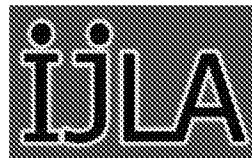
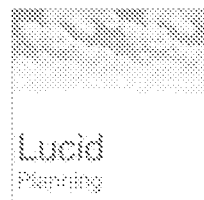


Drainage Strategy & SuDS Statement

DREW SMITH GROUP



Land at Summer Lane
Pagham
Reserved Matters Application

May 2020

Document Control Sheet

Project name: Land north of Summer Lane, Pagham

Project ref: DSM/E4761

Report Title Drainage Strategy &
SuDS Statement

Doc. ref: TRS/E4761/17424

Date: 18th May 2020

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Approved by:	Terry Seymour	Director		May 2020

Revision	Date	Description	Prepared	Approved

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1.0 Introduction

Rogers Cory Partnership Limited have been instructed on behalf of Drew Smith to prepare a Surface Water Drainage Strategy and SuDS Statement to support the planning application for 36no. new dwellings.

The planning application follows the consent of the Reserved Matters Application on 28th February, 2020, which now seeks to switch 21no. of the consented units within two of the development parcels on the western side of the site, to 36no. new dwellings. This results in an increase of 15no. houses, generating an overall figure of 105no. dwellings across the whole site.

This report outlines the development of the Surface Water Drainage and SuDS Strategy following on from the Flood Risk Assessment (FRA) produced by MJA Consulting (Report dated March 2015) which formed part of the original outline planning submission.

Further details, including detailed hydraulic calculations, detailed drainage layouts and associated drainage construction details will be developed and submitted as part of a separate and future Discharge of Conditions application.

The drainage strategy outlined and presented in this report build on the principles of the following:

- Flood Risk Assessment by MJA Consulting Limited (March 2015);
- Combined Geotechnical and Ground Contamination Risk Assessment by Ashdown Investigation Limited (September 2016);
- Geo-Environmental Report by Ashdown Site Investigation Limited (September 2016)
- Winter Groundwater monitoring Report by Wilson Bailey Geotechnical and Environmental (May 2016);
- BRE 365 Soakaway Testing by Geo-Environmental Limited (January 2019);
- Winter Groundwater Monitoring by Geo- Environmental Limited (June 2019);
- Existing Drainage and CCTV survey by DrainTech (March 2019)

2.0 Existing Site

The site is located north of Pagham, adjacent to Summer Lane (Refer to **Figure 1** below). The development is bounded to the north by an existing ditch and a new residential development, to the east and south by existing residential properties and to the west by existing farm lands

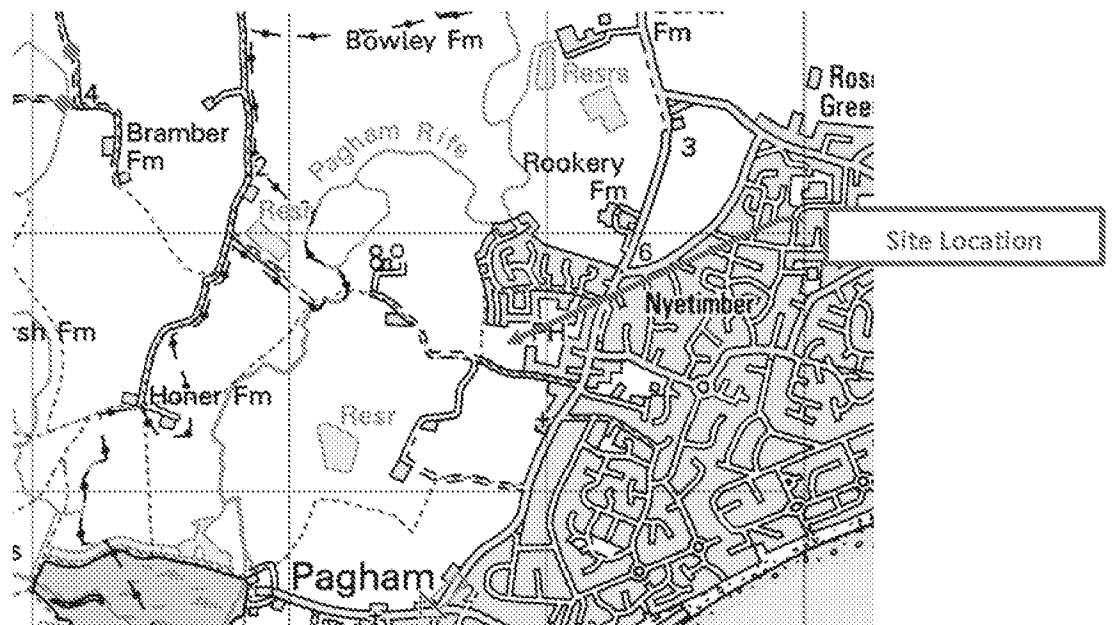


Figure 1: Site Location

The overall wider site proposed for development covers approximately 3.27ha of greenfield land comprising of open grassed fields. The approximate centre of the site is at Ordnance Survey (OS) Grid Reference 488830; 98552.

The application site for the new planning application covers an area of 0.97ha, within the wider site. generally falls in a westerly direction from the south eastern corner to the north west. An overview of the change in topography in this part of the wider site is presented as **Figure 2** overleaf. A copy of the topographical survey can be found in **Appendix A**.

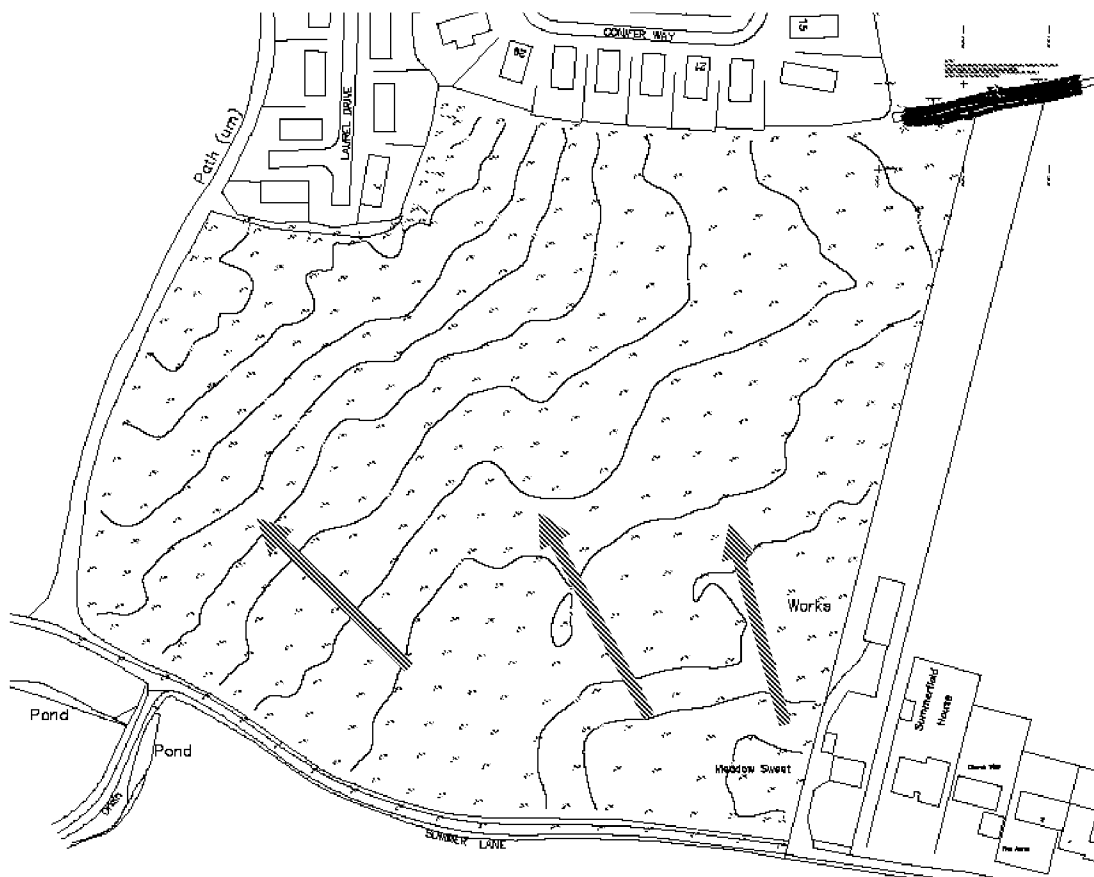


Figure 2: Site Topography

Geotechnical

The current review of the geotechnical aspects of the site are based on the following documents:

- Combined Geotechnical and Ground Contamination Risk Assessment by Ashdown Investigation Limited (September 2016);
- Geo-Environmental Report by Ashdown Site Investigation Limited (September 2016)
- Winter Groundwater monitoring Report by Wilson Bailey Geotechnical and Environmental (May 2016);
- BRE 365 Soakaway Testing by Geo-Environmental Limited (January 2019);
- Winter Groundwater Monitoring by Geo- Environmental Limited (June 2019);

Ground Conditions

BGS geological maps indicate that the site is underlain by the London Clay Formation with River Terrace Deposits superficial deposits.

Intrusive investigations carried out by Ashdown, Wilson Bailey and GESL indicate that the site consists of Topsoil up to 0.3mbgl. MADE GROUND was discovered up to depths of 0.2mbgl at TPO2, TPO4 and TP12 (ref. GESL report), River Deposits (Clay) ranged in depths between 0.1 to 3.0m plus below ground and River Terrace Deposits (Sand) ranged in depth between 1.10m to 3.0m plus below ground. The London Clay Formation was found at depths from 1.90mbgl.

