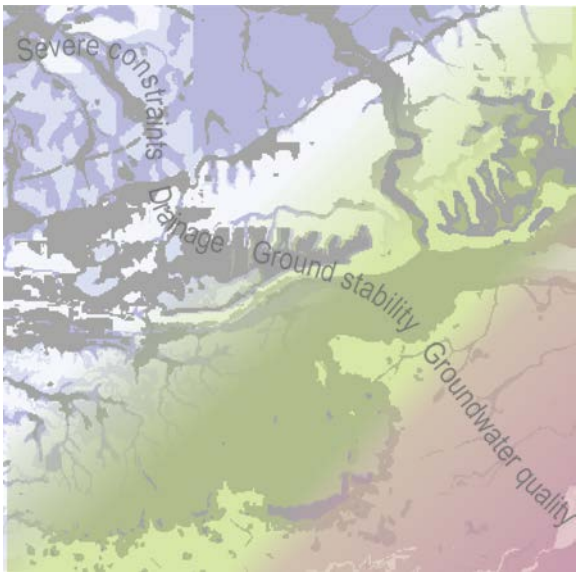
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

User Guide for the Infiltration SuDS Map: Summary

Open Report OR/16/010



BRITISH GEOLOGICAL SURVEY

OPEN REPORT OR/16/010

User Guide for the Infiltration SuDS Map: Summary

R Dearden

Keywords

infiltration SuDS map, SuDS, sustainable drainage, infiltration to the ground.

Front cover

Data from the Infiltration SuDS Map

Bibliographical reference

DEARDEN, R.A.. 2016. User Guide for the Infiltration SuDS Map: Summary. *British Geological Survey Open Report*, OR/16/010. Version 2 29pp.

Keyworth, Nottingham British Geological Survey 2016

BRITISH GEOLOGICAL SURVEY

The full range of our publications are available from BGS shops at Nottingham, Edinburgh, London, and Cardiff (Welsh publications only) see contact details below or shop online at www.geologyshop.com

The London Information Office also maintains a reference collection of BGS publications, including maps, for consultation.

We publish an annual catalogue of our maps and other publications; this catalogue is available online or from any of the BGS shops.

The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as basic research projects. It also undertakes programmes of technical aid in geology in developing countries.

The British Geological Survey is a component body of the Natural Environment Research Council.

British Geological Survey offices

BGS Central Enquiries Desk

Tel 0115 936 3100 Fax 0115 936 3200

email enquiries@bgs.ac.uk

Environmental Science Centre, Keyworth, Nottingham NG12 5GG

Tel 0115 936 3100 Fax 0115 936 3200

email sales@bgs.ac.uk

The Lyell Centre, Research Avenue South, Edinburgh EH14 4AP

Tel 0131 667 1000 Fax 0131 668 2683

email scotsales@bgs.ac.uk

Natural History Museum, Cromwell Road, London SW7 5BD

Tel 020 7589 4090 Fax 020 7584 8270

Tel 020 7942 5344/45 email bgslondon@bgs.ac.uk

Columbus House, Greenmeadow Springs, Tongwynlais, Cardiff CF15 7NE

Tel 029 2052 1962 Fax 029 2052 1963

Maclean Building, Crowmarsh Gifford, Wallingford OX10 8BB

Tel 01491 838800 Fax 01491 692345

Geological Survey of Northern Ireland, Department of Enterprise, Trade & Investment, Dundonald House, Upper Newtownards Road, Ballymiscaw, Belfast BT4 3SB

Tel 028 9038 8462 Fax 028 9038 8461

www.bgs.ac.uk/gsni/

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon SN2 1EU

Tel 01793 411500 Fax 01793 411501

www.nerc.ac.uk

Website www.bgs.ac.uk

Shop online at www.geologyshop.com

Contents

Contents i

Summary iii

Acknowledgements iii

1 Introduction 1

2 About the infiltration SuDS maps 2

2.1 Background 2

2.2 What are infiltration SuDS? 3

2.3 Who might require this map? 5

2.4 About the dataset 5

3 Quick start guide 6

3.1 Overview 6

3.2 GIS set-up 6

4 What information does the dataset provide? 8

4.1 Overview 8

4.2 Infiltration constraints summary layer 8

4.3 Drainage summary layer 9

4.4 Ground Stability Summary 10

4.5 Groundwater Protection Summary Layer 11

4.6 Data summary 12

5 Technical Information 14

5.1 Pre-requisite requirements 14

5.2 Creation of the dataset 14

5.3 Scale 15

5.4 Field Descriptions 15

5.5 Dataset History 15

5.6 Coverage 15

5.7 Data Format 15

5.8 Limitations 16

6 Using the data 17

6.1 Setting up the GIS 17

6.2 How to use the data for a site assessment 18

7 Licensing Information 20

Appendix 1 22

FIGURES

Figure 1. Diagram to show versatility of infiltration SuDS, for example: a) soakaways in free-draining ground; b) permeable pavements incorporating water storage in moderately free-draining ground, and c) infiltration basins with large storage volumes in poorly draining ground 4

Figure 2. *Infiltration SuDS Map: Summary* loaded into ESRI ArcGIS 6

Figure 3. Quick start flow chart: A rapid guide to using the dataset..... 7

Figure 4. Flow diagram showing how data was used to create summary maps. PFM: Predominant flow mechanism. 14

Figure 5. Infiltration SuDS map loaded into ArcGIS, showing legend colours..... 18

TABLES

Table 1. Common infiltration SuDS types. Values derived from Woods-Ballard et al. (2007) 4

Table 2. Description of attribute for the *infiltration constraints summary* layer. 8

Table 3. Description of attribute scores for the *drainage summary* layer..... 9

Table 4. Description of attribute scores for the *ground stability summary* layer. 10

Table 5. Description of attribute scores for the *groundwater protection summary* layer 11

Table 6. Details of the original datasets used in the infiltration SuDS map 13

Table 7. Attribute table field descriptions..... 15

Table 8. RGB colours to be assigned to score classes 17

Table 9. Data for three locations, A, B and C where infiltration devices (soakaway, permeable pavement and infiltration basins respectively) have been installed. All red text derived from Infiltration SuDS Map: Summary..... 19

Summary

This report presents a description of the *Infiltration SuDS Map*: *Summary* developed by the British Geological Survey (BGS). The map provides screening-level data that gives an indication of the suitability of the subsurface for infiltration sustainable drainage systems (SuDS). The map does not provide any specific information about the properties of the ground; such data is included in the *Infiltration SuDS Map: Detailed* (Dearden, 2016). The summary map is designed to be used by those involved in the strategic assessment of the subsurface for the installation of infiltration SuDS. It may be particularly valuable for spatial planners and local authorities who wish to undertake a strategic assessment.

