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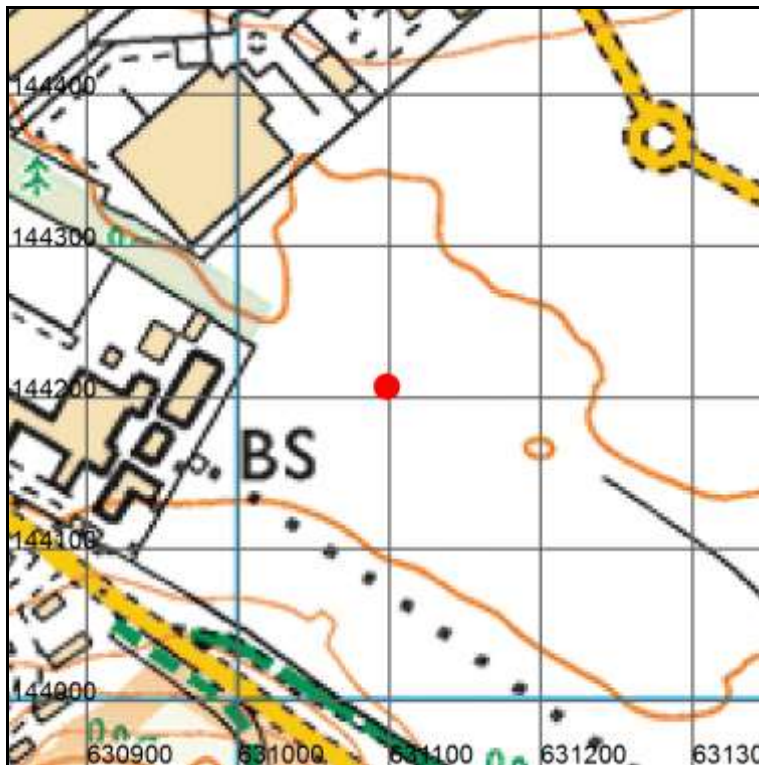
## **Infiltration SuDS GeoReport:**

This report provides information on the suitability of the subsurface for the installation of infiltration sustainable drainage systems (SuDS). It provides information on the properties of the subsurface with respect to significant constraints, drainage, ground stability and groundwater quality protection.

**Report Id: *GR\_213623/1***

**Client reference: PO-4706**

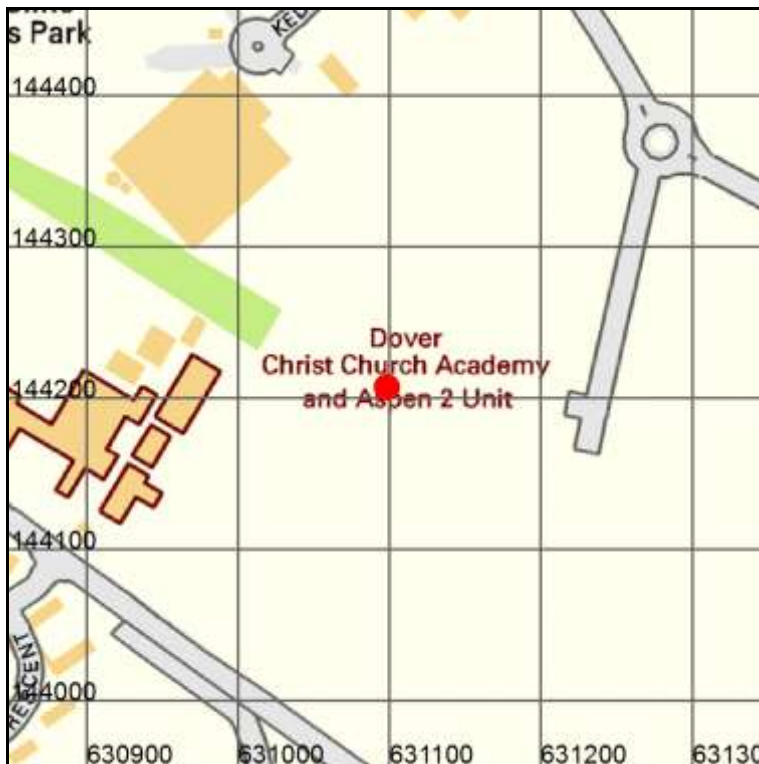
### Search location



Point centred at:  
631098,144207

Search location indicated in red

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## **Assessment for an infiltration sustainable drainage system**

### **Introduction**

Sustainable drainage systems (SuDS) are drainage solutions that manage the volume and quality of surface water close to where it falls as rain. They aim to reduce flow rates to rivers, increase local water storage capacity and reduce the transport of pollutants to the water environment. There are four main types of SuDS, which are often designed to be used in sequence. They comprise:

- **source control:** systems that control the rate of runoff
- **pre-treatment:** systems that remove sediments and pollutants
- **retention:** systems that delay the discharge of water by providing surface storage
- **infiltration:** systems that mimic natural recharge to the ground.

This report focuses on infiltration SuDS. It provides subsurface information on the properties of the ground with respect to drainage, ground stability and groundwater quality protection. It is intended principally for those involved in the preliminary assessment of the suitability of the ground for infiltration SuDS, and those involved in assessing proposals from others for sustainable drainage, but it may also be useful to help house-holders judge whether or not further professional advice should be sought. If in doubt, users should consult a suitably-qualified professional about the results in this report before making any decisions based upon it.

This GeoReport is structured in two parts:

- **Part 1. Summary data.**

Comprises three maps that summarise the data contained within Part 2.

- **Part 2. Detailed data.**

Comprises a further 24 maps in four thematic sections:

- **Very significant constraints.** Maps highlight areas where infiltration may result in adverse impacts due to factors including: ground instability (soluble rocks, non-coal shallow mining and landslide hazards); persistent shallow groundwater, or the presence of made ground, which may represent a ground stability or contamination hazard.
- **Drainage potential.** Maps indicate the drainage potential of the ground, by considering subsurface permeability, depth to groundwater and the presence of floodplain deposits.
- **Ground stability.** Maps indicate the presence of hazards that have the potential to cause ground instability resulting in damage to some buildings and structures, if water is infiltrated to the ground.
- **Groundwater protection.** Maps provide key indicators to help determine whether the groundwater may be susceptible to deterioration in quality as a result of infiltration.


















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This report considers the suitability of the subsurface for the installation of infiltration SuDS, such as soakaways, infiltration basins or permeable pavements. It provides subsurface data to indicate whether, and which type of infiltration system may be appropriate. It does not state that infiltration SuDS are, or are not, appropriate as this is highly dependent on the design of the individual system. This report therefore describes the subsurface conditions at the site, allowing the reader to determine the suitability of the site for infiltration SuDS.

The map and text data in this report is similar to that provided in the '*Infiltration SuDS Map: Detailed*' national map product. For further information about the data, consult the '*User Guide for the Infiltration SuDS Map: Detailed*', available from <http://nora.nerc.ac.uk/16618/>.

## PART 1: SUMMARY DATA

This section provides a summary of the data on the following pages.

<p><b>In terms of the drainage potential, is the ground suitable for infiltration SuDS?</b></p>	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p> Highly compatible for infiltration SuDS. The subsurface is likely to be suitable for free-draining infiltration SuDS.</p>
	<p> Probably compatible for infiltration SuDS. The subsurface is probably suitable although the design may be influenced by the ground conditions.</p>
	<p> Opportunities for bespoke infiltration SuDS. The subsurface is potentially suitable although the design will be influenced by the ground conditions.</p>
	<p> Very significant constraints are indicated. There is a very significant potential for one or more hazards associated with infiltration.</p>
<p><b>Is ground instability likely to be a problem?</b></p>	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p> Increased infiltration is very unlikely to result in ground instability.</p>
	<p> Ground instability problems may be present or anticipated, but increased infiltration is unlikely to result in ground instability</p>
	<p> Ground instability problems are probably present. Increased infiltration may result in ground instability.</p>
	<p> There is a very significant potential for one or more geohazards associated with infiltration.</p>
<p><b>Is the groundwater susceptible to deterioration in quality?</b></p>	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p> The groundwater is not expected to be especially vulnerable to contamination.</p>
	<p> The groundwater may be vulnerable to contamination.</p>
	<p> The groundwater is likely to be vulnerable to contaminants.</p>
	<p> Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.</p>

## PART 2: DETAILED DATA



This section provides further information about the properties of the ground and will help assess the suitability of the ground for infiltration SuDS.




### Section 1. Very significant constraints

Where maps are overlain by grey polygons, geological or hydrogeological hazards may exist that could be made worse by infiltration. The following hazards are considered:

- soluble rocks
- landslides
- shallow mining
- shallow groundwater
- made ground

For more information read 'Explanation of terms' at the end of this report.