Winter groundwater monitoring indicates the presence of shallow groundwater parts of the site varying from 0.00mbgl to 1.81mbgl. Winter infiltration testing to BRE 365 was carried out and indicated permeability rates ranging from 9.5×10^{-7} to 1.1×10^{-5} m/s.

A copy of the extracts from the GESL Ground investigation report is contained in **Appendix B**.

Hydrology

There is an existing ordinary watercourse which runs along the north western boundary of the site as well as along the south western side of the site.

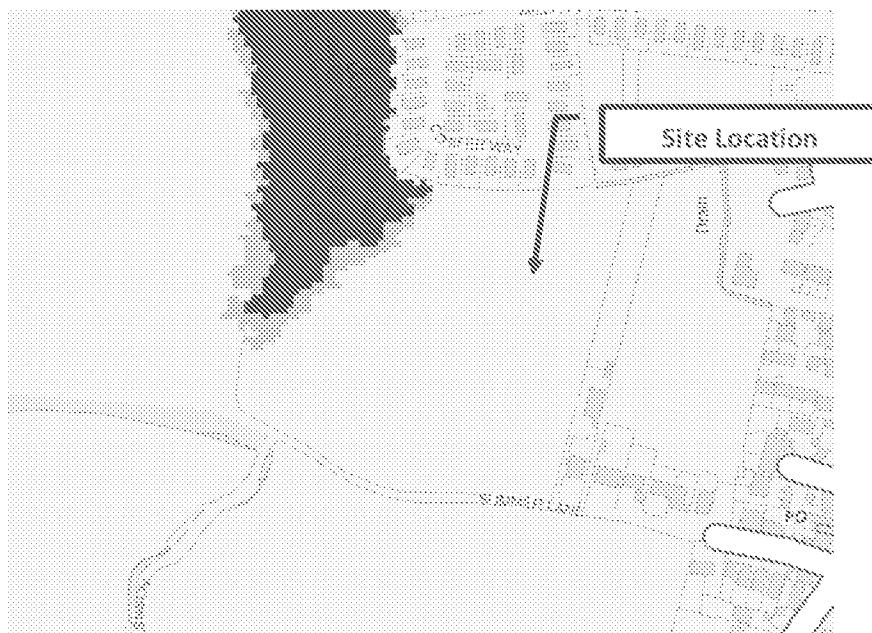


Figure 3: Extract of Flood Map from the EA's website

Hydrogeology

Groundwater mapping published by the EA indicates that the site is located over a and Unproductive Stratum Bedrock and Secondary A Superficial Deposit designation respectively. The site does not lie within a groundwater source protection.

3.0 Flood Risk and Existing Surface Water Drainage

This report reviews the existing risk of flooding to the site and requirements for a compliant drainage strategy by interrogating the following information:

- Available topographic survey information;
- Arun District Council Strategic Flood Risk Assessment (SFRA);
- West Sussex LLFA Policy for the Management of Surface Water;
- Available mapping from the Environment Agency's website;
- Existing Southern Water sewer service records;
- MJA Consulting Limited Flood Risk Assessment (March 2015);

Based on a review of the EA's Flood Zone maps (see **Figure 3**), the development site appears to lie wholly within Flood Zone 1, considered to be at low risk from fluvial and tidal flooding.

The risk of flooding from pluvial sources has been assessed and based on the mapping information provided by the EA is deemed low for the site. Whilst there is a small localised area highlighted as high risk this is due to a localised low point in the site topography which would allow potential exceedance flows to accumulate. The risk to the future development could be mitigated through consideration of proposed finished levels in relation to these existing low points on the site to ensure such localised surface water flooding will not pose a risk to buildings or people, nor increase the risk of surface water flooding elsewhere.

It should be noted that as from April 2015, the Lead Local Flood Authority (LLFA) has now become a statutory consultee with respects to surface water drainage and risk of flooding from surface water, groundwater, reservoirs and sewers. As such West Sussex County Council (WSCC) and Arun District Council (ADC) will become a primary consultee during planning application submission and discharging planning conditions relating to localised flood risk and the surface water drainage strategy.

Existing Site Drainage

A review of the existing topographic information and sewer records has been carried out to assess the existing surface water drainage regime of the site.

The majority of the surface water from fields within the development site appear to drain overland to the existing ditches located on the northern and western extents of the fields.

4.0 Surface Water Management

The surface water management section should ensure that there is no adverse impact on flood risk elsewhere as a result of a change in the surface water runoff regime from the re-development.

Design Principles

Key design principles in the following guidance documents steer the approach to managing surface water runoff at sites:

- Building Regulations hierarchy of drainage (H3);
- Interim Code of Practice for SuDS; and
- CIRIA best practice guidance, including the use of the 'SuDS management train'.

Building Regulations hierarchy of drainage outlines the preferred methods for the disposal of surface water with infiltration methods being the preferred option. If this is not possible the next favoured option is to drain to an existing watercourse. If neither of these options are feasible, the regulations state that rainwater discharge should be directed to a sewer.

The Interim Code of Practice for SuDS provides guidance about the hydraulic design criteria for Sustainable drainage systems. This in general refers to both peak rate of runoff and the volume of runoff, post development. Prior to mitigation measures such as the use of SuDS attenuation features, both the volume and peak rate of runoff may increase post development.

The design principles for surface water management extend beyond simple hydraulic criteria. CIRIA guidance promotes the use of the SuDS management train, a concept where SuDS techniques are used to treat, convey and store surface water runoff. This approach is considered as part of the SuDS selection methodology.

Sustainable Drainage Systems

To drain the development in a sustainable manner whilst complying with the requirements of the NPPF, the scheme should seek to adopt an appropriate form(s) of sustainable urban drainage systems (SuDS).

SuDS techniques comprise of implementation of permeable paving for parking bays and the use of attenuation basins and swales to convey and provide temporary storage of surface water run-off.

Surface Water Drainage Strategy

In view of the requirements of the NPPF, PPG, WSCC and ADC along with the design parameters and constraints associated with redeveloping this site, a surface water drainage strategy design has been devised and hydraulically modelled to demonstrate that the scheme can be suitably implemented without increasing the level of flood risk, when the surface water drainage system experiences a 1:100 year rainfall event (including 40% climate change allowance) and 10% allowance for urban creep

The surface water drainage scheme has been designed to ensure:

- A reduction in the pre development site discharge for peak storm events.
- Sustainable Urban Drainage systems are wholly incorporated within the scheme.
- Consideration is given for the improvement of water quality within the design.
- The designed drainage scheme can satisfactorily retain a critical 1 in 100 Year storm event with climate change.

Wider development site

All new parking bays will be designed as permeable paving to make use of the available infiltration at shallow levels, with an overflow provision to the new surface water network.

Run-off from the access roads and plots will be conveyed to a new below ground surface water drainage network which will direct flows from the eastern parcel of the development, via an existing ditch, which in turn is to be diverted into a new open ditch and swale system located on the western part of the site.

As there is an existing residential development which discharges into the ditch, which runs along the northern boundary of the site, the new swale and ditch system in the western side of the site has been modelled to account for the additional areas from the Crayfern Development to the north. An outline of the above proposal is provided in drawings DSM/E4761/001 in **Appendix E**.

It must be noted that the strategy layout and calculations presented at this stage is to demonstrate that the detailed layout can feasibly be drained in terms of surface water.

Current Planning Application Site

The additional units fall within wider development site and thus fall part of the same surface water drainage strategy. The hydraulic calculations have been reassessed to determine the impacts of the increased impermeable area as a result of the increased number of units

Flow Control

The hydraulic models of the proposed surface water network, incorporating the SuDS attenuation basins and flow control devices can be found in **Appendix F**.

The hydraulic calculations have been simulated under various scenarios up to and including the critical 1 in 100 Year storm event with additional 40% allowance for climate change and 10% allowance for urban creep.

Discharge from the site is proposed to be restricted to the Qbar rate of 7.9l/s for all storm events up to and including the 1 in 100 year plus climate change.

The simulations confirm that the storm can be managed and contained within the curtailment of the site, with small volumes of surface flooding, during peak storm events contained at surface in areas of low risk to people or property.

Catchment	Impermeable Development Area (Ha)	Q1 Year (L/sec)	Q30 Year (L/Sec)	Q100 Year Plus Climate (L/Sec)	Discharge Volume (m3) (360min Winter)
1	2.270 (includes 0.41ha)	5.2	7.9	7.9	257.895

Table 2: Summary of Post Development Run-off with mitigation measures

Water Quality

It is important to address issues with regards to quality when considering surface water management. As part of the surface water is proposed to be discharge to the existing downstream watercourses, treatment is proposed as part of a SuDS Management Train in accordance with the recommendations of the SuDS Manual (CIRIA 753) and as required by the LLFA.

This SuDS management train will be achieved through the use of permeable paving, swales and attenuation basins.

Chapter 26 of the CIRIA SuDS Manual (2015) provides guidance on methods that should be used to design SuDS to meet the water quality design criteria and good practice design standards. Diffuse urban pollution is a significant factor in compromising groundwater and receiving water standards that are required under the EA Water Framework Directive. Chapter 4 of the SuDs Manual summarises factors, which influence pollution levels in urban run-off. This summary is presented in **Table 1 overleaf**:

Factors influencing pollution levels in urban run-off

The amount and type of pollution washed off a surface will depend on many things including:

- Planning activities on, above and adjacent to the surface that affect the deposition of pollutants, their retention on the surface and the extent to which they are mixed with runoff (including pollution prevention strategies)
- Unplanned activities (accidents and spillages) that can cause temporary unexpected high pollution concentrations
- The surface location and type, affecting wash-off rates and contaminant movement mechanisms
- The drainage path
- The length of the dry weather period before the rainfall event
- The intensity and the duration of the rainfall, and the associated flow velocities

Any further pollutant transformations occurring during residence and conveyance within gullies, chambers, pipe or channel networks, gravels, soils and vegetation and quiescent bodies of water.