More information about pricing and licensing the Infiltration SuDS Map is provided at http://www.bgs.ac.uk/products/hydrogeology/infiltrationSuds.html.

The map comprises of four GIS (geographical information system) layers, focusing on significant constraints, potential for drainage, potential for instability and protection of groundwater quality. The layers are derived from a combination of 15 BGS national datasets and show the overall opportunities for the installation of infiltration SuDS. The method has been critically assessed by Dr. V. Banks and Dr. D. Aldiss who specialise in hydrogeology and in geologically derived products at the BGS. The purpose of this user guide is to enable those licensing this dataset to have a better appreciation of how the dataset has been created and therefore a better understanding of its potential applications and limitations.

Acknowledgements

A number of individuals in the Information Products and Derived Products Programmes have contributed to the project and helped compile this report. This assistance has been received at all stages of the study. In addition to the collection and processing of data, many individuals have freely given their advice, and provided the local knowledge. In particular, we thank Don Aldiss, Vanessa Banks, Stephanie Bricker, Rose Hargreaves, Kate Royse and Gerry Wildman. We are also grateful to Mike Barker, Paul Davies, Llew Hancock, Nick Orman, Martin Osborne, Steve Wilson and Bridget Woods-Ballard, who peer-reviewed the Infiltration SuDS Map from an external perspective and provided valuable feedback.

1 Introduction

Founded in 1835, the British Geological Survey (BGS) is the world's oldest national geological survey and the United Kingdom's premier centre for earth science information and expertise. The BGS provides expert services and impartial advice in all areas of geoscience. Our client base is drawn from the public and private sectors both in the UK and internationally.

Our innovative digital data products aim to help describe the ground surface and subsurface across the whole of Great Britain. These digital products are based on the outputs of the BGS survey and research programmes and our substantial national data holdings. This data coupled with our in-house geoscientific knowledge are combined to provide products relevant to a wide range of users in central and local government, insurance and housing industry, engineering and environmental business, and the British public.

Further information on all the digital data provided by the BGS can be found on our website at http://www.bgs.ac.uk/data/home.html or by contacting:

BGS Central Enquiries

British Geological Survey

Environment Science Centre

Keyworth

Nottingham

NG12 5GG

Direct tel. +44(0)115 936 3100

Fax. +44(0)115 936 3200

email **enquiries@bgs.ac.uk**

2 About the infiltration SuDS maps

2.1 BACKGROUND

Following extensive flooding in 2007 across much of the UK, the Government launched a review to determine the causes and consequences of the flood events and to establish the most appropriate course of action to reduce future flooding (Pitt, 2008). The review found that intense rainfall and overland flow on impervious surfaces resulted in flooding particularly in urban areas where the piped drainage networks were overwhelmed. The impacts were not restricted to flooding; storm water flow through combined sewers (that carry both foul and surface water) overflowed to watercourses during storm events, resulting in a deterioration of water quality. To reduce the intensity and magnitude of such impacts during flood events, the review recommended that our reliance on the existing piped drainage network should be decreased. The recommendations were further considered in the *Making Space for Water* strategy (DEFRA, 2005) and were then enacted to law by the Floods and Water Management Act 2010 (HMSO, 2010).

One of the recommendations, enacted to law via Schedule 3 of the Floods and Water Management Act, was the specific provision for the implementation of sustainable drainage systems (SuDS) in all new developments (excluding single dwellings). To promote the use of SuDS, the Act withdraws Section 106 of the Water Industry Act 1991, thereby removing the automatic right for developers to connect to the drainage network (HMSO, 2010). An exception applies to single dwellings, which are excluded from this requirement in law. However, even for single dwellings, there are significant advantages to using SuDS in practice, for example they require reduced drainage infrastructure and attract disconnection rebates for homeowners.

Sustainable drainage aims to reduce the reliance on traditional piped drainage networks by draining surface water in a way that mimics the natural water cycle, thereby decreasing flow rates and reducing peak flows to rivers. In addition, SuDS remove pollutants near to source and thereby play a key role in improving catchment water quality. There are also amenity and biodiversity benefits associated with installing SuDS instead of traditional drains (Woods-Ballard et al., 2007).

Sustainable drainage includes surface water management techniques such as:

- rainwater re-use (water butts, rainwater harvesting systems)
- rainwater storage with discharge to watercourses (detention basins/ponds/subsurface chambers), and
- infiltration to the ground (soakaways, infiltration basins, permeable pavements)

Systems often incorporate two or more SuDS techniques connected in series. This enables an incremental reduction in pollutants, flow rates and volumes along the drainage flow path. The connection of systems in this way is termed the *management train*.

The design, construction, operation and maintenance of SuDS have been the subject of numerous documents since the release of the draft SuDS National Standards (DEFRA, 2011). Since then, the standards have become focused on controlling the rate and quantity of flow (DEFRA, 2015). The National Planning Policy Framework has published further Planning Practice Guidance that supports sustainable drainage and suggests the following order of preference for the runoff destination:

- discharge to the ground
- discharge to a surface water body

- discharge to a surface water sewer
- discharge to a combined sewer.

To determine whether SuDS that infiltrate to the ground are compatible with the subsurface, the ground conditions at each individual site need to be assessed.

The British Geological Survey has developed two series of maps that provide information on the suitability of the subsurface for infiltration SuDS:

a. *Infiltration SuDS Map: Summary*
b. *Infiltration SuDS Map: Detailed*

This user guide focuses on the *Infiltration SuDS Map: Summary*. This series of maps provides screening-level data that provides an indication of the likely suitability of the ground for infiltration. It does not provide information about the properties of the subsurface.

For more detailed information about the properties of the subsurface, the *Infiltration SuDS Map: Detailed* (Dearden, 2016) should be consulted. Alternatively, an Infiltration to the Ground GeoReport can be obtained from http://shop.bgs.ac.uk/georeports/.

> The *Infiltration SuDS Map: Summary* provides screening-level data for the strategic assessment of the suitability of the subsurface for infiltration SuDS.
>
> The *Infiltration SuDS Map: Summary* facilitates strategic decision making.
>
> The map is not a replacement for a soakaway test or site investigation.

2.2 WHAT ARE INFILTRATION SUDS?

Infiltration SuDS is a term that covers a number of different systems including:

- soakaways
- infiltration trenches
- infiltration basins
- permeable pavements
- wetlands
- unlined ponds, and
- unlined swales.

These systems facilitate the infiltration of surface water into the ground. Once in the ground, the water percolates through the subsurface to the groundwater.

