UNIVERSITY OF CHICHESTER EDTP - BOGNOR CAMPUS

FLOOD RISK ASSESSMENT

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WSP | PARSONS BRINCKERHOFF

ARUN DISTRICT COUNCIL BR/54/16/PL

UNIVERSITY OF CHICHESTER EDTP - BOGNOR CAMPUS

FLOOD RISK ASSESSMENT

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EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) has been prepared as part of the supporting documentation for the detailed planning application of a Proposed Development at the University of Chichester Engineering and Digital Technology Park (EDTP) – Bognor Campus.

The FRA has been prepared by WSP | Parsons Brinckerhoff on behalf of the University of Chichester in accordance with the guidelines set out in the National Planning Policy Framework (NPPF) as far as is applicable at this stage of the Proposed Development.

The Application Site is located north of Upper Bognor Road and west of Felpham Way in Bognor Regis, West Sussex. The Ordnance Survey (OS) grid reference for the Application Site is 494427, 99622 and the nearest postcode is PO21 1HP.

The Proposed Development provides an engineering and media facility and residential student accommodation on the University of Chichester's Bognor Campus. This will comprise a new Engineering and Digital Techology building, residential student accommodation and associated car parking. The proposed illustrative masterplan has been produced by Lizard Landscape Design in February 2016 (Drawing no. LLD913/01).

The Application Site covers an area of approximately 3.14 hectares (ha) and is classified as a Greenfield site. The Application Site is currently open land for the vast majority of the area, with some trees throughout the site.

The Application Site is wholly located in Flood Zone 3. This area of flood zone is associated with tidal flooding and not flooding from the river to the east of the Site. This mapping shows the flood risk without the presence of flood defences. The site is protected by coastal defences that are owned and maintained by the Environment Agency.

The Proposed Development is classified as 'More Vulnerable' to flooding in the National Planning Policy Framework – Planning Practice Guidance. Therefore the exception test will need to be satisfied for the proposed development to be acceptable in Flood Zone 3.

The Environment Agency has confirmed that they have no records of previous flood events affecting this site.

West Sussex County Council has confirmed that they have no records within the confines of the Application Site. The area around the site was affected by storms in June 2012, when the storm return period for the event was in excess of the normal design capacity for the surface water system.

Southern Water has confirmed that they do not hold any flood risk data for this area.

The current risk of flooding to the Application Site and the risk of the Proposed Development exacerbating flood risk to neighbouring properties, prior to the implementation of mitigation measures, from the various sources of flood risk are detailed in Table 0.1.

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Table 9-1: Summary of Flood Risk to and from the Application Site / Proposed Development

Sources of flood risk	Current risk to the application site	Risk of the proposed development exacerbating flood risk
Coastal and tidal	Moderate	Low
Fluvial	Moderate	Moderate
Pluvial and overland flow	Moderate	Moderate
Groundwater	Low	Low
Sewer and drainage infrastructure	Low	Low
Artificial Sources	Negligible	Negligible

Risk to the Proposed Development is considered to be moderate for coastal, fluvial and pluvial/overland flow sources. Coastal risk is shown as moderate during an undefended scenario, however the policy for the next 100 years for the relevant policy unit (Felpham to Aldwick – Unit 23) of the Beachy Head to Selsey Shoreline Management Plan (SMP) is to 'Hold the Line' of the existing defences.

The area of moderate fluvial and surface water flood risk is located adjacent to the ordinary watercourse running through the site, where it is proposed to place student accommodation and car parking. The inclusion of built development within these risk areas poses a risk to the Proposed Development and neighbouring properties. As such, mitigation measures will be included in the design of the structures and the drainage strategy for the Proposed Development.

The risk of the Proposed Development exacerbating flood risks from groundwater and sewer infrastructure to neighbouring property is assessed to be negligible. Therefore no mitigation measures are considered necessary for inclusion within the Proposed Development for these sources.

To mitigate the risk of the Proposed Development exacerbating flood risks to neighbouring property from fluvial and surface water sources it is proposed to raise the buildings within the flood risk areas with a void set at 300mm above the 1% annual probability event plus an allowance for climate change flood level. In conjunction with this, it is proposed to utilise a SuDS management train for surface water drainage in accordance with the SuDS Manual[1].

Given the geology of the site, and high groundwater levels, it is anticipated that it will not be possible to discharge surface water to ground. Surface water generated through the increase of impermeable areas will be limited to the mean annual maximum greenfield runoff rate (Q_{bar}) before being discharged into the ordinary watercourse.

It is proposed that a combination of porous asphalt, swales, a wetland area, a small pond and underground storage tanks are incorporated across the Site to store water prior to discharging it to the ordinary watercourse.

Safe and dry access will be provided for the Proposed Development via the central bridge and associated walkways over the watercourse and via the main University entrance on Upper Bognor Road.

[1] CIRIA, 2015, *The SuDS Manual (C753)*

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1 INTRODUCTION

1.1 APPOINTMENT AND BRIEF

1.1.1 WSP | Parsons Brinckerhoff was commissioned by the University of Chichester to prepare a site specific Flood Risk Assessment (FRA) and Drainage Strategy for a Proposed Development at the University of Chichester, Bognor Campus, Bognor Regis.

1.2 AIM AND OBJECTIVES

1.2.1 The aim of this NPPF compliant FRA is to identify flood risks to the Application Site and those that may arise as a result of the Proposed Development. Where risks are identified, mitigation measures are proposed to manage the risks over the lifetime of the development, accounting for the effects of climate change. This includes presentation of an outline surface water drainage strategy for the Proposed Development.

1.2.2 To achieve this aim the following objectives have been met:

- A desk study and data research including review of:
  - The National Planning Policy Framework (NPPF);
  - The NPPF Flood Risk and Coastal Change Planning Practice Guidance (PPG);
  - Development and Flood Risk – Guidance for the Construction Industry (CIRIA C624), CIRIA, 2004;
  - Non-statutory technical standards for sustainable drainage systems, DEFRA 2015;
  - The SuDS Manual (CIRIA C793), CIRIA 2015;
  - Arun District Council Local Plan (2003);
  - Arun District Council Supplementary Requirements for Surface Water Drainage Proposals (2015);
  - Arun District Council Strategic Flood Risk Assessment, February 2008;
  - West Sussex Preliminary Flood Risk Assessment (PFRA), May 2011;
  - West Sussex Local Flood Risk Management Strategy (LFRMS), May 2014;
  - Beachy Head to Selsey Bill Shoreline Management Plan (SMP), May 2006; and
  - Arun and Western Streams Catchment Flood Management Plan (CFMP), December 2009.
- Consultation with regulatory bodies and third parties, including:
  - The Environment Agency;
  - West Sussex County Council; and
  - Southern Water.

  (Copies of correspondence exchanged with these stakeholders are provided in Appendix C).
- An assessment of flooding to the Application Site and Proposed Development from all possible sources, including fluvial, pluvial, groundwater, sewers and man-made infrastructure.
- An assessment of the impact of the Proposed Development on local flood risks.
- An assessment of the residual flood risk to the Proposed Development and neighbouring property from local flood sources.

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- Estimation of surface water flows based on current conditions at the Application Site and existing drainage systems.

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2 POLICY

2.1 NATIONAL POLICY

NATIONAL PLANNING POLICY FRAMEWORK (NPPF)

2.1.1 The NPPF[2] states that a 'site specific flood risk assessment' is required for proposals of 1 hectare (ha) or greater in Flood Zone 1; all proposals for new development (including minor development and change of use in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency), and where Proposed Development or change of use to a more vulnerable class may be subject to other sources of flooding.'

2.1.2 The Environment Agency Flood Map indicates that the majority of the Application Site is situated within Flood Zone 3. The Application Site has a gross area of 3.14ha.

2.1.3 Within Table 2 (Flood Risk Vulnerability Classification) of the NPPF Flood Risk and Coastal Change Planning Practice Guidance[3], the Proposed Development (residential) is classified as 'More Vulnerable'.

2.1.4 Table 3 (Flood Risk Vulnerability and Flood Zone Compatibility) of the NPPF Flood Risk and Coastal Change Planning Practice Guidance, states that 'More Vulnerable' development requires the Exception Test to be undertaken.

NON-STATUTORY SUSTAINABLE DRAINAGE TECHNICAL STANDARDS (MARCH, 2015)

2.1.5 The Non-Statutory Sustainable Drainage Technical Standards document sets out the technical standards for sustainable drainage systems.

2.1.6 The standards state that for greenfield developments the peak runoff rate from the development to any highway drain, sewer or surface water body for the 100% annual probability rainfall event and 1% annual probability rainfall event should never exceed the peak greenfield runoff rate for the same event.

2.1.7 Where is it reasonably practicable for Greenfield developments the runoff volume from the development to any highway drain, sewer or surface water body in the 100% annual probability, 6 hour rainfall event should never exceed the Greenfield runoff volume for the same event. If this is not practicable the runoff volume must be discharged at a rate that does not adversely affect flood risk.

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[2] National Planning Policy Framework (2012) Communities and Local Government - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf - accessed in July 2015

[3] Flood Risk and Coastal Change Planning Practice Guidance to the National Planning Policy Framework (2014) Department for Communities and Local Government - http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/ - accessed July 2015

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2.1.8 The drainage system must be designed so that unless an area is designated to hold and / or convey water as part of the design, flooding does not occur on any part of the site for a 3.33% annual probability rainfall event, and flooding does not occur during a 1% annual probability year rainfall event in any part of a building or utility plant susceptible to water. The design of the site must ensure that where reasonably practicable flows resulting from a rainfall in excess of a 1% annual probability rainfall event are managed in exceedance routes that minimise risks to people and property.

2.1.9 Components must be designed to ensure structural integrity of the drainage system, and any adjacent structures of design lifetime of the development, and the materials which are specified by the designed must be of a suitable nature for their intended use.

2.1.10 Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain the water by gravity.

2.1.11 The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the system. Any damage which does occur must be minimised and rectified before the drainage system is classed as complete.

2.2 LOCAL POLICY

ARUN DISTRICT COUNCIL LOCAL PLAN (2003)

2.2.1 Arun District Council are currently in the process of developing a new Local Plan, however these do not yet hold any weight within planning policy and therefore the 2003 Local Plan is the current document. In 2007 the policies within the Local Plan expired, unless the Secretary of State agreed to save them.

2.2.2 Policies relating to Flood Risk and Drainage that have been saved are:

- GEN9: Foul and Surface Water Drainage: "*Planning permission for development which will materially increase foul and/or surface water discharges will be refused unless the Local Planning Authority is satisfied that either adequate drainage capacity exists or appropriate drainage capacity can be provided as part of the development. Consideration should also be given to the use of SuDS as alternatives to conventional drainage where appropriate*"
  - The LPA will promote the use of balancing ponds for the attenuation of surface water run-off where required. Proposals for the long-term management of any facility must be included in any scheme put forward.
  - Developers should consider the use of SuDS at the earliest possible stage.
- GEN10: Tidal Flooding and Coastal Defence: *"Planning permission will be refused for development which would be at an unacceptable risk of tidal flooding and /or where proposals are detrimental to the integrity of tidal defences or the ability to maintain or improve them. In areas identified to be at risk:*
  - *Outside the built-up areas, planning permission will not be granted for new development, or the significant intensification of existing development.*
  - *Within built up areas planning permission will only be granted where the LPA is satisfied that appropriate flood and coastal defence and mitigation measures have been provided so that the development will not itself be at unacceptable risk and does not pose an unacceptable risk to the existing development in the area."*
- GEN11: Inland Flooding: *"permission for development which would be at risk from flooding and/or materially decrease the capacity of a floodplain to store or pass flows of floodwater, will be refused unless the LPA is satisfied that compensatory flood storage/waterway areas*

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can be provided as part of the development and the function and effectiveness of existing watercourses, or their replacements, are not adversely affected."

- For planning purposes consideration is given to the 1 in 100 year risk of flood and additional 20% allowance on flood flows for changing weather patterns and, when the extent of this is unknown, the developer will be expected to undertake hydraulic analysis and site survey to establish this.

- GEN19: Coast Protection and Sea Defence Works: "Proposals for coast protection and sea defence works or improvements to existing works will be considered in the light of the following:
  - (i) the recommendations of the shoreline management plan and the coastal defence strategies in respect of the physical maintenance of the coastline and coastal defences;
  - (ii) their impact on the visual character of the open, undeveloped coast and on the appearance and use of the coastline in the built-up areas; and
  - (iii) that the proposed method of coastal defence is technically sound and appropriate to the task.
- GEN23: The Water Environment: *"Development will not be permitted if it would have a direct or indirect unacceptable adverse impact on the water environment, notably in relation to rivers, ponds, wetlands, public access in river corridors and water related recreation.*
- GEN25: Water Resources: *"Development will only be permitted where the Local Planning Authority is satisfied that adequate water resources are available or will be provided in time to serve the development, and that provision is not considered detrimental to existing abstractions, river flows, water quality, fisheries, amenity or nature conservation."*
- GEN26: Water Quality: *"Development will only be permitted where the Local Planning Authority is satisfied that it would not lead to a deterioration in the quality or potential yield of surface and groundwater resources.*

ARUN DISTRICT COUNCIL SUPPLEMENTARY REQUIREMENTS FOR SURFACE WATER DRAINAGE PROPOSALS (2015)

2.2.3 Arun District Council has provided further supplementary requirements for surface water drainage proposals that must be considered for any proposed surface water drainage scheme.

2.2.4 The following order of preference for discharge destination must be in line with the hierarchy of discharge from CIRIA C697: The SuDS Manual, BS8582:2013 – Code of Practice for Surface Water Management for Development Sites, and Approved Document H of the Building Regulations

- Discharge into the ground (infiltration);
- Controlled discharge to a surface water body; and
- Controlled discharge to a surface water sewer.

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2.2.5 There is no provision within this discharge hierarchy for surface water to be discharged to either a combined or foul sewer, and discharge to surface water bodies or sewers must be restricted to an agreed rate.

2.2.6 The supplementary guidance states that infiltration devices should be designed in accordance with infiltration rates achieved through percolation test undertaken in line with BRE 365 during the winter period at the location and depth of proposed structures, and that the proposed structures must drain 50% of their volume within 24 hours.

2.2.7 The requirements state that when discharging to a watercourse or surface water sewer, the rate must be restricted to the greenfield mean annual maximum flood (Q_{bar}) by means of a controlled outflow. Attenuation storage features must be designed with groundwater monitoring data in mind to ensure that there is no detrimental impact on the structure or storage from groundwater ingress. Where possible, open form storage such as ponds and basins are to be used in preference to underground tanks.

STRATEGIC FLOOD RISK ASSESSMENT, ARUN DISTRICT COUNCIL (2008)

2.2.8 Arun District Council commissioned a Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS 25), (superseded by NPPF).

2.2.9 The Strategic Flood Risk Assessment (SFRA) for Arun District[4] was published in May 2008. The SFRA establishes flood risk within Arun District at a strategic level. It does not specifically assess flood risk to the Application Site, although detail on coastal and fluvial flood risk in the local area is detailed later in this report.

WEST SUSSEX PRELIMINARY FLOOD RISK ASSESSMENT (PFRA), MAY 2011

2.2.10 The PFRA provides a high level overview of flood risk from local flood sources (surface water, groundwater, ordinary watercourses and canals). It does not specifically assess flood risk to the Application Site.

WEST SUSSEX LOCAL FLOOD RISK MANAGEMENT STRATEGY (LFRMS), MAY 2014

2.2.11 The West Sussex LFRMS (2013 – 2018) sets out how West Sussex County Council carries out its flood risk responsibilities that are a statutory requirement of the Flood and Water Management Act 2010.

2.2.12 The Strategy states that all new development near areas of flood risk needs to be appropriate, and requires building design and drainage to be scrutinised to ensure risk is managed acceptably. Development should not be granted permission if proposals will increase flood risk to others.

2.2.13 Bognor Regis is one of the higher priority wet spots identified in the LFRMS where risk management authorities will initially prioritise work. It is predicted that 900 properties are at risk from surface water flooding, 1200 properties are at risk from fluvial and coastal flooding and 200 properties are at risk of both fluvial / coastal and surface water flooding.

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[4] Strategic Flood Risk Assessment - Arun District (2008) Arun District Council - http://www.arun.gov.uk/main.cfm?type=STRATEGICFLOODRISK&objectid=4183&searchtermredirect=flood - accessed in July 2015

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BEACHY HEAD TO SELSEY BILL SHORELINE MANAGEMENT PLAN (SMP), MAY 2006

2.2.14 The Beachy Head to Selsey Bill SMP sets the strategic policy for the management of the coastal defences that protect Bognor Regis. The policy for the next 100 years for the relevant policy unit (Felpham to Aldwick – Unit 23) is to 'Hold the Line' of the existing defences. Therefore it is expected that the coastal defences that protect the Proposed Development will be maintained to their current standard for the next 100 years.

ARUN AND WESTERN STREAMS CATCHMENT FLOOD MANAGEMENT PLAN (CFMP), DECEMBER 2009

2.2.15 The site is located within the Coastal Plains policy unit of the CFMP which sets the strategic policy for fluvial flood risk management.

2.2.16 The policy for the Coastal Plains policy unit is described as 'Areas of low, moderate or high flood risk where flood risk is being effectively managed but where further actions may be necessary to keep place with climate change.'

WATER.PEOPLE.PLACES – A GUIDE FOR MASTER PLANNING SUSTAINABLE DRAINAGE INTO DEVELOPMENTS

2.2.17 This guidance outlines the process for integrating SuDS into the master planning of developments.

2.2.18 The guidance stresses that SuDS should be used as an interconnected system, enabling a 'treatment train' to be used to remove sediment and other pollutants and to reduce to risk of downstream blockages.

2.2.19 The document provides techniques for employing SuDS on a range of sites, several of these techniques are relevant for the Application Site:

- SuDS in a floodplain area – during storms and heavy rainfall these areas will naturally flood, making them ineffective for storing surface water runoff. However this does not mean that SuDS cannot be used, as they can be used for routine rainfall. As there is likely to be a high groundwater table and vulnerability to erosion floodplain SuDS should be selected and designed accordingly. Design should limit grading and the creation of surface features that could be washed out in a flood. Surface discharge to SuDS should be dispersed (allowed to shed off as sheet flow) and point discharges minimised or eliminated. Attenuation periods for SuDS should be designed so that SuDS empty within 48 hours of rainfall.

  Examples of suitable SuDS include: green roofs, rainwater harvesting, soakaways, permeable paving, filter strips, bioretention areas and swales

- SuDS in an area with local surface water flooding issues - it is important to understand if the site is within or upstream of local surface water flood risk areas, as this may make it subject to additional surface water runoff restrictions. The site may influence the placement or design criteria for SuDS and flow and attenuation requirements should be discussed with the Lead Local Authority.

- SuDS on a site with high groundwater level – the depth of the water table below the ground should be determined, a water table near the surface must be protected from contamination and high groundwater may also cause flooding or damage to SuDS features. SuDS should be designed to be on the surface or shallow in depth and to avoid infiltration. SuDS that normally allow infiltration can be lined with an impermeable liner to prevent infiltration.

  Examples of suitable SuDS include: green roofs, rainwater harvesting, permeable paving (with a liner and underdrain), filter strips, bioretention areas (with a liner and under drain), swales (with a liner), hardscape storage (if above ground), and ponds (with a liner)

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- Use of SuDS on a site with poor permeability – where infiltration is not possible due to permeability or other ground conditions, SuDS should be designed to provide the required attenuation and treatment above ground or near the surface.

  Examples of suitable SuDS include: green roofs, rainwater harvesting, permeable paving, filter strips, bioretention areas, swales, hardscape storage, ponds, wetlands and underground storage.

- Incorporating SuDS on a site that is mainly paved – a number of SuDS are available. Permeable paving can be used for part of the paved area to drain a larger area. Areas of permeable pacing should be the least trafficked and outside of service strips where possible. Hardscape depressions and rills can be used to provide above ground storage and double as a water feature in a courtyard and paved public realm areas. Underground storage is an option but with no amenity benefits. Where neighbourhood character will support additional greenery, bioretention gardens provide a small footprint and double as a landscaped area.

- Prevent reducing the quality of the receiving body of water – different SuDS provide different types of treatment, and a 'treatment train' of SuDS should be used to ensure water is exposed to a variety of filtration mechanisms and attenuated to allow pollutants to settle out.

- Designing to integrate with existing ecological areas – initial site surveys should identify areas of interest, including designated areas for nature conservation, areas with protection species and locally important habitats. SuDS should be designed to protect or enhance these areas. SuDS can include areas of habitat; these should be well thought out in terms of long-term maintenance to ensure that habitat is not harmed during maintenance activities.

- Designing for adoption – adoption discussions should be held early in the design process to ensure that SuDS are designed to the standards required by the adoption authority. Where adoption is uncertain it is beneficial to ensure that design accommodated flexibility and favours simple solution with low maintenance costs.

2.2.20 In sites with a high groundwater level the water table should be protected from contamination. SuDS should be selected and designed to be on the surface or shallow in depth and to avoid infiltration. Alternatively those SuDS that normally allow infiltration can be lined with an impermeable liner to prevent infiltration.

3 BACKGROUND

3.1 SITE LOCATION

3.1.1 The Application Site is situated in the east of Bognor Regis in West Sussex. The site is located north of Upper Bognor Road and west of Felpham Way in Bognor Regis, West Sussex.

3.1.2 The site is bordered by Upper Bognor Road to the south, Felpham Way to the east, open land to the north, and the University of Chichester and residential accommodation to the west. Refer to location plans within Appendix A.

3.1.3 The Ordnance Survey (OS) grid reference for the Application Site is 494427, 99622 and the nearest postcode is PO21 1HP.

3.2 SITE DESCRIPTION

3.2.1 The Application Site has a gross area of 3.14ha and is considered to be a Greenfield development site.

3.2.2 Table 3.1 describes the general Application Site characteristics.

Table 3-1: General Application Site Characteristics

Characteristic	Description	
Area	3.14 hectares	
General Topography	The Application Site generally slopes from the southern and northern boundaries toward the watercourse flowing west to east through the centre of the Application Site.	
Existing Surface	Greenfield	
Current Use	Open Land	
Boundaries	North	Open Land
	South	Upper Bognor Road
	East	Felpham Way
	West	University of Chichester and residential properties
Access	Access to the site will be primarily from Felpham Way (A259) to the east of the site. Access will also be available from the west via the existing university campus.	

3.3 TOPOGRAPHY AND SITE FEATURES

3.3.1 In 2015 Shaw Colgate Land & Building Surveyors completed a topographical survey for the Application Site. The topographical survey indicates levels on site range from 3.12m AOD in the south western corner of the site to -0.82m AOD in the watercourse at the centre of the site.

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3.3.2 The topographical survey indicates that the highest points at the Application Site are in the south west corner of the site and the northern boundary of the site, and the lowest points are in the centre of the site at the watercourse which runs from west to east. The site falls from the southern and northern boundaries towards the watercourse at the centre.

3.3.3 Refer to Appendix B for the topographical survey. Levels on the survey have not been independently verified by WSP | Parsons Brinckerhoff.

3.4 GEOLOGY AND HYDROGEOLOGY

3.4.1 British Geological Survey (BGS) maps (available online at www.bgs.ac.uk and accessed in July 2015) indicate that the southern part of the site is situated on bedrock of Lambeth Group – Clay, Silt and Sand. The northern part of the site is situated on Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation. In addition superficial deposits of River Terrace Deposits also cover the site.

3.4.2 Environment Agency online resources (available online and accessed in July 2015) indicate that the Application Site is not within a Groundwater Source Protection Zone. The site is within a Groundwater Vulnerability Zone, the southern part of the site is within a minor aquifer high zone and the northern part is within a major aquifer high.

3.4.3 The Lambeth Group bedrock geology is designated as a Secondary A aquifer and the chalk bedrock is designated as a Principal Aquifer. The superficial geology is designated as a Secondary A aquifer.

3.4.4 An intrusive ground investigation was undertaken by WSP | Parsons Brinckerhoff between 2nd and 20th December 2015 and comprised eleven dynamic sampled holes to depths of 22.20m, seven rotary boreholes to a maximum depth of 35m, and seven machine excavated trial pits to depths of 3.20m bgl and 4.0m bgl.

3.4.5 Groundwater was encountered in a number of boreholes across the site during the ground investigation at between 1.00m and 1.50m below ground level. Groundwater monitoring was undertaken on 3 occasions during December 2015 and showed groundwater levels between 1.8mbgl up to ground level with some groundwater emergence in boreholes located adjacent to the watercourse.

3.4.6 Soil infiltration tests were undertaken in accordance with BRE 365 within two trial pits at the site. At the test locations, the trial pits encountered primarily cohesive material immediately below Topsoil level and, due to the low infiltration rate, failed to provide sufficient drainage in order to calculate permeability rates.

3.4.7 Full details of the WSP | Parsons Brinckerhoff Ground Investigation can be found in Report GEO/BRTP/70013264_001.

3.5 IDENTIFICATION OF EXISTING WATERCOURSES

3.5.1 The Aldingbourne Rife (Main River) runs south approximately 90m to the east of the eastern boundary of the site.

3.5.2 An unnamed ordinary watercourse runs through the centre of the site from west to east, originating from a culvert outlet on the western boundary of the site and discharging beneath Felpham Way in a 600mm diameter culvert and into the Aldingbourne Rife 150m east of the site. This watercourse sits within an internal drainage district that is currently administered by the Environment Agency who acts as the Internal Drainage Board (IDB). It is understood that the IDB will be dissolved in 2016 and the watercourse will become the responsibility of the Lead Local Flood Authority, West Sussex County Council.

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3.5.3 An unnamed drainage channel runs through the northern section of the site, running north west to south east, through the northern boundary into the existing ordinary watercourse at the centre of the site. In addition a small cut ditch is identified on the eastern boundary of the site, adjacent to Felpham Way.

3.5.4 West Sussex County Council have stated that no development should take place within 5m of any watercourse, and that future maintenance and access of a watercourse must be considered during the design and planning process (please refer to correspondence in Appendix C).

3.5.5 West Sussex County Council have also stated that historic ordnance survey mapping does show the land to the north of the existing watercourse was once divided in smaller fields. It's possible that these fields had boundary ditches that discharged into the adjacent rife. If historic watercourses are discovered during construction and found to be flowing, appropriate measures should be taken.

3.6 IDENTIFICATION OF OTHER WATER FEATURES

3.6.1 No other water features are present within the Application Site boundary. A pond is located in Hotham Park, approximately 425m south west of the site boundary.

3.7 EXISTING FLOOD DEFENCES

3.7.1 Environment Agency correspondence (Appendix C) confirms that no formal flood defences are in place to protect the Application Site from fluvial flooding. Tidal flood defences are in place and offer a standard of protection equivalent to the 0.5% annual probability tidal event.

3.7.2 The Arun District SFRA gives further details of the tidal defences and the associated Felpham pumping station. The Aldingbourne Rife usually discharges beneath the tidal flood defences and across the foreshore through two flapped gravity outfall structures. However, when tidal conditions and river flows dictate, the Felpham pumping station pumps water over the sea wall discharging to a stilling basin on the upper foreshore.

3.8 EXISTING SEWER AND DRAINAGE INFRASTRUCTURE

3.8.1 The Application Site is classified as a greenfield site and currently drains via infiltration and natural overland runoff. Runoff from the site drains to the ordinary watercourse which runs from west to east through the centre of the site.

3.8.2 Southern Water asset records (Appendix C), obtained in May 2015 indicate that a 150mm diameter foul sewer crosses the site from the north western corner, along the western boundary. Three other foul sewers (two 450mm and one 600mm diameter) enter the site from the western boundary joining the sewer that enters to the north. These become three separate foul sewers that run southwards along the western half of the southern portion of the site.

3.8.3 Southern Water asset records also indicate that a 600mm diameter rising main runs along much of the eastern boundary of the site.

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3.9 HISTORIC FLOOD RECORDS

3.9.1 Table 3.2 summarises the historic flood records obtained through consultation and liaison with the various bodies contacted in the production of this FRA.

Table 3-2: Historic Flood Records

INFORMATION SOURCE	FLOOD RECORDS / DETAILS
Environment Agency	Environment Agency correspondence confirms that they have no records of previous flood events affecting this site.
West Sussex County Council	West Sussex County Council has confirmed that they have no records within the confines of the Application Site. The area around the site was affected by storms in June 2012, when the storm return period for the event was in excess of the normal design capacity for the surface water system.
Southern Water	Southern Water have no flood records for this area

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4 PROPOSED DEVELOPMENT

4.1 DESCRIPTION

4.1.1 Full planning permission is sought for a Proposed Development comprising an Engineering and Media facility, residential student accommodation and associated car parking at the University of Chichester, Bogor Regis Campus.

4.1.2 The proposed illustrative masterplan has been produced by Lizard Landscape Design in February 2016 (refer to Drawing no. LLD913/01 in Appendix D).

4.2 CLIMATE CHANGE ALLOWANCES

4.2.1 The lifespan of the proposed development has been assumed to be 50 years which is appropriate for educational developments.

4.2.2 In February 2016 the Environment Agency released 'Flood risk assessments: climate change allowances'[5] guidance to support the NPPF. Within this guidance it states that the appropriate allowances for increases in peak rainfall intensity for the proposed development over the next 50 years are the central and upper end allowances for increases in peak rainfall intensity of 20% and 40% respectively.

4.2.3 This FRA has undertaken calculations to inform the design based on a 20% increase in peak rainfall intensity (central allowance) and assessed the residual risk of a 40% increase (upper end allowance). This has been applied to design of the drainage system, design of the watercourse crossings, design of the residential student accommodation buildings and provision of safe access and egress routes.

[5] Environment Agency, Flood risk assessments: climate change allowances (February 2016) (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances)

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5 OVERVIEW OF FLOOD RISK

5.1 INTRODUCTION

5.1.1 The following section provides an overview of flood risk to the Application Site, and risk arising to and from the Proposed Development. An assessment has been undertaken for each possible source that could affect the Proposed Development in accordance with the NPPF Flood Risk and Coastal Change Planning Practice Guidance (PPG).

5.2 EXISTING RISK OF FLOODING TO THE SITE

FLOODING FROM COASTAL AND TIDAL SOURCES

5.2.1 The Environment Agency's detailed flood mapping (refer to Appendix C) shows the Application Site is within Flood Zone 3. Table 5.1 below shows the levels and depths for undefended tidal flooding for four locations on the site. Environment Agency mapping shows that the majority of the site will flood in a 1% Annual Exceedance Probability (AEP) event.

Table 5.1: Tidal Modelling Depths

Point	Ground Level (m AOD)	1% AEP level	1% AEP Depth	0.5% AEP level	0.5% AEP depth	0.1% AEP level	0.1% AEP depth	0.5% AEP (+CC) Level	0.5% AEP (+CC) Depth
1	2.85	3.77	0.92	3.86	1.01	4.04	1.19	4.91	2.06
2	2.40	3.63	1.23	3.72	1.31	3.90	1.49	4.85	2.44
3	1.20	3.39	2.19	3.49	2.21	3.69	2.41	4.68	3.41
4	1.36	3.39	2.03	3.48	2.12	3.67	2.31	4.65	3.29

5.2.2 The Arun District Council SFRA modelled the risk of flooding from coastal and tidal sources with the presence of defences for the 0.5% AEP (1 in 200 year) event now and with climate change. The maps in the SFRA show that the site is not at risk of tidal flooding in this scenario. Please refer to Arun District Council SFRA Map A2-T.

5.2.3 The Tidal Breach Map of the Arun District Council SFRA (Map B) also shows that the site is at risk of flooding if the tidal defences were to be breached. However it should be recognised that such a breach is only likely to occur if the tidal defences are not maintained. In accordance with the policy stated within the SMP it is assumed that local defences will continue to be maintained.

5.2.4 The risk of coastal and tidal flooding to the Application Site is moderate.

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FLOODING FROM FLUVIAL SOURCES

5.2.5 The Environment Agency's detailed flood mapping (refer to Appendix C) shows the Application Site is within Flood Zone 3. Undefended fluvial levels for the 0.1% AEP event range from 2.14m AOD – 2.76m AOD. The Environment Agency response also shows that the northern half of the site is at risk of flooding in the 0.1% AEP event.

5.2.6 The Arun District Council SFRA modelled the risk of flooding from fluvial sources with the presence of defences for the 1% AEP event now and with climate change. Map A1-F shows this flood extent for the present day. The Application Site is not at risk of fluvial flooding in this scenario.

5.2.7 The fluvial source modelled for this scenario was the Aldinbourne Rife, to the east of the Application Site. The ordinary watercourse running west to east through the site was not modelled as part of this scenario. Hydraulic modelling has been undertaken to better understand the sources of flooding at the Application Site, including the ordinary watercourse. This modelling has shown that waters entering the ordinary watercourse from the surface water sewer network to the west of the Application Site cause it to overtop and flood the site in conjunction with overland flows from the south and north of the watercourse. The 1% annual probability rainfall event with a 20% allowance for climate change leads to a peak water level of 1.54m AOD on the application site to the north of the watercourse.

5.2.8 The risk of flooding from fluvial sources to the Application Site is considered to be high for the site.

FLOODING FROM PLUVIAL / OVERLAND FLOW SOURCES

5.2.9 The Environment Agency Risk of Flooding from Surface Water map (see Appendix C) indicates that the southern part of the site is at Very Low risk of surface water flooding, with the exception of an area of low risk in the south eastern corner.

5.2.10 The northern part of the site is at low to medium risk from surface water flooding. This is associated with the surface water flood route that originates to the west of the site and runs eastward between Hook Lane and the current University of Chichester campus. The Environment Agency defines this area as having a chance of flooding of between 0.1% and 1% in any year. The existing watercourse running across the site and the eastern edge of the site adjacent to the watercourse are shown to be at 'Medium' risk from surface water flooding. Medium means that each year, this area has a chance of flooding of between 1% and 3.3%.

5.2.11 To fully understand the risk of flooding from pluvial and overland flow sources a hydraulic model has been built of the site, and its upstream catchment including the Southern Water surface water sewer network.

5.2.12 This hydraulic modelling exercise was undertaken to provide a greater level of detail for the catchment draining to the Application Site. The Environment Agency's Risk of Flooding from Surface Water Map is modelled for the 1% annual probability rainfall event whereas in line with current climate change guidelines, the developed hydraulic model has been run for the 1% probability rainfall event plus a 20% increase in rainfall intensity to allow for climate change.

5.2.13 The results of the baseline (current situation) hydraulic model confirm that the Application Site is at risk of surface water flooding as per the Environment Agency's updated Flood Map for Surface Water and Risk of Flooding from Surface Water map. Flooding of part of the site occurs on the eastern boundary to the north of the watercourse occurs in the 20% annual probability event. The modelled flood level at the Application Site for the 1% annual probability plus climate change level is shown to be 1.54m AOD.

5.2.14 The risk of flooding from pluvial/overland sources to the Application Site is considered to be high.

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FLOODING FROM GROUNDWATER SOURCES

5.2.15 The Arun District Council SFRA indicates that the Application Site is an area at High risk of Groundwater flooding.

5.2.16 Chalk aquifers such as that which underlies the Application Site in the northern half are more likely to cause groundwater flooding because of the properties of the underlying geology. However it is noted that there are no records of groundwater flooding in the Arun District.

5.2.17 Correspondence from West Sussex County Council also confirms that the proposed development is shown to be at 'High Risk' from groundwater flooding based on the current ESI maps. It also shows that the current geology is shown to have 'moderate susceptibility' to groundwater flooding.

5.2.18 Existing borehole records from 1969 show that water has been encountered 2.5m below ground level in the half of the site underlain by the Chalk and 3.2m below ground in the Lambeth Group half of the site.

5.2.19 Environment Agency groundwater monitoring records were received on 10 August 2015; however the closest site to the Application Site was in Shripney, which is approximately 1.5km north of the Application Site. These groundwater levels were therefore not deemed representative of the Application Site.

5.2.20 The Ground Investigation undertaken by WSP | Parsons Brinckerhoff in December 2015 showed groundwater to be at very high levels during the winter, with groundwater levels above ground level at boreholes located adjacent to the watercourse.

5.2.21 Whilst groundwater levels are shown to be high during the ground investigation in December 2015, this was following a prolonged period of wet weather and the only boreholes showing groundwater levels above ground level were those adjacent to the watercourse. Correspondence from key stakeholders (Table 3.2) and a review of the policy documents in Section 2 have shown that there have been no records of groundwater flooding at the site.

5.2.22 The risk of groundwater flooding to the Application Site is considered to be low.

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FLOODING FROM SEWER AND DRAINAGE INFRASTRUCTURE SOURCES

5.2.23 Southern Water plans show that there are two foul rising mains (600mm and 750mm diameters) running along the eastern boundary of the site before turning southeast and crossing the A259 Felpham Way between the watercourse and the roundabout junction with the A259 Upper Bognor Road. A further decommissioned foul rising main runs along the eastern and southern boundary of the site ending in Upper Bognor Road approximately 50m west of the roundabout.

5.2.24 Two sewers run west to east along the watercourse until turning south through the centre of the site where a further foul sewer joins before leaving the site to the south. A decommissioned foul main runs underneath the existing student accommodation before turning south and running alongside the other foul mains. A combined drain and surface water sewer both run along Upper Bognor Road to the south of the site.

5.2.25 The topography of the surrounding land indicates that if the offsite foul network was to become surcharged foul flooding would flow away from the Application Site, towards the south east.

5.2.26 The Arun District Council SFRA does not include any records of sewerage flooding in the immediate vicinity of the Application Site.

5.2.27 The risk from the network of sewers offsite to the Application Site is considered to be low.

FLOODING FROM ARTIFICIAL SOURCES

5.2.28 The Environment Agency's online map (available online at http://www.watermaps.environment-agency.gov.uk/, accessed in July 2015) indicates that the Application Site does not lie within the inundation zone of any reservoirs.

5.2.29 The Application Site is not located within the vicinity of a canal and is not influenced by canal infrastructure.

5.2.30 The risk of flooding from these sources to the Application Site is considered to be negligible.

5.3 RISK OF FLOODING ARISING FROM THE PROPOSED DEVELOPMENT

FLOODING FROM COASTAL AND TIDAL SOURCES

5.3.1 The Environment Agency's detailed flood mapping (refer to Appendix C) shows the Application Site is within Flood Zone 3.

5.3.2 The Arun District Council SFRA modelled the risk of flooding from coastal and tidal sources with the presence of defences for the 0.5% annual probability event now and with climate change. The maps in the SFRA show that the site is not at risk of tidal flooding in these scenarios. Refer to Arun District Council SFRA Map A2-T.

5.3.3 The Tidal Breach Map of the SFRA (Map B) also shows that the site is at risk of flooding if the tidal defences were to be breached. However it should be recognised that such a breach is only likely to occur if the tidal defences are not maintained. The current situation for tidal defences at this location is to 'Hold the Line' (as stated in the Beachy Head to Selsey Bill Shoreline Management Plan (SMP), May 2006). Please refer to Appendix C for a detailed version of Map B.

5.3.4 In the event of a tidal breach the Proposed Development could displace tidal floodwater resulting in increased risk to neighbouring property.

5.3.5 Therefore the risk of the Proposed Development exacerbating tidal and coastal flooding to neighbouring property is moderate.

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5.3.6 Flood risk management measures to mitigate the risk are discussed within Section 7 of this FRA.

FLOODING FROM FLUVIAL SOURCES

5.3.7 The Proposed Development is located within Flood Zone 3, however the risk to the majority of the site from fluvial flooding is less than 1% annual probability based on the modelling undertaken as part of the Arun District Council SFRA.

5.3.8 Subsequent modelling has shown that the Application site is at risk from fluvial flooding as a result of the ordinary watercourse in the centre of the site. This is in combination with overland flow originating from the north and south of the watercourse. Refer to Appendix F.

5.3.9 The Proposed Development includes buildings within the floodplain of the ordinary watercourse and therefore has the potential to displace flood water from the floodplain resulting in further flooding elsewhere at the Application site and to neighbouring properties

5.3.10 The risk of the Proposed Development exacerbating fluvial flooding to neighbouring property without mitigation measures is moderate.

5.3.11 Flood risk management measures to mitigate the risk are discussed within Section 7 of this FRA.

FLOODING FROM PLUVIAL / OVERLAND FLOW SOURCES

5.3.12 By developing the site, there is a risk of pluvial / overland flows from the Proposed Development increasing, due to the following reasons:

- Increase in impermeable land cover leading to increased volumes and peak discharge rates; and,
- Alteration of / or development within the existing overland flow path.

5.3.13 Hydraulic modelling has been undertaken to assess the potential impact of the proposed development at the Application site and to neighbouring properties. Refer to Appendix F.

5.3.14 The risk of flooding to and arising from the Proposed Development, regarding the pluvial / overland flow, is moderate due to an increase in the impermeable area on the site (1.47ha) and the potential of the development to alter overland flow routes.

5.3.15 Flood risk management measures to mitigate the risk are discussed within Section 7 of this FRA.

FLOODING FROM GROUNDWATER SOURCES

5.3.16 Basements or underground car parks are not proposed as part of the Proposed Development. Foundations for the Proposed Development will be relatively shallow ground beams for buildings to the south of the watercourse, and piled foundations for buildings to the north in the area of surface water flood risk. These foundations are unlikely to significantly influence groundwater across the site.

5.3.17 The risk of the Proposed Development exacerbating groundwater flooding to neighbouring property is low.

FLOODING FROM SEWER AND DRAINAGE INFRASTRUCTURE

5.3.18 Southern Water has confirmed that there are no records of external flooding associated with the public sewer network within the vicinity of the Application Site. Therefore we do not believe there will be issues with the foul sewer network in the area.

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5.3.19 The proposed loading on foul sewers is not known, any infrastructure improvements needed to cope with increases in foul sewer loading due to the development of the site will be made as required.

5.3.20 The surface water from the Proposed Development will not drain into the sewer network; therefore the Proposed Development will have no impact on flood risk from this source to the site, or surrounding area.

5.3.21 The risk of the Proposed Development exacerbating flooding from sewer and drainage infrastructure is low.

FLOODING FROM ARTIFICIAL SOURCES

5.3.22 The Application Site is not within 500m of any dam or canal infrastructure.

5.3.23 The risk of the Proposed Development exacerbating flooding from artificial sources to neighbouring property is negligible.

SUMMARY OF FLOOD RISK

5.3.24 A summary of flood risk to the site is shown in Table 5.1

Table 5-1: Summary of Flood Risk to and from the Application Site / Proposed Development

Sources of flood risk	Current risk to the application site	Risk of the proposed development exacerbating flood risk
Coastal and tidal	Moderate	Moderate
Fluvial	High	Moderate
Pluvial and overland flow	High	Moderate
Groundwater	Low	Low
Sewer and drainage infrastructure	Low	Low
Artificial Sources	Negligible	Negligible

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6 INDICATIVE SURFACE WATER DRAINAGE STRATEGY

6.1 EXISTING DRAINAGE REGIME

6.1.1 The Application Site is a Greenfield site, with a gross area of 3.14ha.

6.1.2 The Application Site currently drains via infiltration and overland flow to the small watercourse that runs from west to east through the centre of the site.

6.1.3 The topographical survey indicates that levels at the Application Site range from 3.12m AOD in the south western corner of the site to -0.82m AOD in the watercourse at the centre of the site.

6.1.4 As the Proposed Development area is less than 50ha, the Institute of Hydrology (IoH) Report 124 Flood Estimation for Small Catchments (1994) method has been used to estimate the Greenfield site peak flow rate, which is an approved methodology specified within the Environment Agency's Rainfall Runoff Management for Developments Report[6].

6.1.5 Table 6.1 summarises the estimated current Greenfield discharge rates for 1ha of developable area. Full calculations are provided in the drainage calculation pack in Appendix D.

Table 6.1: Summary of Greenfield Peak Discharge Rates

DEVELOPABLE AREA (HA)	RETURN PERIOD (YR)	PEAK GREENFIELD DISCHARGE RATE (L/S)
1	QBAR	2.9
	Q1	2.5
	Q30	6.6
	Q100	9.2
3.14	QBAR	9.1
	Q1	7.8
	Q30	20.7
	Q100	28.9

[6] Great Britain, R Kellagher (2013) *Rainfall Runoff Management for Development Report SC030219, Environment Agency, Bristol*

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6.2 SURFACE WATER MANAGEMENT STRATEGY REQUIREMENTS

6.2.1 The proposed surface water drainage strategy seeks to demonstrate the Proposed Development can be drained in a sustainable manger, commensurate with local and national policy.

6.2.2 The NPPF requires that flood risk to land and property is not increased as a result of development upstream. The Non-Statutory sustainable drainage technical standards state that peak runoff rates should be limited to the Greenfield runoff rates, and long term storage should be provided. Exceedance routes should be shown to not impact the safety of property.

6.2.3 Arun District Council's Local Plan states that SuDS should be used for drainage where appropriate, and that planning permission will be refused unless it is demonstrated that adequate drainage capacity exists or can be provided. The Local Plan also states that the water environment and water quality should not be affected by the development.

6.2.4 Water.People.Places guide to master planning sustainable drainage into developments outlines the process for integrating SuDS into the master planning of developments, and states that SuDS should be used as an interconnected system, providing a 'treatment train'.

6.3 PROPOSED SURFACE WATER DRAINAGE STRATEGY

6.3.1 The proposed surface water drainage strategy is summarised below,

6.3.2 Part H of the Building Regulations: Drainage and Waste Disposal establishes a hierarchy for surface water disposal, which encourages a SuDS approach. This hierarchy stipulates that surface water runoff not collected for reuse must be discharged to one or more of the following in order of priority:

1. Discharge into ground (infiltration); or, where not reasonably practicable,
2. Discharge to a surface water body; or, where not reasonably practicable,
3. Discharge to a surface water sewer, highway drain, or another drainage system; or, where not reasonably practicable,
4. Discharge to a combined sewer.

6.3.3 The Arun District Council Supplementary Requirements has taken this hierarchy with the amendment that there is no provision for connection to a combined sewer.

6.3.4 Due to high groundwater levels in the area, and the result of soakage tests showing that infiltration rates could not be calculated for the site, infiltration to ground will not be possible, and this therefore has not been used as a discharge route within this drainage strategy.

6.3.5 Therefore, all surface water runoff generated on site will be discharged to the existing watercourse flowing west to east through the centre of the Application Site. The Arun District Council Supplementary Requirements for Surface Water Drainage Proposals requires that this discharge is limited to the estimated mean annual maximum greenfield runoff rate (Q_{bar}) of 9.1 l/s.

6.3.6 Limiting the discharge rate to Q_{bar} will result in the generation of a volume of water to be attenuated on-site prior to discharge to the watercourse.

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6.3.7 In accordance with current best practice guidance and with a view to protecting the quality of the water environment, the proposed SWMS incorporates a combination of SuDS features to ensure satisfactory levels of treatment of collected runoff in order to reduce the pollution indices in line with the CIRIA SuDS Manual[7] Chapter 26, prior to discharge from the Proposed Development to the ordinary watercourse.

6.3.8 It is proposed that onsite attenuation will be provided in the form of source control methods such as porous asphalt, swales, a wetland area, a small pond and underground storage tanks. Full details of the proposed drainage features are provided in Appendix D.

6.3.9 A minimum discharge rate of 3l/s has been applied at all outfalls to minimise the risk of blockage at flow control devices. Therefore it is proposed that the two outfalls from the southern part of the site discharge at 3.0l/s and the northern part of the site discharges at 3.1l/s to ensure that the site as a whole will have a maximum discharge of 9.1l/s.

6.4 WATER QUALITY MANAGEMENT

6.4.1 Table 26.2 of the SuDS Manual identifies the pollution hazard level associated with the land uses within the Proposed Development as being Low. On a scale from 0-1 a low pollution hazard level relates to the following pollution hazard indices (See table 26.2 of the SuDS Manual):

- Total Suspended Solids = 0.5
- Metals = 0.4
- Hydrocarbons = 0.4

6.4.2 Table 26.3 of the SuDS Manual sets out the indicative mitigation indices provided by different SuDS features for discharge to surface waters. Porous asphalt, wetlands, ponds and swales are shown to individually provide either the required level or in excess of the required level of mitigation for the pollution hazard levels identified for the Proposed Development. The attenuation storage tanks will require a proprietary treatment system such as an oil separator and silt trap to prevent contaminants from being discharged to the watercourse. Further details of the proposed water quality management measures are provided in Appendix E.

6.5 MAINTENANCE AND ADOPTION

6.5.1 It is proposed that all maintenance of the onsite drainage features will be undertaken by the University of Chichester.

6.5.2 Regular inspection and maintenance is required to ensure the effective long term operation of SuDS, these are detailed in the SuDS Manual CIRIA 793.

6.5.3 The surface water drainage strategy is prepared in outline only to demonstrate the Proposed Development can meet national and local requirements. Further development of the surface water management strategy will be undertaken at detailed design.

[7] CIRIA, 2015, *The SuDS Manual (C753)*

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7 FLOOD RISK MANAGEMENT MEASURES

7.1 INTRODUCTION

7.1.1 Following a review of the flood risks to and arising from the Proposed Development; the following section discusses the mitigation measures necessary to ensure the Proposed Development remains safe over its lifetime and does not exacerbate flood risk to the neighbouring property (including allowance for climate change).

