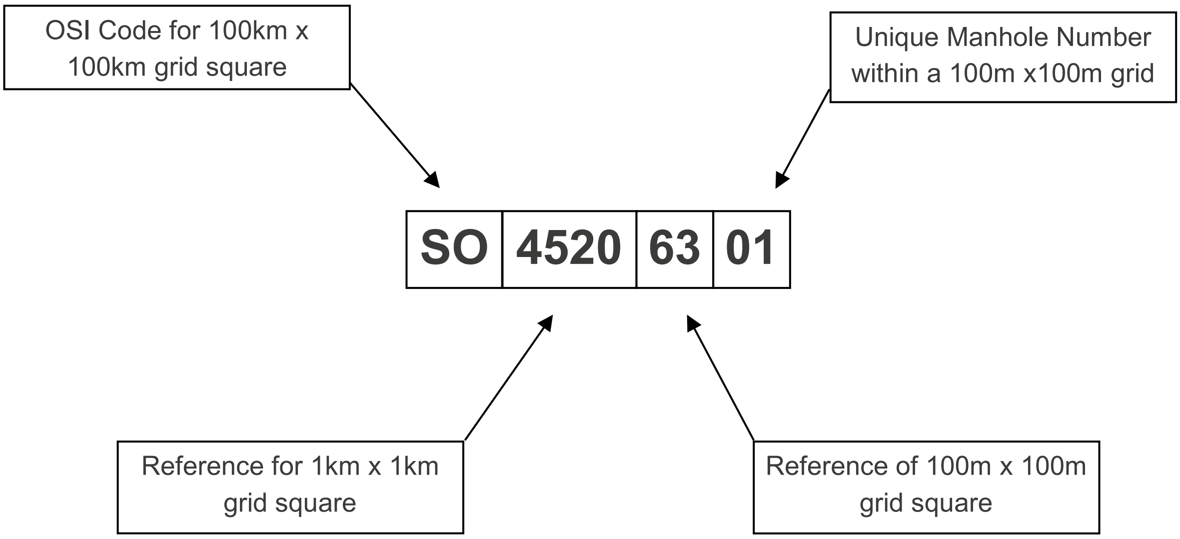

Figure 6.1: STC25 referencing system

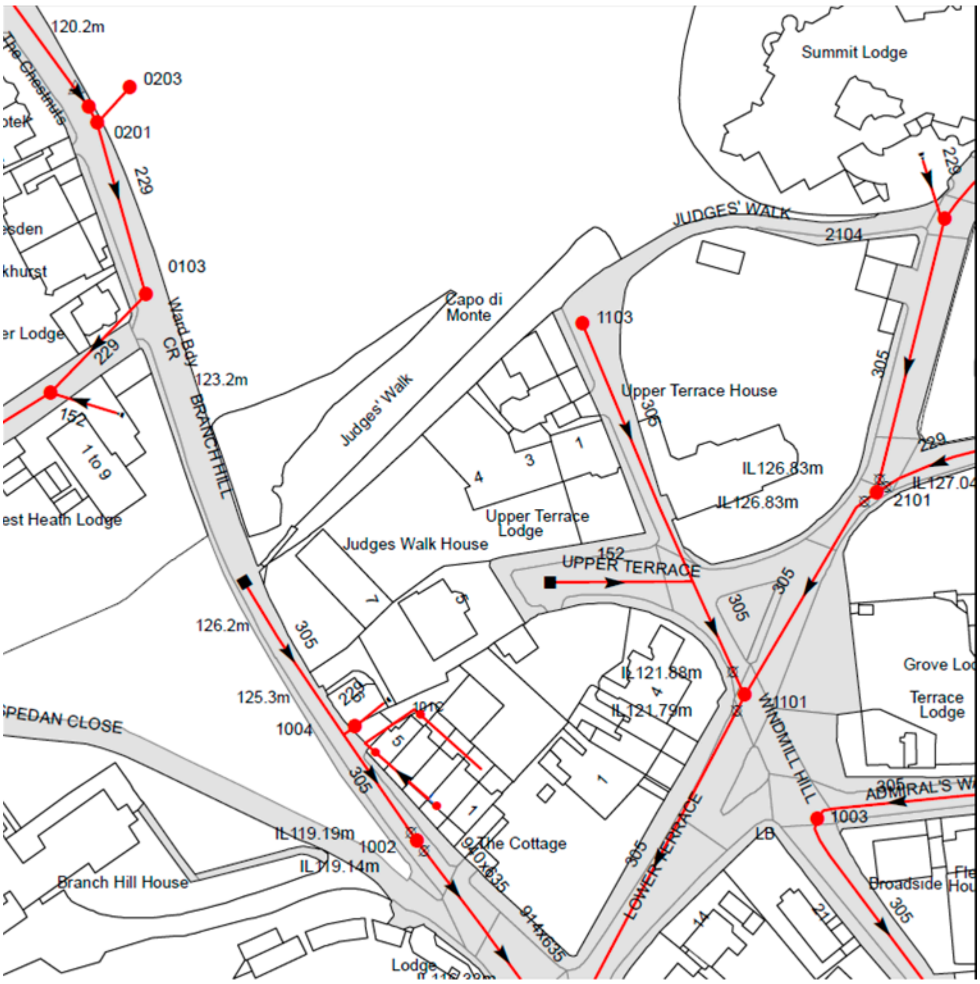

Figure 6.2: Statutory sewer map with manhole STC25 IDs

Figure 6.2 shows that, not only is the manhole referenced, but the pipes between them are shown by a line of a certain colour, line type, length and direction of flow. Sometimes invert levels and pipe sizes are shown, though often these values are missing on the map. Other points of potential interest such as lamp holes at the start of runs are sometimes shown without a reference being allocated, but gullies, private sewer connections etc. do not generally get shown or given references:

There are a range of modifications that have taken place at individual water companies, e.g.:

- each 100m square can be subdivided into four quartiles and referenced as NE, NW, SE and SW to multiply the node numbering options by 4;
- Links are referenced in Scotland based on the manhole reference for the outgoing pipe; it is given the manhole reference followed by X, Y, Z (this is in line with the original STC25 recommendations);
- Non-manhole ancillaries have sometimes been allocated a letter for the penultimate or final digit. Sometimes two alphabetical letters are used such as HD for gullies on a highways system if these are referenced. This provides an indication of the type of asset as well as providing it with a unique ID but limits the number of possible ID references available to each type of asset;
- After 49 and 99, alpha numeric values have been used (0a through to zz) which provides over 1200 potential references for every 100m square area.

All these options have effectively maintained the STC25 concept of the 100m grid system.

The STC25 reference numbering convention started off assuming that only manholes were numbered. Now there are many items that Sewerage Undertakers are interested in recording or may want to include in the future (and thus referencing) which has put further pressure on the numbering system.

It is important to recognise that the majority of referencing systems used do not try to indicate the type of the asset with the ID. Where there is the intention to use the reference as both a unique ID with both the location and the type of the asset, this results in either the ID reference becoming longer, or constrains the number of ID references for any type of asset. If types of asset are to be defined within the reference consistently between water companies then there would need to be agreement on a definitive set of SuDS categories to do this. As SuDS have many variations within a significant number of main categories, there is the potential for the need for a very large number of asset types and corresponding referencing requirements.

Links between nodes are usually referenced with a name derived from the ID of the node upstream and identified by the nodes upstream and downstream. Information relevant to the link is stored as link information.

Highways England (HE) use the same STC25 concept (the approximate location embedded within a unique node ID), but have extended the numbering system to a 10m rather than 100m grid. This ensures that the limitation of 99 unique reference identifiers is no longer an issue. It should be noted that 99 values within a 10m grid is effectively providing a 1m resolution system. Feedback provided by Highways England on referencing of assets and related matters is detailed in Appendix A.

6.2. Asset referencing: recommendations

6.2.1. Option 1 – STC25 based system

Two approaches to future asset referencing for SuDS have been considered.   The first is to move to a wholly coordinate based method to a 1m resolution, but still using the STC25 convention, resulting in an ID for a component which is both unique and location specific. This approach would require a prefix two letters followed by 12 digits (the same as that used by Highways England) rather than 10, and 6 digits to be shown on plans. The only difference to Highways England is that the last four digits would have different values. Figure 6.3 illustrates an option for this.

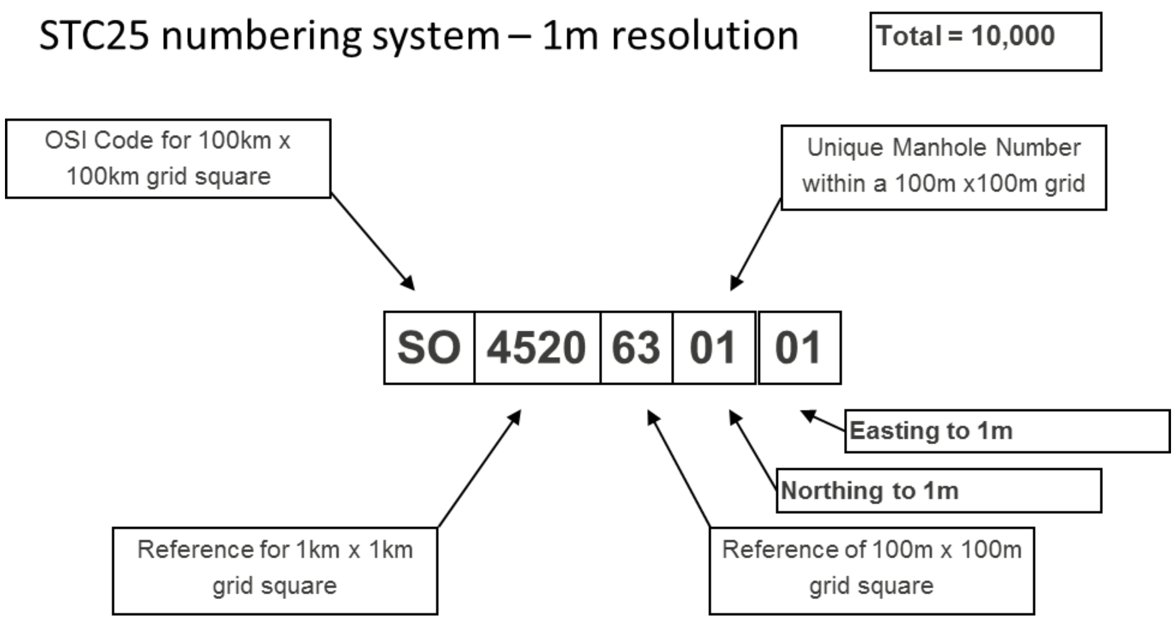

Figure 6.3: Option for a 1m coordinate resolution unique ID system

There is one very significant benefit to moving to this approach. Having a unique reference ID (or perhaps using it as a secondary reference) means that in the transferring of information between stakeholders there will never be the same ID value used as it is virtually impossible for two drainage assets to reside within a 1m square area (unless the location has been incorrectly derived). Any other STC25 based system (in line with those used by Sewerage Undertakers or Highways England) has the potential for confusion - with a risk of duplication of asset references.

However it is highly unlikely that a universal change can be imposed or willingly adopted by any of the main organisations due to the investment in their current asset referencing and significant knock-on impacts. There is a general view held by Sewerage Undertakers that the current use of STC25 for asset referencing (as they apply it) will continue whatever the recommendations of this study.

Another issue is that if IDs are very similar or equivalent to SU references, then it will not be clear whether the asset has been transferred i.e. adopted by an SU (and therefore re-named with a SU reference), or remains within public or private ownership.

6.2.2. Option 2 – Site and SuDS type system

Any alternative system would be to utilise the name of the development and the SuDS type of the asset, recognising that it is likely to be subsequently over-written by any adopting authority. This points to the conclusion that all that is required of a universal numbering system for a new asset as part of a drainage system for a new development, is to have a sensible and consistent method which need have no link to the STC25 concept.

If this is the case, then the second approach for a standardised ID naming convention for drainage assets (that is initiated within the planning process) could be the use of a combination of either the planning reference or the name of the development, a code signifying the type of asset, and a simple numeric number As long as each asset has an independent ID, it is largely immaterial as to what this is - provided the asset attribute information includes the relevant information such as the coordinate location and the physical characteristics of the structure.

It is suggested that an alternative to the use of an STC25 system based on 1m resolution could therefore constitute:

NAME_TYPE_NUMB

Where:

- NAME was a four letter reference to the development or location;
- TYPE was a four letter reference to the drainage or SuDS unit type (gully, pond, manhole…);
- NUMB would be a four digit value (0001, 0002…) providing the potential for recording 9999 items of the same type at that development or location.

In general the feedback obtained from industry favoured the latter approach where IDs enabled recognition of the development and type of drainage unit being referenced. It is felt that this would provide clarity to all parties through the planning process and be a more intuitive and easily applied approach. Any adopting organisation can then chose to change the reference for the adopted elements of the drainage system, retaining the original planning reference as an attribute for record association purposes.

There will be a need to define a nationally consistent set of SuDS 'types', however this is relatively easily addressed using the terminology set out in the SuDS Manual (CIRIA, 2015).

7. System definition and connectivity

There is a need to ensure compatibility with existing Sewerage Undertaker recording of assets which means that the SuDS assets should be based on a Node based referencing system.

It is also recommended that all SuDS information is stored in Nodes and these may be real Nodes defining physical structures e.g. flow control chambers, or Virtual Nodes representing points of change (e.g. gradient change, cross section change etc. or pipe size change where there is no manhole), or centroids of SuDS components (e.g. pond, basin, pervious pavement etc.). Real Links would be used, as in current mapping, to represent linking pipework. 'Virtual links' will be used where there is no physical connecting pipework but where there is a need to indicate connectivity and flow path.

SuDS are rarely points in the way that a manhole might be considered a point. Manufactured SuDS such as sediment vortex units could be considered as points even though they might be more than 1m in diameter, but many vegetated SuDS, ponds or permeable pavements have large plan areas, sometimes irregular in shape and most are also conveyance systems (conveying water from the inlet to an outlet some distance away).

From a modelling point of view it may be important to distinguish between these characteristics, but to ensure simplicity in any database and/or high level plan representation, it is suggested that all SuDS elements (inlets, outlets and the components themselves) are shown as nodes with an appropriate node reference. This does not mean that models cannot be created of SuDS which act like links (swales) from the database information; it just means that the asset data structure is not being defined for the purpose of modelling. Node points can be used to represent large areas and polyline information can be stored as attribute information. This allows mapping to show either or both the node and any polyline layer.

For example, a pond may have multiple pipe inlets as well as having an outfall. There may also be a separate overflow structure. Each of these can be represented as a node, (even if they are not a structure) to ensure their location and characteristics (such as level information) is captured. Similarly many pipes may outfall into a swale from gullies along a road. Each of these should also have the opportunity to be recorded.

It is important to note that there are many potential polyline attributes which need recording. These might include but not be limited to:

- The ownership boundary (say round a pond);
- The normal water line;
- The maximum 1:100 year flood line;
- The level contours of the structure.

Nodes are also already used where there is no discreet structure. A change in pipe size can occur on major sewers without a manhole at that location. NWL use a node indicator reference which includes specific letters to denote these points of change. What this means is that a node can be used at any point on a drainage network where it is felt that it is appropriate to do so. Other examples could be a change in gradient of a linear channel system or changing cross-section along a swale. This would mean duplication of some attribute data where there are a number of nodes used for a long linear structure, but this is not a reason for not using multiple nodes to ensure sufficient resolution of the information about a SuDS unit.

The SuDS component could be given a SuDS node reference and this would record all the SuDS attribute information (which is discussed later). The specific location of this node is not really important (providing it resides within the limits of the areal extent of the SuDS unit), but it would preferably be somewhere appropriate such as the centroid of the unit. To connect the SuDS node with other relevant nodes (inlets and outlets) there is a need for a virtual link (assuming there is no actual physical link such as a pipe) in order to indicate the flow path through the whole drainage network.

Although all SuDS information will be associated with nodes, links between them will be referenced by the upstream and downstream nodes IDs. Information stored in links would include distance, levels and cross-section.

It should be noted that this approach is different to that used by Highways England in their HADDMS system which represents drainage assets as either points, lines or polygons (termed point, continuous or region assets respectively) – see feedback on the proposed approach from Highways England in Appendix A.

8. Mapping of SuDS

- Mapping should show SuDS as Nodes.
- Suggestions are that SuDS could be grouped in a few broad categories based on key aspects of their characteristics, or the 13 categories as defined in the SuDS Manual.
- Any symbol can be devised for each SuDS type and it is felt that a prescriptive output of this report is therefore not needed (though a suggestion has been made as to what symbols might be used). All that has to be achieved is to convey a difference to existing drainage symbols.
- Where SuDS have spatial extents then these can be shown, together with the node for that asset, to facilitate understanding of the drainage system.
- The use of virtual nodes and links will be required where there is no specific structure to ensure all relevant points and flow paths are indicated.
- Compliance with statutory obligations of showing assets will mean that virtual links may not be shown on asset mapping.

8.1. SuDS component representation

As discussed in Chapter 6, it is proposed to have node references for each SuDS unit and in some cases there may be a need for multiple nodes along a linear SuDS unit. These nodes may be virtual nodes either on a pipe or a SuDS element where there is no specific structure, but a need to represent physical change (e.g. changes in cross sections or gradients). It is necessary to consider how the different node types and how the different drainage features that might form part of a SuDS system are represented visually on sewer mapping to best support those using the maps for planning, design or asset management purposes.

In line with approaches initially developed to support implementation of the Flood and Water Management Act, the previous UKWIR study considered the use of a plethora of mapping symbols for SuDS to distinguish between the various components. This approach also included dividing the SuDS symbols into either Node, Area or Link assets. The approach proposed a range of images which were related to the appearance of the SuDS components as well as their functionality. This approach was reconsidered in the current study, which highlighted the following likely limitations:

- A definitive list of images would be difficult to secure agreement on;
- The number of symbols required would be extensive if every variation of any SuDS component type was to be separately distinguished;
- Agreeing a specific range of symbols may hinder further evolution and extension of a symbols library for SuDS components;
- Any proposed symbol colours would need to be complementary with colours and symbols already being used for theming networks by Sewerage Undertakers;
- A Node, Area and Link approach to individual drainage components would be inconsistent with the existing method of recording drainage elements as Nodes.

If a universal node-based system of definition is adopted, then within a digital environment all aspects of drainage features can be described in the attribute information. This means that network mapping need only to be based on some over-arching principles and, in practice, any type of drainage component can be represented as any symbol or image that is appropriate for the purpose for which the plan of the network is required.

Based on the recommendations set out in Chapters 6 and 7, the following network elements need to be able to be represented on maps to allow SuDS components to be identified and adequately defined:

- Nodes
- Virtual nodes (for non-structures)
- Links
- Virtual links.

It is suggested that a simple modification of the present approach to Node mapping is used; perhaps a circular node with a letter S within it for SuDS components while a virtual SuDS node might be VS. It is important to note that end of pipe discharge points into a pond (which has no structure) is already captured in existing systems as being a virtual node by some organisations.

As links are not labelled on plans it is only the line type which is relevant for definition. These would be the same as for standard surface water drainage for pipes or channels even if they are SuDS conveyance elements. There is a need to distinguish links from ‘virtual’ links to indicate that they are only representing the flow path rather than a physical structure. A ‘virtual’ link might therefore be a double dotted line of the same colour for the network being shown.

Figure 8.1 illustrates the situation where SV might be the centroid point of a pond while a node labelled S is used for the outlet structure which is the pond control structure. These two nodes, along with the two inlets shown as V (virtual standard drainage nodes) need to be associated with each other as the information about the pond relates to all these nodes. This grouping of nodes might have a descriptor name (such as Pond_1).