Infiltration SuDS are appropriate in a wide variety of ground conditions, but the design must be compatible with the properties of the subsurface, in particular, the infiltration rate. Infiltration SuDS are commonly installed within freely draining ground, but they can also be used in less permeable deposits, if they are designed to incorporate larger infiltration areas (e.g. permeable pavements), or the capacity to store water (e.g. infiltration basins). By increasing the surface area or volume of the infiltration system, the amount of water infiltrated and the time over which infiltration can occur are increased. This allows infiltration SuDS to be installed in ground that

would not otherwise be suitable for the installation of soakaways. In such ground conditions, infiltration may not provide the whole drainage solution, but may form part of the drainage strategy alongside SuDS that store and re-use water.

Figure 1 illustrates three types of infiltration SuDS and Table 1 summaries the characteristics of infiltration SuDS in terms of typical storage capacity, surface area for infiltration, pollutant attenuation capacity, land take requirement and amenity value.

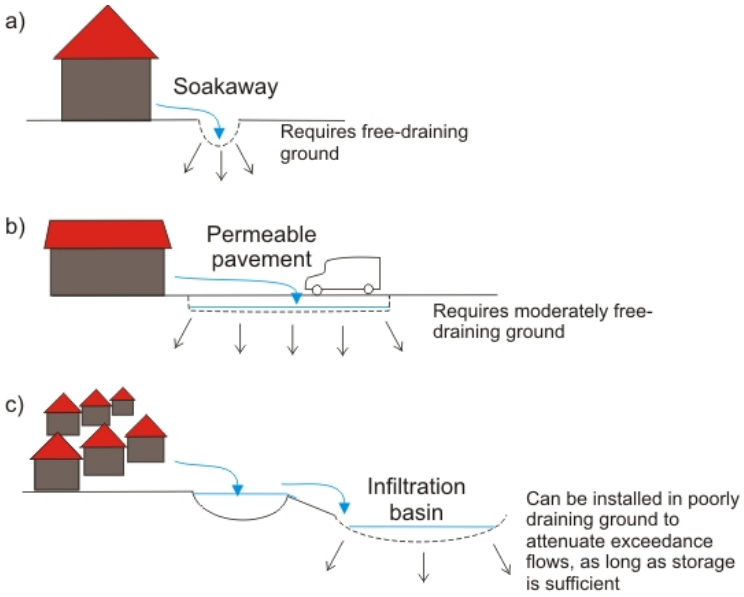


Figure 1. Diagram to show versatility of infiltration SuDS, for example: a) soakaways in free-draining ground; b) permeable pavements incorporating water storage in moderately free-draining ground, and c) infiltration basins with large storage volumes in poorly draining ground

Table 1. Common infiltration SuDS types. Values derived from Woods-Ballard et al. (2007)

Technique	Description	Typical storage capacity	Surface area for infiltration	Pollutant attenuation capacity	Land-take requirements	Amenity value
Infiltration basin	Comprises a depression in the ground, where water can be stored during gradual infiltration through the permeable base	High	Moderate to high	Medium to high	High, but dual use possible	Potentially high
Infiltration trench	Comprises a gravel-filled trench with a permeable base through which water can infiltrate the ground	Moderate	Moderate	Low to high	Low	Low
Permeable pavement	A durable permeable surface, through which water can infiltrate. Systems may allow infiltration directly to the ground, or may be constructed with a subbase providing storage capacity, allowing more gradual infiltration to the ground	Low to high	Low to high	High	High, but dual use normal	Potentially high
Soakaway	Metre-scale pit in the ground, that stores water during gradual infiltration	Low to moderate	Low to moderate	Low to medium	Low	Low
Wetland	Comprises a natural or man-made swampy or boggy area with a permeable base	Moderate	Moderate to high	Medium to high	High	Potentially high

2.3 WHO MIGHT REQUIRE THIS MAP?

This dataset is relevant to those who need to undertake a spatial assessment of the suitability of the subsurface for infiltration SuDS. The data will provide a basic assessment of the suitability of the subsurface for infiltration SuDS, but it is not sufficiently detailed to be used at the local-scale. The dataset does not provide information on the properties of the subsurface.

The *Infiltration SuDS Map: Summary* is relevant to professionals throughout construction, including those involved at an initial stage with planning, land surveying, architecture and construction. It may also be of interest to solicitors, loss adjusters and the insurance industry.

2.4 ABOUT THE DATASET

The *Infiltration SuDS Map: Summary* comprises four GIS layers that provide summarised answers to four key questions:

- **Question 1. Are there any constraints that mean infiltration SuDS should only be used if the potential for, and consequences of flooding and geohazards are known?**
  This GIS layer highlights those areas where geological and hydrogeological hazards may exist that could be initiated or worsened by infiltrating water to the ground. Possible hazards include:

  i) ground instability resulting from the infiltration of water into rocks that are highly susceptible to landslide or collapse associated with dissolution or shallow mining;
  ii) flooding resulting from infiltration into deposits where the water table is shallow and potentially able to rise causing inundation of soakaways or emergence of groundwater at the ground surface, and
  iii) made ground of unknown characteristics that may be unstable or potentially contaminated.

  The map does not state the type of geohazard, it simply indicates the possible presence or absence of such a hazard.

- **Question 2. What is the drainage potential of the subsurface?**
  The drainage potential of the ground depends on the geology and hydrogeology of the subsurface. This GIS layer provides an indication of the extent to which the ground will be suitable for infiltration SuDS with respect to drainage.

- **Question 3. Are there any ground stability considerations?**
  Not all ground instability hazards will preclude the installation of infiltration SuDS, but if present, those hazards should be taken into account during design and construction. This GIS layer highlights the potential for ground instability if water is infiltrated to the ground.

- **Question 4. Is the groundwater susceptible to deterioration in quality?**
  When designing SuDS installations the potential impact on groundwater quality should be considered. This GIS layer gives an overview of the vulnerability of the groundwater to pollutants in surface water.

The dataset is intended to provide the information required to make strategic decisions on the suitability of the ground for infiltration SuDS. The data is NOT an alternative for a site

investigation or an infiltration test. If the data is to be used for local planning applications, the user should obtain the data within the *Infiltration SuDS Map: Detailed.*

3 Quick start guide

3.1 OVERVIEW

This section is aimed at those users who are familiar with GIS software and wish to rapidly start using the dataset. More detailed explanations of how the dataset should be set up and used are presented in Sections 5 and 6.

3.2 GIS SET-UP

Load the layer/shape files into the GIS software. The GIS should appear as shown in Figure 2.