Table 1: Extract of Box 4.1 of the SuDS Manual (CIRIA 753)

Table 4.3 of the SuDS Manual classifies the pollution hazard level for residential sites, including residential car parks, low traffic roads as being “low” and thus only requiring a “Simple index approach” in terms of the requirements for the discharge to surface waters, including coasts and estuaries.

The SuDS Manual summarises the steps for the simple index approach:

Step 1 – *Allocate suitable pollution hazard indices for the proposed land use*

Step 2 – *Select SuDS with a total pollution mitigation index that equals or exceeds the pollution index*

Step 3 – *Where the discharge to a protected surface waters or groundwater, consider the need for a more precautionary approach*

The SuDS Manual describes “protected surface waters” as protected surface water resources, which include those designated for drinking water abstraction or for other environmental protection reasons

Table 26.2 of the SuDS manual notes the following pollution hazard indices for residential land use development:

Land Use	Pollution Hazard Level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (eg. cul-de sacs, home zones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie. Less than 300 vehicle movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospital, retail), all roads except low traffic roads and trunk roads/ motorways	Medium	0.7	0.6	0.7

Table 2: Extract of Table 26.2 of SuDS Manual (2015)

Table 26.3 of the SuDS Manual provides details of the SuDS pollution mitigation indices for various types of SuDS components

Type of SuDS component	Mitigation indices		
	TSS	Metals	Hydrocarbons
Filter Strip	0.4	0.4	0.5
Filter Drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable Paving	0.7	0.6	0.7
Detention Basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5
Wetland	0.8	0.8	0.8

Table 3: Extract of Table 26.3 of SuDS Manual (2015)

As such the total SuDS mitigation index (figure 5) must be greater than the pollution hazard index (figure 4), furthermore when used in combination of two or more SuDS components, a factor of 0.5 is used to account for the reduced performance of the secondary or tertiary components associated with the already reduced inflow of concentration, therefore:

Total SuDS mitigation index = mitigation index₁ + 0.5 (mitigation index₂)

The use of the permeable paving for parking bays and the combination of the attenuation basins and swales will provide the minimum required level of SuDS mitigation index to the run off from the development.

Long Term Maintenance

Consideration will need to be given to the long-term maintenance of the proposed drainage structures. Permeable paving, swales, attenuation basins and all associated external pipework, chambers and manholes within the demise of each plot ownership boundaries will be the responsibility of the future occupants. Elsewhere, the surface water networks below the access roads and open space will be the responsibility of the Management Company. Details of the Maintenance Plan will be provided as part of the separate Discharge of Conditions application of the Outline Consent.

Exceedance

Whilst the drainage system has been designed to a very high standard (1 in 100 Year storm event including climate change), it is possible that a more extreme event will occur and that the design standard for the system will be exceeded. It is best practice to design the drainage system to shed water, primarily into landscaped and other areas, therefore reducing the risk of flooding areas of built development during extreme events.

A strategy for directing overland flows for the site will be confirmed using overland flow modeling and provided as part of the separate Discharge of Conditions application.

5.0 Foul Drainage

The overall proposed foul water discharge generated by the site has been calculated at 4.86l/s (based on 105 dwellings at 4000l/dwelling/day) in accordance with Sewers for Adoption 7th Edition.

The foul water drainage will be conveyed via a new below ground foul sewer network through development and onto a new adoptable foul water pumping station to be located in the south western corner of the site. A new rising main will convey the pumped discharge to the nearest Southern Water public foul sewer within Summer Lane.

All domestic foul drainage will be designed in accordance with Part H of the Building Regulations.

6.0 Conclusion

A surface water drainage strategy has been prepared and demonstrates that the development proposal can be successfully implemented and designed to withstand the impact of a 1:100-year rainfall event (including climate change), in accordance with the NPPF, PPG, WSCC and ADC requirements.

In view of this assessment, the report concludes that:

- i. The Development can be drained in a sustainable manner utilizing SuDS techniques;
- ii. The Development will satisfactorily manage and maintain a 1 in 100 Year storm event with an allowance for climate change;
- iii. The detailed drainage strategy generally follows the principles of the approved FRA and Surface Water Drainage Strategy and SuDS Statement;
- iv. The findings of this report identify the opportunity to promote the sustainable re-use of existing resources and potential to implement an appropriate SuDS strategy.

Appendix (A)

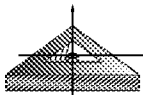
Topographic Survey



NOTES:
Coordinates based on OS grid determined from National GPS Network using OSTN02.
Levels based on OS datum determined from National GPS Network using OSGM02.

Detail on properties & road surrounding site produced from OS ProMap
Crown Copyright. All rights reserved. Licence Number 100020449

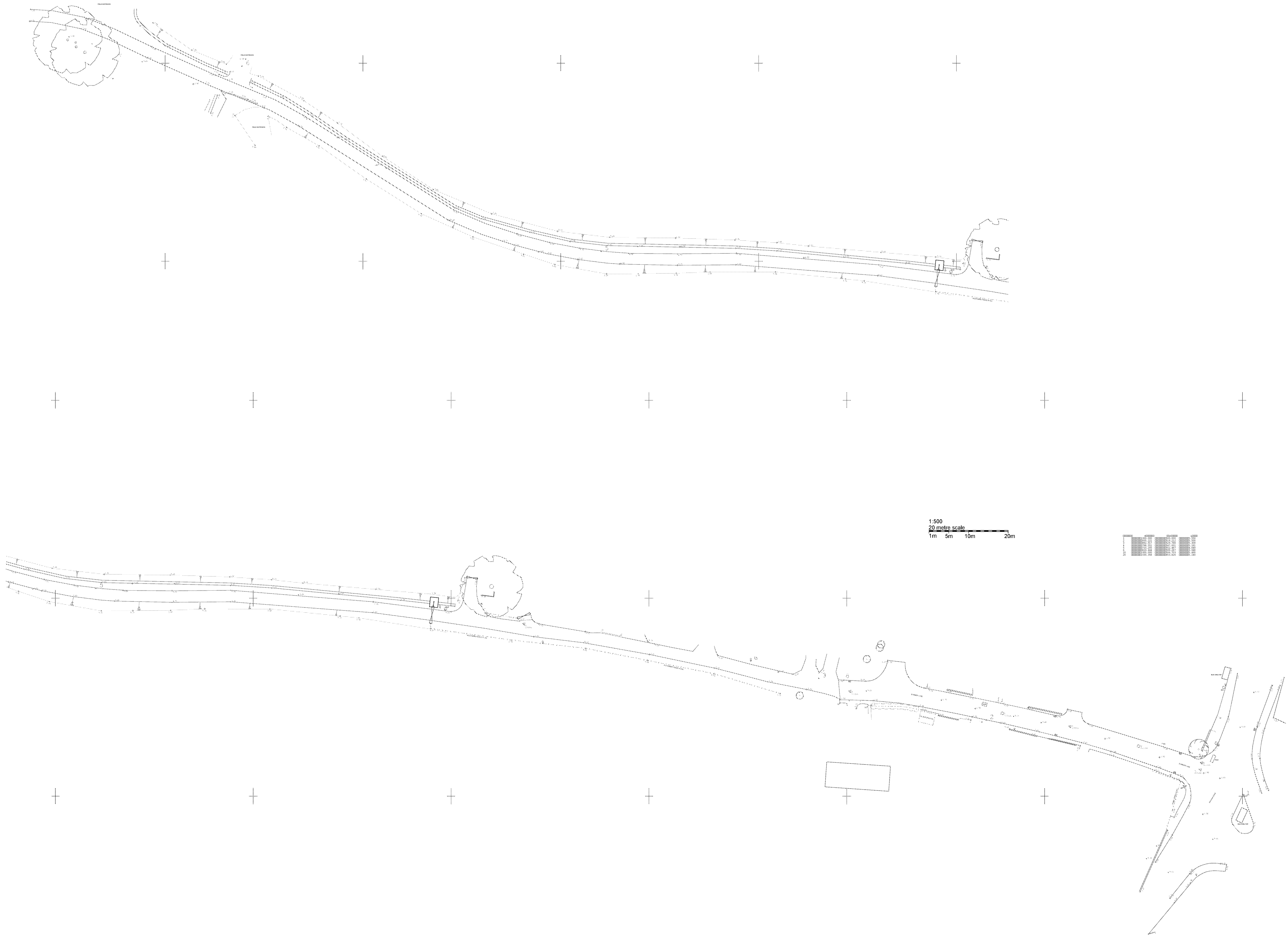
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		Unit E, Woodside 34 Parham Drive Eastleigh SO50 4NU t: 023 8081 1081 f: 023 8081 1012 w: siteline.co.uk	
HANBURY PROPERTIES LTD		Client	
LAND NORTH OF SUMMER LANE SUMMER LANE, PAGHAM		Contract	
LEVEL SURVEY		Title	
657PG01		Drawing No.	
JULY 2012		Date	
1:500 (A1)		Scale	
TL		Surveyor	



ADA Solutions Ltd

Land And Measured Building Surveyors

33 Lower Wardown, Petersfield, Hampshire, GU31 4PA
Tel: 01730 266303 Mob: 07775 835531
Email: sumon@adasolutionsltd.com



Address :

SUMMER LANE
PAGHAM ROAD
PAGHAM
WEST SUSSEX

Legend

CBF = Closed board fence
CH = Chalk to Head height
CLF = Chain-link Fence
F-C = Floor to C/L height
F-H = Fire Hydrant
F-W = Foul water inspection cover
G = Gully
GV = Gas valve
JB = Junction box
IC = Inspection cover
P&W = Post and wire fence
SDP = Soil down pipe
Sp = Spring height
SV = Service valve
SW = Storm water inspection cover
TAP = Water tap
TP = Telegraph pole
UTL = Unable to lift (inspection cover)
WM = Water meter

Symbols

⊗ = Floor level
⊞ = Structural ceiling height
⊝ = Suspended ceiling height

Drainage

Drainage details including pipe sizes and run direction between chamber been taken from surface inspection only, therefore are assumed and ca guaranteed.