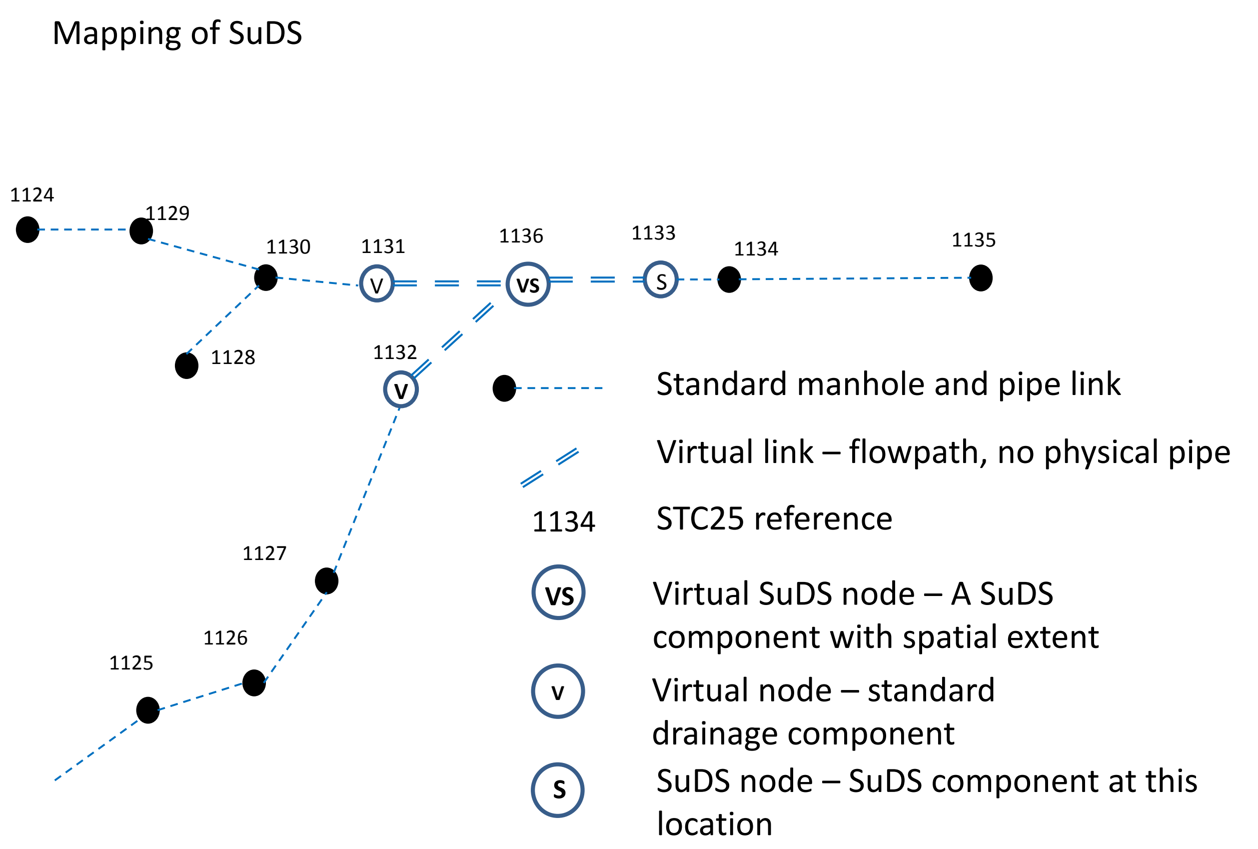

Figure 8.1: Mapping of a SuDS pond – sewer mapping nodes and connectivity

As it might be difficult to see which nodes are all related to a single SuDS unit, it would always be possible for any sewerage undertaker or other data stakeholder to draw on the spatial extents of the SuDS unit as shown in Figure 8.2.

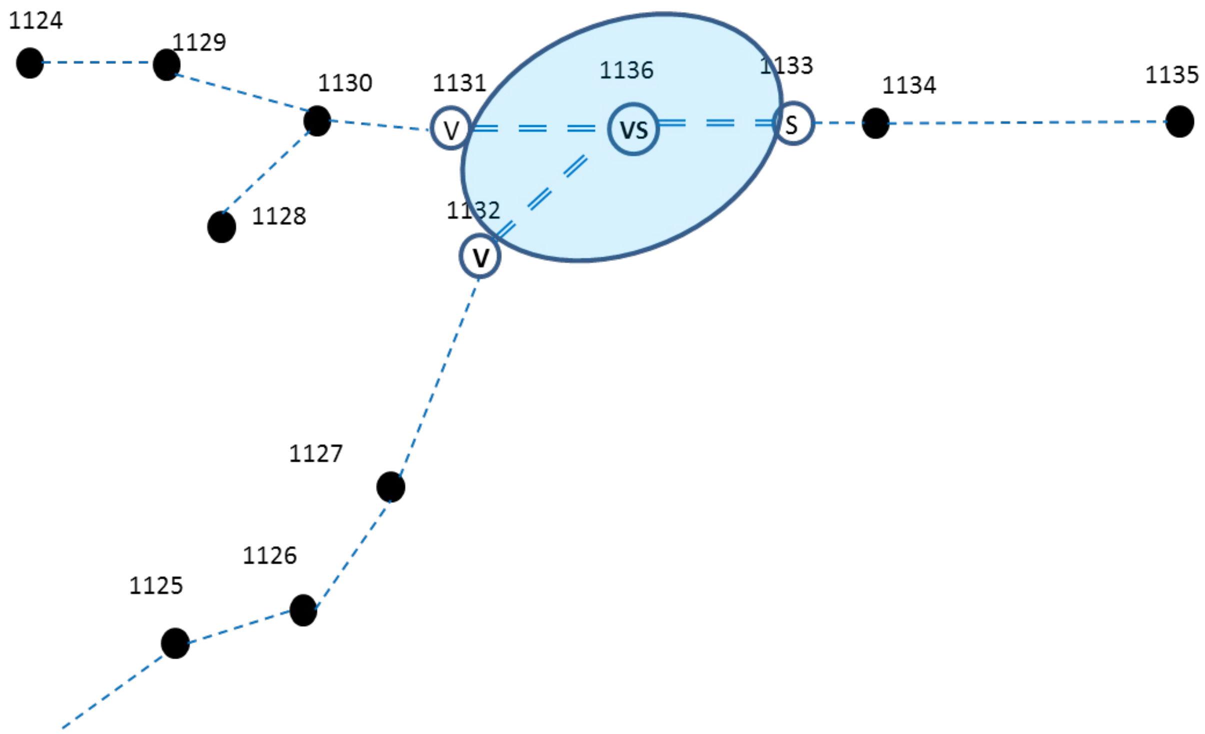

Figure 8.2: Mapping of a SuDS pond – sewer mapping nodes connectivity and area extents

8.2. SuDS symbols

As the illustration above shows, the designation of a SuDS unit need not be aimed at indicating its specific characteristics; it only needs to distinguish it from existing traditional drainage symbols. However, to provide a minimum level of understanding that can be derived from the mapping, there is probably a need to further distinguish the key characteristics of the SuDS component. Too many categories would result in potential for confusion (for example each different type of swale). A suggested approach might be based on say: Type S1 = elevated SuDS (roofs), Type S2 = surface SuDS (ponds etc.) and Type S3 = underground SuDS (storage tanks etc.). Alternatively the 13 SuDS component categories of the CIRIA SuDS Manual could form the basis for symbol selection.

At present, colours are also used for categorising sewers and other utilities (green, blue and red etc.) so colour is not proposed as a distinguishing aspect of SuDS. As SuDS are part of the surface water system, the colours used should integrate with individual Sewerage Undertaker's existing representation of surface water networks.

Figure 8.3 and Figure 8.4 illustrate the proposals further showing the SuDS category, connectivity and referencing.

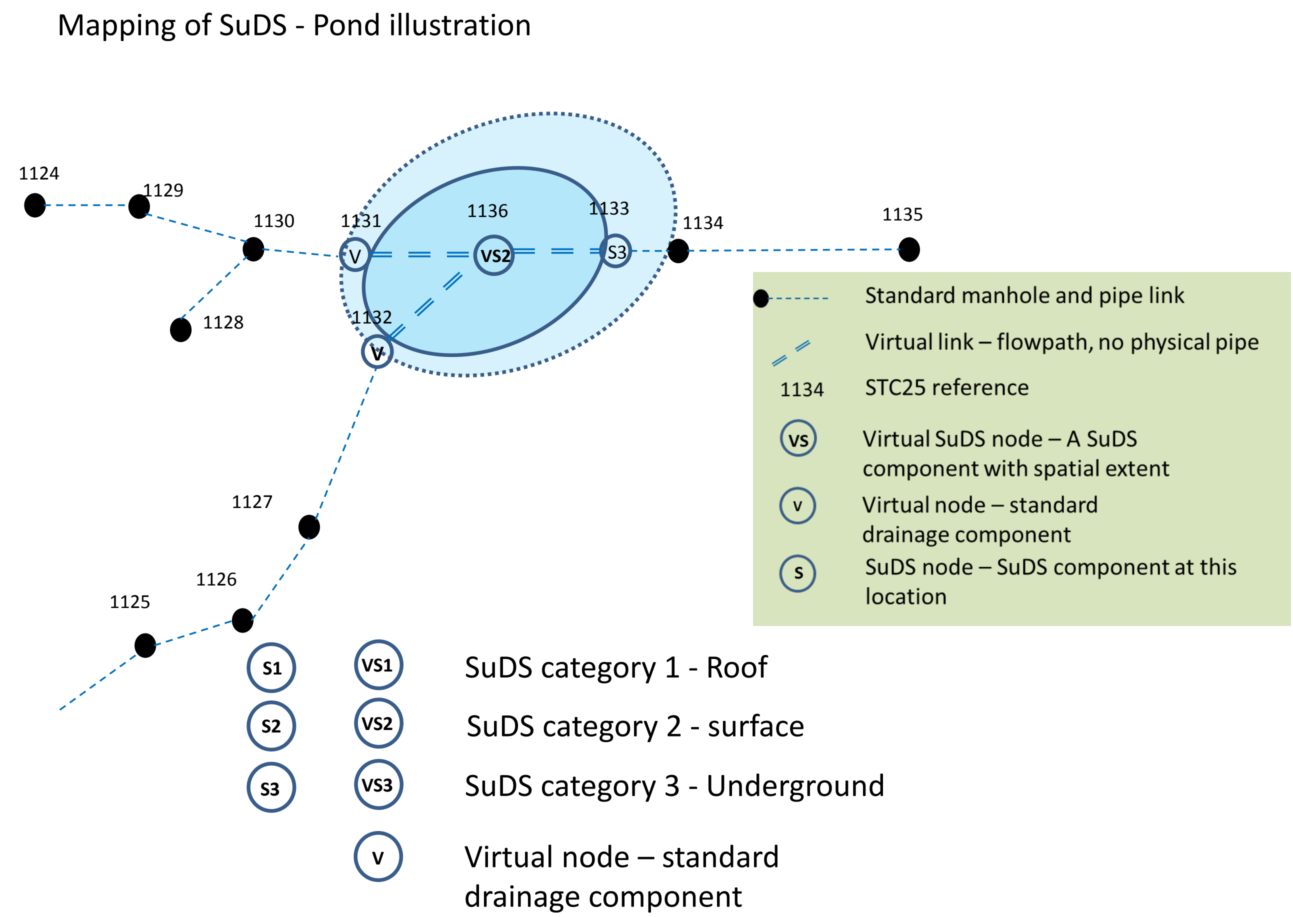

Figure 8.3: Mapping of a SuDS pond showing SuDS category

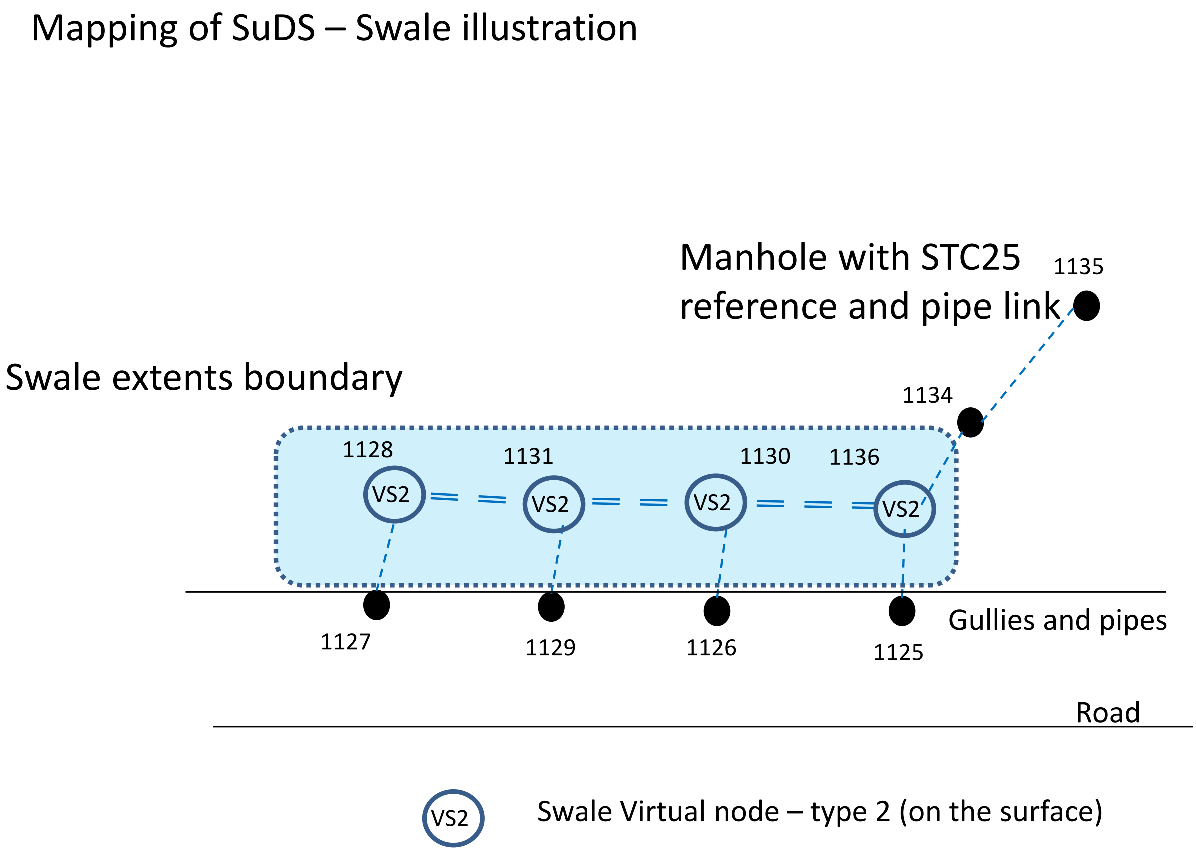

Figure 8.4: Mapping of swale showing SuDS category

There is a final point worth noting associated with the areal extent of a SuDS unit. Many SuDS will have an outline on an OS map. For instance car parks, roofs, ponds will all be shown on maps and these may be thought to have the same delineation as the SuDS asset. Therefore there is an argument that the OS information could be extracted as part of the attribute database. However there are a few reasons not to take this approach:

- in many cases car parks are not necessarily all permeably paved and a delineation of which areas are impermeable and impermeable would be needed as part of the definition of the SuDS component;
- ponds and basins require outlines of areas relating to multiple conditions; the dry weather base condition, the top water level and possibly also the ownership boundary;
- the timescales of OS mapping updates may mean the mapping is not up to date at the time of asset adoption.

9. SuDS asset data requirements

- Effective provision of SuDS attribute data requires a wide range of information and not just the physical characteristics.
- Attribute data can be categorised as Mandatory, Desirable and Optional. Mandatory data is that information which is needed that enables the hydraulic behaviour of the system to be deduced accurately in the context of the drainage network.

9.1. SuDS data categories and data collection/ recording

The amount of SuDS attribute information that could be used to describe the component, its functionality and the way it has been designed is extensive and if a complete understanding is to be gained of its characteristics (particularly if the data is subsequently to be used to include the SuDS scheme within a network hydrodynamic model) then much of it needs to be recorded. However priority levels can be established in order that a minimum dataset is collected so as to ensure the component's principal characteristics are known.

Recording design criteria and how they are met by the scheme will be part of the data collected via the planning approval process. However, these are also important datasets to help in system evaluation in the future.

Because a SuDS network is a complex combination of vegetated elements, pipes, storage features etc., it is not immediately obvious which elements are private, which are public and which are adopted (possibly SU) assets – therefore recording this information is fundamental.

The following information categories are proposed to define SuDS schemes / components:

- SuDS types
- Ownership
- Location
- Reference ID
- Connectivity
- Dimensions
- Construction details
- Contributing areas
- Hydraulic design criteria
- Water quality design criteria
- Amenity / Environmental criteria
- Operation and management plan
- Asset condition, operation and management record.

Each of these are described in the following sections. It is recognised that it may not be practicable or possible to collect or record all the information and that the fields will probably need to be categorised as being essential or optional depending on the use of the asset information and the organisation requiring the data.

The attributes in each category are often relevant in other categories, but to avoid duplication each attribute is only listed once in the category which is most obviously associated with that data.

9.2. SuDS types

There are many types of SuDS and by their very nature there can be a lack of clear distinction between certain SuDS. For example, a swale and a basin might effectively be the same except for the location, shape and scale of the feature.

SuDS types can be grouped in a number of ways.

One possibility (as suggested in Section 8) is that a differentiation is made based on the elevation of the SuDS component relative to ground level, i.e.:

- Roof level
- Ground level
- Below ground.

An alternative approach might be to categorise them as:

- Vegetated structures
- Non-vegetated structures
- Manufactured products.

Another option would be to use the SuDS categories as used in the SuDS Manual.

The first option is currently the project recommendation for the representation of components on maps.

SuDS types can also be broken down into a number of SuDS sub-categories. The following SuDS and their sub-categories are suggested here:

Roof systems – type 1 SuDS

- Green roof:
  - Intensive
  - Extensive
- Blue roof.

Surface systems – type 2 SuDS

- Basin
- Bioretention
- Filter strip
- Filter drain
- Permeable pavements:
  - Concrete block
  - Porous asphalt
  - Other…
- Pond:
  - Wetland

  - Open water
  - Wetland & Open water
- Swale:
  - Conveyance
  - Under-drained
  - Wet
- Tree pits
- Infiltration trench
- Infiltration basin.

Underground systems – type 3 SuDS

- Proprietary products:
  - Water quality (settlement)
  - Water quality (filtration)
  - Water quality (treatment channels)
  - Water quality (oil separators)
- Rainwater harvesting tanks:
  - Resource conservation
  - Passive stormwater control
  - Active stormwater control
- Soakaway:
  - Granular fill
  - Ring
- Tank storage:
  - Over-sized pipes
  - High voids crate
  - Concrete tank.

This list is not a definitive list and more SuDS types could be added by any organisation.

In-curtilage SuDS (e.g. soakaways) will be of interest to SUs for both billing purposes (i.e. identifying if the property is, effectively, not directly connected to the surface water drainage systems) and for determining the standard of service of the downstream system.

9.3. Ownership

Ownership of SuDS is being legislated for in Wales where SABs will be created who will own all SuDS. Otherwise, elsewhere in the UK, an agreement must be secured by the developer for the long term adoption of the SuDS within the development and this might be the local authority, the water company or private management companies. In England sewerage undertakers are likely to adopt more SuDS following implementation of Sewers for Adoption 8 in 2019. In Scotland adoptable SuDS are swales, piped filter trenches, ponds and basins. Other SuDS are vested with private management companies or the local authority. Due to this split in ownership, it is very important to make sure information on who owns each of the SuDS components in a development is recorded.

In-curtilage (private) SuDS e.g. green roofs, soakaways or rainwater harvesting systems are likely to be part of property ownership, solely road drainage is usually adopted by the highways authority, and the sewerage undertaker may adopt other elements.

The SuDS design consultant and the contractor responsible for constructing and landscaping the drainage system are also important contacts for any clarification that might be needed in the future.

Information to be recorded includes:

- The SuDS component reference ID.

Ownership

- Private address / Company organisation and address
- Date of Adoption
- Adoption agreement
- Adoption review documentation (attachments).

Design organisation

- Company organisation and address
- Date of design
- Company project reference.

Construction organisation

- Company organisation and address
- Date of construction
- Date of commissioning
- Construction / As-built drawings (attachments).

9.4. Reference ID

As discussed in Chapter 6, the initial referencing system can be any form as adopting bodies will subsequently apply their own ID referencing. Two options for referencing are proposed; one a variation based on STC25, and the other based on the development, type of drainage unit, and the use of a sequential number for that development.