7.2 MITIGATION MEASURES

EXISTING MITIGATION

7.2.1 The Environment Agency has confirmed within their correspondence that there are no formal fluvial flood defences benefiting the Proposed Development. Coastal defences are in place and protect from the 0.5% year event. . In accordance with the policy stated within the SMP it is assumed that local defences will continue to be maintained.

7.2.2 (refer to Appendix C).

POST DEVELOPMENT FLOOD MITIGATION

FLUVIAL AND SURFACE WATER / PLUVIAL FLOOD RISK MANAGEMENT

7.2.3 Whilst the risk of the proposed development exacerbating flood risk from fluvial and surface water flooding is considered to be high, the proposed structures in combination with a drainage scheme utilising the techniques outlined in section 6 will allow the Proposed Development to be drained via a combination of SuDS for events up to and including the 1% annual probability including an allowance for climate change (20% increase on peak rainfall intensity). Please refer to Appendix D for full details.

7.2.4 Hydraulic modelling of the post development scenario has been undertaken to ensure no increase in risk from surface water flooding occurs to the Application Site or neighbouring properties as a result of the Proposed Development.

7.2.5 Buildings to the north of the watercourse in areas of surface water flood risk will be built on piers with the soffit of the void space underneath set to 300mm above the modelled 1% annual probability plus climate change flood level at 1.84m AOD. The finished floor levels (FFL) of these buildings will be elevated further above the design flood level to accommodate the floor construction which will be approximately 500mm (FFL of 2.34m AOD).

7.2.6 The three proposed crossings of the watercourse have been designed to minimise their impact on flows. The western crossing will be located above the existing culvert pipe and upstream of the open watercourse; therefore this will have no impact on watercourse flows. The central crossing will be formed of a single box culvert with the bridge construction above. The culvert soffit will be set to 300mm above the modelled 1% annual probability with a 20% allowance for climate change flood level at 1.84m AOD. The eastern culvert will require the culvert beneath Felpham Way to be extended into the site beneath the proposed bridge using a box culvert beneath the crossing with its soffit level set at 300mm above the 1% annual probability event with a 20% allowance for climate change.

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7.2.7 Appendix F presents the results of the hydraulic modelling which illustrates that the proposed buildings and structures have no significant impact on flood risk either within or outside the proposed development site.

GROUNDWATER

7.2.8 As groundwater levels have been encountered at shallow depths on the Application site, reliance on infiltration measures will not be possible. Underground attenuation shall be lined to prevent groundwater ingress resulting in a loss of potential attenuation volume. Geocellular storage units will require sufficient weight to avoid flotation within high groundwater areas.

TIDAL

7.2.9 To the north of the on-site watercourse to mitigate the risk of fluvial flooding the buildings will incorporate underfloor voids. Therefore in the event of a tidal breach the floodwater will pass beneath the buildings and not be displaced elsewhere. South of the watercourse finished floor levels will be set to a minimum of 300mm above ground level to provide protection against tidal breach flooding. Although Arun District Council have indicated that flood levels for the breach scenario are not available, as this part of the site is located at the edge of the tidal breach flood cell flood depths are likely to be low and any displacement minimal.

7.3 EXCEEDANCE ROUTES

7.3.1 For surface water flood events greater than the 1% annual probability plus climate change, the volumes storage available within the drainage system would be exceeded. For the areas to the north of the watercourse, water would flow overland beneath buildings into the watercourse. For areas to the south of the watercourse, when the volumes of the attenuation features are exceeded, water will be directed around structures along paths at lower levels than the structures, and swales so as to reduce the risk of flooding to buildings. Further details of exceedance routes are contained within Appendix E.

7.4 SAFE ACCESS AND EGRESS

7.4.1 Safe access and egress to the site will be provided from the main entrance to the University on Upper Bognor Road and via the central bridge over the watercourse. The bridge and associated access paths to the buildings will be constructed at a minimum of 300mm above the modelled 1% annual probability plus an allowance for climate change (1.84m AOD). The bridges will be at a higher elevation as the soffit will be set at 1.84m AOD with the bridge deck construction above this.

7.5 EXCEPTION TEST

7.5.1 The Application Site is the only land owned by University of Chichester in the vicinity of the existing Bognor Regis campus. Consequently there are no reasonably available sites within Flood Zone 1 or 2 for the client to use to develop the University. In order to develop this land the Exception Test is required.

7.5.2 The Exception Test requires the proposed development to show that:

7.5.2.1 it will provide wider sustainability benefits to the community that outweigh the flood risk, and

- Issues of wider sustainability benefits to the community are addressed by the wider supporting planning application documents.

7.5.2.2 it will be safe for its lifetime without increasing flood risk elsewhere and where possible reduce flood risk overall.

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- This FRA demonstrates that despite the flood risks to the Application Site the proposed development can be brought forward with appropriate mitigation measures enabling site occupants and users to be safe from flooding over the developments lifetime (50 years) accounting for the effects of climate change without exacerbating flood risks elsewhere.

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8 CONCLUSIONS

8.1 CONCLUSION

8.1.1 WSP has been commissioned by the University of Chichester to prepare a Flood Risk Assessment and Drainage Strategy for a planning application for a Proposed Development at the University of Chichester, Bognor Regis campus.

8.1.2 Outline planning permission is sought for the Proposed Development, comprising an Engineering and Media facility, residential student accommodation and associated car parking, vehicular and pedestrian accesses, footpaths / cycle ways, public open space and landscaping.

8.1.3 The Application Site is almost wholly located in Flood Zone 3 due to risk of Tidal flooding; however, this is in an undefended scenario (residual risk). Defended modelling undertaken during the Arun District Council SFRA shows that this area is not at risk of Tidal flooding.

8.1.4 Hydraulic modelling has shown that the part of the site north of the onsite watercourse is at risk of flooding from a combination of fluvial and pluvial / overland flow sources.

8.1.5 To mitigate the risk to the buildings north of the watercourse from fluvial and pluvial / overland flow sources the buildings will be elevated on piers with the soffit of the void space underneath at a minimum level of 1.84m AOD. This will ensure that they have a negligible impact on overland flood flows or floodplain displacement.

8.1.6 The flood risk to and from the Proposed Development from artificial sources is negligible, and from groundwater and sewers is low.

8.1.7 The risk of the Proposed Development exacerbating flood risks from pluvial / overland flow, and fluvial flood sources is assessed as being moderate. To mitigate the pluvial / overland risk a SuDS management train for surface water drainage will be implemented in accordance with the SuDS Manual.

8.1.8 Storage will be designed to attenuate flows for all rainfall events up to and including the 1% annual probability event including allowance for climate change (+20% increase in peak rainfall intensity).

8.1.9 The Proposed Development will be limited to the estimated mean annual maximum greenfield runoff rate (Q_{bar}). Therefore it the development will discharge at a maximum rate of 9.1l/s for all events up to the 1% annual probability rainfall event including an allowance for climate change.

8.1.10 Water quality management will be undertaken in line with the CIRIA SuDS Manual chapter 26 to ensure pollution indices are reduced to acceptable levels prior to discharge from the Proposed Development to the ordinary watercourse.

8.1.11 Safe and dry access will be provided for the Proposed Development via the central bridge and associated walkways over the watercourse and via the main University entrance on Upper Bognor Road.

8.1.12 In light of the above mitigation measures the risk of the Proposed Development exacerbating flooding to the neighbouring property from pluvial / overland flow is considered to be low.

ARUN DISTRICT COUNCIL BR/54/16/PL

Appendix A

SITE LOCATION PLANS


Key
Site Location
Middleton-on-Sea
Bognor Regis
Aldwick
Pagham
Felpham
Arundel
0 200 400 600 800
m
Map data ©2016 Google Imagery ©2016 , Bluesky, DigitalGlobe, Getmapping plc, Infoterra Ltd & Bluesky, Landsat
WSP
PARSONS BRINCKERHOFF
TITLE:
University of Chichester
FIGURE No:
General Site Location
Drawn By: LR:CJG002
Date Modified: 19/02/2016 13:29
File: Created using iGIS, WSP's Online Mapping System

ARUN DISTRICT COUNCIL BR/54/16/PL

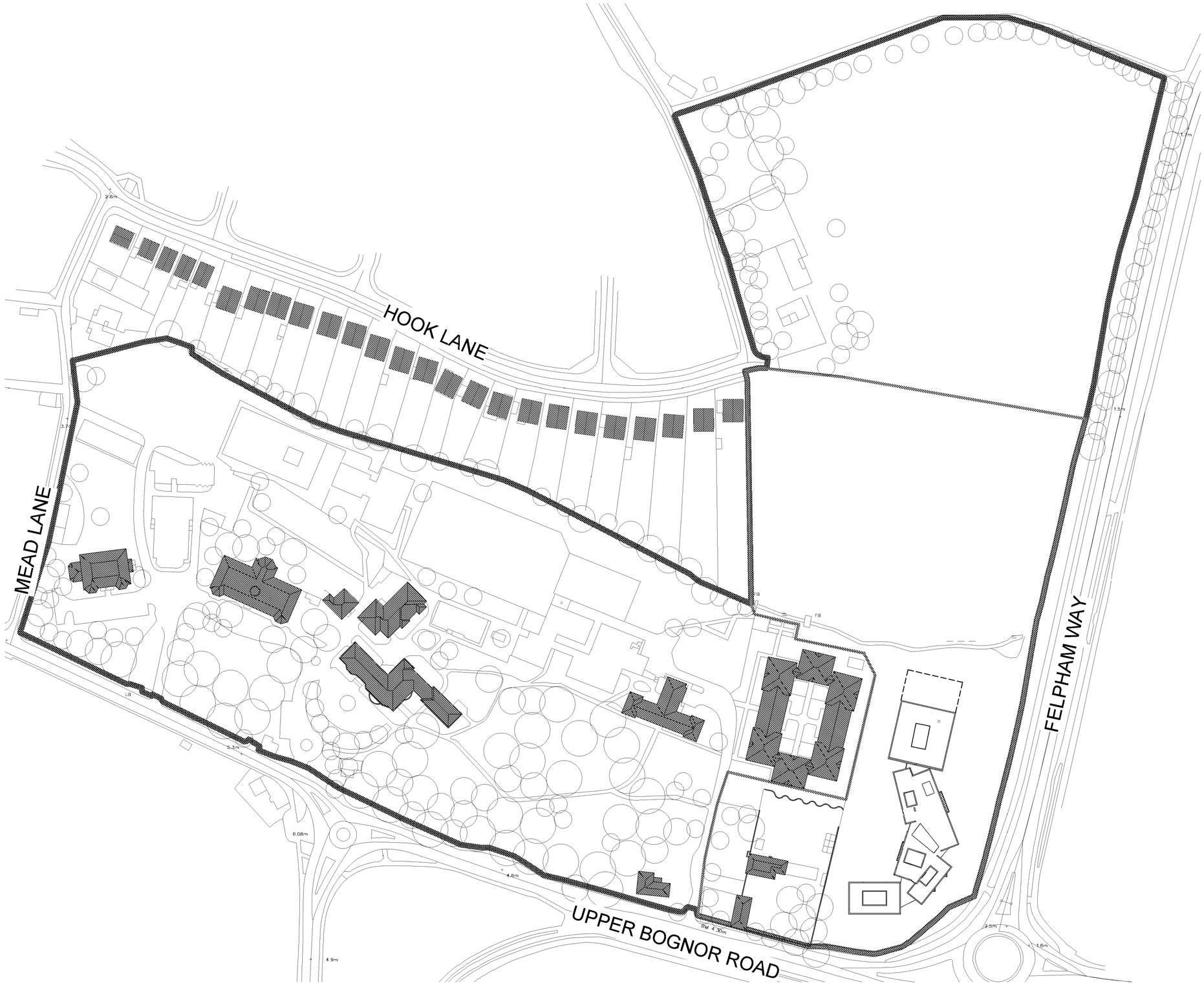
Responsibility is not accepted for errors made by others in scaling from this drawing. All construction information should be taken from figured dimensions only.

0mm 50mm

A2 Original Sheet Size

Site boundary

Ownership boundary



date	rev	name	chk	note

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Architecture Town Planning Interior Design Building Surveying Landscape Design Graphic Design
Promenade House, The Promenade, Clifton Down, Bristol, BS8 3NE
T 0117 974 3271 F 0117 974 5207 www.stridetreglown.co.uk

PROJECT
University of Chichester Engineering and Digital Techology Park, Bognor Regis

DRAWING TITLE
Location Plan

STATUS
PRELIMINARY

SCALE	DATE	DRAWN BY	CHECKED BY
1 : 1250	02.02.16	Author	Checker

PROJECT NUMBER	DRAWING NUMBER	REVISION
50136	AP_000	

18/02/2016 16:23:24 C:\Revit Local\50136_STL_00_ZZ_M3_A_002-FabLabMoved_HLovesmith.rvt

ARUN DISTRICT COUNCIL BR/311/18/PL

Appendix B

TOPOGRAPHICAL SURVEY



Date:	Aug 19th, 2025	Scale:	1:500
Drawn By:	MB	Check By:	JE
Project No:	2025-0001	Sheet No:	1

NEW DISTRICT COUNCIL OFFICE

Appendix C

CORRESPONDENCE

APPENDIX C-1

ENVIRONMENT AGENCY

Lauren Day
WSP
Mountbatten House
Basing View
Basingstoke
Hampshire
RG21 4HJ

Our ref: SSD/6952
Your ref:

Date: 10/08/2015

Dear Lauren

Provision of Product 4 for University of Chichester Bognor Regis Campus

Thank you for your request to use Environment Agency data. The information is attached.

If you have requested this information to help inform a development proposal, then you should note the detail in the attached advisory text on the use of Environment Agency Information for Flood Risk Assessments / Flood Consequence Assessments.

Supporting Information

This information is provided subject to the enclosed notice, which you should read.

Flood History

We do not have any records of previous flood events affecting this site. I would suggest contacting Arun District Council for a more comprehensive flood history check.

Flood Defences

There are no formal raised flood defences to protect this area from river flooding. Coastal flood defences offer a standard of protection of approximately 1in200 (0.5%).

[redacted]

ARUN DISTRICT COUNCIL BR/541/15/PL

If you have any queries or would like to discuss the content of this letter further please don't hesitate to contact me.

Yours faithfully



Jon Denman
FCRM Officer
Partnership and Strategic Overview Team – West Sussex



Enc. Detailed FRA/FCA Map, Modelled Levels and extents

[Standard Notice]

ARUN DISTRICT COUNCIL BR/54/16/PL

Flood Map for Planning Centered on University of Chichester Bognor Regis Campus - Created 10/08/2015 [Ref: SSD/6952]



Environment Agency

Legend

- Main River
- Flood Zone 3
- Flood Zone 2

Flood Map for Planning (assuming no defences)

Flood Zone 3
Shows the area that could be affected by flooding:
- from the sea with an 1 in 200 or greater chance of happening each year.
- or from a river with a 1 in 100 or greater chance of happenening each year.

Flood Zone 2
Shows the extent of an extreme flood from rivers of the sea with up to a 1 in 1000 chance of occuring each year.

1:12,075 *

*when printed at A4.

N

0 310 620

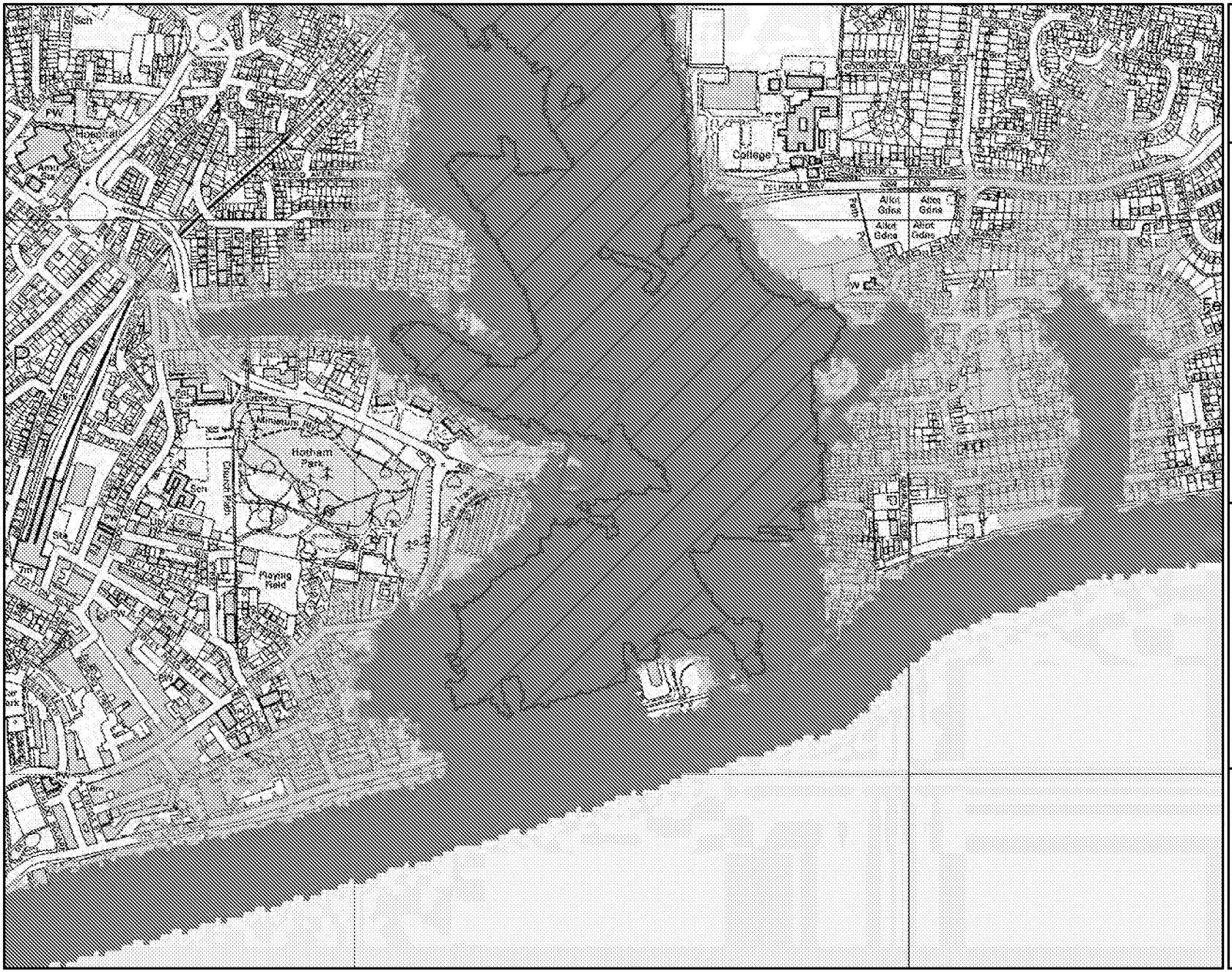
Meters

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ARUN DISTRICT COUNCIL 20/08/2015

Contact Us: National Customer Contact Centre, PO BOX 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Modelled Outputs Centered on University of Chichester Bognor Regis Campus - Created 10/08/2015 [Ref: SSD/6952]



Environment Agency

Legend

- Fluvial 1in1000yr
- Tidal 1in100yr
- Tidal 1in200yr
- Tidal 1in1000yr
- Tidal 1in200yr +CC

1:10,000 *

*when printed at A4.

N

0 250 500

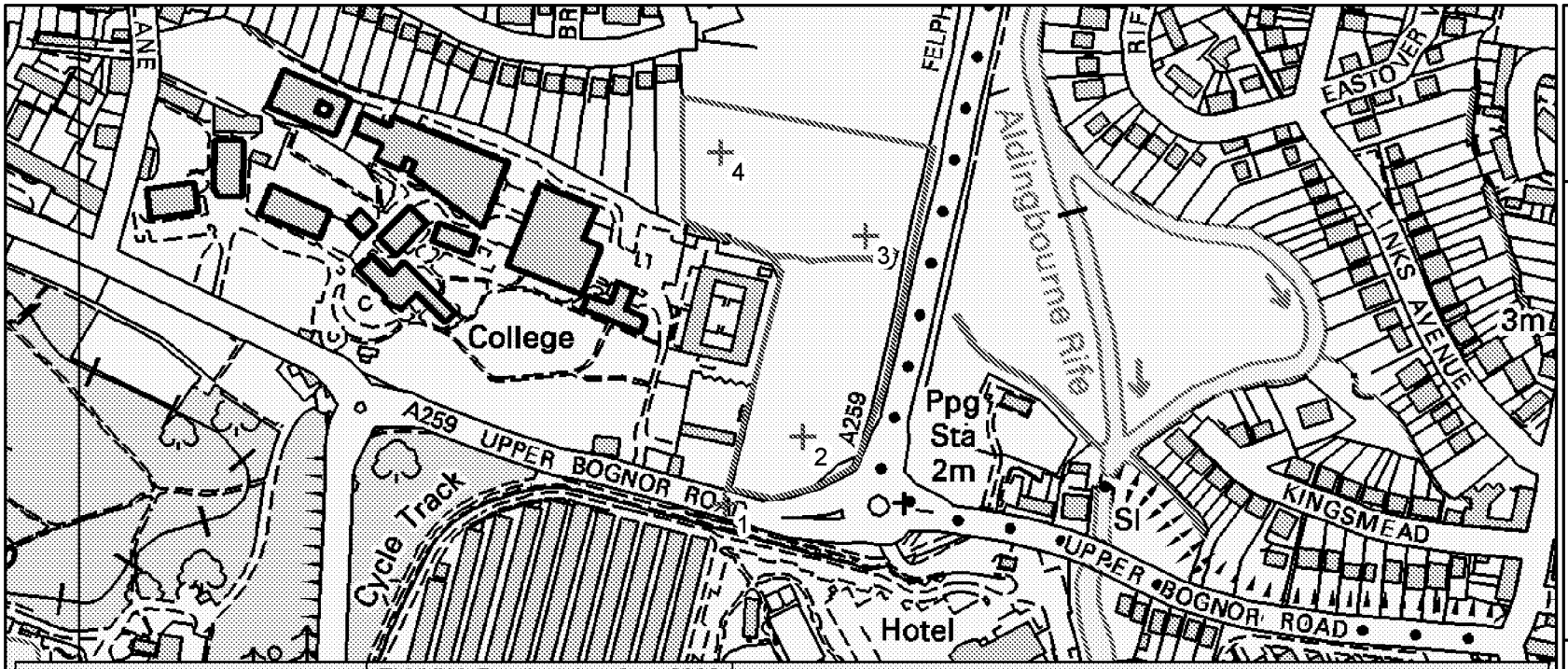
Meters

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ARUN DISTRICT COUNCIL/BR/AM/6952

Contact Us: National Customer Contact Centre, PO BOX 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Modelled Depths and Levels Centered on University of Chichester Bognor Regis Campus - Created 10/08/2015 [Ref: SSD/6952]



Node Point	Easting	Northing	FLUVIAL Depths taken from 2009 JFLOW [m]	TIDAL Depths taken from 2009 TUFLOW model [m]			
				UNDEFENDED			
			0.1% AEP [1in1000yr]	1% AEP [1in100yr]	0.5% AEP [1in200yr]	0.1% AEP [1in1000yr]	0.5% AEP [1in200yr] +CC [2115]
1	495366	99502	Null	0.92	1.01	1.19	2.06
2	494409	99541	Null	1.23	1.31	1.49	2.44
3	494446	99656	0.95	2.19	2.21	2.41	3.41
4	494364	99702	0.81	2.03	2.12	2.31	3.29

Node Point	Easting	Northing	FLUVIAL Levels taken from 2009 JFLOW [mAOD]	TIDAL Levels taken from 2009 TUFLOW model [mAOD]			
				UNDEFENDED			
			0.1% AEP [1in1000yr]	1% AEP [1in100yr]	0.5% AEP [1in200yr]	0.1% AEP [1in1000yr]	0.5% AEP [1in200yr] +CC [2115]
1	495366	99502	Null	3.77	3.86	4.04	4.91
2	494409	99541	Null	3.63	3.72	3.90	4.85
3	494446	99656	2.76	3.39	3.49	3.69	4.68
4	494364	99702	2.14	3.39	3.48	3.67	4.65

Environment Agency

Legend

Node Point

1

1:4,000 *

*when printed at A4.

N

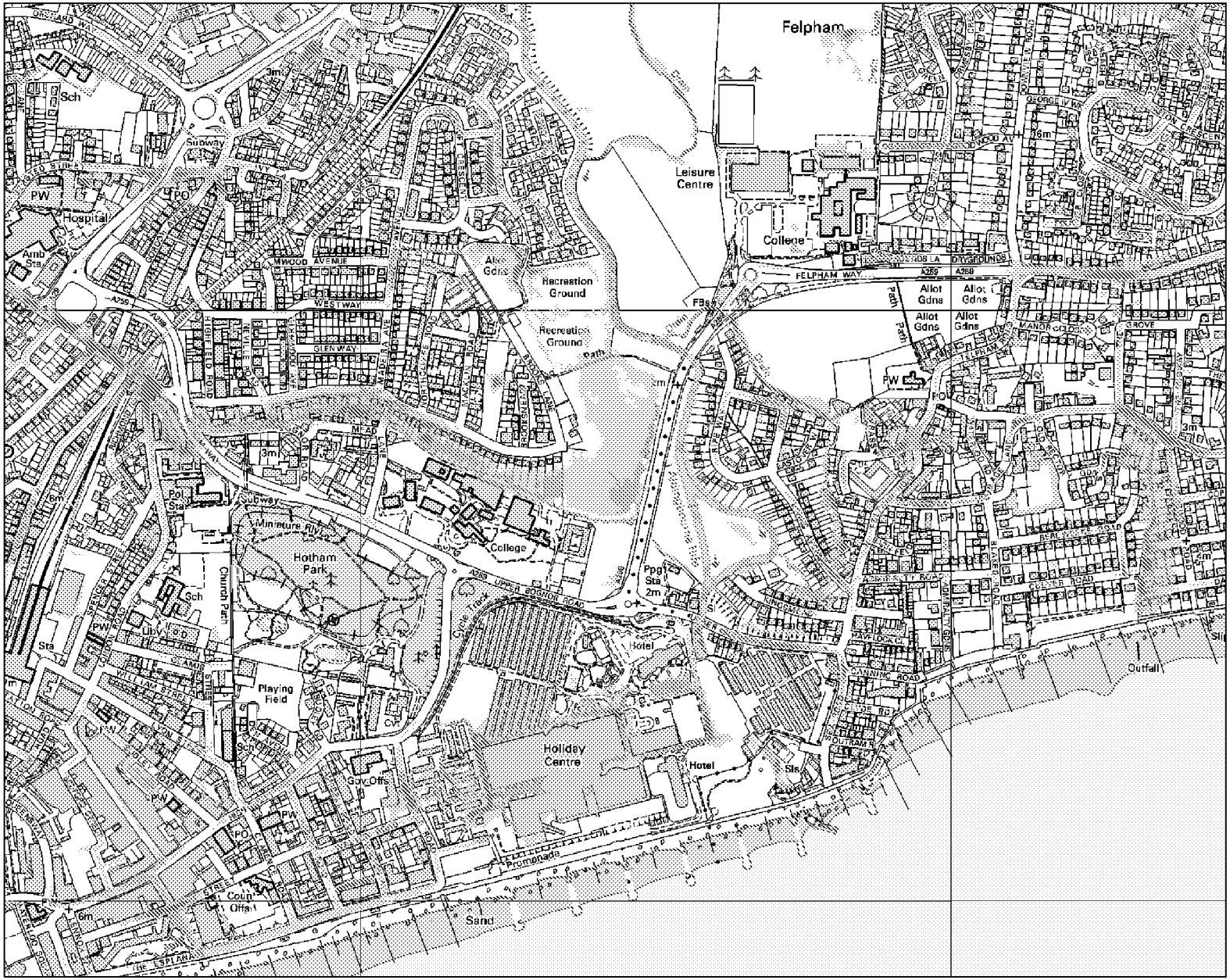
0 100 200

Meters

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Contact Us: National Customer Contact Centre, PO BOX 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Risk of flooding from Surface Water



Environment Agency

Scale 1:10,000

N W E S

Likelihood of flooding from Surface Water

- High
- Medium
- Low
- Very Low

Likelihood of flooding from Surface Water

High:	Greater than or equal to 1 in 30 (3.3%) chance in any given year
Medium:	Less than 1 in 30 (3.3%) but greater than or equal to 1 in 100 (1%) chance in any given year
Low:	Less than 1 in 100 (1%) but greater than or equal to 1 in 1,000 (0.1%) chance in any given year
Very Low:	Less than 1 in 1,000 (0.1%) chance in any given year

This information is shown on the Risk of Flooding from Surface Water map on our website.

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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

APPENDIX C-2

SOUTHERN WATER

Southern Water

CHECKED

Your Ref LM 37994/NR
Our Ref 195268
Date 20 May 2015
Contact [redacted]

Atkins
Atkins Telecoms - Stats Enquiries Team
The Hub - 500 Park Avenue
Aztec West
Almondsbury
Bristol
Attention: Nicholas Westcott

Dear Sirs

Provision of Sewer only Main Record Extracts – VAT Receipt

Bognor Regis, West Sussex PO22 8AT
Further to your recent enquiry regarding the provision of Southern Water apparatus record extracts for the above location.

Please be aware that there are areas within our region in which there are neither sewers nor water mains. Similarly, whilst the enclosed extract may indicate the approximate location of our apparatus in the area of interest, it should not be relied upon as showing that further infrastructure does not exist and may subsequently be found following site investigation. Therefore actual positions of the disclosed (and any undisclosed) infrastructure should be determined on site, because Southern Water does not accept any responsibility for inaccuracy or omission regarding the enclosed plan and accordingly it should not be considered to be a definitive document.

I confirm payment of the appropriate fee in the sum of £49.92

The breakdown of costs is as follows: -

- Provision of record extracts £41.60
- VAT @ 20.0% £8.32

VAT Registration Number 813 0378 56

Should you require any additional information regarding this matter please contact this office at the address given at the foot of this letter.

Yours faithfully

Land Search Department

Letter B



SEWER RECORDS

Node	Cover	Invert	Size	Material	Shape	
0001X	4.34	1.8	225	VC	CIRC	*
0001X	5.86	3.57	150	VC	CIRC	*
0001X	3.98	2.37	225	VC	CIRC	*
0002X	3.66	2.58	225	VC	CIRC	*
0002X	4.29	2.85	225	VC	CIRC	*
0003X	4.23	2.43	225	VC	CIRC	
0004X			150	VC	CIRC	
000DX			225	VC	CIRC	
0051X	3.92	1.99	225	VC	CIRC	*
0051X	4.29	3.49	225	VC	CIRC	*
0052X	3.63	2.22	225	VC	CIRC	*
0052X	4.23	3.07	225	VC	CIRC	*
0055X	5.97		225	VC	CIRC	
0101X	3.77	3.03	225	VC	CIRC	*
0101X	3.91	1.11	OTHER	BAC	CIRC	*
0102X	2.95	0.63	525	CI	CIRC	*
0102X	3.78	1.46	150	VC	CIRC	*
0103X	3.4	1.29	150	VC	CIRC	*
0103X	3.1		525	CI	CIRC	*
0104X	3.04	0.74	OTHER	BAC	CIRC	*
0104X	3.64	2.7	225	VC	CIRC	*
0105X			300	VC	CIRC	
010DX			UNK	UNK	UNK	
0151X	3.92	2.4	225	VC	CIRC	*
0151X	3.76	2.38	225	VC	CIRC	*
0152X	3.04	1.02	525	CP	CIRC	*
0152X	3.64	2.49	225	VC	CIRC	*
0153Y	3.09		UNK	UNK	CIRC	*
0153X	3.09	1.13	525	CP	CIRC	*
0153X	3.23	2.25	225	VC	CIRC	*
0154X			525	CP	CIRC	
0155X	3.09		225	VC	CIRC	
0201X	3.21	0.51	525	CI	CIRC	*
0201X	6.07	3.68	175	VC	CIRC	*
0201X	4.35	2.64	150	VC	CIRC	*
0202X	3.62		300	VC	CIRC	*
0202X	3.57	2.03	150	VC	CIRC	*
0203X	3.45	2.34	150	VC	CIRC	
0204X	3.43	2.31	150	VC	CIRC	
0251X	4.62	3.21	225	VC	CIRC	*
0251X	6	4.42	300	VC	CIRC	*
0252X	5.9	4.36	300	VC	CIRC	*
0252X	3.68	2.61	225	VC	CIRC	*
0253X	4.45	3.22	225	VC	CIRC	
0254X	3.45	2.38	225	VC	CIRC	
0301X	5.89	4.39	225	VC	CIRC	*
0301X	3.05	1.74	150	VC	CIRC	*
0302X	6.1	4.52	225	VC	CIRC	
0351X	3.08	1.98	225	VC	CIRC	
0352X	2.48	1.21	225	CP	CIRC	
0353X	1.77		225	CP	CIRC	
0354X	3.01	1.99	150	VC	CIRC	
0401X	5.24	3.35	150	VC	CIRC	*
0401X			UNK	UNK	CIRC	*
0402X	5.44	4.75	150	VC	CIRC	
0451X	5.25	4	150	CP	CIRC	
0501X	4.86	-0.4	300	VC	CIRC	*
0501X	5.04	3.04	150	VC	CIRC	*
0502X	4.86	2.82	150	VC	CIRC	*
0502X	4.93	0.1	225	VC	CIRC	*
0503X	5.11	3.23	150	VC	CIRC	
0504X	3.9	2.56	150	VC	CIRC	
050DX			300	VC	CIRC	
0551X	4.92	3.33	225	CP	CIRC	
0552X	4.93	3.56	225	CP	CIRC	
0556X	1.85		675	CP	CIRC	
0601X	4.78	2.9	225	VC	CIRC	*
0601X	3.83	-0.06	300	VC	CIRC	*
0601X	1.5	-1.53	225	CP	CIRC	*
0602X	4.91	-0.27	300	VC	CIRC	*
0602X	1.41	-1	150	VC	CIRC	*
0603X	3.57	1.67	175	VC	CIRC	*
0603X	1.61	-1.38	225	CP	CIRC	*
0651X	3.71	2.5	225	VC	CIRC	
0652X	3.9	2.99	300	CP	CIRC	*
0652X	3.43		UNK	UNK	UNK	*
0653X	4.89	3.28	225	CP	CIRC	
0654X	1.34	-0.56	675	CP	CIRC	
0655X	1.67		675	CP	CIRC	
0701X	4.04		300	VC	CIRC	*
0701X	2.82		UNK	UNK	CIRC	*
0702X	3.71	0.01	300	VC	CIRC	*
0702X	2.96		600	CP	CIRC	*
0703X	2.97	0.52	600	CP	CIRC	*
0703X	3.67	1.52	150	VC	CIRC	*
0704X	3.46	1.84	150	VC	CIRC	*
0704X	2.98	0.59	375	VC	CIRC	*
0705X		0.6	450	CI	CIRC	*
0705X			UNK	UNK	UNK	*
0706X			UNK	UNK	UNK	*
0706X	2.84	0.6	375	VC	CIRC	*
0707X	3.54	1.62	375	VC	CIRC	
070DX			UNK	UNK	UNK	
071DX			225	CP	CIRC	
072DX			300	VC	CIRC	
0751X	1.91		750	CP	CIRC	
0801Y	3.65	2.11	175	VC	CIRC	*
0801X	3.65	2.11	175	VC	CIRC	*
0801Y	3.65		OTHER	OTHER	CIRC	*
0801X	2.65	1.5	225	VC	CIRC	*
0802X	2.34	1.39	225	VC	CIRC	
0803X	2.59	1.47	225	VC	CIRC	
0804X			UNK	UNK	CIRC	
0805X			UNK	UNK	CIRC	
0806X			UNK	UNK	CIRC	
0807X			UNK	UNK	CIRC	
080DX			UNK	UNK	UNK	
081DX			225	VC	CIRC	
0851X	2.64	0.91	450	CP	CIRC	
0852X	2.4	0.8	450	CP	CIRC	
0853X	2.57	0.84	450	CP	CIRC	
0854X	2.59		700	BRE	RECT	
0901X	4.09	1.96	225	VC	CIRC	*
0901X	4.87	1.03	225	VC	CIRC	*
0902X	4.95	0.94	225	VC	CIRC	
0903X	4.92	0.86	225	VC	CIRC	
0904X	4.13	0.62	225	VC	CIRC	
0951X	4.02	1.56	225	VC	CIRC	
1001X	3.41	1.22	225	VC	CIRC	*
1001X	4.6	1.32	225	VC	CIRC	*
1001X	2.645	1.215	150	VC	CIRC	*
1002Y	3.28	0.715	150	VC	CIRC	*
1002X	4.36	1.51	225	VC	CIRC	*
1002X	4.34	1.52	225	VC	CIRC	*
1003X	4.92	2.88	225	VC	CIRC	*
1003X	3.415	0.195	150	VC	CIRC	*
1004X	4.65	2.48	225	VC	CIRC	
1005X	2.62	1.59	150	VC	CIRC	*
1005X			100	VC	CIRC	*
1005X			UNK	UNK	UNK	*
101DX			100	VC	CIRC	
102DX			225	VC	CIRC	
1051X	3.6	2.32	300	VC	CIRC	*
1051X	2.675	1.665	225	VC	CIRC	*
1052X	4.23	2.99	300	CP	CIRC	*
1052X	2.552	1.645	225	VC	CIRC	*
1053X	2.92		300	VC	CIRC	*
1053X	4.34	2.89	450	CP	CIRC	*
1054X	3.99	3.06	300	VC	CIRC	*
1054X	3.07	1.685	225	VC	CIRC	*
1055X	3.92	1.33	600	CP	CIRC	
1101X	5.42	3.61	150	VC	CIRC	*
1101X	2.35	0.62	225	VC	CIRC	*
1101X	3.08	0.69	OTHER	BAC	CIRC	*
1102X	5.94	3.02	225	VC	CIRC	*
1102X	2.58	0.97	150	VC	CIRC	*
110DX			225	VC	CIRC	
1151X	2.26	1.36	300	VC	CIRC	*
1151X	5.48	4.65	300	CP	CIRC	*
1151X	2.69	0.51	525	CP	CIRC	*
1152X	5.63	4.59	300	CP	CIRC	*
1152X	2.38	1.49	225	VC	CIRC	*
1152X	3.05	0.4	525	CP	CIRC	*
1153X	2.54	1.55	225	VC	CIRC	*
1153X	5.81	4.55	300	CP	CIRC	*
1154X	2.17	1.65	225	VC	CIRC	*
1154X	5.83	4.33	300	CP	CIRC	*
1155X	5.76	4.34	300	CP	CIRC	
1156X	5.8	4.71	150	VC	CIRC	
1201X	6.18	3.35	225	VC	CIRC	*
1201X	2.24	0.96	225	VC	CIRC	*
1251X	2.27	1.09	300	VC	CIRC	*
1251X	6.3	4.1	450	CP	CIRC	*
1301X	2.89	1.52	225	VC	CIRC	*
1301X	4.89	0.14	525	CI	CIRC	*
1301X	5.98	3.57	225	VC	CIRC	*
1302X	2.65	1.42	225	VC	CIRC	*
1302X	4.32	0.3	525	CI	CIRC	*
1303X	2.52	1.37	225	VC	CIRC	
1304X	2.34	1.29	225	VC	CIRC	
1305X			UNK	UNK	CIRC	
1306X			UNK	UNK	CIRC	
130DX			UNK	UNK	CIRC	
131DX			UNK	UNK	CIRC	
1351X	2.85	1.88	300	VC	CIRC	
1352X	5.95	3.87	450	CP	CIRC	*
1352X	2.66	1.68	300	VC	CIRC	*
1353X	2.51	1.58	300	VC	CIRC	
1354X	2.45	1.51	300	VC	CIRC	
1355X	2.33	0.87	375	CP	CIRC	
1356X	2.24	0.8	375	CP	CIRC	
1401X	5.27	3.49	150	VC	CIRC	*
1401X	5.14	-0.16	525	CI	CIRC	*
1401X	5.5	3.94	225	VC	CIRC	*
1402X	5.1	-0.01	525	CI	CIRC	*
1402X	5.85	3.79	225	VC	CIRC	*
1451X	5.51	3.24	450	CP	CIRC	
1501X	4.91	0.39	175	VC	CIRC	*
1501X	5.25	4.29	150	VC	CIRC	*

Node	Cover	Invert	Size	Material	Shape	
1502X	4.91	1.94	225	VC	CIRC	
1503X	5.17	3.49	150	VC	CIRC	
1551X	4.88	3.84	175	CP	CIRC	*
1551X	4.84	2.48	675	CP	CIRC	*
1601X	2.04	0.33	375	VC	CIRC	*
1601X	4.95	1.33	225	VC	CIRC	*
1601X	4.46	1.72	225	VC	CIRC	*
1602X	3.83	1.46	225	VC	CIRC	
1603X	3.79	-0.54	225	VC	CIRC	
1604X	3.93	-0.02	225	VC	CIRC	
1651X	4.89	3.71	150	VC	CIRC	*
1651X	4.12	1.86	675	CP	CIRC	*
1652X	4.66	3.62	150	VC	CIRC	
1701X	4.17	2.59	150	VC	CIRC	*
1701X	2.8		600	CP	CIRC	*
1702X	4.53	2.78	150	VC	CIRC	
1703X			UNK	UNK	UNK	*
1703X	4.53	2.9	150	VC	CIRC	*
1704X			225	VC	CIRC	
170DY			UNK	UNK	UNK	
1750X			750	CP	CIRC	
1751X			750	CP	CIRC	*
1751X	4.08	3.41	225	CP	CIRC	*
1752X	4.45	3.28	300	CP	CIRC	*
1753X	4.54	3.19	300	CP	CIRC	*
1801X	3.64	0.39	300	VC	CIRC	*
1801X	2.33	0.89	225	VC	CIRC	*
1802X			UNK	UNK	CIRC	*
1802X	3.64	0.39	300	VC	CIRC	*
1803X			UNK	UNK	CIRC	*
1803X	3.83	2.37	150	VC	CIRC	*
1804X			UNK	UNK	CIRC	
1805X			UNK	UNK	CIRC	*
1805X	4.93	3.07	150	VC	CIRC	*
1806X	3.94	0.3	300	VC	CIRC	*
1806X			UNK	UNK	CIRC	*
180DX	4.25	2.31	150	VC	CIRC	
1851X	2.23		450	CP	CIRC	*
1851X	3.56	1.97	225	VC	CIRC	*
1852X	3.42	2.09	225	VC	CIRC	
1853X			UNK	UNK	CIRC	*
1853X	4.48	3.44	150	VC	CIRC	*
1854X			UNK	UNK	CIRC	
1855X			UNK	UNK	CIRC	
1856X			UNK	UNK	CIRC	
1901X	5.2	2.89	175	VC	CIRC	*
1901X	3.75	2.59	UNK	UNK	CIRC	*
1902X			100	VC	CIRC	*
1902X			UNK	UNK	CIRC	*
1903X			100	VC	CIRC	*
1903X	3.815	2.655	150	VC	CIRC	*
1904X	3.865	2.795	150	VC	CIRC	*
1904X			100	VC	CIRC	*
1905X	3.845	0.545	150	VC	CIRC	
1906X	3.715	0.465	150	VC	CIRC	
1907X	3.65		150	VC	CIRC	
1908X	3.5	1.21	150	VC	CIRC	
1909X	3.71	1.025	150	VC	CIRC	
190DX			UNK	UNK	UNK	
191DX			175	VC	CIRC	
192DX			175	VC	CIRC	
1951X	3.79		375	CO	CIRC	*
1951X	4.76		225	VC	CIRC	*
1952X	3.72		450	CO	CIRC	*
1952X	4.76	3.52	225	VC	CIRC	*
1953X			UNK	UNK	CIRC	*
1953X	5.11	3.97	225	CP	CIRC	*
1954X	5.03	4.02	225	CP	CIRC	*
1954X	3.51		300	VC	CIRC	*
1955X	3.835	2.32	150	VC	CIRC	*
1955X			UNK	CP	CIRC	*
1956Y	3.895	2.145	300	VC	CIRC	
1957X	3.775	1.22	300	VC	CIRC	
1958X	3.775	2.42	150	VC	CIRC	
1959X	3.22	1.475	225	VC	CIRC	
1960Y	3.64	2.21	225	VC	CIRC	
2001X	3.79	2.07	225	VC	CIRC	*
2001X	6.04	3.57	300	VC	CIRC	*
2002X	3.77	1.99	225	VC	CIRC	*
2002X	6.5	4.51	300	VC	CIRC	*
2003X	6.54	4.51	300	VC	CIRC	
2004Y	6.3	4.44	300	VC	CIRC	*
2004X	6.3	4.44	300	VC	CIRC	*
2005X	6.3	4.32	300	VC	CIRC	
2006X	6.45	4.35	300	VC	CIRC	
2009X	5.96	4.21	375	VC	CIRC	
2010X	6.1	4.34	300	VC	CIRC	
2010Y	6.1	4.34	300	VC	CIRC	*
2011X			150	VC	CIRC	
202DX			UNK	UNK	UNK	
2051X	6.26	4.63	375	CP	CIRC	*
2051X	3.88		225	VC	CIRC	*
2051X	1.39	-0.33	450	CO	CIRC	*
2051X	4.55	0.94	600	CP	CIRC	*
2051X	5.93		225	VC	CIRC	*
2051Y	3.88		225	CP	CIRC	*
2052X	6.52	5.11	225	VC	CIRC	*
2052X	3.88	2.32	375	CP	CIRC	*
2052X	2.5	1.22	600	CP	CIRC	*
2052X	1.51	0.18	450	CO	CIRC	*
2053X	6.56	5.1	225	VC	CIRC	*
2053X	3.73	2.13	300	VC	CIRC	*
2053X	2.45	0.85	600	CP	CIRC	*
2054X	6.56	5.06	225	VC	CIRC	
2055X	6.54	5.05	225	VC	CIRC	
2056X	6.67	5	225	VC	CIRC	
2057X	6.53	4.97	225	VC	CIRC	
2058X	6.52	4.86	225	VC	CIRC	
2059X	6.4	4.84	225	VC	CIRC	
2101X	6.83	4.8	300	VC	CIRC	*
2101X	5.51	3.15	150	VC	CIRC	*
2101X	2.63	1.59	150	VC	CIRC	*
2101X	1.92	-1.16	300	CI	CIRC	*
2102X	6.86	4.88	300	VC	CIRC	*
2102X	2.4	-0.96	225	VC	CIRC	*
2102X	5.49	3.03	150	VC	CIRC	*
2102X	5.82	2.5	375	CI	CIRC	*
2103X	2.33	-0.89	225	VC	CIRC	*
2103X	5.75	2.43	300	VC	CIRC	*
2103X	5.15	2.63	150	VC	CIRC	*
2103X	6.67	4.51	300	VC	CIRC	*
2104X	2.52	0.51	150	VC	CIRC	*
2104X	5.76	2.45	375	CI	CIRC	*
2104X	5.02	2.57	150	VC	CIRC	*
2104Y	5.76	2.86	225	VC	CIRC	*
2105X	5	2.52	150	VC	CIRC	*
2105X	2	-0.7	225	VC	CIRC	*
2105X	4.93	2.4	225	VC	CIRC	*
2106X	1.85	-0.7	225	VC	CIRC	*
2106X			UNK	VC	CIRC	
2107X			100	VC	CIRC	
210DX			300	VC	CIRC	*
210DX			375	CI	CIRC	*
211BX			UNK	UNK	UNK	
211DX			UNK	UNK	UNK	
211PX	1.9	1.9	125	CI	CIRC	
212DX			UNK	UNK	UNK	*
212DX			UNK	UNK	UNK	*
213DX			UNK	UNK	UNK	*
213DX			UNK	UNK	UNK	*
214DX			UNK	VC	CIRC	
2151X	5.48	4.74	225	CP	CIRC	*
2151X	5.76	4.18	300	VC	CIRC	*
2151X	2.63	1.73	300	VC	CIRC	*
2151X	6.88	4.91	300	VC	CIRC	*
2151X	2.45	1.69	225	VC	CIRC	*
2152X	5.11	3.1	225	CP	CIRC	*
2152X	1.86	0.22	525	CP	CIRC	*
2152X	1.86	0.66	225	CP	CIRC	*
2152X	6.84	4.8	300	VC	CIRC	*
2153X	1.85	0.59	300	CP	CIRC	*
2153X	2.16	0.34	525	CP	CIRC	*
2153X	5	2.89	225	CP	CIRC	*
2153X	6.71	4.69	375	CP	CIRC	*
2154X	1.79	0.56	300	CP	CIRC	*
2154X	4.98	2.78	225	CP	CIRC	*
2155X	1.84	0.48	300	CP	CIRC	*
2155X	4.9	2.6	375	CP	CIRC	*
2156X	6.93	5.06	225	VC	CIRC	
21ADX			300	VC	CIRC	
2201X	5.62	3.61	150	VC	CIRC	*
2201X			UNK	VC	CIRC	*
2201X	7.39	5.11	225	VC	CIRC	*
2201X	1.86	-0.31	225	VC	CIRC	*
2202X			UNK	VC	CIRC	*
2202X	5.09	3.63	150	VC	CIRC	*
220DX			150	VC	CIRC	
220DX			UNK	UNK	UNK	
224BX			UNK	UNK	UNK	
2251X	7.31	5.35	225	VC	CIRC	*
2251X	5.26	4.18	150	VC	CIRC	*
2251X	1.87	0.17	225	CP	CIRC	*
2252X	7.16	5.13	225	VC	CIRC	*
2252X	5.29	3.86	225	CP	CIRC	*
2253X	5.62	4.95	225	CP	CIRC	
2254X	5.13	3.38	225	CP	CIRC	
22BBX			UNK	UNK	UNK	
22CBX			UNK	UNK	UNK	
2301X	1.91	0.03	225	VC	CIRC	
2303X	7.46	5.38	225	VC	CIRC	
2304X	7.42	5.56	225	VC	CIRC	
2305X	7.42	5.29	225	VC	CIRC	
2307X			150	VC	CIRC	
2308X			150	VC	CIRC	
230DX			225	VC	CIRC	
231DX			UNK	UNK	UNK	
2351X	7.45	6.22	225	CP	CIRC	*
2351X	1.95	-0.02	600	CP	CIRC	*
2352X	1.89	-0.03	600	CP	CIRC	*