<b>Soluble rock hazard</b>	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input checked="" type="checkbox"/> Very significant soluble rock hazard.</p> <p>Soluble rocks are present with a very significant possibility of localised subsidence that could be initiated or made worse by infiltration. The site investigation should consider whether the potential for or the consequences of subsidence as a result of infiltration are significant.</p> <p><input type="checkbox"/> Very significant soluble rock hazards are not present; however this hazard may still need to be considered. See Part 3.</p>
<b>Landslide hazard</b>	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input checked="" type="checkbox"/> Very significant landslide hazard.</p> <p>Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail. The site investigation should consider whether the potential for or the consequences of landslide as a result of infiltration are significant.</p> <p><input type="checkbox"/> Very significant landslide hazards are not present; however this hazard may still need to be considered. See Part 3.</p>

<b>Shallow mining hazard</b>	
	<p><input checked="" type="checkbox"/> Very significant mining hazard.</p> <p>Shallow mining is likely to be present with a very significant possibility of localised subsidence that could be initiated or made worse by increased infiltration. Also, infiltration may increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of subsidence and/or remobilisation of pollutants as a result of infiltration are significant.</p>
<p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input type="checkbox"/> Very significant mining hazards are not present; however this hazard may still need to be considered. See Part 3.</p>
<b>Persistent shallow groundwater</b>	
	<p><input checked="" type="checkbox"/> Very high likelihood of persistent or seasonally shallow groundwater.</p> <p>Persistent or seasonally shallow groundwater is likely to be present. Infiltration may increase the likelihood of soakaway inundation, or groundwater emergence at the surface. The site investigation should consider whether the potential for or the consequences of groundwater level rise as a result of infiltration are significant.</p>
<p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input type="checkbox"/> See Part 2 for the likely depth to water table.</p>
<b>Made ground</b>	
	<p><input checked="" type="checkbox"/> Made ground present.</p> <p>Made ground is present at the surface. Infiltration may affect ground stability or increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of ground instability and/or pollutant leaching as a result of infiltration are significant.</p>
<p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input type="checkbox"/> None recorded</p>

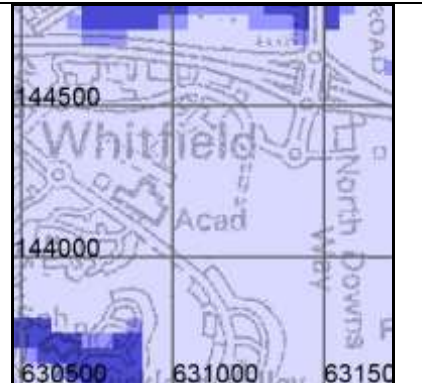



## Section 2. Drainage potential

The following pages contain maps that will help you assess the drainage potential of the ground by considering the:

- depth to water table
- permeability of the superficial deposits
- thickness of the superficial deposits
- permeability of the bedrock
- presence of floodplains

Superficial deposits are not present everywhere and therefore some areas of the *superficial deposit permeability* map may not be coloured. Where this is the case, the *bedrock permeability* map shows the likely permeability of the ground. Superficial deposits in some places are very thin and hence in these places you may wish to consider both the permeability of the superficial deposits and the permeability of the bedrock. The *superficial thickness* map will tell you whether the superficial deposits are thin (< 3 m thick) or thick (>3 m). Where they are over 3 m thick, the permeability of the bedrock may not be relevant.

For more information read 'Explanation of terms' at the end of this report.


Depth to groundwater table	
	<p> Groundwater is likely to be <b>more than 5 m</b> below the ground surface throughout the year.</p> <p> Groundwater is likely to be between <b>3 and 5 m</b> below the ground surface for at least part of the year.</p> <p> Groundwater is likely to be <b>less than 3 m</b> below the ground surface for at least part of the year.</p>
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**Superficial deposit permeability**



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 Superficial deposits are likely to be **free-draining**.

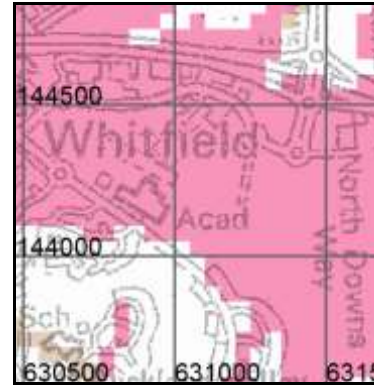
 The superficial deposit permeability is **spatially variable**, but likely to permit moderate infiltration.

 Superficial deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

-  Very Low
-  Low
-  Moderate
-  High
-  Very High

**Minimum**



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**Maximum**





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**Superficial deposit thickness**



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 The thickness of superficial deposits is **< 3 m** and hence the permeability of the ground may be dependent on both the superficial deposits (where present) and underlying bedrock (see below).

 The thickness of superficial deposits is **> 3 m** and hence the permeability of the superficial deposits is likely to determine the permeability of the ground.

**Bedrock permeability**



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Bedrock deposits are likely to be **free-draining**.



The bedrock permeability is **spatially variable**, but likely to permit moderate infiltration.



Bedrock deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

**Key**

-  Very Low
-  Low
-  Moderate
-  High
-  Very High

**Minimum**



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**Maximum**



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**Geological indicators of flooding**



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



Superficial floodplain deposits or low-lying coastal areas have been identified. Groundwater levels may rise in response to high river or tide levels, potentially causing inundation of subsurface infiltration SuDS.

### Section 3. Ground stability

The following pages contain maps that will help you assess whether infiltration may impact the stability of the ground. They consider hazards associated with:

- soluble rocks
- landslides
- shallow mining
- running sands
- swelling clays
- compressible ground, and
- collapsible ground

In the following maps, geohazards that are identified in green are unlikely to prevent infiltration SuDS from being installed, but they should be considered during design. For more information read 'Explanation of terms' at the end of this report.

Soluble rocks	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	 Increased infiltration is unlikely to result in subsidence.
	 Increased infiltration is unlikely to cause localised subsidence, but potential impacts should be considered.
	 Increased infiltration may result in localised subsidence. The potential for or the consequences of subsidence associated with soluble rocks should be considered.
	 Very significant possibility of localised subsidence that could be initiated or made worse by infiltration.

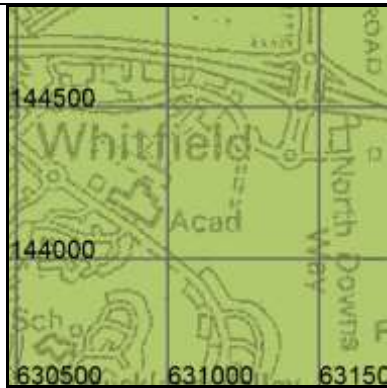
**Landslides**



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- Increased infiltration is unlikely to lead to slope instability.
- Slope instability problems may be present or anticipated, but increased infiltration is unlikely to cause instability
- Slope instability problems are probably present or have occurred in the past, and increased infiltration may result in slope instability.
- Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail.

**Shallow mining**



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- Increased infiltration is unlikely to lead to subsidence.
- Shallow mining is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
- Shallow mining could be present with a significant possibility that localised subsidence could be initiated or made worse by increased infiltration.
- Shallow mining is likely to be present, with a very significant possibility that localised subsidence may be initiated or made worse by increased infiltration.

**Running sand**






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- Increased infiltration is unlikely to cause ground collapse associated with running sands.
- Running sand is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
- Significant possibility for running sand problems. Increased infiltration may result in a geohazard.

**Swelling clays**





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-  Increased infiltration is unlikely to cause shrink-swell ground movement.
-  Ground is susceptible to shrink-swell ground movement. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
-  Ground is susceptible to shrink-swell ground movement. Increased infiltration may result in a geohazard.

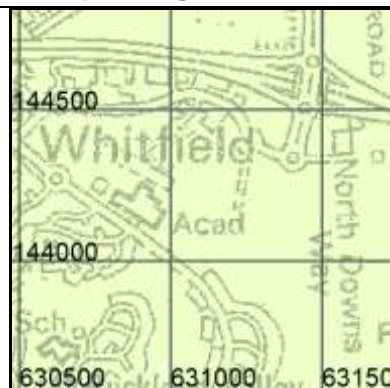
**Compressible ground**






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-  Increased infiltration is unlikely to lead to ground compression.
-  Compressibility and uneven settlement hazards are probably present. Increased infiltration may result in a geohazard.

**Collapsible ground**



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-  Increased infiltration is unlikely to result in subsidence.
-  Deposits with potential to collapse when loaded and saturated are possibly present in places. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
-  Deposits with potential to collapse when loaded and saturated are probably present in places. Increased infiltration may result in a geohazard.

## Section 4. Groundwater quality protection

The following pages contain maps showing some of the information required to ensure the protection of groundwater quality. Data presented includes:

- groundwater source protection zones (Environment Agency data)
- predominant flow mechanism
- made ground

For more information read 'Explanation of terms' at the end of this report.

Groundwater source protection zones	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p> <p>Derived in part from Source Protection Zone data provided under licence from the Environment Agency © Environment Agency 2016.</p>	<p> Groundwater is not within a source protection zone.</p>
	<p> Source protection zone IV</p>
	<p> Source protection zone III</p>
	<p> Source protection zone II</p>
	<p> Source protection zone I.</p>
Predominant flow mechanism	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p> Water is likely to percolate through the unsaturated zone to the groundwater through either the pore space in granular media or through porespace and fractures; these processes have some potential for contaminant removal and breakdown.</p>
	<p> Water is likely to percolate through the unsaturated zone to the groundwater through fractures, a process which has little potential for contaminant removal and breakdown.</p>



**Made ground**



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Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

## Section 5. Geological Maps

The following maps show the artificial, superficial and bedrock geology within the area of interest.