Survey control information

Survey levels are based on OSMB height of 5.96m (NE face of The Bear

Horizontal control is arbitrary only and referenced to survey station 7 at 500m east and 1000m north and rotated to north.

A 50 metre site grid is in place

GPS/GPRS control:

N/A

This survey has been carried out at an accuracy commensurate with the scale shown on the title block of the drawing. Enlarging the drawing by digital means will not increase the accuracy of the survey. Taking dimensions from the drawing is generally not recommended and measurements for design/construction should be taken from the digital version only.

Client : Langmead Children's Farm Partnership

Date June 2014 Project: Topographical Survey

Drawing Number : 0614-HP2-T1

Drawn by : SA Checked: SA Scale: At A 1:500

SUMMER LANE (TOPOGRAPHICAL SURVEY

ARUN DISTRICT COUNCIL 19/02/14

Appendix (B)

Geotechnical Information (Extract)

11th June 2019

Our ref: GE17671/SA01/190611



Daniel O'Shea
Drew Smith Limited
Drew Smith House
Mill Court
The Sawmills
Durley
Southampton
Hampshire
SO32 2EJ

Dear Daniel,

RE: Summer Lane, Pagham, Bognor Regis, PO21 4NQ – Winter Groundwater Monitoring

We are pleased to present the results of the winter groundwater monitoring undertaken at the above site.

Eleven windowless sample boreholes (WS01 to WS11) were drilled on the 11th and 14th January 2019 to allow the installation of monitoring standpipes for winter groundwater level monitoring. Spot monitoring of the groundwater levels within these standpipes was undertaken on eight occasions between 16th January and 25th April 2019. Three additional boreholes (BH03, BH08 and BH10) were drilled on 4th February 2019 immediately adjacent to WS03, WS08 and WS10 and installed with large diameter monitoring standpipes to allow the use of in-situ continuous groundwater dataloggers. Continuous groundwater level dataloggers were installed within BH03, BH08 and BH10 from 5th February to 11th March 2019. The exploratory positions were located in line with instructions from Drew Smith Limited and access constraints at the time of investigation.

The ground conditions revealed within the boreholes are recorded in Geo-Environmental's letter report (GE17671-SA02-190128) which also details the results of the soakage testing previously carried out at the site.

Background

It is understood that the site is proposed to be developed with a residential development and associated infrastructure. As such, winter groundwater monitoring was required to assist in assessing the suitability of underlying soils for drainage via soakaways and to inform the planning, design and construction strategies for the site.

The ground conditions revealed in the exploratory holes at the site comprised River Terrace Deposits of clayey sand and sandy gravelly clay overlying clay soils of the London Clay Formation.

Site Description

At the time of the investigation works the site comprised a section of a large arable field in the west with a grass paddock with areas of trees and scrub in the east. The site appeared generally level. The western field was accessed from the west end of Summer Lane via a gap in the hedgerow. Access to the paddock was afforded by a grass track in the south-eastern corner of the site.

Geo-Environmental Services Ltd
Unit 7, Bannock Farm, Goshals Road, Haverhill, West Sussex BN6 9GL

Environmental Consultants | Geotechnical Engineers | Site Investigations

Geo-Environmental Services Ltd incorporated in England number 3214980 VAT number 679544479



Groundwater Monitoring

The results of the groundwater spot monitoring are summarised in Table 1.

Location	Minimum depth to groundwater (m bgl)	Maximum depth to groundwater (m bgl)
WS01	0.73	1.12
WS02	0.40	0.93
WS03	0.15	1.02
WS04	0.86	1.11
WS05	0.58	0.95
WS06	0.00	0.80
WS07	0.82	1.81
WS08	0.59	0.89
WS09	0.50	1.17
WS10	0.10	0.55
WS11	0.85	1.36

Table 1 Summary of groundwater depths from spot monitoring (January to April 2019)

The full results of the groundwater spot monitoring are presented within Appendix A.

Continuous groundwater level dataloggers were installed within BH03, BH08 and BH10 from 5th February to 11th March 2019. The results are presented graphically in Appendix B.

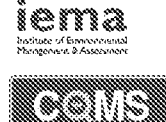
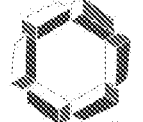
The results have been compared against rainfall observations recorded at Thorney Island weather station approximately 20 kilometres north-west of the site. During the monitoring period two periods of high precipitation occurred: a period of wet weather in the days surrounding 7th February where 13mm of rainfall was recorded; and wet weather between 4th March (16mm rainfall) and 10th March (10mm rainfall).

The groundwater levels over the monitoring period show groundwater at a peak during the first rainfall event, then reducing to a relatively steady level before peaking in response to the second rainfall event.

The time taken for the groundwater level in BH03 to recover following the February rainfall event was approximately 14 days with an approximate decrease of 0.40m. The levels in BH08 took approximately 13 days, dropping approximately 0.25m. Within BH10 the fall in water level took approximately 15 days for an approximate 0.30m drop in water level. The response to the March rainfall event starting on 4th March appears to be less than 12 hours for all of the boreholes with increases in water level of approximately 0.50m, 0.25m and 0.25m for BH03, BH08 and BH10 respectively. The data also shows some evidence of the potential tidal effect on groundwater levels with daily variance in levels of up to 0.05m on some occasions.

Conclusions

The monitoring undertaken indicates that the winter groundwater levels at the site are likely to interfere with the effective performance of conventional stormwater soakaways. As a result, on-site storage and attenuation together with alternative storm water disposal options should be considered.



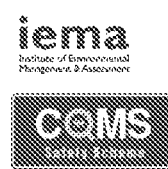
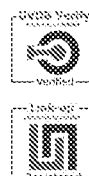
Closure

We trust that we have interpreted your instructions correctly, and please do not hesitate to contact us should you have any queries.

Yours sincerely
For and on Behalf of Geo-Environmental

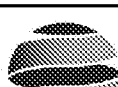

SHAUN ARMITAGE BSc (Hons), FGS
Senior Consulting Engineer


Enc Figure 1 Site Location Plan
 Figure 2 Exploratory Hole Location Plan
 Appendix A Winter Groundwater Monitoring Results
 Appendix B Continuous Groundwater Monitoring Results





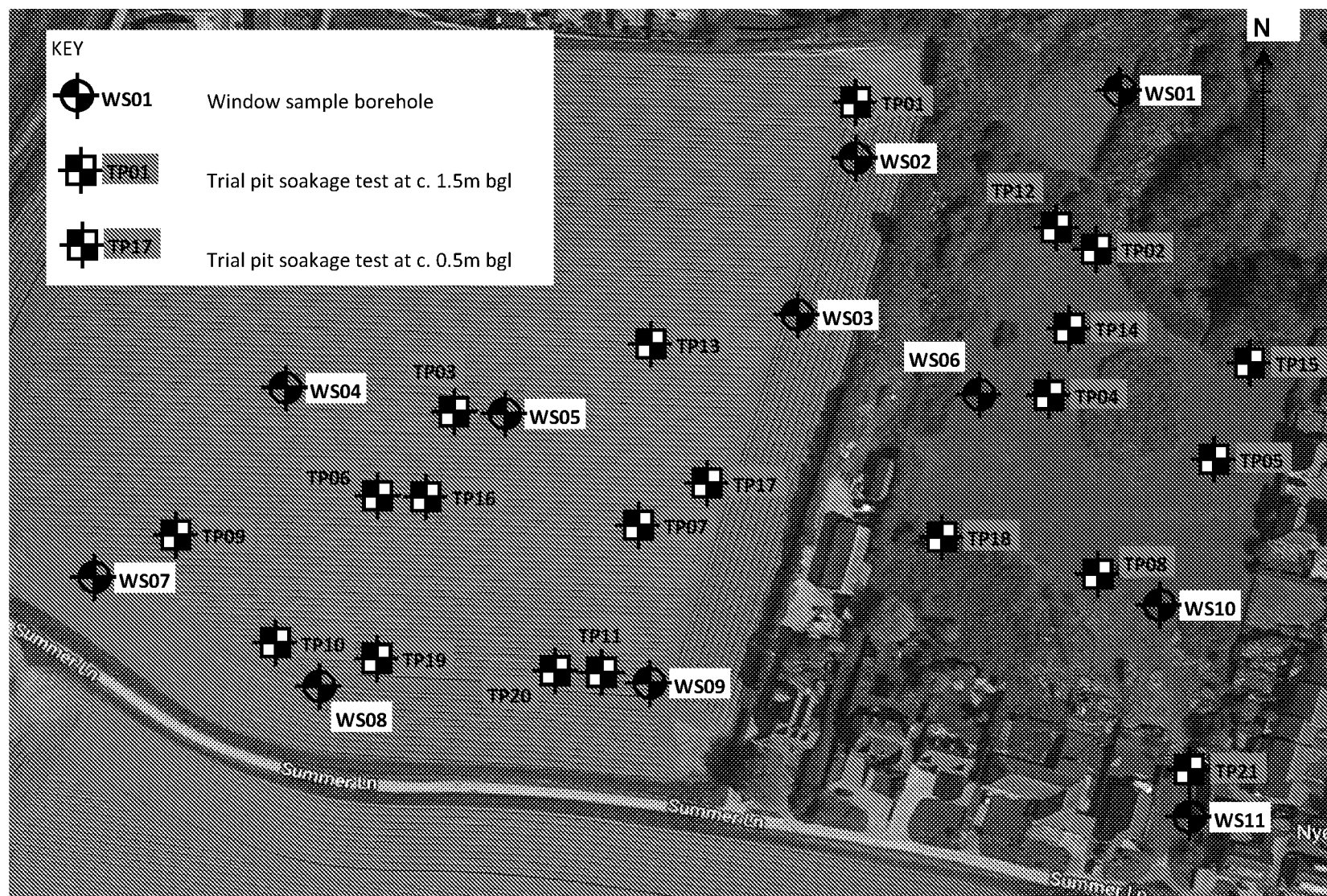
Project:	Summer Lane, Pagham, Bongor Regis, PO21 4NQ			Title	Site Location Plan	
Client:	Drew Smith Limited			Geo-Environmental Services Ltd Unit 7 Danworth Farm, Cuckfield Road Hurstpierpoint, West Sussex BN6 9GL +44(0)1273 832972 www.gesl.net		
Ref No:	GE17671	Revision:	0			
Drawn:	SA	Date:	07/01/2019			
Figure:	1	Scale:	Not To Scale			