Node	Cover	Invert	Size	Material	Shape	
2352X	7.36	5.86	225	VC	CIRC	*
2353X	2.07	-0.09	600	CP	CIRC	
2402X	7.24	4.87	300	VC	CIRC	*
2402X	5.64	3.95	225	VC	CIRC	*
2403X	6.03	4.24	150	VC	CIRC	*
2403X	7.1	4.56	300	VC	CIRC	*
240BX			225	VC	CIRC	
240DX			UNK	UNK	UNK	
241BX			300	VC	CIRC	
242BX			225	VC	CIRC	
242DX			UNK	UNK	UNK	
243DX			UNK	UNK	UNK	
244DX			UNK	UNK	UNK	
2451X	7.3	5.89	225	CP	CIRC	*
2451X	5.08	4.15	225	CP	CIRC	*
2452X	5.65	4.52	225	VC	CIRC	*
2452X	7.2	6.01	225	VC	CIRC	*
2453X	7.17	6.09	225	VC	CIRC	
2501X			100	VC	CIRC	*
2501X	4.83	2.21	225	VC	CIRC	*
2501X	4.07	-0.37	525	CI	CIRC	*
2501X	5.47	4.17	150	VC	CIRC	*
2501X	3.98	2.31	150	VC	CIRC	*
2502X	3.85	0.97	175	VC	CIRC	*
2502X	4.69	-0.27	525	CI	CIRC	*
2503X	4.91	0.72	175	VC	CIRC	
2504X			100	VC	CIRC	
2505X			100	VC	CIRC	
2506X			100	VC	CIRC	
250DX			225	VC	CIRC	
252DY	7	5.23	225	VC	CIRC	*
252DX	7	5.21	225	VC	CIRC	*
253DX			225	VC	CIRC	
2551X	3.8	2.3	225	CP	CIRC	*
2551X	5.48	4.74	150	VC	CIRC	*
2551X	4.31	2.72	675	CP	CIRC	*
2552X	4.91	3.82	150	CP	CIRC	
2553X	6.95	5.8	225	CP	CIRC	
2555X			UNK	UNK	CIRC	
255DX			300	VC	CIRC	
258DX			225	VC	CIRC	
2601X		0.22	300	VC	CIRC	*
2601X	4.33	2.07	225	VC	CIRC	*
2601X	4.63	1.56	225	VC	CIRC	*
2602X	7.65	4.98	225	VC	CIRC	*
2602X	4.31	1.93	225	VC	CIRC	*
2603X	4.27	2.18	150	VC	CIRC	
2604X			100	VC	CIRC	
2605X			100	VC	CIRC	
260DX			UNK	UNK	UNK	
261DX			225	VC	CIRC	
2651X	4.53	3.65	225	CP	CIRC	*
2651X	1.35		750	CP	CIRC	*
2651X	4.61	2.78	225	CP	CIRC	*
2652X	4.28	2.74	225	CP	CIRC	
2654X	3.54	2.5	225	CP	CIRC	
2701X	2.66	0.22	600	CP	CIRC	*
2701X	6.58	3.35	300	VC	CIRC	*
2701X	4.51	3.05	150	VC	CIRC	*
2702X	2.5	1.01	150	VC	CIRC	
2703X	5.07		450	BRE	CIRC	
270DX			UNK	UNK	UNK	*
270DX			UNK	UNK	UNK	*
2751X	4.18	2.96	375	CP	CIRC	*
2751X	6.56	5.09	225	VC	CIRC	*
2752X	4.26	3.01	375	CP	CIRC	
2753X	4.04	3.01	150	VC	CIRC	
2754X			750	CP	CIRC	
2756X	5.27	2.26	600	CI	CIRC	
2801X	3.18	0.77	300	VC	CIRC	*
2801X	2.86	1.28	150	VC	CIRC	*
2802X	2.41	1.59	150	VC	CIRC	
2803X	5.82		300	VC	CIRC	
2804X			UNK	UNK	UNK	
2805X			150	VC	CIRC	
280DX			300	VC	CIRC	
281DX			300	VC	CIRC	
2851X	2.76	1.19	675	CP	CIRC	*
2851Y	2.76		UNK	UNK	CIRC	*
2851X	6.91	5.59	225	CP	CIRC	*
2852X	5.83	4.7	225	VC	CIRC	*
2852X			300	VC	CIRC	
2901X	3.235	1.4	150	VC	CIRC	*
2901X	4.5	1.76	150	VC	CIRC	*
2901X	6.64	4.94	225	VC	CIRC	*
2902X	6.33	3.66	300	VC	CIRC	*
2902X	4.16	1.41	150	VC	CIRC	*
2903X	4.62	3.26	225	VC	CIRC	*
2903X	6.36	3.69	300	VC	CIRC	*
2904X	5.77	3.99	375	VC	CIRC	
2905X	6.13	4.05	375	VC	CIRC	
2951X	4.55	1.96	300	VC	CIRC	*
2951X	6.35		225	VC	CIRC	*
2951X	3.55		450	CO	CIRC	*
2952X	5.78	4.41	450	CP	CIRC	*
2952X	4.51	1.94	300	VC	CIRC	*
2952X	3.366		450	CO	CIRC	*
2953X	4.7	4.15	150	CP	CIRC	*
2953X	3.115	1.685	150	VC	CIRC	*
2954X	5.72	4.66	225	VC	CIRC	*
2954X	2.785	1.345	225	VC	CIRC	*
2955X	6.02	4.54	300	VC	CIRC	*
2955X	2.625		450	CO	CIRC	*
3001X	5.01	2.13	300	VC	CIRC	*
3001X	6.28	4.41	300	VC	CIRC	*
3001X	4.43	2.39	175	VC	CIRC	*
3002Y	5.01	3.18	225	VC	CIRC	*
3002X	5.01	2.07	375	CI	CIRC	*
3002X	6.66	4.61	300	VC	CIRC	*
3003X	4.81	1.91	375	CI	CIRC	
3004X	4.84	1.86	300	VC	CIRC	*
3004X			UNK	UNK	CIRC	*
3005X	5.89		300	VC	CIRC	
3006X			UNK	UNK	CIRC	*
3006X			UNK	UNK	UNK	*
3007X			UNK	UNK	UNK	
300DX			300	VC	CIRC	
3051X	4.81	3.71	300	VC	CIRC	*
3051X	6.24	5.04	300	VC	CIRC	*
3052X	4.97	3.87	300	VC	CIRC	*
3052X	6.71	5.23	300	CP	CIRC	*
3053X	6.85	5.28	300	CP	CIRC	
3054X	6.55	5.45	225	CP	CIRC	
3055X	6.69	5.56	225	CP	CIRC	
3056X	6.47	5.56	225	CP	CIRC	
3057X	6.31	5.53	150	VC	CIRC	
3101X	4.81	3.26	150	VC	CIRC	*
3101X	1.86	-0.57	225	VC	CIRC	*
3101X	5.4	2.21	375	CI	CIRC	*
3101X	6.96	5.19	300	VC	CIRC	*
3101X	2.04	-0.6	225	VC	CIRC	*
3102X	5.15	2.23	300	VC	CIRC	*
3102X	1.88	-0.5	150	VC	CIRC	*
3102X	4.87	2.7	225	VC	CIRC	*
3102X		-0.51	375	CP	CIRC	*
3103X	1.86	-0.04	150	VC	CIRC	*
3103X	5.07	2.08	375	CI	CIRC	*
3103Y	5.07	2.29	225	VC	CIRC	*
3104X	5.11	2.8	225	VC	CIRC	
3105X	6.53	5.203	150	VC	CIRC	
310DX			300	VC	CIRC	
311DX			UNK	UNK	UNK	
312DX			UNK	UNK	UNK	
313DX			375	CI	CIRC	
314DX			UNK	UNK	UNK	
3151Y	5.23		225	VC	CIRC	*
3151Y	5.23		225	VC	CIRC	*
3151X	1.84	0.32	375	CP	CIRC	*
3151X	5.23	3.7	300	VC	CIRC	*
3151X	4.93	2.8	375	CP	CIRC	*
3151X	7.14	5.6	225	VC	CIRC	*
3152X	1.83	0.48	225	CP	CIRC	*
3152X	5.19	3.92	300	VC	CIRC	*
3152X	4.92	2.94	375	CP	CIRC	*
3152X	1.72	0.14	525	CP	CIRC	*
3152X	7.03	5.72	225	VC	CIRC	*
3153X	2.34	0.6	600	CP	CIRC	*
3153X	1.84	0.96	225	VC	CIRC	*
3153X	4.8	3.08	225	CP	CIRC	*
3153X	5.03	3.62	300	VC	CIRC	*
3154X	2.45	0.8	600	CP	CIRC	*
3154X	6.518	5.16	150	VC	CIRC	*
3155X	1.9	0.18	675	CP	CIRC	
3201X	6.46		225	VC	CIRC	*
3201X	1.92	0.17	150	VC	CIRC	*
3201X	7.02	4.99	300	VC	CIRC	*
3201X	1.85	-0.88	375	CP	CIRC	*
3202X			UNK	UNK	CIRC	*
3202X			UNK	UNK	UNK	*
3202X	7.22	5.18	300	VC	CIRC	*
3203X			UNK	UNK	UNK	*
3203X			UNK	UNK	CIRC	*
3203X	7.29	6.08	225	VC	CIRC	*
3204X	6.246	4.817	150	VC	CIRC	
3205X			375	CP	CIRC	*
3205X	6.083	4.645	150	VC	CIRC	*
3206X			375	CP	CIRC	
3207X			375	CP	CIRC	
3208X			375	CP	CIRC	
3208X			225	VC	CIRC	
320DX			UNK	UNK	CIRC	*
320DX			UNK	UNK	UNK	*
321BX			225	VC	CIRC	*
321BX			UNK	UNK	UNK	*
321DX			UNK	UNK	UNK	*
321DX			UNK	VC	CIRC	*
322BX			225	VC	CIRC	*
322BX			UNK	UNK	UNK	*
322DX			225	VC	CIRC	*

LINE STYLES / COLOURS

- Brown: Foul; Foul Syphon Sewer; Foul Vacuum Main; Foul Rising Main
- Red: Combined; Combined Syphon Sewer; Combined Rising Main; Lateral Drain
- Orange: Building Over Agreement Area
- Dark Blue: Treated Effluent
- Purple: Sludge; Sewer Catchment; Section 104 Area
- Light Blue: Surface Water; Surface Water Rising Main
- Yellow: Private
- Green: Access Shaft; Decommissioned

MATERIALS

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

LEGEND - SEWERS

Manhole (SW); Manhole (F&C); Lamphole (SW); Lamphole (F&C); Pumping Station (SW); Pumping Station (F&C); Side entry manhole (SW); Side entry Manhole (F&C); Blind shaft (SW); Blind shaft (F&C); Ejector station (SW); Ejector station (F&C); Watertight door (SW); Watertight door (F&C); Flushing ch. Mn-e (SW); Flushing ch. Mn-e (F&C); Flushing ch. No-e (SW); Flushing ch. No-e (F&C); Oxygenation Chamber

Washout (SW); Washout (F&C); Rodding Eye (SW); Rodding Eye (F&C); Gauging point (SW); Gauging point (F&C); Intercept chamber (SW); Intercept chamber (F&C); Storm Tank (SW); Storm Tank (F&C); Vortex chamber (SW); Vortex chamber (F&C); Label ellipse; Dummy/S24 manhole; Outfall; Penstock chamber; Damboards; Storm Overflow; Backdrop manhole

Other (s); Other; Change in sewer (s); Change in sewer; Reflux valve; Flap valve; Cascade; Anode; Valve; Closed Valve; Air Valve; Hatch box (SW); Hatch box (F&C); Direction arrow; Emptying valve; Catchpit; Soakaway; Inlet; Balancing Pond

Wastewater treatment works; Marine treatment works; Outfall headworks; Vent; Vent column; Tidal storage tank; Blank end; Head of Public Sewer; Micro Pumping Station

SHAPES (S)

A Arched; B Barrel; C Circular; E Egg; H Horseshoe; R Rectangular; S Square; T Trapezoidal; U U Shape; X Other

NODE REFERENCING SYSTEM

1st digit: hundred metre easting identifier
2nd digit: hundred metre northing identifier
3rd digit: sewer type identifier 0-4 = Foul/Combined 5-9 = Surface Water
4th digit: next sequential node

WARNING: BAC pipes are constructed of Bonded Asbestos Cement

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement

O.S. Ref.	SZ9499NW	Drawn by:	mondalb
Scale:	1:2500	Date:	20/05/2015

Title: 195268_Bognor Regis, West Suss

N

Southern Water

The information contained on this plan is provided as a guide to the approximate position of existing public sewers. The accuracy thereof cannot be guaranteed.

THIS INFORMATION MUST BE TREATED WITH CAUTION AND THE ACTUAL POSITION OF THE PUBLIC SEWERS MUST BE ESTABLISHED ON SITE, IN ALL CASES.

Southern Water must be informed before lifting manhole covers or excavating trial holes.

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ARUN DISTRICT COUNCIL BR/311/18/PL

APPENDIX C-3

WEST SUSSEX COUNTY COUNCIL

WEST SUSSEX COUNTY COUNCIL **DATE: 10 July 2015**
FLOOD RISK MANAGEMENT CONSULTATION

FROM: **Kevin Macknay** **TO: WSP**
FAO: Lauren Day

SUBJECT: **Chichester University, Bognor Regis.**

West Sussex County Council (WSCC), in its capacity as the Lead Local Flood Authority (LLFA), has been consulted on the above proposed development in respect of surface water drainage.

The following is the detailed comments of the LLFA relating to surface water drainage and flood risk for the proposed development and any associated observations, advice and conditions.

Current surface water flood risk based on uFMfSW for for 30year and 100year events:	Low risk.

Comments:
Current uFMfSW mapping generally shows the site to be at 'Low' risk from surface water flooding.

However, it should be noted that the existing watercourse that runs across the site and the north east corner of the proposed development area are shown to be at 'High' risk from surface water flooding, during a 1 in 100 storm event. This to be due to the topography of the local area, existing surface water flow paths and possible surface water runoff from adjacent land during periods of prolonged heavy rainfall.

Any existing surface water flow paths across the site must be maintained.

Reason: NPPF paragraph 103 states – 'When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere..'

Therefore, a wholesale site level rise via the spreading of excavated material should be avoided. Any excavated material kept on site should be located in areas designed and designated for that purpose.

Current ground water flood risk based on ESI Ground Water mapping:	High risk / Moderate susceptibility.

Comments:
The proposed development is shown to be at 'High risk' from ground water flooding based on the current ESI maps.

Based on the same mapping the current geology is shown to have 'Moderate susceptibility' to ground water flooding. This means the general geology in the area may be suitable for infiltration / soakaways. However, it should be noted this suitability for infiltration also means that during periods of elevated groundwater any underground system may have reduced capacity to deal with runoff.

Where the intention is to dispose of surface water via infiltration / soakaway, these should be shown to work through an appropriate assessment carried out under BRE Digest 365.

Ground water contamination and Source Protection Zones.
The potential for ground water contamination within a source protection zone has not been considered by the LLFA. The LPA should consult with the EA if this is considered as risk.

ARUN DISTRICT COUNCIL BR/54/15/PL

Is the proposed development is within or close to an existing Flood Zone, as defined by the National Planning Policy Framework (NPPF):	Yes.
Comments: The site is shown to be within Flood zone 2. We recommend the developer / designer should consult and liaise with Environment Agency regarding development on this site.	

Records of any ordinary watercourses or culverted watercourses within or in close vicinity to the site:	Yes.
Comments: Current Ordnance Survey mapping does show an ordinary watercourse running west to east across the proposed development site. We understand that at least part of this watercourse is currently within the ownership, and therefore maintained, by Chichester University. Local or field boundary ditches, not shown on Ordnance Survey mapping, may exists around and across the site. If present these should be maintained and highlighted on future development plans. No development should take place within 5m of any watercourse. Future maintenance and access of an watercourse must be considered during the design and planning process.	

Records of any historic ordinary watercourses shown to have once crossed or been in close vicinity to the site:	Yes.
Comments: Historic ordnance survey mapping does show at the land north of the existing watercourse was once divided in smaller fields. It's possible that these fields had boundary ditches that discharged into the adjacent rife. If historic watercourses are discovered during construction, and found to be flowing, appropriate measures should be taken to deal with the water.	

Records of any historic flooding within the confines of the proposed site:	None.
Comments: We do not have any records of historic flooding within the confines of the proposed site. This should not be taken that this site has never suffered from flooding, only that it has never been reported to the LLFA.	

Records of any historic flooding in close vicinity to the site and/or on the adjacent public highway:	Yes.
Comments: We are aware that the local area was badly affected during the June 2012 storm. However, we do not have any records of flooding within the proposed site. See published report for further details: https://www.westsussex.gov.uk/fire-emergencies-and-crime/dealing-with-extreme-weather/dealing-with-flooding/flood-risk-management/flood-reports-projects-and-policies/	

Existing highway drainage in the vicinity to the site:	Yes.
Comments: The adjacent roads, Upper Bogner Road and Felpham Way, both have a positive highway drainage system.	

Future development - Sustainable Drainage Systems (SuDs)

SuDs seek to mimic natural drainage systems and retain water on or near to the site, when rain falls, in contrast to traditional drainage approaches, which tend to pipe water off site as quickly as possible.

SuDs offer significant advantages over conventional piped drainage systems in reducing flood risk by reducing the quantity of surface water run-off from a site and the speed at which it reaches water courses, promoting groundwater recharge, and improving water quality and amenity. The range of SuDs techniques available means that a SuDs approach in some form will be applicable to almost any development.

Government policy set out in paragraph 103 of the NPPF expects LPAs to give priority to the use of SuDs in determining planning applications. Further support for SuDs is set out in chapter 5 of the flood risk Practice Guide.

Approved Document Part H of the Building Regulations 2000 establishes a hierarchy for surface water disposal, which encourages a SuDs approach beginning with infiltration where possible e.g. soakaways or infiltration trenches.

Where SuDs are used, it must be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems. For example, using soakaways or other infiltration methods on contaminated land carries groundwater pollution risks and may not work in areas with a high water table. Where the intention is to dispose to soakaway, these should be shown to work through an appropriate assessment carried out under BRE Digest 365.

Provision for long-term maintenance should be provided as part of any SuDs scheme submitted to the LPA.

Kevin Macknay
Flood Risk Management Team

APPENDIX C-4

ARUN DISTRICT COUNCIL

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Supplementary Requirements for Surface Water Drainage Proposals

Any proposed surface water scheme must consider sustainable drainage principles.

SuDS Selection

The following destinations must be considered for surface runoff in order of preference:

1. Discharge into the ground (infiltration);

2. Controlled discharge to a surface water body;

3. Controlled discharge to a surface water sewer.

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.

SuDS selection hierarchy based on:
CIRIA C697 - The SuDS Manual
BS8582:2013 – Code of Practice for Surface Water Management for Development Sites
Approved Document H of the Building Regulations

Infiltration Drainage Design

Infiltration rates for soakage structures are to be based on percolation tests undertaken in the winter period at the location and depth of the proposed structures. The percolation tests must be carried out in accordance with BRE 365, CIRIA R156 or a similar approved method, and cater for the 1 in 10 year storm event between the invert of the lowest entry pipe into the infiltration structure and the base. For the purpose of design, the percolation rate must be applied to the sides of the infiltration structure only and the rate for the base must be zero. This does not apply to infiltration basins or permeable pavements, whereby the percolation rate is applied to the base only. There must be provision to ensure that there is capacity in the system to contain the 1 in 100 year storm event plus 30% on stored volumes, as an allowance for climate change. The infiltration structure should also drain 50% of its total volume in 24 hours or less for both the 1 in 10 and 1 in 100 year (plus 30%) storm events, in order to provide spare capacity for subsequent storms.

Any infiltration drainage design must include adequate winter groundwater monitoring data to determine the highest winter groundwater table. Residential developments in excess of five properties will require ground water monitoring to be carried out between October and March inclusive. The extent of monitoring required for smaller developments will be subject to agreement with the Council's Engineers.

Adequate freeboard must be provided between the base of the soakaway structure and the highest recorded groundwater level identified in that location.

Restricted Discharge

Discharge to a watercourse or surface water sewer must be restricted to the estimated mean greenfield runoff rate (Q_{bar}) 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.

Flow Exceedance Routes

The drainage design should show flow routes through the proposed development, demonstrating where surface water will be conveyed for three types of flow:

1. Low flow routes

Regular flow from source control features such as permeable pavements should travel in low flow channels through the development in a controlled way contributing to landscape quality.

2. Overflows

In the event of local blockages or surcharge a simple overflow arrangement should allow water to bypass the obstruction and return to the management train sequence until conditions return to normal.

3. Exceedance routes

When SuDS are overwhelmed by exceptional rainfall, then exceedance routes are required to protect people and property. These provide unobstructed overland flow routes from the development and should be considered for all drainage schemes. Exceedance routes should also be protected from future changes in land use.

Culverting a Watercourse

Culverting (piping) a watercourse is not advised unless there is no alternative. The resulting reduction in storage volume, flow capacity and habitat potential would be unacceptable. Culverted watercourses are also more difficult to maintain due to the limited accessibility.

Land Drainage Consent must be sought from the Lead Local Flood Authority (West Sussex County Council), or its agent (Arun District Council – land.drainage@arun.gov.uk), prior to starting any works (temporary or permanent) that affect the flow of water in the watercourse. Such works may include culverting, channel diversion and the installation of trash screens.

The development layout must take account of any existing watercourses (open or culverted) to ensure that future access for maintenance is not restricted.

See also:
Land Drainage Act 1991 (amended 1994)

Maintenance and Management

Ditches and watercourses should retain a three metre easement with access that allows for its future maintenance.

Details of the maintenance and management of the SuDS system are to be set out in writing in a site specific maintenance manual. This manual shall include details of the financial management and arrangements for the replacement of components at the end of the manufacturers recommended design life. This document is then to be submitted as part of the planning process.

References

The Building Regulations 2000
Drainage and waste disposal
Approved document H
ISBN: 1-859462-08-1

Building Research Establishment,
Soakaway Design – Digest 365 (BRE 365)
ISBN: 1 86081 604 5, 1991

Centre for Ecology and Hydrology
Flood Estimation for Small Catchments - IH Report 124
Marshall, D.C.W. & Bayliss, A.C.
ISBN: 0948540621, 1994

CIRIA
C697 The SUDs Manual
Woods-Ballard, B.; Kellagher, R. et al
ISBN: 978-0-86017-697-8, 2007

CIRIA
R156 Infiltration Drainage – Manual of Good Practice
Bettess, R.
ISBN: 0 86017 457 3

British Standards Institution
BS8582:2013 – Code of Practice for Surface Water Management for Development Sites
ISBN: 978 0 580 76700 5

ARUN DISTRICT COUNCIL BR/54/15/PL

Stevens, Richard

From: Roger Spencer <[redacted]
Sent: 19 August 2015 17:44
To: Day, Lauren
Subject: RE: Arun District Council SFRA - University of Chichester Bognor Regis Campus
Attachments: ArunSFRA2008_Extract-ofMapB-recreated.jpg

Dear Lauren,

At long last I've got the map that I think you want. A word of warning - it is provided by me putting back the various layers that I think went up to make Map B (rather than original 'workspace' of the mapping, which I wasn't able to fully open); however, I believe it matches the published Map B.

I am afraid that I can't find the flood level data but presumably by comparing the extent of the flood with the topography of your site, the depths across the site can be pretty well inferred.

Regards,

From: Day, Lauren[redacted]
Sent: 19 August 2015 08:59
To: Roger Spencer
Subject: RE: Arun District Council SFRA - University of Chichester Bognor Regis Campus

Hi Roger

Thanks for the updated, I'll keep a look out for the data this afternoon.

Kind Regards

Lauren

WSP | PARSONS BRINCKERHOFF

Lauren Day
Graduate Engineer
[redacted]

From: Roger Spencer [[redacted]
Sent: 19 August 2015 08:51
To: Day, Lauren
Subject: RE: Arun District Council SFRA - University of Chichester Bognor Regis Campus

Dear Lauren,

Sorry – IT security issues – the data is on an old DVD, so the rigorous checks we have to do now have caused a few issues.

ARUN DISTRICT COUNCIL BR/54/15/PL

Should be resolved by lunchtime (well, that's IT have promised), so I'll probably be able get the data to you this afternoon.

Regards,

Roger

From: Day, Lauren [redacted]
Sent: 17 August 2015 14:09
To: Roger Spencer
Subject: RE: Arun District Council SFRA - University of Chichester Bognor Regis Campus

Hi Roger

That sounds great, thank you. If you do require any other information from me please don't hesitate to get in touch.

Kind Regards

Lauren

Lauren Day
Graduate Engineer

Mountbatten House, Basing View, Basingstoke, Hampshire, RG21 4HJ
[redacted]

From: Roger Spencer [redacted]
Sent: 17 August 2015 14:04
To: Day, Lauren
Subject: RE: Arun District Council SFRA - University of Chichester Bognor Regis Campus

Dear Lauren,

Thanks for coming back with your detailed requirements.

The message was incomplete – the files are not on our server BUT…. I have found an archived DVD. It will take a little while to get the data to you but I am hopeful of providing this today or early tomorrow.

Regards,

Roger

From: Day, Lauren [redacted]
Sent: 17 August 2015 13:58
To: Roger Spencer
Cc: Stevens, Richard
Subject: Arun District Council SFRA - University of Chichester Bognor Regis Campus

Good Afternoon Roger

I apologise for missing your phone call earlier.

ARUN DISTRICT COUNCIL BR/54/15/PL

I understand that you require a more detailed site location for our site of interest. Please find attached location plans. The OSgrid reference for the site is (494427, 99622) and the nearest Post Code is PO21 1HP.

As discussed earlier we are trying to establish whether there is a higher resolution map of the extent of the tidal breach modelling that is included in the SFRA (Map B). We are also interested in obtaining the flood levels at our site location, as this will enable us to assess how much of the site would be affected. From the note that was left for me it appears that the SFRA mapping is not on your network? Is there anyone else I could contact to try and get hold of it, and do you know how we can obtain the required levels?

Kind Regards

Lauren

Lauren Day
Graduate Engineer

Mountbatten House, Basing View, Basingstoke, Hampshire, RG21 4HJ

[redacted]

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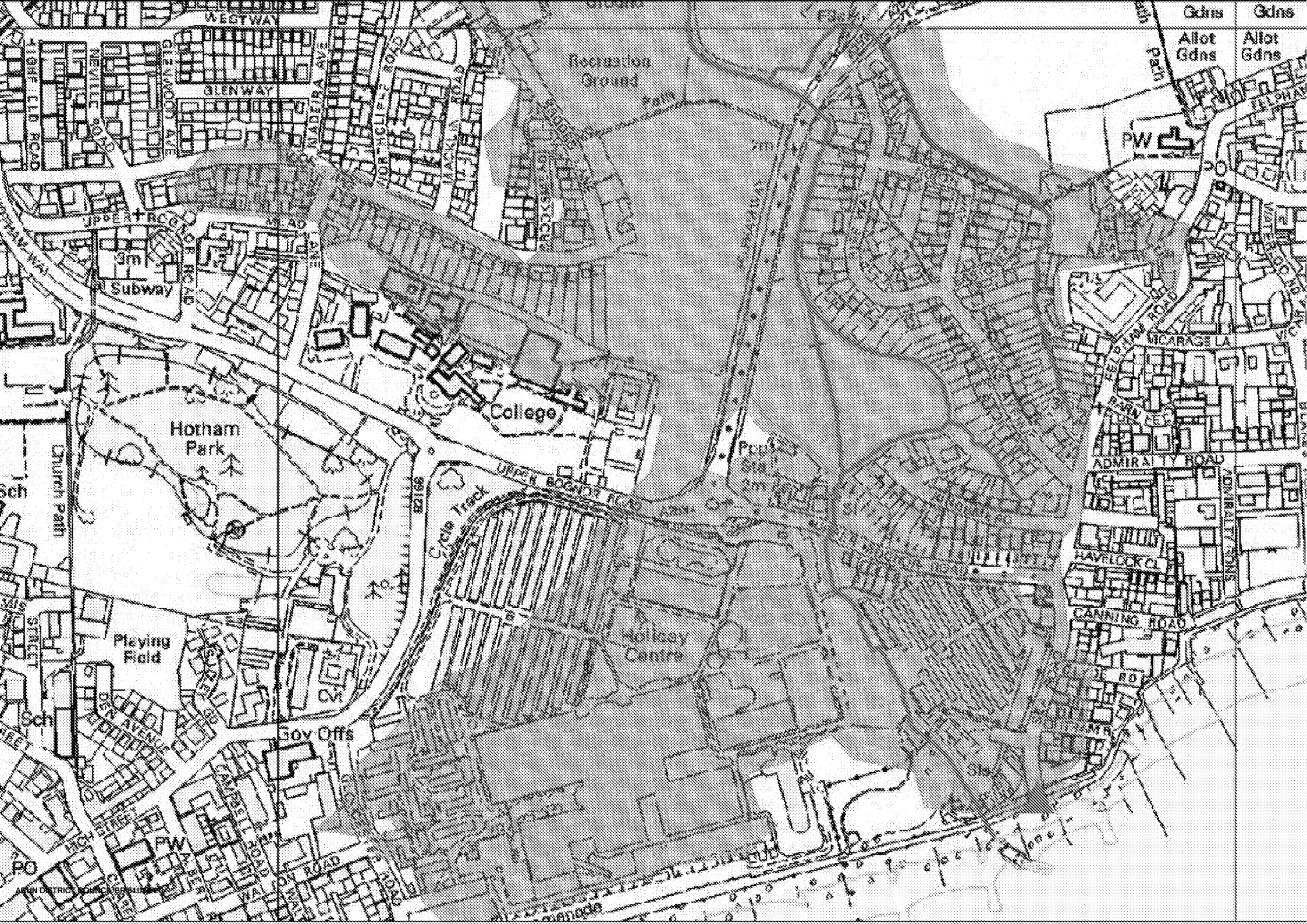
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WESTWAY
GLENWAY
Recreation Ground
Allot Gdns
Allot Gdns
PW
Subway
College
Hotham Park
Playing Field
Cycle Track
Holleoy Centre
Goy Offs
ADMIRALTY ROAD
CANNING ROAD
HAVELOCK CL
NICARAGUA
PO
PW
ARUN DISTRICT COUNCIL

Appendix D

MASTERPLAN



Proposed areas of lawn would allow students to relax in fine weather.



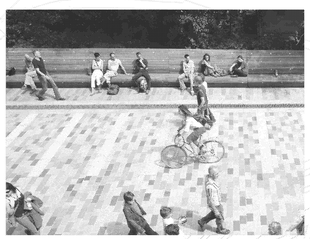
Proposed planting areas would include seating to edges.



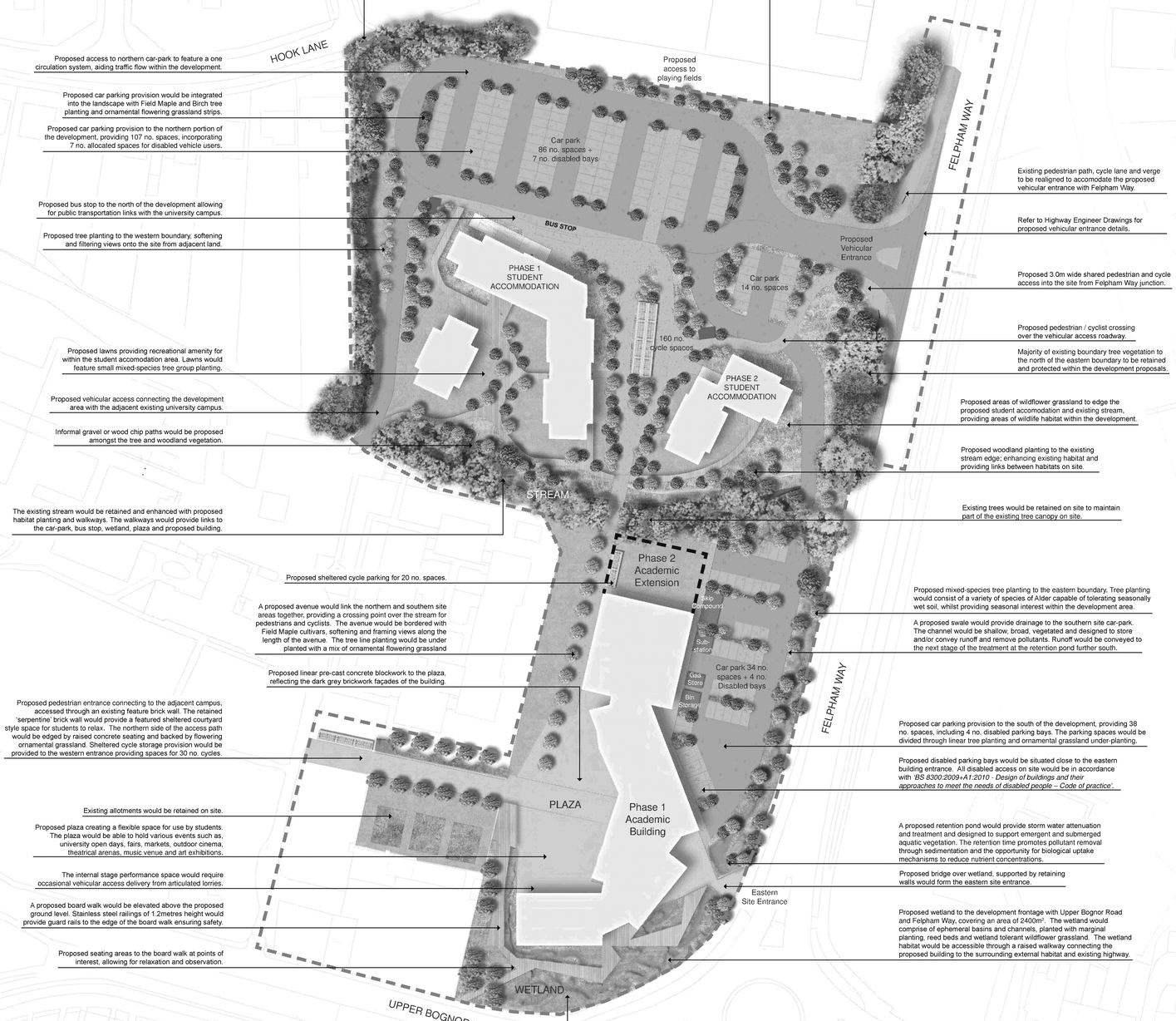
Proposed woodland planting would be situated along the edge of informal pathways.



Proposed car parking provision would be softened through tree planting.



Proposed shared surface surfacing for cyclist and pedestrian use.



Existing playing field entrance onto Hook Lane to be closed with new access provided within the development.

Proposed access to northern car-park to feature a one circulation system, aiding traffic flow within the development.

Proposed car parking provision would be integrated into the landscape with Field Maple and Birch tree planting and ornamental flowering grassland strips.

Proposed car parking provision to the northern portion of the development, providing 107 no. spaces, incorporating 7 no. allocated spaces for disabled vehicle users.

Proposed bus stop to the north of the development allowing for public transportation links with the university campus.

Proposed tree planting to the western boundary, softening and filtering views onto the site from adjacent land.

Proposed lawns providing recreational amenity for within the student accomodation area. Lawns would feature small mixed-species tree group planting.

Proposed vehicular access connecting the development area with the adjacent existing university campus.

Informal gravel or wood chip paths would be proposed amongst the tree and woodland vegetation.

The existing stream would be retained and enhanced with proposed habitat planting and walkways. The walkways would provide links to the car-park, bus stop, wetland, plaza and proposed building.

Proposed sheltered cycle parking for 20 no. spaces.

A proposed avenue would link the northern and southern site areas together, providing a crossing point over the stream for pedestrians and cyclists. The avenue would be bordered with Field Maple cultivars, softening and framing views along the length of the avenue. The tree line planting would be under planted with a mix of ornamental flowering grassland

Proposed linear pre-cast concrete blockwork to the plaza, reflecting the dark grey brickwork façades of the building.

Proposed pedestrian entrance connecting to the adjacent campus, accessed through an existing feature brick wall. The retained 'serpentine' brick wall would provide a featured sheltered courtyard style space for students to relax. The northern side of the access path would be edged by raised concrete seating and backed by flowering ornamental grassland. Sheltered cycle storage provision would be provided to the western entrance providing spaces for 30 no. cycles.

Existing allotments would be retained on site.

Proposed plaza creating a flexible space for use by students. The plaza would be able to hold various events such as, university open days, fairs, markets, outdoor cinema, theatrical arenas, music venue and art exhibitions.

The internal stage performance space would require occasional vehicular access delivery from articulated lorries.

A proposed board walk would be elevated above the proposed ground level. Stainless steel railings of 1.2metres height would provide guard rails to the edge of the board walk ensuring safety.

Proposed seating areas to the board walk at points of interest, allowing for relaxation and observation.

Existing 2 no. sports pitches would be retained in accordance with the site development proposals.

Extensive tree planting is proposed for several areas on site to mitigate against the removal the trees to accommodate the development proposals or due to their poor condition.

Existing pedestrian path, cycle lane and verge to be realigned to accomodate the proposed vehicular entrance with Felpham Way.

Refer to Highway Engineer Drawings for proposed vehicular entrance details.

Proposed 3.0m wide shared pedestrian and cycle access into the site from Felpham Way junction.

Proposed pedestrian / cyclist crossing over the vehicular access roadway.

Majority of existing boundary tree vegetation to the north of the eastern boundary to be retained and protected within the development proposals.

Proposed areas of wildflower grassland to edge the proposed student accomodation and existing stream, providing areas of wildlife habitat within the development.

Proposed woodland planting to the existing stream edge; enhancing existing habitat and providing links between habitats on site.

Existing trees would be retained on site to maintain part of the existing tree canopy on site.

Proposed mixed-species tree planting to the eastern boundary. Tree planting would consist of a variety of species of Alder capable of tolerating seasonally wet soil, whilst providing seasonal interest within the development area.

A proposed swale would provide drainage to the southern site car-park. The channel would be shallow, broad, vegetated and designed to store and/or convey runoff and remove pollutants. Runoff would be conveyed to the next stage of the treatment at the retention pond further south.

Proposed car parking provision to the south of the development, providing 38 no. spaces, including 4 no. disabled parking bays. The parking spaces would be divided through linear tree planting and ornamental grassland under-planting.

Proposed disabled parking bays would be situated close to the eastern building entrance. All disabled access on site would be in accordance with *'BS 8300:2009+A1:2010 - Design of buildings and their approaches to meet the needs of disabled people – Code of practice'.*

A proposed retention pond would provide storm water attenuation and treatment and designed to support emergent and submerged aquatic vegetation. The retention time promotes pollutant removal through sedimentation and the opportunity for biological uptake mechanisms to reduce nutrient concentrations.

Proposed bridge over wetland, supported by retaining walls would form the eastern site entrance.

Proposed wetland to the development frontage with Upper Bognor Road and Felpham Way, covering an area of 2400m². The wetland would comprise of ephemeral basins and channels, planted with marginal planting, reed beds and wetland tolerant wildflower grassland. The wetland habitat would be accessible through a raised walkway connecting the proposed building to the surrounding external habitat and existing highway.

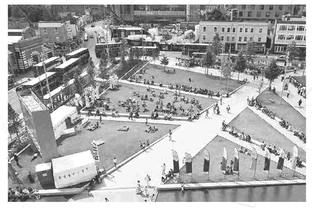
Wetland habitat offers the broadest scope for biodiversity gain, especially when dealing with small parcels of land as is available on-site. The local context provides added motivation for creating wetland habitat because water vole have been recorded approximately 30.00 metres east of the site boundary.



The proposed plaza would provide a flexible open space capable of accommodating fairs, markets, art exhibitions, stage productions and film screenings.



Proposed ornamental flowering grassland would provide seasonal interest across the site, integrating the campus with the surrounding landscape.



Proposed event and film screening within the proposed plaza.



Proposed wetland habitat would offer the broadest scope for biodiversity gain within small parcels of land on-site.



Proposed wetland would be integrated into the campus through the creation of seating areas, public links, board walks and viewpoints.

N

0 5 10 20 30 40 50 75 100 Metres

Legend

- **Existing - Mature Trees - Retained** — Existing mature trees to be retained and protected on site in accordance with BS 5837:2012 - *Trees in Relation to Design, Demolition and Construction - Recommendations'.*
- **Existing - Stream - Retained & Enhanced** — Existing stream running through the centre of the proposed development site to be retained and enhanced with walkways and habitat planting.
- **Proposed - Mixed Species Tree Planting** — Proposed mixed-species tree planting throughout the site to consist of species suited to site conditions and taking into account underground services and development scale.
- **Proposed - Wildflower Grassland** — Native wildflower grassland seed mixes proposed to suit local ground conditions and habitats.
- **Proposed - Car Park Frontage Planting** — Proposed mixed-species tree line planting and ornamental wildflower grassland to parking provision frontages.
- **Proposed - Swale** — Proposed swale to collect surface water run-off from the proposed southern car park. Swale to provide attenuation of excess surface water run off and help feed the wetland area to the southern and eastern site area.
- **Proposed - Wetland** — Proposed wetland area to the south of the site, providing attenuation and treatment to surface water run off. Planting with marginal and aquatic planting and reedbeds, providing habitat for species of birds, reptiles, mammals and invertebrates.
- **Proposed - Board Walk** — Proposed viewing / access board walk to the wetland habitat area to the south-east corner of the development with seating provided at points of interest. Boardwalk to be railings to be 1.2m height stainless steel railings.
- **Proposed - Plaza** — Proposed plaza designed to hold various university events and performances. Plaza to be surfaced with linear pin-pad concrete blockwork paving treatment
- **Proposed - Car Parking** — Proposed car parking provision for a total of 145 no. spaces, incorporating 11 no. disabled parking bays.
- **Proposed - Disabled Parking Bays** — Proposed disabled parking bays located close to proposed buildings and adjacent to paved/hard areas. All disabled access on site would be in accordance with *'BS 8300:2009+A1:2010 - Design of buildings and their approaches to meet the needs of disabled people – Code of practice'.*
- **Proposed - Bus Stop** — Proposed bus stop bay/lay located to the northern site area, allowing for public transport connections.
- **Proposed - Sheltered Cycle Storage** — Proposed sheltered cycle storage provision for 250 no. cycles across the proposed campus development.
- **Proposed - Building Footprints** — Proposed academic building and student accommodation building footprints.
- **Proposed Development Site Boundary**

PLANNING ISSUE

Rev	Description	Date	Initials
04	Planning Issue	26.02.16	TB

Lizard Landscape Design

Lizard Landscape Design and Ecology
34 South Street
Tarring
Worthing
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BN14 7LH
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Project Title

Engineering & Digital Technology Park
Bognor Regis, West Sussex

Drawing Title

Landscape Masterplan Strategy
University of Chichester

Scale	Drawn	Date
1:500@A0	TB	20/10/2015
	Approved	

Drawing No. LLD913 / 01 — *Revision* 04

Filepath: *LLD913\InDesign*

Landscape Masterplan Strategy
Engineering & Digital Technology Park, University of Chichester, Bognor Regis, West Sussex

ARUN DISTRICT COUNCIL 8RN/BO/BRL

Appendix E

DRAINAGE STRATEGY

WSP Property and Development

CALCULATION LOG SHEET

Project Name **University of Chichester, Bognor Regis Campus**
Project No 70013264

Calculation Title **Surface Water Management Strategy Calculation Pack**

Office Location WSP Basingstoke

Prepared by Richard Stevens Date 31 March 2016
Checked by Stephen Riley
Approved by Stephen Riley

Rev	Amendment	By	Date	Checked	Approved
A	First Issue	RS	31 Mar 16	SR	SR

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University of Chichester, Bognor Regis Campus
Surface Water Drainage Strategy

Rationale

The following provides an indicative drainage strategy only and will be subject to a more thorough analysis during the detailed design stage of the development project.

This strategy seeks to demonstrate the principles of surface water management for the Proposed Development in terms of permitted discharge rates, constraints on discharges, and resulting volumes of attenuation required and where this could be provided subject to detailed design.

The rainfall intensities used in this assessment have been taken from the digital catchment descriptors made available on the FEH CD-ROM (CEH 2009).

The Proposed Development is a Greenfield site. Therefore the initial assessment for development runoff rates has been undertaken using greenfield rates, as discussed in the Non-Statutory Sustainable Drainage Technical Standards (March, 2015).

Surface Water Drainage Requirements

The Surface Water Drainage Strategy seeks to demonstrate the Proposed Development can be drained in a sustainable manner, commensurate with local and national policy.

The National Planning Policy Framework (NPPF) requires that flood risk to land and property is not increased as a result of development upstream.

The Non-Statutory sustainable drainage technical standards state that peak runoff rates should be limited to the greenfield runoff rates, and long term storage should been provided. Exceedance routes should be shown to not impact the safety of property.

Arun District Council's Local Plan states that SuDS should be used for drainage where appropriate, and that planning permission will be refused unless it is demonstrated that adequate drainage capacity exists or can be provided. The Local Plan also states that the water environment and water quality should not be affected by the development.

Water.People.Places guide to master planning sustainable drainage into developments outlines the process for integrating SuDS into the master planning of developments, and states that SuDS should be used as an interconnected system, providing a 'treatment train'.

Arun District Council's Supplementary Requirements for Surface Water Drainage Proposals state that when discharging to a watercourse or surface water sewer, the rate must be restricted to the greenfield mean annual maximum flood (Qbar) by means of a controlled outflow.

Site Details

The Application Site is situated to the east of Bognor Regis in West Sussex. The site is located north of Upper Bognor Road and west of Felpham Way in Bognor Regis, West Sussex.

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The site is bordered by Upper Bognor Road and Barbara Smith student accommodation to the south, Felpham Way to the east, open land to the north, and the University of Chichester and residential accommodation to the west.

The Application Site has a gross area of 3.14ha and is considered to be a Greenfield development site.

The Ordnance Survey (OS) grid reference for the Application Site is 494427, 99622 and the nearest postcode is PO21 1HP.

Table 1: General Site Characteristics

CHARACTERISTIC	DESCRIPTION	
Area	3.14 ha	
General Topography	The site slopes from the northern and southern boundaries towards the watercourse that flows through the site from west to east.	
Existing Surface	Greenfield	
Current Use	Open Land	
Boundaries	North	Open Land
	South	Upper Bognor Road and Barbara Smith student accommodation
	East	Felpham Way
	West	University of Chichester and residential properties
Access	Access to the north for the site will be provided by a new road junction from Felpham Way. Access to the site is also provided from the existing university campus to the west of the site.	

British Geological Survey (BGS) maps (available online at www.bgs.ac.uk and accessed in February 2016) indicate that the southern part of the site is situated on bedrock of Lambeth Group – Clay, Silt and Sand. The northern part of the site is situated on Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation. In addition superficial deposits of River Terrace Deposits also cover the site.

An ordinary watercourse runs through the centre of the site, running west to east. It enters the site through a culvert on the western boundary and exits the site into a culvert beneath Felpham Way.

Development Description

Full planning permission is sought for a Proposed Development comprising an Engineering and Media facility, residential student accommodation and associated car parking at the University of Chichester, Bogor Regis Campus.

The proposed illustrative masterplan has been produced by Lizard Landscape Design, and is shown in Appendix D of WSP's Flood Risk Assessment.

Existing Surface Water Management Regime

The Application Site currently drains through overland flow to the watercourse that flows from west to east through the centre of the site.

The topographical survey indicates that ground levels at the Application Site range from 3.12m AOD in the south western corner of the site to -0.82m AOD in the watercourse at the centre of the site.

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As the Proposed Development area is less than 50ha, the Institute of Hydrology (IoH) Report 124 Flood Estimation for Small Catchments (1994) method has been used to estimate the Greenfield peak flow rate, which is an approved methodology specified within the Environment Agency's Rainfall Runoff Management for Developments Report[1].

