

Appendix E Surface Water Information

PBA Technical Note 38848/4001/TN002 - Revision A *Land East of Wandleys Lane, Outline Surface Water Drainage Strategy*

TECHNICAL NOTE

Job Name: Land East of Wandleys Lane, Fontwell
Job No: 40523 – 4001
Note No: TN002 – Revision A
Date: 06 October 2017
Prepared By: Dominic Bergeron
Subject: Outline Surface Water Drainage Strategy

Item	Subject
1.	Introduction This Technical Note has been prepared by Peter Brett Associates LLP (PBA) in accordance with the National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG), the DEFRA 'Non-statutory technical standards for sustainable drainage systems' and West Sussex County Council's guidance on Sustainable Drainage System (SuDS) design for a residential development at Land East of Wandleys Lane in Fontwell with up to 157no. dwellings, open green space and all related infrastructure. This Note accompanies the Flood Risk Assessment (ref. 38848/4001) which has been prepared to support the planning application for the proposed development. An outline drainage strategy has been produced for this development, but it has not yet been designed in detail and therefore this technical note sets out the points that will be covered by the final drainage design.
2.	Existing Site Drainage The existing site is primarily open agricultural land with four small storage structures and gravel paths in the north western corner. The Southern Water (SW) sewer records (provided in Appendix A) show the presence of two public foul water sewers beneath Wandleys Lane, and another beneath West Walberton Lane. No surface water sewers are shown within the vicinity of the site. An ordinary watercourse map provided by Arun District Council (ADC) (see Appendix A) indicates there are surface water ditches along the southern and eastern boundaries of the site. Given the undeveloped nature of the site, it is assumed that the site drains by a combination of natural infiltration and over ground runoff to the existing ditches.
3.	Planning Practice Guidance Hierarchy The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites, and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development, this being complementary to the control of development within the floodplain.

TECHNICAL NOTE

Item	Subject
	The NPPG Paragraph 051 describes SuDS as below: <i>“Sustainable drainage systems are designed to control surface water runoff close to where it falls and mimic natural drainage as closely as possible. The provide opportunities to:</i> <i>• Reduce the causes and impacts of flooding;</i> <i>• Remove the pollutants from urban run-off at source;</i> <i>• Combine water management with green space with benefits for amenity, recreation and wildlife.”</i>
4.	West Sussex County Council Guidance West Sussex County Council (WSCC) is the ‘Lead Local Flood Authority’ (LLFA) for the area and as such is the statutory consultee on major planning applications for surface water management. WSCC provide guidance on SuDS design as part of the ‘Water. People. Places.’ report which was released in September 2013. The WSCC SuDS report provides the following guidance: <i>This guidance outlines the process for integrating sustainable drainage systems (SuDS) into the master planning of large and small developments. Consideration of the movement of water and its interaction with space at the earliest stage of design is crucial to the success of SuDS and allows the developer to maximise wider benefits. This guidance complements existing guidance on SuDS design, maintenance and operation which should be used to inform detailed design and delivery of SuDS.</i> The DEFRA ‘Non-statutory technical standards for sustainable drainage systems’ (March 2015) sets out the requirements for the design and maintenance of SuDS components within a drainage design.
5.	Arun District Council Guidance Arun District Council (ADC) provide the following guidance for SuDS design: <i>Surface water must not be discharged into the foul sewer system. Infiltration structures include soakaways, basins, swales and permeable paving. Discharge to surface water bodies and surface water sewers must be restricted to an agreed rate.</i> <i>Discharge to a watercourse or surface water sewer must be restricted to the estimated mean greenfield runoff rate (Qbar) by means of a controlled outflow (or restricted to existing runoff rates for brownfield sites). This can be derived from IH124 or a similar approved method. Any storage design must be submitted with groundwater monitoring data where applicable to ensure there will be no detrimental effect on the structure or storage. Storage areas are preferred to be in an ‘open’ form such as ponds, rather than underground tanks.</i>

TECHNICAL NOTE

Item	Subject												
6.	Consideration of Infiltration Drainage Based on the aforementioned PPG and WSCC Design Guidance SuDs hierarchy, the preferred method for the disposal of surface water from the new development is via infiltration drainage. Review of the British Geological Survey (BGS) Infiltration SuDS GeoReport for the site (Appendix A) shows the groundwater table is likely to be less than 3m below the ground surface for at least part of the year but not persistently shallow. During a PBA site visit, the previous land owner indicated that ‘springs’ tend to form in the southern area of the site during the winter. Based on these two pieces of information, it can be deduced that there is a potentially shallow groundwater table located on site. Thus, it may not be feasible to maintain a 1m unsaturated buffer zone below any infiltration structure on-site as required by the Environment Agency (EA). As such, infiltration drainage is not likely a feasible method of surface water disposal.												
7.	Consideration of Discharge to Watercourse The next preferred option in the PPG SuDS hierarchy is to discharge surface water to a watercourse. A map of the ordinary watercourses in the area provided by ADC (Appendix A) shows there is an existing ditch along the western boundary of the site, and another on the southern boundary next to Wandleys Copse. Both these ditches meet at the south-eastern corner of the site and continue south. The topographical survey (Appendix A) indicates the site falls from the north-west corner to the south-east corner. Thus, it is feasible to discharge the surface water runoff that arises from the proposed development through a gravity system and series of attenuation structures to the existing ditches.												
8.	Consideration of Discharge to Sewer Where discharge via infiltration or watercourse is not feasible or appropriate, the final preference in the PPG SuDS hierarchy is to discharge to a sewer. Based on Southern Water asset records received in May 2017, there are no surface water sewers located within the vicinity of the site. The only accessible sewer is a foul main. As the site can discharge to a watercourse, it is not necessary to consider this further.												
9.	Preliminary Strategy The site has a total area of 6.98ha and the proposal will develop 5.24ha into residential housing and associated infrastructure, with the remaining 1.74ha remaining as open green space through which rainfall can infiltrate. Existing greenfield runoff rates were calculated using MicroDrainage based on the ICP SuDS method (Appendix C). Table 1: Greenfield runoff rates <table><tr><td></td><td>Q_{BAR} (l/s/ha)</td><td>Q_{1yr} (l/s/ha)</td><td>Q_{30yrs}(l/s/ha)</td><td>Q_{100yrs} (l/s/ha)</td><td>Q_{100yrs+30%} (l/s/ha)</td></tr><tr><td>Site</td><td>2.08</td><td>1.77</td><td>4.71</td><td>6.63</td><td>8.62</td></tr></table> It is proposed that the new development discharges to the ordinary watercourse at the south east corner of the site. The site will discharge surface water runoff at the existing greenfield runoff rate. Based on the existing site catchments shown in PBA		Q _{BAR} (l/s/ha)	Q _{1yr} (l/s/ha)	Q _{30yrs} (l/s/ha)	Q _{100yrs} (l/s/ha)	Q _{100yrs+30%} (l/s/ha)	Site	2.08	1.77	4.71	6.63	8.62
	Q _{BAR} (l/s/ha)	Q _{1yr} (l/s/ha)	Q _{30yrs} (l/s/ha)	Q _{100yrs} (l/s/ha)	Q _{100yrs+30%} (l/s/ha)								
Site	2.08	1.77	4.71	6.63	8.62								



TECHNICAL NOTE

Item	Subject																								
	drawing 38848/4001/002A in Appendix B, an area of 1.25ha currently drains to the ordinary watercourse which equates to a greenfield runoff rate of 10.8l/s for the 1 in 100 annual probability +30% rainfall event. PBA Drawing 38848/4001/001A (Appendix B) shows the preliminary drainage strategy and the proposed catchment areas: it is proposed a series of 3no. detention basins attenuate the surface water runoff from the proposed development. Below is a summary of the scheme: • Catchments D and E will remain undeveloped except for a detention basin and footpath; • Basin A will collect the runoff from catchment A and discharge at a controlled maximum rate of 5l/s to the outfall; • Basin B will collect the runoff from catchment B and has been upsized to provide Long Term Storage requirements and will discharge at Qbar to Pond C; • Basin C will collect the runoff from catchment C and the outflow from Basin B and subsequently discharge, at a controlled rate of 5.8l/s, to the outfall; • The outfall channels from Basin A and C will join at the south eastern corner of the site and discharge through a single channel to the existing ditch running along the site boundary at the greenfield runoff rate of 10.8l/s (5l/s from Basin A and 5.8l/s from Basin C). Long term storage requirements for the site was calculated using the method outlined in DEFRA 'Rainfall runoff management for developments' and resulted in a requirement of 1009m³ storage to be provided. This storage will be provided by Basin B which will discharge a rate of Qbar. The calculation for the long term storage can be found in Appendix C. Table 2: Attenuation storage structures details <table><tr><th>Attenuation Structure</th><th>Catchment Area (ha)</th><th>PIMP (%)</th><th>Storage Volume (m³)</th><th>Discharge Rate (l/s)</th><th>Plan Area* (m²)</th></tr><tr><td>Basin A</td><td>1.16</td><td>65</td><td>485</td><td>5.0</td><td>330</td></tr><tr><td>Basin B</td><td>1.83</td><td>65</td><td>1105</td><td>2.5</td><td>740</td></tr><tr><td>Basin C</td><td>2.49</td><td>65</td><td>1480</td><td>5.8</td><td>985</td></tr></table> <i>*Plan areas are based on a maximum depth of water of 1.5m.</i> Proposed flood flow routes are shown in PBA Drawing 38848/4001/001. These will help mitigate any damage or flooding caused during the 1 in 100 annual probability + 40% climate change storm event. MicroDrainage calculations for the proposed basins can be found in Appendix C.	Attenuation Structure	Catchment Area (ha)	PIMP (%)	Storage Volume (m ³)	Discharge Rate (l/s)	Plan Area* (m ²)	Basin A	1.16	65	485	5.0	330	Basin B	1.83	65	1105	2.5	740	Basin C	2.49	65	1480	5.8	985
Attenuation Structure	Catchment Area (ha)	PIMP (%)	Storage Volume (m ³)	Discharge Rate (l/s)	Plan Area* (m ²)																				
Basin A	1.16	65	485	5.0	330																				
Basin B	1.83	65	1105	2.5	740																				
Basin C	2.49	65	1480	5.8	985																				
10.	Approach to further work At the Detailed design stage post planning permission, the following work will be undertaken: The DEFRA Technical Standards will be followed for the detailed design. These require that flooding does not occur at any part of a site during a 1 in 30 annual probability event, that no building is flooded during a 1 in 100 annual probability event and flows resulting from exceedance in events greater than 1 in 100 annual probabilities are managed within exceedance routes that minimise risk to people and property. The new SuDS Manual recommends that the run-off from all hard surfaces shall receive an appropriate level of treatment to minimise the risk of pollution. Previously																								



TECHNICAL NOTE

Item	Subject
	this was based upon a prescribed minimum number of treatment modules or features for each situation. The new manual is more flexible in the provision of pollution prevention depending on the receiving sewer or watercourse. During detailed design, these requirements will be assessed in full but the following measures are likely to be included: • Roof water will pass through leaf / debris filters within the downpipes then via water butts for harvesting. • The parking areas will be paved by porous blocks where necessary with a high voids sub base to gain water quality improvements. • Tarmac paved access roads will drain via trapped road gullies to swales, wetlands and / or ponds. All routes would pass through an oil separator or a vortex type separator such as Hydro Research's 'Downstream Defender'. Consideration will also be given to the residual risk of flooding should the proposed SuDS fail or be overwhelmed by extreme rainfall events to minimise the impact of flooding where possible.
11.	Maintenance Subject to agreement with WSCC as Local Lead Flood Authority, it is proposed that the various detention basins are adopted either by themselves or a Management Company. Highway only drainage would be adopted by WSCC as the Highway Authority. As with any drainage system, SuDS require regular inspection and maintenance to ensure that they continue to operate as designed, both in terms of hydraulic capacity and potential pollutant removal. The inspection and maintenance requirements for long term management of the development's surface water drainage system will be in accordance with The SuDS Manual, CIRIA C753. Specific maintenance schedules will be prepared and the maintenance needs monitored and adjusted to suit each components particular requirements and location.

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
38848/4001/TN002	-	15.09.17	Dominic Bergeron	Andy Robertson		
38848/4001/TN002	A	06/10/17	Dominic Bergeron	Andy Robertson		

Peter Brett Associates LLP disclaims any responsibility to the Client and others in respect of any matters outside the scope of this report. This report has been prepared with reasonable skill, care and diligence within the terms of the Contract with the Client and generally in accordance with the appropriate ACE Agreement and taking account of the manpower, resources, investigations and testing devoted to it by agreement with the Client. This report is confidential to the Client and Peter Brett Associates LLP accepts no responsibility of whatsoever nature to third parties to whom this report or any part thereof is made known. Any such party relies upon the report at their own risk.