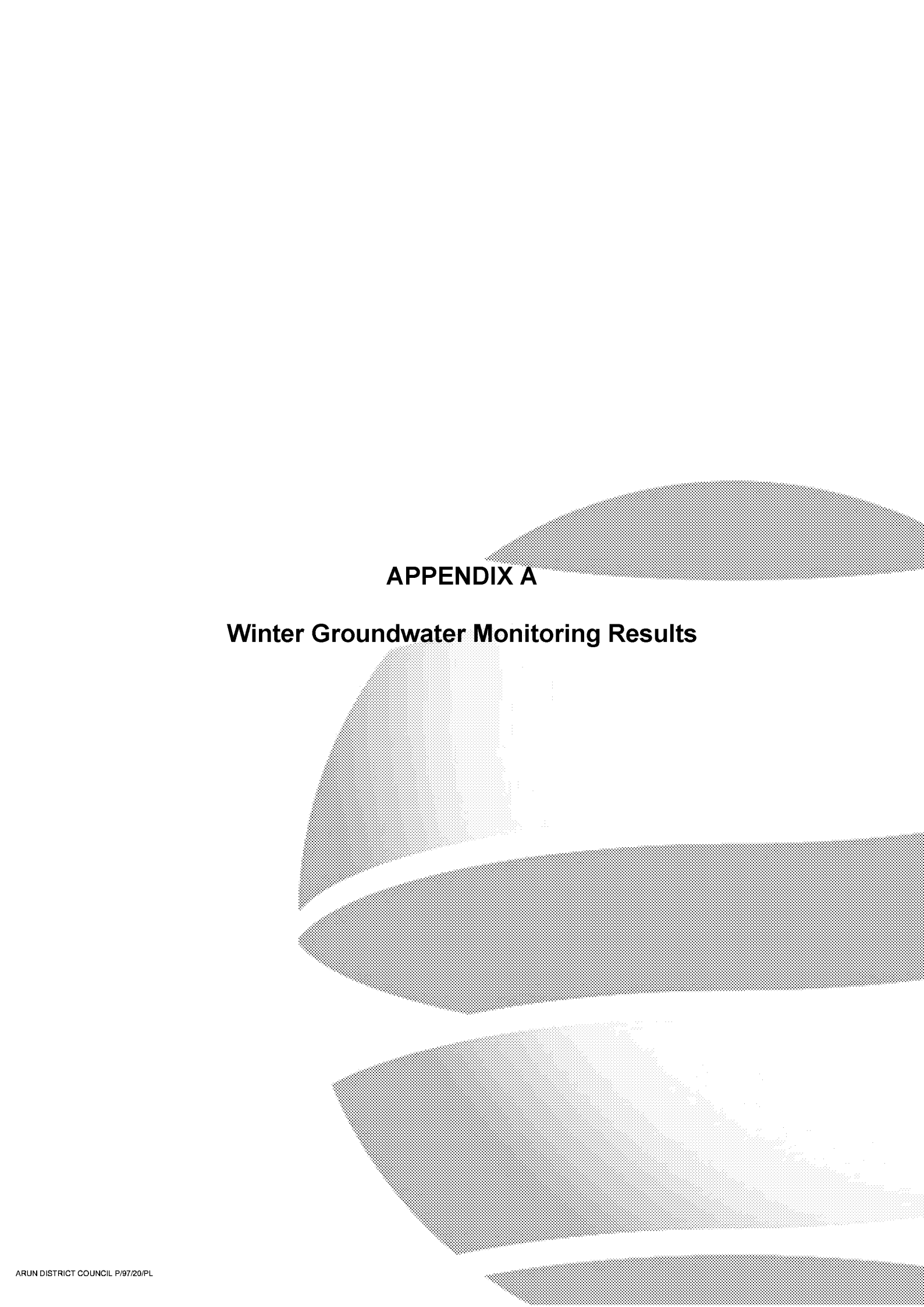
Geo-Environmental



Geo-Environmental



Project:	Summer Lane, Pagham, Bongor Regis, PO21 4NQ			Title	Exploratory Hole Location Plan	
Client:	Drew Smith Limited			Geo-Environmental Services Ltd Unit 7 Danworth Farm, Cuckfield Road Hurstpierpoint, West Sussex BN6 9GL +44(0)1273 832972 www.gesl.net	 Geo-Environmental	
Ref No:	GE17671	Revision:	0			
Drawn:	SA	Date:	23/01/2019			
Figure:	2	Scale:	Not To Scale			



APPENDIX A

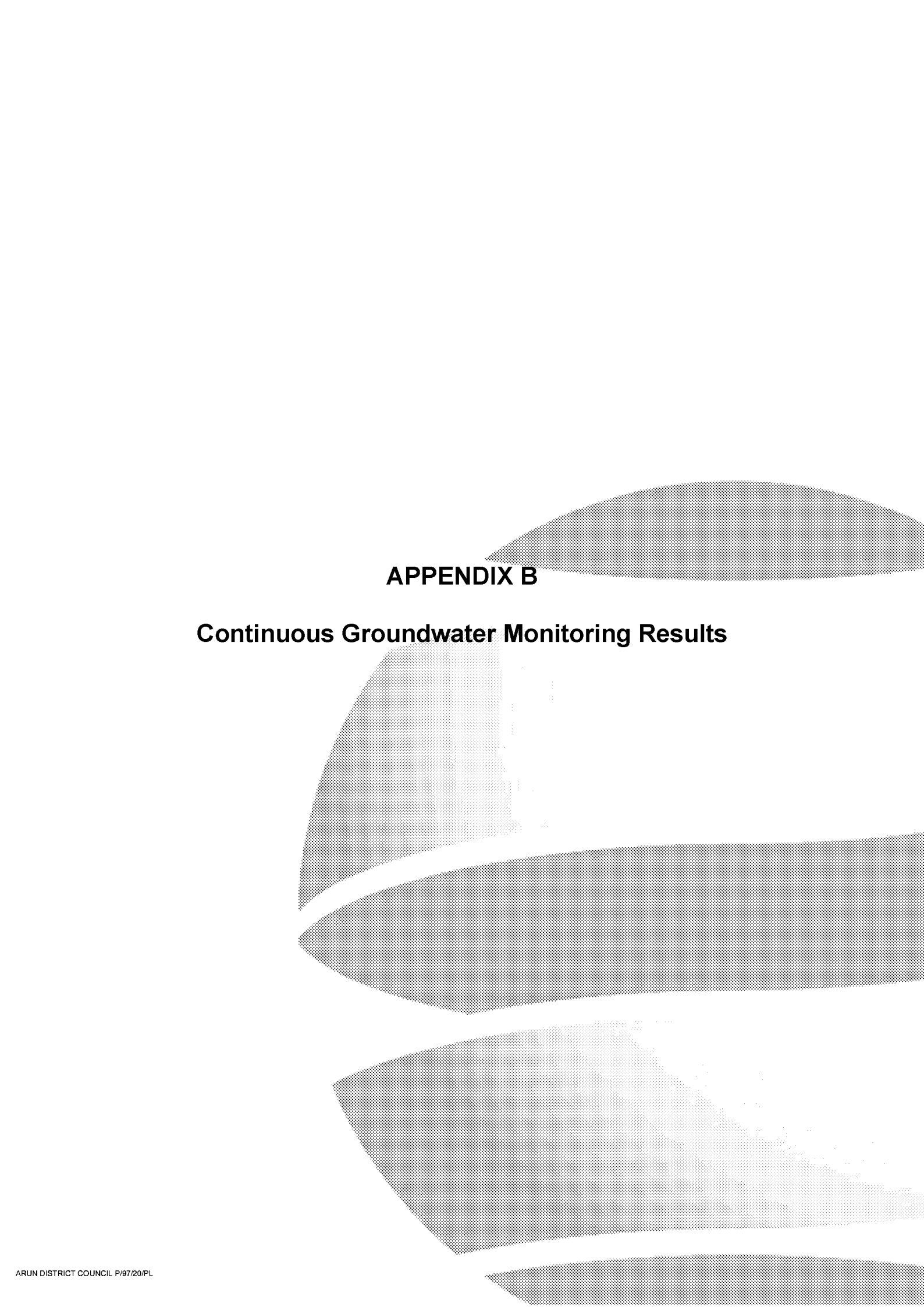
Winter Groundwater Monitoring Results

Project: Summer Lane, Pagham, Bognor Regis.
Ref: GE17671
Client: Drew Smith Limited