### Artificial deposits



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### Superficial deposits



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### Bedrock



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Fault




Coal, ironstone or mineral vein

Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

Key to Artificial deposits:

**No deposits recorded by BGS in the search area**

Key to Superficial deposits:




Map colour	Computer Code	Rock name	Rock type
	HEAD-XCZSV	HEAD	CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
	HEAD-XZV	HEAD	SILT AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
	CWF-XCZSV	CLAY-WITH-FLINTS FORMATION	CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]





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Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	MACK-CHLK	MARGATE CHALK MEMBER	CHALK
	SECK-CHLK	SEAFORD CHALK FORMATION	CHALK
	LECH-CHLK	LEWES NODULAR CHALK FORMATION	CHALK



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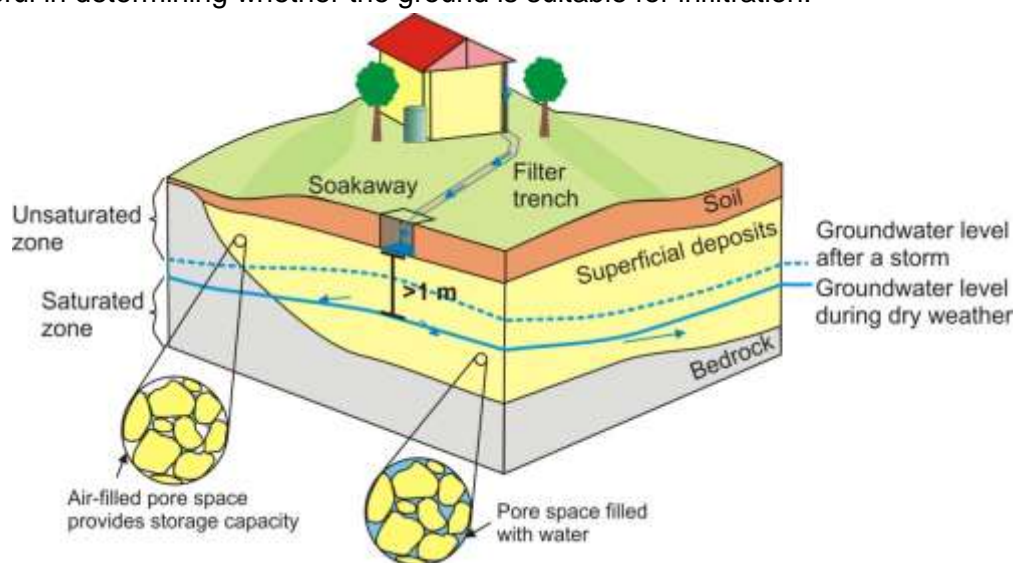
### Limitations of this report:

- This report is concerned with the potential for infiltration-to-the-ground to be used as a SuDS technique at the site described. It only considers the subsurface beneath the search area and does NOT consider potential surface or subsurface impacts outside of that area.
- This report is NOT an alternative for an on-site investigation or soakaway test, which might reach a different conclusion.
- This report must NOT be used to justify disposal of foul waste or grey water.
- This report is based on and limited to an interpretation of the records held by the British Geological Survey (BGS) at the time the search is performed. The datasets used (with the exception of that showing depth to water table) are based on 1:50 000 digital geological maps and not site-specific data.
- Other more specific and detailed ground instability information for the site may be held by BGS, and an assessment of this could result in a modified assessment.
- To interpret the maps correctly, the report must be viewed and printed in colour.
- The search does NOT consider the suitability of sites with regard to:
  - previous land use,
  - potential for, or presence of contaminated land
  - presence of perched water tables
  - shallow mining hazards relating to coal mining. Searches of coal mining should be carried out via The Coal Authority Mine Reports Service: [www.coalminingreports.co.uk](http://www.coalminingreports.co.uk).
  - made ground, where not recorded
  - proximity to landfill sites (searches for landfill sites or contaminated land should be carried out through consultation with local authorities/Environment Agency)
  - zones around private water supply boreholes that are susceptible to groundwater contamination.
- This report is supplied in accordance with the GeoReports Terms & Conditions available separately, and the copyright restrictions described at the end of this report

## Explanation of terms

### Depth to groundwater

In the shallow subsurface, the ground is commonly unsaturated with respect to water. Air fills the spaces within the soil and the underlying superficial deposits and bedrock. At some depth below the ground surface, there is a level below which these spaces are full of water. This level is known as the groundwater level, and the water below it is termed the groundwater. When water is infiltrated, the groundwater level may rise temporarily. To ensure that there is space in the unsaturated zone to accommodate this, there should be a minimum thickness of 1 m between the base of the infiltration system and the water table. An estimate of the *depth to groundwater* is therefore useful in determining whether the ground is suitable for infiltration.



### Groundwater flooding

Groundwater flooding occurs when a rise in groundwater level results in very shallow groundwater or the emergence of groundwater at the surface. If infiltration systems are installed in areas that are susceptible to groundwater flooding, it is possible that the system could become inundated. The susceptibility map seeks to identify areas where the geological conditions and water tables indicate that groundwater level rise could occur under certain circumstances. A high susceptibility to groundwater flooding classification does not mean that groundwater flooding has ever occurred in the past, or will do so in the future as the susceptibility maps do not contain information on how often flooding may occur. The susceptibility maps are designed for planning; identifying areas where groundwater flooding might be an issue that needs to be taken into account.



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### **Geological indicators of flooding**

In floodplain deposits, groundwater level can be influenced by the water level in the adjacent river. Groundwater level may increase during periods of fluvial flood and therefore this should be taken into account when designing infiltration systems on such deposits. The *geological indicators of flooding* dataset shows where there is geological evidence (floodplain deposits) that flooding has occurred in the past.

For further information on flood-risk, the likely frequency of its recurrence in relation to any proposed development of the site, and the status of any flood prevention measures in place, you are advised to contact the local office of the Environment Agency (England and Wales) at [www.environment-agency.gov.uk/](http://www.environment-agency.gov.uk/) or the Scottish Environment Protection Agency (Scotland) at [www.sepa.org.uk](http://www.sepa.org.uk).

### **Artificial ground**

Artificial ground comprises deposits and excavations that have been created or modified by human activity. It includes ground that is worked (quarries and road cuttings), infilled (back-filled quarries), landscaped (surface re-shaping), disturbed (near surface mineral workings) or classified as made ground (embankments and spoil heaps). The composition and properties of artificial ground are often unknown. In particular, the permeability and chemical composition of the artificial ground should be determined to ensure that the ground will drain and that any contaminants present will not be remobilised.

### **Superficial permeability**

Superficial deposits are those geological deposits that were formed during the most recent period of geological time (as old as 2.6 million years before present). They generally comprise relatively thin deposits of gravel, sand, silt and clay and are present beneath the pedological soil in patches or larger spreads over much of Britain. The ease with which water can percolate through these deposits is controlled by their permeability and varies widely depending on their composition. Those deposits comprising clays and silts are less permeable and thus infiltration is likely to be slow, such that water may pool on the surface. In comparison, deposits comprising sands and gravels are more permeable allowing water to percolate freely.

### **Bedrock permeability**

Bedrock forms the main mass of rock forming the Earth. It is present everywhere, commonly beneath superficial deposits. Where the superficial deposits are thin or absent, the ease with which water will percolate into the ground depends on the permeability of the bedrock.

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### **Natural ground instability**

Natural ground instability refers to the propensity for upward, lateral or downward movement of the ground that can be caused by a number of natural geological hazards (e.g. ground dissolution/compressible ground). Some movements associated with particular hazards may be gradual and of millimetre or centimetre scale, whilst others may be sudden and of metre or tens of metres scale. Significant natural ground instability has the potential to cause damage to buildings and structures, especially when the drainage characteristics of a site are altered. It should be noted, however, that many buildings, particularly more modern ones, are built to such a standard that they can remain unaffected in areas of significant ground movement.

### **Shrink-swell**

A shrinking and swelling clay changes volume significantly according to how much water it contains. All clay deposits change volume as their water content varies, typically swelling in winter and shrinking in summer, but some do so to a greater extent than others. Contributory circumstances could include drought, leaking service pipes, tree roots drying-out the ground or changes to local drainage patterns, such as the creation of soakaways. Shrinkage may remove support from the foundations of buildings and structures, whereas clay expansion may lead to uplift (heave) or lateral stress on part or all of a structure; any such movements may cause cracking and distortion.

### **Landslides (slope stability)**

A landslide is a relatively rapid outward and downward movement of a mass of ground on a slope, due to the force of gravity. A slope is under stress from gravity but will not move if its strength is greater than this stress. If the balance is altered so that the stress exceeds the strength, then movement will occur. The stability of a slope can be reduced by removing ground at the base of the slope, by placing material on the slope, especially at the top, or by increasing the water content of the materials forming the slope. Increase in subsurface water content beneath a soakaway could increase susceptibility to landslide hazards. The assessment of landslide hazard refers to the stability of the present land surface. It does not encompass a consideration of the stability of excavations.

### **Soluble rocks (dissolution)**

Some rocks are soluble in water and can be progressively removed by the flow of water through the ground. This process tends to create cavities, potentially leading to the collapse of overlying materials and possibly subsidence at the surface. The release of water into the subsurface from infiltration systems may increase the dissolution of rock or destabilise material above or within a cavity. Dissolution cavities may create a pathway for rapid transport of contaminated water to an aquifer or water course.



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### **Compressible ground**

Many ground materials contain water-filled pores (the spaces between solid particles). Ground is compressible if a building (or other load) can cause the water in the pore space to be squeezed out, causing the ground to decrease in thickness. If ground is extremely compressible the building may sink. If the ground is not uniformly compressible, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The compressibility of the ground may alter as a result of changes in subsurface water content caused by the release of water from soakaways.

### **Collapsible deposits**

Collapsible ground comprises certain fine-grained materials with large pore spaces (the spaces between solid particles). It can collapse when it becomes saturated by water and/or a building (or other structure) places too great a load on it. If the material below a building collapses it may cause the building to sink. If the collapsible ground is variable in thickness or distribution, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The subsurface underlying a soakaway will experience an increase in water content that may affect the stability of the ground. This hazard is most likely to be encountered only in parts of southern England.

### **Running sand**

Running sand conditions occur when loosely-packed sand, saturated with water, flows into an excavation, borehole or other type of void. The pressure of the water filling the spaces between the sand grains reduces the contact between the grains and they are carried along by the flow. This can lead to subsidence of the surrounding ground. Running sand is potentially hazardous during the drainage system installation. During installation, excavation of the ground may create a space into which sand can flow, potentially causing subsidence of surrounding ground.