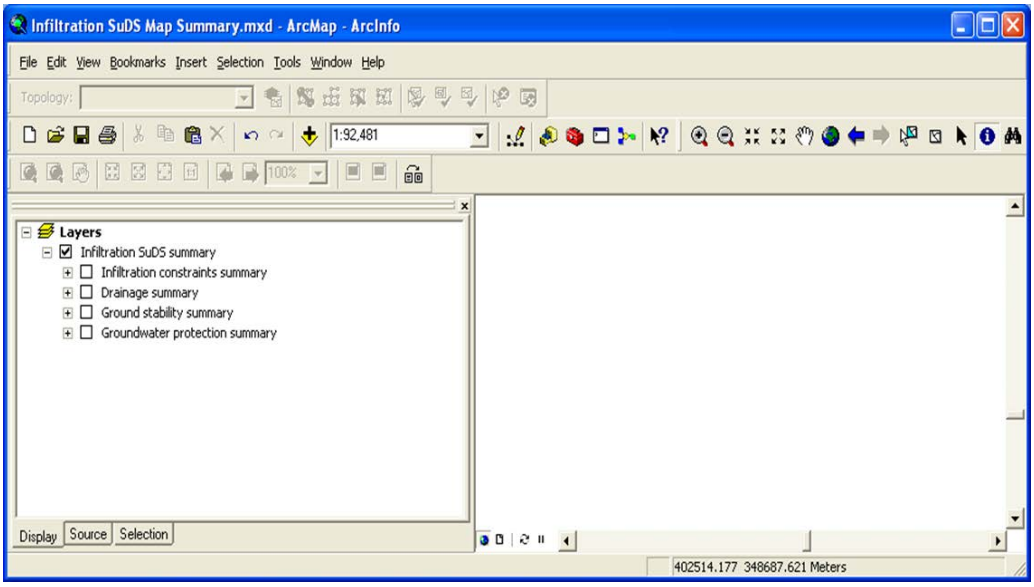


Figure 2. *Infiltration SuDS Map: Summary* loaded into ESRI ArcGIS

Pan to a location of interest and work through the datasets sequentially, following the flow chart in Figures 3.

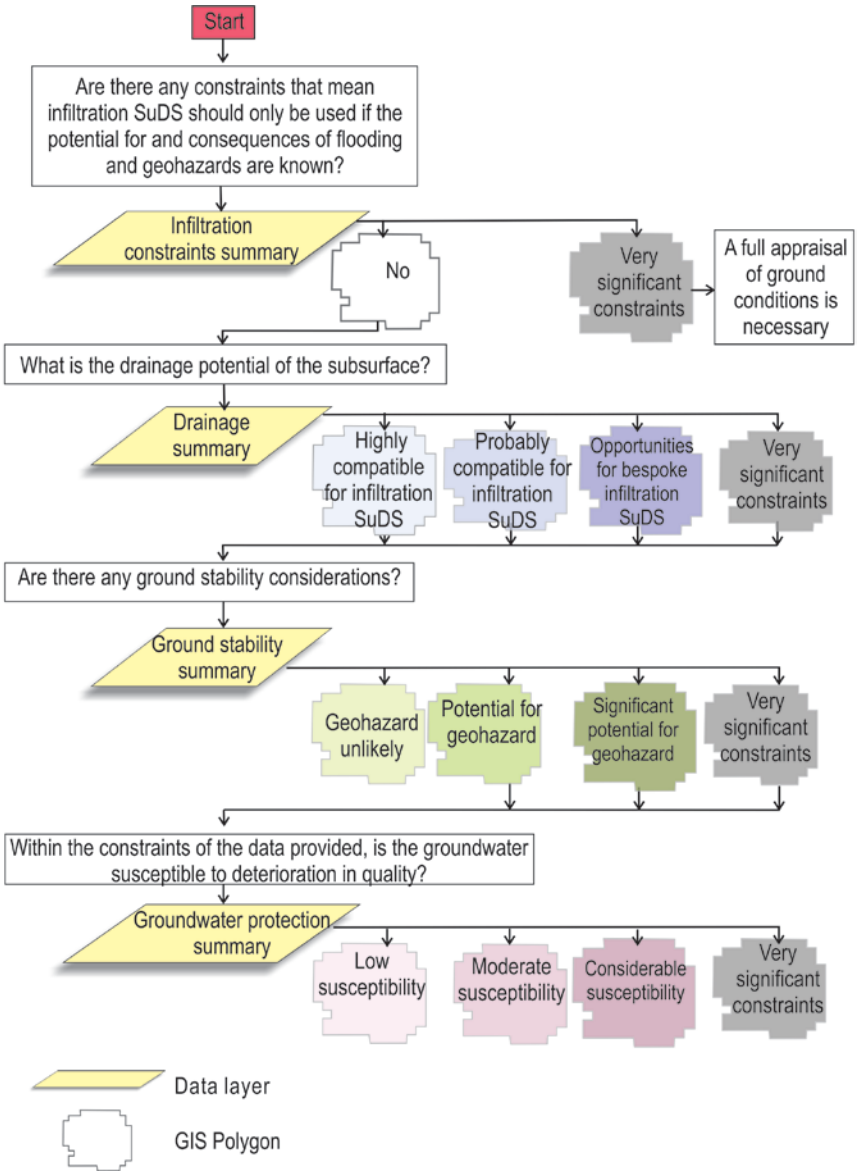


Figure 3. Quick start flow chart: A rapid guide to using the dataset

4 What information does the dataset provide?

4.1 OVERVIEW

This section describes the four summary maps and the data from which they are derived.

- Section 4.2 focuses on the *infiltration constraints* summary layer.
- Section 4.3 focuses on the *drainage summary* layer.
- Section 4.4 focuses on the *ground stability summary* layer.
- Section 4.5 focuses on the *groundwater protection summary* layer.

Each polygon has four key attributes; score, short description, detailed description, and advice. The score is used in the creation of the summary maps; a lower score reflects greater suitability and a higher score reflects lesser suitability.

4.2 INFILTRATION CONSTRAINTS SUMMARY LAYER

The infiltration constraints summary layer highlights areas where there is potential for a hazard if water is infiltrated to the ground. In such areas, infiltration SuDS should only be installed if the potential for, or the consequences of, the constraint are considered not to be significant. Table 2 shows the attribute used in this summary layer.

Table 2. Description of attribute for the *infiltration constraints summary* layer.

Score	Short description	Detailed description
4*	Very significant constraints are indicated	There is a very significant potential for one or more geohazards associated with infiltration

* Polygons with the highest score (4) are shown independently in the 'Infiltration Constraints Summary' layer to provide an overview of where hazards may occur if water is infiltrated to the ground.

If an area is identified as having an infiltration constraint, there is significant potential for one of the following hazards to be present:

- **Soluble rock hazards**

  Some types of ground contain layers of material that can dissolve in underground water. This can cause cavities to develop. Cavities created by dissolution of soluble rocks can collapse, resulting in subsidence of the land above. More commonly, changes in ground or surface water flow can flush away unconsolidated sediment, potentially leading to the collapse of overlying materials leading to subsidence at the surface. Infiltration may exacerbate this problem causing acute collapse around infiltration SuDS.