Location	Date	GWL (m bgl)
WS01	16/01/19	1.07
WS02	16/01/19	0.80
WS03	16/01/19	0.76
WS04	16/01/19	1.00
WS05	16/01/19	0.88
WS06	16/01/19	0.52
WS07	16/01/19	1.53
WS08	16/01/19	0.83
WS09	16/01/19	0.99
WS10	16/01/19	0.42
WS11	16/01/19	1.32
WS01	04/02/19	0.88
WS02	04/02/19	0.62
WS03	04/02/19	0.42
WS04	04/02/19	0.86
WS05	04/02/19	0.63
WS06	04/02/19	0.32
WS07	04/02/19	1.32
WS08	04/02/19	0.65
WS09	04/02/19	0.59
WS10	04/02/19	0.10
WS11	04/02/19	0.97
WS01	13/02/19	0.80
WS02	13/02/19	0.40
WS03	13/02/19	0.22
WS04	13/02/19	0.97
WS05	13/02/19	0.65
WS06	13/02/19	0.07
WS07	13/02/19	0.82
WS08	13/02/19	0.70
WS09	13/02/19	0.52
WS10	13/02/19	0.15
WS11	13/02/19	1.13
WS01	28/02/19	1.02
WS02	28/02/19	0.74
WS03	28/02/19	0.67
WS04	28/02/19	1.01
WS05	28/02/19	0.85
WS06	28/02/19	0.30
WS07	28/02/19	1.50
WS08	28/02/19	0.79
WS09	28/02/19	0.86
WS10	28/02/19	0.36
WS11	28/02/19	1.26

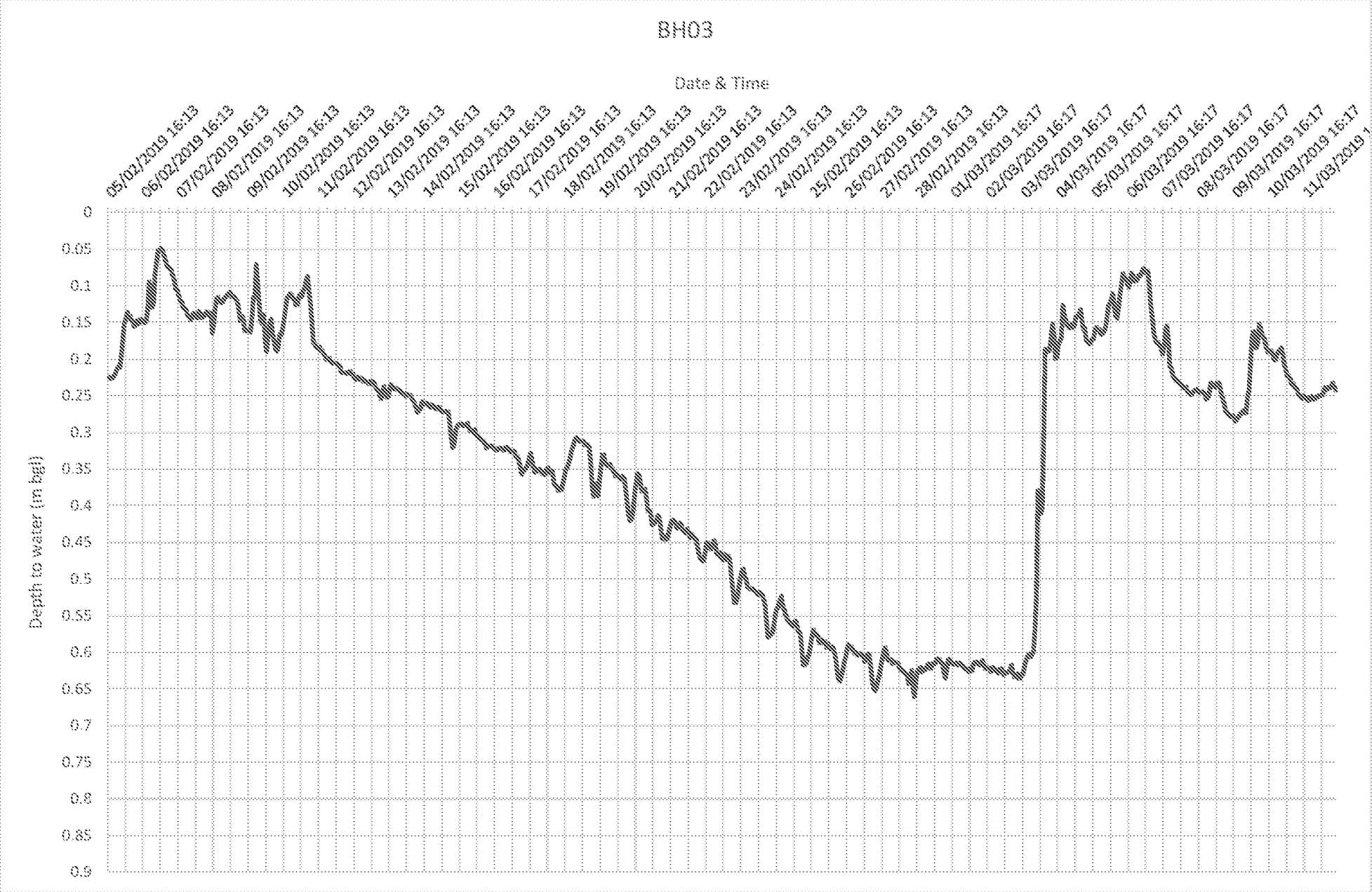
Project: Summer Lane, Pagham, Bognor Regis.
Ref: GE17671
Client: Drew Smith Limited

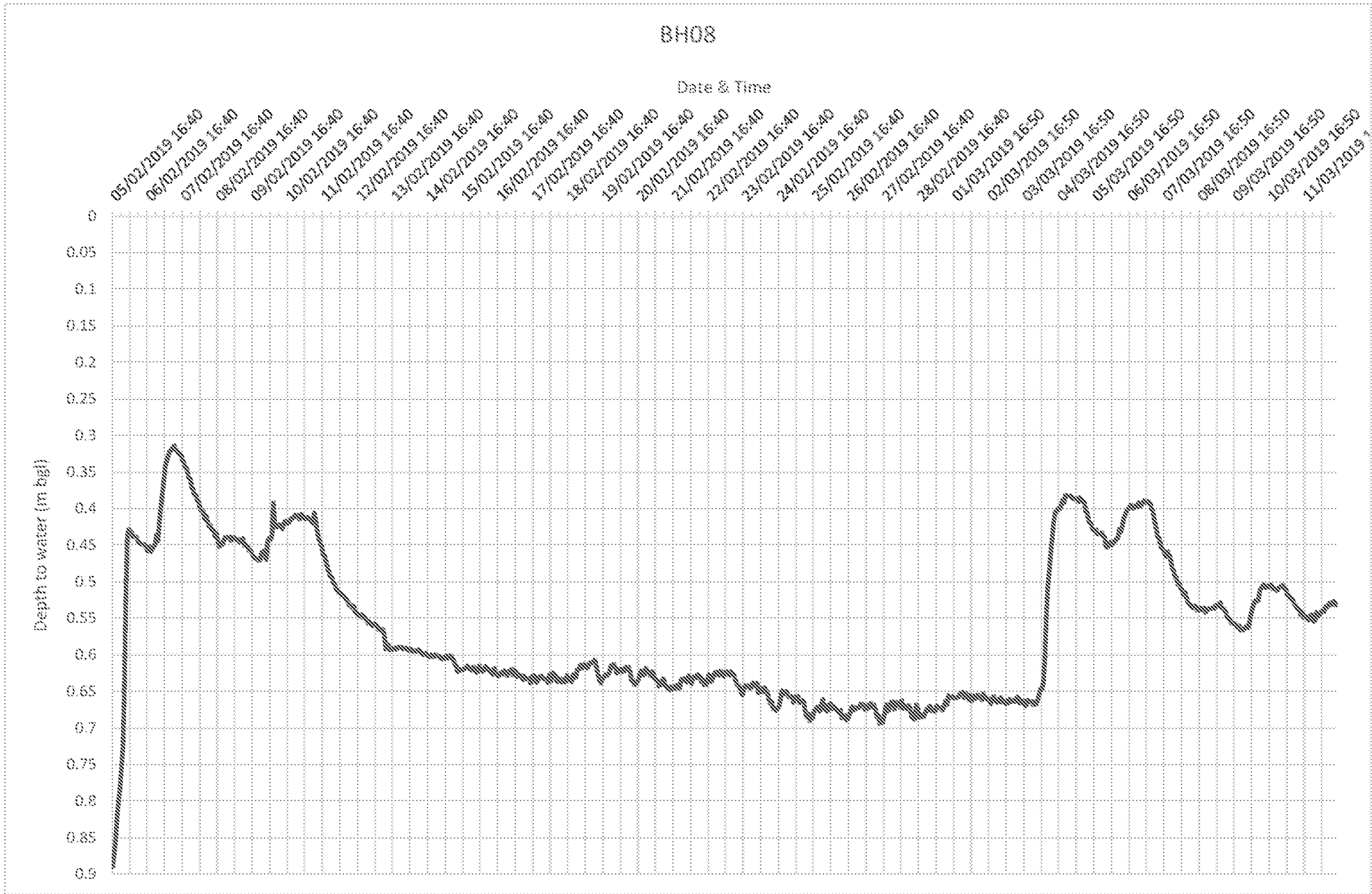
Location	Date	GWL (m bgl)
WS01	12/03/19	0.73
WS02	12/03/19	0.42
WS03	12/03/19	0.15
WS04	12/03/19	0.94
WS05	12/03/19	0.58
WS06	12/03/19	0.00
WS07	12/03/19	1.02
WS08	12/03/19	0.59
WS09	12/03/19	0.50
WS10	12/03/19	0.21
WS11	12/03/19	0.85
WS01	29/03/19	1.03
WS02	29/03/19	0.78
WS03	29/03/19	0.74
WS04	29/03/19	1.01
WS05	29/03/19	0.85
WS06	29/03/19	0.51
WS07	29/03/19	1.49
WS08	29/03/19	0.76
WS09	29/03/19	0.88
WS10	29/03/19	0.48
WS11	29/03/19	1.29
WS01	11/04/19	1.09
WS02	11/04/19	0.88
WS03	11/04/19	0.91
WS04	11/04/19	1.05
WS05	11/04/19	0.91
WS06	11/04/19	0.66
WS07	11/04/19	1.68
WS08	11/04/19	0.85
WS09	11/04/19	1.15
WS10	11/04/19	0.53
WS11	11/04/19	1.30
WS01	25/04/19	1.12
WS02	25/04/19	0.93
WS03	25/04/19	1.02
WS04	25/04/19	1.11
WS05	25/04/19	0.95
WS06	25/04/19	0.80
WS07	25/04/19	1.81
WS08	25/04/19	0.89
WS09	25/04/19	1.17
WS10	25/04/19	0.55
WS11	25/04/19	1.36
Max values		1.81
Min Vaules		0.00