Table 2 summarises the estimated current Greenfield discharge rates for 1ha of developable area. Full calculations are provided in the drainage calculation pack in Appendix A.

Table 2: Summary of Greenfield Peak Discharge Rates

DEVELOPABLE AREA (HA)	RETURN PERIOD (YR)	PEAK GREENFIELD DISCHARGE RATE (L/S)
1	QBAR	2.9
	Q1	2.5
	Q30	6.6
	Q100	9.2

Proposed Surface Water Drainage Strategy

Part H of the Buildings Regulations: Drainage and Waste Disposal, establishes a hierarchy for surface water disposal, which encourages a SuDS approach. This hierarchy stipulates that surface runoff not collected for reuse must be discharged to one or more of the following in order of priority:

1. discharge into the ground (infiltration); or, where not reasonably practicable,
2. discharge to a surface water body; or, where not reasonably practicable,
3. discharge to a surface water sewer, highway drain, or another drainage system; or, where not reasonably practicable,
4. discharge to a combined sewer.

The Arun District Council Supplementary Requirements has elaborated on this hierarchy with the amendment that there is no provision for connection to a combined sewer.

Due to high groundwater levels in the area, and the result of soakage tests showing that infiltration rates could not be calculated for the site, infiltration to ground will not be possible, and this therefore has not been used within this drainage strategy. Full details of the WSP | Parsons Brinckerhoff Ground Investigation can be found in Report GEO/BRTP/70013264_001 (Appendix C).

Therefore, all surface water runoff generated on site will be discharged to the existing watercourse flowing west to east through the centre of the Application Site. The Arun District Council Supplementary Requirements for Surface Water Drainage Proposals requires that this discharge is limited to the estimated mean annual maximum greenfield runoff rate (Qbar) of 9.1 l/s.

[1] Great Britain, R Kellagher (2013) *Rainfall Runoff Management for Development Report SC030219, Environment Agency, Bristol*

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Limiting the discharge rate to Qbar will result in the generation of a volume of water to be attenuated on-site prior to discharge to the watercourse.

The open watercourse on site will be used as the discharge point for all surface runoff from the site.

As surface water can be discharged to a surface watercourse discharge to a local public sewer is not considered necessary for the Proposed Development.

Based on the masterplan and the topographic levels, the site has been split into three distinct sub-catchments;

- north of the watercourse;
- south of the watercourse to the east of the proposed main building and including the majority of the main building; and,
- west of the main building, south of the on-site watercourse.

These are shown on Figure E1.

The Proposed Development will result in a net increase of impermeable area onsite. The impermeable area for the development has been calculated using the masterplan. The Proposed Development will have a total impermeable area, including highway, parking areas, pavements and buildings of 1.47ha.

Table 3 summarises the Proposed Development peak discharge rates for a variety of storm events, using the Rational Method:

$$Q\ (l/s) = 2.78\ x\ C\ x\ A\ (ha)\ x\ i\ (mm/hr)$$

Where C is a coefficient of permeability (taken as 1 to represent no infiltration), A is the impermeable area and *i* the rainfall intensities for the 5 minute storm from the Transport and Road Research Laboratory Report LR 595 – 'Estimated rainfall for drainage calculations in the United Kingdom'.

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Table 3: Rational method, Post Development Peak Discharge Rates

CATCHMENT	PROPOSED DEVELOPMENT AREA (HA)	IMPERMEABLE AREA (HA)	RAINFALL EVENT PROBABILITY	RAINFALL INTENSITY (MM/HR)	PEAK POST DEVELOPMENT DISCHARGE RATES (L/S)
A – Northern Catchment	1.77	0.86	100%	50.8	118
			3.33%	113	262
			1%	143.9	334
			1% + CC (20%) Error! Bookmark not defined.	172.7	401
B – South Eastern Catchment	0.96	0.41	100%	50.8	56
			3.33%	113	126
			1%	143.9	160
			1% + CC (20%) Error! Bookmark not defined.	172.7	192
C – South Western Catchment	0.41	0.20	100%	50.8	28
			3.33%	113	61
			1%	143.9	78
			1% + CC (20%) Error! Bookmark not defined.	172.7	94

The Quick Storage Estimate (Design Suite for Micro Drainage) has been used to calculate the attenuation required for all events up to the 1% annual probability rainfall event, including an allowance for climate change.

A minimum discharge rate of 3l/s has been applied at all outfalls to minimise the risk of blockage at flow control devices.

The results are summarised within Table 4 and full calculations are provided in Appendix B.

The attenuation required within the site is based on the 85th percentile of the range of the Quick Storage Estimate. This figure provides a conservative estimate of the volume of attenuation required to ensure the site does not discharge at a greater rate or volume than it does currently.

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Table 4: Surface Water Attenuation Volume Calculations

Catchment	Proposed Development Area (ha)	Impermeable Area (ha)	Rainfall Event probability	Existing Greenfield Peak Discharge Rate (l/s)	Unmitigated Peak Post Discharge Rates (l/s)	Proposed Discharge Rate (l/s)	Required Storage Volume Range (QSE) (m^3)	85th Percentile of QSE (m^3)
A	1.77	0.86	100%	4.4	118	3.1	75 – 120	113
			3.33%	11.7	262	3.1	234 – 329	315
			1%	16.3	334	3.1	329 – 449	431
			1% + CC (20%)Error! Bookmark not defined.	16.3	401	3.1	415 – 563	541
B	0.96	0.41	100%	2.4	56	3.0	26 – 44	41
			3.33%	6.4	126	3.0	89 – 129	123
			1%	8.9	160	3.0	129 – 179	172
			1% + CC (20%)Error! Bookmark not defined.	8.9	192	3.0	162 – 225	216
C	0.41	0.20	100%	1.0	28	3.0	9 – 16	15
			3.33%	2.6	61	3.0	33 – 51	48
			1%	3.7	78	3.0	49 – 72	69
			1% + CC (20%)Error! Bookmark not defined.	3.7	94	3.0	63 – 91	87

Based on Table 4 the Proposed Development will have a maximum discharge of9.1l/s for all events up to an including the 1% annual probability rainfall event including an allowance for climate change.

In aggregate discharges from the site for all events in excess of the 100% annual probability event will be less than their equivalent greenfield runoff rates. However for 100% event the gross discharge from the proposed development will be 9.1l/s (i.e. Qbar) compared to a greenfield discharge rate of 7.85 l/s, a 1.25l/s increase.

Drainage Systems

To control the rate and volumes of runoff discharged by the Proposed Development, SuDS will be utilised throughout the development site. The size and placement of these will be dictated by the constraints presented by topography and geology and the proposed site plan.

Currently the CIRIA document C753 forms the best practice document for the design of SuDS for development sites and has been used to inform this Drainage Strategy. In addition Code of Practice For Surface Water Management For Development Sites" BS8582:2013 has also been referred to when developing the strategy.

The concept of sustainable drainage is that environmental and social factors such as the quantity and quality of runoff and amenity value of surface water in the urban or developed environment are considered when making decisions about drainage. SuDS can be used to compliment or replace conventional piped urban drainage to replicate the natural water cycle. This process can be used in certain locations to reduce or even eliminate the existing problems associated with such systems: risk of flooding, potential of pollution or poor water quality and damage to the natural environment.

A wide range of drainage systems and techniques can be categorised as SuDS. From site wide installations (ponds/basins) to domestic source control (permeable pavements), the scale of SuDS schemes and their benefits can vary widely. For a development such as this, it is often necessary to incorporate a combination of site control and source control measures within the overall strategy.

It is proposed that onsite attenuation will be provided by a combination of SuDS features including swales, a wetland, a pond, permeable paving and underground storage tanks. The storage has been located to avoid buried utilities (pipes and cables) and provide sufficient easements to ensure the utility infrastructure can be replaced if required. Figure E2 shows the key buried utilities on the site and the constraints these place upon the proposed drainage strategy layout. This includes a foul rising main along the western side of the site and the foul sewer along the western boundary .

The following sections set out how the necessary storage is provided for each of the three catchments.

Northern Catchment

This catchment drains the entire development north of the onsite watercourse including the three residential student accommodation buildings, the car parking areas and pedestrian walkways.

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All roof water from the three buildings will be conveyed directly to underground storage tanks beneath the landscaped areas surrounding the buildings. Water will be released from these tanks at a controlled rate via a pipe network to a point of outfall into the watercourse at the eastern side of the site.

All tanks have been sized to have a storage depth of 0.45m a void space of 95% (i.e.geocellular storage crates) and a minimum depth of cover of 0.3m. All tanks are sufficiently sized to contain the 3.3% annual probability rainfall event without any outflow.

All tanks should incorporate non-return valves at their outlets to prevent water backing up into them from the rest of the onsite drainage system. Appropriate measures will need to be taken to mitigate any risk of tank flotation as a result of high groundwater levels.

All runoff from hard standing areas will be collected by areas of porous asphalt/paving located within the roads, pathways and car parking areas. This will be then be discharged at a controlled rate using a conventional pipe drainage system to the single outfall for this catchment. All porous asphalt areas have been sized based on storage in the sub-base layers with a void ratio of 30% and a storage depth of up to 0.5m, with the exception of one area (PP N10) which will utilise geocellular storage crates (95% void). This is necessary as insufficient space is available within part pf the development to provide sufficient storage with a granular sub-base construction.

The drainage strategy illustrates that the total volume of storage provided to the north of the watercourse is sufficient to accommodate the 1% annual probability rainfall event with a 20% allowance on rainfall intensity for climate change in this part of the Proposed Development.

Drainage of this part of the site will be affected by flooding from the watercourse and overland flow. During extreme rainfall events of 3.3% annual probability and greater the majority of this part of the site will be inundated to shallow depths of flooding (less than 0.3m).

Storage provided in tanks will be sealed to prevent ingress of flood water from overland flow and the watercourse. However, storage provided for impermeable areas at ground level (roads, paths and car parking) will only be effective for events where flooding does not occur to the site from the watercourse and overland flows.

However in the event of a catchment flood the resulting on-site flooding (from the watercourse and overland flow will ingress into the drainage system. In effect however the contribution of the site drainage system to mitigating the impact of the development will be realised early in a catchment flood event. As the catchment flood propagates to inundate the site the proposed development runoff will be no greater than the current undeveloped site due to rain falling on floodwater in both scenarios.

South Eastern Catchment

This catchment drains the majority of the proposed academic teaching building south of the watercourse, the southern part of the plaza area and the car parking areas to the east of the main building.

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Surface water runoff from the plaza area will be captured by a swale to the west of the building and conveyed southwards to the wetland area south of the building. Roof runoff from the building will also be directed into the wetland area. The wetland will be designed to accommodate a storage depth of 0.3m above the permanent water level and also incorporate a 0.3m freeboard above the design water level. Water from the wetland area will be released at a controlled rate to the small pond.

Surface water runoff from the car parking and road areas east of the building will flow overland to the swale on the eastern boundary of the site. This will capture runoff and provide some storage before discharge to the pond at the southern end of the swale. The swale will have a maximum storage depth of 0.6m with a 0.15m allowance for freeboard; the longitudinal slope will be 1:150 and the side slopes will be 1:3.

The small pond will receive water from both the swale and wetland, and be designed to accommodate a depth of storage of 0.4m above the permanent water level. Water will be released at a controlled rate from the pond via a pipe connection to the onsite watercourse.

South Western Catchment

This catchment drains the pedestrian walkway from the existing campus, the northern part of the plaza, the access road from the plaza to the central bridge and the northern part of the main academic building.

Surface water from the hard standing areas will be captured by porous asphalt/paving surfaces with sub-surface storage layers. Water from the northern part of the academic building will also be conveyed to these storage features. All three areas of porous asphalt/paving will be designed to have a 0.5 deep storage layer comprising aggregate sub-base with a void ratio of 30%.

Water will be conveyed from these storage features via a conventional pipe network to an outfall into the watercourse, to the east of the central bridge.

Summary

Table 6 outlines the different storage requirements of each feature for each catchment for the 1% annual probability event with a 20% allowance for climate change. The location of each feature can be seen in Figure E3.

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Table 6: Storage requirements

Catchment	Storage required (m^3)	Storage Feature	Storage Volume (m^3)	Total Storage (m^3)	Excess Storage Available
A	478	Porous Asphalt	501	624	84
		Storage Tanks	124		
B	216	Wetland	143	251	35
		Eastern Swale	66		
		Pond	42		
C	87	Porous Asphalt	90	90	3

Points of Discharge

Given the topography and layout of the proposed development the surface water drainage network will discharge to the open watercourse that flows from west to east through the site. There will be three points of discharge, one from the catchment to the north of the watercourse and two for the catchments to the south.

Discharge to the watercourse will require ordinary watercourse consent to be obtained from the Environment Agency who are responsible for this watercourse as part of their role as the Internal Drainage Board. This will be sought once detailed designs for the proposed drainage system and outfall have been developed following receipt of planning permission.

Exceedence Routes

The onsite surface water drainage system has been sized to accommodate the 1% annual probability rainfall event with a 20% allowance for climate change. As required by the Environment Agency's Flood risk assessments: climate change allowances'[2] guidance the impact of a 40% increase in peak rainfall intensity has been assessed.

Figure E4 shows the routes water would take as a consequence of exceedance of the drainage system. This divides the site into four exceedance catchments.

Over the site as a whole the additional volume generated in the 1% annual probability rainfall event for a 40% climate change allowance compared to a 20% allowance is $180m^3$. Figure E4 shows the distribution of this volume across the three catchments.

In Catchment A (northern area) water would flow southwards towards the watercourse, along the roads and pathways. All three buildings are raised above the surrounding ground levels to ensure they are safe from fluvial / pluvial flood risk, therefore any additional water generated by rainfall onto the site would flow beneath the buildings through the void spaces.

[2] Environment Agency, Flood risk assessments: climate change allowances (February 2016) (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances)

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In Catchment B (south eastern area) water would be retained in the storage features (Swales, pond and wetland) within the freeboard allowances. A total of 11m^3 of additional runoff would be generated above that which has already been catered for in the design of the drainage system. This would lead to an increase in peak water level across the pond and wetland areas of 0.02m which is less than the freeboard allowances of 0.3m incorporated into both features. If the storage provided by the freeboard allowances was to be exceeded water would flow overland northwards across the car parking areas and into the watercourse at the centre of the site.

In Catchment C (south western area) a total of 15m^3 of additional runoff would be generated above that which has already been catered for in the design of the drainage system. This would flow overland along the plaza and the road to the central bridge before flowing into the watercourse to the east of the bridge.

Water Quality Management

In line with Table 4.3 of the SuDS Manual CIRIA C753 the pollution hazard level of the site is low to medium. The SuDS Manual CIRIA C753 simple index approach has been used to assess the pollution mitigation performance of the proposed drainage system. The respective pollution hazard levels for the different parts of the site and how these will be mitigated is set out in the following sections.

Northern Catchment

Roof water from non-residential roofs has a pollution hazard level of Low, which relates to the following pollution hazard indices (See table 26.2 of the SuDS Manual):

- Total Suspended Solids = 0.3
- Metals = 0.2
- Hydrocarbons = 0.05

Where this runoff is conveyed directly to geocellular storage tanks proprietary treatment systems (Silt traps and oil interceptors) should be installed to treat this water prior to discharge to the tanks.

The roads and pathways also have a pollution hazard level of Low, however this relates to the following higher pollution hazard indices (See table 26.2 of the SuDS Manual):

- Total Suspended Solids = 0.5
- Metals = 0.4
- Hydrocarbons = 0.4

All of the runoff is directed through porous asphalt/paving which has pollution mitigation indices of 0.7, 0.6 and 0.7 for Total Suspended Solids, Metals and Hydrocarbons respectively. Therefore these features have sufficient pollution mitigation indices to deal with the anticipated level of pollution hazard.

South Eastern Catchment

Roof water from non-residential roofs has a pollution hazard level of Low, which relates to the following pollution hazard indices (See table 26.2 of the SuDS Manual):

- Total Suspended Solids = 0.3

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- Metals = 0.2
- Hydrocarbons = 0.05

The roads and pathways also have a pollution hazard level of Low, however this relates to the following higher pollution hazard indices (See table 26.2 of the SuDS Manual):

- Total Suspended Solids = 0.5
- Metals = 0.4
- Hydrocarbons = 0.4

All of the runoff is directed through either a swale, the wetland and the pond or a swale and the pond. Both combinations of features have sufficient pollution mitigation indices to adequately provide enough mitigation for discharges to surface water (See table 26.3 of the SuDS Manual).

South Western Catchment

Roof water from non-residential roofs has a pollution hazard level of Low, which relates to the following pollution hazard indices (See table 26.2 of the SuDS Manual):

- Total Suspended Solids = 0.3
- Metals = 0.2
- Hydrocarbons = 0.05

The roads and pathways also have a pollution hazard level of Low, however this relates to the following higher pollution hazard indices (See table 26.2 of the SuDS Manual):

- Total Suspended Solids = 0.5
- Metals = 0.4
- Hydrocarbons = 0.4

All of the runoff is directed through porous asphalt which has pollution mitigation indices of 0.7, 0.6 and 0.7 for Total Suspended Solids, Metals and Hydrocarbons respectively. Therefore these features have sufficient pollution mitigation indices to deal with the level of pollution hazard.

Ownership and Maintenance

The onsite drainage system for the proposed development will remain private and the responsibility of the University of Chichester. The responsibility for operation and maintenance of all elements of the drainage system will remain with the University of Chichester.

There is no need for any parts of the proposed drainage system to be constructed on third party land as both outfalls are to the watercourse within the site boundary.

The general maintenance regime of the proposed strategy is outlined below:

Porous Asphalt/ paving

Ownership / adoption: University of Chichester

Maintenance requirement: Brushing and vacuuming three times per year; removal of weeds, repair any broken blocks / damaged areas; maintain vegetation; 3 monthly inspection of

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poor operation and/or weed growth; annual inspection of silt accumulation and inspection chambers.

Onsite Sewer Network

Ownership / adoption: University of Chichester

Maintenance requirement: Six monthly maintenance and inspection of the surface water sewer network.

Geocellular Storage Tanks

Ownership / adoption: University of Chichester

Maintenance requirement: Six monthly inspection of system to check issues and blockages including all inlets, outlets, vents and overflows; annual removal of sediment from pre-treatment structures / internal forebays; 5 yearly survey inside tank to check for sediment accumulation and remove as required.

Pond and Wetland

Ownership / adoption: University of Chichester

Maintenance requirement: Monthly removal of litter and debris, and inspection of inlets, outlets and overflows for blockage, vegetation management, 6 monthly inspection of silt accumulation and removal as required.

Swales

Ownership / adoption: University of Chichester

Maintenance requirement: Monthly removal of litter and debris, and inspection of inlets, outlets and overflows for blockage; monthly cutting of grass during growing season; 6 monthly inspection of silt accumulation and removal as required.

Regular inspection and maintenance is required to ensure the effective long term operation of SuDS, these are detailed in the SuDS Manual CIRIA C753.

ARUN DISTRICT COUNCIL BR/54/15/PL

Summary

This Drainage Strategy demonstrates that the site can be drained in a sustainable manner in accordance with National and Local policy.

In accordance with the NPPF the drainage strategy demonstrates that flood risk to land and property will not increase as a result of the proposed development.

In accordance with the Non-Statutory sustainable drainage technical standards peak runoff rates are limited to the greenfield runoff rates, and long term storage has been provided. Exceedance routes have been shown to not impact the safety of property.

This drainage strategy demonstrates that the proposed development can be drained in a sustainable manner without increasing the risk of flooding to neighbouring properties for events up to and including the 1% annual probability plus climate change (20%) return period.

The impacts of the 1% annual probability plus climate change (40%) exceedance event have been assessed and this drainage strategy demonstrates that this will not increasing the risk of flooding to neighbouring properties.

It should be noted that the above presents one possible solution to demonstrate that the development can be sustainably drained, to comply with the requirements of the NPPF and West Sussex / Arun District policy. Other solutions may be feasible that would meet these criteria and may prove to be better suited to the site. These may become apparent during detailed design. The strategy above should not therefore be interpreted as the definitive scheme solution.

The drainage strategy is prepared in outline only to demonstrate the proposed development can meet national and local requirements, which is appropriate for this planning application. Further development of the drainage strategy will be required during the detailed design stage of the project.

ARUN DISTRICT COUNCIL BR/54/17/PL

Figures

ARUN DISTRICT COUNCIL BR/54/16/PL

Date Modified: 23/03/2016

Drawn By: ukris003

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Drainage Strategy Figures\E1 Drainage Catchments.mxd

Key

Catchments

- Northern
- South Eastern
- South Western

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0 5 10 20 30 40 50

Meters

WSP | PARSONS BRINCKERHOFF

TITLE:

University of Chichester EDTP Bognor Regis

FIGURE No:

FIGURE E1
Drainage Catchments

Date Modified: 24/03/2016

Drawn By: ukrfs003

Key

- Foul Sewer
- Foul Rising Main
- Foul Sewer Easement
- Rising Main Easement

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0 5 10 20 30 40 50 Meters

WSP | PARSONS BRINCKERHOFF

TITLE:

University of Chichester EDTP Bognor Regis

FIGURE No:

FIGURE E2
Utilites Constraints

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Drainage Strategy Figures\E2 Utilites Constraints.mxd

Date Modified: 23/03/2016

Drawn By: ukrls003

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Drainage Strategy Figures\E3 Drainage Strategy Layout.mxd

PP N1
PP N2
PP N3
PP N4
PP N5
PP N6
PP N7
PP N8
PP N9
PP N10
PP N11
PP N12
PP N13
T1
T3
T3
T4
S1
S2
PP S1
PP S2
PP S3
P1
W1
Outfall N
Outfall SE
Outfall SW

Key

- Outfall Location
- Pipe
- Wetland (W)
- Pond (P)
- Swale (S)
- Storage Tank (T)
- Porous Asphalt (PP)

Northern Attenuation Storage

PP N1	35m^3
PP N2	35m^3
PP N3	35m^3
PP N4	17m^3
PP N5	15m^3
PP N6	19m^3
PP N7	14m^3
PP N8	17m^3
PP N9	146m^3
PP N10	112m^3
PP N11	16m^3
PP N12	17m^3
PP N13	23m^3
T1	24m^3
T2	32m^3
T3	32m^3
T4	36m^3

South Western Attenuation Storage

PP S1	32m^3
PP S2	43m^3
PP S3	15m^3

South Eastern Attenuation Storage

S1	negligible
S2	66m^3
W1	143m^3
W2	42m^3

Site Discharge

Northern Outfall
Total Storage Provided 624m^3
Maximum Discharge Rate 3.1l/s

South Western Outfall
Total Storage Provided 90m^3
Maximum Discharge Rate 3.0l/s

South Eastern Outfall
Total Storage Provided 251m^3
Maximum Discharge Rate 3.0l/s

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0 5 10 20 30 40 50 Meters

WSP | PARSONS BRINCKERHOFF

TITLE:
University of Chichester EDTP
Bognor Regis

FIGURE No:
FIGURE E3
Drainage Layout

Date Modified: 23/03/2016

Drawn By: ukrls003

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Key

Exceedence Catchments

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0 5 10 20 30 40 50 Meters

WSP | PARSONS BRINCKERHOFF

TITLE:

University of Chichester EDTP Bognor Regis

FIGURE No:

FIGURE E4
Exeedence Routes

Appendices

ARUN DISTRICT COUNCIL BR/54/16/PL

Appendix A: Greenfield Runoff rates

ARUN DISTRICT COUNCIL BR/54/17/PL

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.370
Area (ha)	1.000	Urban	0.000
SAAR (mm)	704	Region Number	Region 7

Results l/s

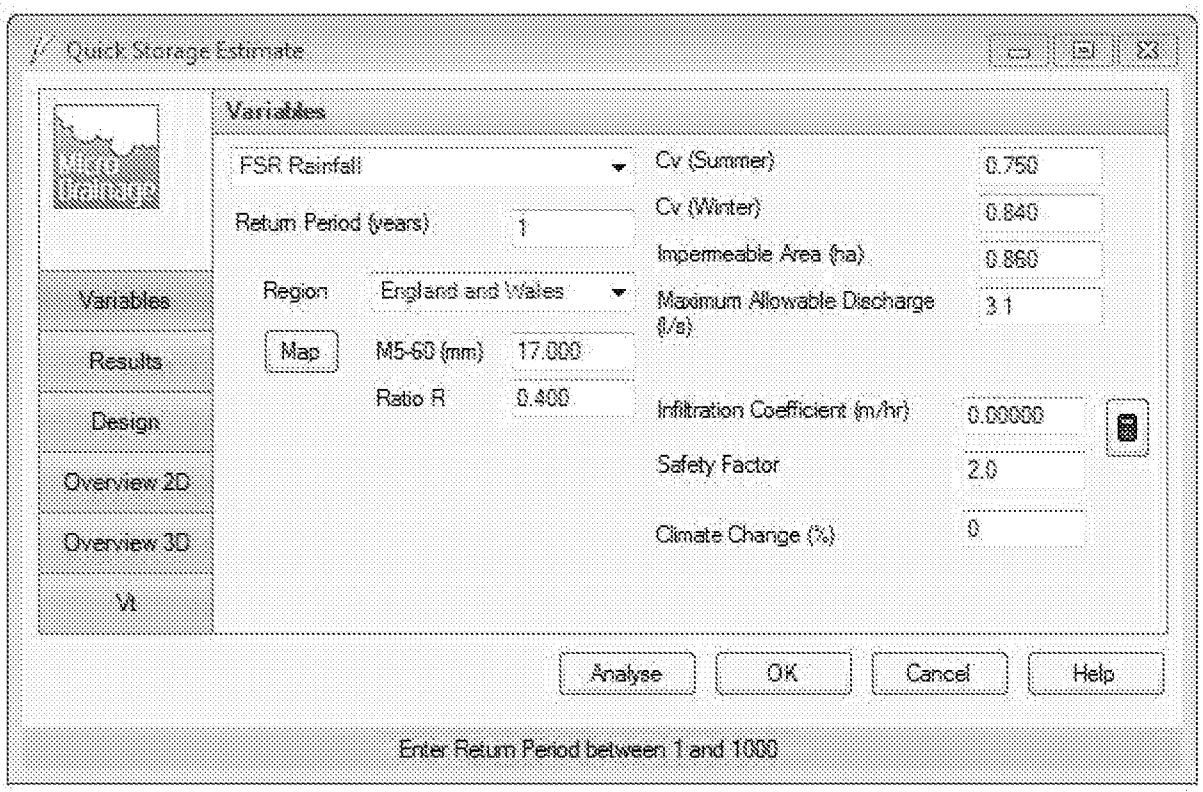
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QBAR Urban	2.9
Q100 years	9.2
Q1 year	2.5
Q30 years	6.6
Q100 years	9.2

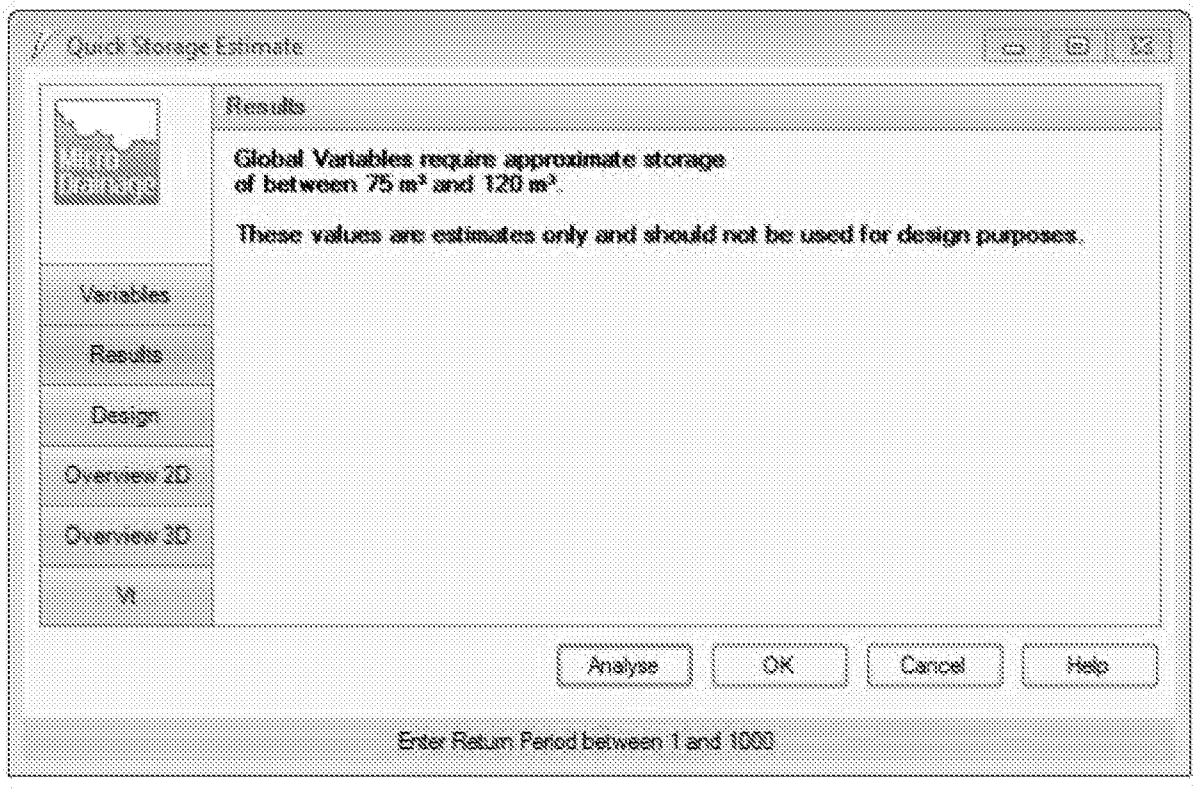
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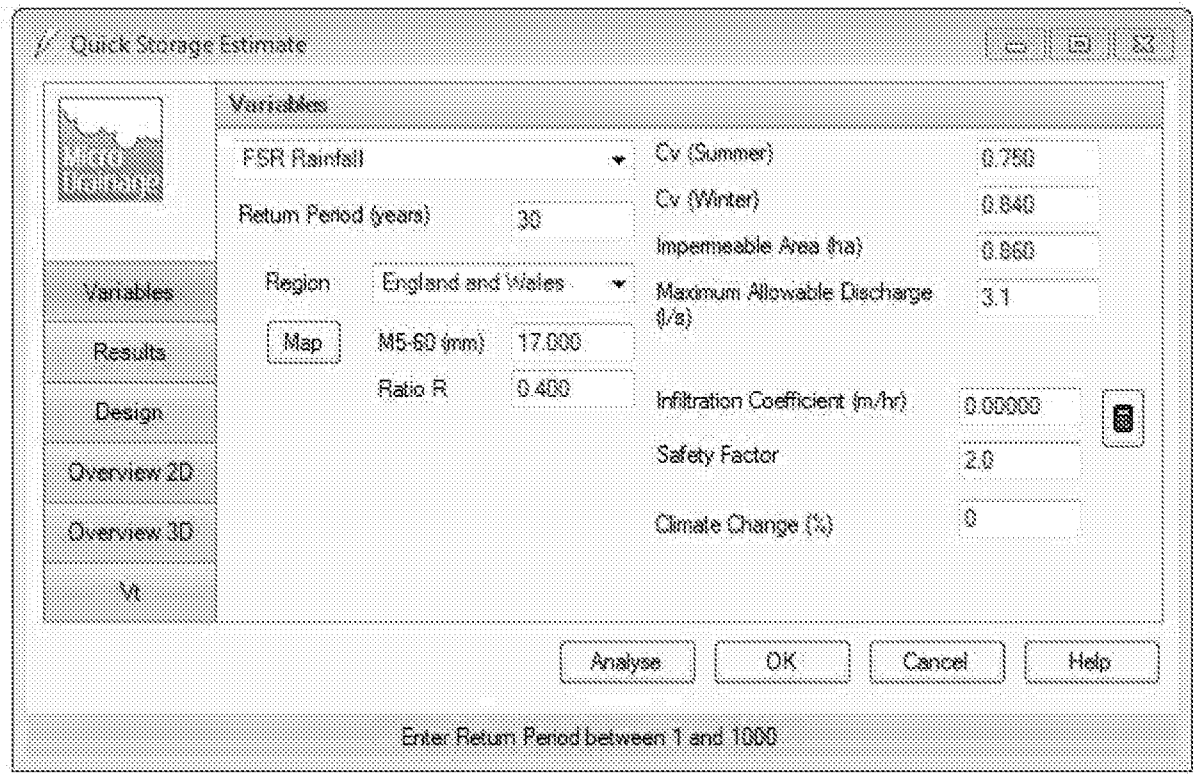
Appendix B: Quick Storage Estimates

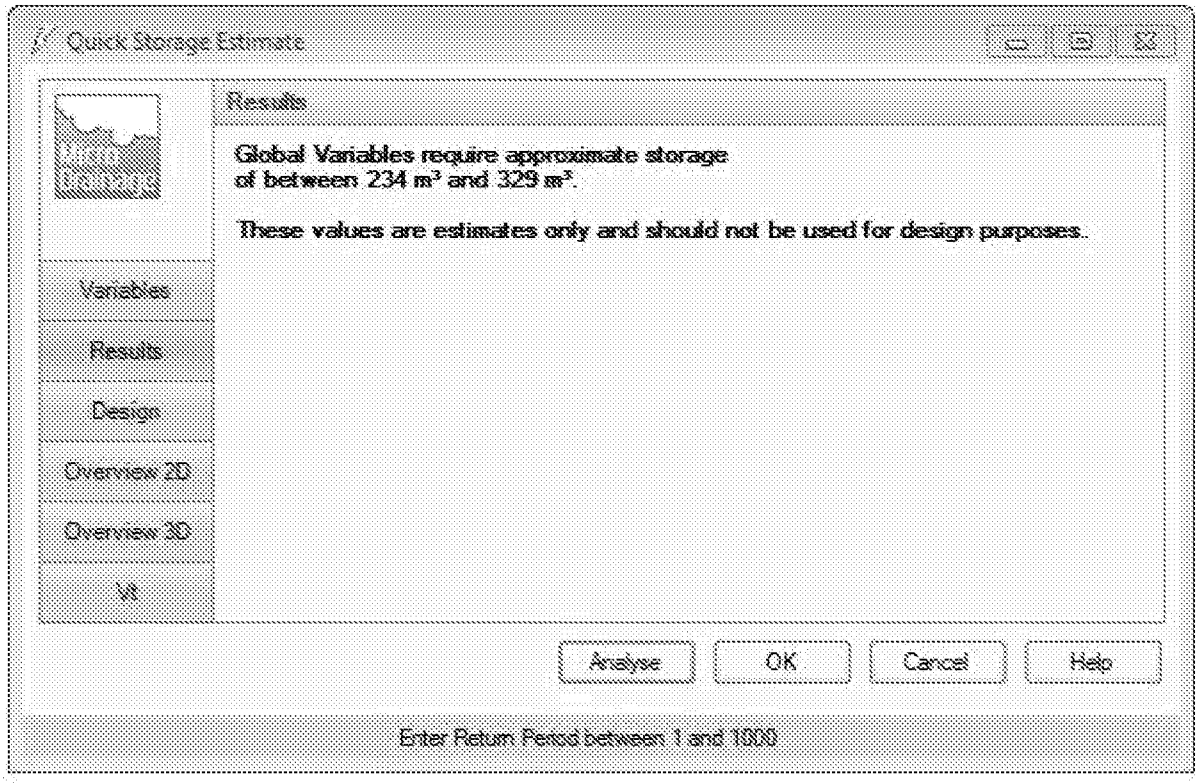
A - Northern Catchment



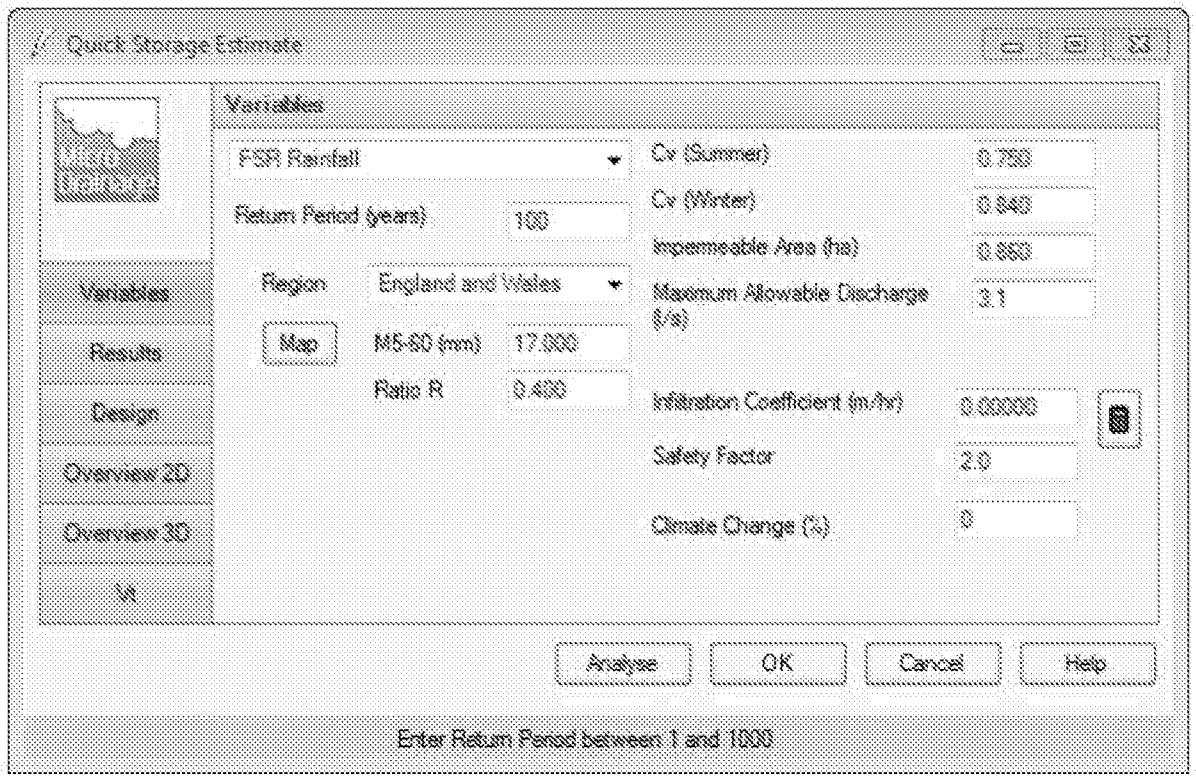


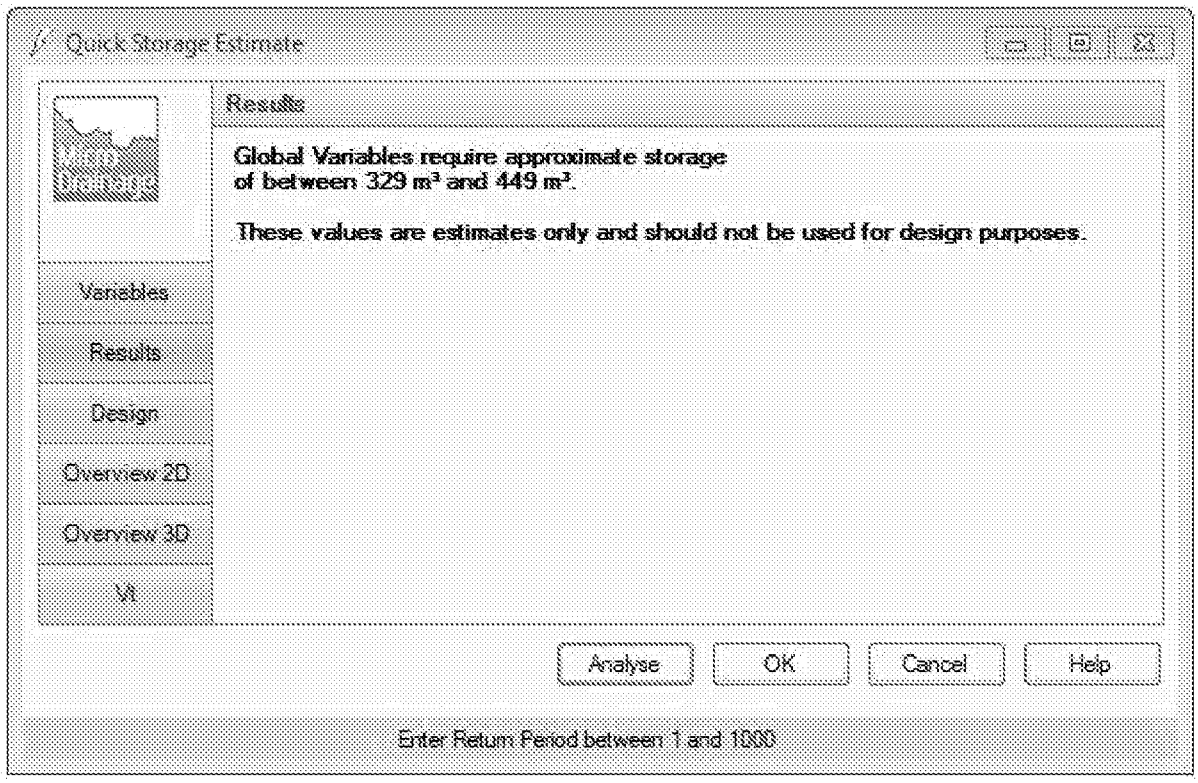
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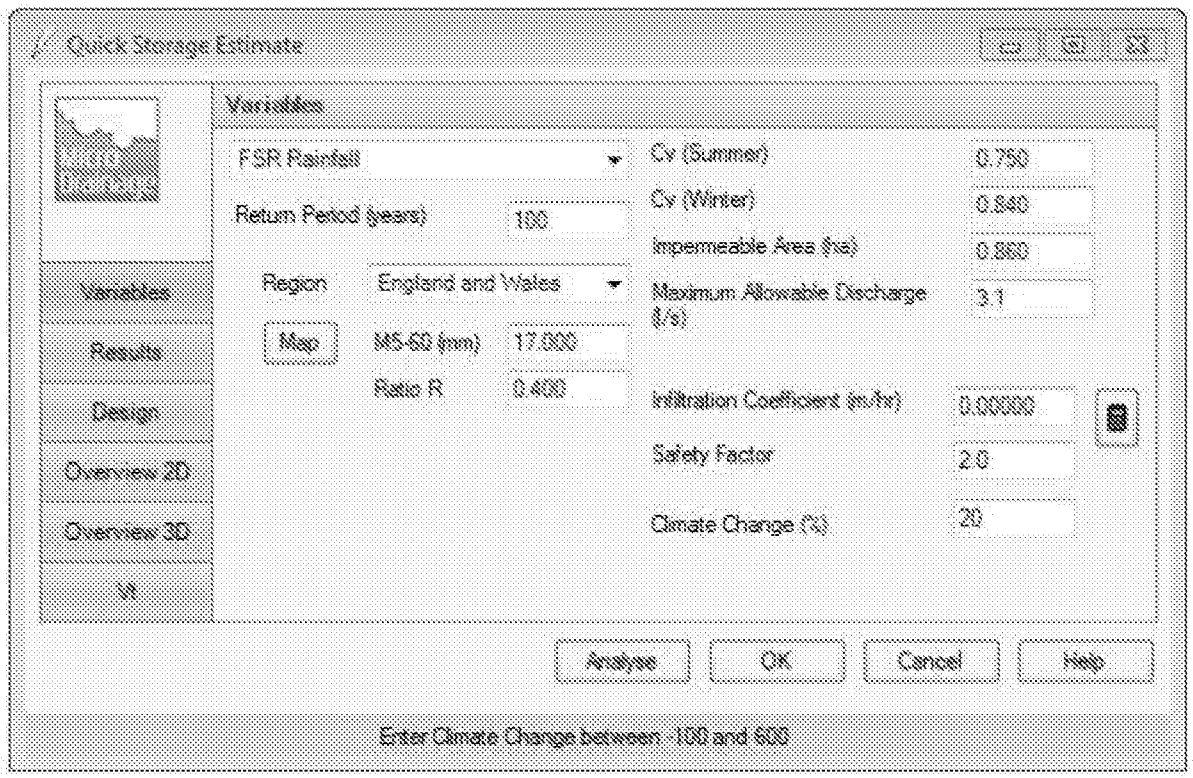


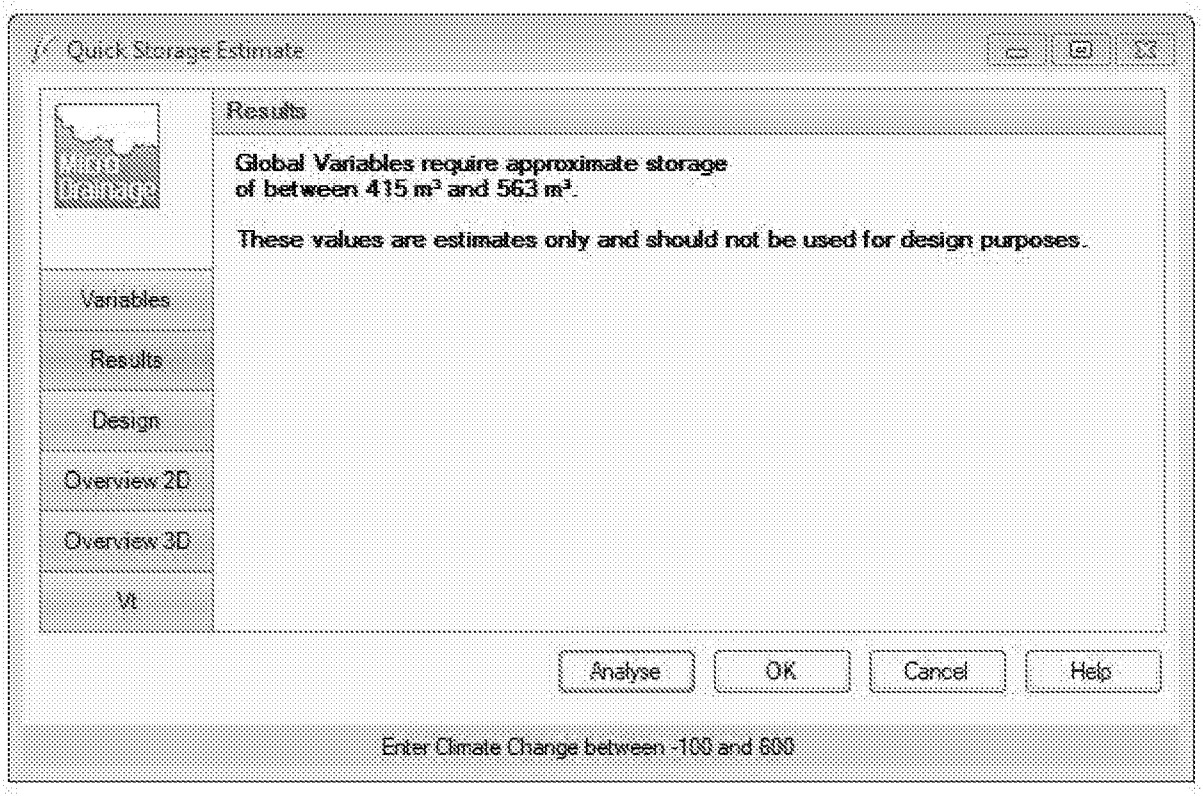
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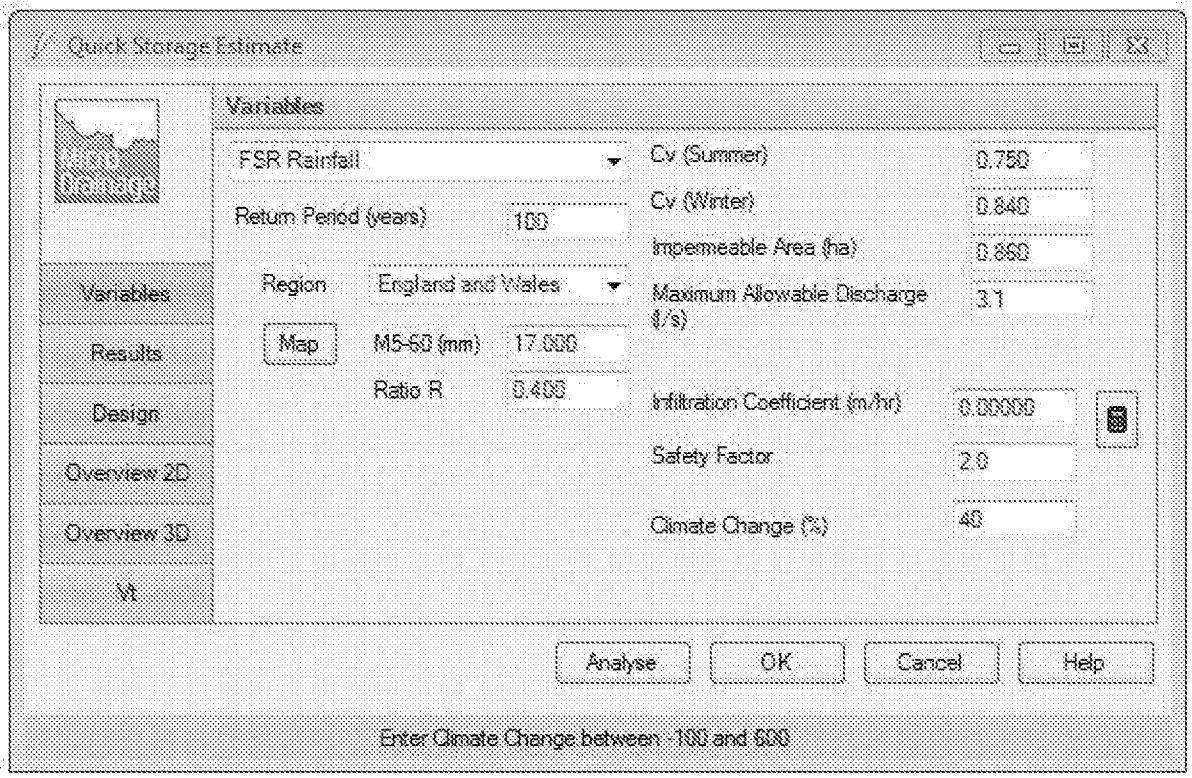