- **Landslide hazards**

  In deposits that are highly susceptible to landslide, the infiltration of water to the ground may decrease the strength of the deposit, resulting in slope instability. This may occur if water is infiltrated to the ground on or above the susceptible area. In such deposits, the installation of infiltration SuDS should proceed only following a full appraisal of the ground conditions.

- **Shallow mining hazards (non-coal)**

  In areas where current or past underground mining has resulted in cavities at shallow depths, the infiltration of water may destabilise material above or within a cavity potentially resulting in ground collapse in highly susceptible areas. In such areas, infiltration of water to the ground may initiate or exacerbate the instability of material leading to collapse around the infiltration system. This dataset only considers mining for commodities other than coal. For information regarding underground and opencast coal mining, please contact the Coal Authority, Mining Reports, 200 Lichfield Lane, Mansfield, Nottinghamshire, NG18 4RG; telephone 0845 762 6848 or at www.coal.gov.uk.

- **Made ground**

  Made ground, including ground that has been infilled or landscaped has an unknown composition and structure. Infiltration through such material may result in ground instability or in the remobilisation of contaminants from within that ground.

- **Persistently shallow groundwater**

  In areas where the water table is shallow either persistently or seasonally, the installation of infiltration SuDS requires further consideration. In such areas, potential rises in shallow groundwater as a result of infiltration, may result in the inundation of subsurface storage chambers, or possibly the emergence of groundwater at the ground surface (termed groundwater flooding).

This map does not state which hazard is present, this information is provided in the *Infiltration SuDS Map: Detailed.* For more information about the hazards above and the limitations of the dataset, see Dearden (2016).

4.3 DRAINAGE SUMMARY LAYER

The *drainage summary* layer provides an overview of the extent to which the ground will drain. Table 3 shows the four attributes used in this summary layer.

Table 3. Description of attribute scores for the *drainage summary* layer

Score	Short description	Detailed description
1	Highly compatible for infiltration SuDS	The subsurface is likely to be suitable for free-draining infiltration SuDS.
2	Probably compatible for infiltration SuDS	The subsurface is probably suitable for infiltration SuDs although the design may be influenced by the ground conditions.
3	Opportunities for bespoke infiltration SuDS	The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions.
4	Very significant constraints are indicated	There is a very significant potential for one or more geohazards associated with infiltration.

The *drainage summary* layer is derived from the following datasets:

- Infiltration constraints summary layer
- Superficial deposit permeability
- Superficial deposit thickness
- Bedrock permeability
- Depth to water level
- Geological indicators of flooding

If a site scores a value of 1, the subsurface is likely to be highly permeable, with a deep water table and not underlain by floodplain deposits that may respond rapidly to changes in river levels. In this environment, the installation of infiltration SuDS is likely to be straightforward. Sites that score a value of 2 may be characterised by a spatially variable permeability or a water table that may be within 1 m of the base of the infiltration system, or both. These areas are probably compatible for infiltration SuDS, but the system design may be influenced by the local ground conditions. Sites that score a value of 3 may be poorly draining, or have a shallow water table, or are located on floodplain deposits, or have some combination of these characters. In these areas, the subsurface may potentially be suitable for infiltration SuDS, but the design will be strongly dependent on the local ground conditions. Finally, sites that score a value of 4 have a constraint that needs investigation to determine whether the potential for, or the consequences of the constraint are likely to be significant.

The dataset does not state the properties of the subsurface, this information is provided in the *Infiltration SuDS Map: Detailed.*

4.4 GROUND STABILITY SUMMARY

The *ground stability summary* layer provides an overview of the potential for ground instability as a result of infiltration. The summary layer is derived from BGS' GeoSure datasets. Table 4 shows the four attributes used in this summary layer.

Table 4. Description of attribute scores for the *ground stability summary* layer.

Score	Short definition	Detailed definition
1	Geohazard unlikely	Increased infiltration is very unlikely to result in ground instability.
2	Potential for geohazard	Ground instability problems may be present or anticipated. Increased infiltration is unlikely to result in ground instability.
3	Significant potential for geohazard	Ground instability problems are probably present. Increased infiltration may result in ground instability.
4	Very significant constraints are indicated	There is a very significant potential for one or more geohazards associated with infiltration.

Geohazards considered include:

- **Soluble rocks**
  As discussed in Section 4.2, infiltration may result in ground collapse where the geological deposits are susceptible to dissolution.

- **Landslide hazards**
  As discussed in Section 4.2, the infiltration of water into deposits that are susceptible to landslide, may decrease the 'strength' of the deposit, resulting in slope instability.

- **Compressible ground**
  When the ground is compressed by a building or other load, water in the pore space can be squeezed out, causing the ground to compress. If water is added to the ground through an infiltration system, the compressibility may alter, possibly initiating settlement.

- **Swelling clays**
  Clays susceptible to shrink and swell, can change volume significantly according to how much water they contain. If water is added to the ground through an infiltration system, susceptible clays may swell, possibly introducing differential uplift.

- **Running sands**
  Running sand conditions occur when loosely-packed sand, saturated with water, flows into an excavation or other type of void. This can lead to subsidence of the surrounding ground. Running sand is potentially hazardous during the installation of infiltration SuDS if a void is excavated.

- **Shallow mining hazards (non coal)**
  As discussed in Section 4.2, infiltration may destabilise material bridging above or within a mined cavity, potentially resulting in ground collapse.

- **Collapsible ground**
  Collapsible deposits can collapse when they have been loaded and then become saturated by water. If the ground below a building collapses it may cause the building to sink, tilt, crack or distort. Infiltration will result in an increase in water content, which may affect the strength of the ground.

The stability of an area with a score of 1 is not anticipated to be impacted as a result of infiltration. Areas with a score of 2 or 3 may need investigation prior to infiltration; however the hazards present should not prevent infiltration SuDS from being used. Finally, for areas with a score of 4, the potential for and consequences of the identified hazard should be fully appraised.

The dataset does not state which hazard is present, this information is provided in the *Infiltration SuDS Map: Detailed.*

4.5 GROUNDWATER PROTECTION SUMMARY LAYER

The *groundwater protection summary* layer provides an overview of subsurface factors that may impact the planning and design of infiltration SuDS in respect of protecting groundwater quality. Table 5 shows the four attributes used in this summary layer.