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

Current or past underground mining for coal or for other commodities can give rise to cavities at shallow or intermediate depths, which may cause fracturing, general settlement, or the formation of crown-holes in the ground above. Spoil from mineral workings may also present a pollution hazard. The release of water into the subsurface from soakaways may destabilise material above or within a cavity. Cavities arising as a consequence of mining may also create a pathway for rapid transport of contaminated water to an aquifer or watercourse. The mining hazards map is derived from the geological map and considers the potential for subsidence associated with mining on the basis of geology type. Therefore if mining is known to occur within a certain rock, the map will highlight the potential for a hazard within the area covered by that geology.



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For more information regarding underground and opencast **coal mining**, the location of mine entries (shafts and adits) and matters relating to subsidence or other ground movement induced by **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](http://www.coal.gov.uk). For more information regarding other types of mining (i.e. non-coal), please contact the British Geological Survey.

#### **Groundwater source protection zones**

In England and Wales, the Environment Agency has defined areas around wells, boreholes and springs that are used for the abstraction of public drinking water as source protection zones. In conjunction with Groundwater Protection Policy the zones are used to restrict activities that may impact groundwater quality, thereby preventing pollution of underlying aquifers, such that drinking water quality is upheld. The Environment Agency can provide advice on the location and implications of source protection zones in your area ([www.environment-agency.gov.uk/](http://www.environment-agency.gov.uk/))



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**Report issued by  
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# Evans & Langford LLP

- ◆ Structural & Civil Engineers
- ◆ Land & Building Surveyors
- ◆ Geo-Environmental Engineers
- ◆ Project Managers
- ◆ CDM Consultants
- ◆ Contract Administrators

Our Ref: 13850X/HW/CPS

23 June 2016

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**By email only**

Dealt with by: Colin Shackelford

Direct Dial No: 01622 621978

For the attention of Mr Tom Pinnington

Dear Tom

## **Land off Honeywood Parkway, Dover**

This report has been prepared to present an initial assessment of surface water drainage options for the proposed Dover Leisure Centre at Land off Honeywood Parkway in Dover. In order to complete this assessment, Environment Agency (EA) and British Geological Survey (BGS) maps were consulted along with a BGS Infiltration SuDs GeoReport, which is specific to the site and is appended to this report.

### **Site Location and Setting**

The site is located approximately 1.1km to the south east of Whitfield, 2.7km to the north-north west of Dover and is centred on National Grid Reference 631100, 144230.

Currently the site comprises open farm land, occupying an area of around 12.5 hectares, bound to the north by Honeywood Parkway. The northern part of the site is bound to the west by commercial developments off Kedleston Road and to the east by a spur road from Honeywood Parkway. The southern part of the site is bound to the west by Dover Christ Church Academy and to the south by Melbourne Avenue. The eastern extent of this part of the site is undefined. The northern boundary is defined in part by a hedgerow.

The site lies in a fairly open area with some further commercial development to the north west and a little to the north east and with residential areas to the south and south east. Land to the north of the A2 is largely undeveloped, with the exception of Whitfield to the north west and smaller villages to the north and north east.

Evans & Langford LLP (E&L) have previously carried out a topographical survey of the north western part of the site. This shows the most northern part of the site to lie at 119.3m, with land sloping up to the south west to 126.3m over a horizontal distance of 260m. Ordnance Survey mapping of the site as a whole shows the site to slope up from the northern corner, which lies a little below the 120m OD contour, up to 125m OD at about the mid-point of the site, then down to the south western boundary which lies close to the 120m OD contour.

Southern Water asset plans show that there are no surface water sewers close to the site. There is a foul sewer with a number of spurs beneath Honeywood Parkway to the north. There is a foul pumping main from Honeywood Park Industrial Park pumping station just to the north of the site. The 225mm vitrified clay rising

Continued /



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main runs just within the site, following the north western boundary. Manhole information close to the south western corner of the site shows the pipe to be 1.47m below ground level. It should be noted that as part of the topographic survey works undertaken previously, E&L commissioned a buried utilities survey specialist to attempt to trace the rising main. All efforts proved fruitless; it is non-metallic and too small to be picked up by ground penetrating radar.

### **Geology**

Reference to the BGS records for the area indicates that the site is underlain by the Margate Chalk Member. At the most southerly extent of the site, close to Melbourne Avenue the overlying Seaford Chalk Formation is present. Superficial deposits of the Clay-with-Flints Formation are mapped across the entire site, with the exception of a very small area along the centre of the southern boundary. Made/artificial ground, other than that present as a result of disturbance caused by ploughing is not likely to be present on the site.

The Margate Chalk Member comprises marl-free smooth white chalk with little flint. The Seaford Chalk Formation consists of firm white chalk with conspicuous semi-continuous nodular and tabular flint seams. Hardgrounds and thin marls are known from the lowest beds. Some flint nodules are large to very large. The Clay-with-Flints Formation is a residual deposit formed from the dissolution, decalcification and cryoturbation of bedrock strata of the Chalk Group and Palaeogene formations. It is unbedded and heterogenous. The dominant lithology is orange-brown and red-brown sandy clay with abundant nodules and rounded pebbles of flint. Angular flints are derived from the Chalk, and rounded flints, sand and clay from Palaeogene formations. The deposit locally includes bodies of yellow fine to medium grained sand, reddish brown clayey silt, and sandy clay with beds of well-rounded flint pebbles, derived from Palaeogene formations.

The Chalk generally has an undulating upper surface, which is often characterised by the presence of solution features. These generally consist of fissures in the top of the chalk but may also take the form of pipes and cavities in otherwise intact chalk, at or about the groundwater table level. The voids are often filled with loose material that has collapsed into them or alternatively, in the case of fissures in the top of the chalk, any more competent materials may arch over the void. In this instance collapse into the void can be brought about by an increase in applied load or weakening of the overlying soil, possibly by water leaking from defective drainage. These features are particularly common at the margins of any overlying deposits.

### **Hydrogeology**

The EA classifies the superficial deposits on the site as unproductive strata in terms of groundwater storage. Both the Margate Chalk Member and Seaford Chalk Formation are classified as principal aquifers. These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifers.

EA records and the GeoReport show the majority of the site to lie in a Zone III, total catchment groundwater source protection zone (SPZ). The eastern part of the site lies in a Zone II, outer SPZ,. A Zone III SPZ represents the area around a source within which all groundwater recharge is presumed to be discharged at the source. A Zone II SPZ is defined by a 400-day travel time from a point below the water table. This zone has a minimum radius of 250 or 500 meters around the source, depending on the size of the abstraction. EA maps do not show any licensed groundwater abstractions within 1km of the site.

The GeoReport indicates that:

- Water is likely to percolate through the unsaturated zone to the groundwater through fractures; a process which has little potential for contaminant removal and breakdown.
- Groundwater is likely to be more than 5m below the surface throughout the year.
- The superficial deposits across the site are likely to be less than 3m thick and of spatially variable permeability. These soils have a range of very low to high permeability, but are likely to permit moderate infiltration. Bedrock deposits are likely to be free draining with very high permeability.

Groundwater flow direction beneath the site is considered likely to be towards the south/south west, based on the location of the nearest surface water feature, the topography and the location of the groundwater source protection zones.

Continued/

The Ground Stability maps in the GeoReport highlight that:

- There is considered to be a very significant soluble rock hazard across the site (i.e. the solution features referred to previously) which leads to the very significant possibility of localised subsidence, that could be initiated or made worse by infiltration.
- Slope instability problems (landslides) may be present or anticipated, but increased infiltration is unlikely to cause instability.
- Shallow mining is possibly present. Increased infiltration is unlikely to cause a geohazard but potential impacts should be considered.
- The clay soils are susceptible to shrink-swell ground movement. Increased infiltration is unlikely to cause a geohazard but potential impacts should be considered.
- Ground stability hazards associated with running sand, compressible or collapsible ground are unlikely to present a problem on this site with respect to increased infiltration to the ground.

### **Hydrology**

The nearest surface water feature evident on maps of the area is the River Dour which lies approximately 1.50km to the south, and flows to the south east. The ground level around the river to the south/south east of the site is approximately 100m vertical lower than the site itself.

EA mapping shows that the site and all areas within a 1km radius lie outside of any areas considered at risk of flooding from rivers and the sea. Additionally, the site is not considered at risk of flooding from surface water or reservoirs. There are no geological indicators of flooding highlighted in the GeoReport on or close to the site.

EA maps do not show any licensed surface water abstractions within 1km of the site.

### **Nearby Records and Previous Investigations**

There are no BGS borehole record scans for the site itself. There are a number of boreholes shown just to the west of the southern part of the site, but no records other than the depth and location are available on their website. The exception to this is for a borehole that dates from September 1970, located to the west of the central part of the site. This borehole was drilled to 1.80m, successively through topsoil, silty clay with occasional flint chips, and flints in a silty clay matrix, identified as Head Brickearth, and Head respectively. This borehole reminded dry.

In 2007 E&L excavated six trial pits across the northern part of the site. These found Fill/topsoil to 0.30m over Clay-with-flints which was typically stiff brown silty CLAY with occasional flints. CHALK was found in five positions in pockets, for example the end or corner of a pit found chalk at a certain depth but this was not present elsewhere in the pit. The depth of chalk was variable and was seen from a minimum of 1.20m, but elsewhere the chalk was not present at the full depth of the pits, which were excavated to between 3.50 and 4.00m. A soakage test was carried out in one of the pits which found chalk in one corner; this gave an infiltration rate of  $1.6 \times 10^{-5}$  m/s. This investigation also included thirty-five dynamic probes which were taken to a maximum depth of 10m; locally, these showed low blow counts at depth, indicating the likely presence of solution features. The desk study associated with this work also identified the known presence of solution features within the vicinity of the site.