There is likely to be more than one node associated with a SuDS component and therefore any node reference will need to be grouped and cross-referenced to the specific SuDS component to which it is linked.

9.5. Location

The coordinate location of a manhole is easily established. However for many SuDS components there is a relative large associated area and the conceptual location of the SuDS is likely to be represented by its centre or centroid. As proposed in Chapter 7, a virtual SuDS node would identify a SuDS component – the location for which may not be a structure at that specific point, but the point at which the actual component area is defined.

Whether or not the geo-referenced boundary of the SuDS plan area is shown on a map is optional, but it would normally be shown to help in showing the extent of the SuDS component and the land included within the asset ownership (i.e. including maintenance access strips). This is important in ensuring the component is not subsequently altered or damaged and for defining maintenance requirements. It will also be helpful in understanding the grouping of nodes related to that component.

9.6. Connectivity

Documenting the connectivity of the drainage system is very important. Usually links represent connecting pipework and are referenced to the upstream and downstream nodes (normally manholes) they serve. However in the case of SuDS the link may be the SuDS unit, in which case the connectivity data may be associated with the SuDS node and virtual links may be used to indicate flow path and direction (see Chapter 8).

Link information would need to include:

- Upstream node
- Downstream node
- Whether it is a virtual or physical link
- Invert level upstream
- Invert level downstream
- Conduit diameter / dimensions
- Length.

9.7. Hydraulic design criteria

Unlike a pipe, where its capacity and conveyance capability is easily determined from a few dimensions, the assumptions that have been made by the SuDS design engineer may not be able to be determined from an examination of the SuDS structure. Different design criteria may be relevant for different types of SuDS and different components may contribute to meeting different aspects of the design criteria for the entire development site. The following information is an indication of the information that should be stored for new assets (but may not easily be accessible for existing or historic assets):

- Design return periods:
  - 1 (frequency of occurrence)
  - 2 (frequency of occurrence)
  - 3 (frequency of occurrence)
- Interception depth (mm)
- Interception compliance probability (if used):
  - summer %
  - winter %
- Rainfall Model (FSR / FEH / FEH13)
- SAAR (Standard Average Annual Rainfall) (mm)
- Time series data (if used)
- Runoff model type

- Runoff factors Paved & Pervious:
  - 1 (frequency of occurrence)
  - 2 (frequency of occurrence)
  - 3 (frequency of occurrence)
- Assumed infiltration rates and factors of safety
- Maximum groundwater level
- Assumed conveyance roughness factor (e.g. Manning's 'n')
- Climate change rainfall uplift factor
- Limiting discharge rate (where relevant)
- Rainwater harvesting: Active or Passive control
- Rainwater harvesting: single property or communal system
- Rainwater harvesting: Daily demand
- Rainwater harvesting: collection surface area
- Design documents (attachments).

9.8. Water quality design criteria

Designing to meet water quality criteria is not a requirement in England, however regulations are applied with respect to water quality in Scotland and water quality control will form part of the suite of statutory standards being enacted in Wales. Water quality design for SuDS is not an exact science and, as such, water treatment performance can never be guaranteed. There are usually two approaches that are taken; either aiming to reduce influent concentrations of various parameters by a stated proportion or to reduce concentrations below a stated threshold. If the simple approaches suggested in the SuDS Manual (CIRIA, 2015) are applied then the asset database could easily capture key parameters associated with these approaches, however if more complex methods are adopted then the design documentation will need to be attached in order to provide all the information associated with this aspect.

There are several categories of pollutants which are considered. These include:

- Sediments
- Nutrients
- PAHs
- Oil
- Bacteria / Pathogens
- Metals.

Water quality and treatment design is rarely if ever done, so more detailed specification of design attributes are not suggested. However if and when water quality design is carried out, the metrics used should be recorded.

9.9. Amenity, biodiversity and other environmental criteria

Best practice SuDS should aim to deliver multi-functional benefits, and criteria relating to amenity and biodiversity. These are explicitly stated in the new statutory standards to be implemented in Wales in January 2019. This means that SuDS components will often be providing environmental services over and above just the provision of drainage infrastructure, e.g. a pervious pavement may also be a car park or a cycle path; a detention basin may also be a recreational area; a wet swale may also be delivering strategic habitat; and a series of tree pits may be supporting the reduction of air pollution in an urban area. Many of these characteristics are not easily captured in a database so only the obvious categories are indicated here. As with the design for water quality more detailed metrics can be recorded where the design has been specific about the intended benefits:

- Vegetation plant type(s)
- Habitat provision
- Amenity provision
- Additional environmental service provision
- Attached documentation.

9.10. Design criteria – geotechnics/hydrogeology/contaminated land

The inter-relationship between SuDS design and local soil characteristics, groundwater and hydrogeology is important in order that design infiltration rates are robust, groundwater and surface water are separated, and risks posed to local geological features or topographic inclines by infiltrating water are managed appropriately. In addition, the use of SuDS on sites where there is known to be contamination present, will need particular care in the design. Because of the potential risks posed, key site investigation and design information relating to these aspects should be stored in any database, such as:

- All soil investigations
- Infiltration testing results
- Groundwater monitoring
- Geotechnical assessments relating to geotechnical hazards
- Contaminated land definition and remediation reports (and details regarding the management of risks associated with the SuDS design).

9.11. Design characteristics: dimensions

All the dimensions of a structure need to be recorded in order to understand its hydraulic properties and how it behaves within a drainage system; so that it can be represented hydraulically within any future modelling exercise, and so that it can be identified on site for asset inspection and management. In some cases the easiest way of capturing a complex shape of a SuDS unit is to provide a 3D geo-referenced data file. Otherwise, the following dimensions should be captured:

- Length
- Width
- Height
- Base plan area

- Base geo-referenced polyline
- Outlet invert level plan area
- Outlet invert level geo-referenced polyline
- Overflow level plan area
- Overflow level geo-referenced polyline
- Full component extent area
- Full component extent geo-referenced polyline
- 3D geo-referenced information
- Base level
- Depth – storage volume curve
- Cross-section (may be multiple)
- SuDS component (as constructed drawings showing on-site levels, plans and sections documents (attachments)).

9.12. Design characteristics: materials

Although dimensional data captures the size and shape of a SuDS structure, there are a number of other construction details which need to be captured. There is no limit to the amount of detail that might be recorded, but these are the primary elements that should be recorded where they apply:

- Outlet(s) depth-discharge curve(s)
- Porosity factor
- Under-drained bedding
- Under-drain pipe size
- Under-drain pipe type
- Roof media depth
- Roof media type
- Roof gradient
- Vegetation type
- Soil thickness
- Thickness of other component media layers
- Attached drawings.

9.13. Contributing areas

It is unusual to associate contributing areas with asset data in an asset database. It is therefore probably an optional element to record in most instances, however it is one that the Sewerage Undertakers did consider important (in the workshop) as it enables an understanding regarding runoff areas and assumptions made. There is an aspect to consider which is different to conventional subsurface drainage assets in that SuDS elements (being on the surface) are themselves a contributing area to the drainage system. To represent contributing areas within the asset database requires the following information to be recorded:

- Plan area of contributing SuDS unit;

- Geo-referenced plan areas of contributing SuDS unit;
- Plan area of directly contributing road and pavement surfaces;
- Geo-referenced plan areas of directly contributing road and pavement surfaces;
- Plan area of directly contributing roof surfaces;
- Geo-referenced plan areas of directly contributing roof surfaces;
- Plan areas of pervious area contribution;
- Geo-referenced plan areas of pervious area contribution;
- Soil type and SPR value of pervious contributing areas.

9.14. Operation and management plan

A plan from the designer on the likely operation and maintenance requirements of the SuDS units is an important document for planning; both for the adoption body, and also for organisations adopting downstream components (whose functionality may be dependent on upstream component maintenance). Required information should include:

- Maintenance performance objectives;
- Type of activity
- Frequency of activity
- Available access
- Equipment required
- Safety equipment required
- Skills required.

This information would then form the basis of future asset management review and ongoing planning.

9.15. Asset condition, operation and management record

An operational record of maintenance activities is not a direct requirement of recording the existence of assets. However just as the structural state of a pipe or the sediment build up in it is important for pipework, a record of the state of the SuDS unit and the activities taking place to maintain it are equally important. These activities may or may not be relevant for sharing between stakeholders. The availability of this information will be dependent on record keeping by the organisation owning the system and on their commitment to making the data accessible to others. Valuable information would include:

- Date of visit
- Activity carried out
- State of the structure
- Images.

10. SuDS Data Model

10.1. Overview

The first step to developing a common approach to data recording has to be agreement between users of a common data structure, ensuring that asset information is recorded and described in the same way across different organisations (Environment Agency, 2010). Alongside this is the need for organisations to be able to link these records with their locations and to facilitate automation of this process. There is a need to promote a shift away from scanned images to digital geospatial information.

This chapter describes a 'data model' – defined as a set of database tables and their relationships that allow data about the various SuDS types and their attributes (as detailed in Chapter 9), to be stored by relational database software (see Section 10.2). The chapter also suggests an initial spreadsheet tool that could provide some initial consistency for data collation and recording purposes between stakeholders.

10.2. Data sharing

There are a series of data quality needs when data is being shared between stakeholders that will need addressing in any form of data recording system (i.e. database or spreadsheet) including its fitness for purpose, e.g.:

- Is it a complete dataset?
- Is it up to date?
- When a standard description is used, what does that mean exactly?
- What are the units?
- How spatially accurate are mapped features?

Two things can be used to facilitate data exchange and data use:

- Metadata: used to describe the provenance, quality and content of the data; and
- Standard data definitions: that define precisely how data is structured and what it represents.

The issue of asset spatial referencing is vital in creating a nationally consistent surface water management asset register that is searchable and useful to all stakeholders.

10.3. SuDS data model (relational database)

10.3.1. Introduction to the data model

The version shown in Figure 10.1 provides an indication of the type of data model structure that could be used for SuDS data storage, subject to refinement at implementation stage. This figure has been simplified and some fields are omitted e.g. most simple attributes of a SuDS asset, such as length and width, are not shown, and lookup-tables, such as the list of valid SuDS asset types, are omitted here.

The data model aims to be sufficiently flexible to allow data for all types of asset to be stored in a common set of database tables while ensuring that all types of data can be recorded.

The model does not attempt to enforce all data integrity rules. For example, the model provides for a number of categories that may be applied to an asset, such as a permeable pavement being categorised as "concrete block" or "porous asphalt". However as the asset category table will contain all categories that might apply to any SuDS asset, the data model does not prevent the attribute "open water" being applied to the permeable pavement – this level of data integrity must be maintained by other software or features such as database triggers that are not described here.

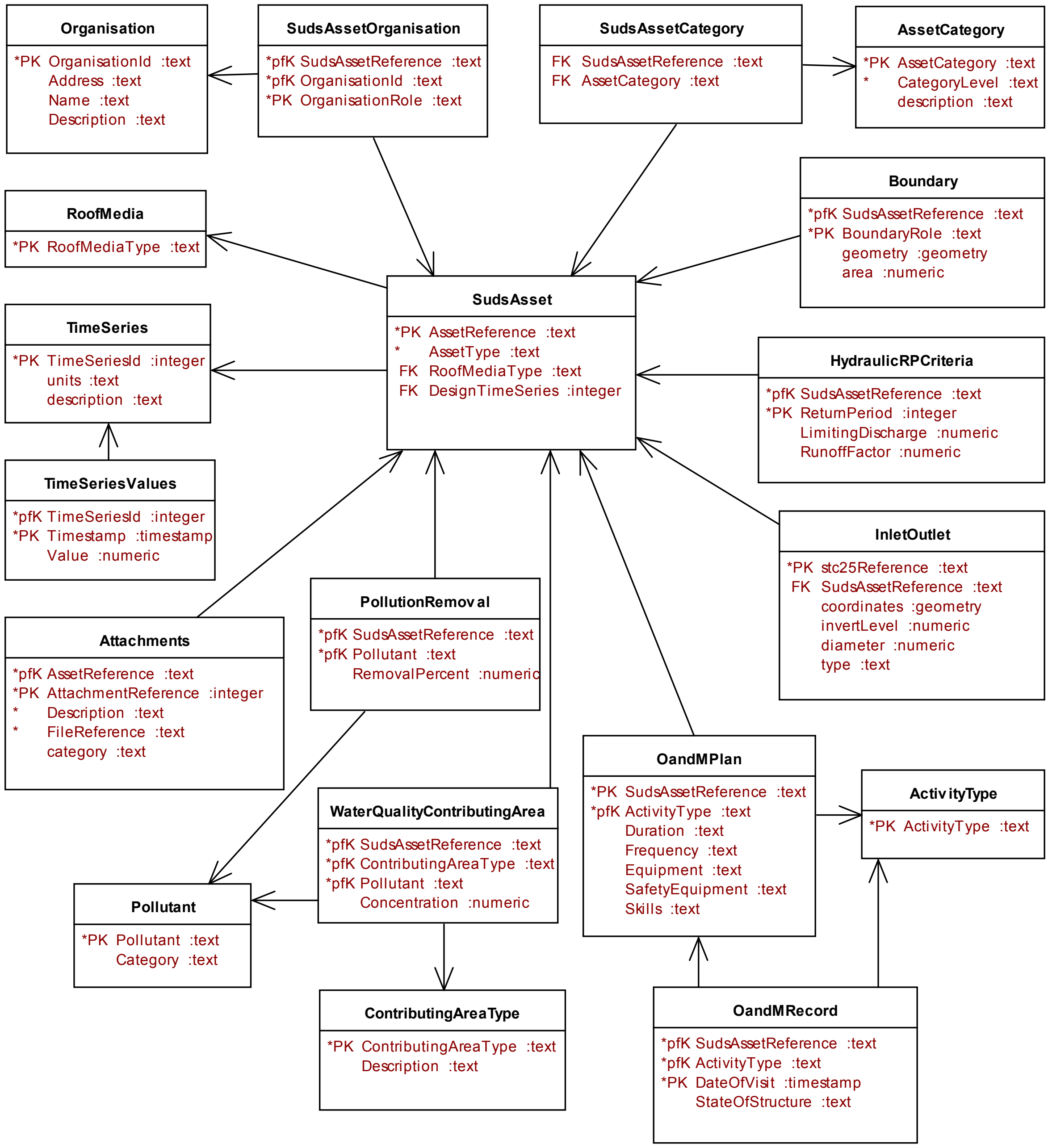

Figure 10.1: Data Model

The model is not primarily focussed on a simple spatial representation of each SuDS asset. Each asset may have several spatial boundaries and parts of the model express quite complex data relationships. As a result, this data model cannot be easily stored using simple spatial formats such as a shapefile.

The following sections provide an overview of how the data listed in Chapter 9 might be stored in such a data model.

10.3.2. SuDS types

Each SuDS asset is represented by a record in the 'SudsAsset' table.

All simple attributes of the asset are to be stored directly in this table – simple attributes are those which have a single value for each asset, such as length or the asset reference. The main type of the asset, e.g. Pond, Swale or Green Roof, is encoded by the 'AssetType' column. The asset type can be further described by assigning one or more 'AssetCategory' values (wetland, concrete block, conveyance and so on) to the asset.

10.3.3. Ownership and associated organisations

The model allows multiple organisations to be associated with an asset, such as the owner, designer or contractor, through the Organisation and SudsAssetOrganisation tables. The Organisation table provides details of the organisation, while the SudsAssetOrganisation table described the organisations role in relation to the asset. Each organisation may be associated with multiple assets and have several roles for any single asset.

10.3.4. Location and dimensions

An asset may have multiple boundaries that, in part, describe the location and dimensions of an asset. These boundaries are described as polygon geometries in the boundary table and represent, for example, the geographical ownership limits, the area of the asset at the outlet invert level or overflow level. Simple dimensions such as length, depth and volume are stored as attributes of the 'SudsAsset table'.

10.3.5. Connectivity and construction details

The set of inlets and outlets associated with the asset are held in the InletOutlet table. Each entry in this table describes any characteristics of the inlet or outlet including its location as a point geometry, its invert level and diameter. The 'InletOutlet' type attribute says whether a particular data item represents an inlet or an outlet. Most other construction details are stored as simple attributes of the asset in the 'SudsAsset' table.

10.3.6. Hydraulic design criteria

Most of the hydraulic design criteria that are not dependent on return periods are stored as simple attributes in the 'SudsAsset table'. Time series data (if available) are stored separately in the 'TimeSeries' and 'TimeSeriesValues' tables. Design data that is related to return periods (limiting discharge and runoff factor) are stored in the 'HydraulicRPCriteria' table.

10.3.7. Water quality design criteria

The storage of the water quality design criteria is a little complex because each contributing area may involve several land use types and may have different simple design parameters. These data are held in the 'WaterQualityContributingArea', 'ContributingAreaType', 'Pollutant and PollutantRemoval' tables.

This table structure allows for a number of contributing area types to be specified (e.g. road, industrial, residential) in the 'ContributingAreaType' table. The Pollutant table lists the pollutant categories e.g. sediments, metals, hydrocarbons etc. For each type of area that could contribute contaminants to an asset, the 'WaterQualityContributingArea' stores the relevant assumed hazard level (or pollutant concentration range if appropriate).

The 'PollutantRemoval' table gives the percentage of each pollutant that the asset is expected to remove or the relevant SuDS Manual mitigation indices.

10.3.8. Amenity/biodiversity and other environmental criteria

These attributes are stored as free text in the 'SudsAsset table'.

10.3.9. Operation and management plans and records

The 'OandMPlan' table stores the set of plans for an asset. The type of activity must be one of a defined list (from the ActivityType table), but the remaining attributes, such as the equipment required are free text entries.

The 'OandMRecord table' records each execution of an OandMPlan.

10.3.10. Attachments

Additional material, such as reports, drawings and images may exist to augment the data held in the model. These are not directly stored in the model, but a reference to them can be entered into the Attachments table. This includes a general description of the attachment, a reference to the data file and a category. The category is expected to relate to one of the data categories listed, e.g. SuDS types, Ownership or Location.

10.4. Data storage and transfer

10.4.1. Storage

This data model described in Section 10.3 is a traditional relational data model. It is semi-abstract in that the data types are not specific to a particular relational database implementation. For example, the implementation of a "geometry" type will vary between different relational databases. Also, at present, the lengths and precisions of fields have not been specified.

The data model (or the simple spreadsheet described in Section 4.2.5) could also be implemented using non-relational software, such as NoSQL databases, XML or JSON formatted text files. The only requirement placed on an implementation is that it must be able to support the data types and relationships expressed by the model and maintain the referential integrity of the data. Storing the data in simple text files may be particularly suitable where the volume of data is small and there is no need to execute ad-hoc queries against it. This would avoid the complexity of setting up a database.

10.4.2. Transfer

There are many ways and formats in which data that conforms with the data model can be exchanged between organisations. The most suitable approach will depend on the primary use by the recipient, the complexity of constructing the transfer object and the software required by the sender and receiver.

An important consideration when choosing the transfer format is whether or not the data is primarily considered to be spatial; if it is essential that it can be read directly into GIS software then a geospatial format must be used.

Only a small part of the model represents spatial data – the asset boundaries, inlets and outlets – and the more complex parts of the data model are not naturally supported by some geospatial formats.

The following sections consider some possible data formats. Once a preferred format has been chosen additional work will be needed to determine how the components of the data model should be encoded within that format.

XML

XML is the traditional method for transferring these types of data between systems. As a text format it is human readable (though often with difficulty), relatively easy to construct and can support the complexity of the data model. A key feature of XML is the existence of the XSD schema definition language. This allows the structure of the document to be validated to ensure that it is formatted correctly and contains all mandatory data.

Drawbacks of XML are that it can be very verbose and that it may not be directly readable by GIS software. It may be possible to base the SuDS data transfer format on the GML geographic exchange standard to allow it to be read by GIS systems.

JSON

JavaScript Object Notation (JSON) is a very widely used text format for transferring data between systems, particularly where Web applications are involved. The primary advantages over XML is that it is much more concise and generally easier and faster to manipulate with software. It can also be easier for humans to read.

The GeoJSON format is extensively used for exchanging spatial data between systems. However, it cannot directly encode the complex data relationships contained in this data model.

The main objection to using JSON as a data exchange format is that it does not have a widely supported equivalent of the XSD schema definition. As a result it is more difficult to check that a JSON document complies with a specific format and contains mandatory data.