Table 5. Description of attribute scores for the *groundwater protection summary* layer

Score	Short description	Detailed description
1	Low susceptibility	The groundwater is not expected to be especially vulnerable to contamination. Infiltration water should be free of contaminants.
2	Moderate susceptibility	The groundwater may be vulnerable to contamination. Infiltrating water should be free of contaminants.
3	Considerable susceptibility	The groundwater is likely to be vulnerable to contaminants. Infiltrating water should be free of contaminants.
4	Very significant constraints are indicated	Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

The summary layer is derived from the following datasets:

- **Source protection zone dataset**

The source protection zone dataset sourced from the Environment Agency, and Natural Resources Wales define zones around public water supply abstraction points where additional protection is required to safeguard drinking water quality. In these areas, activities that may affect the quality of the drinking water abstraction may be restricted. This data is included here to show where restrictions on the installation of infiltration SuDS may apply.

- **Predominant flow mechanism**

Some geological deposits will attenuate surface water pollutants more than others. The predominant flow mechanism (intergranular flow, fracture flow or a mixture of both) in the unsaturated zone is one proxy for determining the extent to which attenuation is likely.

- **Made ground**

As discussed in Section 4.2, infiltration through made ground may impact groundwater quality as such deposits can contain contaminants that may be remobilised from the unsaturated zone into the groundwater.

In consideration of the above three factors, lower scores indicate areas where groundwater is less susceptible to surface water contaminants and higher scores represent those areas that may be more susceptible. This groundwater quality assessment is limited to an assessment of the datasets listed above and does not constitute a full risk assessment, which will need to be undertaken. Importantly, it does not consider the presence of contaminated land.

The dataset does not state which factor may be important, this information is provided in the *Infiltration SuDS Map: Detailed.*

4.6 DATA SUMMARY

The datasets from which the *Infiltration SuDS Map: Summary* is derived, are shown in Table 6.

Table 6. Details of the original datasets used in the infiltration SuDS map

Data layer	Layer ID	Original dataset	Dataset owner	Scale
Infiltration constraints summary				
Soluble rock constraints	SuDS_infiltrationconstraints_solublerocks_2016	GeoSure v7	BGS	1:50 000
Landslide constraints	SuDS_infiltrationconstraints_landslides_2016	GeoSure v7	BGS	1:50 000
Shallow groundwater constraints	SuDS_infiltrationconstraints_shallowGW_2016	Groundwater Flooding Susceptibility v6.1	BGS	1:50 000
Made ground constraints	SuDS_infiltrationconstraints_madeground_2016	DiGMapGB-50 v7	BGS	1:50 000
Shallow mining constraints	SuDS_infiltrationconstraints_shallowmining(non-coal)_2016	Mining hazard (non-coal) GB v7	BGS	1:50 000
Drainage summary				
Depth to water table	SuDS_drain_depthtowater_2016	gwlevelgb (2016)	BGS	---
Superficial deposit thickness	SuDS_drain_superficialthickness_2016	Basic superficial thickness model, version 2.1, GI_SDTM v2.1	BGS	1:50 000
Superficial deposit permeability	SuDS_drain_superficialpermeability_2016	Permeability indices v7	BGS	1:50 000
Bedrock permeability	SuDS_drain_bedrockpermeability_2016	Permeability indices v7	BGS	1:50 000
Floodplains	SuDS_drain_geologicalindicatorsofflooding_2016	Geological indicators of flooding v6	BGS	1:50 000
Ground stability summary				
Soluble rocks	SuDS_stability_solublerocks_2016	GeoSure v7	BGS	1:50 000
Landslides	SuDS_stability_landslides_2016	GeoSure v7	BGS	1:50 000
Compressible ground	SuDS_stability_compressibles_2016	GeoSure v7	BGS	1:50 000
Swelling clay	SuDS_stability_swellingclay_2016	GeoSure v7	BGS	1:50 000
Running sand	SuDS_stability_runningsand_2016	GeoSure v7	BGS	1:50 000
Shallow mining	SuDS_stability_shallowmining_2016	Mining hazard (non- coal) GB V7	BGS	1:50 000
Collapsible ground	SuDS_stability_collapsibles_2016	GeoSure v7	BGS	1:50 000
Groundwater protection summary				
Source protection zones	SuDS_waterquality_sourceprotectionzone_2016	Downloaded 2015	EA	--
Predominant flow mechanism	SuDS_waterquality_predominantflowmechanism_2016	Permeability indices v7	BGS	1:50 000
Made ground	SuDS_waterquality_madeground_2016	DiGMapGB-50 v7	BGS	1:50 000

5 Technical Information

5.1 PRE-REQUISITE REQUIREMENTS

To use the Infiltration SuDS Map, a computer with vector-based GIS software is required.

5.2 CREATION OF THE DATASET

The component datasets are directly derived from the datasets listed in Table 6. The original datasets were modified to create the component datasets in one or more of the following ways:

a) polygons were reclassified with SuDS scores (scores used are stated in Tables 2 to 5) and those with identical attributes were merged
b) raster datasets with continuous numerical values were classified into intervals
c) polygons that were not relevant were not incorporated in the map

Resulting polygons were attributed with a score, a short description, a detailed description, an advice description layer identification (ID), where relevant, further information about the dataset. The only exception was the superficial thickness data layer, which was not attributed with a score classification.

The four summary maps were derived from the rasterised component datasets as shown in Figure 4. For each raster cell, the maximum score from the individual datasets was calculated and used to create the summary map.

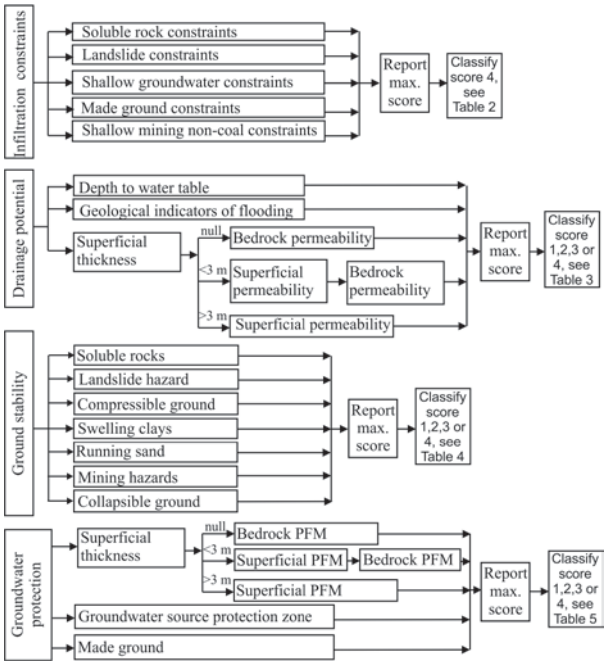


Figure 4. Flow diagram showing how data was used to create summary maps. PFM: Predominant flow mechanism.

5.3 SCALE

The Infiltration SuDS Map is produced for use at 1:50 000 scale providing 50 m ground resolution. A cell size of 50 m is deemed reasonable given that 1:50 000 geological linework has a cartographic accuracy of 50 m. The mapping scales on which the original geological linework are based are shown in Appendix 1.