© Peter Brett Associates LLP 2017

Peter Brett Associates LLP Caversham Bridge House Waterman Place, Reading Berkshire RG1 8DN

T: +44 (0)118 950 0761 +44 (0)118 959 7498 E: reading@peterbrett.com

\\pba\ash\Projects\38848 - GH - Wandleys Lane, Fontwell\BRIEF 0001 - Drainage & Flood risk\TECHNICAL NOTES\40523-4001_TN002_WandleysLane_Drainage Strategy_Oct17_RevA.docx



TECHNICAL NOTE

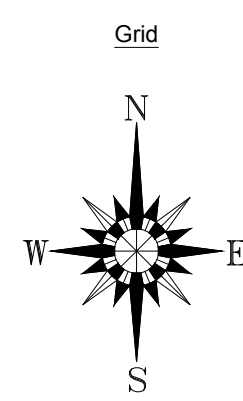
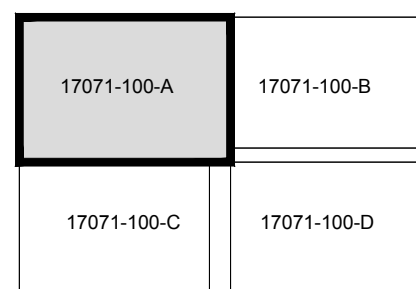
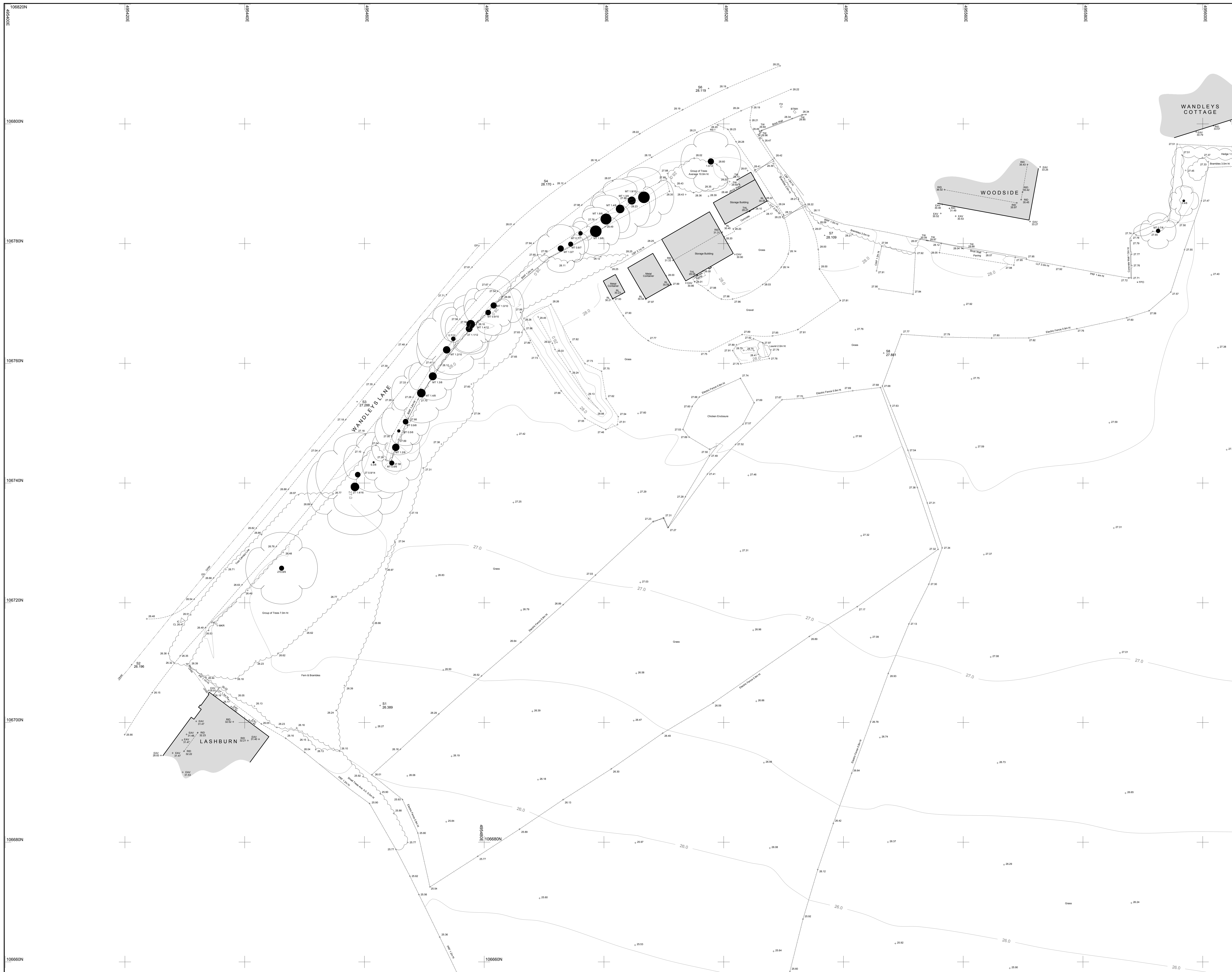
Appendix A

Maltby Surveys Ltd Drawing 17/071/100-500 dated March 2017 – *'Topographical Survey'*

British Geological Survey *'Infiltration SuDS GeoReport'*. Report ID GR_215915/1 dated 28 April 2017

Southern Water *'Drainage and water enquiry'*. Reference LS/K1283649 and dated 23 May 2017

Arun District Council *Map of ordinary watercourses* dated 12 June 2017

[illegible]

REV.	NOTES	DWN	DATE
------	-------	-----	------



Notes:

Grid and levels relate to OS GPS Active Network.
Sheet is North orientated unless stated.

Maltby Surveys Ltd



2 QUEEN'S ROAD
HAYWARDS HEATH
WEST SUSSEX
RH16 1EB

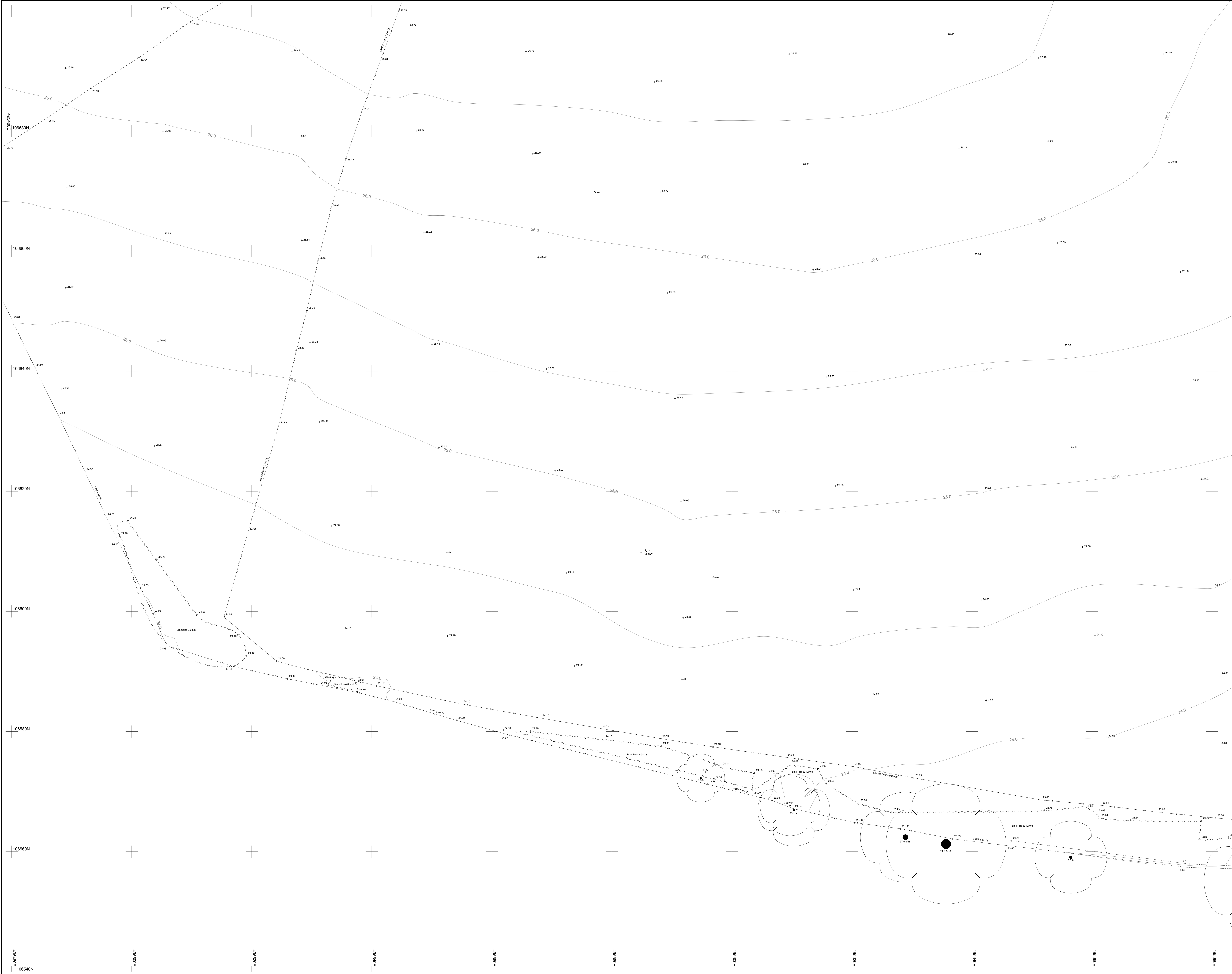
Tel: 01444 416246
Fax: 01444 417697
E-Mail: MLS@maltbysurveys.com
WebSite: <http://www.maltbysurveys.com>

SURVEYED	NBJ	ECE Architecture
DRAWN	NBJ	
CHECKED	RB	
		SCALE
		1/200 (A0 Sheet)

Wandleys Farm Fontwell BN18 0QR

TOPOGRAPHICAL SURVEY

Job No	Rev	Drawing Number
17/071		17/071/100-A
Date :	March 2017	



Sheet Layout

17071-100-A	17071-100-B
17071-100-C	17071-100-D

Grid

N

W E

S

LEGEND

BANKING

BUSHES & HEDGES

TREES

GATES

WALL

BUILDING

OPEN SIDED BUILDING

GLASS ROOFED

CONTOURS

ABBREVIATIONS (WHERE APPLICABLE)

ARCH HEAD HEIGHT	ARRH	MARKER	MKR
ARCH SPRINGER HEIGHT	ASPH	MONITORING WELL	MW
ARCH SPRINGER LEVEL	ASL	NOTICE BOARD	NB
AIR VALVE	AV	OVERHEAD WIRES	OP
BED LEVEL	BL	PARKING METER	PM
BELLSIA REASON	BR	ROOF LEVEL	RL
BOLLARD	B	ROAD SIGN	RS
BRITISH TELECOM BOX	BTS	ROOF EYE	RE
BROWWORK	BTW	RETAINING WALL	RTW
BUS STOP	BS	RAIN WATER PIPE	RWP
CABLE T.V.	CTV	SLICE VALVE	SV
CABLE MARKER	CM	SOFT LEVEL	SOF
COVER LEVEL	CL	STOP COOK	SC
CORNER POST	CP	STRUCTURAL SLAB LEVEL	SSL
EAVES LEVEL	EAV	SOL AND VENT PIPE	SVP
ELECTRICAL COVER	ELEC	THRESHOLD LEVEL	THL
ELECTRICITY CONTROL BOX	ECB	TELEGRAPH POLE	TLP
ELECTRICITY POLE	EP	TELEPHONE CALL BOX	TCB
FLORIN BED	FB	TOP OF KERB	TK
FINISHED FLOOR LEVEL	FFL	TRAFFIC LIGHT	TL
FIRE HYDRANT	FH	TOP OF WALL	TW
FLOOR LEVEL	FL	UNABLE TO LEFT	UTL
FLAG STAFF	FS	UNABLE TO SURVEY	UTS
GAS PIPE	GP	VENT PIPE	VP
GAS VALVE	GV	WATER METER	WM
GALLY	G	WATER LEVEL	WL
GATE STOP	GS	WASH OUT	WO
INSPECTION COVER	IC	WASTE PIPE	WP
INVERT LEVEL	L	WATER TANK	WT
LAMP POST	LP	WATER VALVE	WV

FENCES

BARBED WIRE FENCE	BWF	LARCH LAP FENCE	LLF
CORRUGATED IRON FENCE	CIF	METAL RAILING FENCE	MRF
CLOSE BOARD FENCE	CBF	POST AND CHAIN FENCE	PCF
CHAIN LINK FENCE	CLF	POST AND RAIL FENCE	PRF
CHESTNUT PALING FENCE	CPF	POST AND WIRE FENCE	PWF
FENCE POST	FPS	STEEL PALISADE SECURITY FENCE	SPSF
INTERWOVEN FENCE	INF	STUBBLY STEEL RAIL FENCE	STRF
IRON RAILING FENCE	IRF		

REV.	NOTES	DWN	DATE
A			

Notes:

Grid and levels relate to OS GPS Active Network.
Sheet is North orientated unless stated.