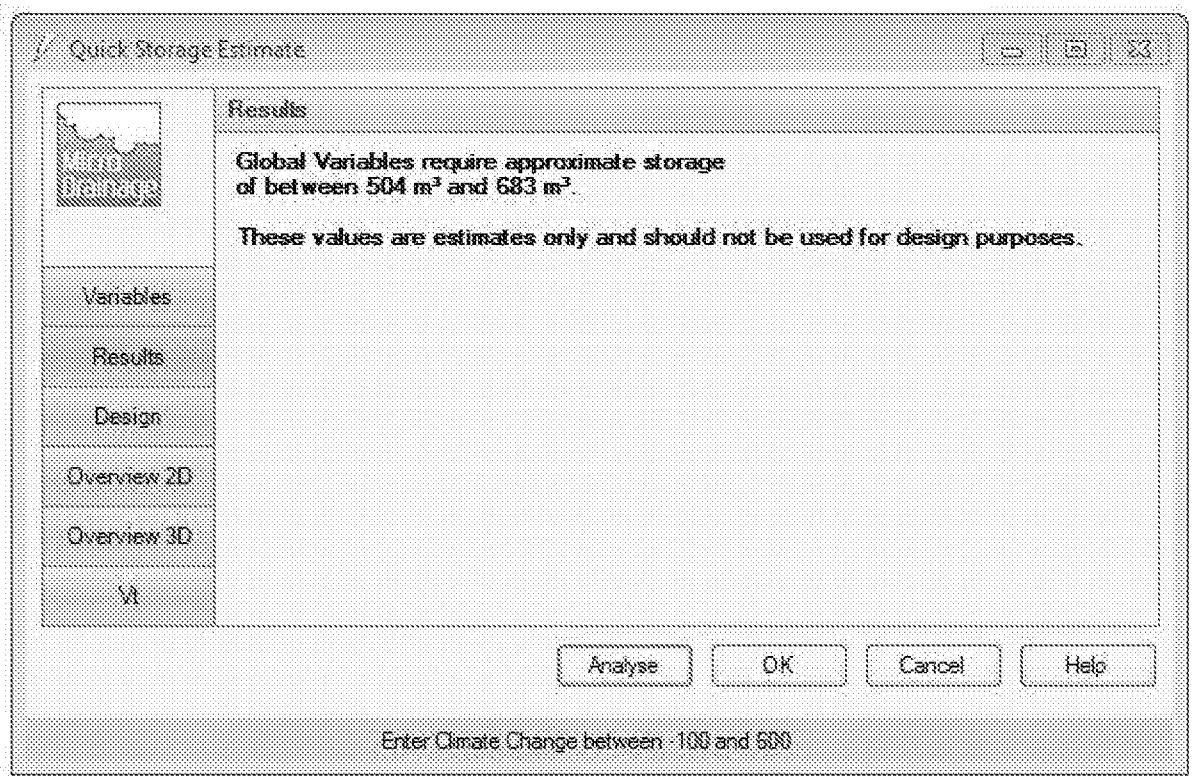
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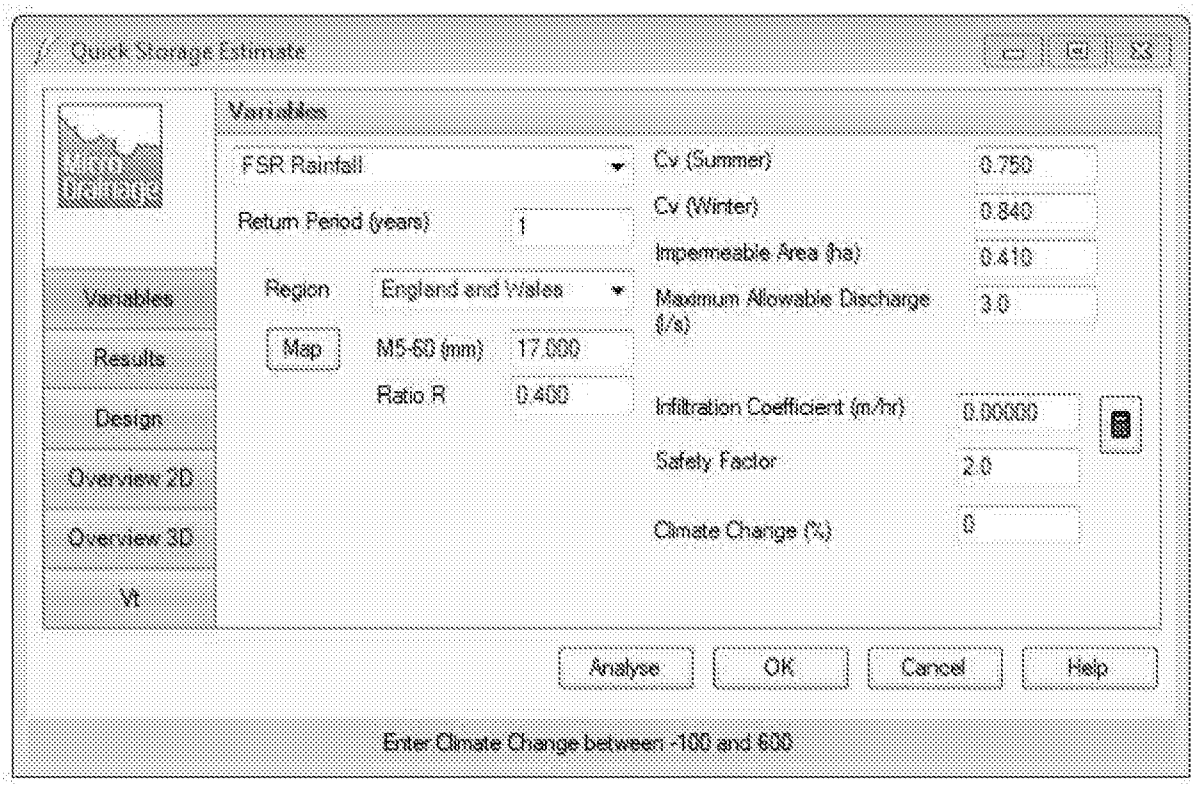
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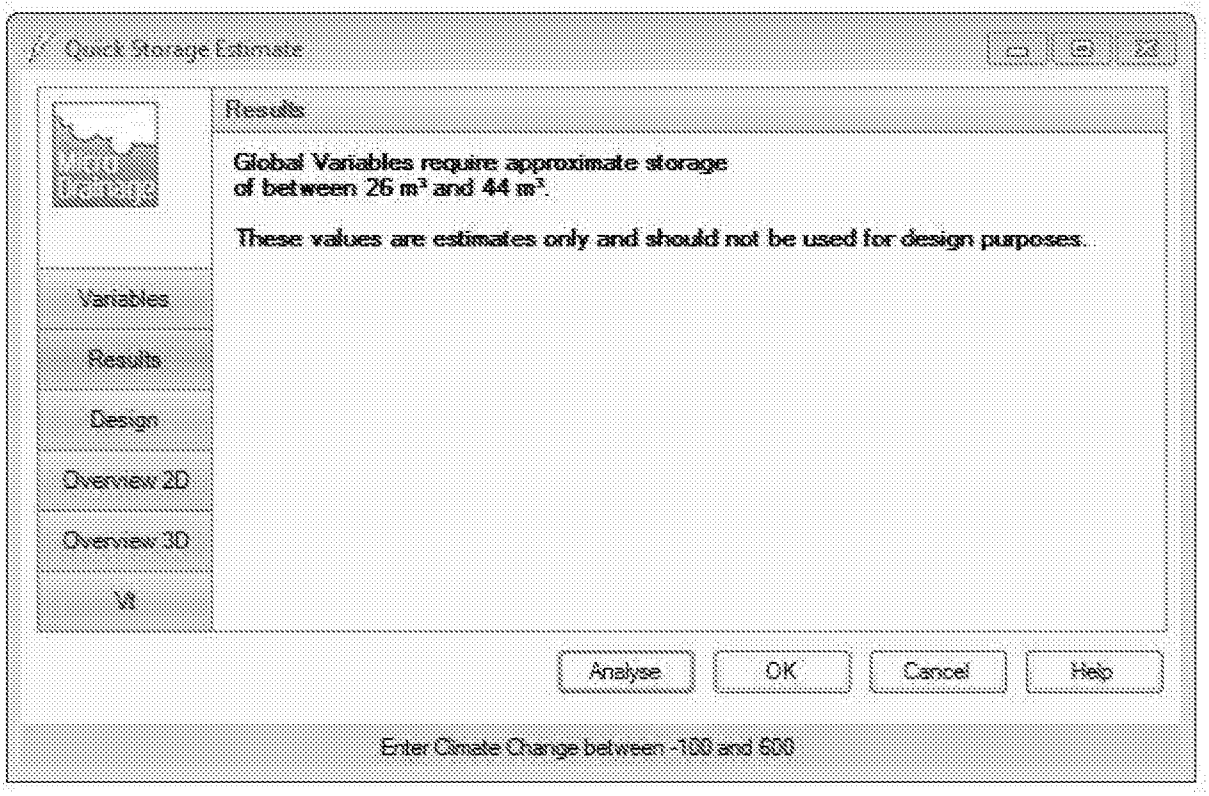




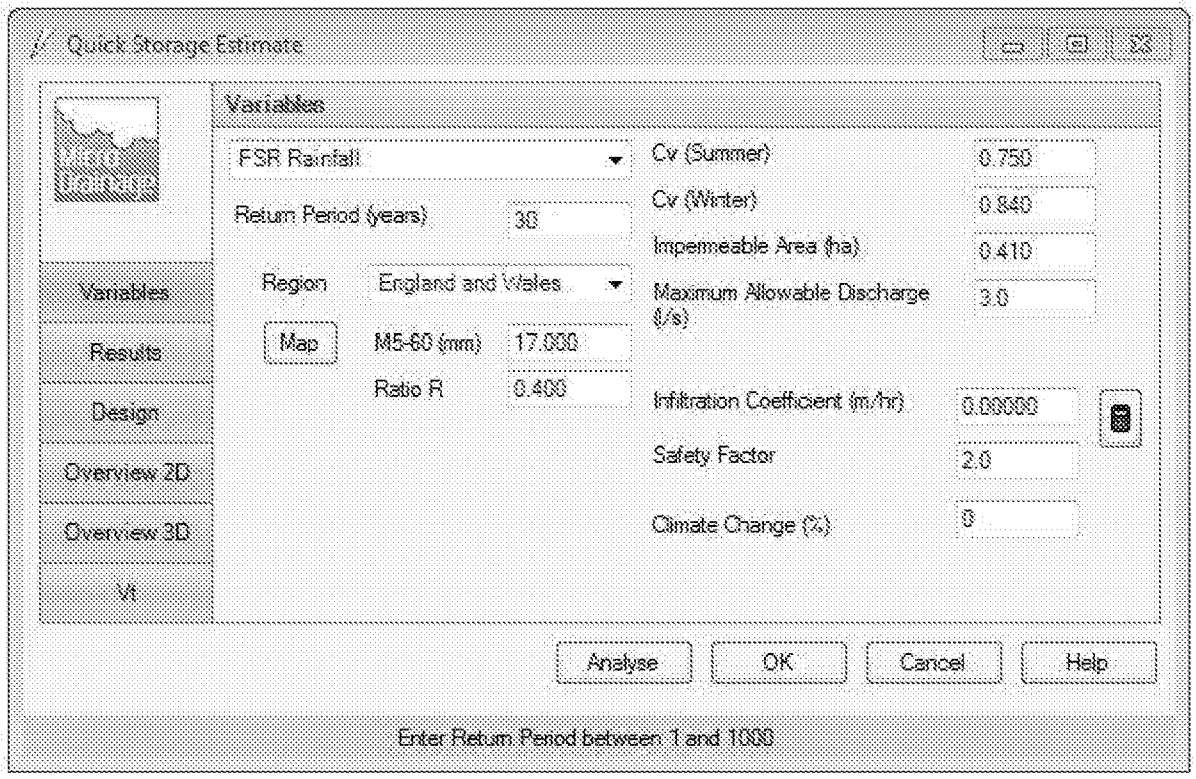
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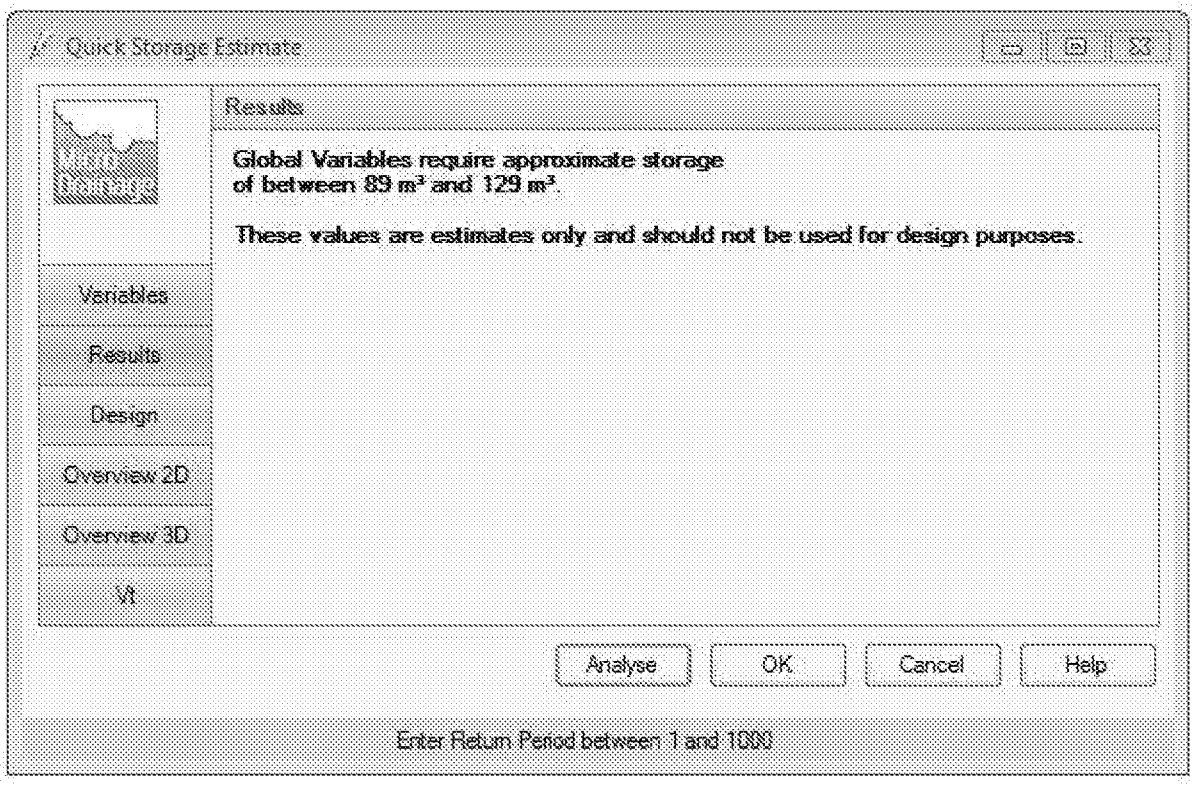
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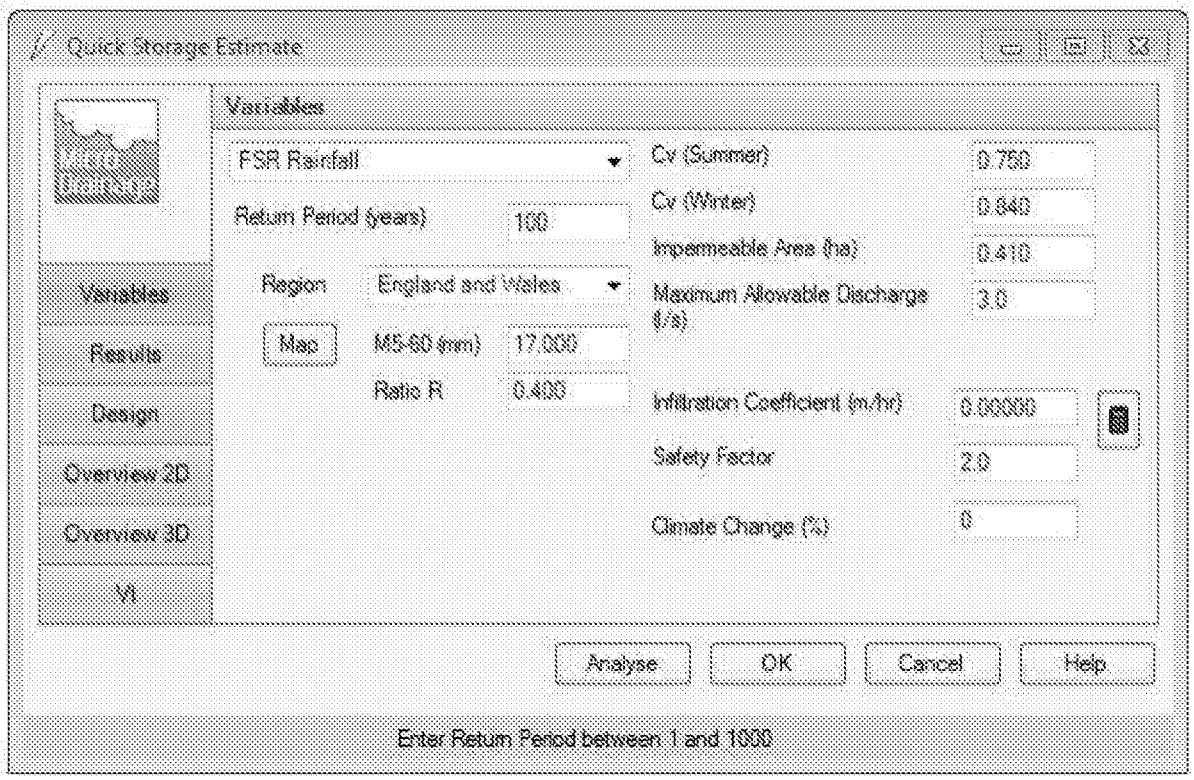


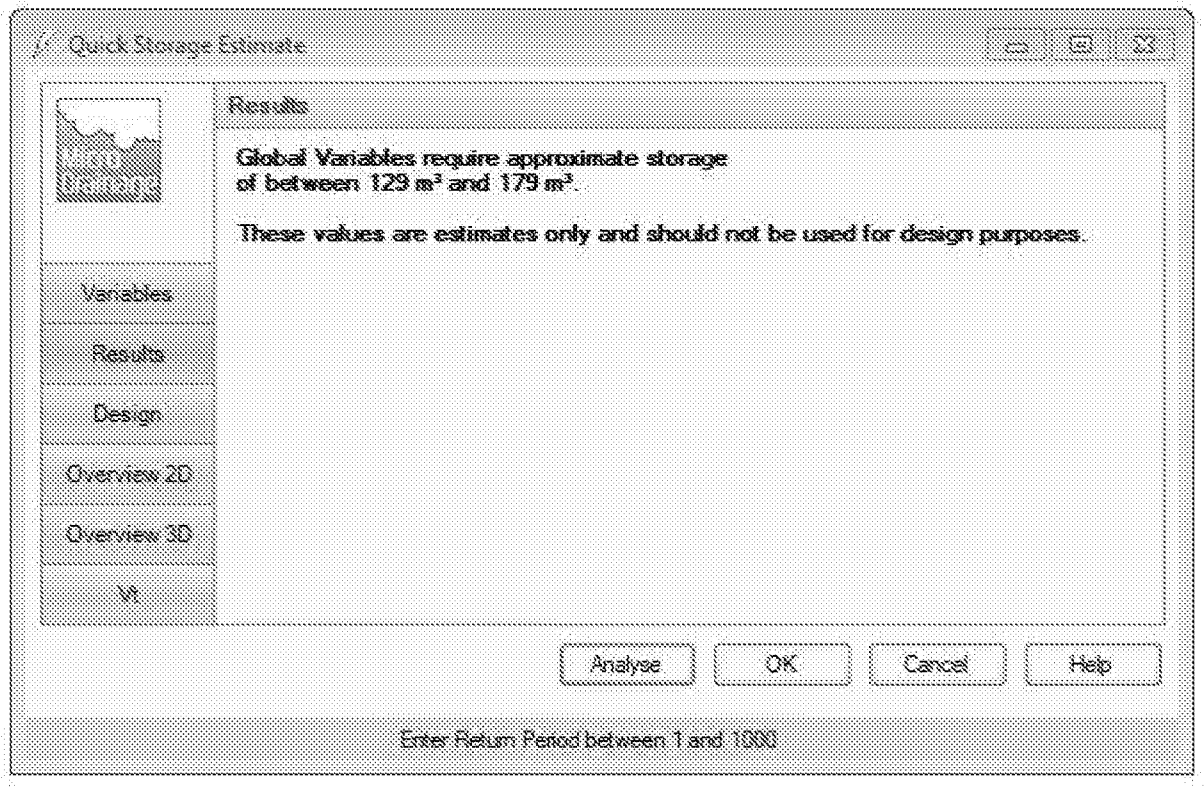
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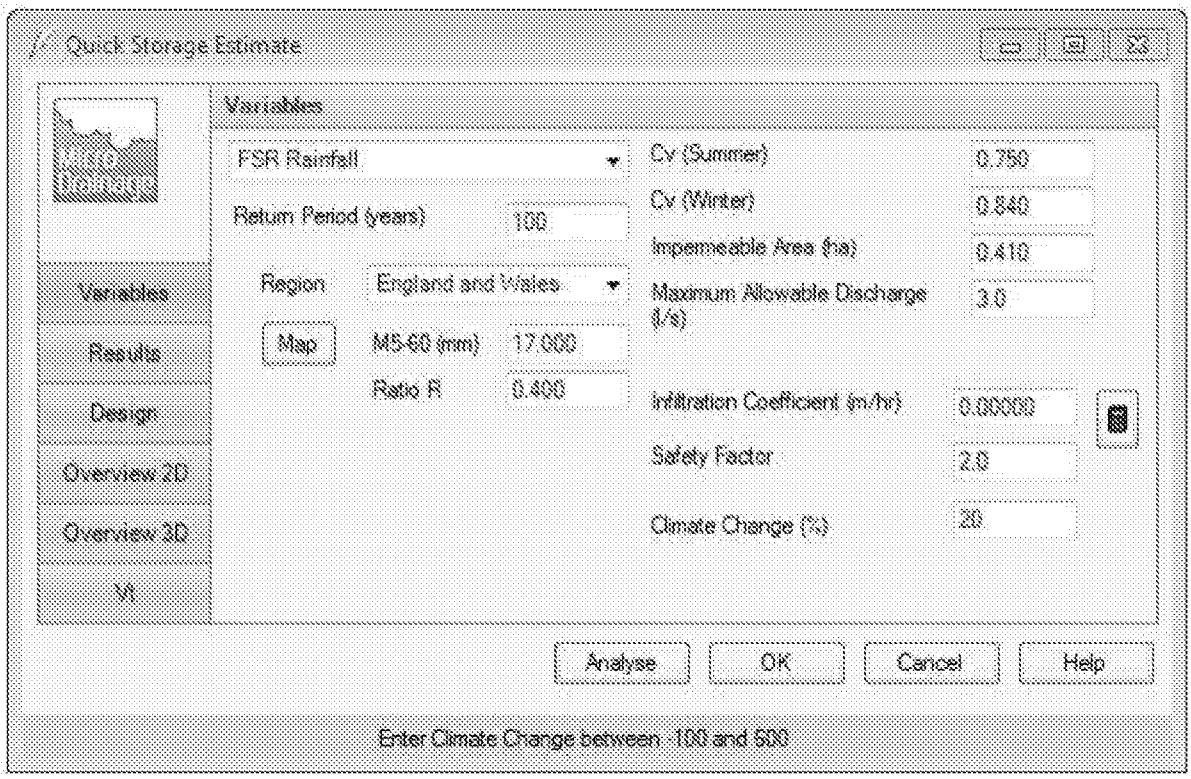


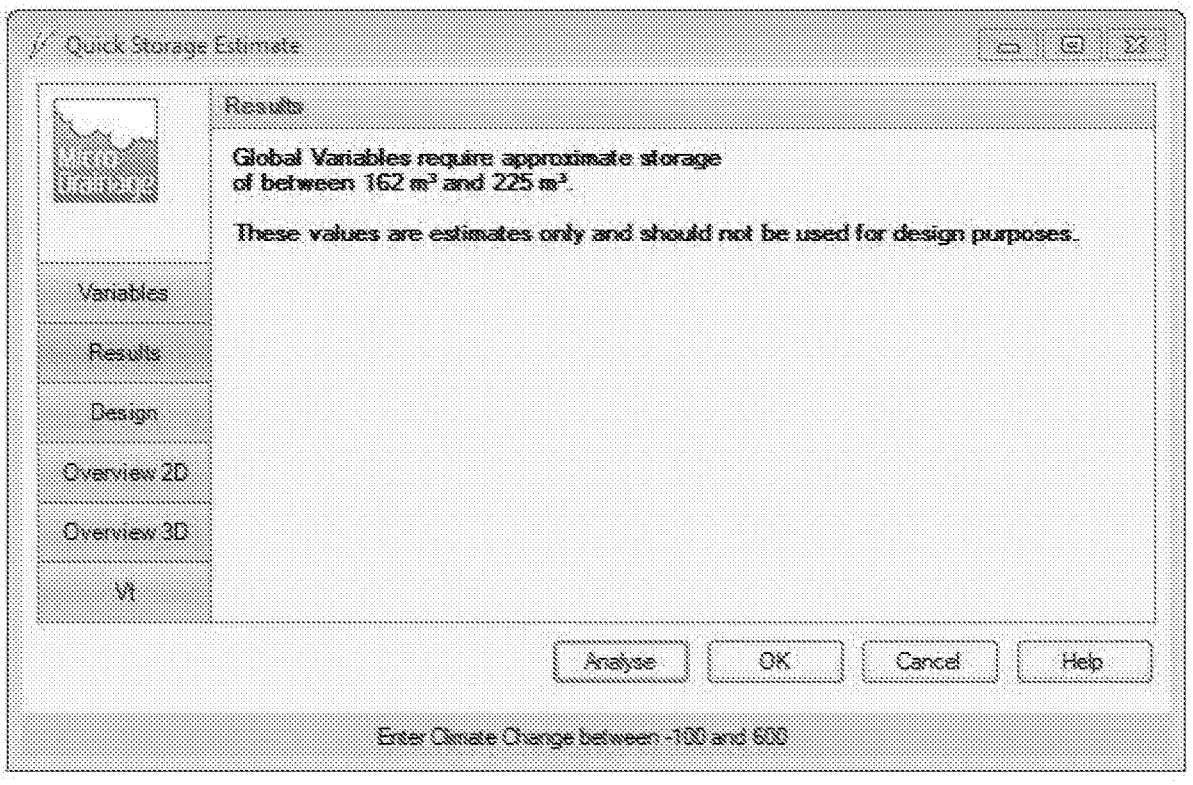
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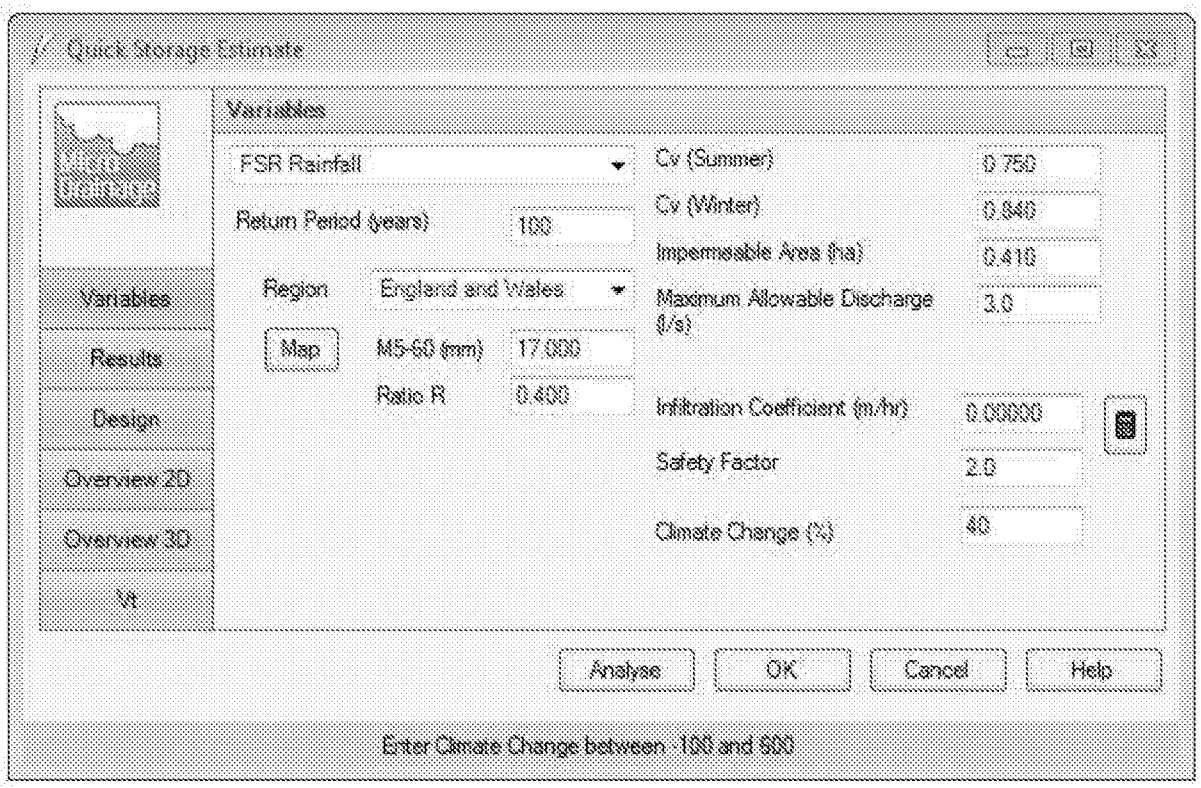


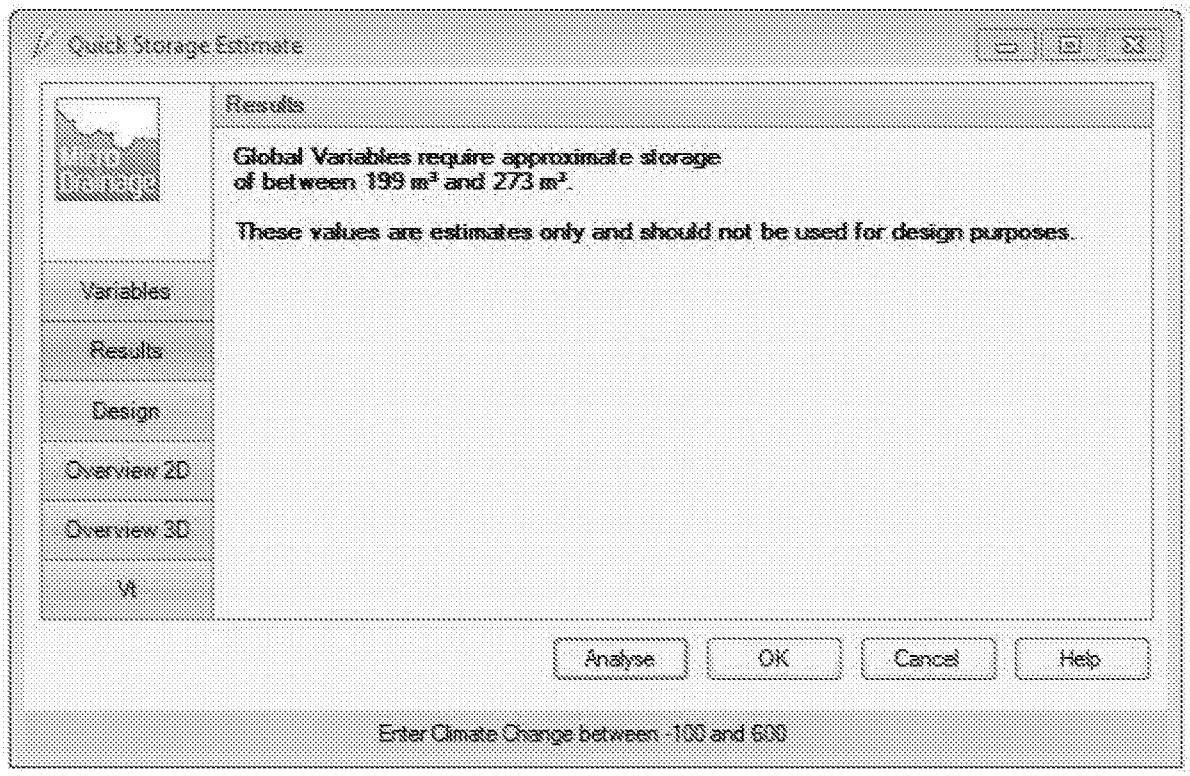
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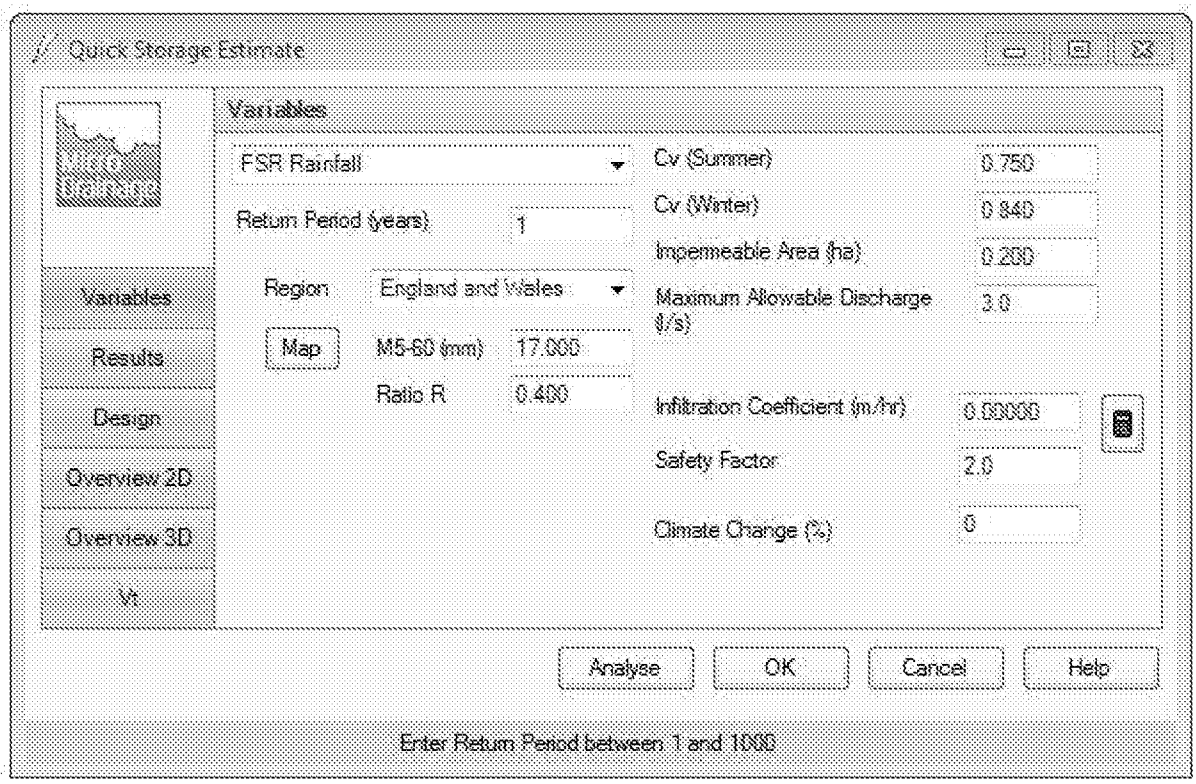
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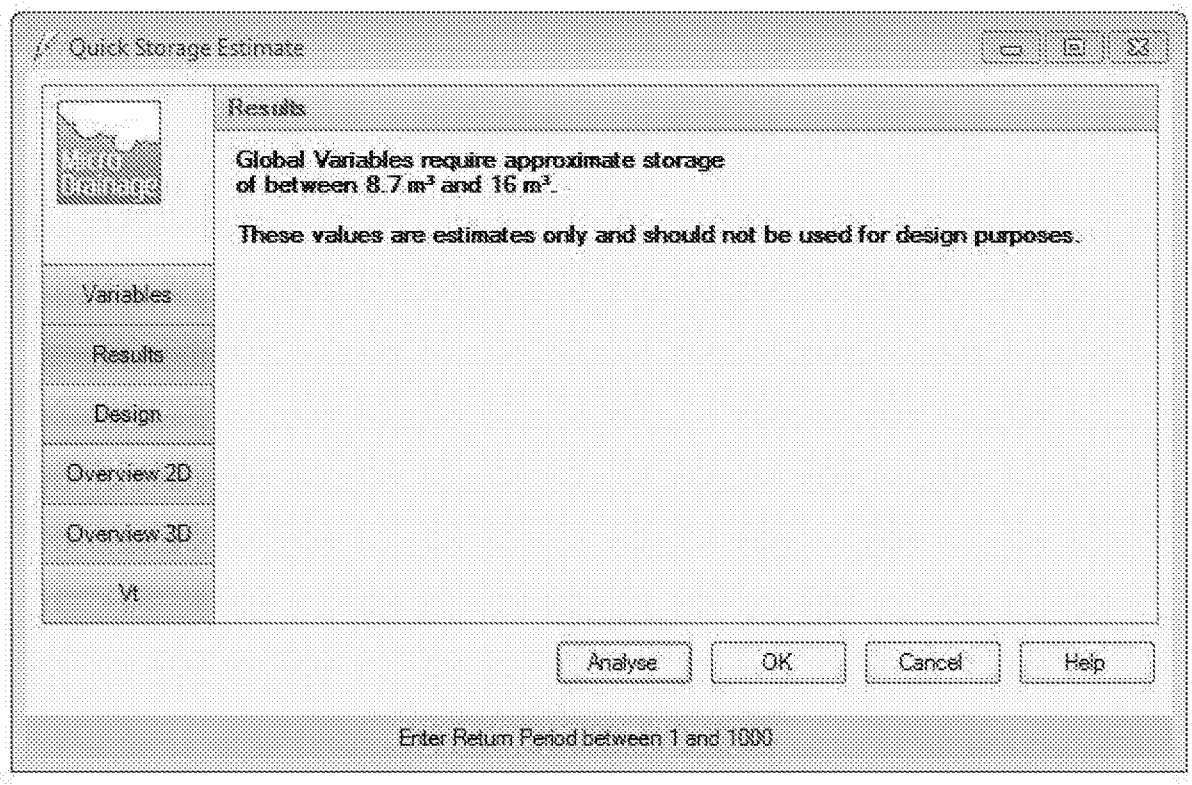




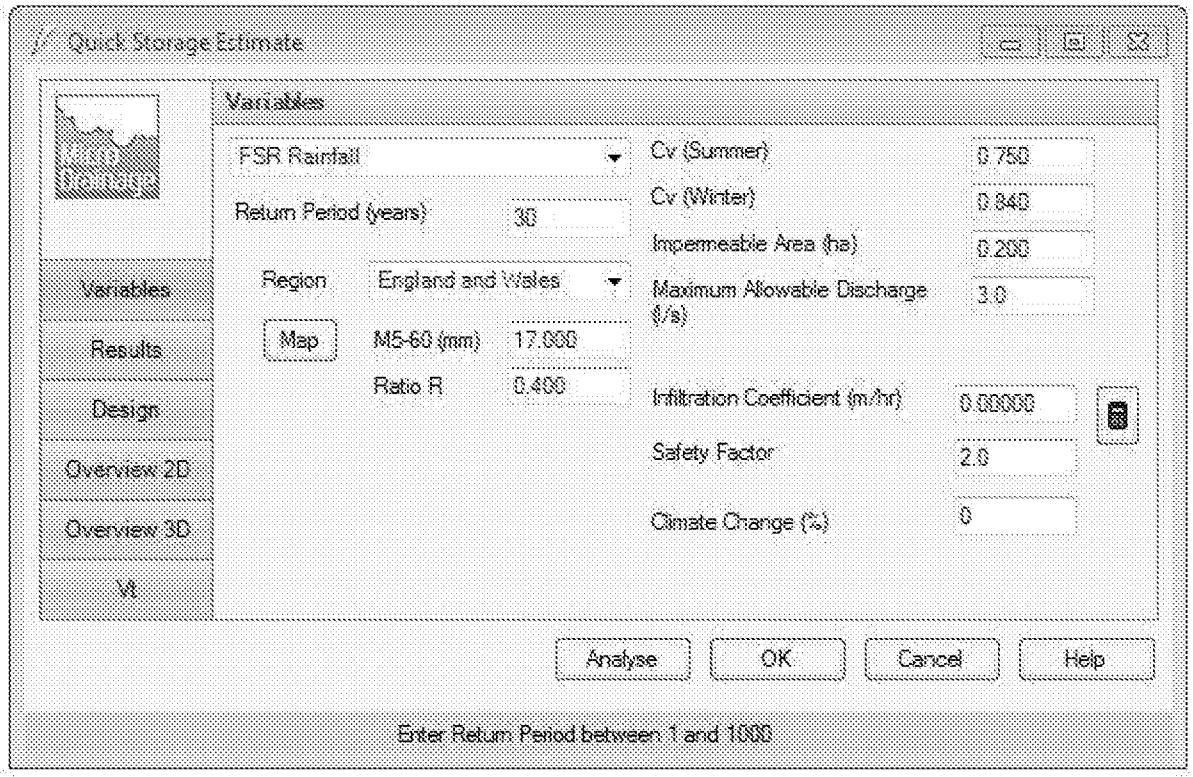
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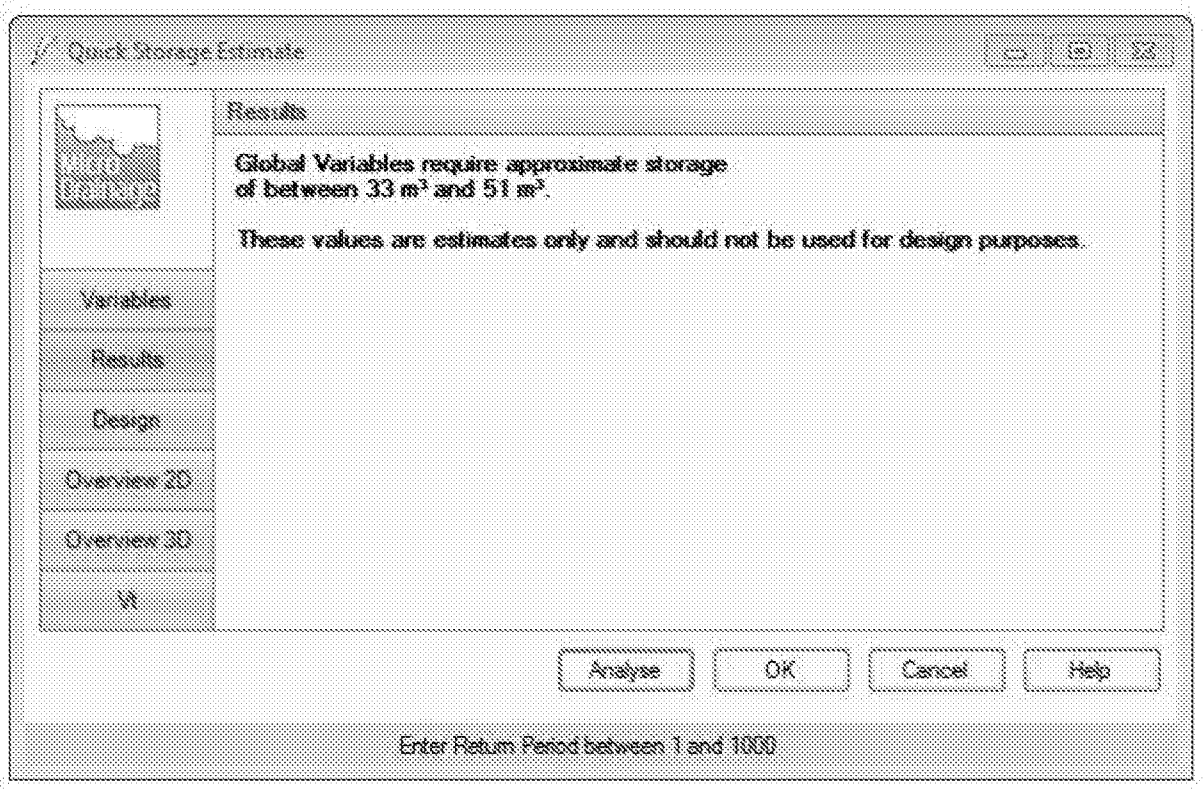
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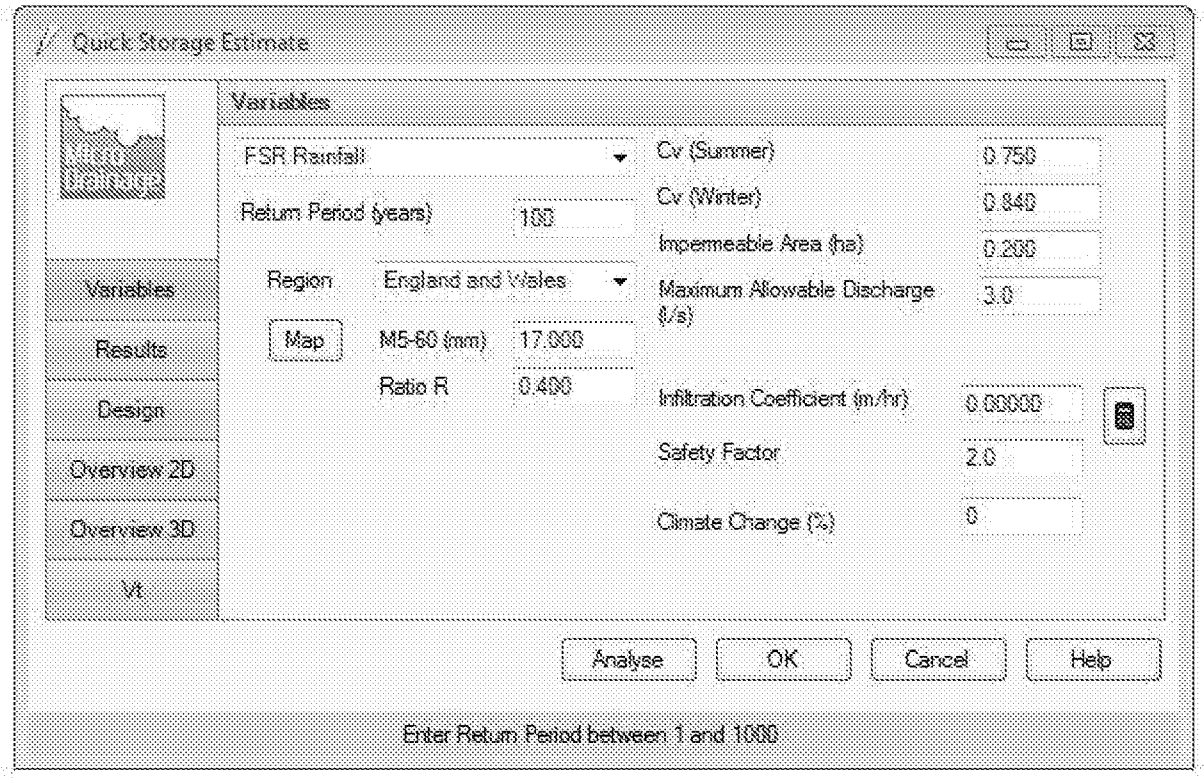