In 2009 E&L drilled a number of cable percussion boreholes on the parcel of land immediately east of the northern part of the site and for the spur road which abuts the site to the east. These found topsoil to a maximum depth of 0.40m, over superficial deposits comprising CLAY layers, with a little organic mottling at the top of the formation. Clay generally contained flints, and was locally clayey or silty. The lower clay horizons included a little chalk silt and/or gravel. Below the clay, Upper Chalk was encountered as white CHALK silt with some intact chalk gravel (it should be noted that the action of the drilling tools reduces the chalk, at least in part, to a chalk silt slurry, thus recovered samples do not necessarily represent the nature/structure of the chalk in situ). The top level of the chalk varied significantly across the site from between 1.65m and 9.80m deep (123.26m and 112.35m OD); this is considered likely to indicate significant solution feature activity on the site. Two of the thirteen holes drilled found infilled solution features at depth within otherwise intact chalk. These were found at 16.10m to 17.80m and at 9.20m to 10.20m below ground level. The location of the solution features does not represent a specific area or any particular predictable pattern across the site. All boreholes remained dry whilst open.

Continued/

Falling head soakage tests were carried out in six boreholes across the site, with the exposed section of the borehole being at around 8.00-10.00m. These tests found variable soakage rates, but indicated that deep bored soakaways would be a feasible option for disposing of surface water on the site. For a head of 6.80/7.00m, i.e. water around 2.00m below ground level, infiltration rates in chalk of between 36-206 l/m<sup>2</sup>/min were calculated. For a head of 4.80/5.00m, i.e. water level at 4.00m below ground level, the range was 10-44 l/m<sup>2</sup>/min.

The planning database of Dover District Council was also searched for nearby ground investigation information. None was found, except for the full report prepared by E&L following the above mentioned ground investigation.

### **Recommendations for Surface Water Drainage**

In view of the above information above it can be concluded that it is very likely that solution features will be present on the site. The infill to these features may be susceptible to washout of fine material or collapse settlement, which can result in the formation of a void that will eventually migrate to the surface and cause significant subsidence issues, potentially damaging buildings and critical services, and causing a safety hazard to site staff and users. If damage is caused to water mains or sewers, these would add more water to the shallow soils, exacerbating the problems. Surface water must therefore be kept away from solution features. Foul drainage and water mains must also be designed to be robust and not prone to leakage; in particular, they must be able to resist seasonal movements that will occur at shallow depth in the clay soils present. The design of landscaping for the proposed scheme should keep any tree planting well away from water-bearing (and any other critical) services, since seasonal volume change will be increased within the zone of influence of trees.

In addition, the thickness of the superficial deposits and thus the depth to the surface of the chalk is likely to vary considerably across the site. These deposits will exhibit variable, and likely low soakage rates, given their predominantly clayey nature, but more significantly it will not be possible to determine whether the superficial deposits seen at a given location are above (or indeed within) a solution feature within the chalk.

It is therefore recommended that all surface water be discharged into intact chalk at depth by a series of deep bored soakaways, located at intervals across the site. These must be sealed through any superficial deposits and solution feature infill (including any found at depth, as in the E&L investigation on the adjacent site). Soakaways should be sited as far as is practically possible and certainly no closer than 10m from buildings.

Clean roof water may discharge straight to soakaway chambers, provided this is via sealed down pipes, with no possible access for pollutants. Surface water from car parks, paving and the like should pass through trapped gullies and a well maintained oil interceptor. As noted above, the pipework must be robust and designed to accommodate a degree of ground movement; the National House Building Council Standards, Chapter 4.2, "Building near Trees" has some guidance on this.

The EA may require a permit to discharge surface water over a principal aquifer and are likely to require that discharge of water occurs a certain distance, normally 10m, above the groundwater table.

Swales and unlined ponds (i.e. 'suds' features) are not considered to be suitable options for this site as although there is likely to be adequate space, the shallow soils should not be inundated with water. Permeable paving, which mimics the current situation (i.e. rain falling on land and entering the ground at that location) may be acceptable for small, untrafficked areas. The principle is that there should be no concentrated discharge into the ground, except at the deep-bored soakaway locations.

Due to the nature of the proposals for the site, rainwater harvesting may be an option, which would reduce the volume of water discharged to the soakaways, and also the demands of the development for potable water supply.

It is considered that the range of soil infiltration rates noted above, for the adjacent site, could be used for preliminary design purposes. The next stage would be to drill a series of cable percussion boreholes across the site, to determine site-specific infiltration rates, and to assess further the spatial/vertical frequency of solution features. If the boreholes were to be drilled at likely soakaway locations, liner pipes could be installed, capped and buried, and their location accurately recorded, for later use in the development itself.

Continued/

We hope that our report is clear. Please do not hesitate to contact us if you have any queries.

Yours sincerely  
For and on behalf of Evans & Langford LLP

A handwritten signature in black ink, appearing to be 'C. Langford', written in a cursive style.

Enc.

BGS Infiltration SuDS GeoReport



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## **Infiltration SuDS GeoReport:**

This report provides information on the suitability of the subsurface for the installation of infiltration sustainable drainage systems (SuDS). It provides information on the properties of the subsurface with respect to significant constraints, drainage, ground stability and groundwater quality protection.

**Report Id: *GR\_213623/1***

**Client reference: PO-4706**

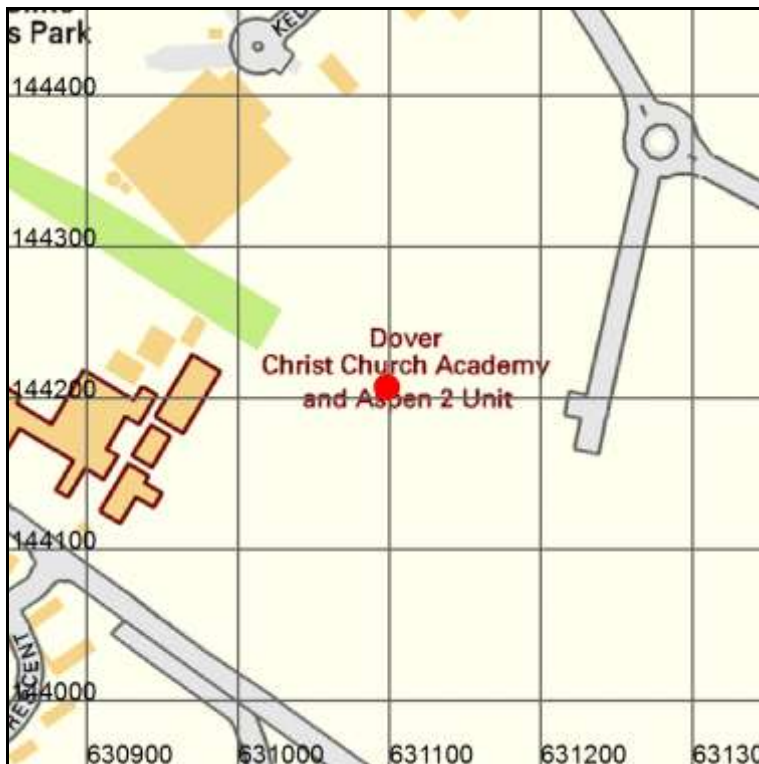
### Search location



Point centred at:  
631098,144207

Search location indicated in red

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## Assessment for an infiltration sustainable drainage system

### Introduction

Sustainable drainage systems (SuDS) are drainage solutions that manage the volume and quality of surface water close to where it falls as rain. They aim to reduce flow rates to rivers, increase local water storage capacity and reduce the transport of pollutants to the water environment. There are four main types of SuDS, which are often designed to be used in sequence. They comprise:

- **source control:** systems that control the rate of runoff
- **pre-treatment:** systems that remove sediments and pollutants
- **retention:** systems that delay the discharge of water by providing surface storage
- **infiltration:** systems that mimic natural recharge to the ground.

This report focuses on infiltration SuDS. It provides subsurface information on the properties of the ground with respect to drainage, ground stability and groundwater quality protection. It is intended principally for those involved in the preliminary assessment of the suitability of the ground for infiltration SuDS, and those involved in assessing proposals from others for sustainable drainage, but it may also be useful to help house-holders judge whether or not further professional advice should be sought. If in doubt, users should consult a suitably-qualified professional about the results in this report before making any decisions based upon it.

This GeoReport is structured in two parts:

- **Part 1. Summary data.**

Comprises three maps that summarise the data contained within Part 2.

- **Part 2. Detailed data.**

Comprises a further 24 maps in four thematic sections:

- **Very significant constraints.** Maps highlight areas where infiltration may result in adverse impacts due to factors including: ground instability (soluble rocks, non-coal shallow mining and landslide hazards); persistent shallow groundwater, or the presence of made ground, which may represent a ground stability or contamination hazard.
- **Drainage potential.** Maps indicate the drainage potential of the ground, by considering subsurface permeability, depth to groundwater and the presence of floodplain deposits.
- **Ground stability.** Maps indicate the presence of hazards that have the potential to cause ground instability resulting in damage to some buildings and structures, if water is infiltrated to the ground.
- **Groundwater protection.** Maps provide key indicators to help determine whether the groundwater may be susceptible to deterioration in quality as a result of infiltration.


















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This report considers the suitability of the subsurface for the installation of infiltration SuDS, such as soakaways, infiltration basins or permeable pavements. It provides subsurface data to indicate whether, and which type of infiltration system may be appropriate. It does not state that infiltration SuDS are, or are not, appropriate as this is highly dependent on the design of the individual system. This report therefore describes the subsurface conditions at the site, allowing the reader to determine the suitability of the site for infiltration SuDS.

The map and text data in this report is similar to that provided in the '*Infiltration SuDS Map: Detailed*' national map product. For further information about the data, consult the '*User Guide for the Infiltration SuDS Map: Detailed*', available from <http://nora.nerc.ac.uk/16618/>.

## PART 1: SUMMARY DATA

This section provides a summary of the data on the following pages.