Maltby Surveys Ltd

2 QUEENS ROAD
WEST SUSSEX
RH16 1EB
Tel: 01444 416246
Fax: 01444 417697
E-Mail: MLS@maltbysurveys.com
WebSite: <http://www.maltbysurveys.com>

SURVEYED	NBJ	ECE Architecture
DRAWN	NBJ	
CHECKED	RB	
RICS		SCALE
Wandleys Farm Fontwell BN18 0QR		1/200 (A0 Sheet)
TOPOGRAPHICAL SURVEY		
Job No	Rev	Drawing Number
17/071		17/071/100-C
Date	March 2017	



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

GeoReports

**Dominic Bergeron
Peter Brett Associates
Caversham Bridge House
Waterman PI
Reading
Berkshire
RG1 8DN**

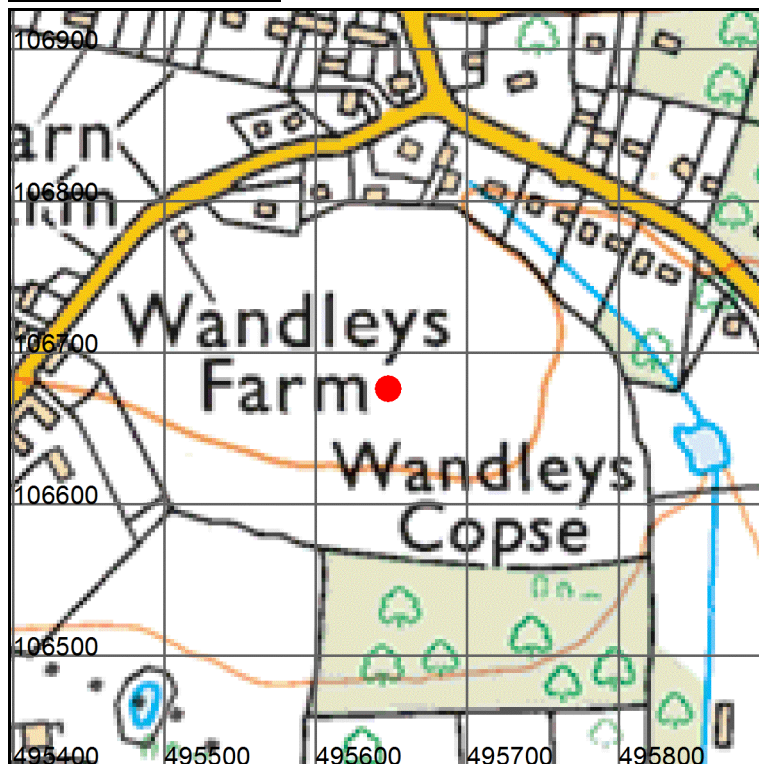
Infiltration SuDS GeoReport:

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_215915/1*

Client reference:

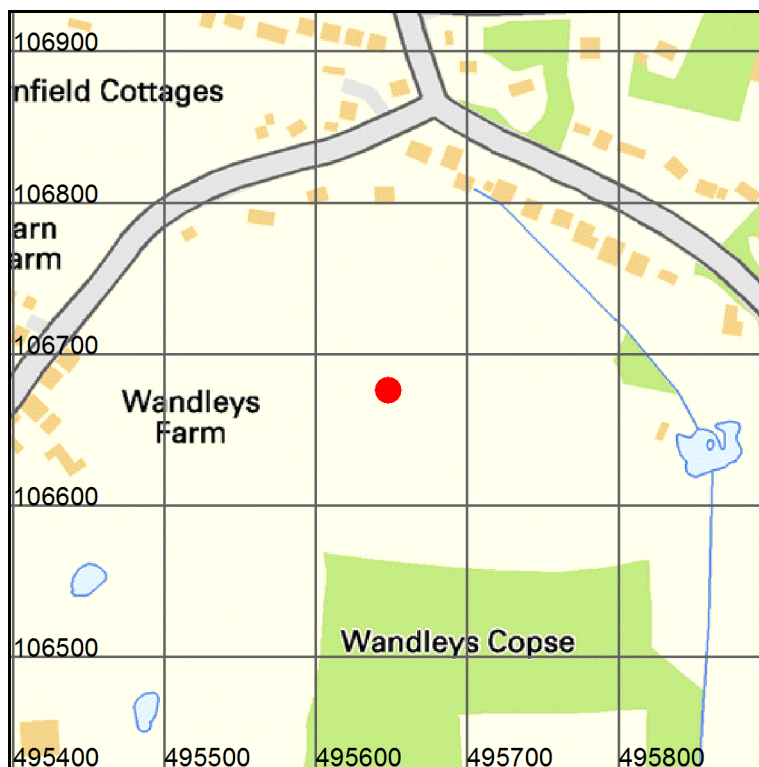
Search location



Point centred at:
495648,106676

Search location indicated in
red

This product includes mapping data licensed from Ordnance Survey.
© Crown Copyright and/or database right 2017. Licence number 100021290 EUL
Scale: 1:5 000 (1cm = 50 m)



Contains Ordnance Survey data © Crown Copyright and database right 2017
OS Street View: Scale: 1:5 000 (1cm = 50 m)

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.

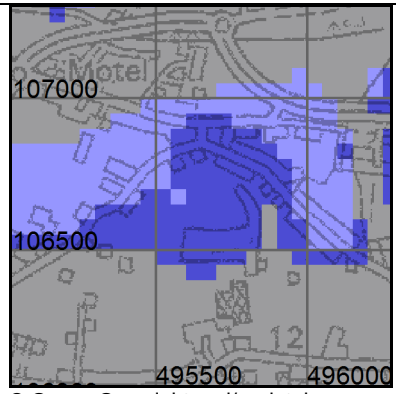
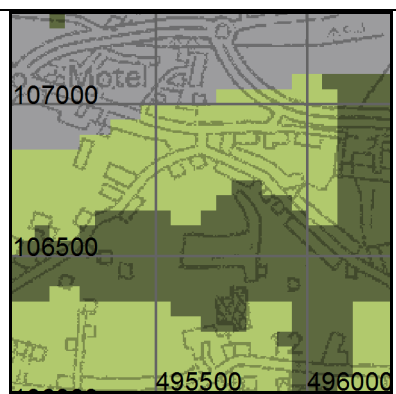
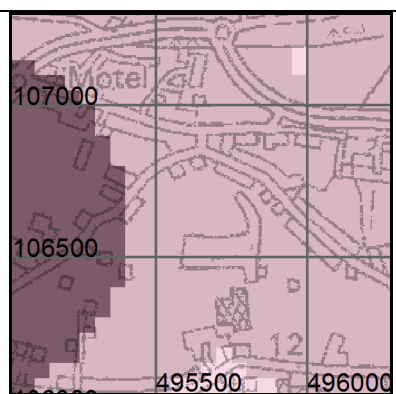


This report considers the suitability of the subsurface for the installation of infiltration SuDS, such as soakaways, infiltration basins or permeable pavements. It provides subsurface data to indicate whether, and which type of infiltration system may be appropriate. It does not state that infiltration 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.

In terms of the drainage potential, is the ground suitable for infiltration SuDS?	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Highly compatible for infiltration SuDS. The subsurface is likely to be suitable for free-draining infiltration SuDS.
	 Probably compatible for infiltration SuDS. The subsurface is probably suitable although the design may be influenced by the ground conditions.
	 Opportunities for bespoke infiltration SuDS. The subsurface is potentially suitable although the design will be influenced by the ground conditions.
	 Very significant constraints are indicated. There is a very significant potential for one or more hazards associated with infiltration.
Is ground instability likely to be a problem?	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is very unlikely to result in ground instability.
	 Ground instability problems may be present or anticipated, but increased infiltration is unlikely to result in ground instability
	 Ground instability problems are probably present. Increased infiltration may result in ground instability.
	 There is a very significant potential for one or more geohazards associated with infiltration.
Is the groundwater susceptible to deterioration in quality?	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 The groundwater is not expected to be especially vulnerable to contamination.
	 The groundwater may be vulnerable to contamination.
	 The groundwater is likely to be vulnerable to contaminants.
	 Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

PART 2: DETAILED DATA

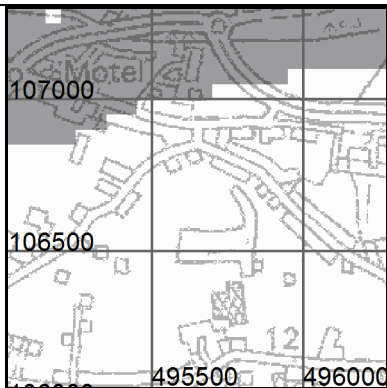
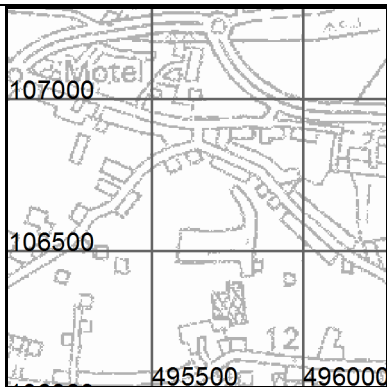
This section provides further information about the properties of the ground and will help assess the suitability of the ground for infiltration SuDS.

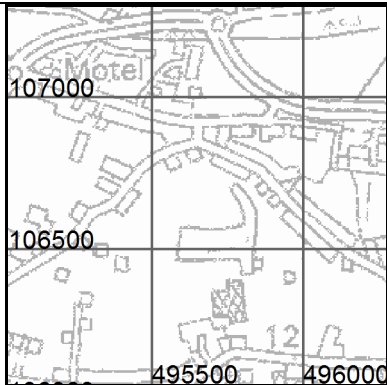
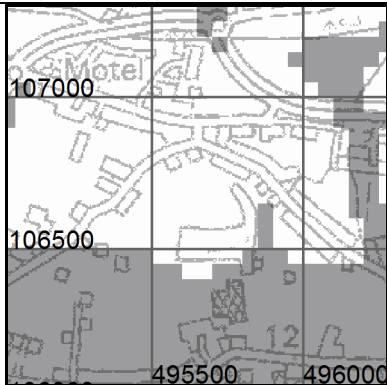
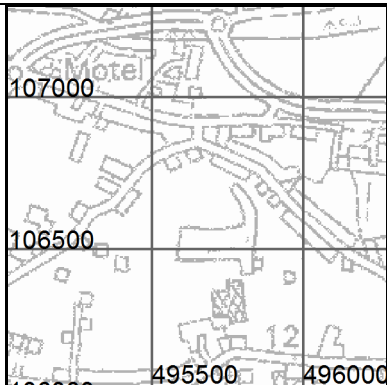
Section 1. Very significant constraints

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	
	 Very significant soluble rock hazard. 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.
	 Very significant soluble rock hazards are not present; however this hazard may still need to be considered. See Part 3.
Landslide hazard	
	 Very significant landslide hazard. 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.
	 Very significant landslide hazards are not present; however this hazard may still need to be considered. See Part 3.

Shallow mining hazard	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	☒ Very significant mining hazard. 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. ☐ Very significant mining hazards are not present; however this hazard may still need to be considered. See Part 3.
Persistent shallow groundwater	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	☒ Very high likelihood of persistent or seasonally shallow groundwater. 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. ☐ See Part 2 for the likely depth to water table.
Made ground	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	☒ Made ground present. 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. ☐ None recorded

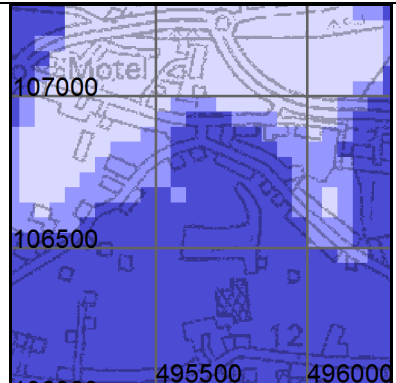
Section 2. Drainage potential

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

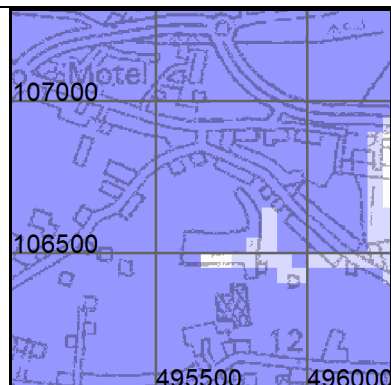
- depth to water table
- permeability of the superficial deposits
- thickness of the superficial deposits
- permeability of the bedrock
- presence of floodplains

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	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Groundwater is likely to be more than 5 m below the ground surface throughout the year.
	 Groundwater is likely to be between 3 and 5 m below the ground surface for at least part of the year.
	 Groundwater is likely to be less than 3 m below the ground surface for at least part of the year.

Superficial deposit permeability



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

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

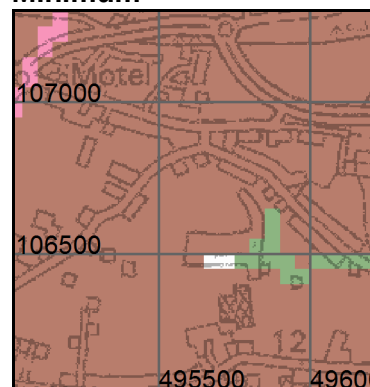
The superficial deposit permeability is **spatially variable**, but likely to permit moderate infiltration.

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

These maps show the permeability range that is summarised above.