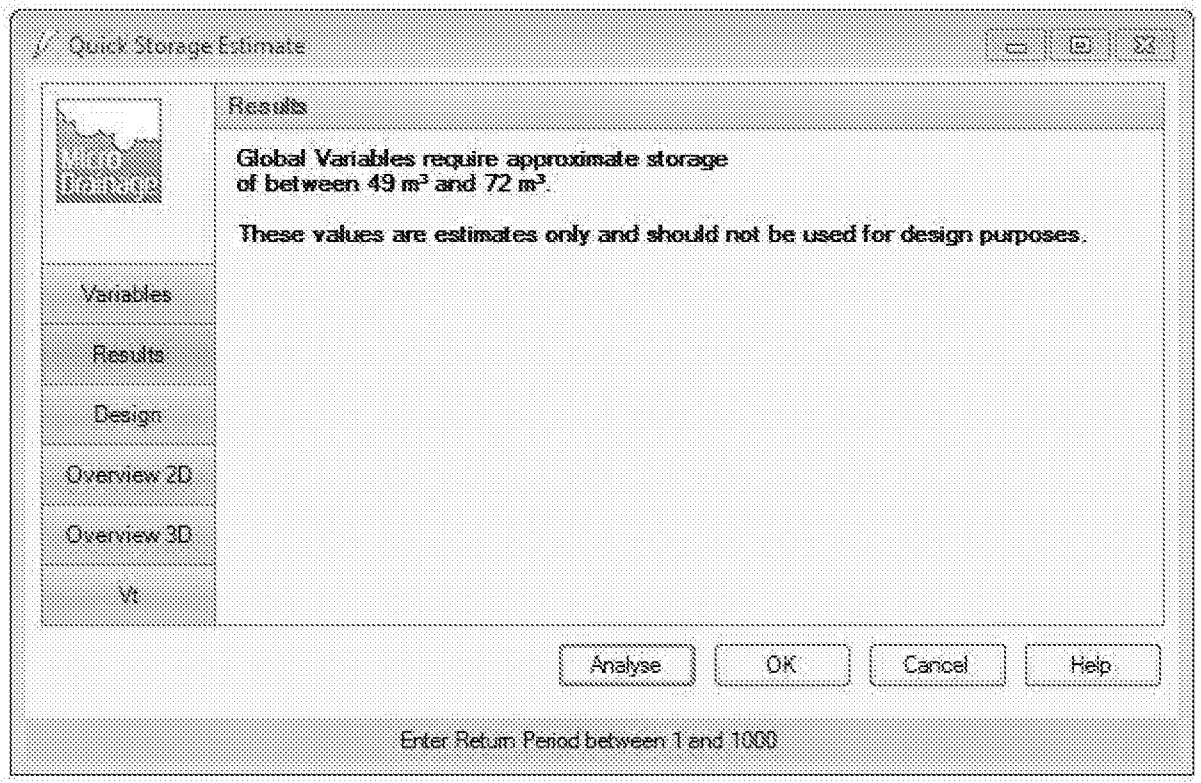
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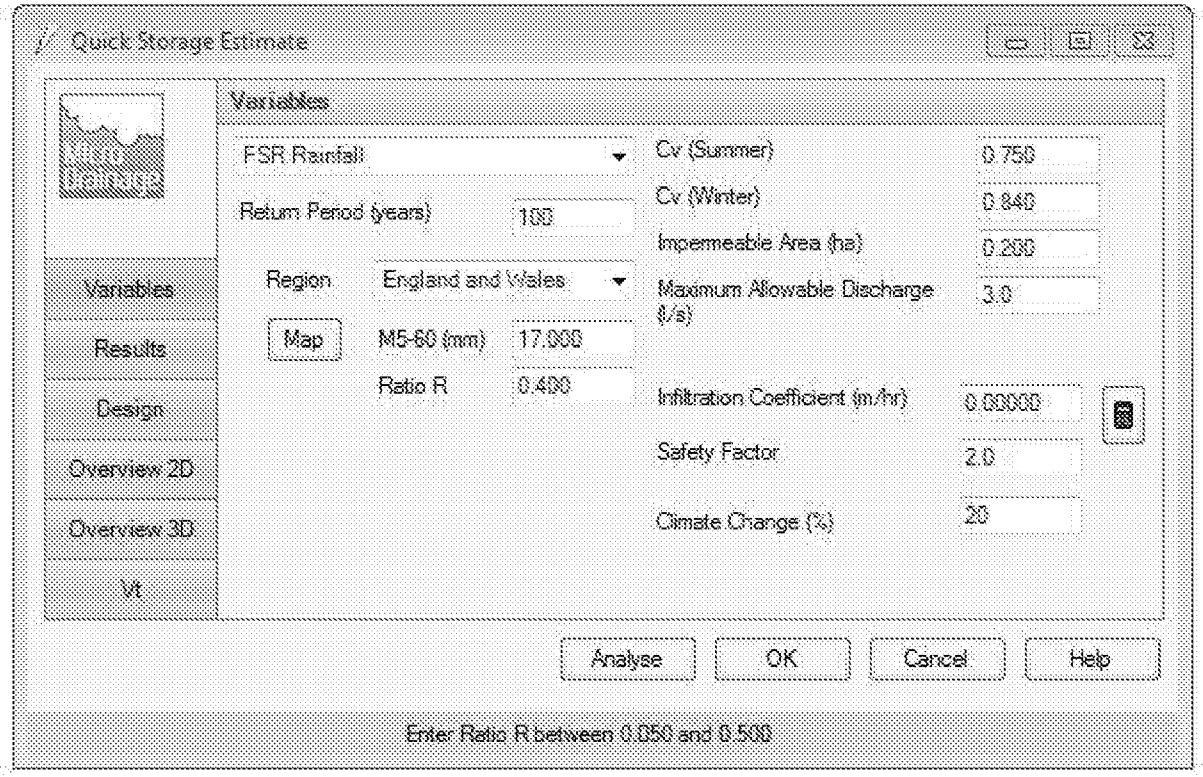


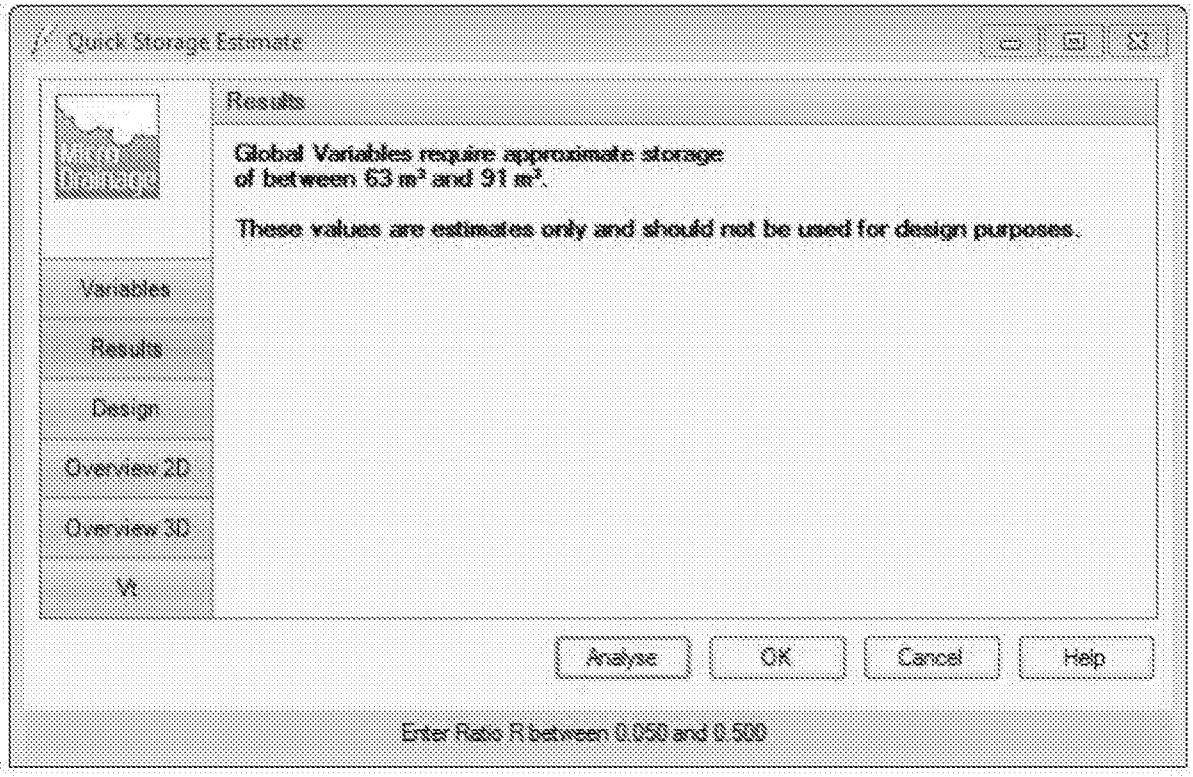
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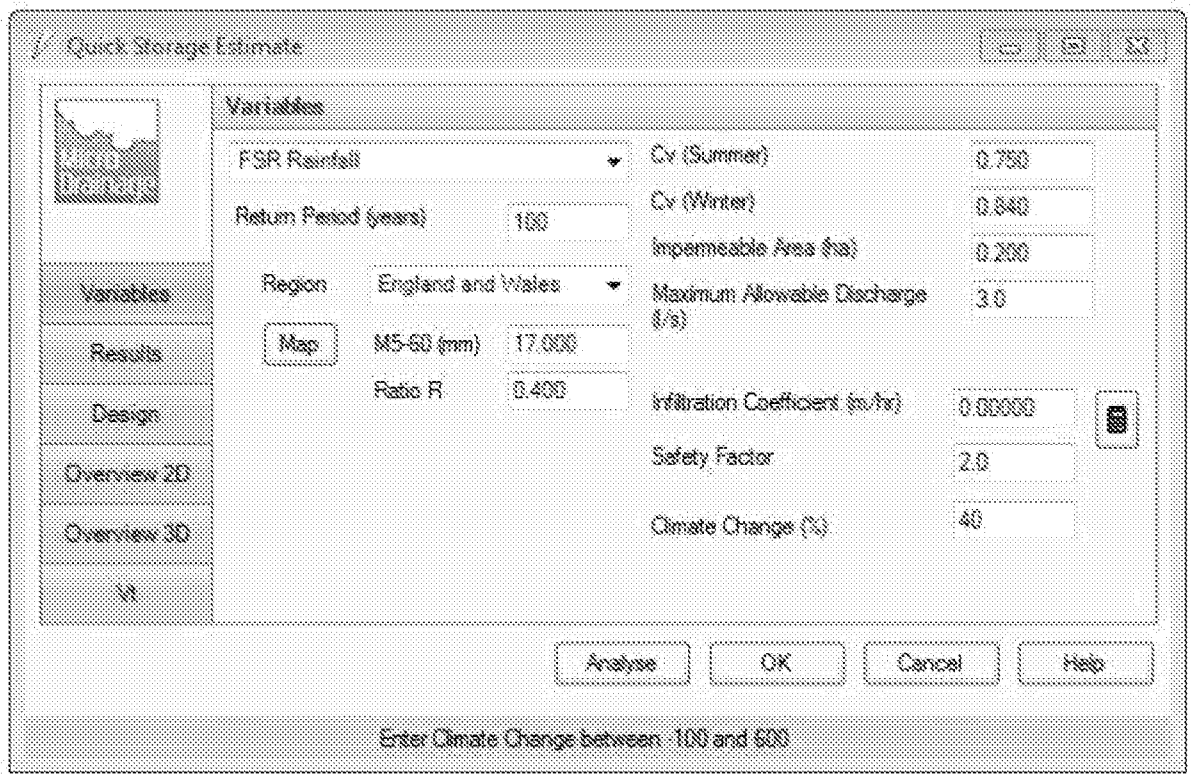


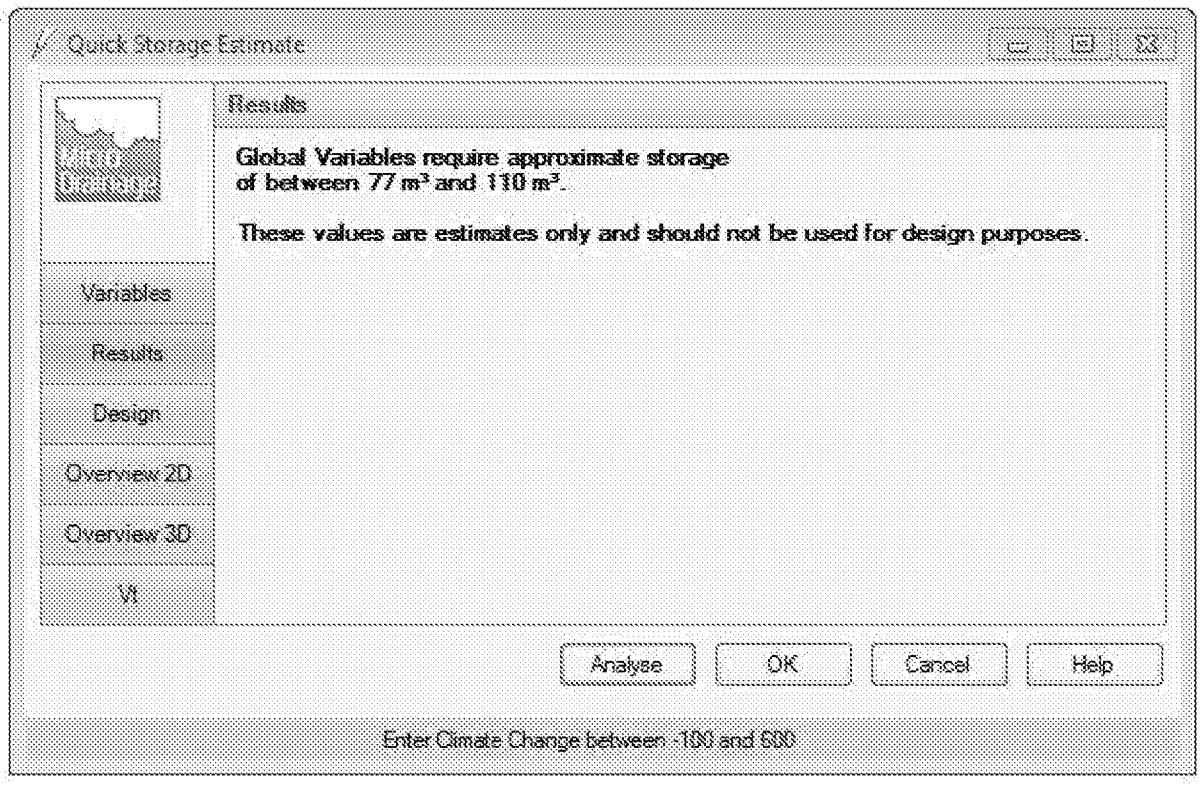
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Appendix C: Ground Investigation

ARUN DISTRICT COUNCIL BR/54/16/PL

REPORT N^{O} GEO/BRTP/70013264_001

UNIVERSITY OF CHICHESTER, BOGNOR REGIS

GROUND INVESTIGATION REPORT

CONFIDENTIAL

FEBRUARY 2016

WSP | PARSONS BRINCKERHOFF

ARUN DISTRICT COUNCIL BR/54/16/PL

UNIVERSITY OF CHICHESTER, BOGNOR REGIS

GROUND INVESTIGATION REPORT

Kier Construction Ltd.

Confidential

Project no: 70013264
Date: February 2016

WSP | Parsons Brinckerhoff
WSP UK Ltd
Mountbatten House, Basing View,
Basingstoke, Hampshire, RG21 4HJ

[redacted]

ARUN DISTRICT COUNCIL BR/54/16/PL

QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1
Remarks	For Comments	Revision to Section 6.8.
Date	12/02/2016	19/02/2016
Prepared by	Justin Hobkirk	Justin Hobkirk
Signature		
Checked by	Owen George	Owen George
Signature		
Authorised by	Liam Barber	Liam Barber
Signature		
Project number	70013264	70013264
Report number	GEO/BRTP/70013264	GEO/BRTP/70013264
File reference		

PRODUCTION TEAM

CLIENT

University of Chichester	Andrew Cardy

WSP | PARSONS BRINCKERHOFF UK LTD. (WSP)

Associate	Paul Conie

SUBCONSULTANTS/CONTRACTORS

Ground Investigation Contractors	CC Ground Investigations Ltd.
Utilities and Services Inspection	JV Surveys
Unexploded Ordnance Surveyors	First Line Defence.
Geotechnical Laboratory Analysis	Professional Soils Laboratory
Chemical Laboratory Analysis	I2 Analytical Ltd.

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ARUN DISTRICT COUNCIL BR/54/16/PL

1 EXECUTIVE SUMMARY

WSP | Parsons Brinckerhoff UK Ltd. (WSP) was instructed by the University of Chichester (UoC) to undertake a Ground Investigation to inform designs for a proposed Engineering and Digital Technology Park at the University of Chichester, Bognor Regis Campus. The site is located on Upper Bognor Rd, Bognor Regis, West Sussex, PO21 1HR.

This report fulfils the requirements for a Ground Investigation Report (GIR) to BS EN 1997-1:2004 +A2:2013 *Eurocode 7: Geotechnical Design* (Eurocode 7) and generally follows the format of HD 22/08 *Managing Geotechnical Risk*.

It is understood that University of Chichester has an overall development masterplan for its Bognor Regis Campus, which includes developing land currently occupied by sports fields and scrubland. The University proposes to construct a four/five storey building on the southern part of this area. It is anticipated that the building will be operational by September 2017.

The site is adjacent to Chichester University buildings fronting on to Upper Bognor Road, which forms the southern boundary of the Site. Adjacent to the eastern boundary of the site is Felpham Way. An unnamed watercourse borders the northern boundary of the Site, with recreational fields situated beyond. To the west of the Site are residential properties backing on to Brooks Lane. In addition, three Grade II listed buildings lie within the southern section of the site, including properties 67, 69 and 71 of Upper Bognor Road. The majority of the site is currently a private field, however University buildings are situated within the south west of the site and another unnamed building is located within the western portion of the site boundary. It is also noted that the site is prone to flooding and does not have any flood defences.

There are no areas of environmentally sensitive designations influencing the site and thus requires no specific or precautionary measures to be undertaken on site. The highest risks are considered to be associated with Made Ground deposits encountered under the proposed new school building footprint as well as the existing school grounds.

An intrusive ground investigation was undertaken between the dates of 2nd and 20th of November 2015 and comprised eleven dynamic sampled holes to depths of 22.20m, seven rotary cored boreholes to a maximum depth of 35m, and seven machine-excavated trial pits to depths of 3.20mbgl to 4.0mbgl. Insitu testing was undertaken during the intrusive investigation which consisted of SPT tests and Hand Shear Vane tests. Soil and groundwater samples were recovered for laboratory analysis. In general, ground conditions were found to comprise Topsoil of approximately 0.25m thickness or Made Ground from surface with thickness of 0.20m to 1.3m. Groundwater strike was encountered during drilling within four boreholes, this has been mentioned in Section 5. Furthermore, subsequent groundwater monitoring has recorded levels between 0.55mbgl (0.81m OD) and 2.54mbgl (-1.18m OD).

In order to appropriately manage the contamination constraints identified the following recommendations are made:

- A detailed review of the development design and a cost benefit analysis should be undertaken to establish whether the contaminated Made Ground can be retained / re-used on site;
- A delineation / detailed material classification assessment should be completed within areas of proposed cut to provide greater certainty and refinement of the indicative budget cost estimates and constraints to the programme from the Made Ground (landfill material);

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- A Material Management Plan; and / or an Environmental Permit will be required if contaminated materials are to be re-used or treated on-site;
- An allowances should be made for the management of contamination during and post construction, including risks from asbestos which will require management in accordance with the Control of Asbestos Regulations (CAR) 2012 and dewatering of excavations;

Given the history of the site and limited access in some areas, the potential for encountering unidentified contamination during construction should be recognised.

General limitations of the assessment are included in **Appendix A**.

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2 PROJECT BACKGROUND

2.1 SCOPE AND AIMS OF REPORT

WSP | Parsons Brinckerhoff Ltd. (WSP) was instructed by University of Chichester (UoC) to undertake a Ground Investigation for a proposed development of an Engineering and Digital Technology Park Project at the University of Chichester, Bognor Regis Campus, Upper Bognor Rd, Bognor Regis, West Sussex PO21 1HR. The site layout and its location are presented in **Figure 1** and **Figure 2**.

This report fulfils the requirement for a Ground Investigation Report (GIR) to BS EN 1997-1:2004 +A2:2013 *Eurocode 7: Geotechnical Design* **(Reference 1)** and generally follows the format of Design Manual for Roads and Bridges - Managing Geotechnical Risk HD 22/08 (**Reference 2**). Soil profiles and descriptions in the report reflect the results of the current ground investigation.

The aims of this report are to:

- characterise the ground in terms of the soil composition and groundwater regime which could be used to inform design;
- identify possible geotechnical constraints in relation to the ground conditions encountered; and
- assess potential ground contamination and identify possible constraints to the proposed scheme.

In addition, a ground contamination assessment has been prepared as a separate report as a Generic Quantitative Risk Assessment (GQRA) which will be appended to this Ground Investigation Report (GIR).

This assessment was undertaken in accordance with the scope agreed between WSP | Parsons Brinckerhoff and the University of Chichester.

2.2 DESCRIPTION OF THE PROJECT

The University of Chichester wishes to develop an Engineering and Digital Technology Park, located to the north of Upper Bognor Road, adjacent to the current University Bognor campus. The Engineering and Digital Technology Park will consist of multi-storey buildings, access roads, car parks and associated infrastructure. An intrusive ground investigation is required in order to assess the ground conditions to inform the foundation design, pavement design, screen for land contaminants and also to establish the hydrogeological regime to support the drainage and Sustainable Drainage (SUDS) design.

The following ground investigation was specified by WSP in order to characterise the entire development site as shown on the Stride Treglown drawing SK_007 included in **Appendix B**.

The development site is approximately 2.2ha and located in an area of dense scrubland and on a flood plain to the north of Upper Bognor Road and west of Felpham Way at National Grid Reference 494414 099634. This is immediately east of the current University Campus. The northern extent of the proposed site is marked by Ladybrook Community Orchard. The maximum level of the site is in the west (approximately 4m Above Ordnance Datum (mOD)) and the site slopes down toward the minimum level in the southeast corner of the site (approximately 1mOD).

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The properties immediately surrounding the University campus comprise semi-detached houses. The main University buildings are located to the west of the proposed site, with halls of residence beyond the western boundary. There are recreational/sports fields covering most of the northern half of the site and a derelict field (Donkey Field) in the south region of the site (**Figure 1**).

Appendix B provides an existing site layout plan (**Figure 1**), a site location plan (**Figure 2**), an exploratory hole location plan (**Figure 3**) and a geological map of the site (**Figure 4**), as well as drawings provided by the client that show the proposed site layout and a topographical survey.

2.3 GEOTECHNICAL CATEGORY OF PROJECT

This scheme has been classified as a Geotechnical Category 2 scheme, as described within Eurocode 7. Geotechnical Category 2 projects include conventional structures and foundation forms, such as those likely to be proposed for this development, with no exceptional risk, difficult ground conditions or difficult loading conditions.

2.4 PREVIOUS REPORTS

There has been no previous ground investigation works undertaken on this site before and therefore no previous reports have been provided.

2.5 CONFIDENTIALITY STATEMENT AND LIMITATIONS

This report has been prepared for the University of Chichester in accordance with our proposal 2015 and the terms and conditions as set out therein. It has further been prepared based on the site conditions encountered at the time of the intrusive site investigations as presented. The scope of WSP's investigation and assessment is limited to that defined in our original proposals as confirmed or amended (where relevant and appropriate) within this report. Consequently this report should not be used in a different context without the express written consent of WSP.

Where relevant, any interpretation within this report refers to the condition of the site at the time of the investigation and is based on WSP's understanding of any development proposals as described. Possible future changes in the condition of the site which may occur, or alterations in any proposed development layout / design will require further assessment.

It is further noted that whilst site conditions have been recorded at the investigation locations, variations may occur in the actual conditions present in other, un-investigated areas of the site. New or amended legislation may necessitate re-assessment of the site conditions and the associated risks and liabilities.

This report is addressed to and may be relied upon by the University of Chichester. It may not be relied upon or transferred to any other parties without the express written authorisation of WSP. The report should be read and used in full. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

Third party information used in the production of this report has been taken in good faith as being accurate. WSP cannot and will not accept any liability for errors and / or omissions in data provided by others and WSP cannot warrant the work of others.

General limitations of the assessment are included in **Appendix A**.

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3 EXISTING INFORMATION

3.1 TOPOGRAPHICAL MAPS

A topographical survey of the site was undertaken by Shaw Colegate Land and Building Surveyors for the UoC in May 2015. The survey shown on the drawing enclosed in **Appendix B,** 05515_TOPO_REV_A, dated May 2015, indicates that the local topography is close to sea level across the site. The northern part of the site is generally lower with an elevation varying locally from approximately 1.14 to 1.45mOD with increasing site levels in the south of the site which varies locally from approximately 1.50 to 3.14mOD. Within the southern part of the site there is an earth bund, which runs from west to east, with a crest height of approximately 3.30mOD. The bund has been recorded within the historical maps within the Landmark Envirocheck report since 1879 as an embankment running from west to southeast outside the site boundary.

3.2 GEOLOGICAL AND HYDROGEOLOGICAL MAPS

The 1:50,000 series geology map of Chichester and Bognor (Sheet 317/332) (**Reference 3**) published by the British Geological Survey (BGS), together with information available on the BGS on-line Geology of Britain Viewer (**Reference 4**), indicate that the entire site is underlain by superficial deposits noted to comprise Raised Beach Deposits, Marine Beach Deposits and River Terrace Deposits. Lambeth Clay Formation is present within the south of the site and the White Chalk Subgroup Formation (White Chalk Subgroup) is present at depth over the entire site.

The Superficial Deposits are indicated to comprise shingle, sand, silt and clay and vary in thickness locally. The composition is dependent on the upslope source and distance from source. The Raised Beach Deposits may be bedded or chaotic and the beach deposits may be in the form of sand dunes, sheets or banks. The Raised Beach Deposits are designated as a Secondary A aquifer strata by the Environment Agency (**Reference 5**).

The Lambeth Clay Formation which comprise primarily clay, some silty or sandy, with some sands and gravel beds. The thickness can be up to approximately 39m in the west of the London Basin where Bognor Regis is inclusive of this area.

The Lambeth Clay is underlain by White Chalk Subgroup Formation (White Chalk Subgroup) which is composed of hard to very hard nodular chalks and hardgrounds with interbedded soft to medium hard chalks (some grainy). The softer chalks become more abundant towards the top of the Formation. Nodular chalks are typically lumpy and iron-stained.

Both the Lambeth Clay Formation and The White Chalk Subgroup are designated as Secondary A and Principal Aquifer respectively by the Environment Agency (EA) (**Reference 5**). The EA reports that the site is not within a Source Protection Zone or a Drinking Water Safeguard Zone. No groundwater abstractions are recorded within 1km of the site.

3.3 RECORDS OF MINES AND MINERAL DEPOSITS

On the basis of database information accessed through Envirocheck, there is no record of mining or mineral deposits within a 1km area of the site.

3.4 ARCHAEOLOGICAL AND HISTORICAL INVESTIGATIONS

On the basis of database information accessed through Envirocheck, it is identified that the main changes in land use within the site boundary have been:

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- 1879 to 1967, embankment running from west to the south east continuing beyond the site boundary.
- 1932 to 1967, buildings established in the south western part of the site.
- 1975 to 2006, tress established along the eastern boundary of the site.
- 1990 to present, man-made drainage feature located mid-site running east to west.

3.5 EXISTING GROUND INVESTIGATIONS

WSP | PB are not currently aware of any previous investigation for development on the site.

3.6 CONSULTATION WITH STATUTORY BODIES AND AGENCIES

Environmental database information has been accessed through Envirocheck; no consultation was undertaken prior to any ground investigation works.

3.7 FLOOD RECORDS

With reference to the EA website (**Reference 5**), it indicates that the site is within an area of low to medium risk of flooding from surface water, however, within the Land Mark Envirocheck report, it states that the area is subject to extreme flooding from rivers or seas without defence.

3.8 GROUND CONTAMINATION

The EA website indicates that there are no sites within 500m (the subject site included) which are designated as contaminated land under Part 2A of the Environmental Protection Act 1990 (**Reference 6**). Within the Landmark Envirocheck report shows low levels of concentration of any ground contamination.

3.9 SURFACE WATER

A man-made drainage feature, which permits groundwater drainage, flows through the middle of the site from east to east.

The nearest named surface water feature is the Aldingbourne Rife River which flows to the east of the site, approximately a minimum distance of 50m from the boundary. The Environment Agency has identified that river is susceptible to flooding during heavy periods of rain mostly likely to occur during the winter months. There is also a water body (The English Channel) located approximately 500m south from the site.

3.10 UNEXPLODED ORDNANCE

As part of a Desk Study prior to the ground investigation works the site was identified by Zetica (**Reference 7**) as an area at risk of unexploded ordnance (UXO). This concluded that the site lies within an area considered to be at moderate risk of UXO due to Bognor Regis being targeted for bombing during the Second World War. The report suggested that mitigation measures should be required during development works and that an unexploded ordnance engineer should be present during intrusive works.

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4 FIELD AND LABORATORY STUDIES

4.1 WALKOVER SURVEY

A site walkover was undertaken on 20th October 2015 by a WSP representative, prior to site works commencing. During the site walkover the following features were identified and recorded:

- Evidence of below ground services/utilities whilst on site there was no immediate evidence of underground services however, there were occasional manholes which are for water drainage.
- Areas of soft ground within the playing fields there were no signs of soft ground however, if there was to be a high amount of rainfall the ground would be subject to softening.
- Site topography was generally flat with a gentle sloping toward the south.
- Potential on-site sources of contamination, there was no immediate evidence for contamination directly on site.
- Accessibility to the proposed borehole locations, access to the borehole locations was easy, however there was some vegetation clearance required before entering the south part of the site (Donkey field).
- No signs of standing water present on site; and
- Overhead services/obstructions were located on the east of the site boundary between the road and the vegetation.

It was noted that the site has one access point which means tracking distances for the drill rigs are increased over what is typically ideal. Consequently, it was noted that there could be disturbance and damage to the ground and if the weather conditions are poor then the likelihood is increased.

A charged sewerage drain was noted and, in order to avoid damage to the drain, further identification and location prior to undertaking any exploratory holes was required. Due to proximity with further underground services, a number of proposed boreholes required relocation approximately 10m away from any known services.

4.2 GEOMORPHOLOGICAL/GEOLOGICAL MAPPING

No geological mapping was carried out due to the absence of outcrops across the area of investigation.

4.3 GROUND INVESTIGATION

DESCRIPTION OF FIELDWORK

WSP designed the joint geotechnical and ground contamination investigation. The objective of the geotechnical investigation was to obtain information on the ground and groundwater conditions and obtain Eurocode 7 compliant samples in order to derive information for use in design of the building for the proposed Engineering & Technology Park development.

The fieldwork was undertaken between 2nd and 20th November 2015. The investigatory boreholes were undertaken by CC Ground Investigations Ltd with the trial pitting supervised by WSP. WSP monitored the entire investigation on a full time basis to check technical compliance with the ground investigation specification. A UXO engineer from Fellows International Ltd. was present on

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site on a full time basis to assess the presence of potential buried UXO during the ground investigation.

To avoid contact with existing below ground services/utilities, in advance of any intrusive works each exploratory hole location was scanned and cleared using a Cable Avoidance Tool (CAT) and Generator. In addition, inspection pits were hand dug to a depth of 1.2m bgl by CC Ground Investigations at all borehole locations prior to drilling.

Table 4-1 provides a summary of the exploratory holes completed as part of the ground investigation, along with the rationale for utilising the selected techniques. An exploratory hole location plan is provided in **Figure 3, Appendix B**.

Table 4-1: Exploratory Hole Rationale

Element of Investigation	Details	Rationale
Rotary cored boreholes	BH101 to BH111	▪ To allow inspection of soils and to allow the retrieval of samples for geotechnical and chemical laboratory testing. ▪ To derive the ground model. ▪ To assign material properties and to aid the derivation of geotechnical parameters for design purposes.
Trial pits	TP101 to TP107	▪ To allow the inspection of soils and to retrieve samples for geotechnical and chemical laboratory testing. ▪ To derive the ground model. ▪ Insitu infiltration tests were undertaken in Trial Pits TP101 and TP103 to provide information for drainage design.
Insitu testing	Standard Penetration Tests (SPTs) were undertaken at 1.5m intervals up to the surface of the chalk and at 3.0m intervals thereafter in all boreholes. TRL probes were taken up to 2.0m bgl	▪ In order to assign material properties and to aid the derivation of geotechnical parameters for design purposes. ▪ Assess ground conditions for pavement design.
Installation of groundwater and gas monitoring wells	Installed in BH101 to BH111.	▪ To provide information to characterise the groundwater conditions and quality including standing groundwater conditions and variations over a period of time post installation. ▪ To undertake ground gas monitoring to determine potential constraints to the development from soil gas generation.
Geotechnical laboratory testing	Selected soil samples were sent by CC Ground Investigations Ltd., to Professional Soils Laboratory (PSL) a UKAS accredited laboratory, for geotechnical testing	▪ To obtain material properties and to aid the derivation of geotechnical parameters for use in design.
Chemical laboratory testing	Selected soil samples were sent by CC Ground Investigations Ltd., to I2 Analytical Ltd a UKAS and	▪ To determine any potential contamination within the ground where the newly proposed buildings are to be developed.

	MCERTS accredited laboratory, for chemical testing	

The boreholes were positioned primarily within the vicinity of the proposed building footprint and to depths appropriate for the proposed four to five storey building and likely piled foundation depth requirements. Additional boreholes were located across the whole site and around the proposed car park and access roads to provide general site coverage and identify any prevalent constraints to subsequent phases of the overall development. All boreholes were commenced with a Fraste ML multipurpose drill rig utilising dynamic sampling and were extended, where possible, with rotary core boring to depths ranging from 10mbgl (BH104, BH105, BH110 and BH111) to (BH101 to BH103, and BH106 to BH109) to 35mbgl. In some instances dynamic window sampling was undertaken to termination depth due to the ground conditions being unsuitable for rotary coring methods and in this instance Class 1 sub samples could not be obtained. This is in accordance with BS EN ISO 22475-1-2006 (**Reference 8**) for sampling methods during the ground investigation.

Trial pits were located within the areas of proposed car park and roads. These were excavated using a backhoe excavator to depths ranging between 3.2 and 4.0m bgl.

Soil samples were collected for chemical laboratory testing by I2 Analytical Laboratories Ltd. All samples were taken with due regard to industry good practice and procedures were designed to minimise the potential for cross-contamination. Samples were collected into labelled containers provided by the laboratory and chain of custody documentation was completed. The samples were suitably preserved and submitted to I2 Analytical Laboratories Ltd, a UKAS and MCERTS accredited laboratory, for analysis.

GROUND INVESTIGATION REPORT

The ground conditions encountered are presented in the borehole logs and the trial pit logs which were prepared by CC Ground Investigations Ltd. The logs are included in **Appendix C** and the ground conditions are summarised in **Section 5**.

RESULTS OF IN SITU TESTS

Standard Penetration Tests (SPTs) were carried out in all the dynamic sample boreholes, BH101 to BH111. The results are shown on the borehole log sheets in the Factual Report and summary plots are included in Section 6 of this report. A calibration certificate for the hammer used for the Standard Penetration Tests is provided in **Appendix C**.

4.4 DRAINAGE STUDIES

Soil infiltration tests were undertaken in accordance with BRE 365 (**Reference 9**) within two trial pits (TP101 and TP103) to inform the proposed drainage strategy for the site. At the test locations, the trial pits encountered primarily cohesive material immediately below Topsoil level and, due to the low infiltration rate, failed to provide sufficient drainage in order to calculate permeability rates.

4.5 PILE TESTS

None undertaken.

4.6 GROUNDWATER MONITORING

Groundwater monitoring has been undertaken on three separate visits (02/12/2015, 07/12/2015 and 14/12/2015). The results are presented within the Generic Quantitative Risk Assessment Report (GQRA) which is in **Reference 10.**

4.7 SOIL GAS MONITORING

Ground gas monitoring has been undertaken on three separate visits (01/12/2015, 07/12/2015 and 14/12/2015). The results are presented within the Generic Quantitative Risk Assessment Report (GQRA) **Reference 10** and in **Appendix D.**

4.8 LABORATORY ANALYSIS

DESCRIPTION OF TESTS

The laboratory testing programme instructed by WSP was based on the soil types encountered and the relevant proposed design. Selected soil samples were submitted to a UKAS accredited laboratory for geotechnical and chemical testing in order to inform the strength and composition of the ground. The testing regime included the following:

- Soil classification tests comprising Bulk Density, Natural Moisture Content, Atterberg Limits and Particle Size Distribution;
- Saturation Moisture Content of chalk;
- Intact Dry Density (IDD) of chalk;
- Uniaxial Compressive Strength (ISRM);
- Point Load Strength testing;
- Chalk Crushing Value (CCV);
- Quick undrained triaxial testing;
- Compaction testing using 2.5 kg dynamic compaction method; and
- Chemical testing to determine acid and water soluble sulphate contents, pH, total sulphur, total potential sulphate and oxidisable sulphide.

Screening for soil contamination was undertaken on samples which are presented in the Generic Quantitative Risk Assessment Report **Reference 10** and in **Appendix D.**

TEST RESULTS

Full sets of laboratory test certificates are included together with summary tables in **Appendix E.** The data are discussed in **Section 7**.

5 GROUND SUMMARY

5.1 GENERAL

The ground conditions encountered in the exploratory holes are generally consistent with the geological sequence as detailed on the regional BGS mapping for the site and the ground conditions are described below. Exploratory hole logs for the investigation and an interpretative ground model in the form of a long section through the site, alongside the detailed geological logs for each exploratory hole are provided in **Appendix C** and **Appendix F**.

5.2 TOPSOIL

Topsoil was encountered where maintained grassed and other soft landscaped areas are present at the site. This includes the fields in the north and south. Topsoil was generally brown, slightly sandy, slightly gravelly Clay or Silt with rootlets, approximately 0.30 m in thickness and underlain typically by River Terrace Deposit or Made Ground where present.

5.3 MADE GROUND

Made Ground was encountered at twelve exploratory hole locations and generally between 0.20m and 1.3m in terms of thickness. The Made Ground included, in varying proportions across the site, fragments of brick and clinker. The matrix of the Made Ground was also found to vary across the site. In the area of the northern fields the matrix generally comprised slightly sandy slightly gravelly Clay.

Within the footprint of the proposed four to five storey building, the depth of Made Ground was between 0.3m bgl and 1.30m bgl. This contained fragments of brick flint, concrete, siliceous material, steel tubing, rare ash, clay tile fragments, porcelain fragments, and clay pipes in a matrix of slightly sandy slightly gravelly Clay.

5.4 SUPERFICIAL DEPOSITS

Superficial Deposits were encountered beneath the Made Ground or Topsoil in seventeen of the exploratory hole locations.

The Superficial Deposits comprise of three strata and vary across and near to the site, in accordance with the BGS geology map;

- Raised Marine Deposits – north of the site and within the south;
- Raised Beach Deposits – central of the site, to the south of the stream;
- Raised Terrace Deposits – south of the site, not located within site boundary.

The Superficial Deposits all comprise of firm light brown and greyish brown locally off-white slightly sandy slightly gravelly CLAY. Gravel is sub-angular to sub-rounded fine to medium of chalk and flint with rare organic material.

Note that there is some organic material with Superficial Deposits which is varies locally.

The site can be generally characterised between the north and south. The typical thickness of the Superficial Deposits within the north half of the site was between 3.20mbgl and 15.90mbgl.

In the southern part of the site the typical thickness of the Superficial Deposit was between 0.60mbgl and 3.50mbgl. This is due to the Lambeth Clay formation being present within the southern area of the site.

5.5 LAMBETH CLAY

Lambeth Clay was encountered beneath the Superficial Deposits in seven of the exploratory hole locations, and was found only within the southern area of the site where the geological boundary is located, near to the drainage outlet. The depth of the Lambeth Clay was proven to a maximum depth of 8.50mbgl, with a typical thickness of 4.30mbgl, varying locally across the site.

5.6 WHITE CHALK SUBGROUP FORMATION

White Chalk Subgroup Formation was encountered within eleven exploratory borehole locations (BH101 to BH111) due to the scheduled depth for these holes.

The Chalk can be considered to have two horizons; Structureless Chalk (weathered) and Structured Chalk (intact). The Structured Chalk was encountered beneath the structureless chalk within borehole locations BH101 to BH104, BH106 to BH109 and BH111. The structureless chalk varied in depth ranging from between 6.50mbgl to 18.90mbgl as well as the thickness which varied across the site from between 0.15mbgl to 4.80mbgl.

The structureless chalk encountered within the building footprint (BH101 to BH103) was relatively consistent in depth ranging from between 8.00mbgl to 11.30mbgl as well as thickness being consistent across the building footprint from between 0.60m to 1.40m. The structureless chalk typically comprised white stained orangish brown and yellowish brown chalk composed of slightly sandy silty gravel. Gravel is sub-angular to sub-rounded fine to coarse low density chalk. Typical grading for the structureless chalk was of Dc, this in accordance with the CIRIA C574 Chalk Grading system (**Reference 12**).

The structured chalk was encountered in BH101 to BH104, BH106 to BH109 and BH111, the thickness was not proven for this stratum; however the depth ranged between 8.90mbgl and 11.10mbgl. The structured chalk comprised very weak to weak medium density white mottled orangish brown Chalk. Discontinuities are very closely to medium spaced with minimum infill of off white comminuted chalk. The chalk typically graded a B3 chalk with strength and grade generally increased with depth.

A summary table (Table 5-1) of the thicknesses of each stratum is given below. Note the structured chalk has not been included as the thickness was not proven.

Table 5-1: Summary of Stratum Thickness

STRATUM	TOPSOIL/ MADE GROUND	SUPERFICIAL DEPOSITS	LAMBETH CLAY	STRUCTURELESS CHALK
Exploratory Hole	**Thickness (m)**	**Thickness (m)**	**Thickness (m)**	**Thickness (m)**
[1]BH101	0.3	1.3	5.8	0.6
[1]BH102	0.3	1.4	6.9	0.7
[1]BH103	0.8	0.6	8.5	1.4
BH104	0.3	6.9	*	4.8
BH105	0.3	12.4	*	2
BH106	0.4	1.1	4.2	0.8
BH107	0.4	3.5	1.7	1.9
BH108	0.1	8.3	*	2

BH109	0.7	15.9	*	2.3
BH110	0.8	6.25	*	0.15
BH111	0.2	5.4	*	4.2
TP101	1.3	*	1.9	*
TP102	0.3	1.9	1.3	*
TP103	0.2	3.8	*	*
TP104	0.3	3.7	*	*
TP105	0.3	3.4	*	*
TP106	0.4	3.2	*	*
TP107	0.4	3.2	*	*

*Strata not encountered
[1]Exploratory hole within building footprint

A summary table (Table 5-2) of the typical surface levels for each stratum is given below.

Table 5-2: Summary of Surface Levels for Stratum

LOCATION	TYPICAL SURFACE LEVELS (M OD)	TOPSOIL/ MADE GROUND	SUPERFICIAL DEPOSIT	LAMBETH CLAY	STRUCTURELESS CHALK
		Level To (m AOD)	Level To (m AOD)	Level To (m AOD)	Level To (m AOD)
North	**Average**	1.01	-5.58	*	-10.78
South	**Average**	1.81	0.22	-3.91	-6.18

*Stratum not encountered.

5.7 ENCOUNTERED GROUNDWATER

Groundwater was encountered during the ground investigations as follows:

- BH107 2015: groundwater strike at 1.50mbgl rising and settling to 1.30mbgl after five minutes;
- BH108 2015: groundwater seepage at 1.20mbgl, no rise recorded;
- BH110 2015: groundwater strike at 1.00mbgl and remaining at 1.00mbgl after twenty minutes;
- BH111 2015: Groundwater strike at 1.50mbgl rising to 1.30mbgl after twenty minutes.

5.8 GROUNDWATER LEVEL MONITORING

Groundwater level monitoring data are presented in Table 5-3 of this report and further detailed results will be presented in a separate Generic Quantitative Risk Assessment Report (GQRA). These four wells were monitored on three occasions (2nd, 7th and 14th December 2015) for the 2015 ground investigation.

Table 5-3: Groundwater level monitoring results

EXPLORATORY HOLE	LEVEL FROM (M OD)	VISIT 1 (M BGL) (MOD)	VISIT 2 (M BGL) (MOD)	VISIT 3 (M BGL) (MOD)
BH101*	2.44	1.73 (0.71)	2.12 (0.32)	1.75 (0.69)
BH102*	2.18	1.78 (0.4)	1.72 (0.46)	1.31 (0.87)
BH103*	2.91	2.54 (0.37)	2.37 (0.54)	1.96 (0.95)
BH104	1.53	0.93 (0.6)	0.93 (0.6)	0.81 (0.72)

BH105	1.39	0.88 (0.51)	0.9 (0.49)	0.75 (0.64)
BH106*	2.24	1.60 (0.64)	1.48 (0.76)	1.44 (0.81)
BH107*	1.91	1.34 (0.57)	1.35 (0.56)	1.01 (0.9)
BH108*	1.36	0.78 (0.58)	0.8 (0.56)	0.55 (0.81)
BH109*	1.18	1.43 (-0.25)	1.16 (0.02)	0.69 (0.49)
BH110	1.42	0.78 (0.78)	0.78 (0.64)	0.62 (0.8)
BH111	1.44	0.77 (0.67)	0.79 (0.65)	0.71 (0.73)

*Boreholes within the building footprint.

5.9 GROUND GAS MONITORING

The results of the ground gas monitoring will be presented in a separate Generic Quantitative Risk Assessment Report (GQRA) (**Reference 10**) and in **Appendix D**.

6 GROUND CONDITIONS AND MATERIAL PROPERTIES

6.1 INTRODUCTION

The following chapter summarises the results of the insitu testing and laboratory testing for individual soil types encountered across the site and selects characteristic parameters. No previous ground investigations have been undertaken on this site and therefore only the information obtained from the recent (2015) ground investigation results will be used to determine the ground conditions.

This report is intended to meet the EC7 requirements for a GIR. Test data is presented and interpreted using published correlations to produce derived values. Mean and lower quartile trend lines are presented where applicable to guide the user. The selection of suitable characteristic and design values will depend on the particular location and extent of the structure and the design calculation being undertaken and as such will be selected and presented in the GDR.

6.2 TOPSOIL

Where Topsoil was present across the field areas and typically comprised grass over brown silt with low gravel content. No geotechnical assessment has been made of this material.

6.3 MADE GROUND

Made Ground was encountered in twelve of the exploratory holes with a maximum thickness of 1.3m however; typical thickness is approximately 0.46m. Due to the limited amount testing that was undertaken on the material, only Atterberg Limits can be interpreted for geotechnical assessment and it should be assessed on a case by case basis if required.

Two Atterberg Limit tests were undertaken on cohesive samples of Made Ground. The Plasticity Index (PI) of the cohesive material ranges from 30% to 33%. The two test results, when plotted on a Casagrande/A-Line Plot show that cohesive material is classified as high plasticity clay.

6.4 SUPERFICIAL DEPOSITS

Superficial Deposits were encountered below all Made Ground, where present and was predominantly found within the northern area of the site. The surface of the Superficial Deposits was recorded between 0.48mOD to 2.14mOD.

Within the Superficial Deposits numerous laboratory tests were carried out to derive characteristic values for the strata, which are as follows in this section.

Atterberg Limit tests were undertaken on forty samples from the Superficial Deposits. Plastic Limits ranged from 22% to 34% with an average of 27%. Liquid Limit ranged from 45% to 87% with an average of at 63%. Plasticity Index (PI) ranged from 23% to 53% with an average of 36%. Plasticity Index has been plotted against depth in Figure 6-1, and on a moisture content, liquid limit and plastic limit against depth below ground Figure 6-2. This shows that moisture content sits closer to the plastic limit indicating the Lambeth Clay is of a higher strength. A Casagrande/A-Line Chart has been plotted in Figure 6-3. The chart shows the Superficial Deposits to plot above the "A" line and has been classified as an intermediate to very high plasticity clay. The data presented in Figure 6-1 suggests that there is an increase in plasticity with depth, as indicated by the trend line.