<p><b>In terms of the drainage potential, is the ground suitable for infiltration SuDS?</b></p>	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p> Highly compatible for infiltration SuDS. The subsurface is likely to be suitable for free-draining infiltration SuDS.</p>
	<p> Probably compatible for infiltration SuDS. The subsurface is probably suitable although the design may be influenced by the ground conditions.</p>
	<p> Opportunities for bespoke infiltration SuDS. The subsurface is potentially suitable although the design will be influenced by the ground conditions.</p>
	<p> Very significant constraints are indicated. There is a very significant potential for one or more hazards associated with infiltration.</p>
<p><b>Is ground instability likely to be a problem?</b></p>	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p> Increased infiltration is very unlikely to result in ground instability.</p>
	<p> Ground instability problems may be present or anticipated, but increased infiltration is unlikely to result in ground instability</p>
	<p> Ground instability problems are probably present. Increased infiltration may result in ground instability.</p>
	<p> There is a very significant potential for one or more geohazards associated with infiltration.</p>
<p><b>Is the groundwater susceptible to deterioration in quality?</b></p>	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p> The groundwater is not expected to be especially vulnerable to contamination.</p>
	<p> The groundwater may be vulnerable to contamination.</p>
	<p> The groundwater is likely to be vulnerable to contaminants.</p>
	<p> Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.</p>

## PART 2: DETAILED DATA


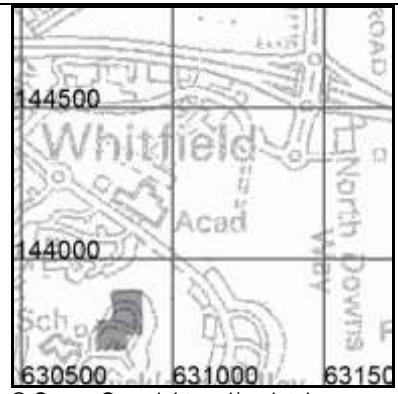
This section provides further information about the properties of the ground and will help assess the suitability of the ground for infiltration SuDS.


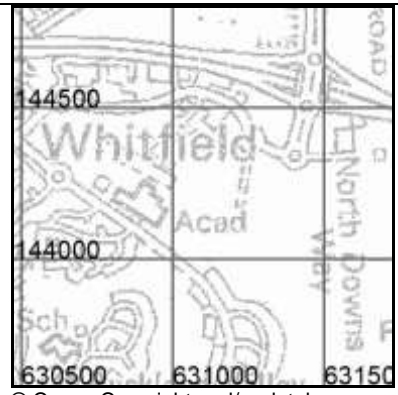
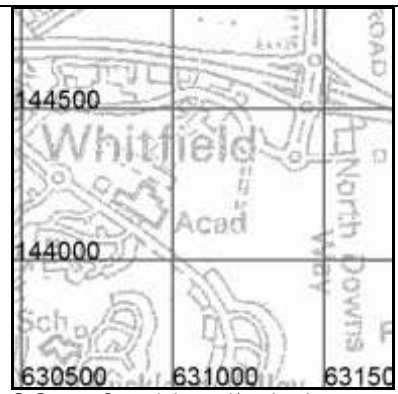
### Section 1. Very significant constraints

Where maps are overlain by grey polygons, geological or hydrogeological hazards may exist that could be made worse by infiltration. The following hazards are considered:

- soluble rocks
- landslides
- shallow mining
- shallow groundwater
- made ground

For more information read 'Explanation of terms' at the end of this report.

Soluble rock hazard	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input checked="" type="checkbox"/> Very significant soluble rock hazard.</p> <p>Soluble rocks are present with a very significant possibility of localised subsidence that could be initiated or made worse by infiltration. The site investigation should consider whether the potential for or the consequences of subsidence as a result of infiltration are significant.</p> <p><input type="checkbox"/> Very significant soluble rock hazards are not present; however this hazard may still need to be considered. See Part 3.</p>
Landslide hazard	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input checked="" type="checkbox"/> Very significant landslide hazard.</p> <p>Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail. The site investigation should consider whether the potential for or the consequences of landslide as a result of infiltration are significant.</p> <p><input type="checkbox"/> Very significant landslide hazards are not present; however this hazard may still need to be considered. See Part 3.</p>

<b>Shallow mining hazard</b>	
	<p><input checked="" type="checkbox"/> Very significant mining hazard.</p> <p>Shallow mining is likely to be present with a very significant possibility of localised subsidence that could be initiated or made worse by increased infiltration. Also, infiltration may increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of subsidence and/or remobilisation of pollutants as a result of infiltration are significant.</p>
<p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input type="checkbox"/> Very significant mining hazards are not present; however this hazard may still need to be considered. See Part 3.</p>
<b>Persistent shallow groundwater</b>	
	<p><input checked="" type="checkbox"/> Very high likelihood of persistent or seasonally shallow groundwater.</p> <p>Persistent or seasonally shallow groundwater is likely to be present. Infiltration may increase the likelihood of soakaway inundation, or groundwater emergence at the surface. The site investigation should consider whether the potential for or the consequences of groundwater level rise as a result of infiltration are significant.</p>
<p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input type="checkbox"/> See Part 2 for the likely depth to water table.</p>
<b>Made ground</b>	
	<p><input checked="" type="checkbox"/> Made ground present.</p> <p>Made ground is present at the surface. Infiltration may affect ground stability or increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of ground instability and/or pollutant leaching as a result of infiltration are significant.</p>
<p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p><input type="checkbox"/> None recorded</p>

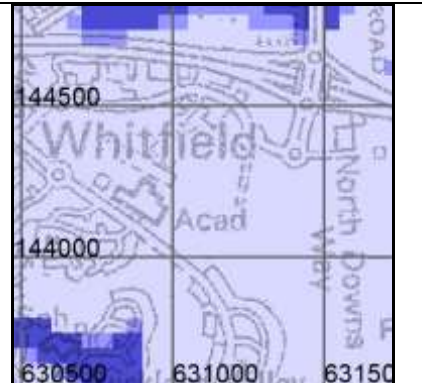



## Section 2. Drainage potential

The following pages contain maps that will help you assess the drainage potential of the ground by considering the:

- depth to water table
- permeability of the superficial deposits
- thickness of the superficial deposits
- permeability of the bedrock
- presence of floodplains

Superficial deposits are not present everywhere and therefore some areas of the *superficial deposit permeability* map may not be coloured. Where this is the case, the *bedrock permeability* map shows the likely permeability of the ground. Superficial deposits in some places are very thin and hence in these places you may wish to consider both the permeability of the superficial deposits and the permeability of the bedrock. The *superficial thickness* map will tell you whether the superficial deposits are thin (< 3 m thick) or thick (>3 m). Where they are over 3 m thick, the permeability of the bedrock may not be relevant.


For more information read 'Explanation of terms' at the end of this report.


Depth to groundwater table	
	<p> Groundwater is likely to be <b>more than 5 m</b> below the ground surface throughout the year.</p> <p> Groundwater is likely to be between <b>3 and 5 m</b> below the ground surface for at least part of the year.</p> <p> Groundwater is likely to be <b>less than 3 m</b> below the ground surface for at least part of the year.</p>
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**Superficial deposit permeability**



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 Superficial deposits are likely to be **free-draining**.

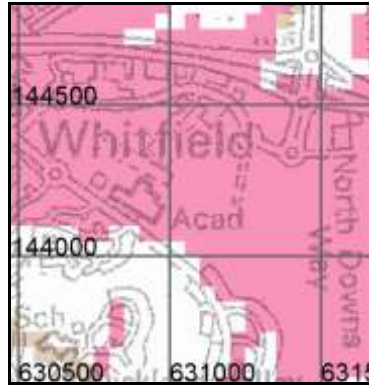
 The superficial deposit permeability is **spatially variable**, but likely to permit moderate infiltration.

 Superficial deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

-  Very Low
-  Low
-  Moderate
-  High
-  Very High

**Minimum**



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**Maximum**





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**Superficial deposit thickness**



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 The thickness of superficial deposits is **< 3 m** and hence the permeability of the ground may be dependent on both the superficial deposits (where present) and underlying bedrock (see below).

 The thickness of superficial deposits is **> 3 m** and hence the permeability of the superficial deposits is likely to determine the permeability of the ground.

**Bedrock permeability**



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Bedrock deposits are likely to be **free-draining**.



The bedrock permeability is **spatially variable**, but likely to permit moderate infiltration.



Bedrock deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

**Key**

-  Very Low
-  Low
-  Moderate
-  High
-  Very High

**Minimum**



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**Maximum**



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**Geological indicators of flooding**



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Superficial floodplain deposits or low-lying coastal areas have been identified. Groundwater levels may rise in response to high river or tide levels, potentially causing inundation of subsurface infiltration SuDS.








### Section 3. Ground stability

The following pages contain maps that will help you assess whether infiltration may impact the stability of the ground. They consider hazards associated with:

- soluble rocks
- landslides
- shallow mining
- running sands
- swelling clays
- compressible ground, and
- collapsible ground





In the following maps, geohazards that are identified in green are unlikely to prevent infiltration SuDS from being installed, but they should be considered during design. For more information read 'Explanation of terms' at the end of this report.

Soluble rocks	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	 Increased infiltration is unlikely to result in subsidence.
	 Increased infiltration is unlikely to cause localised subsidence, but potential impacts should be considered.
	 Increased infiltration may result in localised subsidence. The potential for or the consequences of subsidence associated with soluble rocks should be considered.
	 Very significant possibility of localised subsidence that could be initiated or made worse by infiltration.