SQLite and GeoPackage

Data could be exchanged as an SQLite database. This is a light-weight relational database which uses a single data file for storage and could implement the data model directly. If implemented as a GeoPackage (https://www.geopackage.org) it can be directly opened by some GIS packages.

However, it is a binary format that cannot be read by humans and may be awkward to use with some software without reformatting.

Shape files

ESRI Shape files are a binary format which is commonly used for exchanging geospatial data. It is a proprietary format but, due to its ubiquity, can be opened by many GIS software packages.

However, it is not possible to directly represent the complexity of this data model in a shape file. For example, a shapefile cannot hold the water quality design criteria or operation and management plan data as represented in this model. It would be necessary to provide the more complex elements of the SuDS asset data in auxiliary data files.

10.4.3. Recommendations for data transfer

We recommend the development of an XML document format and associated XSD schema for transferring SuDS asset data between organisations. The main reason for this recommendation is that the XSD schema provides a mechanism for validating the structure of the file and so will aid reliable data transfer. The SQLite/GeoPackage approach would be an interesting alternative worth investigation.

11. Implementation strategy for effective recording of SuDS information

11.1. Asset ownership of drainage and sewerage systems in the UK

The responsibility for ownership of drainage assets is diverse and with the many management companies being created as a result of the current position of regulations, it is going to become even more fragmented. Added to this with the reduced obligations of providing information on sewer data by management companies, there is clearly a concern that if data recording is not made mandatory, then there will be many drainage assets where information is lost.

There is a presumption that asset information would best be adopted by the sewerage undertaker wherever possible, thus securing knowledge of its existence and integrating it with the traditional drainage information thus ensuring a more complete understanding of the drainage infrastructure. However it is also worth noting that where obligations set by Sewerage undertakers might be regarded as too stringent, or even that as management companies can be created to manage the surface water assets, that developers may not be prepared to be overly interested in securing adoption of these assets. This is reinforced by the fact that as the sewerage undertaker is only prepared to take on certain SuDS types which therefore still obliges the developer to deal with the ownership of remaining assets. There is one other point which also adds to the risk of adoption not being sought; the most cost-effective approach to draining a site may not be the use of adoptable SuDS elements. For instance, permeable pavement is regarded as one of the most cost-effective ways of providing storage, but these are excluded from being adopted.

The outlook therefore for adoption by sewerage undertakers of SuDS systems may not be as enhanced by the significant development of Sewers for Adoption 8, even though this is regarded by the water industry as a major positional change on sewer assets.

11.2. Current sewerage and drainage asset data capture processes

Currently, where drainage infrastructure is to be adopted by either the highway authority or the sewerage undertaker there are standard processes (via Section 38 and Section 104 agreements) in place for adoption to take place and for relevant information to be provided to the adoption authority. As part of these there is a commissioning and approval process to ensure conformity to the requisite standards (such as water tightness for piped drainage systems).

Sewerage undertakers sometimes record information on drainage assets that are not owned by them, but there are no established protocols for this to be done consistently and the only information that they are required to share with others is that relating to their own assets.

Lead Local Flood Authorities (LLFAs) are obliged under the Flood and Water Management Act (2010) to record all ’significant’ local flood risk assets. This information is essential for delivery of their role in local flood risk management and is also available to the Environment Agency (EA) who have oversight in relation to national flood risk management. There is no national position regarding whether SuDS should be treated as ‘flood risk’ assets and no definition of the term ‘significant’. Interpretation of whether and which SuDS are significant flood risk assets varies across the country. For example Kent County Council records only control structures. Central Bedfordshire County Council assume that SuDS are designed with robust exceedance flow management; therefore if they fail it is assumed that the impacts would not pose a risk and they are therefore not recorded on that basis. Drainage designs do not routinely evaluate failure risks, therefore risks associated with blockage (a possible hazard) are not understood. As resources in local authorities are currently heavily constrained, very few SuDS are being recorded by LLFAs as designated assets. Deciding on the circumstances under which SuDS should become “designated “assets in the context of flood risk asset data is an important aspect that needs addressing. The LLFA flood risk asset register is also meant to report ‘condition’. This would imply that any SuDS on the register would require feedback from adoption bodies of condition state through time.

The local planning authority (LPA) will receive drainage proposals associated with planning applications. However, they will often approve applications on the basis of only outline drainage design, and detailed SuDS design criteria (and a long term adoption agreement for the system) will normally be a condition of planning approval. Although final design drawings should be submitted to the LPA following the discharge of conditions, it is understood that this is not routinely complied with and as-built drawings following construction are rarely received. Commissioning information, whether for the implementation of SuDS (e.g. photographic evidence of construction best practice) or other infrastructure testing or certification is also rarely received. Information available to the LPA at planning application stage (that is currently stored on the planning portal) is unlikely to be suitable for storing in an asset database, as there are often significant changes made during detailed design and construction.

There is currently limited focus on collating and digitally recording SuDS information as part of this process (although this information is likely to reside with designers), and data is generally stored in the form of the drawings and reports (including hydrodynamic model output files) supplied for planning.

As most SuDS in England are not currently being adopted by either the local authority or the sewerage undertaker, management companies are being created to manage the SuDS that are built. Information on these organisations and the asset databases being used by these organisations is not currently tracked. Little is therefore known about how many there are, how they operate, the data they request from developers prior to taking on maintenance responsibilities, and whether they maintain an adequate record of the SuDS and their ongoing management activities.

Property owners are responsible for the management of SuDS within the curtilage (boundary) of their property. Information on property-level SuDS should be retained within the deeds of a property, alongside a requirement of the owner that they maintain the performance of the system and do not undertake any works that might impact on its functionality. Sewerage Undertakers that adopt SuDS downstream of property level SuDS need to understand what the expected performance of these components are so that, if downstream system capacity is put under pressure, issues can be tracked to source components.

Legacy / orphaned SuDS (i.e. SuDS that have not been formally adopted, and have no maintenance arrangements) may not be recorded at all, if plans uploaded to the planning portal are prior to the discharge of planning conditions and/or pre-construction.

11.3. Current stakeholder data sharing processes

There is an obligation for the sewerage undertaker to make information on their network available to the public and the local authority. Formats for sharing this information is usually limited to PDF images and tables.

Planning application reports are hosted on the national Planning Portal but, as discussed in Section 11.2, this may not hold the final design and/or as-constructed drainage system details.

Local authority highway drainage assets are not routinely made publically available. Information on their assets (gullies and connecting pipework to combined sewers or separate sewers) are also rarely kept on an asset database.

LLFA flood risk asset databases should be publically available, but SuDS details are unlikely to be recorded in these data sets unless they are classified as being significant assets associated with flood risk protection (which is unusual).

11.4. A strategy for the effective collection and recording of SuDS information

For the foreseeable future, the approval of new surface water drainage infrastructure will remain part of the development planning approval process, undertaken by the local planning authority. The only stakeholder, therefore, with sight of all proposals for new drainage assets (from both private developers and company development applications) is the local planning authority; and it seems clear that any asset data collection process would be most efficient if linked into the planning approval process.

It is the future drainage asset adoption body who will be most interested in securing final, as-constructed data on their new SuDS assets, as the liability for future performance will ultimately rest with them. The adoption body will therefore need to be sure that the system has been constructed as designed, unless there are protected liabilities associated with their operation, performance and other risks. SuDS component adoption is likely to fall to a range of stakeholders including local highways authorities (for solely road drainage), local authority public space teams (for components that form a significant part of public open space), sewerage undertakers (where designs meet the requirements of Sewers for Adoption 8) and private property management companies. Where an organisation adopts a system with components upstream that are owned by others, there will be a further incentive to record details for those upstream assets in order they can ensure that there are no risks to their own assets as a result of poor functionality.

As SuDS are surface systems their functionality potentially provides additional benefits to a wide range of stakeholders. This and the existence of a plethora of adopting organisations points to the fundamental need for a database within which all components and schemes are stored in a consistent manner, with a preference for this to be publically accessible.

To deliver this will necessitate the planning process to include a requirement for as-built and construction verification information for all surface water drainage systems to be provided in a suitable form to the local authority (as either the LLFA or the Planning Authority). This is likely to be required as a condition of planning, but should also be a condition of adoption by all potential adoption bodies in order to ensure that the developer has sufficient incentive to deliver the information in a timely manner.

Paragraph 206 of the National Planning Policy Framework states “Planning conditions should only be imposed where they are:

1. necessary;
2. relevant to planning and;
3. to the development to be permitted;
4. enforceable;
5. precise and;
6. reasonable in all other respects.”

There is some uncertainty within local authorities over the legitimacy of using planning conditions to request the provision of data, but conditions have been used successfully in several authority areas and examples of such conditions are provided in Box 11.1 and Box 11.2.

Box 11.1: Planning Conditions: Example 1

Pre-Commencement Planning Condition

Condition 1: No development shall take place until surface water drainage works, designed in accordance with Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015) or any subsequent replacements national standards, and details have been submitted to and approved in writing by the Local Planning Authority. In order to avoid/discharge the above drainage condition the following additional information has to be provided:

- XXX (as appropriate)

Reason: To promote sustainable development, secure proper drainage and to manage the risk of flooding and pollution. This condition is imposed in light of national policies within the NPPF and NPPG and local policies XX and XX.

Post-Construction Planning Condition

Condition 2: No development hereby permitted shall be occupied until details of the implementation, maintenance and management of the sustainable drainage scheme have been submitted to and approved by the local planning authority. The scheme shall be implemented and thereafter managed and maintained in accordance with the approved details. Those details shall include:

- Verification report providing photographic evidence of construction as per design drawings;
- As built construction drawings if different from design construction drawings;
- Management and maintenance plan for the lifetime of the development which shall include the arrangements for adoption by any public body or statutory undertaker, or any other arrangements to

secure the operation of the sustainable drainage scheme throughout its lifetime.

Reason: To manage flooding and pollution and to ensure that a managing body is in place for the sustainable drainage system and there is funding and maintenance mechanism for the lifetime of the development.

Box 11.2: Planning Conditions: Example 2

No building on any phase (or within an agreed implementation schedule) of the development hereby permitted shall be occupied until a Verification Report pertaining to the surface water drainage system, carried out by a suitably qualified professional, has been submitted to the Local Planning Authority which demonstrates the suitable modelled operation of the drainage system such that flood risk is appropriately managed, as approved by the Lead Local Flood Authority. The Report shall contain information and evidence (including photographs) of earthworks; details and locations of inlets, outlets and control structures; extent of planting; details of materials utilised in construction including subsoil, topsoil, aggregate and membrane liners; full as built drawings; topographical survey of 'as constructed' features; and an operation and maintenance manual for the sustainable drainage scheme as constructed.

Reason: To ensure that flood risks from development to the future users of the land and neighbouring land are minimised, together with those risks to controlled waters, property and ecological systems, and to ensure that the development as constructed is compliant with and subsequently maintained pursuant to the requirements of paragraph 165 of the National Planning Policy Framework (July 2018).

Requiring information for in-curtilage SuDS may be challenging if not regulated and/or a requirement of planning. In curtilage asset data also needs logging within the deeds of a property, and the property owner should be under obligation to update these records if any redevelopment occurs that materially impacts on the drainage system.

For this process to be effective it will be important for Defra and / or MHCLG to promote this new requirement and provide industry support for an efficient and effective collation, recording and sharing process.

Legacy / orphaned SuDS (i.e. SuDS that have not been formally adopted, with no current maintenance arrangements) is the most problematic area of making asset records. It is likely that the Lead Local Flood Authority should be the lead stakeholder for recording these, but to do that they need both a clear understanding of where they are, together with powers and resources to inspect and record the systems properly. Legacy SuDS (and SuDS adopted by resident's organisations with limited understanding of maintenance requirements) potentially pose a threat to Sewerage Undertaker infrastructure where they lie upstream of adopted assets – if their performance is not to their design standards due to poor construction or lack of maintenance. Condition assessment is therefore critical for legacy assets. Data for legacy SuDS will be more difficult to obtain that for new build, and information that can be collected via visual inspection may be all that can be secured.

11.5.SuDS Asset Data Recording Process

Lengthy development phasing on large sites may mean that assets are not presented to SUs for adoption for many years. This points to the need for active involvement of SU stakeholders through the development phasing process to ensure that SuDS are constructed and maintained to design standards up until the point of adoption.

It will be important for any specified asset recording system not to duplicate data requests that are required for planning – it must therefore tie in with both approval and adoption processes to minimise burdens on developer. This points to a system that can be used initially to check the suitability of the proposed scheme for planning approval purposes, and is then extended and updated to include detailed design, as-built and asset verification information – suitable for use by the SUs through the Section 104 vesting process.

Key elements of the process are articulated in Figure 11.1.

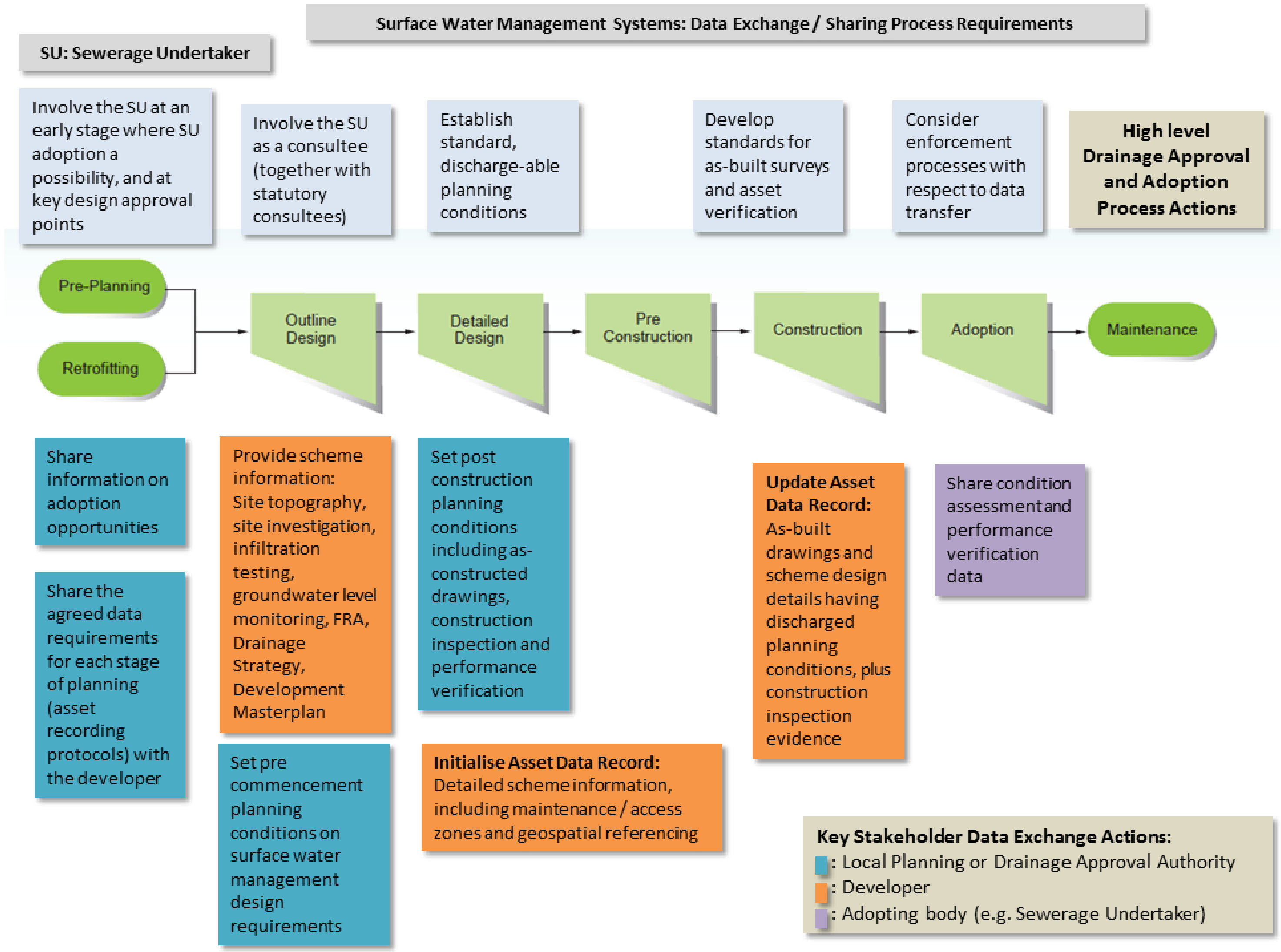

Figure 11.1: Surface Water Management Systems: Data Exchange Process Requirements

11.6.A tool for recording SuDS information

A bespoke tool or facility similar to the planning portal that hosts a database (based on the model described in Chapter 10) would enable this obligation to be implemented practically and efficiently. Without such a tool, considerable effort will be incurred by all parties involved in recording and receiving data, and the risk of inconsistent records being provided is high.

Such a tool could be a standalone system or linked to the existing planning portal which has been so successful in providing a point of reference for planning application information. To achieve this would require government backing to require data to be collected and shared, and government funding for system development and maintenance.

12.Modelling of SuDS

12.1.Historical perspectives and future needs

The UK is probably at the forefront of the modelling of drainage and sewerage systems worldwide. Not only do models include all nodes (manholes), surface runoff analysis now uses the digital surface topography for transmission of flood flows and even gullies are being represented in some cases. Sewer data is stored in databases which not only incorporate dimensional information, but also have information on levels of sedimentation and structural state.

Analysis of model outputs is moving towards the estimation of annual damage due to flooding whereas previously flooding return period was the only measure of level of service and assessment of adequacy of performance of the drainage system. This trend should start to remove the artificial ceiling of the 1:20 and 1:30 year return period performance limit which has been set by the industry for many years.

To get to this situation of being able to accurately model drainage systems has been a long journey of collecting data using various survey techniques since the privatisation of the water industry to determine what is actually in the ground. Having achieved such progress in 30 years it is clear that the current trend of a potential legacy of ‘lost’ SuDS assets which have been built, but for which the industry has no records, is a significant risk to a robust and resilient future surface water management system for the 21st century.

12.2.Comparing the modelling of piped drainage systems with SuDS

In spite of the progress on data collection and modelling, surface water models are given a lower priority than foul sewer systems and there are many drainage systems which remain to be modelled and analysed.

Runoff models for piped drainage systems have historically been calibrated on the basis of overland flow passing to gullies and hence to sewer pipework with available capacity being dependent on the peak rate of flow in the system for short duration events. SuDS systems are volumetric (i.e. they store significant volumes of water) and their performance response to short intense rainfall is very different. Unless the water industry adequately records SuDS asset information, whether it owns these assets or not, it will not be able to properly replicate the hydraulic response in any downstream sewer systems.

Modelling tools have developed from the days of manually transposing information on the primary network from drawings by hand with the significant risk of error. Now models are being created automatically from databases at the touch of a button (examples include the whole of the central Singapore drainage system). This ensures that the continued updating of the drainage database automatically feeds into the hydraulic model; thus removing the risk of out of date model redundancy. This approach has yet to become standard practice in the UK, but it will take place in due course, and there is therefore a need to prepare for that future.

12.3. Utilising recorded SuDS asset records for modelling

The data model and approach to recording asset information must ensure that outputs can be used by the modelling industry to build hydrodynamic models efficiently. However it is important not to create an asset data model dictated by the requirements of the modelling of networks which then results in an unwieldy asset data system and overly burdensome data requests of developers. Although all SuDS units are proposed to be nodes in the asset database, this does not prevent hydraulic modellers extracting the relevant information to build models with appropriate links, areas and node points. Tools such as InfoAsset are well set up to be able to capture the information from the data model and export suitable hydrodynamic models of the network system.

13. Conclusions and recommendations

13.1. SuDS ownership

Sewers for Adoption 8 (pre-implementation version - Water UK, 2018) provides the mechanisms by which sewerage undertakers (SUs) can secure the adoption of a wide range of SuDS components. However it may not mean that SUs become the default adopting body for all SuDS for the following reasons:

- The most cost effective drainage design may include non-adoptable SuDS (e.g. pervious pavements);
- Drainage designs that combine the management of highway runoff and runoff from other impervious surfaces may not be adoptable by SUs but may be the most efficient in terms of space for a development;
- Drainage designs that deliver high value landscaping and environmental benefits (but which may mean they are considered to receive land drainage) may not be adoptable by SUs;
- If some SuDS components are not adoptable by SUs, then it may be more cost-effective for a developer to transfer the entire system to a management company for adoption or long-term management;
- Some developers may consider that specific management companies are more suited to deliver high value landscape management (that promotes the image of the developer) than SUs and therefore may elect not to request SU adoption of SuDS assets.