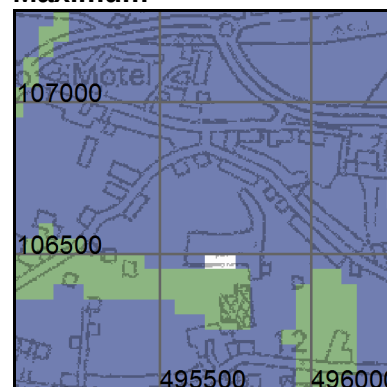
- Very Low
- Low
- Moderate
- High
- Very High

Minimum



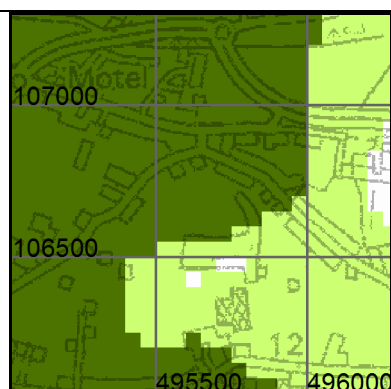
© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Maximum



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Superficial deposit thickness

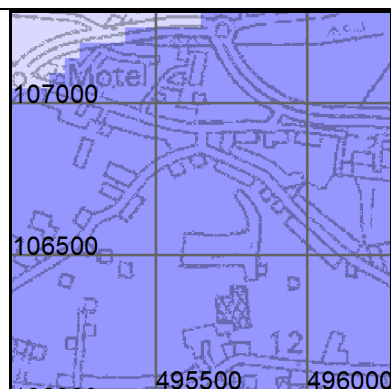


© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

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



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL



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



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



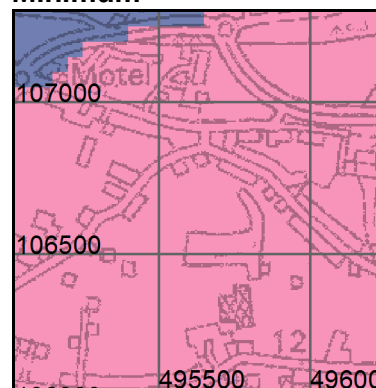
Bedrock deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

Key

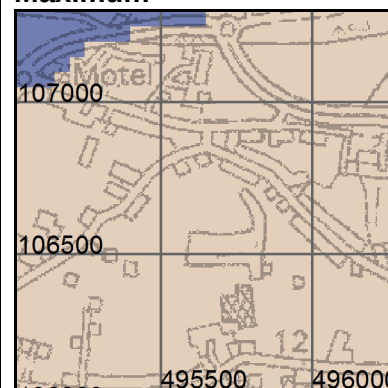
-  Very Low
-  Low
-  Moderate
-  High
-  Very High

Minimum



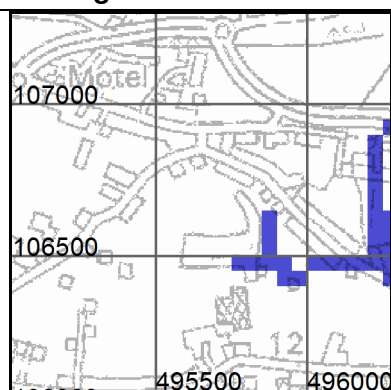
© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Maximum



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Geological indicators of flooding



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL



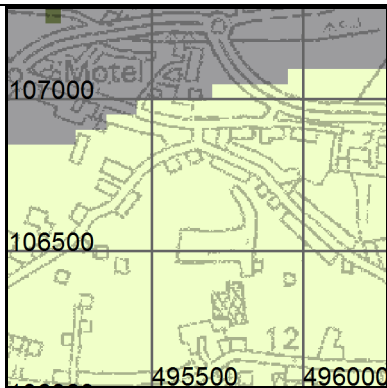
Superficial floodplain deposits or low-lying coastal areas have been identified. Groundwater levels may rise in response to high river or tide levels, potentially causing inundation of subsurface infiltration SuDS.

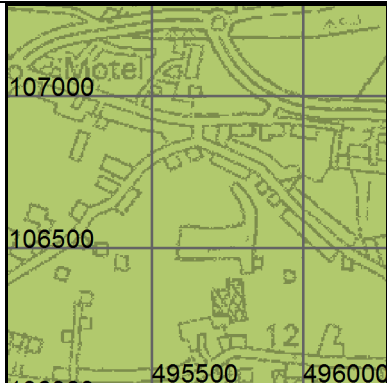
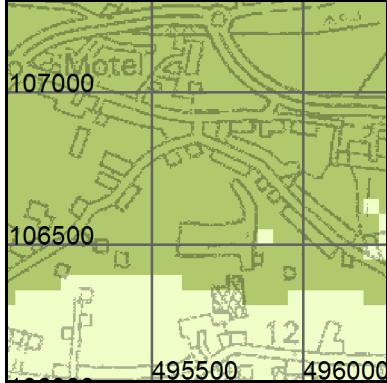
Section 3. Ground stability

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

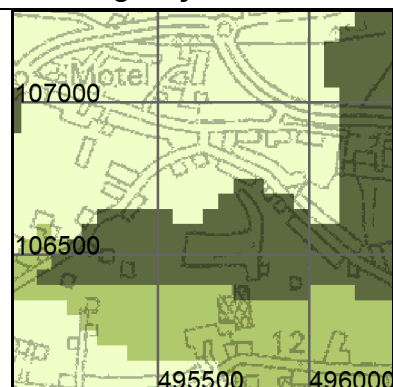
- soluble rocks
- landslides
- shallow mining
- running sands
- swelling clays
- compressible ground, and
- collapsible ground

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	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 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	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 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	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 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	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 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.

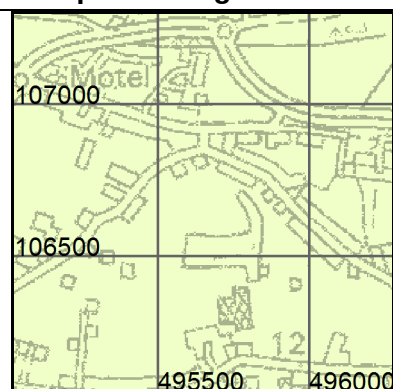
Swelling clays



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

-  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.

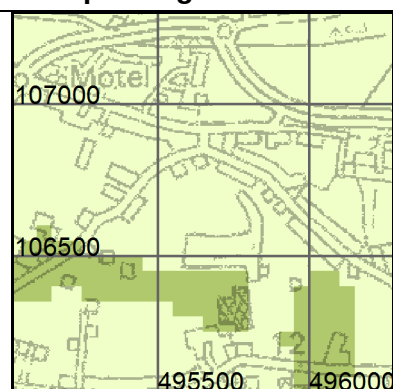
Compressible ground



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

-  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



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

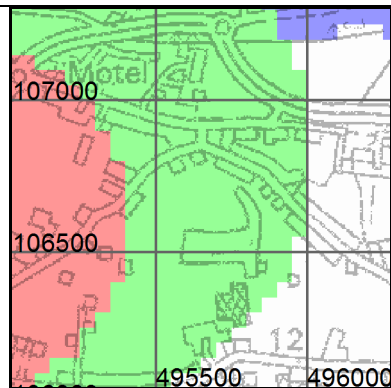
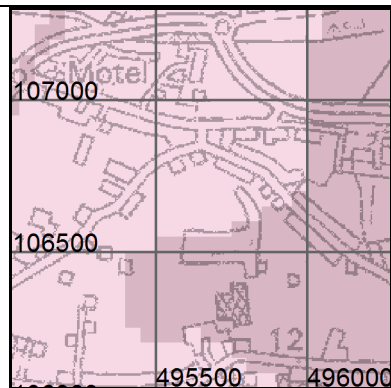
-  Increased infiltration is unlikely to result in subsidence.
-  Deposits with potential to collapse when loaded and saturated are possibly present in places. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
-  Deposits with potential to collapse when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

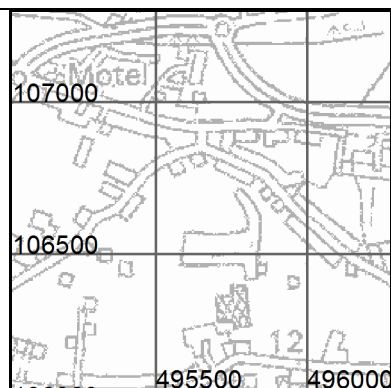
- groundwater source protection zones (Environment Agency data)
- predominant flow mechanism
- made ground

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

Groundwater source protection zones	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL Derived in part from Source Protection Zone data provided under licence from the Environment Agency © Environment Agency 2017.	 Groundwater is not within a source protection zone.
	 Source protection zone IV
	 Source protection zone III
	 Source protection zone II
	 Source protection zone I.
Predominant flow mechanism	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 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.
	 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.



Made ground



© Crown Copyright and/or database
right 2017. All rights reserved.
Licence number 100021290 EUL

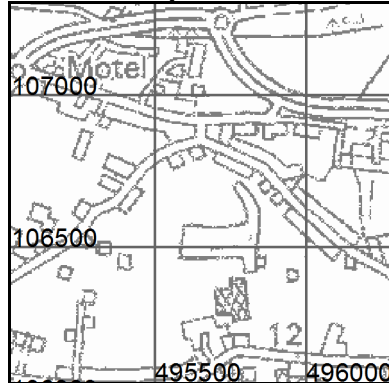


Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

Section 5. Geological Maps

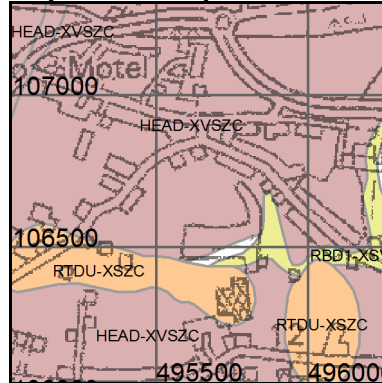
The following maps show the artificial, superficial and bedrock geology within the area of interest.

Artificial deposits



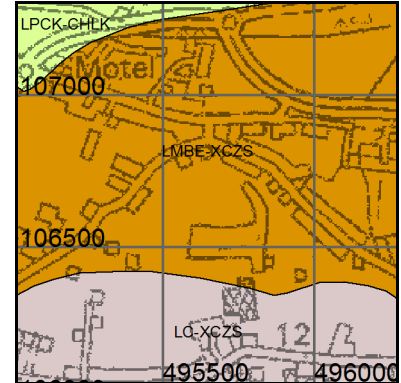
© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Superficial deposits



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Bedrock



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL



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
	HEAD-XVSZC	HEAD	GRAVEL, SAND, SILT AND CLAY
	RBD1-XSV	RAISED BEACH DEPOSITS, 1	SAND AND GRAVEL
	RTDU-XSZC	RIVER TERRACE DEPOSITS (UNDIFFERENTIATED)	SAND, SILT AND CLAY



Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	LC-XCZS	LONDON CLAY FORMATION	CLAY, SILT AND SAND
	LMBE-XCZS	LAMBETH GROUP	CLAY, SILT AND SAND
	LPCK-CHLK	LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION, NEWHAVEN CHALK FORMATION, CULVER CHALK FORMATION AND PORTSDOWN CHALK FORMATION (UNDIFFERENTIATED)	CHALK



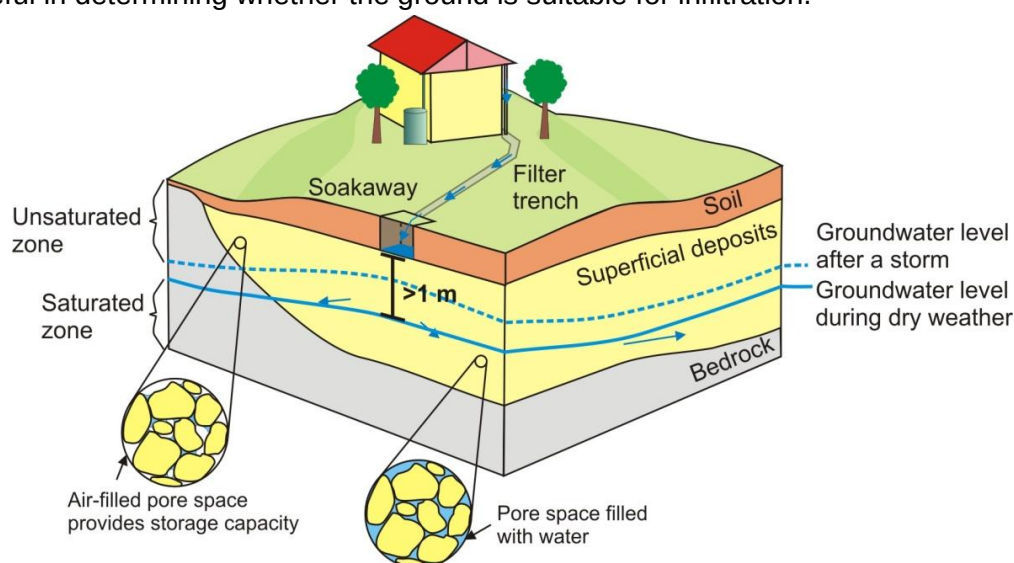
Limitations of this report:

- 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.
 - 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.

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/ or the Scottish Environment Protection Agency (Scotland) at 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.

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.



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. 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/)



Contact Details

Keyworth Office

British Geological Survey
Environmental Science Centre
Nicker Hill
Keyworth
Nottingham
NG12 5GG
Tel: 0115 9363143
Fax: 0115 9363276
Email: enquiries@bgs.ac.uk

Wallingford Office

British Geological Survey
Maclean Building
Wallingford
Oxford
OX10 8BB
Tel: 01491 838800
Fax: 01491 692345
Email: hydroenq@bgs.ac.uk

Edinburgh Office

British Geological Survey
Lyell Centre
Research Avenue South
Edinburgh
EH14 4AP
Tel: 0131 6671000
Email: enquiry@bgs.ac.uk



Terms and Conditions

General Terms & Conditions

This Report is supplied in accordance with the GeoReports Terms & Conditions available on the BGS website at <https://shop.bgs.ac.uk/georeports> and also available from the BGS Central Enquiries Desk at the above address.