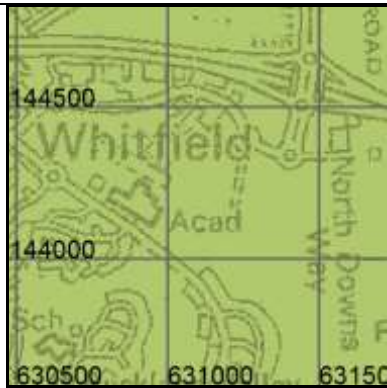
**Landslides**







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-  Increased infiltration is unlikely to lead to slope instability.
-  Slope instability problems may be present or anticipated, but increased infiltration is unlikely to cause instability
-  Slope instability problems are probably present or have occurred in the past, and increased infiltration may result in slope instability.
-  Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail.

**Shallow mining**






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-  Increased infiltration is unlikely to lead to subsidence.
-  Shallow mining is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
-  Shallow mining could be present with a significant possibility that localised subsidence could be initiated or made worse by increased infiltration.
-  Shallow mining is likely to be present, with a very significant possibility that localised subsidence may be initiated or made worse by increased infiltration.

**Running sand**






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-  Increased infiltration is unlikely to cause ground collapse associated with running sands.
-  Running sand is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
-  Significant possibility for running sand problems. Increased infiltration may result in a geohazard.

**Swelling clays**





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-  Increased infiltration is unlikely to cause shrink-swell ground movement.
-  Ground is susceptible to shrink-swell ground movement. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
-  Ground is susceptible to shrink-swell ground movement. Increased infiltration may result in a geohazard.

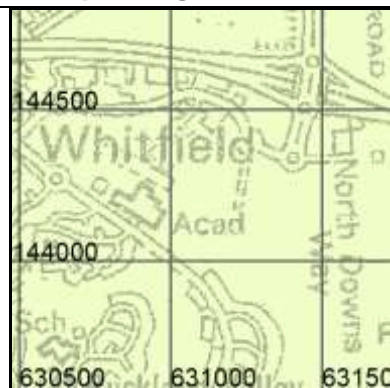
**Compressible ground**






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-  Increased infiltration is unlikely to lead to ground compression.
-  Compressibility and uneven settlement hazards are probably present. Increased infiltration may result in a geohazard.

**Collapsible ground**



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-  Increased infiltration is unlikely to result in subsidence.
-  Deposits with potential to collapse when loaded and saturated are possibly present in places. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
-  Deposits with potential to collapse when loaded and saturated are probably present in places. Increased infiltration may result in a geohazard.

## Section 4. Groundwater quality protection

The following pages contain maps showing some of the information required to ensure the protection of groundwater quality. Data presented includes:

- groundwater source protection zones (Environment Agency data)
- predominant flow mechanism
- made ground

For more information read 'Explanation of terms' at the end of this report.

Groundwater source protection zones	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p> <p>Derived in part from Source Protection Zone data provided under licence from the Environment Agency © Environment Agency 2016.</p>	<p> Groundwater is not within a source protection zone.</p>
	<p> Source protection zone IV</p>
	<p> Source protection zone III</p>
	<p> Source protection zone II</p>
	<p> Source protection zone I.</p>
Predominant flow mechanism	
 <p>© Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL</p>	<p> Water is likely to percolate through the unsaturated zone to the groundwater through either the pore space in granular media or through porespace and fractures; these processes have some potential for contaminant removal and breakdown.</p>
	<p> Water is likely to percolate through the unsaturated zone to the groundwater through fractures, a process which has little potential for contaminant removal and breakdown.</p>



**Made ground**



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Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

## Section 5. Geological Maps

The following maps show the artificial, superficial and bedrock geology within the area of interest.

### Artificial deposits



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### Superficial deposits



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### Bedrock



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Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

Key to Artificial deposits:




**No deposits recorded by BGS in the search area**

Key to Superficial deposits:

Map colour	Computer Code	Rock name	Rock type
	HEAD-XCZSV	HEAD	CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
	HEAD-XZV	HEAD	SILT AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
	CWF-XCZSV	CLAY-WITH-FLINTS FORMATION	CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]



Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	MACK-CHLK	MARGATE CHALK MEMBER	CHALK
	SECK-CHLK	SEAFORD CHALK FORMATION	CHALK
	LECH-CHLK	LEWES NODULAR CHALK FORMATION	CHALK



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### Limitations of this report:

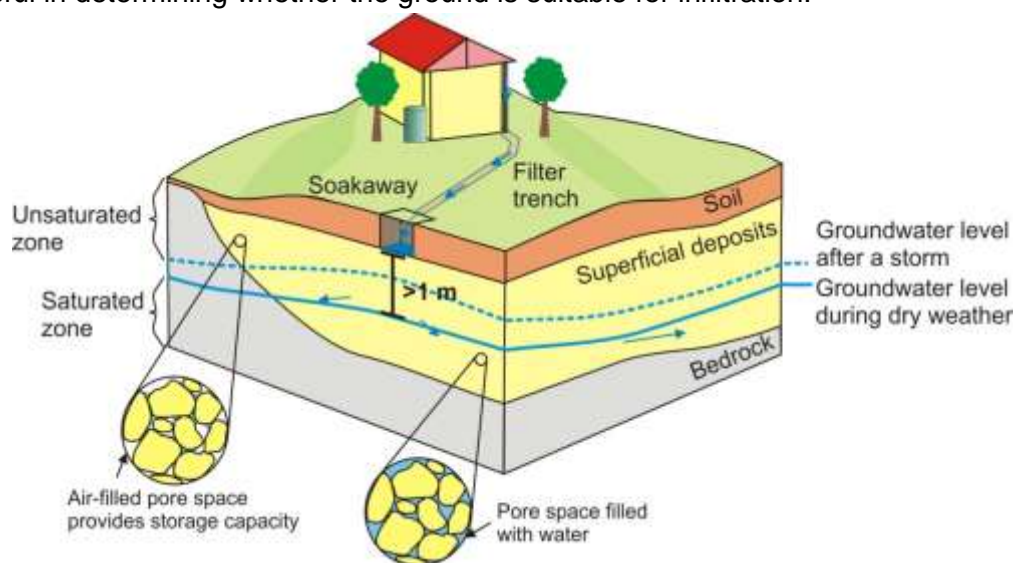
- This report is concerned with the potential for infiltration-to-the-ground to be used as a SuDS technique at the site described. It only considers the subsurface beneath the search area and does NOT consider potential surface or subsurface impacts outside of that area.
- This report is NOT an alternative for an on-site investigation or soakaway test, which might reach a different conclusion.
- This report must NOT be used to justify disposal of foul waste or grey water.
- This report is based on and limited to an interpretation of the records held by the British Geological Survey (BGS) at the time the search is performed. The datasets used (with the exception of that showing depth to water table) are based on 1:50 000 digital geological maps and not site-specific data.
- Other more specific and detailed ground instability information for the site may be held by BGS, and an assessment of this could result in a modified assessment.
- To interpret the maps correctly, the report must be viewed and printed in colour.
- The search does NOT consider the suitability of sites with regard to:
  - previous land use,
  - potential for, or presence of contaminated land
  - presence of perched water tables
  - shallow mining hazards relating to coal mining. Searches of coal mining should be carried out via The Coal Authority Mine Reports Service: [www.coalminingreports.co.uk](http://www.coalminingreports.co.uk).
  - made ground, where not recorded
  - proximity to landfill sites (searches for landfill sites or contaminated land should be carried out through consultation with local authorities/Environment Agency)
  - zones around private water supply boreholes that are susceptible to groundwater contamination.
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## Explanation of terms

### Depth to groundwater

In the shallow subsurface, the ground is commonly unsaturated with respect to water. Air fills the spaces within the soil and the underlying superficial deposits and bedrock. At some depth below the ground surface, there is a level below which these spaces are full of water. This level is known as the groundwater level, and the water below it is termed the groundwater. When water is infiltrated, the groundwater level may rise temporarily. To ensure that there is space in the unsaturated zone to accommodate this, there should be a minimum thickness of 1 m between the base of the infiltration system and the water table. An estimate of the *depth to groundwater* is therefore useful in determining whether the ground is suitable for infiltration.



### Groundwater flooding

Groundwater flooding occurs when a rise in groundwater level results in very shallow groundwater or the emergence of groundwater at the surface. If infiltration systems are installed in areas that are susceptible to groundwater flooding, it is possible that the system could become inundated. The susceptibility map seeks to identify areas where the geological conditions and water tables indicate that groundwater level rise could occur under certain circumstances. A high susceptibility to groundwater flooding classification does not mean that groundwater flooding has ever occurred in the past, or will do so in the future as the susceptibility maps do not contain information on how often flooding may occur. The susceptibility maps are designed for planning; identifying areas where groundwater flooding might be an issue that needs to be taken into account.



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### **Geological indicators of flooding**

In floodplain deposits, groundwater level can be influenced by the water level in the adjacent river. Groundwater level may increase during periods of fluvial flood and therefore this should be taken into account when designing infiltration systems on such deposits. The *geological indicators of flooding* dataset shows where there is geological evidence (floodplain deposits) that flooding has occurred in the past.

For further information on flood-risk, the likely frequency of its recurrence in relation to any proposed development of the site, and the status of any flood prevention measures in place, you are advised to contact the local office of the Environment Agency (England and Wales) at [www.environment-agency.gov.uk/](http://www.environment-agency.gov.uk/) or the Scottish Environment Protection Agency (Scotland) at [www.sepa.org.uk](http://www.sepa.org.uk).

### **Artificial ground**

Artificial ground comprises deposits and excavations that have been created or modified by human activity. It includes ground that is worked (quarries and road cuttings), infilled (back-filled quarries), landscaped (surface re-shaping), disturbed (near surface mineral workings) or classified as made ground (embankments and spoil heaps). The composition and properties of artificial ground are often unknown. In particular, the permeability and chemical composition of the artificial ground should be determined to ensure that the ground will drain and that any contaminants present will not be remobilised.