5.4 FIELD DESCRIPTIONS

Table 7 describes the attributes attached to each dataset.

Table 7. Attribute table field descriptions

FIELD NAME	FIELD TYPE	DESCRIPTION
LayerID	String	Layer name
Score	Integer	SuDS score
Short description	String	Short description of polygon attribute
Detailed description	String	Detailed description of polygon attribute
Advice	String	Advice on action necessary

5.5 DATASET HISTORY

The Infiltration SuDS Map was originally created and released in 2012. This report describes the second version of the map released in 2016. The methodology used to create the map remains the same; however a number of the source datasets have been re-released since the Infiltration SuDS Map was released and thus the new versions of these datasets are now incorporated. The changes to these datasets (permeability, predominant flow mechanism, geohazards, groundwater flooding and artificial ground) are a result of changes to the underlying DigMapGB-50 and other advances in methodology/understanding. A new version of the depth to water table dataset has been incorporated. This dataset has been completely revised and as a result you may notice some differences compared to the old dataset. Since the last release, the Environment Agency, and Natural Resources Wales, have released new versions of the source protection zone datasets and these are now incorporated.

5.6 COVERAGE

The data covers Great Britain, but not the Isle of Man. The source protection zone dataset does not have coverage in Scotland and hence queries will not return any data.

5.7 DATA FORMAT

The *Infiltration SuDS Map: Summary* has been created as vector polygons, which are available in a range of GIS formats, including ArcGIS (.shp) and MapInfo (.tab).

A sample of the map is available at
http://www.bgs.ac.uk/products/hydrogeology/infiltrationSuds.html.

5.8 LIMITATIONS

- The Infiltration SuDS Map has been developed at 1:50 000 scale and must not be used at larger scales.
- The Infiltration SuDS Map is based on, and limited to, an interpretation of the records in the possession of the British Geological Survey at the time the dataset was created.
- The search does NOT consider the suitability of sites with regard to previous land use, for example with regard to water quality issues that might arise as a result of infiltration through contaminated land and associated mobilisation of surface or subsurface contaminants.
- This dataset is NOT an alternative for a site investigation or for infiltration testing, either of which may reach a different conclusion.
- Site observations represent the properties of the ground more accurately than the data provided by the infiltration SuDS map.
- This dataset must NOT be used to justify the disposal of foul waste or grey water.
- This dataset considers only the subsurface beneath the search area and does NOT consider potential surface or subsurface impacts outside of that area.
- Other more specific and detailed ground instability information may be held by BGS, and an assessment of this could result in a different outcome.
- An indication of potential natural ground instability does not necessarily mean that a location will be affected by ground movement or subsidence. Such an assessment can only be made by inspection of the area by a qualified professional.
- Limitations associated with the individual datasets are highlighted in Section 4.
- The dataset does not represent a complete list of factors that should be considered when designing infiltration SuDS. In particular, the dataset does not consider:
    - presence of contaminated land
    - potential for perched water tables
    - shallow mining hazards relating to coal mining
    - made ground, where not recorded, and
    - zones around private water supply boreholes that are susceptible to groundwater contamination
- The dataset may under-represent some hazards, in particular:
    - shallow mining hazards in areas that are not typically mined, or are subject to historical artisan mining
    - Landslide hazards in some coastal areas

6 Using the data

6.1 SETTING UP THE GIS

To ensure that the dataset is used as designed, follow the proceedings steps to set-up the map:

a) Make sure the required data layers, as shown below, are present.
- Infiltration_constraints_summary
- Drainage_summary
- Ground_stability_summary
- Groundwater_protection_summary

If you have licensed data as a MapInfo .tab file and the infiltration constraint file is missing, this may be because the chosen area is not affected by any constraints (i.e. there is no data). MapInfo cannot create a file without data, conversely, ArcGIS shape files can be created regardless and so there should not be any .shp files missing.

b) Import the data layers into the GIS software such that they appear in the order shown in Figure 2.

If you're using ESRI ArcGIS, the GIS can be set-up simply by using the single group layer file called *Infiltration_SuDS_Map_Summary.lyr*. Either import this into an existing ArcGIS document, or double click on the file to open a new GIS document.

Alternatively, import the layer files (.lyr) from the *Severe_Constraints*, *Drain*, *Stability*, and *Water_Quality* folders provided. By using layer files, the polygons will be imported with the correct symbology. The map should be coloured via the *short description* attribute as shown in Table 8, such that it mirrors that shown in Figure 5 for the *Drainage Summary* layer.

Table 8. RGB colours to be assigned to score classes

Datasets	Score			
	1	2	3	4
Infiltration Constraints Summary				R: 156 G: 156 B: 156
Drainage Summary	R: 235 G: 240 B: 255	R: 199 G: 209 B: 255	R: 156 G: 156 B: 227	R: 156 G: 156 B: 156
Ground Stability Summary	R: 229 G: 245 B: 179	R: 198 G: 222 B: 133	R: 145 G: 163 B: 97	R: 156 G:156 B: 156
Groundwater Protection Summary	R: 245 G: 220 B: 229	R: 217 G: 169 B: 187	R: 179 G: 117 B: 143	R: 156 G: 156 B: 156

c) We recommend setting the polygon transparency to 30 per cent.

If you need support setting up the GIS, please contact digitaldata@bgs.ac.uk.

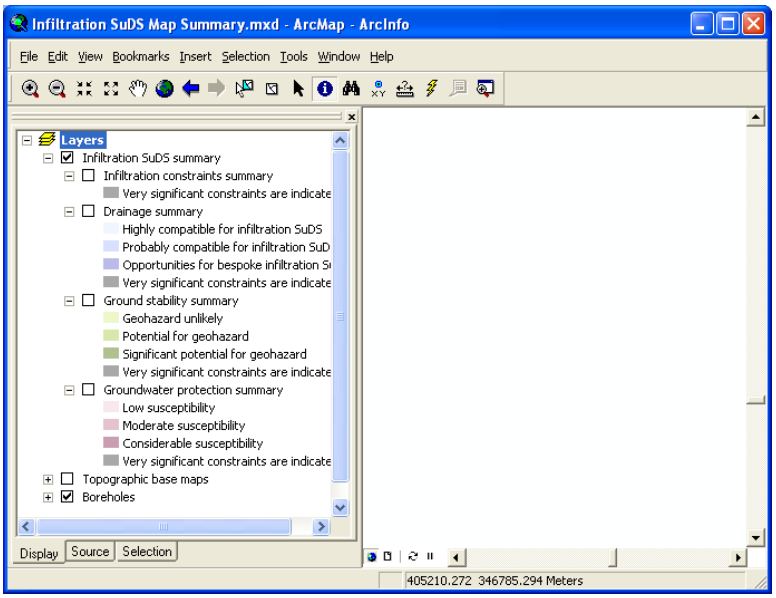


Figure 5. Infiltration SuDS map loaded into ArcGIS, showing legend colours

6.2 HOW TO USE THE DATA FOR A SITE ASSESSMENT

This section provides advice on how to use the dataset. Turn on each dataset individually, so that only one dataset and the topography layer is visible at any one time.