Important notes about this Report

- The data, information and related records supplied in this Report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. You must seek professional advice before making technical interpretations on the basis of the materials provided.
- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- Detail, which is clearly defined and accurately depicted on large-scale maps, may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- 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.
- Data may be compiled from the disparate sources of information at BGS's disposal, including material donated to BGS by third parties, and may not originally have been subject to any verification or other quality control process.
- Data, information and related records, which have been donated to BGS, have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.
- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- 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.

Copyright:

Copyright in materials derived from the British Geological Survey's work, is owned by the Natural Environment Research Council (NERC) and/ or the authority that commissioned the work. You may not copy or adapt this publication, or provide it to a third party, without first obtaining NERC's permission, but if you are a consultant purchasing this report solely for the purpose of providing advice to your own individual client you may incorporate it unaltered into your report to that client without further permission, provided you give a full acknowledgement of the source. Please contact the BGS Copyright Manager, British Geological Survey, Environmental Science Centre, Nicker Hill, Keyworth, Nottingham NG12 5GG. Telephone: 0115 936 3100.

© NERC 2017 All rights reserved.

This product includes mapping data licensed from the Ordnance Survey® with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright 2017. All rights reserved. Licence number 100021290 EUL



**Report issued by
BGS Enquiry Service**



Land Searches Map Legend

Sewer

Pipe Line Styles/Colours

	Foul Sewer
	Foul Rising Main
	Foul Syphon Sewer
	Foul Vacuum Sewer
	Foul Trunk Sewer
	Foul Tank Sewer
	Surface Water Sewer
	Surface Water Rising Main
	Surface Water Syphon Sewer
	Surface Water Trunk Sewer
	Surface Water Tank Sewer
	Culverted Watercourse
	Combined Sewer
	Combined Rising Main
	Combined Syphon Sewer
	Combined Trunk Sewer
	Combined Tank Sewer
	Treated Effluent
	Treated Effluent Rising Main
	Sludge Rising Main
	Flow Direction Arrows (All Styles)
	As above line styles but decommissioned
	(Yellow) As above line styles but private
	Access Shaft – Personnel Only

Boundary Line Styles/Colours

	Catchment Boundary
	Sub-Catchment Boundary
	Section 104 Agreement Area
	Building Over Agreement Area

Materials

AK Alkathene	GRP Glass Reinforced Plastic
BAC Bonded Asbestos Cement *	MAC Masonry in regular courses
BRE Brick (Engineering)	MAR Masonry in random courses
BRC Brick (Common)	PE Polyethylene
CC Concrete Box Culvert	PF Pitch Fibre
CI Cast Iron	PP Polypropylene
CO Concrete (In-Situ)	PVC Polyvinyl Chloride
CP Concrete (Pre-Cast)	RPM Reinforced Plastic Matrix
CSB Concrete Segments (Bolted)	SI Spun Iron
CSU Concrete Segments (Un-Bolted)	ST Steel
DI Ductile Iron	VC Vitriified Clay
GRC Glass Reinforced Concrete	UNK Unknown*

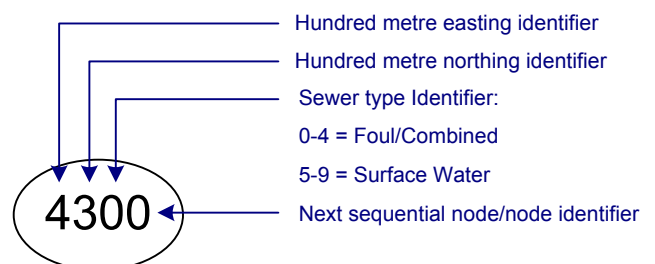
*Warning
BAC Pipes are constructed of Bonded Asbestos Cement
UNK Pipes are may be constructed of Bonded Asbestos Cement

Symbols

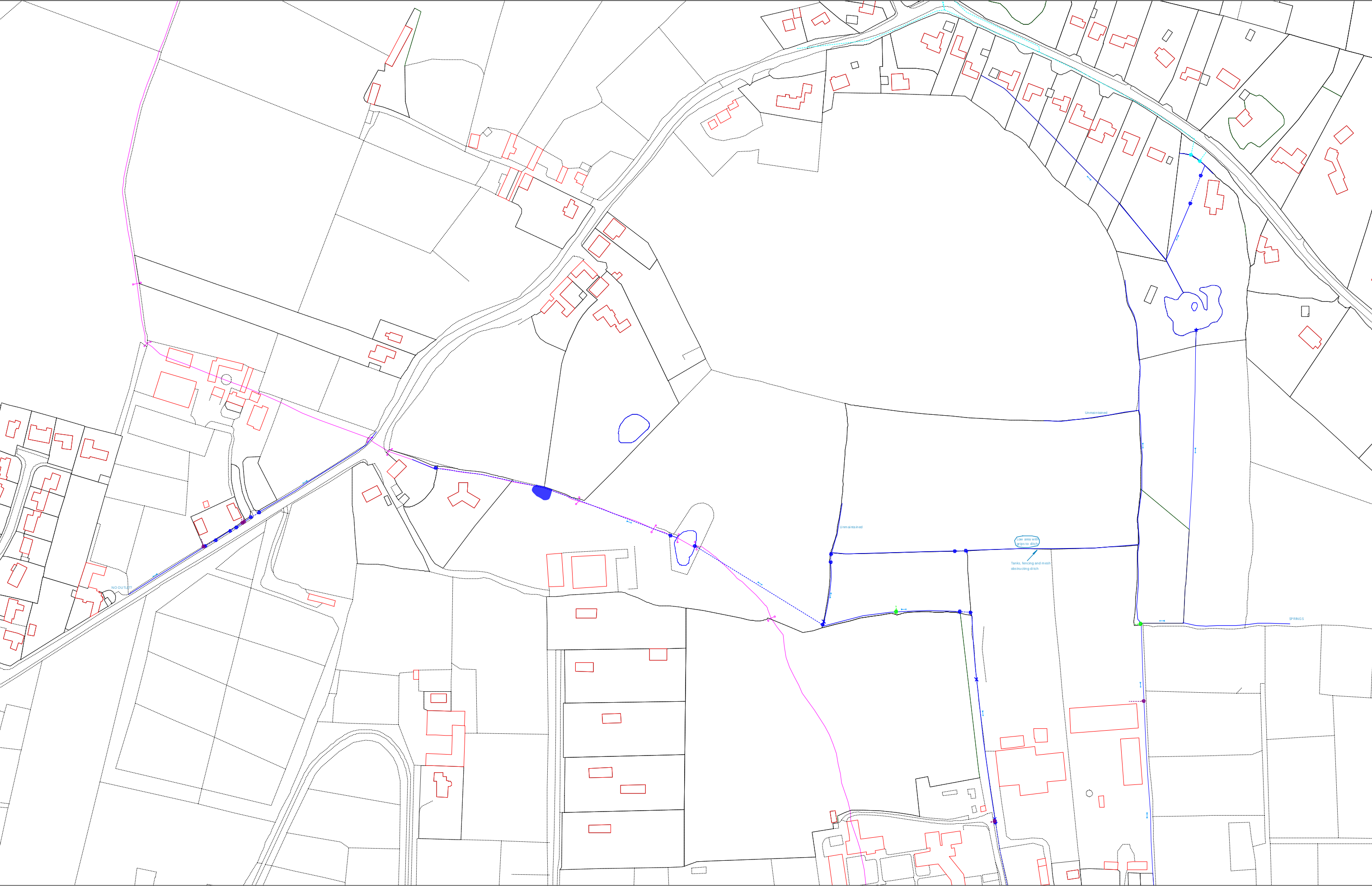
Surface	Foul	Combined	
			Label Ellipse
			Manhole
			Dummy/S.24 Manhole
			Manhole Backdrop
			Catchpit
			Soakaway
			Balancing Pond
			Rodding Eye
			Washout
			Flushing Chamber Mn-E
			Flushing Chamber No-E
			Hatch Box
			Lamphole
			Interceptor Chamber
			Blind Shaft
			Storm Tank
			Vortex Chamber
			Vent
			Vent Column
			Other/Unknown
			Penstock
			Cascade
			Change Node
			Pumping Station
			Micro Pumping Station
			Air Valve
			Valve
			Reflux Valve
			Anti-Flood Device
			Blank End
			Head of Public Sewer
			Inlet
			Outfall
			Storm Overflow
			Treatment Works

Other symbols or text may be visible which are not shown here.
These are used for Southern Water operational guidance only.

Node Referencing System



Arun District Council Maps

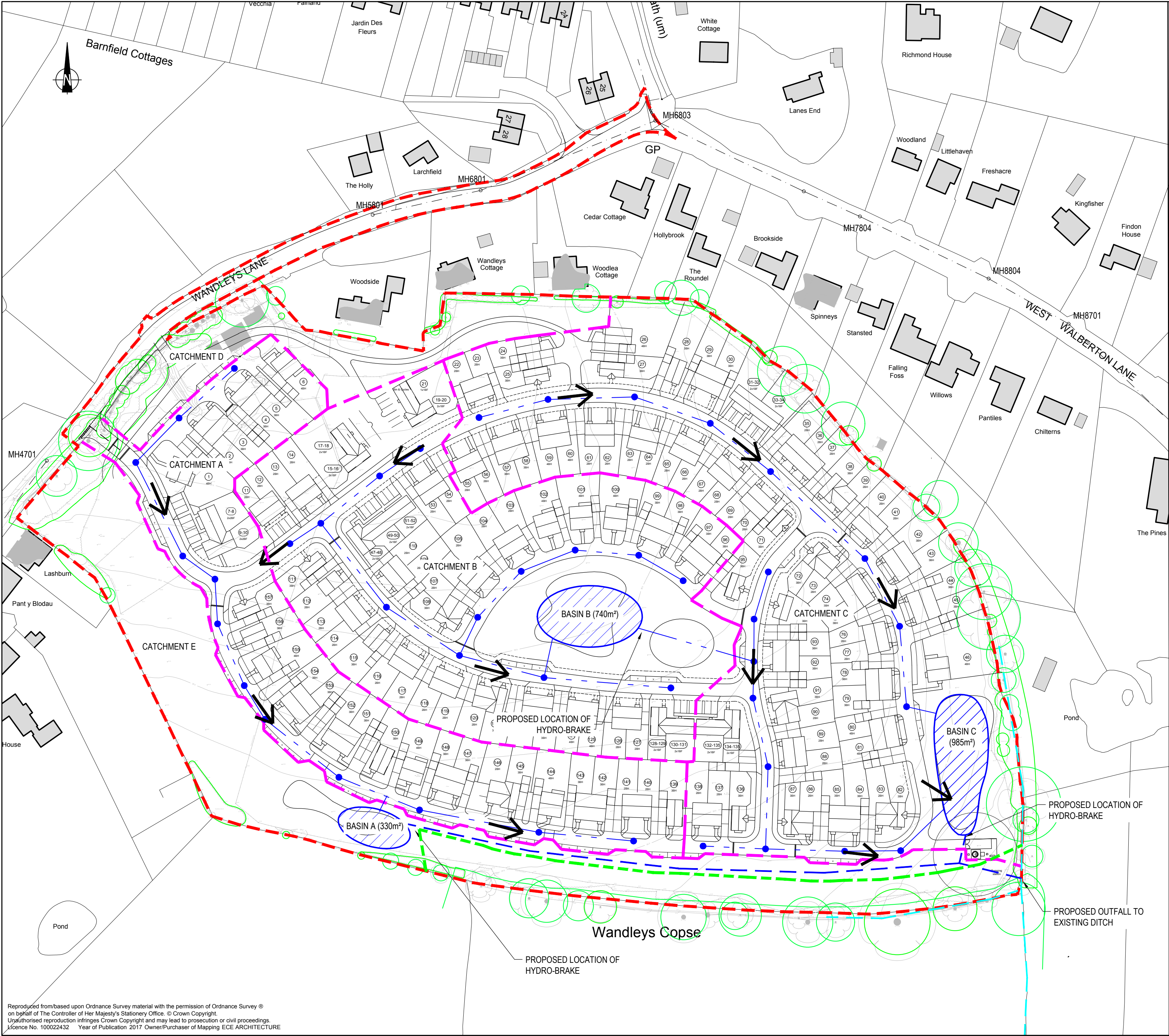


TECHNICAL NOTE

Appendix B

PBA drawing 40523/4001/001 Revision A – Proposed Outline Surface Water Drainage Strategy

PBA drawing 40523/4001/002 Revision A– Existing Catchment Areas



- KEY:
- EXISTING SOUTHERN WATER FOUL SEWER
 - EXISTING SOUTHER WATER FOUL MANHOLE
 - EXISTING SURFACE WATER DITCH
 - PROPOSED SURFACE WATER SEWER
 - PROPOSED SURFACE WATER CHANNEL
 - PROPOSED SURFACE WATER DETENTION BASIN
 - SITE BOUNDARY
 - PROPOSED CATCHMENT BOUNDARY
 - PROPOSED FLOOD FLOW ROUTE
 - ROOT PROTECTION AREA (CAT A, B, C)
 - WANDLEYS COPSE 15m OFFSET

- NOTES:
- LAYOUT IS BASED ON ECE ARCHITECTURE MASTERPLAN DATED 29/09/17.
 - EXISTING SEWER LOCATIONS ARE BASED ON SOUTHERN WATER ASSET RECORDS DATED 23/05/17.
 - TOPOGRAPHICAL SURVEY ARE BASED ON MALTBY SURVEYS LTD DRAWING 17/071/100-500 DATED MARCH 2017.
 - DETENTION BASINS, SURFACE WATER PIPES AND MANHOLES ARE SHOWN INDICATIVELY ONLY. ACTUALLY POSITION AND SHAPE TO BE DETERMINED DURING DETAILED DESIGN.
 - ROOT PROTECTION AREAS BASED ON PJC CONSULTANCY DRAWING PJC/4419/17/A DATED 26/04/17.
 - WANDLEYS COPSE ANCIENT WOODLAND 15m OFFSET ADVISED BY THE ECOLOGY PATERNSHIP.