### **Superficial permeability**

Superficial deposits are those geological deposits that were formed during the most recent period of geological time (as old as 2.6 million years before present). They generally comprise relatively thin deposits of gravel, sand, silt and clay and are present beneath the pedological soil in patches or larger spreads over much of Britain. The ease with which water can percolate through these deposits is controlled by their permeability and varies widely depending on their composition. Those deposits comprising clays and silts are less permeable and thus infiltration is likely to be slow, such that water may pool on the surface. In comparison, deposits comprising sands and gravels are more permeable allowing water to percolate freely.

### **Bedrock permeability**

Bedrock forms the main mass of rock forming the Earth. It is present everywhere, commonly beneath superficial deposits. Where the superficial deposits are thin or absent, the ease with which water will percolate into the ground depends on the permeability of the bedrock.

---

### **Natural ground instability**

Natural ground instability refers to the propensity for upward, lateral or downward movement of the ground that can be caused by a number of natural geological hazards (e.g. ground dissolution/compressible ground). Some movements associated with particular hazards may be gradual and of millimetre or centimetre scale, whilst others may be sudden and of metre or tens of metres scale. Significant natural ground instability has the potential to cause damage to buildings and structures, especially when the drainage characteristics of a site are altered. It should be noted, however, that many buildings, particularly more modern ones, are built to such a standard that they can remain unaffected in areas of significant ground movement.

### **Shrink-swell**

A shrinking and swelling clay changes volume significantly according to how much water it contains. All clay deposits change volume as their water content varies, typically swelling in winter and shrinking in summer, but some do so to a greater extent than others. Contributory circumstances could include drought, leaking service pipes, tree roots drying-out the ground or changes to local drainage patterns, such as the creation of soakaways. Shrinkage may remove support from the foundations of buildings and structures, whereas clay expansion may lead to uplift (heave) or lateral stress on part or all of a structure; any such movements may cause cracking and distortion.

### **Landslides (slope stability)**

A landslide is a relatively rapid outward and downward movement of a mass of ground on a slope, due to the force of gravity. A slope is under stress from gravity but will not move if its strength is greater than this stress. If the balance is altered so that the stress exceeds the strength, then movement will occur. The stability of a slope can be reduced by removing ground at the base of the slope, by placing material on the slope, especially at the top, or by increasing the water content of the materials forming the slope. Increase in subsurface water content beneath a soakaway could increase susceptibility to landslide hazards. The assessment of landslide hazard refers to the stability of the present land surface. It does not encompass a consideration of the stability of excavations.

### **Soluble rocks (dissolution)**

Some rocks are soluble in water and can be progressively removed by the flow of water through the ground. This process tends to create cavities, potentially leading to the collapse of overlying materials and possibly subsidence at the surface. The release of water into the subsurface from infiltration systems may increase the dissolution of rock or destabilise material above or within a cavity. Dissolution cavities may create a pathway for rapid transport of contaminated water to an aquifer or water course.



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### **Compressible ground**

Many ground materials contain water-filled pores (the spaces between solid particles). Ground is compressible if a building (or other load) can cause the water in the pore space to be squeezed out, causing the ground to decrease in thickness. If ground is extremely compressible the building may sink. If the ground is not uniformly compressible, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The compressibility of the ground may alter as a result of changes in subsurface water content caused by the release of water from soakaways.

### **Collapsible deposits**

Collapsible ground comprises certain fine-grained materials with large pore spaces (the spaces between solid particles). It can collapse when it becomes saturated by water and/or a building (or other structure) places too great a load on it. If the material below a building collapses it may cause the building to sink. If the collapsible ground is variable in thickness or distribution, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The subsurface underlying a soakaway will experience an increase in water content that may affect the stability of the ground. This hazard is most likely to be encountered only in parts of southern England.

### **Running sand**

Running sand conditions occur when loosely-packed sand, saturated with water, flows into an excavation, borehole or other type of void. The pressure of the water filling the spaces between the sand grains reduces the contact between the grains and they are carried along by the flow. This can lead to subsidence of the surrounding ground. Running sand is potentially hazardous during the drainage system installation. During installation, excavation of the ground may create a space into which sand can flow, potentially causing subsidence of surrounding ground.

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

Current or past underground mining for coal or for other commodities can give rise to cavities at shallow or intermediate depths, which may cause fracturing, general settlement, or the formation of crown-holes in the ground above. Spoil from mineral workings may also present a pollution hazard. The release of water into the subsurface from soakaways may destabilise material above or within a cavity. Cavities arising as a consequence of mining may also create a pathway for rapid transport of contaminated water to an aquifer or watercourse. The mining hazards map is derived from the geological map and considers the potential for subsidence associated with mining on the basis of geology type. Therefore if mining is known to occur within a certain rock, the map will highlight the potential for a hazard within the area covered by that geology.



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For more information regarding underground and opencast **coal mining**, the location of mine entries (shafts and adits) and matters relating to subsidence or other ground movement induced by **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](http://www.coal.gov.uk). For more information regarding other types of mining (i.e. non-coal), please contact the British Geological Survey.

#### **Groundwater source protection zones**

In England and Wales, the Environment Agency has defined areas around wells, boreholes and springs that are used for the abstraction of public drinking water as source protection zones. In conjunction with Groundwater Protection Policy the zones are used to restrict activities that may impact groundwater quality, thereby preventing pollution of underlying aquifers, such that drinking water quality is upheld. The Environment Agency can provide advice on the location and implications of source protection zones in your area ([www.environment-agency.gov.uk/](http://www.environment-agency.gov.uk/))



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- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
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- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- Note that for some sites, the latest available records may be quite historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

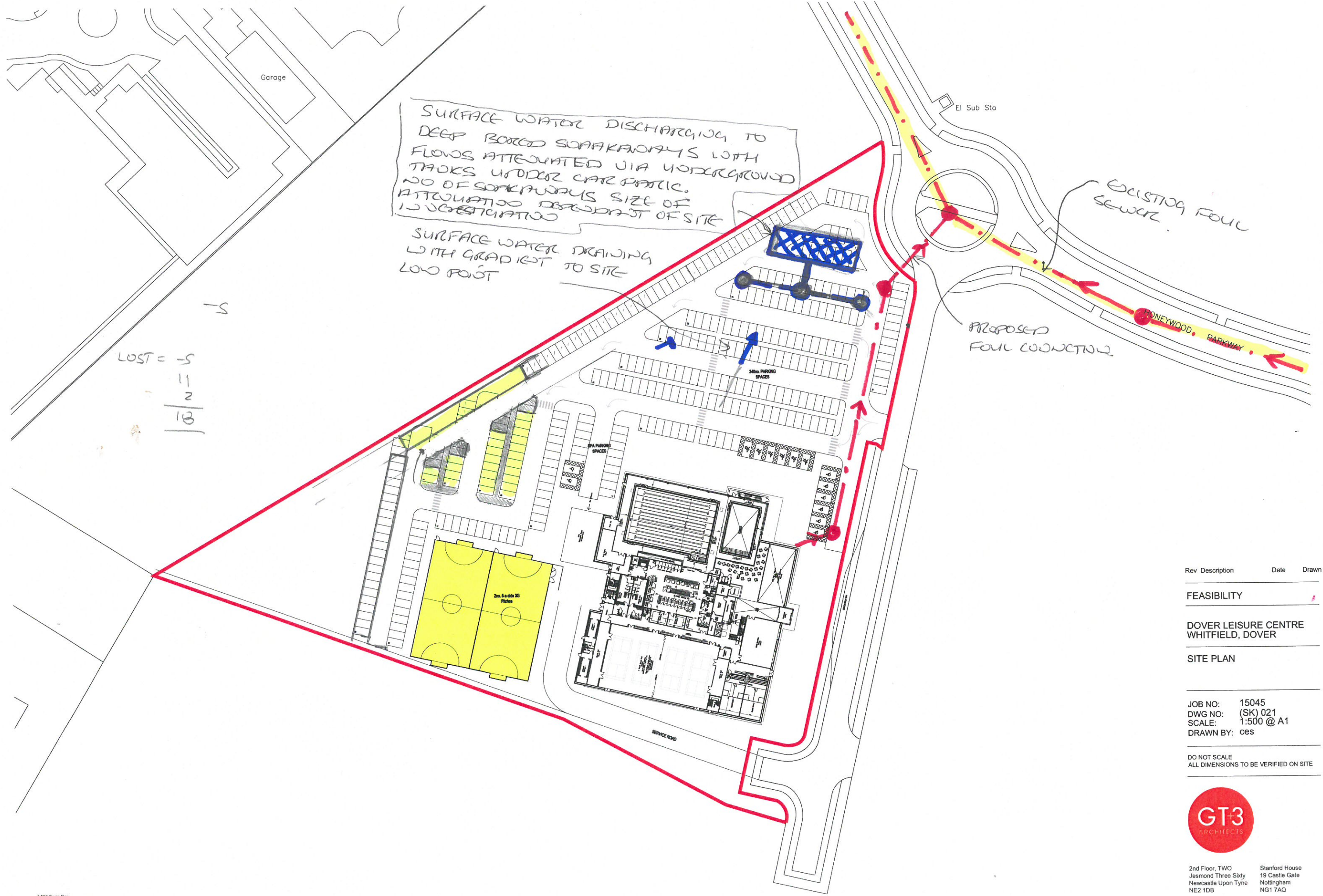
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**Report issued by  
BGS Enquiry Service**



Rev	Description	Date	Drawn
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FEASIBILITY

DOVER LEISURE CENTRE  
WHITFIELD, DOVER

SITE PLAN

JOB NO: 15045  
 DWG NO: (SK) 021  
 SCALE: 1:500 @ A1  
 DRAWN BY: ces

DO NOT SCALE  
 ALL DIMENSIONS TO BE VERIFIED ON SITE



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