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Figure 6-1: Plasticity index against depth below ground

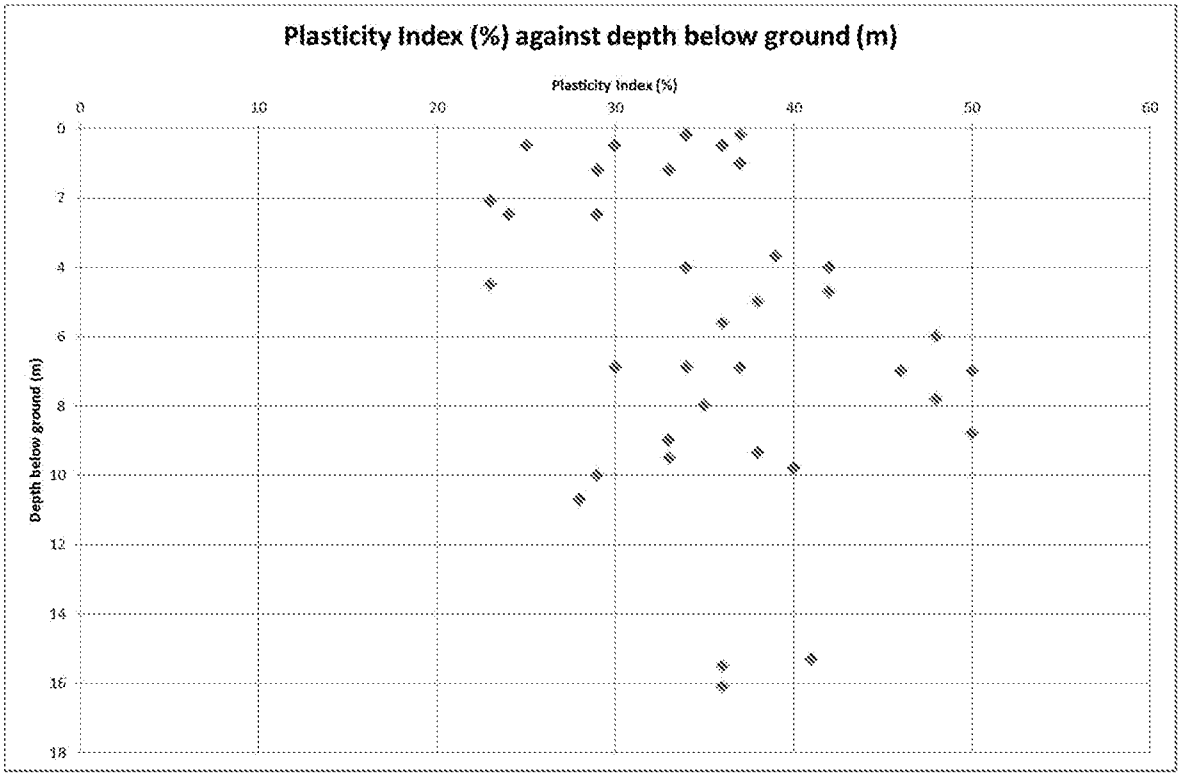
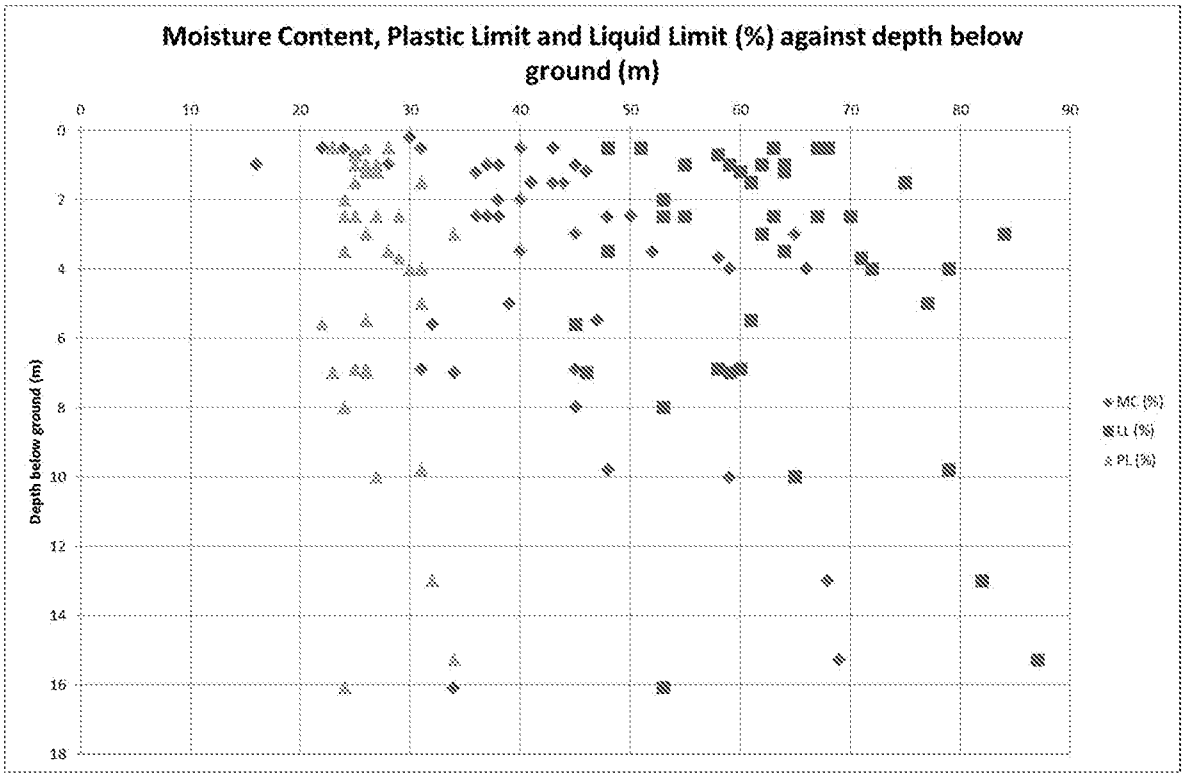
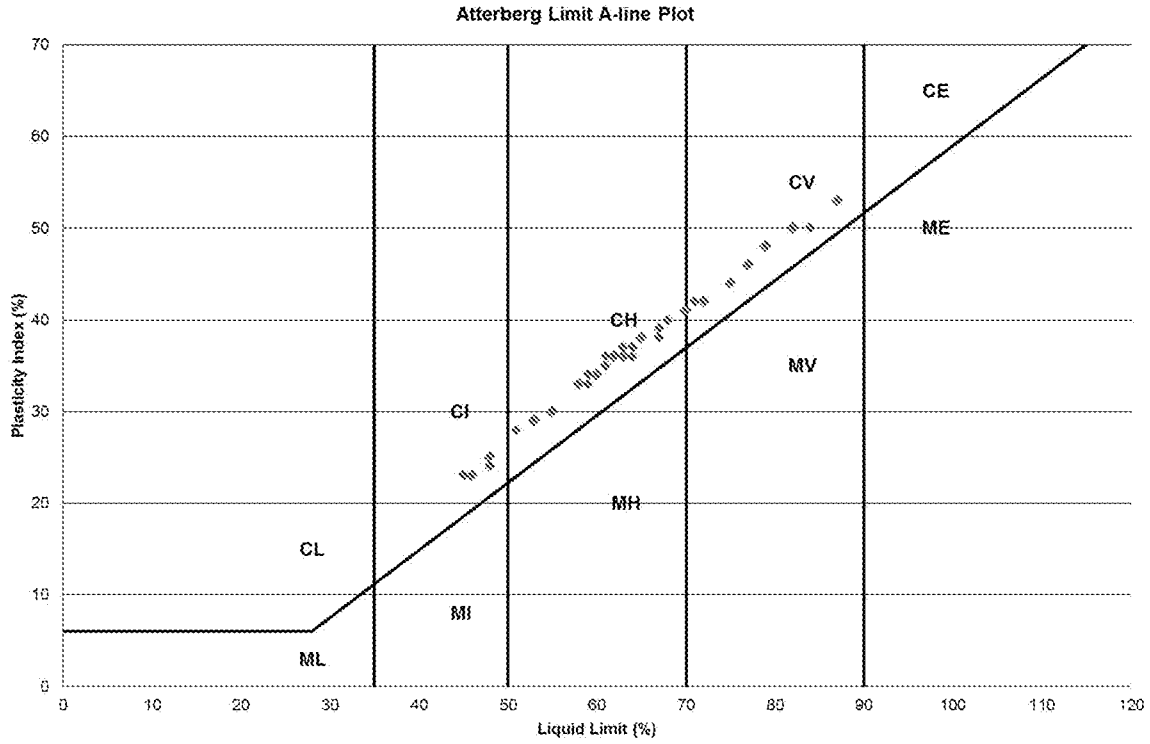


Figure 6-2: Moisture content, liquid limit and plastic limit (%) against depth below ground



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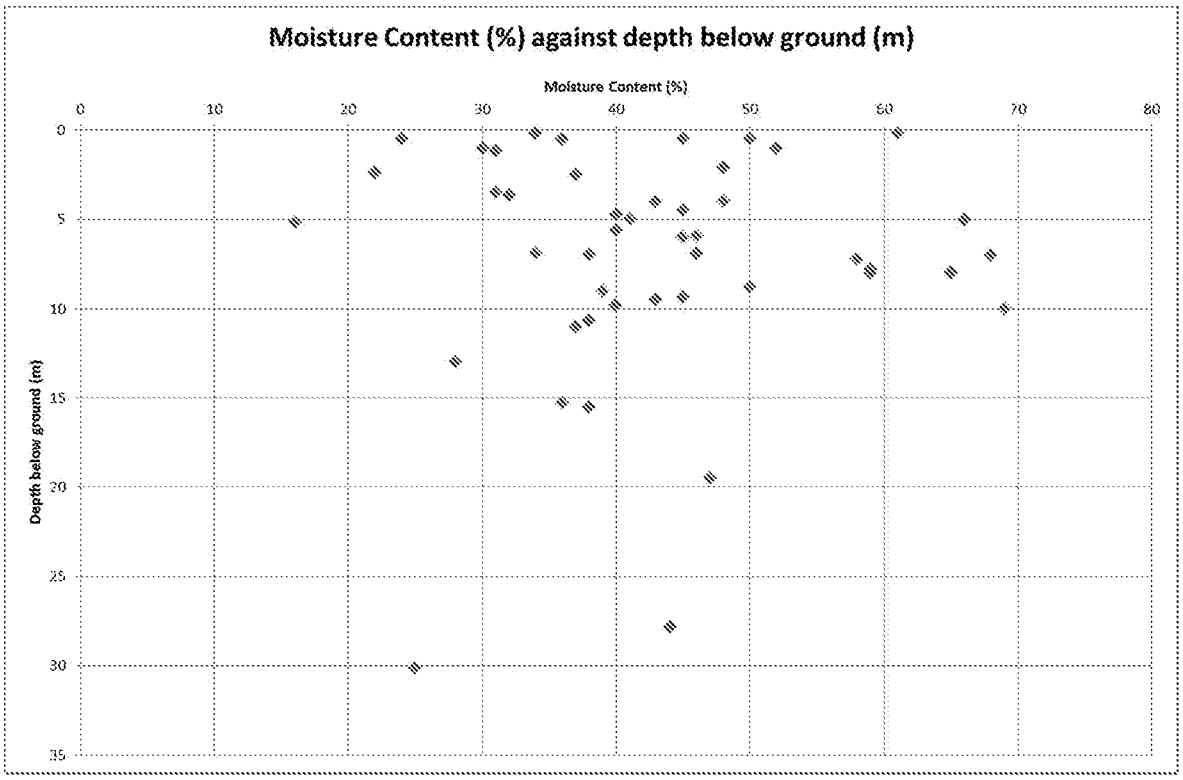
Figure 6-3: Casagrande/A-Line Chart



Moisture content tests were conducted on forty-six samples from the Superficial Deposits, as part of both the Atterberg limit tests and natural moisture content tests. Moisture content ranged from 16% to 69% with an average of 43%. Moisture content is plotted against depth below ground in Figure 6-4. This plot shows that there is some trend in moisture content with depth. Between ground level and 5m bgl the moisture content generally lies between values of 30% and 50%. Between 5m bgl and 10m bgl the data records show that moisture content increase from 40% to 70%.

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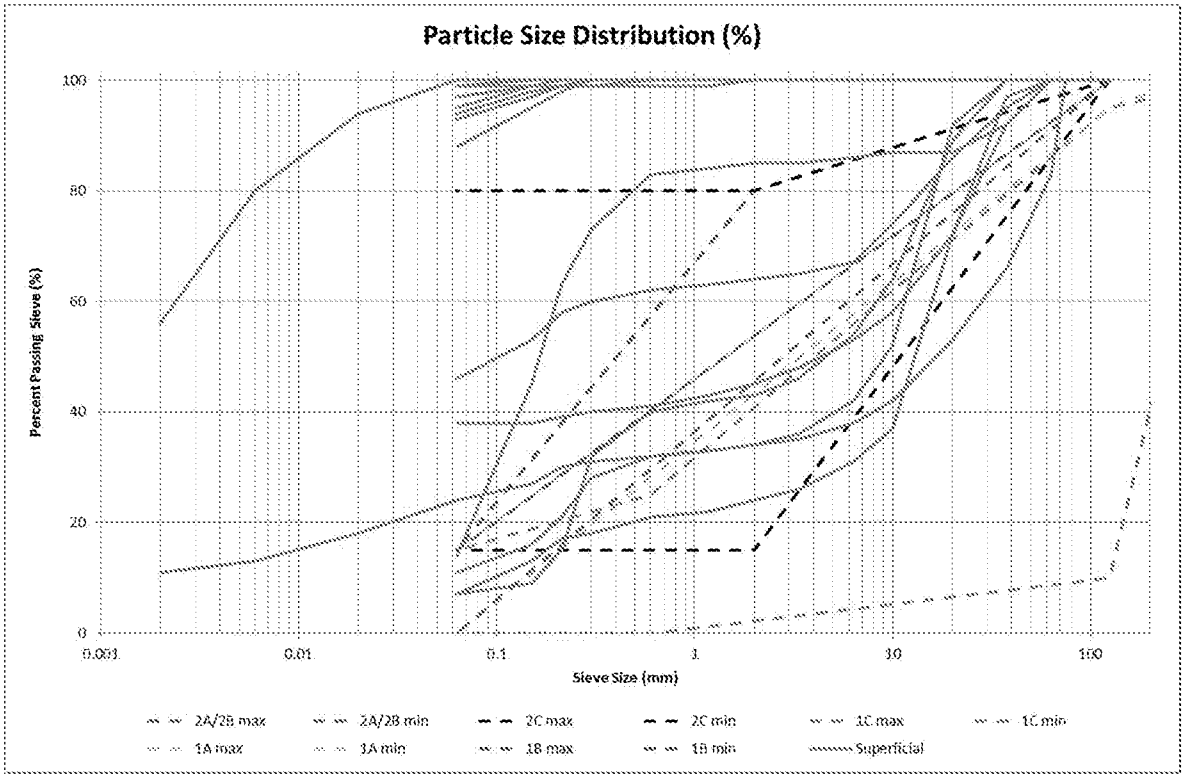
Figure 6-4: Moisture Content against depth below ground



Particle Size Distribution testing was conducted on sixteen samples of Superficial Deposit. The sixteen grading curves are presented in Figure 6-5. Based on the particle sizes this stratum classifies as a Class 2 cohesive material in accordance with the Specification for Highways Works

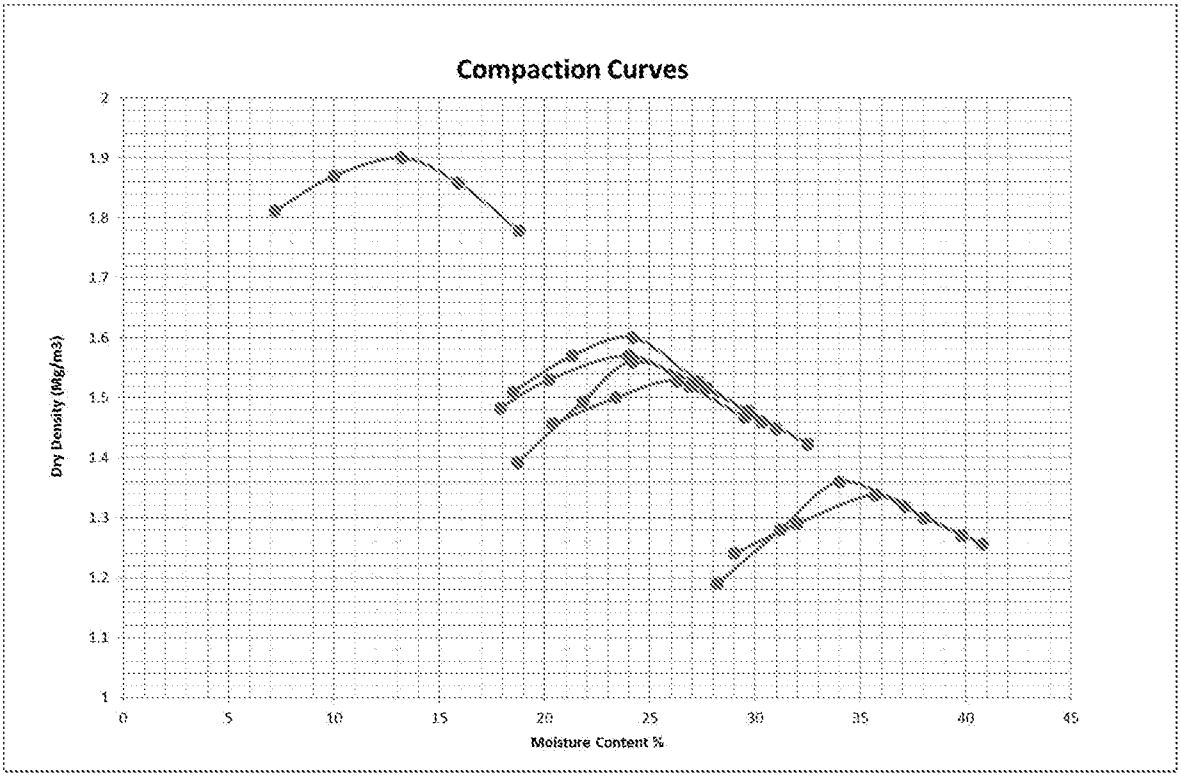
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Figure 6-5: Particle Size Distribution



Compaction testing was undertaken using a 2.5kg proctor on seven samples of Superficial Deposits. The tests reported a maximum dry density range of 1.34Mg/m^3 to 1.90Mg/m^3. The optimum moisture content range is reported as 13.2% to 35.7%. The compaction curves are presented in Figure 6-6.

Figure 6-6: Compaction Curves



6.5 LAMBETH CLAY

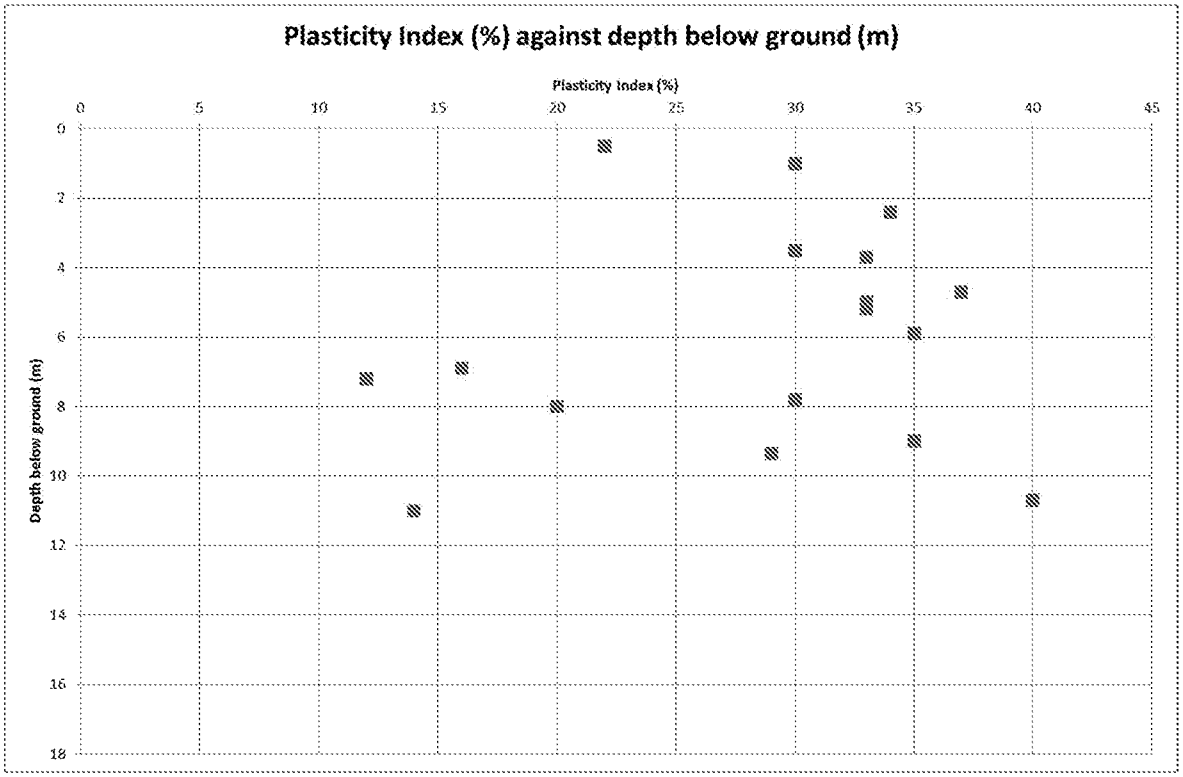
Lambeth Clay was encountered below the Made Ground and Superficial Deposits, respectively, and is generally encountered in the southern part of the site (BH101, BH102, BH103, BH106, BH107, TP101, TP102). The surface of the Lambeth Clay was recorded between 1.51mOD and 1.99mOD.

Within the Lambeth Clay numerous laboratory tests were carried out to derive characteristic values for the strata, which are as follows in this section.

Atterberg Limit tests were undertaken on seventeen samples from the Lambeth Clay. Plastic Limits ranged from 14% to 28% with an average of 23%. Liquid Limit ranged from 26% to 68% with an average of at 51.5%. Plasticity Index (PI) ranged from 12% to 40% with an average of 28%. Plasticity Index has been plotted against depth below ground in Figure 6-7 and moisture content, liquid limit and plastic limit Figure 6-8. This shows that moisture content sits closer to the plastic limit indicating the Lambeth Clay is of a higher strength. A Casagrande/A-Line Chart is presented in Figure 6-9. The chart shows the Lambeth Clay to plot above the "A" line and has been classified as a low to high plasticity clay. The data does not indicate any clear trends in order to determine the division of Lambeth Clay encountered.

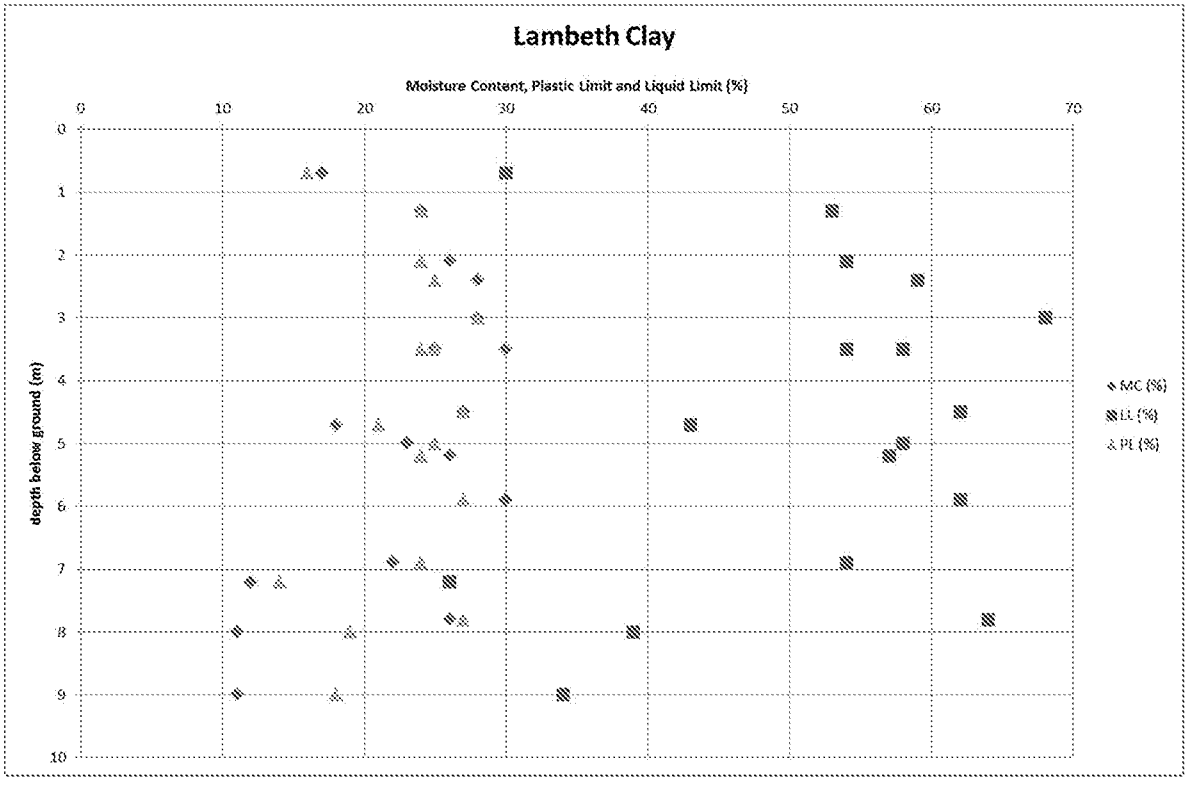
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Figure 6-7: Plasticity Index of Lambeth Clay.



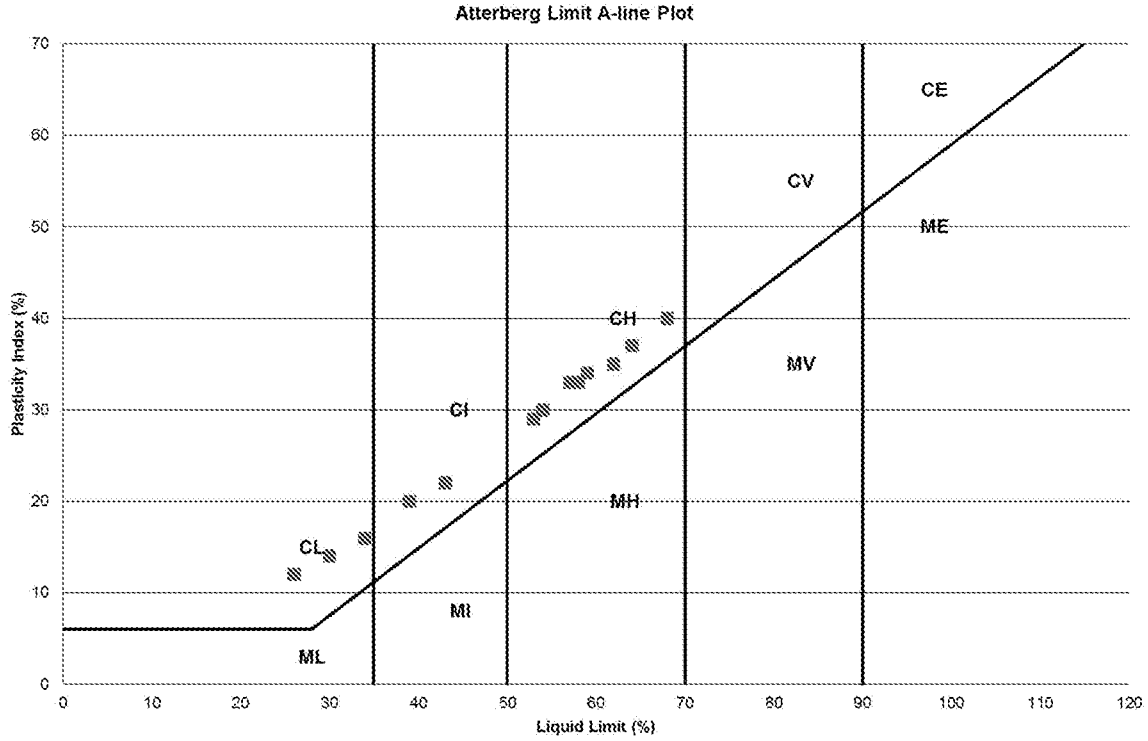
Plot of Plasticity Index against depth below ground level is presented in Figure 6-7. This indicates no real trend of the Plasticity Index.

Figure 6-8: Moisture content, liquid limit and plastic limit (%)against depth for Lambeth Clay



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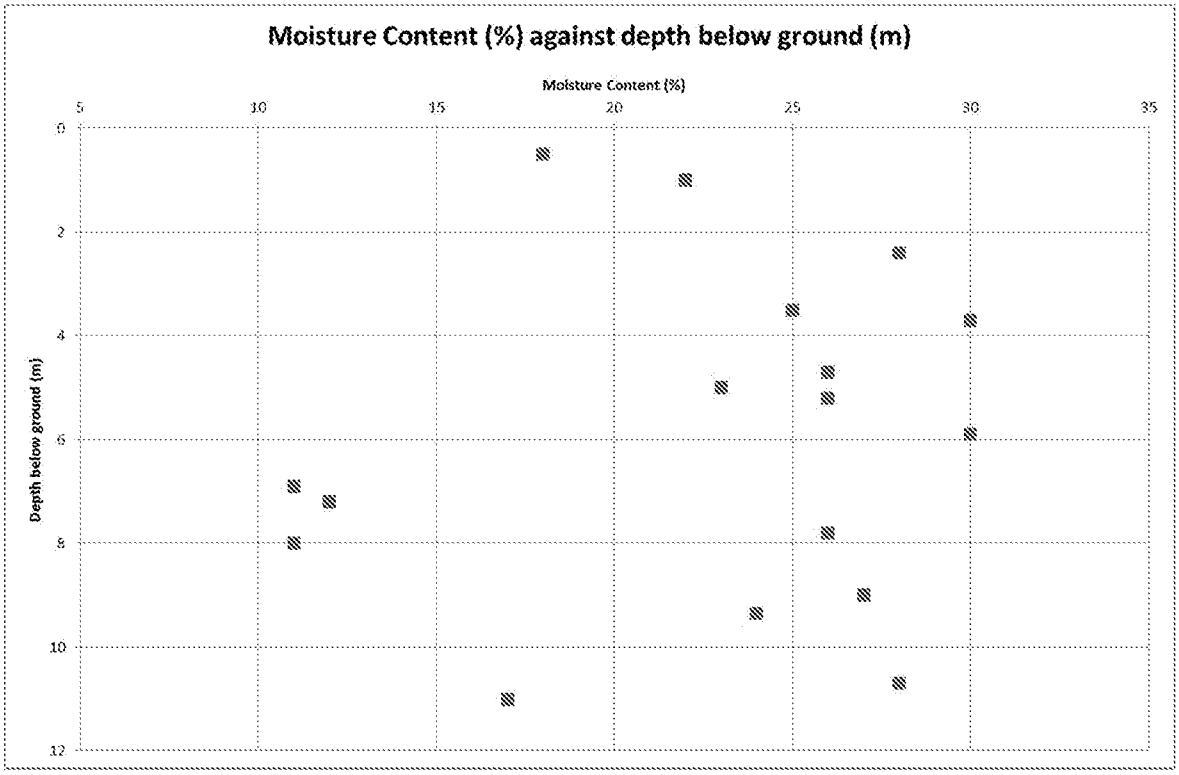
Figure 6-9: Atterberg Limit A-Line plot for Lambeth Clay.



Moisture content tests were conducted on seventeen samples from the Lambeth Clay, as part of both the Atterberg limit tests. Moisture content ranged from 11% to 30% with an average of 23%. Moisture content is plotted against depth below ground in Figure 6-10. This plot shows that there is no trend in moisture content by depth and it continues to vary from around 11% to 30% throughout the depth range.

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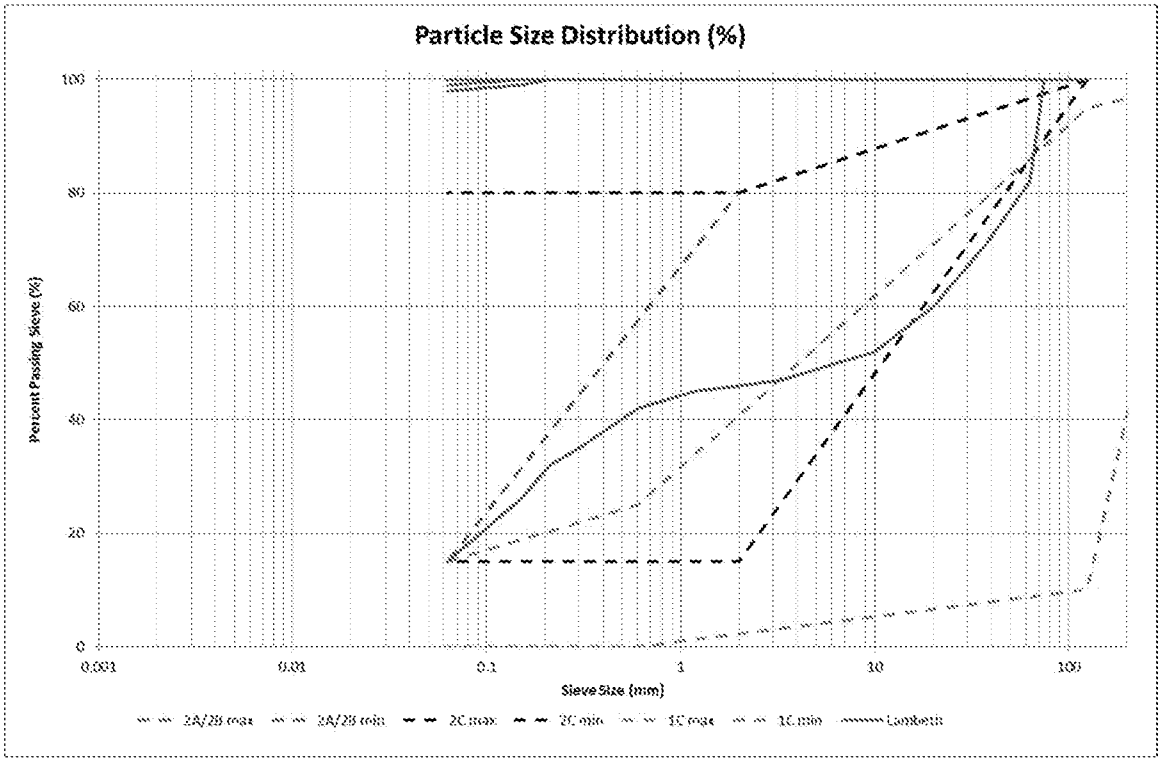
Figure 6-10: Moisture Content versus depth below ground (m) for Lambeth Clay.



Particle Size Distribution testing was conducted on four samples of Lambeth Clay. However, one of the samples comprised sand and gravel which is likely to come from the Upnor formation within the Lambeth Clay. The Upnor Formation typically is a pebble band with the Lambeth Clay and comprises fine to coarse black flint in fine to medium pale grey sand or clay, which is represented in the plot, Figure 6-11. The material is primarily comprised of silt and clay with no sand and gravel sized content and indicates a class 2A/B material, based on the particle sizes.

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Figure 6-11: Particle Size Distribution Curves in Lambeth Clay.

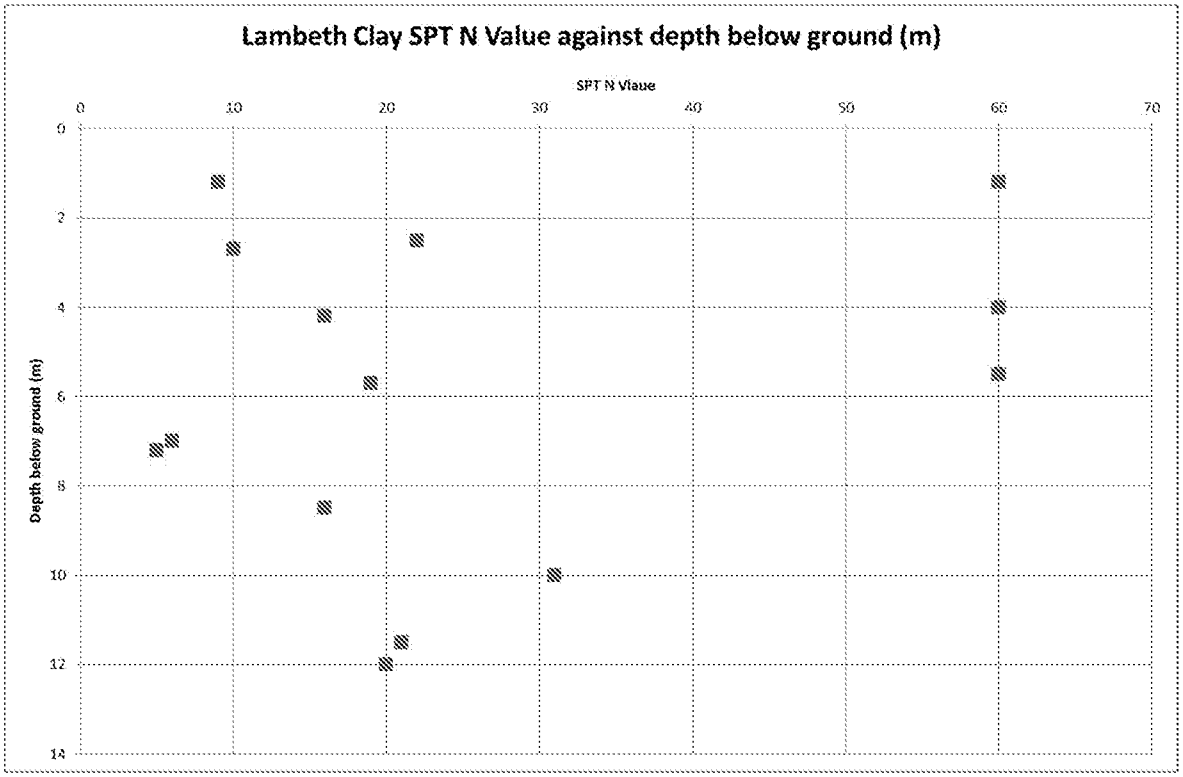


Compaction testing was undertaken on one sample of Lambeth Clay. The tests reported a maximum dry density of 1.58 Mg/m^3. The optimum moisture content is reported as 23.8%.

STRENGTH AND STIFFNESS

Standard Penetration Tests, SPTs were undertaken twenty-one times within the Lambeth Clay. The SPT N values have been limited to a maximum value of 60. The recorded SPT N values have been corrected to N_{60} values and ranged from 5 to 60, with an average of 23. Figure 6-12 presents a plot of recorded SPT N values against depth below ground level and shows an increase in SPT N value with depth. This indicates that the strength and stiffness of the material generally increases with depth which is as expected for Lambeth Clay.

Figure 6-12: SPT N60 against depth below ground level for Lambeth Clay.

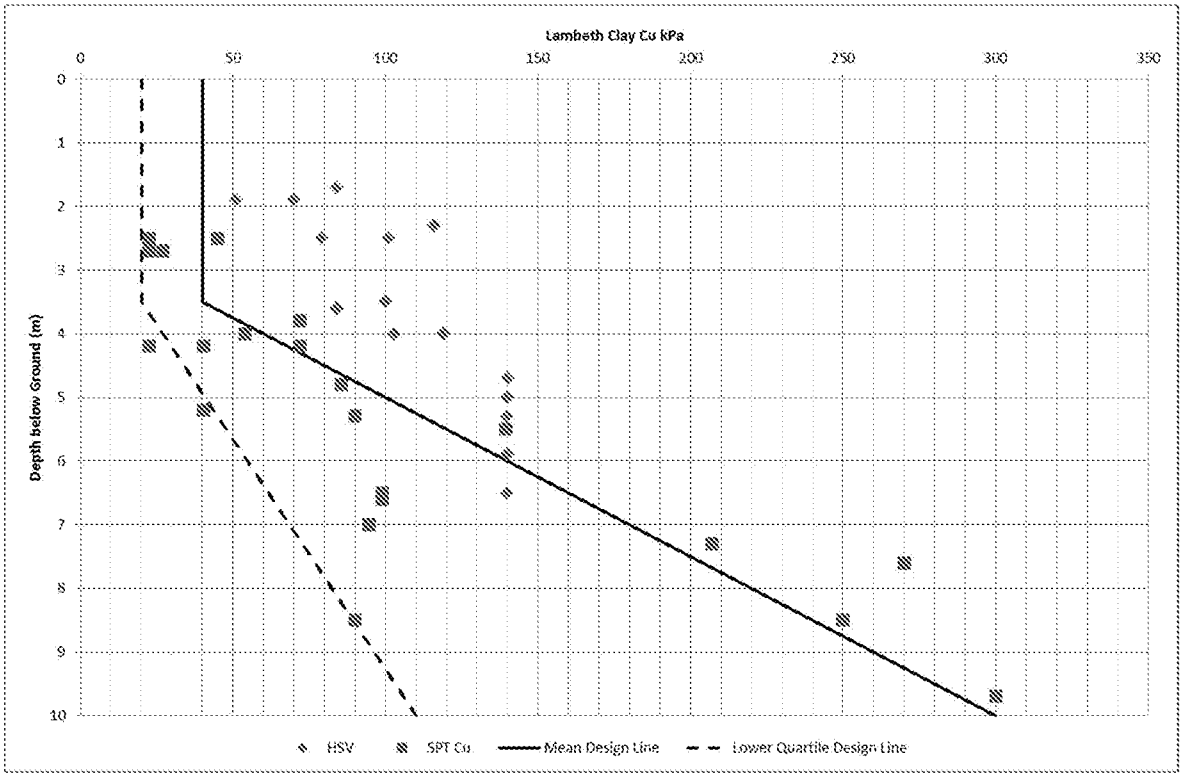


Undrained shear strength (c_u) of the clay in the Lambeth Group has been assessed using correlations with Standard Penetration Tests (Stroud, **Reference 11**). The undrained shear strength derived from the SPT blow counts (using a conversion of c_u/N = 4.2 based on the average PI in the layer of 33%) varies between 22.5kPa and 300kPa (average = 102kPa).

Results from Hand Shear Vane testing undertaken during the logging process on the core, within the liner, were at depths ranging from 1.7m bgl to 6.5m bgl. The results show a trend that strength generally increases with depth. However, results from this testing method are usually disregarded due to the low reliability of the method when undertaken on core samples and the 140kPa limiting maximum value.

The results of both the SPT correlation and HSV testing are plotted against depth below ground surface in Figure 6-12 and show that undrained shear strength generally increases with depth.

Figure 6-13: SPT and HSV correlation against depth below ground.



A mean design line and lower quartile design line are plotted on Figure 6-13 in order to arrive at recommended values for undrained shear strength at various depths. The use of mean values or lower quartile values depends upon the design application being considered and should be selected by the design engineer. The trend lines are summarised below:

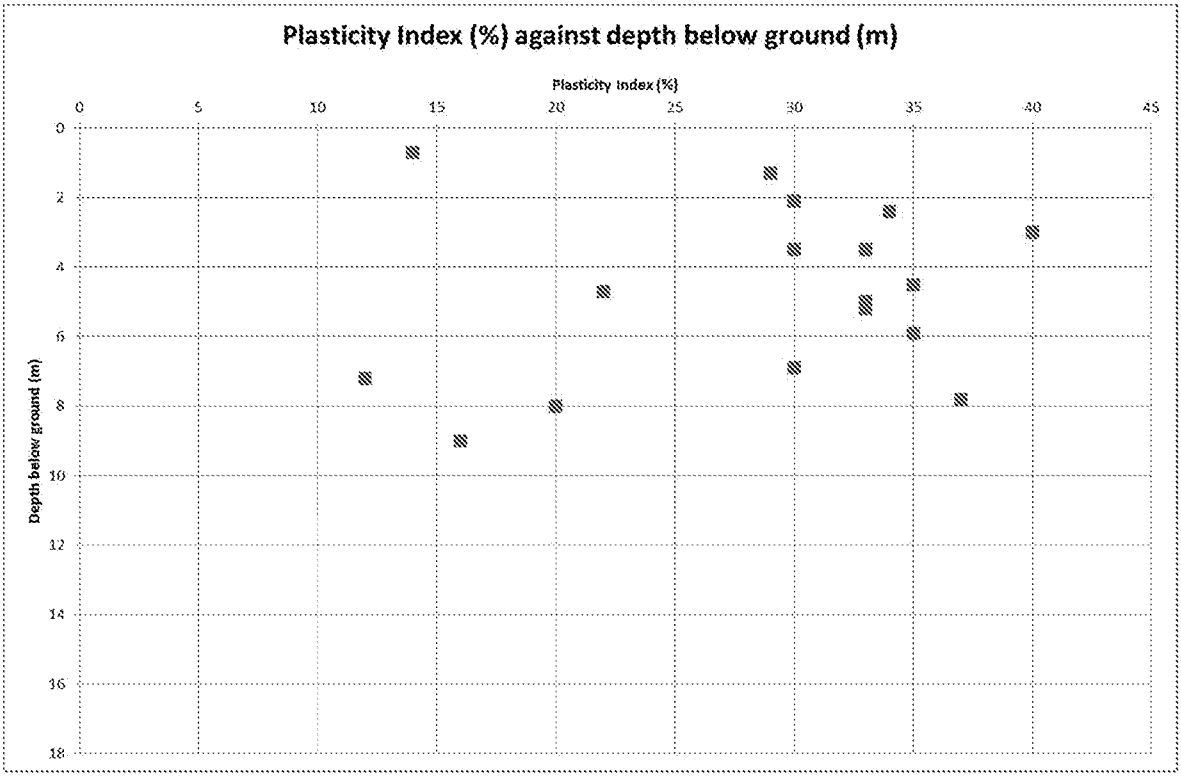
The average design line gives a strength profile of:

- c_u = 40kPa + 40z, where z is depth below 3.5m bgl.

The lower quartile design line gives a strength profile of:

- c_u = 20kPa + 13.85z, where z is depth below 3.5m bgl.

Figure 6-14: Undrained Shear Strength (Cu) against depth below surface (m) of Lambeth Clay.



Drained internal angle of friction (ϕ') has been estimated from PI (BS6031:2007). The range of PI is 12% to 40%, corresponding to an internal angle of friction (ϕ') of 23° to 27°. The average PI is 28% corresponding to an average ϕ' of 25°. This is represented in Figure 6-14.

A summary of the in situ field testing and laboratory geotechnical testing undertaken in the Lambeth Clay is provided in Table 6-1.

Table 6-1: Lambeth Clay test results

	Atterberg Limits (%)			Moisture Content (%)	SPT N_{60} Value	c_u correlated from SPT (kPa)
	LL	PL	PI			
No. of tests	17	17	17	17	21	21
Maximum	68	28	40	30	60	300
Minimum	26	14	12	11	5	22.5
Average	51	23	28	23	23	102
Rec' Value	-	-	-	-	-	Lower quartile: 20kPa + 13.85z[1] Mean: 40kPa + 40z[1]

[1] Where z is depth below 3.50m

6.6 WHITE CHALK SUBGROUP

White Chalk Subgroup was encountered below all Superficial Deposits and Lambeth Clay, respectively. The surface of the White Chalk Subgroup was recorded from between -3.46mOD to -17.72mOD and extended beyond the termination of all exploratory holes. There is a clear zone of

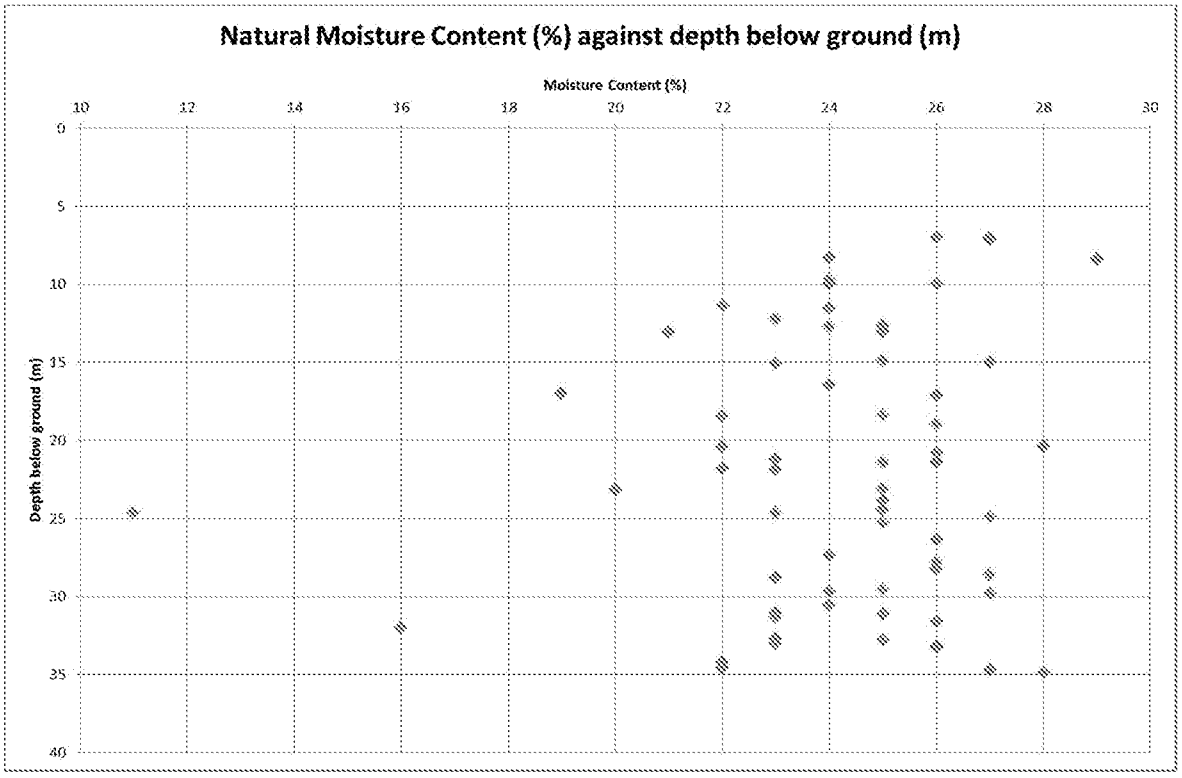
weathered chalk which is present within most boreholes. For the purposes of this report and analysis of parameters, this weathered zone is included.