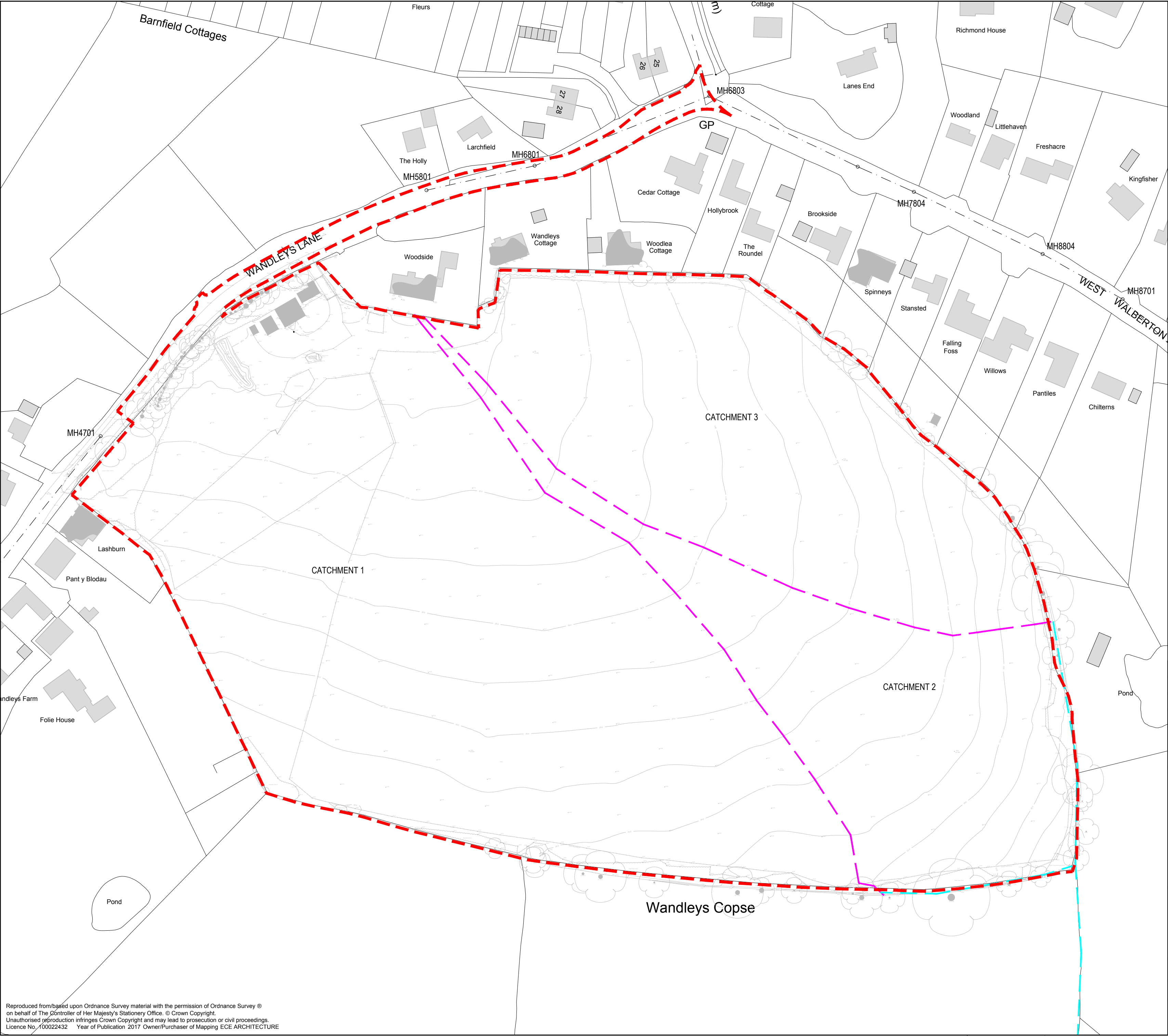
PROPOSED CATCHMENT AREAS	
CATCHMENT	AREA (ha)
A	1.16
B	1.83
C	2.49
D	0.37
E	1.13
TOTAL	6.98

A		UPDATED MASTERPLAN	06.10.17	DB	DB	ASR
Mark	Revision		Date	Drawn	Chkd	Appd
SCALING NOTE: Do not scale from this drawing. If in doubt, ask. UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.						

Drawing Issue Status	
FOR INFORMATION	

LAND EAST OF WANDLEYS LANE
FONTWELL
OUTLINE SURFACE WATER DRAINAGE
STRATEGY

Client		WELBECK LAND		pba peterbrett	
Date of 1st Issue	15.09.17	Designed	DB	Drawn	DB
A2 Scale	1:1000	Checked	DB	Approved	ASR
Drawing Number	38848/4001/001	Revision	A	Offices throughout the UK and Europe www.peterbrett.com © Peter Brett Associates LLP READING Tel: 01189 500 761	



- KEY:
- EXISTING SOUTHERN WATER FOUL SEWER
 - MH4701 EXISTING SOUTHERN WATER FOUL MANHOLE
 - EXISTING SURFACE WATER DITCH
 - SITE BOUNDARY
 - EXISTING CATCHMENT BOUNDARY

- NOTES:
- EXISTING SEWER LOCATIONS ARE BASED ON SOUTHERN WATER ASSET RECORDS DATED 23/05/17.
 - TOPOGRAPHICAL SURVEY IS BASED ON MALTBY SURVEYS LTD DRAWING 17/071/100-500 DATED MARCH 2017.

EXISTING CATCHMENT AREAS	
CATCHMENT	AREA (m ²)
1	3.89
2	1.25
3	1.83
TOTAL	6.97

A	UPDATED SITE BOUNDARY	06.10.17	DB	DB
Mark	Revision	Date	Drawn	Chkd
			ASR	Appd

SCALING NOTE: Do not scale from this drawing. If in doubt, ask.
UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

Drawing Issue Status

FOR INFORMATION

LAND EAST OF WANDLEYS LANE
FONTWELL
EXISTING CATCHMENTS

Client

 WELBECK LAND

Date of 1st Issue
15.09.17

Designed
DB

Drawn
DB

A2 Scale
1:1000

Checked
DB

Approved
ASR

Drawing Number
38848/4001/001

Revision
A


Offices throughout the UK and Europe
www.peterbrett.com
© Peter Brett Associates LLP
READING
Tel: 01189 500 761

TECHNICAL NOTE

Appendix C

MicroDrainage ICP SuDS Greenfield Runoff Calculations

MicroDrainage Basin A Calculations

MicroDrainage Basin B Calculations

MicroDrainage Basin C Calculations

Long Term Storage Calculations

Peter Brett Associates LLP		Page 1
Caversham Bridge House Waterman Place Reading Berkshire RG1 8DN		
Date 15/06/2017 10:14 File	Designed by Dbergeron Checked by	
Micro Drainage Source Control 2015.1		

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	10.000	Urban	0.000
SAAR (mm)	783	Region Number	Region 7

Results l/s

QBAR Rural	20.8
QBAR Urban	20.8
Q100 years	66.3
Q1 year	17.7
Q30 years	47.1
Q100 years	66.3

©1982-2015 XP Solutions

Brett Consulting Ltd							Page 1
Caversham Bridge House							
Waterman Place							
Reading RG1 8DN							
Date 04/09/2017 16:04			Designed by dbergeron				
File POND A.SRCX			Checked by				
XP Solutions			Source Control 2015.1				
Summary of Results for 100 year Return Period (+30%)							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	95.487	0.487	4.9	0.0	4.9	160.7	O K
30 min Summer	95.657	0.657	4.9	0.0	4.9	216.9	O K
60 min Summer	95.842	0.842	4.9	0.0	4.9	277.8	O K
120 min Summer	96.026	1.026	4.9	0.0	4.9	338.6	O K
180 min Summer	96.119	1.119	4.9	0.0	4.9	369.2	O K
240 min Summer	96.172	1.172	4.9	0.0	4.9	386.9	O K
360 min Summer	96.236	1.236	4.9	0.0	4.9	407.9	O K
480 min Summer	96.264	1.264	4.9	0.0	4.9	417.0	O K
600 min Summer	96.271	1.271	4.9	0.0	4.9	419.3	O K
720 min Summer	96.266	1.266	4.9	0.0	4.9	417.8	O K
960 min Summer	96.249	1.249	4.9	0.0	4.9	412.2	O K
1440 min Summer	96.203	1.203	4.9	0.0	4.9	396.9	O K
2160 min Summer	96.125	1.125	4.9	0.0	4.9	371.4	O K
2880 min Summer	96.045	1.045	4.9	0.0	4.9	345.0	O K
4320 min Summer	95.873	0.873	4.9	0.0	4.9	287.9	O K
5760 min Summer	95.689	0.689	4.9	0.0	4.9	227.4	O K
7200 min Summer	95.551	0.551	4.9	0.0	4.9	181.8	O K
8640 min Summer	95.442	0.442	4.9	0.0	4.9	145.9	O K
10080 min Summer	95.358	0.358	4.9	0.0	4.9	118.1	O K
15 min Winter	95.546	0.546	4.9	0.0	4.9	180.3	O K
30 min Winter	95.739	0.739	4.9	0.0	4.9	243.8	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	116.556	0.0	161.1	0.0	19		
30 min Summer	79.359	0.0	219.6	0.0	34		
60 min Summer	51.576	0.0	289.3	0.0	64		
120 min Summer	32.297	0.0	362.4	0.0	122		
180 min Summer	24.143	0.0	406.3	0.0	182		
240 min Summer	19.502	0.0	437.6	0.0	242		
360 min Summer	14.451	0.0	486.2	0.0	362		
480 min Summer	11.662	0.0	522.9	0.0	480		
600 min Summer	9.865	0.0	552.6	0.0	600		
720 min Summer	8.599	0.0	577.7	0.0	686		
960 min Summer	6.916	0.0	618.3	0.0	800		
1440 min Summer	5.077	0.0	673.4	0.0	1054		
2160 min Summer	3.718	0.0	753.6	0.0	1472		
2880 min Summer	2.976	0.0	804.1	0.0	1900		
4320 min Summer	2.170	0.0	878.9	0.0	2724		
5760 min Summer	1.735	0.0	938.7	0.0	3408		
7200 min Summer	1.459	0.0	986.9	0.0	4112		
8640 min Summer	1.267	0.0	1028.0	0.0	4840		
10080 min Summer	1.125	0.0	1063.7	0.0	5456		
15 min Winter	116.556	0.0	180.5	0.0	19		
30 min Winter	79.359	0.0	245.9	0.0	33		
©1982-2015 XP Solutions							

Brett Consulting Ltd							Page 2
Caversham Bridge House Waterman Place Reading RG1 8DN							
Date 04/09/2017 16:04 File POND A.SRCX							
XP Solutions			Designed by dbergeron Checked by				
Source Control 2015.1							
Summary of Results for 100 year Return Period (+30%)							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	95.948	0.948	4.9	0.0	4.9	312.9	O K
120 min Winter	96.156	1.156	4.9	0.0	4.9	381.6	O K
180 min Winter	96.264	1.264	4.9	0.0	4.9	417.2	O K
240 min Winter	96.328	1.328	4.9	0.0	4.9	438.2	O K
360 min Winter	96.408	1.408	4.9	0.0	4.9	464.5	O K
480 min Winter	96.447	1.447	4.9	0.0	4.9	477.4	O K
600 min Winter	96.464	1.464	4.9	0.0	4.9	483.0	O K
720 min Winter	96.466	1.466	4.9	0.0	4.9	483.8	O K
960 min Winter	96.446	1.446	4.9	0.0	4.9	477.2	O K
1440 min Winter	96.385	1.385	4.9	0.0	4.9	457.0	O K
2160 min Winter	96.276	1.276	4.9	0.0	4.9	421.0	O K
2880 min Winter	96.157	1.157	4.9	0.0	4.9	381.7	O K
4320 min Winter	95.899	0.899	4.9	0.0	4.9	296.5	O K
5760 min Winter	95.613	0.613	4.9	0.0	4.9	202.2	O K
7200 min Winter	95.425	0.425	4.9	0.0	4.9	140.4	O K
8640 min Winter	95.301	0.301	4.8	0.0	4.8	99.2	O K
10080 min Winter	95.222	0.222	4.5	0.0	4.5	73.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
60 min Winter	51.576	0.0	324.0	0.0	62		
120 min Winter	32.297	0.0	405.9	0.0	122		
180 min Winter	24.143	0.0	455.0	0.0	180		
240 min Winter	19.502	0.0	490.0	0.0	238		
360 min Winter	14.451	0.0	544.3	0.0	354		
480 min Winter	11.662	0.0	585.2	0.0	468		
600 min Winter	9.865	0.0	618.2	0.0	578		
720 min Winter	8.599	0.0	645.8	0.0	688		
960 min Winter	6.916	0.0	689.5	0.0	894		
1440 min Winter	5.077	0.0	725.1	0.0	1112		
2160 min Winter	3.718	0.0	844.1	0.0	1580		
2880 min Winter	2.976	0.0	900.6	0.0	2048		
4320 min Winter	2.170	0.0	984.3	0.0	2944		
5760 min Winter	1.735	0.0	1051.4	0.0	3624		
7200 min Winter	1.459	0.0	1105.4	0.0	4256		
8640 min Winter	1.267	0.0	1151.5	0.0	4920		
10080 min Winter	1.125	0.0	1191.7	0.0	5544		
©1982-2015 XP Solutions							