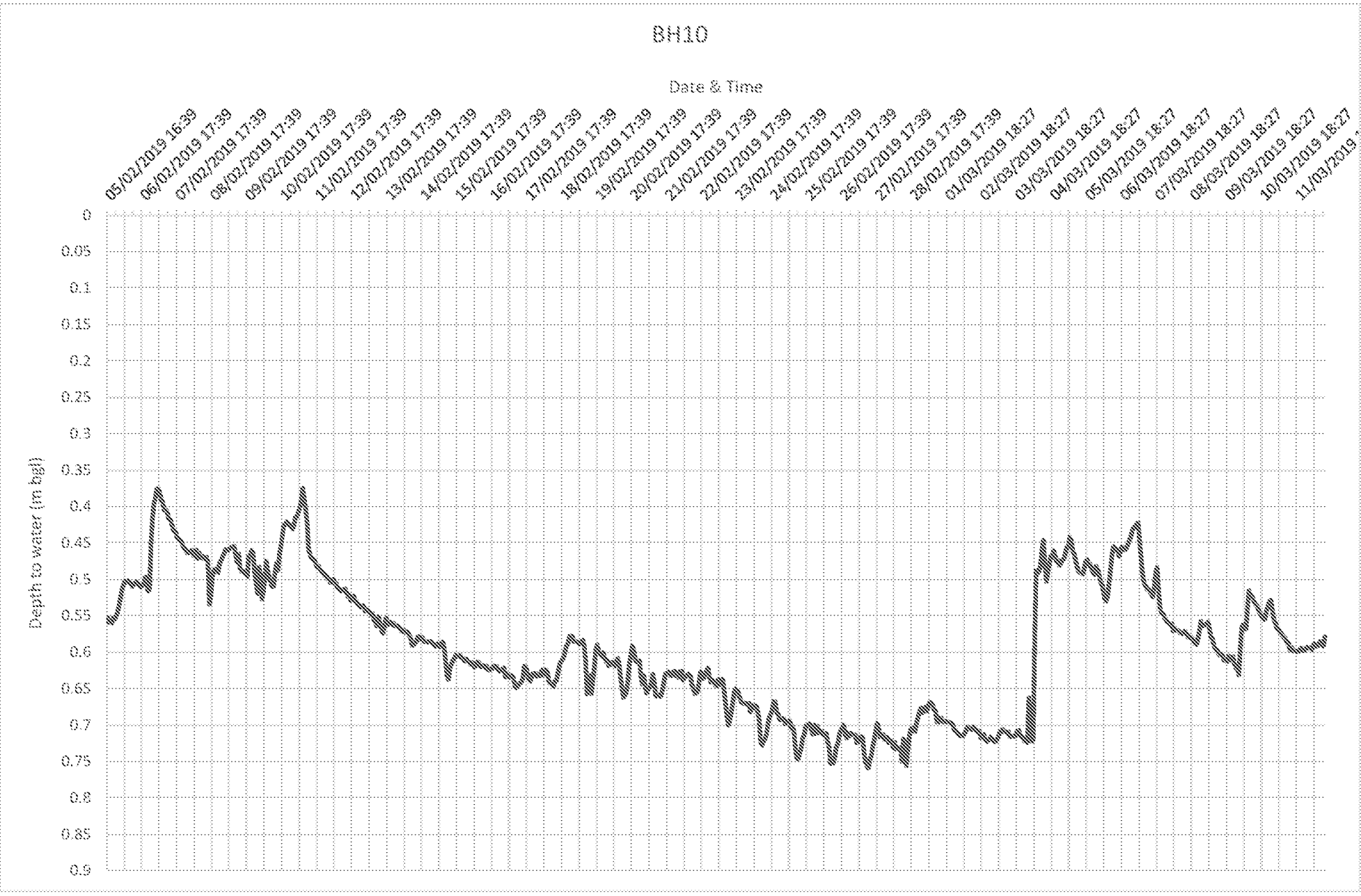


APPENDIX B

Continuous Groundwater Monitoring Results







28th January 2019

Our ref: GE17671/SA02/190128



Daniel O'Shea
Drew Smith Limited
Drew Smith House
Mill Court
The Sawmills
Durley
Southampton
Hampshire
SO32 2EJ

Dear Daniel,

RE: Summer Lane, Pagham, Bognor Regis, PO21 4NQ – Soakage Testing

We are pleased to present the results of the soakage testing undertaken at the above site. The soakage tests were undertaken broadly in accordance with BRE Digest 365 'Soakaway Design' BRE, 2016 with the testing limited to three consecutive days.

A geo-environmental engineer attended site on the 11th, 14th, 15th and 16th January 2019 to undertake the intrusive investigation. A total of twenty-one full scale soakage tests (TP01 to TP21) were undertaken within trial pits. Eleven windowless sample boreholes (WS01 to WS11) were also drilled during the works to allow the installation of monitoring standpipes for winter groundwater level monitoring. The exploratory positions were located in line with instructions from Drew Smith Limited and access constraints at the time of investigation.

Background

It is understood that the site is proposed to be developed with a residential development and associated infrastructure. As such, soakage testing is required to confirm the suitability of underlying soils for drainage via soakaways and to inform the planning, design and construction strategies for the site.

Published geological records indicate that the ground conditions were likely to comprise River Terrace Deposits overlying London Clay Formation.

Site Description

At the time of the investigation works the site comprised a section of a large arable field in the west with a grass paddock with areas of trees and scrub in the east. The site appeared generally level. The western field was accessed from the west end of Summer Lane via a gap in the hedgerow. Access to the paddock was afforded by a grass track in the south-eastern corner of the site.

Ground Conditions

The ground conditions encountered were relatively consistent with those anticipated from published geological maps, i.e. a thickness of Topsoil and/or Made Ground overlying River Terrace Deposits in turn overlying London Clay. A generalised summary of the encountered conditions is presented in Table 1.

Geo-Environmental Services Ltd
Unit 2 Danworth Farm, Cuckfield Road, Hurrstierpoint, West Sussex BN6 9GL

Environmental Consultants | Geotechnical Engineers | Site Investigations

Geo-Environmental Services Ltd incorporated in England number 3214980 VAT number 679544479



Top (m bgl)	Base (m bgl)	Geology
0	0.10 – 0.30	TOPSOIL: Brown CLAY with varying proportions of silt and gravel with occasional or frequent rootlets. (All locations except TP02 and TP12).
0 – 0.10	0.10 – 0.20	MADE GROUND: Brown silty clay with rubbish and brown gravelly clay with brick. (TP02, TP04 and TP12 only).
0.10 – 0.30	1.90 – 3.00+	RIVER TERRACE DEPOSITS (CLAY): Typically CLAY with medium or high proportions of sand and gravel. Silty CLAY and CLAY with no secondary constituents occasionally encountered. The clay soils appeared visually desiccated to depths between 0.40m and 0.70m bgl. (All locations).
1.10 – 2.00	1.40 – 3.00+	RIVER TERRACE DEPOSITS (SAND): Thicknesses of clayey SAND, clayey gravelly SAND and gravelly SAND soils frequently encountered at depths greater than 1.50m bgl. (TP08, TP11, WS01 to WS06 and WS08 to WS11).
1.90 – 2.80	3.00+	LONDON CLAY FORMATION: CLAY or slightly sandy CLAY. (WS02 to WS04 and WS07 to WS11).

Table 1 Summary of Ground Conditions

Groundwater was encountered during the investigation as shown in Table 2.

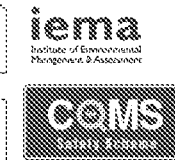
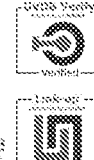
Location	Depth to groundwater (m bgl)	Comment
TP01	1.50	Rose to 1.49m bgl
TP03	1.34	
TP05	1.50	Rose to 1.40m bgl
TP06	1.50	
TP07	1.38	
TP08	1.40	Rose to 1.33m bgl
TP10	1.60	
TP11	1.45	
WS01	1.65	
WS02	1.30	
WS03	1.30	
WS04	1.30	
WS05	1.30	
WS06	1.05	
WS07	1.30	
WS08	1.30	
WS09	1.30	
WS10	1.05	
WS11	1.50	

Table 2 Summary of Groundwater Strikes

For full details of the ground conditions encountered, reference should be made to the exploratory hole logs presented within Appendix A.