a) Load the Infiltration SuDS Map dataset into the preferred GIS software as described in Section 6.1.

b) Pan to, or locate by coordinates, the location of interest

c) Turn on the *Infiltration constraints summary* layer
If an 'infiltration constraints' polygon is identified at the site it indicates that there is potential for a hazard if water is infiltrated to the ground. In such areas, infiltration SuDS should only be installed if the potential for, or the consequences of, the constraint are considered not to be significant.

d) Turn on the *Drainage Summary* layer to obtain a rapid assessment of the drainage potential of the ground. At the location of interest, use the cursor in 'Identify' mode to determine the attributes of the polygon overlaying the site. The following attributes may be encountered.

- Highly compatible for infiltration SuDS.
- Probably compatible for infiltration SuDS.
- Opportunities for bespoke infiltration SuDS.
- Very significant constraints are identified.

e) Turn on the *ground stability summary* layer to obtain a spatial assessment of the expected stability of the subsurface should water be infiltrated. At the location of interest, use the cursor in 'Identify' mode to determine the attributes of the polygon overlaying the site. The following attributes may be encountered:

- Geohazard unlikely.
- Potential for geohazard.
- Significant potential for geohazard.
- Very significant constraints are identified.

f) Turn on the *groundwater protection summary* layer to obtain a rapid assessment of factors that may influence infiltration SuDS design with respect to protecting groundwater quality. At the location of interest, use the cursor in 'Identify' mode to determine the attributes of the polygon overlaying the site. The following attributes may be encountered.

- Low susceptibility.
- Moderate susceptibility.
- Considerable susceptibility.
- Very significant constraints are indicated.

Worked examples

Table 9 summarises data obtained from the *Infiltration SuDS Map: Summary* for three locations; A, B and C, each of which represents a location where an infiltration system has been installed. The data does not state which type of infiltration system is appropriate, or, in any way, offer advice on appropriate infiltration systems, but does allow you to develop a conceptual model of the subsurface geology as shown in Figure 9.

Table 9. Data for three locations, A, B and C where infiltration devices (soakaway, permeable pavement and infiltration basins respectively) have been installed. All red text derived from Infiltration SuDS Map: Summary

Data layer	Location A	Location B	Location C
System installed	**Soakaways**	**Permeable pavements**	**Infiltration basin**
Infiltration constraints summary	Null	Null	Null
Drainage summary	Highly compatible for infiltration SuDS	Probably compatible for infiltration SuDS	Opportunities for bespoke infiltration SuDS
Ground stability summary	Potential for geohazard	Significant potential for geohazard	Potential for geohazard
Groundwater protection summary	Low susceptibility	Low susceptibility	Moderate susceptibility

7 Licensing Information

The British Geological Survey does not sell its digital mapping data to external parties. Instead, BGS grants external parties a licence to use this data, subject to certain standard terms and conditions. In general, a licence fee will be payable based on the type of data, the number of users, and the duration (years) of a licence.

All recipients of a licence (potential licensees) are required to return a signed digital data licence document to us before authorisation for release of BGS digital data is given. For more information see http://www.bgs.ac.uk/about/copyright/digital_availability.html.

In general terms, a BGS digital data licensee **will** be permitted to

- make internal use of the dataset(s)
- allow a specified number of internal users to access/use the data (the number of users will be agreed with the licensee and specified in the licence document) for the purposes of their day-to-day internal activities
- reproduce extracts from the data up to A3 for use in external analogue (paper/hard copy) or non-queryable electronic (e.g. secured .pdf) format: to meet a public task duty; fulfil a statutory requirement; and/or as part of academic or other non-commercial research

But **will not** be permitted to:

- provide a bureau service for others or incorporate the data in the generation of products or services for commercial purposes
- sell, assign, sublicense, rent, lend or otherwise transfer (any part of) the dataset(s) or the licence
- place (any part of) the dataset(s) on the Internet

The BGS is committed to ensuring that all the digital data it holds which is released to external parties under licence has been through a robust internal approval process, to ensure that geoscientific standards and corporate quality assurance standards are maintained. This approval process is intended to ensure that all data released: (i) is quality assured; (ii) meets agreed BGS data management standards; (iii) is not in breach of any 3rd party intellectual property rights, or other contractual issues (such as confidentiality issues), that would mean that release of the data is not appropriate.

When the BGS digital datasets are revised any upgrades will be automatically supplied to the licensee, at no additional cost. Most geological map datasets are revised on a periodic rather than on an annual basis, so licensees will not automatically receive a new dataset each year.

These are general comments for guidance only. A licensee of BGS's digital data is provided with full details of the basis on which individual BGS datasets licensed to them are supplied.

If you have any doubts about whether your proposed use of the BGS data will be covered by a BGS digital licence, the BGS Intellectual Property Rights (IPR) section will be happy to discuss this with you and can be contacted through the following email address: iprdigital@bgs.ac.uk. BGS IPR will usually be able to provide reassurance that the licence will cover individual user requirements and/or to include additional 'special conditions' in the licence documentation, addressing specific requirements within BGS's permitted usage.

References

DEARDEN, R. 2016. User guide for the Infiltration SuDS Map: Detailed. British Geological Survey Open Report, OR/11/061.

DEFRA (2005) Making space for water: Taking forward a new Government strategy for flood and coastal erosion risk management in England, *Department for Environment, Food and Rural Affairs*, PB10516

DEFRA. 2008. Future Water: The Government's water strategy for England. *H M Government* (London).

DEFRA. 2011. National Standards for Sustainable Drainage. Draft. *H M Government* (London)

DEFRA. 2015 Sustainable Drainage Systems. Non-statutory technical standards for sustainable drainage systems. DEFRA. March 2015

HMSO. 2002. The building regulations 2000: Approved document H - Drainage and waste disposal, Office of the Deputy Prime Minister.

HMSO. 2010. Floods and Water Management Act, Chapter 29, HM Government, Her Majesty's Stationery Office.

PITT, M. (2008) Pitt Review: Learning lessons from the 2007 floods, *HM Government*

WOODS-BALLARD, B, KELLAGHER, R, MARTIN, P, JEFFERIES, C, BRAY, R, and SHAFFER, P. 2007. The SUDS Manual. *CIRIA*, RP697

Appendix 1

Mapping scales