Therefore the proliferation of SuDS adoption bodies and the associated need for collecting and sharing consistent datasets between stakeholders is likely to remain.

In Wales, the recent enactment of Schedule 3 of the Flood and Water Management Act means that SuDS Approving Bodies are now responsible for the approval and adoption of all SuDS. It is currently unclear how consistent asset data records will be collated across Wales as their current flood risk asset database does not appear to be appropriate for large-scale national collection of all SuDS asset data. The new obligations of Schedule 3 may, however, create a driver and mechanism for the implementation of a standard data reporting framework, and this may potentially differ from anything implemented by English WaSCs.

13.2. SuDS mapping symbols

It is recommended that SuDS should all be treated as nodes, and that these nodes should be represented on sewer plans using a limited set of simple symbols. These symbols need not try to reflect the physical features or behavioural characteristics of the different SuDS types. It is suggested that SuDS types could be broadly grouped and simple symbols used to distinguish them from other current symbols used by the water industry. As the information on SuDS will be stored digitally, the data attributes enables any organisation to use any symbol to show the presence of any type of SuDS unit and bespoke plans can always be produced to show SuDS in any form.

Recommendation

A prescriptive recommendation for specific SuDS symbols is not being made as attribute information can be used to select appropriate symbols for the purpose of any plans or maps. Nevertheless, the following is suggested:

- Represent SuDS elements using a consistent simple symbol for a 'SuDS node' – identified using the letter 'S' within the symbol, or alternatively a letter related to the SuDS type;
- Subdivided SuDS into several principal categories, or the categories as defined by the SuDS Manual (S1, S2…..); Use links to show flow paths between nodes; whether or not these are physically-based links such as pipes or virtual links.

13.3. SuDS mapping using nodes

Recommendation

- Many SuDS will have more than one node associated with their various features (for example inlets, outlets, overflow, pond structure).
- All SuDS nodes associated with one SuDS unit should be cross-referenced.
- Use 'Virtual' Nodes for locations where there is no specific structure (such as the end of a pipe).
- Use 'Virtual' Links to indicate flow path direction for hydraulic connectivity where a physical link does not exist.

13.4. SuDS asset referencing

Each sewerage undertaker and some other organisations have their own form of STC25 referencing system and this will not change as a result of this project. Therefore recommendations for asset referencing needs to recognise that although each asset must have a reference for recording new information that adopted SuDS will be re-referenced by the adopting organisation.

Recommendation

This report is therefore not making a prescriptive recommendation for a referencing system, but two options are suggested:

- Option 1: Use of the STC25 system, but making it fully coordinate based to 1m resolution rather than based on a 100m (used by sewerage undertakers) or 10m grid (used by Highways England).

- Option 2: Use a 4 – 4 – 4 alpha-numeric system for Location- SuDS type / drainage element type - Number for each asset.

13.5. SuDS data attributes

As with manhole information which is collected currently, SuDS information needs to be collected to capture all of its attributes to understand its hydraulic and other characteristics is extensive. This information could be categorised into a hierarchy of two or three levels of importance to assist in minimising the time and effort of data input.

Recommendation

Definition of all attributes that are likely to be useful has been made by this report. The data that needs to be mandatory are:

- Dimensional and physical data that enables all of its hydraulic characteristics to be understood;
- CDM and Health and Safety information;
- Information associated with hydrogeology and contaminated land.

Nevertheless it is considered best practice to record all information associated with the design, ownership, construction and management of the SuDS units.

13.6. SuDS data model: format

Recommendation

A simple approach to recoding data is recommended. There is little need for a data model to be defined. The data information needs to record:

- spatial information;
- numeric; and
- descriptive text.

13.7. SuDS data model: data transfer

Recommendation

An XML data transfer based protocol is proposed for ensuring ease of data transfer between stakeholders.

13.8. Requirements for ensuring the recording of SuDS assets

Recommendation

- There should be a mandatory requirement (as a condition of planning) for final design asset data to be collated and recorded in a consistent way, with an agreed content, structure and format;
- There should be a mandatory requirement (as a condition of adoption) that drainage system data should be amended with any design revisions implemented during construction and supported with as-constructed asset drawings;
- There needs to be support (in policy) from central government for the above requirements.

13.9. Implementation process stages for effective recording of SuDS information

Recommendation

An implementation process plan is needed to achieve effective recording of SuDS information. This will require the following stages and activities:

- Government support and backing to require SuDS data to be collected;
- Inter-country dialogue of principal stakeholders to unify the requirements for SuDS data records (England, Wales, Scotland, N. Ireland);
- Agreement on the process and procedures to be followed between all the principal stakeholders;
- Agreement on requirements of the data information and data protocols;
- Training on SuDS data collection plus the integration of SuDS and other drainage and sewerage data;
- Development of tools or a portal to facilitate consistent data acquisition.

Whether this can be achieved without secondary legislation in any of the countries of the UK is not known. However urgent action is required to manage the current risks associated with an incomplete and inadequate record of surface water management assets.

14. References

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Appendices

A. Feedback from Highways England SuDS Asset Register & Mapping

This Technical Note is in response to the minutes of the first PSG, as Highways England (Andy Bailey Andrew.Bailey@highwaysengland.co.uk) was unfortunately unable to attend the meeting.

- Highways England (HE) considers SuDS to be an integral part of its drainage asset, and does not distinguish between SuDS and non-SuDS drainage assets in the way they are recorded.
- HE would want the output of the project to be applicable to all drainage assets, not specifically SuDS.
- How HE records its drainage asset is defined in the DMRB Standard HD43 (2004), which was substantially revised to bring it into the digital age with the publication of IAN147 (2012). HD43 is currently being revised but basically retains the way the asset was defined and the nomenclature of HD43 (2004) with the digital representation of IAN147 (2012). The detailed data dictionary of drainage asset attributes has been moved to the Asset Data Management Manual (ADMM). All of these documents are published on http://www.standardsforhighways.co.uk. The new version of HD43 (which will likely be renumbered) should be published in 2019.
- HE records all of its drainage assets in an online GIS system (HADDMS) which has a simple and limited symbology. HE's approach is that the detailed information on each drainage asset is held in the asset attributes in the database that sits behind the GIS, it does not attempt to convey too many of those attributes through symbology in the mapping interface. The simple symbology means that it is flexible, so for example, a linear drainage run can be colour coded to represent its overall service or structural condition, to allow rapid identification of areas of poor asset condition. The symbology is defined and embedded within the online GIS system, and is not part of the asset data:
  - HE would be concerned if a standard detailed symbology was the outcome of this project. There needs to be flexibility to cover the different use cases that the various asset owners have. The proposed approach of a very limited basic symbology allowing bespoke adoption appears appropriate.
- HE represents all of its drainage assets in HADDMS as either points, lines or polygons (termed point, continuous or region assets, respectively). Chambers, inlets, outlets and some ancillaries such as control devices are points. Pipes, filter drains, ditches and channels (including swales) are continuous assets. Only ponds, basins and reservoir pavements are recorded as region assets:
  - This approach is compatible with the proposed Tier 2 GIS representation.
  - The proposal that all SuDS components, including conveyance, will be a node, would not be compatible with HE's approach. Any linear conveyance asset (ditch, swale, pipe etc.) is a continuous asset in HE's GIS model.
- HE considers that how the drainage asset functions as a system is vitally important to managing the asset. Therefore, how the individual assets are connected together and the flow direction of the water within the system are very important. HADDMS includes a flow modelling functionality, specifically for managing accidental spills of potentially polluting substances on the highway network:
  - The proposed use of dummy links to model connectivity is not fully understood from the meeting minutes. HE's approach is to define in HADDMS how all of the point, continuous and region assets

connect together, by recording the actual physical connectivity of the assets, and the flow direction in each continuous asset. Where connectivity or flow direction is uncertain this is recorded in the asset attributes. Dummy links are only used to define how water flows through a region asset, or where it has not been possible to map the actual location of a buried pipe.

- The HE's HADDMS data structure allows a drainage system model to be exported in a standard GIS format, together with all of the asset attributes, including connectivity and flow direction. This GIS data can then be imported into modelling software, for more detailed off-line studies:
  - The statement in the PSG minutes that there is "no focus at export for modelling" is of concern to HE. The asset database should represent the "one version of the truth" for the asset owner, and this data including connectivity between assets should be re-useable as widely as possible across the organisation for all sorts of purposes. To not consider this data re-use feels short-sighted to HE.
- HE's view on asset referencing has changed. The referencing system defined in HD43 (2004) is now obsolete, as a manual process. The location of the asset is specifically defined in terms of its Ordnance Survey coordinates as part of the asset's attributes.
- HE distinguishes between System, Mandatory, Required, Optional and Conditional asset data in the ADMM data dictionary:
  - System: includes the HADDMS assigned unique reference ID, and any attributes automatically calculated by the system from other attributes, such as asset condition grade which is determined from the record of defects.
  - Mandatory: is user entered data without which the drainage asset cannot be recorded on HADDMS. This is a short list of: Ordnance Survey coordinates, asset type, connectivity and flow direction, connectivity and flow direction certainty, whether the asset entry is based on field survey or digitised records, date of last survey and asset field reference IDs in the source survey data.
  - Required: Data required in new asset surveys, but may not be available in historic data. Includes asset dimensions, material, owner, asset age, etc.
  - Optional: Secondary asset data that is "nice to have", such as more detail on dimensions and materials.
  - Conditional: General notes fields that supplement other data attributes:
    - In the context of the PSG1 meeting minutes HE would consider only the System and Mandatory attributes to be "Essential", i.e. the asset ID, what is the asset, where is it, how does it connect together as part of the drainage system, and how confident are we in this data. Anything else is "Non-essential"; even the Required data is non-essential, as HE does not hold it for all of their assets. The PSG proposal to include functional characteristics and ownership would go beyond HE's current usage.
- The HE asset model distinguishes between the asset data dictionary (defined in the ADMM) which lists all of the asset attributes, the data formats required for uploading survey data to HADDMS or for downloading data from the system, and the database structure used internally in the HADDMS system. The data dictionary and data formats are relevant to the system users. The internal database structure is irrelevant to the users:
  - The data model defined in the PSG1 minutes includes the asset referencing system, as noted above; HE considers that this should not be defined by the Asset Model, it should be a unique reference assigned by the system.

  - The component connectivity and asset attributes listed in the minutes are part of HE's data dictionary.
  - The idea of a portability format specification, being a standard data interchange format between systems is a good one, and HE would be fully supportive of this. However, HE would see this as an additional import/export format it would support, with appropriate validation rules, rather than a replacement of its existing, long established data formats.
  - The inclusion of standard data storage in the Asset Model would not be supported by HE. Every asset management system is different, and will adopt its own data structure. What is important is that data could be transferred between systems in a standard interchange format, and this is unrelated to the way the data is stored in the system. Data interchange formats are not generally appropriate for data storage, and vice versa.
- BIM is important to all civil engineering businesses, and compliance with BIM standards and protocols is a government requirement. HE is developing its own BIM protocols across all of its assets to achieve compliance with government requirements:
  - The PSG1 meeting minutes state that "BIM is a future rather than current driver". HE considers that the development and adoption of BIM standards cannot be deferred.
- HE already shares its drainage data with external parties following appropriate Memoranda of Understanding that clearly state the uses that the data can be put to, agreement on retention period and disposal, and any caveats on the reliance that may be placed upon it:
  - HE considers that the concept of a national data portal to hold all SuDS data would need to recognise data ownership, and legal constraints on usage. This may make it rather difficult to implement.
  - HE's own experience of similar collaborative ventures is that funding is usually a challenge.

B. Stakeholder feedback from questionnaires and workshop

B.1. Questionnaire feedback

SuDS Asset Recording

Questionnaire Consultation

19th November 2018

Record of Outcomes

1. Introduction

As part of the stakeholder engagement process for this project, HR Wallingford (with the support of the Project Steering Group (PSG)) undertook a questionnaire consultation to try and establish:

1. What SuDS asset data recording is currently undertaken or proposed?
2. What SuDS asset referencing systems are currently used and/ or might be appropriate?
3. What approaches are currently used and/or might be appropriate for representing SuDS on sewer maps?
4. What stakeholder needs are in relation to SuDS asset data (i.e. what data should be collected);
5. What is likely to be the most effective approach for collecting, storing and sharing this data; and
6. Any foreseen challenges.

Bespoke questionnaires were sent out to Sewerage Undertakers, Local Authorities (both Planning Authorities and Lead Local Flood Authorities), Developers (and their consultants), and Property Management Companies. The PSG were tasked with circulating the questionnaire to their local contacts, and the questionnaires were promoted on the CIRIA susdrain website (https://www.susdrain.org/) and on the local authority Flownet Knowledge Hub SuDS Group (https://khub.net/web/flownet).

This document provides a high level summary of the questionnaire responses. A more detailed description of views from each stakeholder group is provided in Appendix A.

2. Responses

A total of 39 completed questionnaires were received up to 16th November 2018. Figure 1 shows the spread of stakeholders who engaged in the consultation and the region in which they operate.

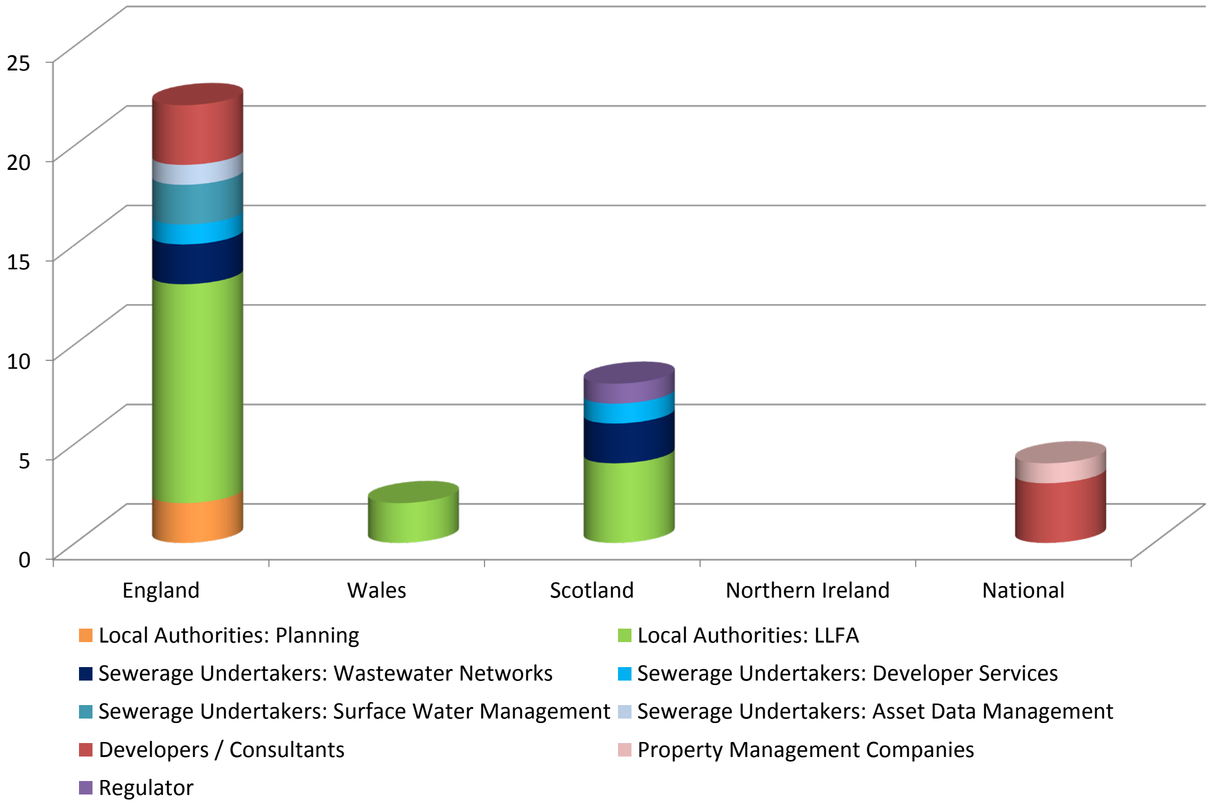

Figure 1: Stakeholders who responded to the questionnaire consultation

3. Summary of views

3.1. Sewerage Undertakers (SUs)

Responses indicated a feeling that they are gearing up in preparation for OFWATs announcement associated with SuDS adoption (rather than the fact that SfA8 provides a limited list of SuDS which they can adopt in line with the legal definition associated with drainage). There is little to indicate a mature formalised set of procedures even in Scotland where they already have adoption processes in place.

3.1.1. Do they need to record SuDS data?

- Universal agreement on recording the assets to be adopted;
- Minority want all SuDS information and even those are mostly interested downstream rather than upstream to ensure their service provided is not compromised;
- Soakaways upstream are of interest for billing implications;
- The view was stated that they don't need to know what's upstream as they wouldn't make an allowance for this in the management or performance assessment of their assets.

3.1.2. What information is provided to them and how is SuDS information stored?

- Information on SuDS is provided at two stages: at planning for discharge consent aspects and at Section 104 adoption. The latter usually requires CDM and Health and Safety files which effectively means that full as built drawings are also provided.
- Formats vary from scanned PDFs and MicroDrainage outputs through to more complex digital formats.
- Drainage assets are usually stored in a number of different asset databases.
- Normally only adopted (and thus verified) asset information is stored (and shared).
- There is a misunderstanding that any tool constrains or requires alteration of their current data storage arrangements (rather than facilitating the transfer / provision of useful information which can be interrogated and abstracted).

3.1.3. What information on SuDS should be stored?

- The extent of SuDS attribute information was noted with the implication that there was probably too much of it and they didn't need it all.
- However listing out all the aspects of the data that were proposed, there was generally agreement that all the given information should be provided to effectively mitigate risks to their adopted assets and allow future performance evaluation.
- The relative importance attributed to each generic data type by the Sewerage Undertakers is shown in Figure 2. Asset definition and responsibilities (including as-constructed details) were considered of most importance; followed by hydraulic aspects, health and safety and operation and maintenance; with water quality, amenity and biodiversity being seen as potentially of lesser importance.

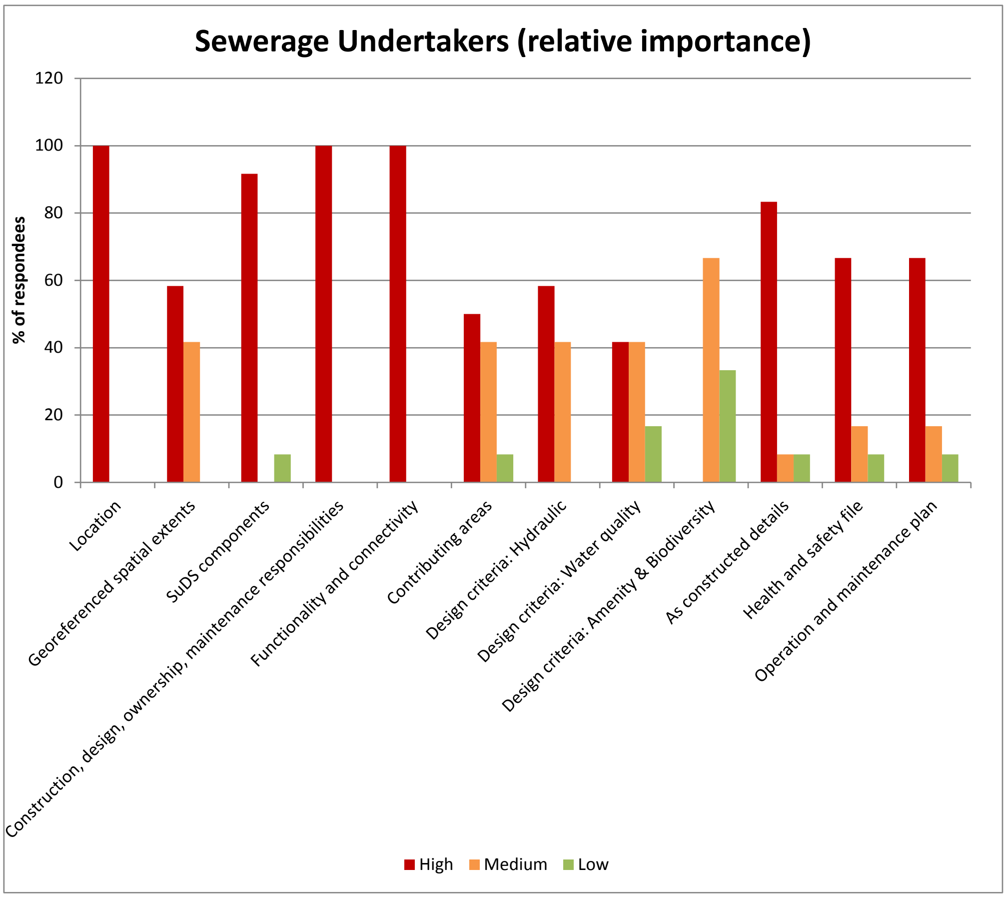

Figure 2: Relative importance of different data types to Sewerage Undertakers

3.1.4. How should SuDS be shown on mapping?

- There was little emphasis on discussing symbol types because all recognised that any symbol can be used if there is attribute information which can inform them as to what the SuDS unit is.
- There was however a desire expressed by some for developing a consistent set of naming terminology for all types of SuDS (which goes beyond the purpose of this study).
- There was a general view (and usually associated with showing ponds) that SuDS extents should be shown on mapping.