Brett Consulting Ltd		Page 3																																	
Caversham Bridge House Waterman Place Reading RG1 8DN																																			
Date 04/09/2017 16:04	Designed by dbergeron																																		
File POND A.SRCX	Checked by																																		
XP Solutions		Source Control 2015.1																																	
<u>Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FSR</td> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Return Period (years)</td> <td>100</td> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>M5-60 (mm)</td> <td>19.600</td> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Ratio R</td> <td>0.324</td> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> <td>Climate Change %</td> <td>+30</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 0.752 <table> <thead> <tr> <th colspan="2">Time (mins)</th> <th>Area</th> </tr> <tr> <th>From:</th> <th>To:</th> <th>(ha)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>4</td> <td>0.752</td> </tr> </tbody> </table>			Rainfall Model	FSR	Winter Storms	Yes	Return Period (years)	100	Cv (Summer)	0.750	Region	England and Wales	Cv (Winter)	0.840	M5-60 (mm)	19.600	Shortest Storm (mins)	15	Ratio R	0.324	Longest Storm (mins)	10080	Summer Storms	Yes	Climate Change %	+30	Time (mins)		Area	From:	To:	(ha)	0	4	0.752
Rainfall Model	FSR	Winter Storms	Yes																																
Return Period (years)	100	Cv (Summer)	0.750																																
Region	England and Wales	Cv (Winter)	0.840																																
M5-60 (mm)	19.600	Shortest Storm (mins)	15																																
Ratio R	0.324	Longest Storm (mins)	10080																																
Summer Storms	Yes	Climate Change %	+30																																
Time (mins)		Area																																	
From:	To:	(ha)																																	
0	4	0.752																																	
©1982-2015 XP Solutions																																			

Brett Consulting Ltd		Page 4
Caversham Bridge House Waterman Place Reading RG1 8DN		
Date 04/09/2017 16:04 File POND A.SRCX	Designed by dbergeron Checked by	
XP Solutions Source Control 2015.1		

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 95.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	330.0	1.000	330.0	2.000	330.0	3.000	330.0

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0098-5000-1500-5000

Design Head (m) 1.500

Design Flow (l/s) 5.0

Flush-Flo™ Calculated

Objective Minimise upstream storage

Diameter (mm) 98

Invert Level (m) 95.000

Minimum Outlet Pipe Diameter (mm) 150

Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.0
Flush-Flo™	0.431	4.9
Kick-Flo®	0.878	3.9
Mean Flow over Head Range	-	4.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.2	1.200	4.5	3.000	6.9	7.000	10.3
0.200	4.4	1.400	4.8	3.500	7.4	7.500	10.7
0.300	4.8	1.600	5.1	4.000	7.9	8.000	11.0
0.400	4.9	1.800	5.4	4.500	8.4	8.500	11.3
0.500	4.9	2.000	5.7	5.000	8.8	9.000	11.6
0.600	4.8	2.200	6.0	5.500	9.2	9.500	11.9
0.800	4.3	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.5	6.500	10.0		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 99.500

©1982-2015 XP Solutions

Brett Consulting Ltd							Page 1	
Caversham Bridge House			Designed by dbergeron					
Waterman Place								
Reading RG1 8DN			Checked by					
Date 04/09/2017 16:04			Source Control 2015.1					
File POND B.SRCX								
XP Solutions								
Summary of Results for 100 year Return Period (+30%)								
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status	
15 min Summer	95.349	0.349	2.0	0.0	2.0	258.5	O K	
30 min Summer	95.475	0.475	2.0	0.0	2.0	351.5	O K	
60 min Summer	95.615	0.615	2.0	0.0	2.0	455.3	O K	
120 min Summer	95.765	0.765	2.0	0.0	2.0	566.2	O K	
180 min Summer	95.852	0.852	2.0	0.0	2.0	630.2	O K	
240 min Summer	95.911	0.911	2.0	0.0	2.0	674.0	O K	
360 min Summer	95.999	0.999	2.1	0.0	2.1	739.1	O K	
480 min Summer	96.061	1.061	2.1	0.0	2.1	784.9	O K	
600 min Summer	96.107	1.107	2.2	0.0	2.2	819.5	O K	
720 min Summer	96.144	1.144	2.2	0.0	2.2	846.7	O K	
960 min Summer	96.198	1.198	2.3	0.0	2.3	886.5	O K	
1440 min Summer	96.259	1.259	2.3	0.0	2.3	931.9	O K	
2160 min Summer	96.293	1.293	2.3	0.0	2.3	957.0	O K	
2880 min Summer	96.292	1.292	2.3	0.0	2.3	956.4	O K	
4320 min Summer	96.262	1.262	2.3	0.0	2.3	934.2	O K	
5760 min Summer	96.230	1.230	2.3	0.0	2.3	909.9	O K	
7200 min Summer	96.197	1.197	2.3	0.0	2.3	886.1	O K	
8640 min Summer	96.166	1.166	2.2	0.0	2.2	862.6	O K	
10080 min Summer	96.135	1.135	2.2	0.0	2.2	839.7	O K	
15 min Winter	95.392	0.392	2.0	0.0	2.0	289.8	O K	
30 min Winter	95.533	0.533	2.0	0.0	2.0	394.1	O K	
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
15 min Summer	116.556	0.0	171.3	0.0	22			
30 min Summer	79.359	0.0	173.7	0.0	37			
60 min Summer	51.576	0.0	335.6	0.0	68			
120 min Summer	32.297	0.0	316.7	0.0	126			
180 min Summer	24.143	0.0	311.1	0.0	186			
240 min Summer	19.502	0.0	310.7	0.0	244			
360 min Summer	14.451	0.0	318.7	0.0	364			
480 min Summer	11.662	0.0	328.1	0.0	484			
600 min Summer	9.865	0.0	334.6	0.0	604			
720 min Summer	8.599	0.0	339.1	0.0	724			
960 min Summer	6.916	0.0	344.5	0.0	962			
1440 min Summer	5.077	0.0	346.5	0.0	1442			
2160 min Summer	3.718	0.0	681.9	0.0	2160			
2880 min Summer	2.976	0.0	684.3	0.0	2880			
4320 min Summer	2.170	0.0	665.3	0.0	3584			
5760 min Summer	1.735	0.0	1298.0	0.0	4328			
7200 min Summer	1.459	0.0	1256.7	0.0	5120			
8640 min Summer	1.267	0.0	1214.5	0.0	5960			
10080 min Summer	1.125	0.0	1178.0	0.0	6760			
15 min Winter	116.556	0.0	174.0	0.0	22			
30 min Winter	79.359	0.0	170.9	0.0	37			
©1982-2015 XP Solutions								

Brett Consulting Ltd							Page 2
Caversham Bridge House Waterman Place Reading RG1 8DN							
Date 04/09/2017 16:04 File POND B.SRCX							
XP Solutions			Designed by dbergeron Checked by				
Source Control 2015.1							
Summary of Results for 100 year Return Period (+30%)							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	95.690	0.690	2.0	0.0	2.0	510.7	O K
120 min Winter	95.858	0.858	2.0	0.0	2.0	635.2	O K
180 min Winter	95.956	0.956	2.0	0.0	2.0	707.5	O K
240 min Winter	96.023	1.023	2.1	0.0	2.1	757.1	O K
360 min Winter	96.123	1.123	2.2	0.0	2.2	831.3	O K
480 min Winter	96.194	1.194	2.3	0.0	2.3	883.9	O K
600 min Winter	96.249	1.249	2.3	0.0	2.3	924.1	O K
720 min Winter	96.292	1.292	2.3	0.0	2.3	955.9	O K
960 min Winter	96.356	1.356	2.4	0.0	2.4	1003.2	O K
1440 min Winter	96.432	1.432	2.4	0.0	2.4	1059.8	O K
2160 min Winter	96.482	1.482	2.5	0.0	2.5	1097.0	O K
2880 min Winter	96.494	1.494	2.5	0.0	2.5	1105.7	O K
4320 min Winter	96.465	1.465	2.5	0.0	2.5	1083.9	O K
5760 min Winter	96.423	1.423	2.4	0.0	2.4	1053.0	O K
7200 min Winter	96.382	1.382	2.4	0.0	2.4	1022.8	O K
8640 min Winter	96.338	1.338	2.4	0.0	2.4	990.1	O K
10080 min Winter	96.293	1.293	2.3	0.0	2.3	956.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
60 min Winter	51.576	0.0	326.3	0.0	66		
120 min Winter	32.297	0.0	312.5	0.0	124		
180 min Winter	24.143	0.0	314.4	0.0	184		
240 min Winter	19.502	0.0	322.4	0.0	242		
360 min Winter	14.451	0.0	337.4	0.0	360		
480 min Winter	11.662	0.0	346.9	0.0	478		
600 min Winter	9.865	0.0	353.4	0.0	596		
720 min Winter	8.599	0.0	357.9	0.0	714		
960 min Winter	6.916	0.0	362.8	0.0	950		
1440 min Winter	5.077	0.0	363.5	0.0	1414		
2160 min Winter	3.718	0.0	722.3	0.0	2096		
2880 min Winter	2.976	0.0	722.9	0.0	2768		
4320 min Winter	2.170	0.0	700.1	0.0	4016		
5760 min Winter	1.735	0.0	1347.2	0.0	4552		
7200 min Winter	1.459	0.0	1321.7	0.0	5472		
8640 min Winter	1.267	0.0	1299.1	0.0	6400		
10080 min Winter	1.125	0.0	1262.9	0.0	7360		
©1982-2015 XP Solutions							

Brett Consulting Ltd		Page 3
Caversham Bridge House Waterman Place Reading RG1 8DN		
Date 04/09/2017 16:04	Designed by dbergeron	
File POND B.SRCX	Checked by	
XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Shortest Storm (mins)	15
Ratio R	0.324	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.192

Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)
0	4 1.000	4	8 0.192

©1982-2015 XP Solutions

Brett Consulting Ltd		Page 4
Caversham Bridge House Waterman Place Reading RG1 8DN		
Date 04/09/2017 16:04 File POND B.SRCX	Designed by dbergeron Checked by	
XP Solutions Source Control 2015.1		

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 95.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	740.0	1.000	740.0	2.000	740.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0068-2500-1500-2500
Design Head (m)	1.500
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	68
Invert Level (m)	95.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	2.5
Flush-Flo™	0.300	2.0
Kick-Flo®	0.609	1.7
Mean Flow over Head Range	-	2.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.7	1.200	2.3	3.000	3.4	7.000	5.1
0.200	2.0	1.400	2.4	3.500	3.7	7.500	5.3
0.300	2.0	1.600	2.6	4.000	3.9	8.000	5.4
0.400	2.0	1.800	2.7	4.500	4.2	8.500	5.6
0.500	1.9	2.000	2.9	5.000	4.4	9.000	5.8
0.600	1.7	2.200	3.0	5.500	4.6	9.500	5.9
0.800	1.9	2.400	3.1	6.000	4.8		
1.000	2.1	2.600	3.2	6.500	4.9		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 99.000