Soakage Testing

Soakage testing was undertaken broadly in accordance with BRE Digest 365 Soakaway Design in all twenty-one trial pits with the exception of TP03, TP06 and TP10 where the trial pit walls collapsed and testing was abandoned. Testing was undertaken in TP01 to TP11 at depths between 1.33m and 1.50m bgl, suitable for likely proposed



conventional stormwater soakaways. Testing in TP12 to TP21 was undertaken at depths between 0.44m and 0.70m bgl, suitable for any proposed permeable pavement.

During the testing in TP01 to TP11 and TP13-TP14 the fall in water level during the test period was insufficient to calculate a rate of infiltration. Test periods ranged between 20 and 48 hours, unless water levels were noted to be increasing during testing as in TP02, TP04 and TP05. Infiltration rates within the remaining shallow soils (TP12 and TP15 to TP21) ranged between $9.5 \times 10^{-7} \text{m/s}$ and $1.1 \times 10^{-5} \text{m/s}$, however in some instances the time taken to complete the tests was such that it was not possible to undertake three complete fillings in some locations. The results of the testing are summarised in Table 2 below. The full soakage test results are presented within Appendix B.

Location	Permeability (m/s)			Test Depth (m)	Comments
	Test 1	Test 2	Test 3		
TP01	-	-	-	1.49*	Insufficient fall in water to complete test
TP02	-	-	-	1.50	
TP03	-	-	-	1.34*	Trial pit collapsed during testing
TP04	-	-	-	1.58*	Insufficient fall in water to complete test
TP05	-	-	-	1.40*	
TP06	-	-	-	-	Trial pit collapsed during testing
TP07	-	-	-	1.38*	Insufficient fall in water to complete test
TP08	-	-	-	1.33	
TP09	-	-	-	1.35	
TP10	-	-	-	-	Trial pit collapsed during testing
TP11	-	-	-	1.45*	Insufficient fall in water to complete test
TP12	1.9×10^{-6}	-	-	0.63	
TP13	-	-	-	0.70	Insufficient fall in water to complete test
TP14	-	-	-	0.60	Infiltration ceased in Test 1
TP15	1.1×10^{-5}	4.9×10^{-6}	4.1×10^{-6}	0.55	Test 3 based on data extrapolation
TP16	1.4×10^{-6}	-	-	0.67	Based on data extrapolation
TP17	5.5×10^{-6}	1.8×10^{-6}	1.5×10^{-6}	0.60	Test 3 based on data extrapolation
TP18	1.2×10^{-6}	-	-	0.50	
TP19	2.0×10^{-6}	1.9×10^{-6}	-	0.55	Infiltration ceased in Test 3
TP20	1.7×10^{-6}	1.3×10^{-6}	9.5×10^{-7}	0.55	Test 2 & 3 based on data extrapolation
TP21	8.9×10^{-6}	9.1×10^{-6}	-	0.44	Infiltration ceased in Test 3

Note: *indicates test carried out at groundwater level

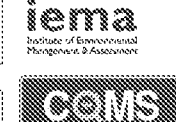
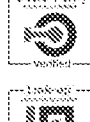
Table 2 Soakage Test Results

Winter Groundwater Monitoring

Groundwater level monitoring within the borehole standpipes installed in WS01 to WS11 is proposed to be undertaken between January and April 2019, the results of which will be reported under separate cover.

Conclusions

The testing undertaken indicates that the soils at the site are unlikely to be suitable for stormwater drainage via conventional soakaways owing to the presence of cohesive soils, clayey granular soils and the presence of groundwater. As a result, on-site storage and attenuation together with alternative storm water disposal options should be considered.





The shallow soils at the site were shown to be moderately permeable in the majority of locations tested therefore permeable paving may be an effective component in the site drainage scheme for storage and peak flow attenuation.

Closure

We trust that we have interpreted your instructions correctly, and please do not hesitate to contact us should you have any queries.

Yours sincerely

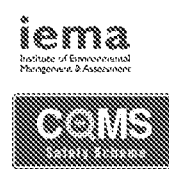
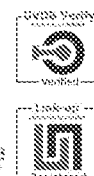
Shaun Armitage BSc (Hons), FGS, Geo-Environmental



SHAUN ARMITAGE BSc (Hons), FGS
Senior Consulting Engineer



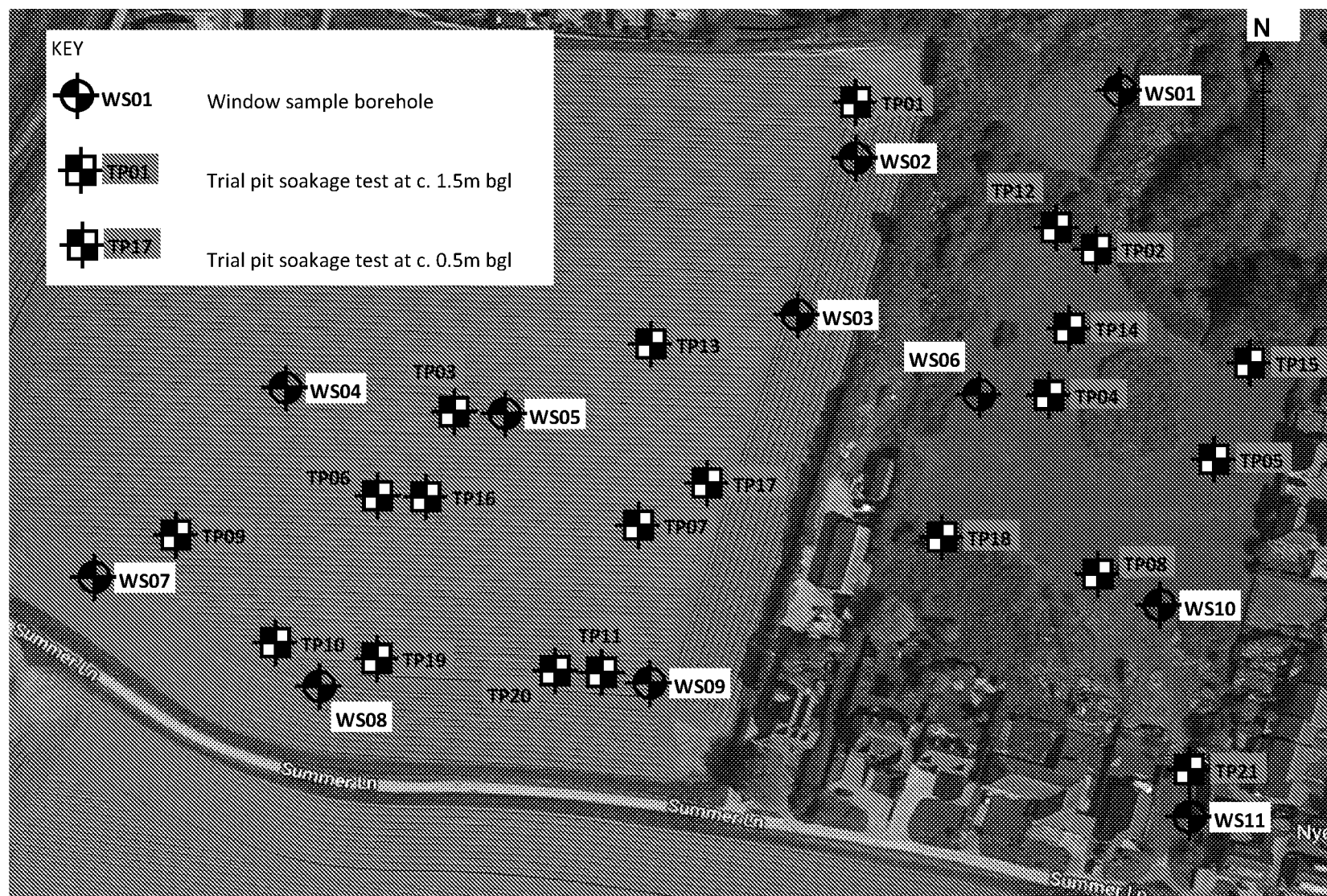
Enc	Figure 1	Site Location Plan
	Figure 2	Exploratory Hole Locations Plan
	Appendix A	Exploratory Hole Logs
	Appendix B	Soakage Test Results



FIGURES



Project:	Summer Lane, Pagham, Bongor Regis, PO21 4NQ			Title	Site Location Plan	
Client:	Drew Smith Limited			Geo-Environmental Services Ltd Unit 7 Danworth Farm, Cuckfield Road Hurstpierpoint, West Sussex BN6 9GL +44(0)1273 832972 www.gesl.net	 Geo-Environmental	
Ref No:	GE17671	Revision:	0			
Drawn:	SA	Date:	07/01/2019			
Figure:	1	Scale:	Not To Scale			



Project:	Summer Lane, Pagham, Bongor Regis, PO21 4NQ			Title	Exploratory Hole Location Plan	
Client:	Drew Smith Limited			Geo-Environmental Services Ltd Unit 7 Danworth Farm, Cuckfield Road Hurstpierpoint, West Sussex BN6 9GL +44(0)1273 832972 www.gesl.net	 Geo-Environmental	
Ref No:	GE17671	Revision:	0			
Drawn:	SA	Date:	23/01/2019			
Figure:	2	Scale:	Not To Scale			