3.1.5. Exchange of data

- Some organisations implied they would provide information, but dependent on the reason and details of the request.
- Others had exchange conditions / sharing agreements in place with organisations such as LLFAs and LAs.
- It was pointed out that asset information they might have that was not owned by them would not be provided.

3.1.6. Referencing convention

- They all generally agreed with using STC25 as the basis for the referencing convention and therefore SuDS needed to be recorded effectively as Nodes.
- They pointed out that they had their own version of STC25 (and they would stick to it).
- Therefore although there was agreement, any ID allocated to a SuDS unit would not necessarily be used for that drainage element once it was adopted (or even not adopted if recorded). This implies a need to allocate an ID which may or may not be STC25 (which might be permanently associated with the SuDS unit), but which will not be the primary ID used by the SUs subsequently.

3.2. Views from other stakeholders

- There is a need for universally adopted SuDS approval, and then adoption checklists to drive consistency in data required from developers at different stages in the SuDS implementation process.
- There is a need for common language / terminology for characterising SuDS assets.
- There are concerns over the enforceability of requesting SuDS asset information and whether this require legislative change. Standard, approved wording of a relevant planning condition is needed (including consideration of a pre-occupation condition for Management rather than a pre-commencement condition).
- There is a need to have access to design, construction and maintenance details of all SuDS components forming part of a complete surface water management system for a site. Concerns over burdens of recording all soakaways and all gullies.
- There are concerns over the current status of Operation and Maintenance (Management) planning at design stage, and what happens to Management Plans post implementation.
- There are concerns over who (or whether anyone) is accepting responsibility for the appropriate construction of sub-surface and proprietary SuDS (contractual sign-off).
- There is a need for a contractual requirement to record and store SuDS inspection and maintenance data and maintenance responsibility (so the local authority (LA) has recourse for action in the event of flooding or public complaints).
- There are concerns over the current lack of joined up process: currently data collection and storage is divided between stakeholders and between different stages in the implementation process e.g. some datasets are 'approved' as part of the planning approval process, some are required by adoption body, some are stored on planning portal (or internally within LA), some are stored by contractor or remain with designer, some are stored by adoption body…
- There are many challenges and complexities over requiring as-built drawings and post construction performance verification (after a suitable operational period e.g. 12 months). Currently little control. Limited construction 'evidence' collected.
- Concerns were raised over the sufficiency, robustness, stakeholder accessibility of storage of SuDS details on planning application websites.
- There are many drivers for storing SuDS data (asset register, con 29 searches, planning policy monitoring, flood risk management, FWMA s21 requirements, input to other strategic statutory plans e.g. RBMPs), designation of SuDS as assets under the FWMA , Schedule 1.

- Current lack of clarity and consistency as to when / whether SuDS assets are a 'significant' flood risk management asset, and therefore whether or not they need to be designated.
- There is a general positivity about the need for and potential value of a universal SuDS data entry portal, but concern over whether this would pose too much of a burden for developers (particularly if duplicate information to that required by planning was requested), and whether stakeholders with existing asset management databases would find it confusing.
- Figures 3 and 4 show the relative importance attributed to each generic data type by the Local Authorities and Property Management Company.

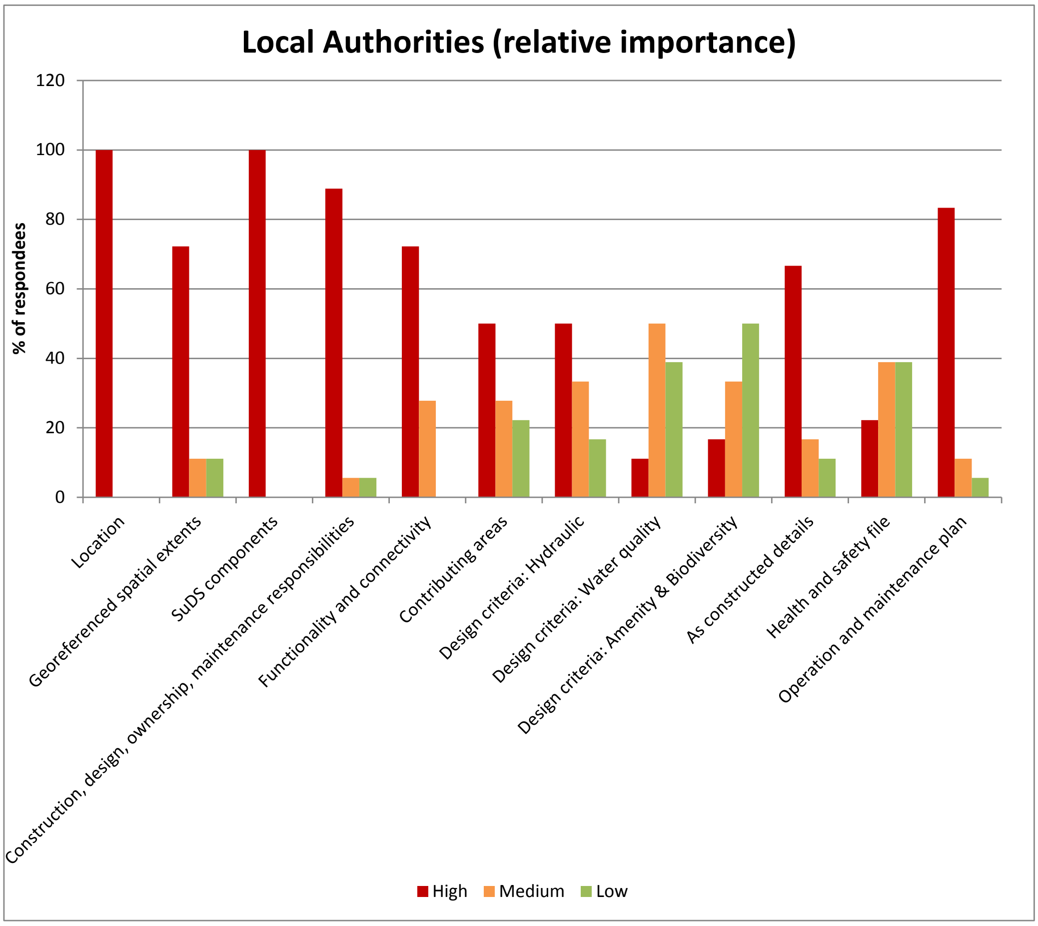

Figure 3: Relative importance of different data types to Local Authorities

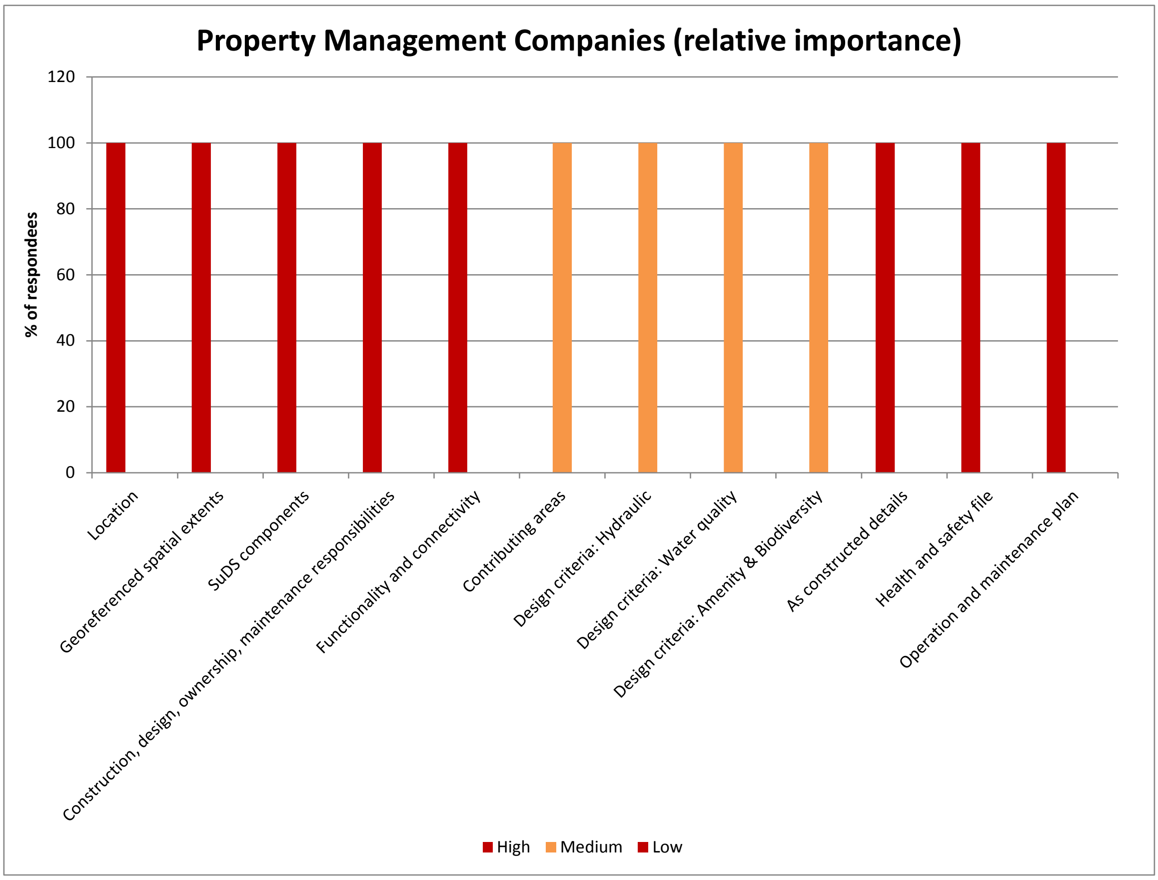

Figure 4: Relative importance of different data types to (a single) Property Management Company

Figure 5 shows how easy developers consider it would be to provide the equivalent information.

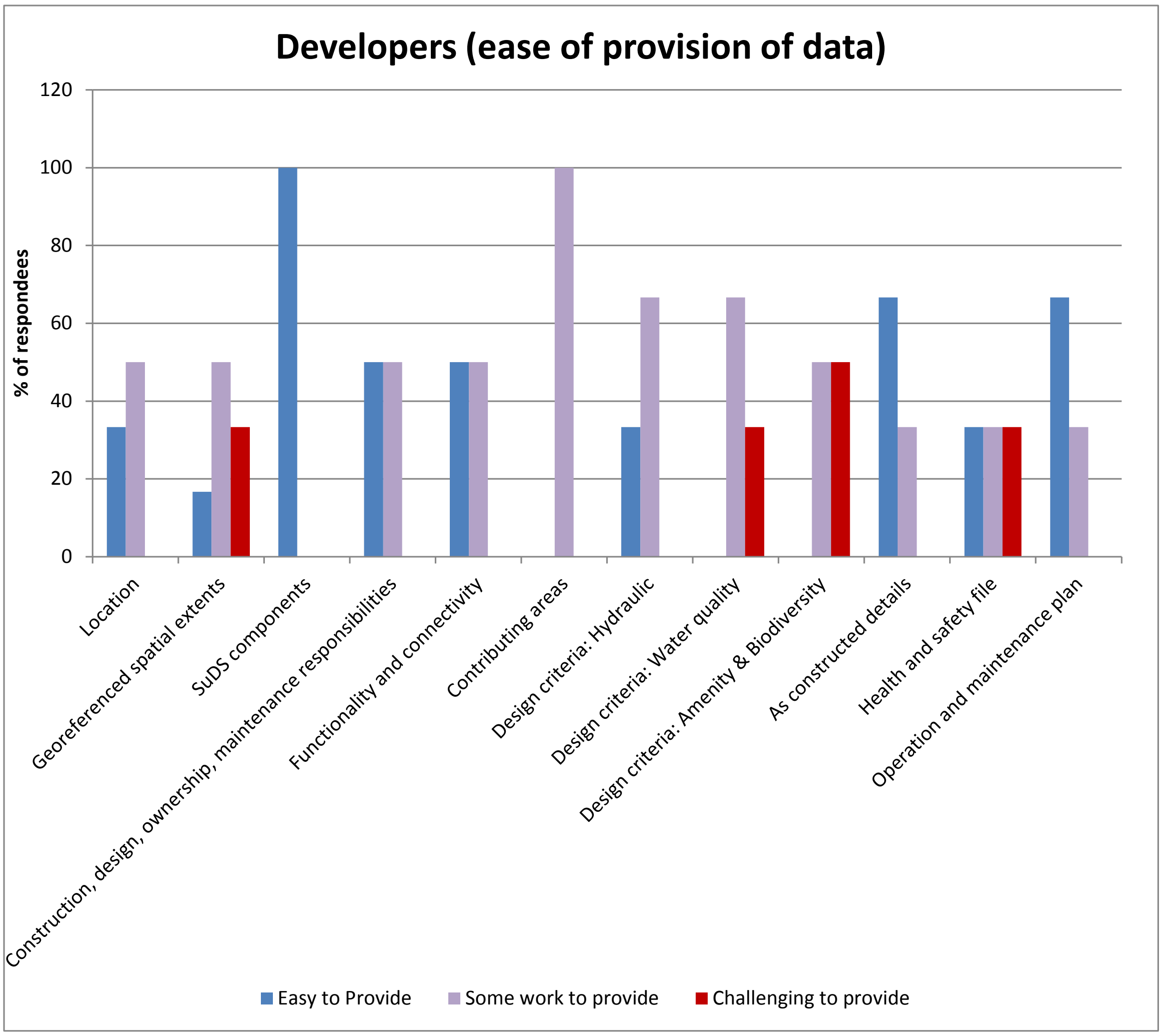

Figure 5: Relative ease of provision of different data types by Developers

Appendix A: detailed questionnaire responses

A.1. Sewerage Undertaker Responses

- Only adopted assets currently held on corporate GIS.
- Recognise benefits of recording upstream suds info but currently not collected (though highway drainage and 3rd party Management Company assets may be e.g. AW).
- Non-adopted SuDS would need to be shown as non-verified on systems.
- If property not connected to the sewer – this needs to be understood, both by water company (to correctly bill) and by solicitors undertaking searches at point of house sales.
- Format in which data is provided varies depending on scale and expertise of those submitting the calcs – can range from hand drawings and calculations (scanned), to pdf's to fully GIS outputs and model files.
- Traditional pipe system details generally submitted as model files and Autocad drawings.
- As an adopting body for SuDS, feeling is that they would want to see Commissioning report, Operation and Maintenance Plan, Health and Safety File (including risk assessments), Access and land ownership details, Manufactured components (including guarantees, product and manufacturer details).
- This data would needs to be accessible by Data Services, Legal, and SU Inspection teams.
- Currently information only transferred to SU by developers or their drainage consultants. No data transfer via LLFA/LPA.
- Standard process: Detailed design layout drawing are uploaded in our GIS system as "proposed / non-operational" once they pass a technical audit (Section 104 application stage). These GIS records are updated to " existing / operational once as-built records are received and connections are live (on 100% construction, 50% occupancy – provisional vesting certificate stage). H & S and risk assessment are recorded prior to vesting.
- Only vested asset data records can be shared.
- Feeling that any SU would want to take part in the pre-planning discussions, planning consultation, and adoption approval where information should be provided by all of the above.
- The different SuDS attributes may be held in different (digital) locations: physical/geographic characteristics in the GIS system (ESRI), modelling information in the modelling system (Infoworks), asset management plans and other data in another system (MARS, SAP based). Other data such as amenity and biodiversity criteria would be recorded in other systems, some of which would be linked to the project. Some of the data described in the suggested attributes, would not be currently held and would have to be derived.
- On maps, variation but generally point / line / area features. In general, component extent represented as polyline.
- Variation in views on the value of an on-line data entry tool from very positive to very negative.
- Standardised symbology, asset attribution and ways of showing connectivity (including to ground) would be of benefit.
- Consider use of SuDS Manual to establish hierarchical asset categorisation.
- Key to consider essential data carefully to ensure high quality datasets requested from developers / design consultants and time/resource is not wasted / frustrated.

A.2. Local Authority Responses

- SuDS design information required for planning approval (for all major developments as a minimum). As-built information, following discharge of any conditions, is not always requested / transferred. LLFA often have no access to record of as-constructed assets.
- In some cases, design information may not be provided until discharge of conditions.
- Some LA's are under the impression that a planning condition requesting verified as-built designs is not legal – and are seeking legal guidance and the definition of a standard condition wording.
- Management plans and responsibilities (for SuDS remaining private or passing to management companies) are generally a planning application / condition requirement but are not always provided. One LA suggested a pre-occupation condition may be more appropriate than a pre-commencement one for Management Plans?
- SuDs data currently provided in a range of format complexities, generally held on planning portal, only 1 LA mentioned requesting photographs of sub-surface construction.
- Generally held for lifetime of development although some mention of 6+ years was made. A couple of LA's store SuDS designs in separate case files.
- As-built and construction data generally considered difficult to secure due to lack of involvement / resources later on in the process.
- Management Plan data generally provided but no evidence as to whether it is delivered post completion.
- Variations in views on value of on-line data entry portal. Most considered it would be useful, but would not want it to duplicate current requirements of developers through planning process; funding and administrative arrangements considered likely to be problematic; also data storage – local or on the cloud (local preferred)?
- Clear checklists of what is required of developers at each stage in the process is considered important.
- Legislative change considered necessary by some.
- Variation in the extent of SuDs asset recording by LA. Some record only 'significant', some only record those they own, one LA is migrating to new GIS system are recording all SuDS with a link to as-built drawings.
- Access to a data sharing system for all Risk Management Authorities would be of significant value.
- Highway Authorities collect a lot of information on drainage assets – there won't be the appetite for two separate asset management systems for drainage.
- Recording all gullies and soakaways considered by some to be too onerous.
- Need for agreement of any approach / terminology etc with very wide stakeholder group.

A.3. Developer Responses

- As-built construction drawings not undertaken by all and considered a burden / complicated by several.
- Concern as to whether on-line data entry portal may duplicate planning approval and management company adoption requirements.

A.4. Property Management Companies

- Requires all information prior to adoption.

A.5. Environmental Regulators

- SEPA highlighted risk associated with lack of consistent recording between multiple stakeholders.
- The Flood Risk Management (Scotland) Act 2009 section 17 requires local authorities to map SUDS in their area (regardless of who owns and maintains the SUDS) https://www.legislation.gov.uk/asp/2009/6/part/3/crossheading/bodies-of-water-etc-mapping-and-assessment but Scottish Ministers have not directed any date for when this must be done, and have not specified what information must be collected.