©1982-2015 XP Solutions

Brett Consulting Ltd							Page 1	
Caversham Bridge House Waterman Place Reading RG1 8DN								
Date 04/09/2017 16:01				Designed by dbergeron				
File				Checked by				
XP Solutions				Source Control 2015.1				
<u>Cascade Summary of Results for pond C.srcx</u>								
Upstream Outflow To Overflow To Structures								
pond B.srcx (None) (None)								
Storm	Max	Max	Max	Max	Max	Max	Status	
Event	Level	Depth	Control	Overflow	Σ Outflow	Volume		
	(m)	(m)	(l/s)	(l/s)	(l/s)	(m³)		
15 min Summer	95.355	0.355	5.7	0.0	5.7	350.0	O K	
30 min Summer	95.483	0.483	5.8	0.0	5.8	475.3	O K	
60 min Summer	95.624	0.624	5.8	0.0	5.8	614.4	O K	
120 min Summer	95.774	0.774	5.8	0.0	5.8	762.6	O K	
180 min Summer	95.862	0.862	5.8	0.0	5.8	848.8	O K	
240 min Summer	95.922	0.922	5.8	0.0	5.8	908.4	O K	
360 min Summer	96.013	1.013	5.8	0.0	5.8	997.4	O K	
480 min Summer	96.075	1.075	5.8	0.0	5.8	1059.4	O K	
600 min Summer	96.123	1.123	5.8	0.0	5.8	1105.8	O K	
720 min Summer	96.159	1.159	5.8	0.0	5.8	1142.1	O K	
960 min Summer	96.213	1.213	5.8	0.0	5.8	1194.6	O K	
1440 min Summer	96.272	1.272	5.8	0.0	5.8	1253.3	O K	
2160 min Summer	96.303	1.303	5.8	0.0	5.8	1283.2	O K	
2880 min Summer	96.298	1.298	5.8	0.0	5.8	1278.8	O K	
4320 min Summer	96.257	1.257	5.8	0.0	5.8	1237.9	O K	
5760 min Summer	96.214	1.214	5.8	0.0	5.8	1195.5	O K	
7200 min Summer	96.172	1.172	5.8	0.0	5.8	1154.3	O K	
8640 min Summer	96.131	1.131	5.8	0.0	5.8	1113.5	O K	
Storm	Rain	Flooded	Discharge	Overflow	Time-Peak			
Event	(mm/hr)	Volume	Volume	Volume	(mins)			
		(m³)	(m³)	(m³)				
15 min Summer	116.556	0.0	431.6	0.0	23			
30 min Summer	79.359	0.0	477.0	0.0	38			
60 min Summer	51.576	0.0	881.7	0.0	68			
120 min Summer	32.297	0.0	947.4	0.0	126			
180 min Summer	24.143	0.0	943.5	0.0	186			
240 min Summer	19.502	0.0	921.0	0.0	246			
360 min Summer	14.451	0.0	874.2	0.0	366			
480 min Summer	11.662	0.0	845.2	0.0	486			
600 min Summer	9.865	0.0	827.2	0.0	606			
720 min Summer	8.599	0.0	816.4	0.0	724			
960 min Summer	6.916	0.0	810.2	0.0	964			
1440 min Summer	5.077	0.0	817.4	0.0	1442			
2160 min Summer	3.718	0.0	1673.6	0.0	2160			
2880 min Summer	2.976	0.0	1632.2	0.0	2880			
4320 min Summer	2.170	0.0	1579.4	0.0	3636			
5760 min Summer	1.735	0.0	3239.3	0.0	4440			
7200 min Summer	1.459	0.0	3200.8	0.0	5192			
8640 min Summer	1.267	0.0	3056.4	0.0	6048			
©1982-2015 XP Solutions								

Brett Consulting Ltd							Page 2
Caversham Bridge House							
Waterman Place							
Reading RG1 8DN							
Date 04/09/2017 16:01			Designed by dbergeron				
File			Checked by				
XP Solutions			Source Control 2015.1				
<u>Cascade Summary of Results for pond C.srcx</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Summer	96.089	1.089	5.8	0.0	5.8	1072.6	O K
15 min Winter	95.398	0.398	5.7	0.0	5.7	392.2	O K
30 min Winter	95.541	0.541	5.8	0.0	5.8	532.9	O K
60 min Winter	95.700	0.700	5.8	0.0	5.8	689.2	O K
120 min Winter	95.870	0.870	5.8	0.0	5.8	857.1	O K
180 min Winter	95.970	0.970	5.8	0.0	5.8	955.4	O K
240 min Winter	96.038	1.038	5.8	0.0	5.8	1022.4	O K
360 min Winter	96.139	1.139	5.8	0.0	5.8	1122.1	O K
480 min Winter	96.211	1.211	5.8	0.0	5.8	1192.5	O K
600 min Winter	96.265	1.265	5.8	0.0	5.8	1245.9	O K
720 min Winter	96.308	1.308	5.8	0.0	5.8	1288.0	O K
960 min Winter	96.371	1.371	5.8	0.0	5.8	1350.1	O K
1440 min Winter	96.444	1.444	5.8	0.0	5.8	1422.8	O K
2160 min Winter	96.490	1.490	5.8	0.0	5.8	1467.2	O K
2880 min Winter	96.496	1.496	5.8	0.0	5.8	1473.3	O K
4320 min Winter	96.455	1.455	5.8	0.0	5.8	1433.4	O K
5760 min Winter	96.397	1.397	5.8	0.0	5.8	1375.9	O K
7200 min Winter	96.343	1.343	5.8	0.0	5.8	1323.0	O K
8640 min Winter	96.286	1.286	5.8	0.0	5.8	1266.5	O K
10080 min Winter	96.226	1.226	5.8	0.0	5.8	1207.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
10080 min Summer	1.125	0.0	2887.4	0.0	6864		
15 min Winter	116.556	0.0	454.6	0.0	23		
30 min Winter	79.359	0.0	485.4	0.0	37		
60 min Winter	51.576	0.0	926.6	0.0	66		
120 min Winter	32.297	0.0	947.1	0.0	126		
180 min Winter	24.143	0.0	908.2	0.0	184		
240 min Winter	19.502	0.0	878.7	0.0	244		
360 min Winter	14.451	0.0	844.7	0.0	362		
480 min Winter	11.662	0.0	831.4	0.0	480		
600 min Winter	9.865	0.0	831.0	0.0	598		
720 min Winter	8.599	0.0	839.3	0.0	716		
960 min Winter	6.916	0.0	853.7	0.0	950		
1440 min Winter	5.077	0.0	860.9	0.0	1414		
2160 min Winter	3.718	0.0	1708.5	0.0	2100		
2880 min Winter	2.976	0.0	1708.1	0.0	2768		
4320 min Winter	2.170	0.0	1670.4	0.0	4060		
5760 min Winter	1.735	0.0	3410.5	0.0	4616		
7200 min Winter	1.459	0.0	3297.2	0.0	5544		
8640 min Winter	1.267	0.0	3160.9	0.0	6480		
10080 min Winter	1.125	0.0	3027.5	0.0	7456		
©1982-2015 XP Solutions							

Brett Consulting Ltd		Page 3
Caversham Bridge House Waterman Place Reading RG1 8DN		
Date 04/09/2017 16:01 File	Designed by dbergeron Checked by	
XP Solutions		Source Control 2015.1

Cascade Rainfall Details for pond C.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Shortest Storm (mins)	15
Ratio R	0.324	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.615

Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)
0	4 1.000	4	8 0.615

©1982-2015 XP Solutions

Brett Consulting Ltd		Page 4
Caversham Bridge House Waterman Place Reading RG1 8DN		
Date 04/09/2017 16:01 File	Designed by dbergeron Checked by	
XP Solutions Source Control 2015.1		

Cascade Model Details for pond C.srcx

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 95.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	985.0	1.000	985.0	2.000	985.0	3.000	985.0

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0106-5800-1500-5800

Design Head (m) 1.500

Design Flow (l/s) 5.8

Flush-Flo™ Calculated

Objective Minimise upstream storage

Diameter (mm) 106

Invert Level (m) 95.000

Minimum Outlet Pipe Diameter (mm) 150

Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.8
Flush-Flo™	0.450	5.8
Kick-Flo®	0.921	4.6
Mean Flow over Head Range	-	5.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	1.200	5.2	3.000	8.0	7.000	11.9
0.200	5.2	1.400	5.6	3.500	8.6	7.500	12.3
0.300	5.6	1.600	5.9	4.000	9.1	8.000	12.7
0.400	5.7	1.800	6.3	4.500	9.7	8.500	13.1
0.500	5.7	2.000	6.6	5.000	10.2	9.000	13.4
0.600	5.7	2.200	6.9	5.500	10.6	9.500	13.8
0.800	5.2	2.400	7.2	6.000	11.1		
1.000	4.8	2.600	7.5	6.500	11.5		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 99.000

©1982-2015 XP Solutions

4.3 Initial sizing of long term storage volume

Long term storage is to be provided to cater for the additional runoff caused by the development compared to the volume that would be contributed from the site in its greenfield state. This volume must be catered for as either infiltration storage or in storage with the ability to be discharged at a rate of less than 2 l/s/ha. Designing the drainage system with Long Term storage will result in less total storage being required than not providing LTS.

Discussion on the equation and practical provision of Long Term storage is provided in Chapter 7.

1. Development area	(A)	5.48 ha	Excluding public open space which is not modified by the development
2. Estimate of PIMP (percentage impermeable area)	(PIMP)	65 %	
3. Impermeable area (A · PIMP/100)	(AP)	3.56 ha	All hard surfaces in the development
4. Long Term storage factor	(LTF)	4.50	Storage volume per unit area per mm of rainfall (see Figure A10.1 or A10.2) see note 3.
5. Rainfall depth	(RD)	63 mm	Rainfall depth for 100 year 6 hour event (Appendix 1 Figure A3.1).
6. Long Term storage volume (RD · LTF · AP)	(LTVol _{100yr 6hr})	1009 M ³	See note 2

- Note 1** Where Long Term storage is being discharged directly to the receiving water at 2 l/s/ha, the values for Q_{30} and Q_{100} for attenuation storage discharge rate should be reduced accordingly. If this is the case, the calculation for Attenuation storage should be based on $(Q_{BAR}/A - 0.5)$ l/s/ha unless this reduces below a value of 1.0 l/s/ha, in which case 1.0 l/s/ha should be used.
- 2** LTF is defined such that the equation of item 6 uses rainfall depth in millimetres and area in hectares.
- 3** There is a choice of LTF factor based on the assumption as to whether the pervious area contributes to the 100 year runoff based on its SPR value. The conservative assumption would be to assume it does (Figure A10.1) unless the site is designed to minimise the runoff from green areas (Figure A10.2). 80% runoff is assumed to occur from pervious surfaces. Other options can be assumed working from first principles using the formulae in Chapter 7.

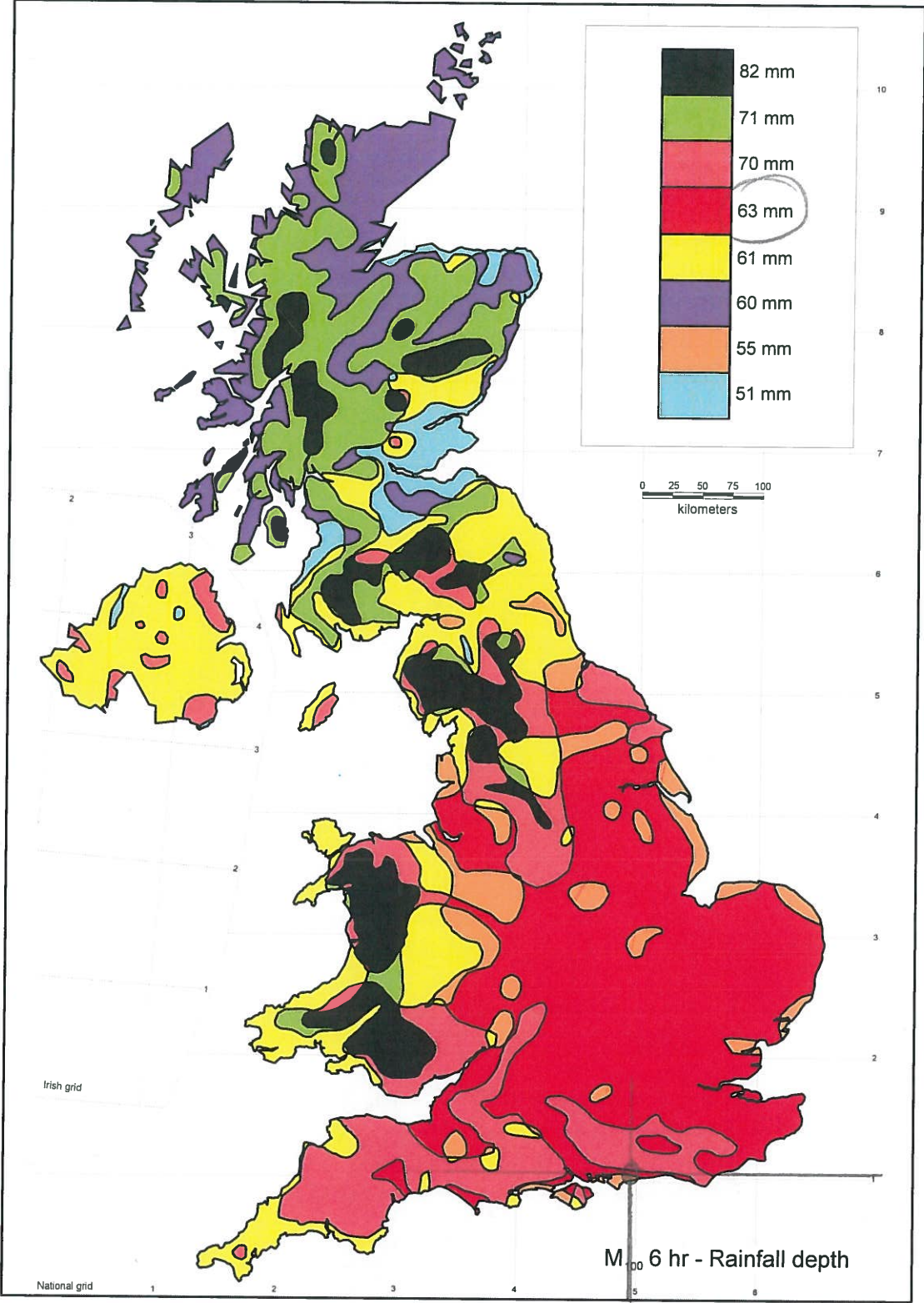


Figure A3.1 100 year 6 hour rainfall depths of UK



This page is intentionally blank