B.2. Workshop feedback

SuDS Asset Recording

Water UK Workshop

13th November 2018

Record of Outcomes

Workshop Attendees

Name	Organisation
Brian Smith	Yorkshire Water
Phil Reaney	Water UK
Richard Kellagher	HR Wallingford
Bridget Woods Ballard	HR Wallingford
Mark Wetton	HR Wallingford
Martin Banks	Southern Water
Martin Brockington	Thames Water
Jeremy Sykes	Yorkshire Water
Hayley Bowman	Environment Agency
Bronwyn Buntine	Kent County Council
Alys Bishop	Central Bedfordshire County Council
Oliver Singleton	Sheffield City Council
David Charlton	Northumbrian Water
Matt Delaney	United Utilities
Gordon Stenhouse	Scottish Water
Richard Behan	South West Water
David Milligan	Ardent Consulting
Peter Coombs	Innovyze
Tony Griffiths	United Utilities
Hannah Freeman	Wildfowl & Wetlands Trust
Louise Walker	CIRIA
Lara Day	Severn Trent Connect
Steve Teague	South West Water
Daniel Collier	Peter Brett Associates
Martyn Chatham	Dwr Cymru
Jonathan Glerum	Anglian Water
Arbon Damian	Anglian Water

Name	Organisation
Williams, Dawn	Severn Trent Connect
Nicola Coppen	Ebbsfleet District Council
Thomas Bacon	WSP
Neil Clarke	Kent County Council
Neil Berwick	Greenbelt Group
Tony Andrews	Innovyze
Sue Illman	Illman Young Associates

Record of Discussion

Discussion Topic	Outcomes
1: Do We Need to Record SuDS ?	• Overwhelmingly – yes • New build presents issues but recording legacy / orphaned SuDS presents greater problems. The LLFA should be the lead stakeholder on these, but need an understanding of where they are, powers and resources to inspect and record properly. • There are also legacy assets that developers continue to have responsibility for that SU (Scottish Water) will not adopt yet; either because subsequent development phases are to be built or due to their current state (until they are cleaned and remediated to as-designed condition with no siltation and good vegetation establishment). Difficulties with getting developers to fund this remediation if they have left the site, and impossible if they have gone bust. • Legacy assets may not conform to adequate design and health and safety criteria – therefore their adoption would present risks to the SU. • Recording 'legacy' vs 'SfA8 conforming' SuDS are both required whether they are adoptable by SUs or not but may require different asset recording processes. • Development phasing presents a real issue with assets potentially not being presented for adoption for many years. • Recording design criteria (and how they are met by the scheme) should be part of planning approval process as this will be required by any potential adoption body. • Without recording the design criteria, it would not be possible for evaluation in the future to confirm that the SuDS still meets the intended criteria. • Failing or non-maintained SuDS may pose a surface water flood risk in time (relevant for LLFA) and/or problems for SU sewer capacity (relevant for SU e.g. if pervious pavements subsequently sealed or property level soakaways infilled). • There is a need for much more detailed evidence on 'actual' SuDS delivery (Defra / EA). Current reviews are based on interpretation of evidence available. See ASC report on metrics for reporting progress on surface water management (CCC, 2018). Asset register would help with government adaptation evidence. Also see EA 2010 report, LA FR asset registers – scoping tools and guidance for LA responses on attributes / systems needed. • Private management companies that usually involve resident's committees present issues. Resident's committees tend to have insufficient understanding of the system risks and financing maintenance may be challenging.

Discussion Topic	Outcomes
	• The LLFA flood risk asset register is meant to report 'condition'. This would imply that any SuDS on the register would require feedback from adoption bodies of condition state through time. • Interpretation of the extent to which SuDS are significant flood risk assets varies across the country. Kent CC record all control structures. Central Bedfordshire CC assume that SuDS are designed with robust exceedance flow management, therefore if they fail the impacts will not be significant – therefore not recorded on that basis. • General view that drainage designs do not often evaluate failure risks. • The entire SuDS network is a complex combination of vegetated elements, pipes, storage features etc. At a basic level, need visibility of which elements are private, which are public etc. • Without records of all elements and system functionality, there is a risk that SUs will respond to public complaints about issues that are not related to their assets.
2. Which SuDS should we be recording?	• Need for everything e.g. if pervious roads not recorded (and that data isn't accessible), downstream SU capacity issues won't be able to look at potential upstream issues. • Everything should be recorded, and available as data to be mapped if required. • SU's shouldn't have sole responsibility for recording entire system. • 'Requiring' or 'enforcing' in-curtilage assets will be challenging. Regulation will be key. • In curtilage asset data should be logged with the deeds of a house, including updates (included within house surveys) if/when things are changed. • In Scotland, Sewers for Scotland 3 tends to drive end of pipe solutions – easier to understand and regulate, generally limited / no links to upstream / downstream assets. • Need to future proof asset records and we need to start recording now ! • For Section 278 (Highway Works) agreements – there is a requirement for a post construction GIS survey – why not for SuDS too ? (note Section 278 agreements are a legal requirement). • Kent CC require SuDS details to be provided in a drainage verification report. • In the CIRIA SuDS construction guidance, it says – you should do as-built surveys, you must confirm it is working, you must record details for each asset. This has been transposed into Sewers for Adoption 8. • Adoption options will affect SuDS designs. Some developers may not want to transfer assets to SU's, in which case they may intentionally design non-compliant systems (e.g. with > 50% highway drainage). This may be driven by a range of reasons including asset data recording requirements if these are considered to be too onerous. May end up appointing inset company (not an FRM stakeholder) – easy to get license from Ofwat. • SUs need to record all assets (including SuDS) that connect to their network. They will all have the ability to impact on downstream sewer performance. SUs record a wide range of features not owned by them; either due to them being legacy information or because they impact on their network.
3. How should SuDS assets be recorded ?	• Using a logical model that incorporates each element that needs to be maintained. • Flow paths need to be preserved. • Need to be able to capture all relevant information (such as over-the-edge drainage for filter strips / swales – i.e.. the kerb / pavement edge as a continuous lateral inflow).

Discussion Topic	Outcomes

	• The way the data is recorded has to be clear to all stakeholders not just asset managers. Having shaded areas showing extent of SuDS on maps is helpful in highlighting areas that form part of the drainage system and, as a minimum requirement, would help ensure land does not get re-designated, damaged, re-surfaced (e.g. pervious areas of car parks) or used for tree planting etc.
	• Most asset maps are sent out on an OS base. These show objects such as ponds anyway (but with a time delay).
	• Need to start from an understanding of what sewer asset maps are actually used for and by which stakeholders:
	  ○ For regulatory reporting of assets
	  ○ Customer service – data sharing.
	• Different areas of the SU may use different software packages to support the various uses of the data. Software can incorporate most non-standard features.
	• 'Virtual' nodes won't mean anything for management contractors.
	• Need to ensure (by recording) 'maintenance strips' to ensure unaffected for future use.
	• Which stakeholder should hold which bits of data ? LLFA/LPA have a duty to cooperate, but LLFA only required to store 'basic information' (description and owner).
	• A CON29 search should identify whether a particular property is served by SuDS – however this can just point to a verification report or planning condition (even though this may not have been discharged).
	• You <u>cannot</u> show a virtual link or node on a public record in compliance with legal requirements – you must show physical assets that someone can potentially connect into. However this does not mean that these cannot be used as features in the recording and management of assets.
	• United Utilities offer recording and mapping of other drainage assets, in addition to their own. SUs obliged to show assets, but there is nothing to stop them mapping other things including private and highway systems (potentially on another overlay, not presented to the public).

4. How should SuDS be referenced?	• You can't assume an object will never move or has been recorded in the correct location. • STC ref is used by a number of SU teams. • Developers not concerned over the defining of an asset ID. • KCC think need for a unique reference, but should be recognisably different from SUs – to make it clearer and easy to identify that it is a LLFA / KCC ref rather than an already-adopted SU asset. • Consider dangers of providing misleading geospatial information as part of the reference (as it may be incorrectly located). • Suggest using stakeholder or development identifier. • SUs already capture other referencing systems. For example Yorkshire Water have an attribute field for EXT.REF.ID which is used for fire service reference code numbers for fire hydrants.
5. How should SuDS be represented on maps?	• Defining symbols for the type of SuDS is a non-issue (although consider points made in previous sessions) ? • Symbols are important if user needs to make quick decisions by interpreting the images (e.g. marine maps). • If developer submits data for the entire system, there is a need to be able to see that on a map. How will the data come in? Is there potential for data confusion if different stakeholders show things differently on maps?

Discussion Topic	Outcomes

	• In a SU data model, every attribute has to have a 'flag' that indicates history of provenance (who added the data, who changed it etc) – but this would add another layer of complexity.
	• Key issue to answer – is consistent visualisation important ? It seems it may be…
	• Alternative view on standardisation:
	  o It can drive down supply chain costs
	  o Now is the only chance, else it will become more expensive
	  o It could just be very high level i.e. surface, sub-surface, roof level
	  o Standardisation provides opportunities for machine learning / AI
	  o Might allow greater transferability e.g. to meet duties under Flood Risk Regulations.

6. What data should be recorded ?	• Meeting SuDS Standards (design criteria and how these have been met). • Water quality, amenity and biodiversity (natural capital drivers). • Catchment areas to SuDS – perhaps. • Land ownership. • Date of construction. • Planning conditions (e.g. for maintenance). • Hydraulic design (need to understand performance). As-built modelling (but what happens if it doesn't meet the performance criteria?)? • Future proofing. • Associated files (e.g. CDM health and safety file). • Management Plan (note will change through time). • Post construction inspection record. • SUs need opportunity to review design for adoptability (therefore need a consistent design record), and construction inspection.
7. Data Model	• Could be facilitated through BIM. It is possible to extract pdf attributes into any BIM package. • Housing sector does not universally implement BIM, particularly at the smaller scale. • Scale of authority will determine capacity to deal with complexity of data model. • Suggest a simple web page that allows free text or drop down lists within consistent data fields. Can be written in XML and fed into GIS package. • Are there conflicts between public and private data model needs ? • We need to move forwards from scanned images to geospatial datasets – this will drive progress. • Should the process circumvent the Local Authority ? i.e. should the SU collect all SW asset information for all development and feedback relevant data to LA? • Issue – when could it be a requirement for it to be submitted to SU and how enforceable is that? • Developer services currently get data in huge range of different formats from electronic submissions to 'back of fag packet calculations'.

8. Implementation Road Map	• There is a need for a central data repository – but who should host / fund this, or should it be a collaboration?
	• Everyone involved in a development should have access for lifetime of the development.
	• Suggestion - make it part of the planning process:
	  o Pre-planning: issue unique ref nr
	  o Through planning, info is updated via portal
	  o Linked to S104 process

Discussion Topic	Outcomes
	○ Post construction, available for occupier enquiries. • The process as set out is not one that all stakeholders would use, needs tweaking or two categories - < 10 and > 10 houses ? • Consider where the S104 process fits in (note: point of vesting could be many years into the future). • Hard drainage assets may not be handed over for adoption for e.g. 5 years due to phasing / completion. Soft assets may need to be adopted much earlier. • High level data may come in pre-planning (or at outline). • Need to require developers to take photos at key points in the construction process so suitable and robust evidence is collated. • How to facilitate 'commissioning? ○ Current reliance on indemnity insurance of contractor ○ Building control is not appropriate ○ Water company visits / inspection during construction. • Can't require anything at pre-app stage as this is at discretion of developer. • Need a consistent format specification. If left to LPA/LLFA will always be local, too detailed for national policy / guidance, WASC policy / standard won't carry sufficient weight. Solution : LPA nationally standardised policy requirement. • SUs need to see detailed designs prior to approval: make WASCs statutory consultees ? • Currently, LPA wouldn't record individual assets spatially (pdf saved to case file) – too onerous. • Detailed surveys timing will depend on when developer can get on site – lots of push back from developers if this is asked for up front. • Developers resist due diligence tests. Solution: need it as a requirement on the planning applications, LPA condition. • Link to Section 98, Section 104 and Section 106 agreement processes. • Need to record maintenance access and buffer zones on mapping. • Other adoption bodies: IDBs, Canals and Rivers Trust, leisure and open spaces (LA), Parish / Town Councils ? • What about approval officer (planning officer ?) recording data using GPS on site to removal onerous data entry phase ? • Would need guidance for self-builds. • If conditioned by LLFA/LPA, would cove through at post-construction with verification report. • Notification process important. • Need guidance on format for as-built surveys. • Consider links to enforcement if not done correctly / timely manner. • How will record review work for multi-functional SuDS as WASC may only verify hydraulic functionality. • Issue: LLFA has no oversight of final asset design, completion, maintenance. Solution: WASC notify LLFA of adoption – provide LLFA with asset details – add to S21 register, land searches etc.
Other thoughts:	• Use SuDS Manual definitions for SuDS categories. • Pre-fix ID for each development / site / location / road. • Where is the system characteristics as a whole defined (last node in the system ? – could be linked to / referenced by upstream nodes). • Consider the risks associated with possible future transfer of private sewer assets (including SuDS). • Consider planning conditions for requirement of data – however risks of

Discussion Topic	Outcomes
	creating a condition that cannot be discharged. May need legal guidance on standard policy wording (planning advisory service ?). • This should be a framework for best practice, not regulation. • Although SuDS may not be considered a designated asset, they may form part of any SFRA or Section 19 study. • Also need to define asset inspection record.

C. Glossary

There are terms in this glossary of general relevance to SuDS which are not used the report.

Adopting body	The organisation responsible for taking ownership of the SuDS.
Adoption	The process of transfer of ownership of a structure or system is accepted to an organisation.
Amenity	The quality of being pleasant, attractive, desirable and/or useful.
Approving body	The organisation responsible for approving the SuDS.
Attenuation	Reduction of peak flow rate and increased duration of a flow event.
Attenuation storage	Volume in which runoff is stored when the inflow to the storage is greater than the controlled outflow.
Basin	A ground depression that is normally dry, designed to store surface water prior to infiltration (see Infiltration basin) and/or provide attenuation (see Detention basin).
Biodiversity	The diversity of plant and animal life in the world, an area, or a particular habitat – a high level of which is usually considered to be important/desirable.
Biofiltration	Filtration using living materials (see Filtration).
Bioretention system	A shallow planted depression that allows runoff to pond temporarily on the surface, before filtering through vegetation and underlying soils prior to collection or infiltration. In its simplest form it is often referred to as a rain garden. Engineered soils (gravel and sand layers) and enhanced vegetation can be used to improve treatment performance.
Block paving	Paving designed to allow rainwater falling onto the surface or runoff discharged over the surface to infiltrate through the joints or voids between the blocks into the underlying pavement structure (see permeable pavements).
Blue roof	A roof construction that stores water; can include open water surfaces, storage within or beneath a porous media or modular surface, or below a raised decking surface or cover.
Brownfield site	A site that has been previously developed.
Catchment	The area contributing surface water flow to a point on a drainage or river system. Can be divided into sub-catchments.
Climate change	A change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic

	changes in the composition of the atmosphere, ocean or in land use.
Climate resilience	The capacity of a system to cope with a hazardous climate event or trend or disturbance, responding or reorganising in ways that maintain (or recover) its essential function, identity, and structure, while also maintaining the capacity for adaptation (see Adaptability).
Combined sewer	An underground pipe designed to carry both foul sewage and surface water runoff.
Combined sewer overflow (CSO)	A structure on a combined or partially separate sewer system that allows the discharge of flow in excess of that which the sewer is designed to carry, usually to a receiving surface water body.
Contaminated ground	Ground that has the presence of substances that, when present in sufficient quantities or concentrations, could cause significant harm to people or protected species, or significant pollution of surface waters or groundwater.
Control structure	Structure to control the volume or rate of flow of water through or over it.
Conventional drainage	The method of draining surface water using subsurface pipes and storage tanks.
Conveyance	Movement of water from one location to another.
Cost-effective	Something that is value for money. In economic terms, the benefits received and/or services delivered are worth at least what is paid for them.
Creep	A load placed on a polymer material will result in an initial deformation, but with the load remaining over time, further deformation will continue to occur. The rate of creep becomes greater as the applied load increases.
Critical duration event	The duration of rainfall event likely to cause the highest peak flows and/or levels at a particular location, for a specified return period event.
Curtilage	Land area within property boundaries.
Data model	A description of how information is stored as digital data.
Design criteria	A set of agreed criteria that the proposed system should be designed to satisfy.
Design event	A synthetic rainfall event of a given duration and return period that has been derived by statistical.
Designated drainage system	All parts of a drainage system (including above ground conveyance and storage areas that may only be used relatively infrequently) that form the management of surface water runoff up to the designed level of service.
Designing for exceedance	See Exceedance design.

Detention	The temporary storage of water to attenuate flows.
Detention basin	A landscaped depression that is normally dry except during and following rainfall events. Constructed to store water temporarily to attenuate flows and, where vegetated, provided treatment.
Development	Any area of land that has been or is being developed (i.e. land use change that includes construction). This includes new developments, redevelopments, infill and retrofit.
Diffuse pollution	Pollution arising from land-use activities (urban and rural) that are dispersed across a catchment, or sub-catchment, and do not arise as a process effluent, municipal sewage effluent, or an effluent discharge from farm buildings.
Discharge consent	Permission to discharge effluent, subject to conditions laid down in the consent, issued by the relevant environment regulator.
Ecology	The study of plants (flora) and animals (fauna) and the relationships between them and their physical environment.
Ecosystem	A biological community and its physical environment.
Environmental regulator	The primary environmental regulators in the UK are: the Environment Agency in England, Natural Resources Wales, the Scottish Environment Protection Agency and the Northern Ireland Environment Agency. Other organisations that have regulatory responsibilities relating to the environment include local authorities (with respect to e.g. contaminated land and tree preservation), Natural England and Scottish Natural Heritage (with respect to nature conservation).
ESRI	A supplier of geographic information systems that developed and regulates the shapefile data format.
Exceedance design	Designing a system to manage effectively events that exceed (i.e. are bigger and rarer than) the drainage system's required level of service.
Exceedance event	A rainfall or flow event that exceeds (i.e. is bigger and rarer than) the design event (see Design event). Not be confused with an extreme event (see Extreme event).
Extreme event	A rainfall or flow event that is relatively rare, generally considered to be an event with a return period of 30 years or more. Not be confused with an exceedance event (see Exceedance event).
Filter drain	A linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage.
Filter strip	A vegetated area of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
Filtration	The act of removing sediment or other contaminants from a fluid by passing it

	through a filter.
Fines	Small soil particles less than 63 micron in size.
First flush	The initial runoff from a site or catchment following the start of a rainfall event. As runoff travels over a catchment it will collect or dissolve pollutants, and the “first flush” portion of the flow may be the most contaminated as a result. This is specially the case for intense storms and in small or more uniform catchments. In larger or more complex catchments pollution wash-off may contaminate runoff throughout a rainfall event.
Flexibility	The ability to cope with a range of conditions or requirements.
Flood frequency	The concept of the probable frequency of occurrence of a flood event of a given size.
Flow control device	A device used to limit the flow through the outlet from a SuDS component, usually necessary to meet a required discharge rate.
Forebay	A small basin or pond upstream (or at the upstream end) of the main drainage component, with the function of trapping sediment.
Foul drainage	The infrastructure that drains the water and sewage that is discharged from within houses.
Foul sewer	An underground pipe design to carry only foul sewage.
Freeboard	Distance between the design water level and the top of a structure, provided as a precautionary safety measure against early system failure.
Frequent (rainfall) event	Rainfall events that happen more often than once a year.
Geocellular (structure)	A plastic box structure used in the ground, often to attenuate runoff.
Geocellular storage systems	Modular plastic units with a high porosity (generally around 95%) that can be used to create a below ground structure for the temporary storage of surface water prior to controlled release or use. The storage structure (tank) is formed by assembling the required number of individual units (sometimes in several layers) and wrapping them in either a geotextile or a geomembrane.
Geocomposite	A form of geosynthetic that is made by creating a single component from two or more elements (e.g. a drainage core and a geotextile).
Geogrid	Plastic grid structure used to increase the strength of soils or aggregates.
GeoJSON	A popular data format for encoding geographic data structures based on JavaScript Object Notation (JSON).

Geomembrane	An impermeable plastic sheet, typically manufactured from polypropylene, high density polyethylene or other geosynthetic material.
Geopackage	A data format for geographic information systems implemented using the SQLite database.
Geosynthetics	Man-made products used to stabilise groundworks. These include geotextiles, geomembranes, geocomposite clay liners and geocomposite drainage products.
Geotextile	A permeable fabric, which can separate, filter, reinforce, protect and/or drain.
GML	Geography Markup Language, a data format for storing and exchanging data on geographical features based on XML (extensible markup language).
Green infrastructure	A strategically planned and delivered network of natural and man-made green (land) and blue (water) spaces that sustain natural processes. It is designed and managed as a multifunctional resource capable of delivering a wide range of environmental and quality of life benefits for society.
Green roof	A roof with plants growing on its surface, which contributes to local biodiversity. The vegetated surface provides a degree of retention, attenuation and treatment of rainwater, and promotes evapotranspiration.
Green space	An area of grass, trees or other vegetation set apart for recreational or aesthetic purposes in an otherwise urban environment.
Greenfield	Relating to land that has never been developed, other than for agricultural or recreational use.
Greenfield runoff	The surface water runoff regime from a site before development.
Groundwater	Water that is below the surface of ground in the saturation zone.
Gully	Opening in the road pavement, usually covered by metal grates, which allows water to enter conventional drainage systems.
Habitat	The area or environment where an organism or ecological community normally lives or occurs.
Hazard	A property, situation, or substance with potential to cause harm.
Heavy metal	Loosely, metals with a high atomic mass (sometimes given as metals with an atomic mass greater than that of calcium), often used in discussion of metal toxicity. No definitive list of heavy metals exists, but they generally include cadmium, zinc, mercury, chromium, lead, nickel, thallium, and silver. Some metalloids, e.g. arsenic and antimony, are classified as heavy metals for discussion of their toxicity.
Highway authority	A local authority with responsibility for the maintenance and drainage of highways

	maintainable at public expense.
Highway drain	A component draining the highway on highway land that is maintainable at the public expense; vested in the highway authority.
Highways England	The government agency responsible for strategic highways in England, i.e. motorways and trunk roads (formerly the Highways Agency). In other parts of the UK this role is fulfilled by Transport Scotland, Welsh Government, and Transport Northern Ireland.
Hydraulics	Hydraulics is another term for fluid mechanics used in the context of water engineering, and is the study of flows. In the context of this report, hydraulics covers the storage, conveyance and control of flows within the proposed drainage network.
Hydrogeology	Hydrogeology is the study of water below the ground surface and geological aspects of surface water. In the context of this report, hydrogeology covers the dissipation of the rainfall-runoff beneath a permeable soil surface.
Hydrograph	A graph illustrating changes in the rate of flow from a catchment with time.
Hydrology	The study of the waters of the Earth, their occurrence, circulation, and distribution; their chemical and physical properties; and their relation with the environment, including their relation to living things.
Hyetograph	Temporal rainfall profile.
Impermeable	Will not allow water to pass through it.
Impermeable area	The area within a defined catchment that is impermeable, usually given as a percentage.
Impermeable surface	An artificial non-porous surface that generates a surface water runoff after rainfall.
Indicator	A means of measuring, at least in part, the extent to which design criteria are achieved (see Design criteria).
Infiltration (to a sewer)	The entry of groundwater to a sewer.
Infiltration (to the ground)	The passage of surface water into the ground.
Infiltration basin	A dry basin designed to promote infiltration of surface water to the ground.
Infiltration component	A component specifically designed to aid infiltration of surface water into the ground.

Infiltration trench	A trench, usually filled with permeable granular material, designed to promote infiltration of surface water to the ground.
Initial rainfall loss	The amount of rain that falls on a surface before water begins to flow off the surface.
Inlet	A structure or landscape feature that manage the flow into a SuDS component.
Interception	The prevention of runoff from the site for the majority of small (frequent) rainfall events (or for the initial depth of rainfall for larger events).
Interception storage	The capture and storage of small rainfall depths prior to infiltration, evapotranspiration and/or use.
Joint probability	The calculated probability of two or more specific events occurring together.
Land use	The main activity that takes place on an area of land based on economic, geographic or demographic use, such as residential, industrial, agricultural or commercial.
Landscape	A term that encompasses the entirety of all external space, whether urban or rural, often considered in terms of their aesthetic appeal.
Lead local flood authority	Unitary authorities or county councils responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and for maintaining a register of flood risk assets. Also responsible for managing the risk of flooding from surface water, groundwater and ordinary watercourses.
Level of service	The performance of a system, either designed or measured. Also referred to as Standard of service.
Link	A line between two points; in terms of drainage modelling usually a pipe between two manholes.
Local Planning Authority (LPA)	The local authority or council that is empowered by law to exercise town planning functions for a particular area of the UK. In Scotland where all of the local authorities are unitary, the term “planning authority” is used without the “local” prefix.
Multi-functional	Something that has or fulfils more than one function.
Multi-functionality	The degree to which a system can have or perform multiple functions.
Natural capital	The elements of nature that produce value to people, such as the stock of forests, water, land, minerals and oceans. These provide many benefits, by providing food, clean air, wildlife, energy, wood, recreation and protection from hazards.

Nature conservation bodies	The four organisations that have regional responsibility for promoting the conservation of wildlife and natural features: Natural England, Natural Resources Wales, Scottish Natural Heritage and Northern Ireland Environment Agency.
Node	A point; in terms of drainage modelling usually a manhole or similar object.
Nutrient	A substance providing nourishment for living organisms (such as nitrogen and phosphorus).
Off-line	A part of the drainage system that does not receive flows during frequent events.
Oil separator	A component designed to separate gross amounts of oil and sediments from surface water runoff.
On-line	A part of the drainage system that receives flows during all frequent events.
Organic pollution	A general term describing the type of pollution that, through the action of bacteria, consumes the dissolved oxygen in rivers. The effects of organic pollution are described by the levels of bio-chemical oxygen demand, ammonia, and dissolved oxygen found in a waterbody.
Orifice plate	Structure with a fixed aperture to control the flow of water.
Outfall	The point, location or structure where surface water runoff discharges from a drainage system.
Outlet	A structure or landscape feature that manages the flow out of a SuDS component.
Overflow	The flow of water from a conveyance or storage component once the capacity of that component is exceeded. Not to be confused with a Combined Sewer Overflow.
Pathogen	An organism that causes disease.
Pathway	The route by which potential contaminants may reach targets.
Pavement	The road or car park surface and underlying structure, usually asphalt, concrete, or block paving. Note: the path next to the road for pedestrians (the UK colloquial term of pavement) is the footway.
Peak flow	The point at which the flow of water from a given event is at its highest.
Penstock	A sliding plate which moves vertically to vary the size of an aperture (or close it completely).
Percentage runoff	The proportion of rainfall volume falling on a specified area that runs off that surface.
Percolation	The passing of water (or other liquid) through a porous substance or small holes (e.g. soil or geotextile fabric).

Permeability	A measure of the ease with which a fluid can flow through a porous medium. It depends on the physical properties of the medium, for example grain size, porosity, and pore shape.
Permeable pavement	A surface that is formed of material that is itself impervious to water, but is laid to provide void space through the surface to the sub-base.
Pervious area	Area of ground that allows infiltration of water, although some surface runoff may still occur.
Pervious pavement	A surface that provides a pavement suitable for pedestrian and/or vehicular traffic, whilst allowing rainwater to infiltrate through the surface and into the underlying structural layers.
Pervious surface	A surface that allows inflow of rainwater into the underlying construction or soil.
Pollution	A change in the physical, chemical, radiological, or biological quality of a resource (air, water or land) caused by man or man's activities that is injurious to existing, intended, or potential uses of the resource.
Pond	Permanently wet depression designed to temporarily store surface water runoff above the permanent pool and permit settlement of suspended solids and biological removal of pollutants.
Porous asphalt	An asphalt material used to make pavement layers pervious, with open voids to allow water to pass through (previously known as pervious macadam).
Porous pavement	A permeable surface that allows water to infiltrate across the entire surface material through voids that are integral to the pavement.
Porous surface	A surface that infiltrates water to the sub-base across the entire surface of the material forming the surface, for example grass and gravel surfaces, porous concrete and porous asphalt.
Precipitation	1. (Meteorology) Any product of the condensation of atmospheric water vapour that falls under gravity, including rain, sleet, snow and hail.
Pre-treatment	The removal of contaminants (usually sediments) that may reduce the treatment performance of a specific downstream component.
Previously developed land	Land that is, or was, occupied by a permanent structure (excluding agricultural or forestry buildings) and associated fixed surface infrastructure, including the curtilage of the development.
Proprietary treatment systems	Subsurface and surface structures designed to provide treatment of water through the removal of contaminants. Type and design is usually specific to each manufacturer and is often covered by patents.

Public Open Space (POS)	The open space required under the local authority's open space and recreation standard defined as any land laid out as a public garden or used for the purposes of public recreation. This means space that has unimpeded public access and that is of suitable size and nature for sport, active or passive recreation or children and teenagers' play. Private or shared amenity areas, for example in a development of flats, or buffer landscape areas are not included as public open space.
Public sewer	A sewer that is vested and maintained by the sewerage undertaker.
Rain garden	See Bioretention systems.
Rainfall event	A single occurrence of rainfall before and after which there is a dry period that is sufficient to allow its effect on the drainage system to be defined.
Rainfall intensity	Amount of rainfall occurring in an unit of time generally expressed in mm/hr.
Rainwater butt	Small scale garden water storage device which collects rainwater from the roof via the drainpipe.
Rainwater harvesting system	A system that collects rainwater from where it falls and stores it for use.
Recharge	The addition of water to the groundwater system by natural or artificial processes.
Recurrence interval	The average time between runoff events that have a certain flow rate, e.g. a flow of 2 m/s might have a recurrence interval of two years.
Reed bed	Area of grass-like marsh plants, primarily adjacent to freshwater. Artificially constructed reed beds can be used to accumulate suspended particles and associated heavy metals, or to treat small quantities of partially treated sewage effluent.
Resilience	The speed and ease of recovery from an incident that affects the performance of a system.
Return period	An estimate of the likelihood of a particular event occurring. A 100-year storm refers to the storm that occurs on average once every hundred years. In other words, its annual probability of exceedance is 1% (1 in 100).
Riparian	Of, on, or relating to the banks of a natural course of water.
Risk	Risk is the combination of the probability of that potential hazard being realised, the severity of the outcome if it is, and the numbers of people exposed to the hazard.
Runoff	Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or rainfall is particularly intense.
Runoff coefficient	A measure of the amount of rainfall that is converted to runoff.

Schedule 3	The section of the FWMA (2010) which was not enacted to produce SuDS standards and other intended changes related to SuDS.
Sediment	Sediments are the layers of particles that cover the bottom of water-bodies such as lakes, ponds, rivers, and reservoirs.
Separate sewer	A sewer for surface water or foul sewage, but not a combination of both.
Sewer	A pipe or channel taking domestic foul and/or surface water from buildings and associated paths and hard-standings from two or more curtilages and having a proper outfall.
Sewer flooding	The blockage or overflowing of a sewer causing it to flood.
Sewer mapping	A plan of a part of a sewer network showing pipes, manholes and other drainage structures with their principal dimensions.
Sewerage Undertaker	A collective term relating to the statutory undertaking of water companies that are responsible for sewerage and sewage disposal including surface water from roofs and yards of premises.
Sewers for Adoption	A guide agreed between sewerage undertakers and developers (through the House Builders Federation) specifying the standards to which private sewers need to be constructed to facilitate adoption.
Sewers for Scotland	The objective is the same as Sewers for Adoption (i.e. defining construction standards for drainage systems), but varying in technical legal detail.
Shapefile	A popular data format used by geographical information systems. It was developed by and is regulated by the ESRI company.
Silt	The generic term for waterborne particles with a grain size of 4-63 μm, i.e. between clay and sand.
Soakaway	A sub-surface structure into which surface water is conveyed, designed to promote infiltration.
Soil	The terrestrial medium on which many organisms depend, which is a mixture of minerals (produced by chemical, physical and biological weathering of rocks), organic matter, and water. It often has high populations of bacteria, fungi, and animals such as earthworms.
Soil moisture deficit	A measure of soil wetness, calculated by the Meteorological Office in the UK, to indicate the capacity of the soil to absorb rainfall.
Source control	The control of runoff at or near its source, so that it does not enter the drainage system or is delayed and attenuated before it enters the drainage system.

Source protection zone (SPZ)	Areas where groundwater supplies are at risk from potentially polluting activities and accidental releases of pollutants. They are a policy tool used to control activities close to water supplies intended for human consumption.
SQLite	A database that is easy to copy between computers and does not need database server software to be installed.
Stakeholder	Person or organisation with a specific interest (commercial, professional or personal) in a particular issue (political, regulatory, economic, financial, social, environmental etc.).
Standard	Minimum performance target or levels of service that SuDS designs should meet (see Level of service).
Statutory	Formally defined statement by statute (law). In the case of drainage, an organisation to which it is mandatory to make a submission to for planning review.
Storm	An occurrence of rainfall, snow, or hail.
Sub-base	A layer of material on the sub-grade that provides a foundation for a pavement surface.
Subcatchment	A division of a catchment, to allow runoff to be managed as near to the source as is reasonable.
SuDS asset	A SuDS unit which is classified in an inventory of SuDS and other drainage structures which has an implied value.
SuDS component / element	An individual element or part of a SuDS unit that conveys, stores and/or treats surface water runoff.
SuDS unit / structure	A drainage entity which comprises a number of SuDS elements in providing conveyance and stores and/or treats surface water runoff.
Sump	A pit that may be lined or unlined and is used to collect water and sediments before being pumped out.
Surface water	Water bodies or flows that appear as a result of rainfall.
Surface water body	Permanent flows or bodies of water on the surface e.g. lakes, rivers, streams, standing water, ponds.
Surface water runoff	See runoff.
Surface water sewer	An underground pipe design to convey only surface water runoff.

Sustainable drainage system (SuDS)	Drainage systems that are considered to be environmentally beneficial in mitigating the impacts of surface water runoff particularly polluted urban runoff as well as providing societal benefits.
Swale	A shallow vegetated channel designed to convey, treat and occasionally store surface water, and may also permit infiltration.
Symbols	Images used to indicate the presence of an object (SuDS units and other drainage structures on sewer maps).
Time Series Rainfall	A continuous or discontinuous record of individual rainfall events generated artificially or selected real historical events that are representative of the rainfall in that area.
Topsoil	The upper, outermost layer of soil, usually the top 5 to 20 cm. It has the highest concentration of organic matter and microorganisms.
Trash rack	Rack of bars installed to trap litter or debris to minimise risks of blockage of a conveyance path (e.g. pipe).
Treatment	Improving the quality of water by physical, chemical and/or biological means.
Tree pit	A constructed underground structure that is used to create voided space to contain a soil and/or storage volume, and protect the root system of one or more trees when located within a paved area.
Urban creep	The increasing density of development, due extensions, paving over of gardens and other permeable areas, and the addition or extension of roads or buildings, which increases the impermeability of developed areas and causes rates and volumes of runoff to rise.
Urban heat island effect	Where a town or city is significantly warmer than its surrounding rural areas due to human activities and the modification of land surfaces. The temperature difference is usually larger at night than during the day.
Void ratio	The ratio of open air space to solid particles in a soil or aggregate.
Vortex flow control	The induction of a spiral/vortex flow of water in a chamber used to control or restrict the flow.
Washoff	The transport of pollutant mass from the catchment surface during a rainfall event.
Waste	Any substance or object that the holder discards, intends to discard, or is required to discard.
Wastewater	Water used as part of a process that is not retained but discharged. This includes water from sinks, baths, showers, WCs, and water used in industrial and commercial processes.

Water body	A body of water forming a physiographical feature. In the WFD this covers: rivers, lakes, transitional waters, coastal waters and groundwater (aquifers).
Water Framework Directive (WFD)	A European Community Directive (2000/60/EC) of the European Parliament and Council designed to integrate the way water bodies are managed across Europe. It requires all inland and coastal waters to reach "good status" by 2015 through a catchment based system of River Basin Management Plans, incorporating a programme of measures to improve the status of all natural water bodies.
Water quality	The chemical, physical and biological characteristics of water with respect to its suitability for a particular purpose.
Watercourse	A term including all rivers, streams, ditches, drains, cuts, culverts, dykes, sluices, and passages through which water flows.
Weir	Horizontal structure of predetermined height to control flow.
Wetland	A pond with a higher proportion of shallow zones that promote the growth of bottom rooted plants.

D. Abbreviations

BMP	Best Management Practice
BS	British Standard
BSI	British Standards Institution
CIRIA	Construction Industry Research and Information Association
CIWEM	The Chartered Institution of Water and Environmental Management
CLG	Communities and Local Government
CSO	Combined Sewer Overflow
DCLG	Department for Communities and Local Government
DDF	Depth-duration-frequency
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges (Highways Agency; Development Department, The Scottish Executive; National Assembly for Wales; and the Department for Regional Development, Northern Ireland Executive)
DoE	(former) Department of the Environment
DTLR	(the former) Department for Transport, Local Government and the Regions
EA	Environment Agency (England)
EIA	Environmental Impact Assessment
EU	European Union
FEH	Flood Estimation Handbook (developed by CEH Wallingford, formerly the Institute of Hydrology, and published in 1999)
FEH13	Rainfall model (issued 2015) which supersedes the FEH rainfall model
FRA	Flood Risk Assessment
FSR	Flood Studies Report
FWMA	Flood and Water Management Act (2010)
GIS	Geographic information system
GML	Geography Markup Language
HE	Highways England
HOST	Hydrology of soil types
ICE	Institution of Civil Engineers

ID	Identifier / Identity
IDB	Internal Drainage Board
IoH (or IH)	Institute of Hydrology (now Centre for Ecology and Hydrology)
ISO	International Organization for Standardisation
JSON	JavaScript Object Notation
LA	Local Authority
LASOO	Local Authority SuDS Officer Organisation; an association of local authority officers that have involvement in sustainable drainage systems
LHA	Local Highway Authority
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
M5-2d	2 day rainfall of 5 year return period (mm)
M5-60	60 minute rainfall of 5 year return period (mm)
NHBC	National House Builders Council
NIEA	Northern Ireland Environment Agency
NoSQL	A database that stores data using a means other than the tabular form used by relational databases
NRW	Natural Resources Wales
ODPM	(the former) Office of the Deputy Prime Minister
OFWAT	The Water Services Regulation Authority is the body responsible for economic regulation of the privatised water and sewerage industry in England and Wales
OS	Ordnance Survey
PAH	Poly Aromatic Hydrocarbons
PPS15	Planning Policy Statement 15
Q_{BAR}	the (arithmetic) mean annual maximum flood (m3/s)
r	FSR parameter ratio of rainfall depths (M5-60min) / (M5-2d)
ReFH	Revitalised Flood Hydrograph method
ReFH2	Revitalised Flood Hydrograph method superseding ReFH
RWH	Rainwater harvesting
SAAR	standard average annual rainfall (mm)
SAB	SuDS Approval Body
SEPA	Scottish Environment Protection Agency

SfA8	Sewers for Adoption version 8
SPR	Standard Percentage Runoff
SPRHOST	HOST related Standard Percentage Runoff (see HOST)
SPZ	source protection zone
SSSI	Site of Special Scientific Interest
STC25	A referencing convention for providing unique IDs for manholes.
SU	Sewerage Undertaker
SuDS	sustainable drainage system
SWM	Surface water management
TSR	Time series rainfall
UK	All countries of the United Kingdom of Great Britain and Northern Ireland
UKCP09	UK climate projections 2009
UKWIR	UK Water Industry Research
WaSC	Water Sewerage Company
Water UK	A body representing water companies in UK.
WFD	Water Framework Directive (2000/60/EC)
WIA	Water Industry Act
WRAP	Winter Rainfall Acceptance Potential; an FSR based measure of soil rainfall runoff
WRc	Water Research Centre
XML	Extensible Markup Language
XSD	XML Schema Definition

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HR Wallingford is an independent engineering and environmental hydraulics organisation. We deliver practical solutions to the complex water-related challenges faced by our international clients. A dynamic research programme underpins all that we do and keeps us at the leading edge. Our unique mix of know-how, assets and facilities includes state of the art physical modelling laboratories, a full range of numerical modelling tools and, above all, enthusiastic people with world-renowned skills and expertise.

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