Within the White Chalk Subgroup numerous laboratory tests were carried out to derive characteristic values for the strata, which are as follows in this section.

Atterberg Limit tests were recorded on three samples of chalk. The Liquid Limit ranges from 36% to 57% and the average is 46%. The Plastic Limit ranges from 21% to 25% and the average is 23.6%. Plasticity Index (PI) ranges from 11% to 32% and the average is 22%.

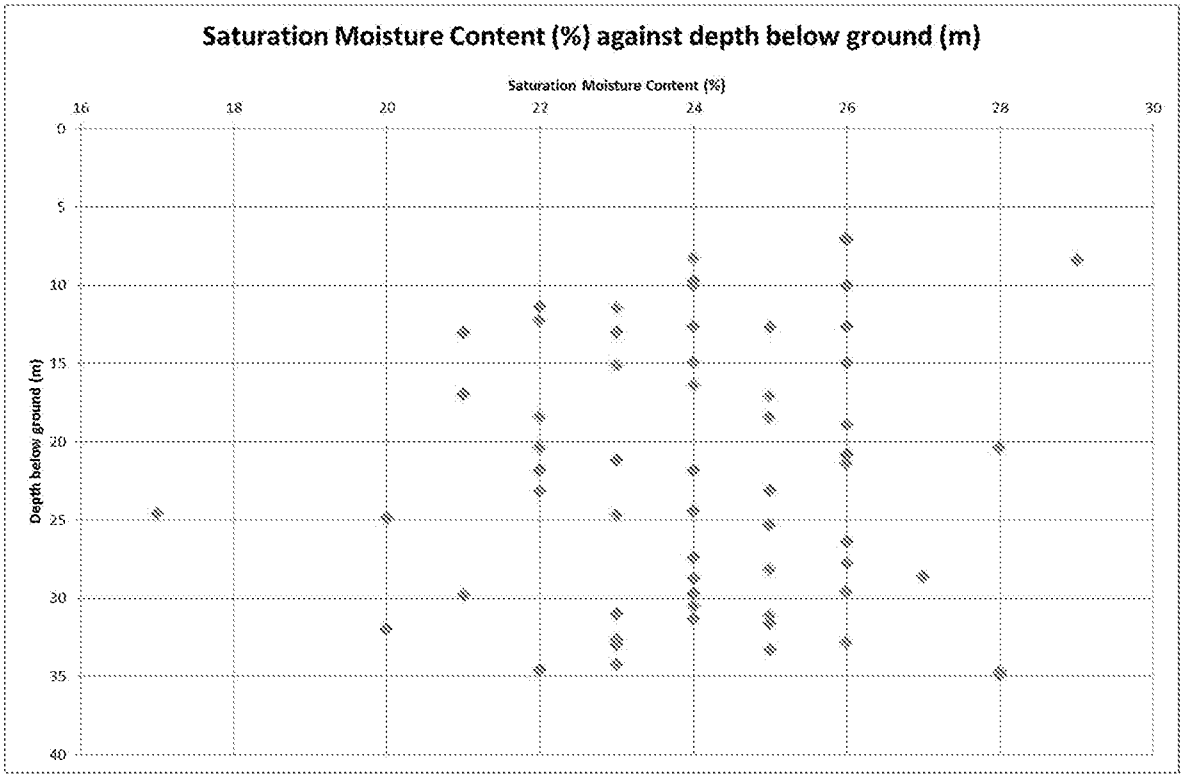
Natural moisture content tests were conducted on sixty-two samples of the White Chalk Subgroup. Results ranged from 11% to 29% with an average of 24%. Natural moisture content is plotted against depth below ground level in Figure 6-15. This plot shows that moisture content generally increases with depth and the majority of values range from between 22% to 26%.

Figure 6-15: Natural Moisture Content against depth below ground level



Saturation moisture content (SMC) tests were conducted on sixty-two samples of the structured White Chalk Subgroup. Results ranged from 17% to 29% with an average of 24%. Saturation moisture content is plotted against depth below ground level in Figure 6-16. This plot shows that saturation moisture content ranges between 22% and 26% with some outliers above and below this range.

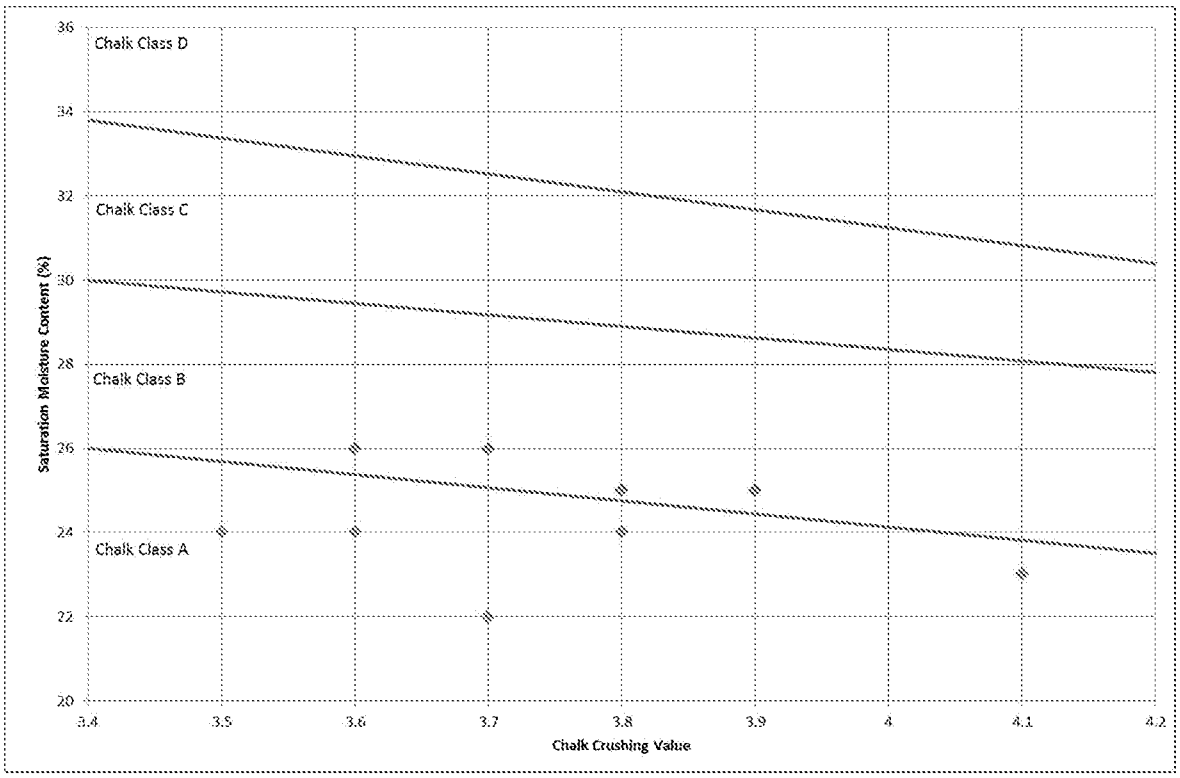
Figure 6-16: Saturation Moisture Content against depth below ground level



Thirteen chalk crushing value (CCV) samples have been undertaken on the structured chalk and can be used in conjunction with the saturation moisture content to classify the chalk in accordance with CIRIA C574 (**Reference 12**). The CCV ranged between 3.5 and 4.1, and have been plotted against Saturation Moisture Content (SMC) in Figure 6-17, that records the chalk as being a Earthwork Class A/B chalk, in accordance with Figure 5.1(b) Modified chalk classification chart (from Departmental Advice Note HA44/91 DTp 1991), in CIRIA C574.

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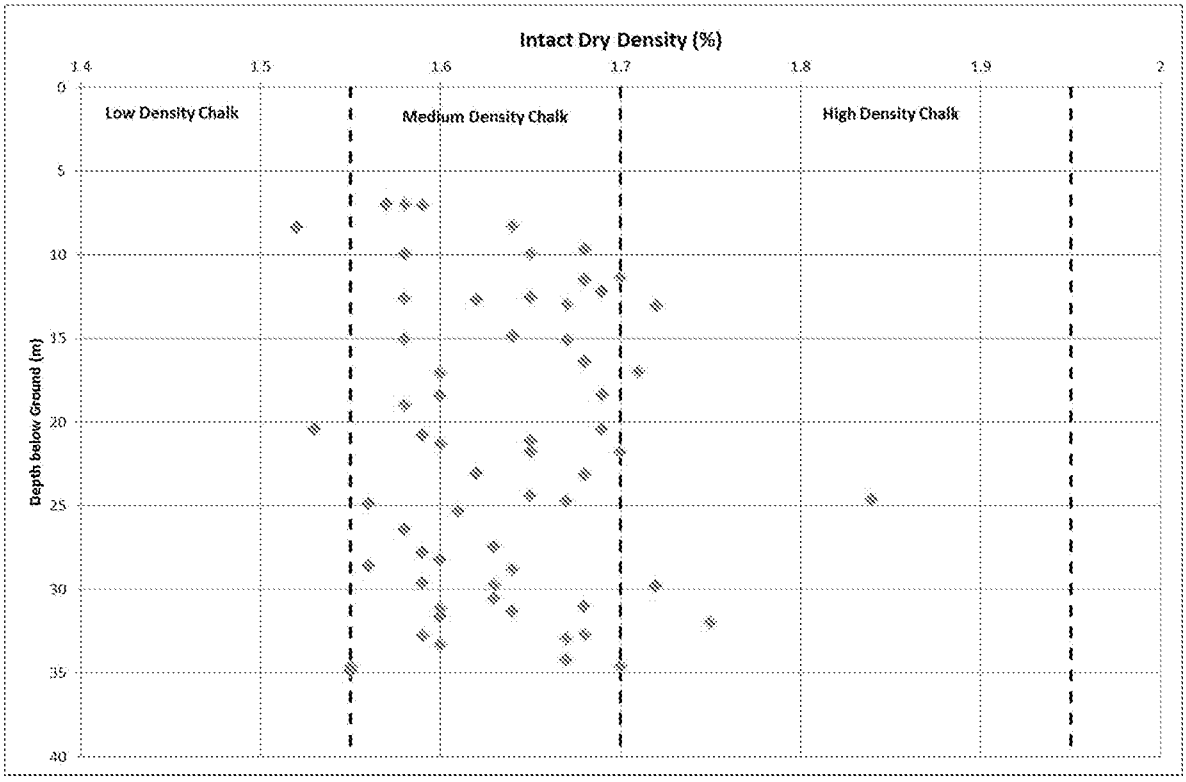
Figure 6-17: Chalk Earthwork Classification based on Saturation Moisture Content against Chalk Crushing Value



Intact dry density testing was undertaken on sixty-two samples of structured chalk from the ground investigation. Results ranged from 1.52% to 1.84% with an average of 1.63%. These values indicate the chalk is generally classified as a medium density chalk. This correlates with the data from the ground investigation factual report and borehole logs.

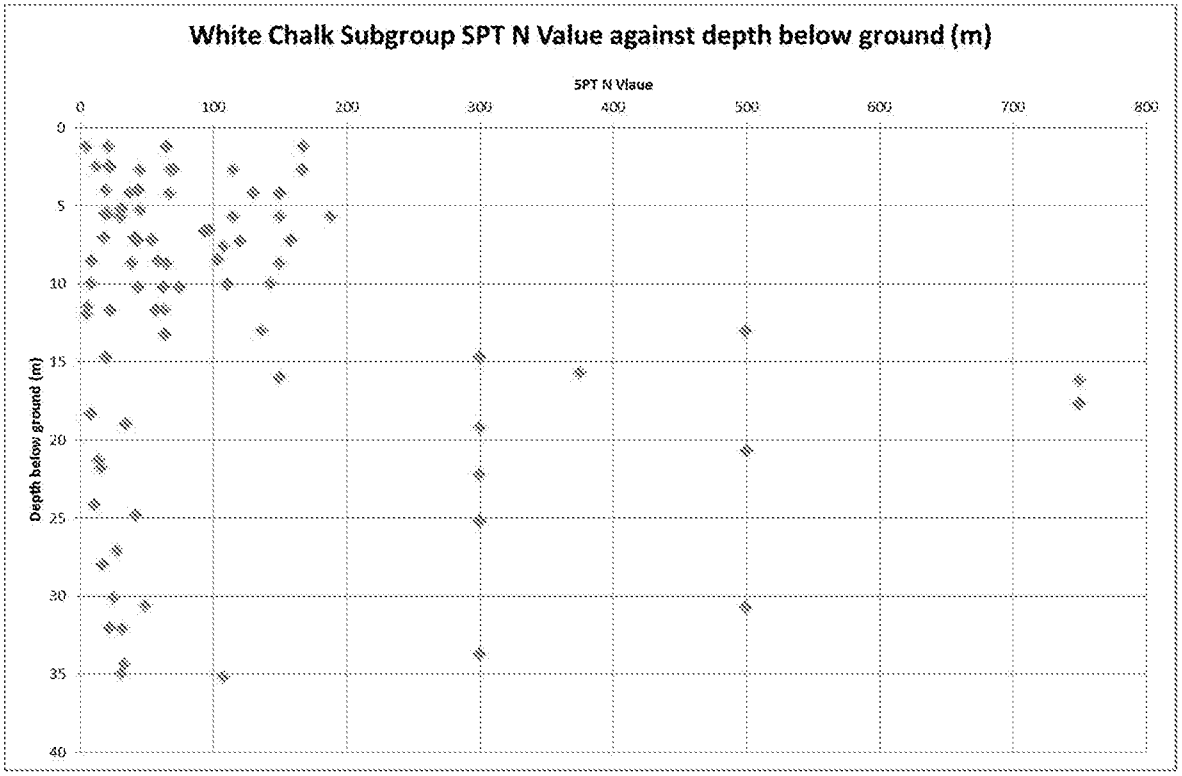
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Figure 6-18: Intact Dry Density against depth below ground level



Standard Penetration Tests, (SPTs) were undertaken on eighty-three samples within the chalk. The recorded SPT N values have been corrected to N^{60} values which are between 5 and 750 with an average of 114. However, it should be noted that twenty-four tests present high values of 120 to 750; these values have been extrapolated during the in-situ testing. Figure 6-19 presents SPT N Value plotted against depth below ground level.

Figure 6-19: SPT N Value against depth below ground level



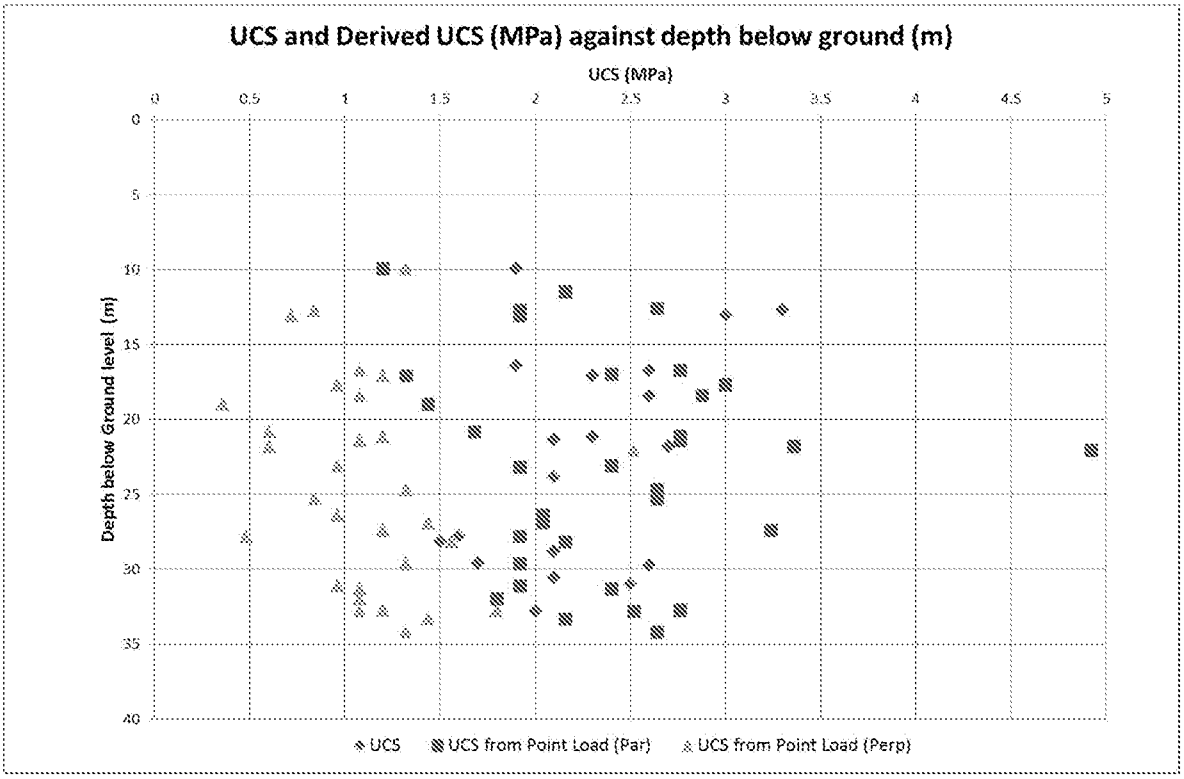
Thirty-two samples of the chalk were subject to a Point Load Strength Index Test which was split between two orientations, parallel and perpendicular, to give sixty-four results and gave an Is_{50} of between 0.05MPa and 0.41MPa, with an average of 0.15MPa. The tests that were in the parallel orientation gave a range of results between 0.10MPa and 0.41MPa with an average of 0.20MPa. The results undertaken in the perpendicular orientation have given a range between 0.03MPa and 0.21MPa with an average of 0.09MPa.

Nineteen Unconfined Compressive Strength (UCS) tests were undertaken recording a range of between 1.5MPa and 3.3MPa, with an average of 2.26MPa. UCS values have been plotted along with UCS derived from Is_{50} results[1], against depth below ground level (m bgl), in Figure 6-20.

[1] UCS can be taken as 10 times (range 16 – 25 times) the Point Load Index (Is_{50}) – David Norbury Limited 2008

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Figure 6-20: UCS and Derived UCS vs Depth below Ground Level



The results of the UCS and Point Load testing provide values typically lower than 3MPa, identifying the chalk as low density (CIRIA C574). This does not agree with the results of the saturation moisture content, intact dry density and chalk crushing value testing which all identify the material as a medium density chalk. A reason for this is that saturation moisture content, intact dry density and chalk crushing value tests require an intact lump of chalk, and often the chalk lump selected represents the best part of the sample (i.e. the only good lump available) thus the results reflect the upper end of the quality for the chalk material. It may therefore be that the UCS better reflects the chalk mass.

A summary of the laboratory geotechnical testing undertaken in the White Chalk Subgroup is provided in Table 6-2.

Table 6-2: White Chalk Subgroup test results

	Atterberg Limits (%)			Moisture Content (%)	Saturation Moisture Content (%)	Chalk Crushing Value (%)	Unconfined Compressive Strength testing (MPa)	Point Load index Is_{50} (MPa)	Intact Dry Density (Mg/^{3})
	LL	PL	PI						
No. of tests	3	3	3	65	62	13	19	64	62
Maximum	57	25	32	29	29	4.1	3.3	0.41	1.84
Minimum	36	21	11	11	17	3.5	1.5	0.03	1.52
Average	45	23	22	24.2	24	3.8	2.3	0.15	1.63

[1] Where z is depth below surface of White Chalk Subgroup

6.7 GROUNDWATER/CHEMISTRY

GROUNDWATER

Standpipe piezometers were installed in BH101 to BH111; these boreholes were included in a programme of groundwater level monitoring. These eleven wells were monitored on three occasions (2nd, 7th and 14th December 2015). The results are tabulated in Table 5-3.

BURIED CONCRETE

In accordance with the assessment methodology outlined in British Research Establishment (BRE) Special Digest 1: Concrete in Aggressive Ground (**Reference 13**), chemical testing was undertaken on soil samples obtained during the ground investigation. The results have been utilised to determine the Design Sulphate Class of the strata present and the Aggressive Chemical Environment for Concrete (ACEC). This is summarised in Table 6-3 below:

Table 6-3: Summary of Sulphate Calculations

Exploratory Hole	Top Depth (m)	Strata [1, 2]	pH	Total Sulphur (%)	Water Soluble 2:1 (mg/l)	Water Soluble 2:1 (g/l)	Total Sulphate Content (%)	Sulphate Class	ACEC Class	Total Potential Sulphate (%)
BH102	1.9	LMBE	8.8	0.04	350	0.35	0.09	DS5	AC-2	0.38
TP102	2.5	LMBE	7.3	0.05	220	0.22	0.1	DS5	AC-2	0.42
BH106	3.5	LMBE	8.3	0.02	150	0.15	0.06	DS5	AC-2	0.25
BH101	3.9	LMBE	8.2	0.02	120	0.12	0.03	DS5	AC-2	0.13
TP101	3	LMBE	8.4	0.01	120	0.12	0.04	DS5	AC-2	0.17
BH103	5.3	LMBE	8.2	<0.01	83	0.083	0.03	DS5	AC-2	0.13
BH103	1.9	LMBE	8.3	0.02	81	0.081	0.04	DS5	AC-2	0.17
BH107	5	LMBE	8.8	0.02	50	0.05	0.04	DS5	AC-2	0.17
TP101	1.3	LMBE	8.2	0.02	32	0.032	0.02	DS5	AC-2	0.08
BH109	4	SUPD	8.2	0.64	520	0.52	0.21	DS5	AC-2	0.88
BH108	6.3	SUPD	8.8	0.46	520	0.52	0.17	DS5	AC-2	0.71
BH108	1.65	SUPD	8.3	0.39	490	0.49	0.19	DS5	AC-2	0.80
BH109	15.5	SUPD	8	1.8	340	0.34	2.2	DS5	AC-2	9.24
BH104	5.2	SUPD	9	0.21	270	0.27	0.1	DS5	AC-2	0.42
TP104	1.5	SUPD	8.7	0.08	170	0.17	0.08	DS5	AC-2	0.34
TP106	2	SUPD	8.5	0.02	82	0.082	0.04	DS5	AC-2	0.17
TP107	1.5	SUPD	8.2	0.01	32	0.032	0.02	DS5	AC-2	0.08
TP103	1	SUPD	7.4	<0.01	31	0.031	0.02	DS5	AC-2	0.08

[1] LMBE - Lambeth Clay

[2] SUPD - Superficial Deposits

Eighteen samples were obtained for sulphate testing, from both the Superficial Deposits and Lambeth Clay. The mean of the highest 20% of the values recorded provides a characteristic value for the total potential sulphate of 2.91%, water soluble sulphate of 468 mg/l with a pH value of 8.3. These values correspond to a Design Sulphate Class of DS-5.

However, it is anticipated that the proposed building foundations are likely to be piled and therefore there will be no excavation/disturbance of the ground which prohibits oxidation of the

pyrite. This is based on the following extract from (BRE) Special Digest 1: Concrete in Aggressive Ground (**Reference 13**) stating '*Concrete in pyritic ground which is initially low in soluble sulphate does not have to be designed to withstand a high potential sulphate class unless it is exposed to ground which has been disturbed to the extent that contained pyrite might oxidise and the resultant sulphate ions reach the concrete. This may prompt redesign of the structure or change to the construction process to avoid ground disturbance; for example, by using precast or cast-in-situ piles instead of constructing a spread footing within an excavation.*'

Therefore it is suggested that the design sulphate class is reduced to DS-2, taking account of the water soluble sulphate content. This corresponds to concrete class of AC-2.

6.8 GROUND CONDITIONS FOR PROPOSED STRUCTURES

The following sub-sections use the findings of the ground investigation and laboratory testing to provide some general guidance on likely ground engineering solutions for the proposed development.

FOUNDATION SOLUTIONS – MAIN BUILDING

Column loadings for the four- to five-storey building are anticipated to be in the order of 4000kN (unfactored) / 4400kN (factored). It is expected that the bearing resistance of the Superficial Deposits and Lambeth Clay would not be sufficient to accommodate the anticipated column loads. Furthermore, it is also anticipated that potential differential settlements could occur due to the variability in the thickness of the Superficial Deposits. It is therefore likely that a piled foundation solution and a suspended ground floor slab would be required. Provisional pile lengths are provided in Table 6-4 for the anticipated building loads. Note these are indicative, and not to be used for detailed design. It is recommended that a Geotechnical Design Report (GDR) is produced at detailed design stage. It is noted that the pile lengths for the northern area of the site are likely to be significantly longer.

Table 6-4: Preliminary Pile Lengths for building footprint.

EUROCODE 7	PROVISIONAL REQUIRED PILE LENGTH (M)		
Pile Diameter (mm)	4 Pile Grouping	3 Pile Grouping	Single Pile
450	13	16	34
600	11	13	26
750	10	11	22

FOUNDATION EXCAVATIONS

The stability of any foundation trenches will need to be inspected and monitored as the upper materials may be unstable, especially in the presence of groundwater. Where ground is unstable or there is a need to leave steep sided excavations open for longer periods, there may be a need for excavations to be supported.

Groundwater may be encountered in the deeper foundation excavations and an appropriate method of groundwater management, such as draining to a sump and pumping out, may be required.

PRELIMINARY PAVEMENT DESIGN

The California Bearing Ratio (CBR) for pavement design has been estimated using Table 5.1 of IAN 73/06 Rev 1 (2009) (**Reference 14**). This estimates the equilibrium subgrade CBR based on the soil type and Plasticity Index. For this project it is assumed that any Made Ground will be removed and therefore all pavements will be founded upon the Superficial Deposits. The Plasticity

Index of the Superficial Deposits range from 23% to 53%. Taking a conservative preliminary design value corresponds to an equilibrium subgrade CBR of 2%. This assumes thin construction of 300mm from pavement surface to subgrade. To increase the preliminary design value, it is likely capping or a geosynthetic layer will be required to enable a cost effective design.

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7 LAND CONTAMINATION RISK ASSESSMENT

7.1 LAND CONTAMINATION ASSESSMENT

Introduction

It is understood that the Client is proposing to construct an Engineering and Digital Technology Park (comprising teaching facilities) in the south-eastern area of the Bognor Regis Campus and associated student accommodation, access roads, car parking and landscaping adjacent to the north.

A land contamination assessment was undertaken alongside the geotechnical ground investigation, the aims of which were to build upon findings of the WSP 'Phase 1 Land Contamination Assessment, University of Chichester, Bognor Regis Campus, Digital Technology Park', (Ref. 70014375-001, dated August 2015) (**Reference 15**).

This current assessment was carried out in order to further quantify potential ground contamination liabilities associated with historical and current site use; and to advise on potential options for mitigating potential contamination risks associated with the development.

A summary of the contamination assessment undertaken and is provided in the following section. A full Preliminary Land Quality Assessment has been produced under a separate cover (Ref: 70013264-300, February 2016) (**Reference 10**) and should be read in conjunction with this report.

7.2 CONTAMINATION ASSESSMENT APPROACH

The contamination assessment comprised the following elements which are summarised within this section:

- Review of previous Phase 1 Land Contamination Assessment and publicly available information in order to establish potential sources of contamination which required assessment;
- Analysis of soil, groundwater and gas samples to enable a generic quantitative risk assessment to be completed to assess potential risks to human health and controlled water receptors;
- Development of a conceptual site model summarising potential contaminant linkages; and
- Provision of recommendations with respect to the management / mitigation of potential contaminated land development constraints.

7.3 POTENTIAL SOURCES OF CONTAMINATION

Potential sources of contamination identified from the previous report and publicly available data sources prior to the investigation included the following:

- Electrical substation and pump house within 50m of the site, to the north of Barbara Smith Halls;
- Current embankment (approx. 1m high spanning width of the site) in the south eastern area of the site;
- Felpham Way (A259), Upper Bognor Road and allotments adjacent to the east of the site; and
- Fly tipping to the south of Barbara Smith Halls.

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Based on the above information, the current assessment scope was designed to target the above areas of concerns, whilst also providing general site coverage to enable an assessment of contamination risks to be completed.

The rationale and scope of the contamination assessment is summarised in Table 7-1:

Table 7-1: Exploratory Hole Rationale

Potential Area of Concern (PAOC)	Proposed Location (s)	Rationale
PAOC 1 – Made Ground	All locations	→ HP101 – 102 undertaken in earth bund to determine nature and composition of materials → All further locations to determine possible presence of Made Ground
PAOC 2 – Ground gas assessment	All BHs	→ BH106 installed as a shallow ground gas monitoring well to determine potential shallow ground gas generation → Further monitoring locations installed in superficial deposits and chalk to determine potential gas generation from sources including organic matter and carbonates
PAOC 3 – migration of contaminants from off-site	BH101 – BH103, BH106 – 109, TP102 – TP103 and TP107	→ BH101 – 103, BH106 – 109, TP102 and TP107 located adjacent to eastern and southern boundaries to investigate migration from adjacent road and allotments → BH107 and TP102 – 103 are located on-site adjacent to the pump house and electrical substation
Assessment of the groundwater regime / groundwater quality	All BHs	→ BH109 and BH110 installed as groundwater wells in shallow superficial deposits to determine hydraulic connectivity with underlying chalk aquifer. → BH101 installed as groundwater well in the Lambeth Group bedrock to determine hydraulic connectivity with chalk aquifer beneath → BH102 – BH105, BH107, BH108 and BH111 installed as groundwater wells in chalk bedrock deposits, triangulated to infer flow direction and possible contaminant migration

7.4 CONTAMINATION ASSESSMENT

The following section represents a summary of the Generic Quantitative Risk Assessment (GQRA) (**Reference 10**) for potential risk to human health and controlled water receptors. Details of the full assessment methodology are provided in **Appendix G**.

7.5 HUMAN HEALTH – SOIL

It has been assumed for the basis of the assessment that the land to the south of the on-site drainage ditch will be used for a commercial / teaching building and the land to the north of the ditch will be utilised for high-rise student accommodation flats and car parking. As such the results of the analysis have been compared to WSP Generic Assessment Criteria (GACs) for a residential end use, with no consumption of home grown produce and 1% soil organic matter, which is based on laboratory analysis of soils and represents a conservative approach to the assessment.

Human health receptors considered as part of this assessment are:

- Future students and teaching/support staff in the teaching building;
- Maintenance workers;
- Residents in student accommodation; and
- Future site visitors.

Construction and maintenance works have been discounted from the assessment, as risks to these will be mitigated by the implementation of good environmental practices and health and safety measures during future construction and maintenance works.

A total of thirty soil samples were submitted for chemical analysis and compared to WSP GACs. The following observations were made:

- Exceedances of the GAC for benzo(a)pyrene (1mg/kg) was recorded in two locations, in BH104 at 0.1m bgl (3.2mg/kg) and BH105 at 0.1m bgl (1.3mg/kg). Both samples were collected from Made Ground and are located immediately to the adjacent to the north of the drainage ditch (BH104) and in the central northern boundary (BH105). No further analytes exceeded their respective screening criteria;
- No Asbestos Containing Materials (ACM) was recorded in all sixteen soil samples screened; and
- No pesticides, herbicides or volatile organic compounds (VOCs) were recorded greater than the laboratory limits of detection.

7.6 CONTROLLED WATERS ASSESSMENT

The controlled waters risk assessment was conducted in accordance with the principles of EA 'Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination' 2006 (EA 2006) and on the 'prevent and limit' approach of the Water Framework Directive (2000/60/EC). Level 1 (leachate) and level 2 (groundwater) assessments were undertaken, which allows a direct comparison of results against appropriate assessment criteria.

Controlled water receptors considered as part of this assessment were:

- The underlying Chalk Principal Aquifer;
- Secondary A Aquifers within the Lambeth Group and River Terrace Deposits;
- The on-site drainage ditch;
- Aldingbourne Rife to the east; and
- The English Channel approximately 300m south of the site.

One surface water abstraction is recorded within 1km of the site, 170m south at Butlins Holiday Village. No groundwater abstractions are recorded within 1km of the site.

Due to the potential for risks to a Principal Aquifer and surface water, contaminant concentrations have been screened against both the UK Drinking Water Quality Standards (DWQS) 2000 (Amended 2004) and the Water Framework Directive (WFD) standards and groundwater threshold values for surface waters and transitional and coastal waters.

Based on groundwater conditions encountered, it is considered that groundwater within the chalk aquifer is flowing in a southern / easterly direction. It is considered that groundwater within the chalk bedrock is in vertical hydraulic continuity with the overlying superficial deposits and Lambeth Group.

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7.7 LEVEL 1 ASSESSMENT – LEACHATE

A total of twelve soil samples were submitted for leachate analysis. The following observations were made:

- Copper concentrations within leachate from three soil samples (BH102 at 0.1m bgl, 7.5µg/l; BH107 at 0.2m bgl, 7.1µg/l and TP104 at 0.1m bgl, 6.1µg/l) marginally exceeded the WFD criteria for coastal waters (5µg/l). All samples were collected from Made Ground, except BH102 at 0.1m bgl which comprised Topsoil;
- Lead concentrations within leachate from four soil samples (BH102 at 0.1m bgl, 10µg/l; BH107 at 0.2m bgl, 9.3µg/l; BH109 at 0.5m bgl, 7.4µg/l and BH110 at 0.2m bgl, 8.5µg/l) marginally exceeded the WFD standard for coastal waters (7.2µg/l). All samples were collected from Made Ground except BH102 0.1m bgl which comprised Topsoil; and
- No petroleum hydrocarbons were detected in any samples and PAHs were only detected in low concentrations not exceeding their respective screening criteria in BH102 at 1.3m bgl (Lambeth Group).

7.8 LEVEL 2 ASSESSMENT – GROUNDWATER

A total of ten groundwater samples were collected from all the boreholes with the exception of BH106 (which was dry at the time of sampling) and were submitted for laboratory chemical analysis. The following observations were made:

- No PAHs, petroleum hydrocarbons or VOCs were present above limits of detection;
- Mercury concentrations in all samples (in the range of 0.12 to 0.4µg/l), exceeded the WFD coastal and freshwater standards (0.05µg/l). Samples were taken from the Lambeth Group, chalk bedrock and superficial deposits in the north of the site; and
- Selenium concentrations exceeded the DWS (10µg/l) in four samples (BH101 27µg/l, BH103 16µg/l, BH105 14µg/l and BH107 10µg/l). Of these, BH103, BH105 and BH107 were screened in the chalk bedrock and BH101 was screened in the Lambeth Group.

7.9 GAS ASSESSMENT

Ground gas monitoring was undertaken on three occasions in December 2015. Utilising guidance presented in CIRIA C665 (**Reference 16**) and taking a worst case gas concentration of 3.7% CO_2, 0.5% CH_4 and a maximum flow of 18.0l/hr, a worst case GSV of 0.67 l/hr for carbon dioxide and 0.09 l/hr for methane is calculated.

The results indicate the Site to be classified as Characteristic Gas Situation 2 (CS2). CIRIA C665 states a typical source for CS2 to be 'natural soil, high peat/ organic content', which is typical of the superficial deposits encountered in the northern portion of the site. This should be confirmed with the Local Planning Authority prior to development.

The WSP Phase 1 Land Contamination Assessment indicated that the site is located within an intermediate probability radon area, as between 1 and 3% of homes are above the action level for radon gas.

Full details of the ground gas monitoring and ground gas assessment are provided in **Appendix D**.

7.10 CONTAMINATION CONCLUSIONS & RECOMMENDATIONS

Based on available data to date, it is considered that contamination risks to the proposed development are low. Whilst localised marginal contaminant exceedances were observed in soil,

leachate and groundwater samples collected during this assessment, they are not considered to represent a potential significant risk to human health or controlled water receptors.

Spatial distribution of analyte exceedances in soil and leachate samples was attributed to the location of Made Ground. Of the two soil samples that exceeded the screening criteria (1mg/kg) for benzo(a)pyrene, BH105 at 0.1m bgl (1.3mg/kg) is situated beneath the proposed car park and it is considered that this will limit exposure of any potential contamination by breaking the direct contact exposure pathways to human health.

The minor exceedance of benzo(a)pyrene in BH104 at 0.1m bgl (3.2mg/kg) is located in an area of soft landscaping adjacent to the south of the proposed student accommodation block. Whilst the risk of significant exposure to human health is considered low, given the sensitive land use (accommodation), it is considered prudent to delineate and install a suitable thickness of clean cover to mitigate the potential risk. If site levels do not allow the installation of a clean cover layer, then impacted material may require excavation and re-use under areas of hard-standing / building footprint. It is understood that the proposed site layout is not confirmed for the northern portion of the site and should the layout change, this may impact on potential remedial options and further assessment may be necessary.

Fly tipping observed to the south of Barbara Smith Halls was discounted as a potential source of contamination, as no soil samples collected from BH103 and TP101 adjacent to the off-site fly tipping indicated soil contamination. Furthermore, no fly tipping was observed in the southern portion of the site following vegetation clearance. Asbestos was discounted as a potential source of contamination, as no visual or laboratory evidence of this was recorded.

Marginal exceedances of copper and lead were recorded in leachates; and selenium and mercury in groundwater from all strata. No discernible soil source or off-site sources of contamination has been identified. Given the marginal exceedances and the development proposals to install areas of hard-standing it is considered that the risks to groundwater are low. However, it is considered prudent to undertake a further round of confirmatory groundwater and surface water sampling.

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8 GEOTECHNICAL RISK REGISTERS

The geotechnical risk registers identify geotechnical hazards / risks associated with the various ground related aspects of the proposed development and associated structures.

Risk is taken as the possibility of adverse consequences such as danger, loss, injury or other arising from a hazard, the hazard being something with the potential to cause harm. The geotechnical risk is assessed as the risk is created by the site ground conditions which can adversely affect the scheme cost, completion time, health and safety, environment and quality of product.

The risk register is intended as a live document and is included on the following pages, Table 8-1.

Table 8-1: Geotechnical Risk Register

ITEM	DATE RAISED	DESIGN / CONSTRUCTION RISK	CONSEQUENCE	QUALITATIVE RISK LEVEL HIGH / MEDIUM / LOW	POSSIBLE MITIGATION(S)
1	February 2016	Limited groundwater monitoring data.	Incorrect assumptions in groundwater and geotechnical designs.	Low	Assume conservative groundwater profiles.
2	February 2016	Change in ground conditions at depth which will change in strength profile and subject to settlement and over consolidation. If organic material this may cause ground gas.	Structural damage. Cost of repairs. Long term performance. Reputational damage	High	Consider issues in design of temporary and permanent works. Additional monitoring during the construction phase of the development.
3	February 2016	Geological strata encountered at formation are different to design.	Unsuitable construction methods. Cost of redesign. Reputational damage.	Medium	Data gaps to be determined at detail design stage. Carry out additional ground information if necessary.
4	February 2016	Settlement of underlying strata due to consolidation settlement in compressible soils/made ground.	Unacceptable settlement of foundations. .	Medium	Design to consider this and site inspections needed to make sure design assumptions met.
5	February 2016	Sulphate attack on buried concrete.	Structural damage. Cost of repairs. Long term performance. Reputational damage.	Low	Use test results from ground investigation to select concrete class from BRE Special Digest 1.
6	February 2016	Unexploded Ordnance.	Risk to human life. Structural damage.	High	Attendance of Unexploded Ordnance Engineer on site to provide a watching brief during construction works and mitigate risk.
7	February 2016	Buried services and utilities.	Structural damage. Health and safety of workforce. Reputational damage. Financial and programme implications.	Medium	Service clearance to be undertaken to identify buried services and utilities prior to any intrusive works. Risk assessments and permit to dig issued before intrusive works. Following these procedures will reduce risk to low.
8	February 2016	Desiccated ground in the Superficial Deposits	Potential for heave also high strength shouldn't be used in design as it will reduce when desiccation reduces/reaches equilibrium	Medium	A shallow foundation solution has not been proposed due to potential heave, and therefore a piled solution is recommended.
9	February 2016	This report constitutes a Ground Investigation Report (GIR) and not a Geotechnical Design report (GDR).	Outline recommendations presented in this report are used for construction and	High	Detailed design should be carried out at the appropriate time with the insitu and laboratory test information presented within this report used as the baseline. The preliminary geotechnical

ITEM	DATE RAISED	DESIGN / CONSTRUCTION RISK	CONSEQUENCE	QUALITATIVE RISK LEVEL HIGH / MEDIUM / LOW	POSSIBLE MITIGATION(S)
			detailed design not carried out.		foundation recommendations presented within this report should not be solely relied upon and WSP shall not accept liability if designs are carried out on this report alone.

REFERENCES

1 BSI: BS EN 1997-1:2004 Eurocode 7: Geotechnical Design – Part 1: General Rules.

2 Highways Agency: Design Manual for Roads and Bridges, Volume 4, Part 2, HD 22/08, Managing Geotechnical Risk, 2008

3 British Geological Survey: Sheet 317/332, Chichester & Bognor Regis (Solid and Drift edition) 1:50,000 Series, 1996

4 British Geological Survey: Geology of Britain Viewer website, accessed 23/11/2015 http://mapapps.bgs.ac.uk/geologyofbritain/home.html

5 Environment Agency: What's In Your Backyard website accessed 23/11/2015 http://watermaps.environment-agency.gov.uk/

6 Part 2A, Environmental Protection Act 1990

7 Zetica UXO, Regional Unexploded Bomb Risk Map for West Sussex, 2015

8 BSI: BS EN ISO 22475-1:2006 Geotechnical investigation and testing. Sampling methods and groundwater measurements. Technical principles for execution

9 Building Research Establishment: Digest 365 Soakaway Design, 2003

10 WSP, Generic Quantitative Risk Assessment, 2016

11 Stroud, M.A.: The Standard Penetration Test, Its Application and Interpretation. Penetration Testing in the UK, pp. 29-46, 1989

12 CIRIA C574, Engineering in Chalk, London 2002

13 Building Research Establishment: BRE Special Digest 1, Concrete in Aggressive Ground 2005

14 Highways Agency: Interim Advice Note 73/06 Revision 1 Design Guidance for Road Pavement Foundations, 2009

15 WSP 'Phase 1 Land Contamination Assessment, University of Chichester, Bognor Regis Campus, Digital Technology Park', (Ref. 70014375-001, dated August 2015)

16 CIRIA C665, Assessing Risks posed by Hazardous Ground Gases to Buildings, London 2007

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Appendix A

REPORT LIMITATIONS

General Limitations

Limitations for WSP Land Restoration and Ground Engineering Division

General

WSP has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report. Unless explicitly agreed otherwise, in writing, this report has been prepared under WSP Standard Terms and Conditions, as included within our proposal to the Client.

Project specific appointment documents may be agreed on a project by project basis, at our discretion. A charge may be levied for both the time to review and finalise appointments documents and also for associated changes to the appointment terms. WSP reserve the right to amend the fee should any changes to the appointment terms create an increase risk to WSP.

The report needs to be considered in the light of the WSP proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report. The report is only valid for its originally intended purpose as set out in either our report or the proposal.

Phase 1 Geo Environmental Preliminary Risk Assessments

The works undertaken to prepare this report comprise a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects responses may not have been received from all parties. It is not standard, due to the timescales, to visit archives and local libraries as part of these works. WSP cannot be held responsible for any disclosures that are provided post production of our report and will not automatically update our report.

The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP reserves the right to review such information and, if warranted, to modify the opinions accordingly.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the Site.

WSP does not warrant work / data undertaken / provided by others.

This section covers reports with the following titles or combination of titles: Phase 1; Desk Top Study; Geo-Environmental Assessment; Development Appraisal; Preliminary Environmental Risk Assessment; Constraints Report; Due Diligence Report; Geotechnical Development Review; Environmental Statement; Environmental Chapter; Geotechnical Development Risk Register or Baseline Environmental Assessment. These limitations associated with preliminary works also apply when they are reported within an intrusive investigation report.

Intrusive Investigation Reports

The investigation has been undertaken to provide information concerning the type and degree of contamination present at the Site in order to allow a generic risk assessment to be undertaken or identification of the soil properties to allow for geotechnical development constraints to be identified.

The objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters. For geotechnical investigations the purpose is to broadly identify the development constraints associated with the physical property of the soils underlying the site.

The amount of exploratory work, soil property and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site

usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of localised "hotspots" of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report. For example these include spatial variations in soil properties; the varying thickness and physical nature of the strata identified and changes in groundwater levels or flow rates.

The inspection; testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. WSP has interpreted between these points based upon assumptions to develop our interpretation and conclusions. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation.

On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 2 became the mandatory baseline standard for geotechnical ground investigations.

In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. A GDR can strictly only be prepared following confirmation of all structural loads and serviceability requirements. The design process requires close co-operation between the geotechnical engineer and the structural engineer and is iterative. Where a GDR is prepared using preliminary or assumed loadings and/or serviceability limits it should only be considered as an interim report and should not be relied upon for the procurement or construction of the works it describes. A GDR will be a standalone specifically entitled report.

During any build programme WSP should be consulted if alternative ground conditions are encountered. It assumes during any site works that the contractor will use their best endeavours to manage and control groundwater and other unforeseen ground conditions. WSP will not be liable for actions taken prior to consultation.

The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.

The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values. Specific assumptions associated with the WSP risk assessment process have been outlined within the body or associated appendix of the report.

Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.

If costs have been included in relation to additional site works, and / or site remediation works these must be considered as indicative only and must, be confirmed by a qualified quantity surveyor.

The following report titles (or combination) may cover this category of work: geo environmental site investigation; geotechnical assessment; GIR (Ground Investigation reports); preliminary environmental and geotechnical risk assessment; geotechnical risk register.

Detailed Quantitative Risk Assessments and Remedial Strategy Reports

These reports either use primary data or build upon previous report versions and associated notes. The scope of the investigation; further testing and monitoring and associated risk assessments were selected on the basis of the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination

concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.

The outputs of the Detailed Quantitative Risk Assessments are based upon WSP manipulation of standard risk assessment models. Models are simulations based on the available data set and should not be used as predictions.

Where a remediation strategy is proposed, this is based on our interpretation of the risk assessment criteria and is specific to a particular location and a particular intended land use and configuration / layout. Prior to adoption they will need discussing and agreeing with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of WSP. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

Monitoring (including Remediation Monitoring reports)

These reports are factual in nature and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of an earthworks or remedial works.

The data is presented and will be compared with assessment criteria.

Asbestos in soils

Unless explicitly included for in our proposal, our investigation does not include for a formal asbestos assessment and the inspection for asbestos, either as asbestos containing materials (ACMs) lying on the surface or as ACMs and/or as loose asbestos fibres within made ground/stockpiles is excluded. Our report will include only the factual reporting of any laboratory asbestos soil screening results, if completed. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and/or trace loose asbestos fibres within the soil matrix at the site.

Where we indicate in our proposal that we will consider asbestos we will undertake screening of representative soil samples for the presences / absence of loose asbestos fibres. If these are found a further and more detailed specific investigation into asbestos in soils will need to be undertaken, which will include asbestos quantification testing. These investigations are associated with more rigorous monitoring of asbestos and health and safety provisions.

Appendix B

SITE PLANS & MAPS

Drawn By: UKJJH012 Date Modified: 24/11/2015 08:39

Key

Site Location

LONDON

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 2.5 5 7.5 10 km

File: Created using ArcGIS WSP's Online Mapping System

WSP | PARSONS BRINCKERHOFF

TITLE:

University of Chichester, Bognor Regis Campus

FIGURE No:

Figure 1 - Site Location Plan

Drawn By: UKJJH012 Date Modified: 24/11/2015 09:22



File: Created using ArcGIS, WSP's Online Mapping System

WSP | PARSONS BRINCKERHOFF

TITLE:

University of Chichester, Bognor Regis Campus

FIGURE No:

Figure 2 - Site Layout

DO NOT SCALE

Final car park and landscaping for development zone TBC

Existing utilities corridor extent TBC

BH105
BH111
BH110
TP105
TP107
TP106
BH103
42
28
48
48
27
Proposed Phase 3 Development Zone
TP104
17
BH104
BH108
TP103
BH107
TP102
Proposed Phase 2 Development Zone
BH106
TP101
Phase 1
2m maintenance access to be created within university ownership boundary
Extent of OPTION 5 building within Phase 01 of works
FELPHAM WAY
UPPER BOGNOR ROAD

REV	DATE	BY	DESCRIPTION	CHK	APD
B	29.10.2015	PRE	UPDATED WITH NEW MASTERPLAN AND SERVICES INFORMATION	JH	PMC
A	24.07.2015	PRE	ISSUED WITH GROUND INVESTIGATION SPECIFICATION	JH	PMC

DRAWING STATUS:
FOR INFORMATION ONLY

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CLIENT:
University of Chichester

PROJECT:
UNIVERSITY OF CHICHESTER
EDT PARK
BOGNOR REGIS

TITLE:
EXPLORATORY HOLE
LOCATION PLAN

SCALE @ A3:	CHECKED:	APPROVED:
NTS	JH	PC
CAD FILE:	DESIGN-DRAWN:	DATE:
EHLP-B.dwg	PRE	24 July 2015

PROJECT No:	DRAWING No:	REV:
70010938	FIGURE 3	B

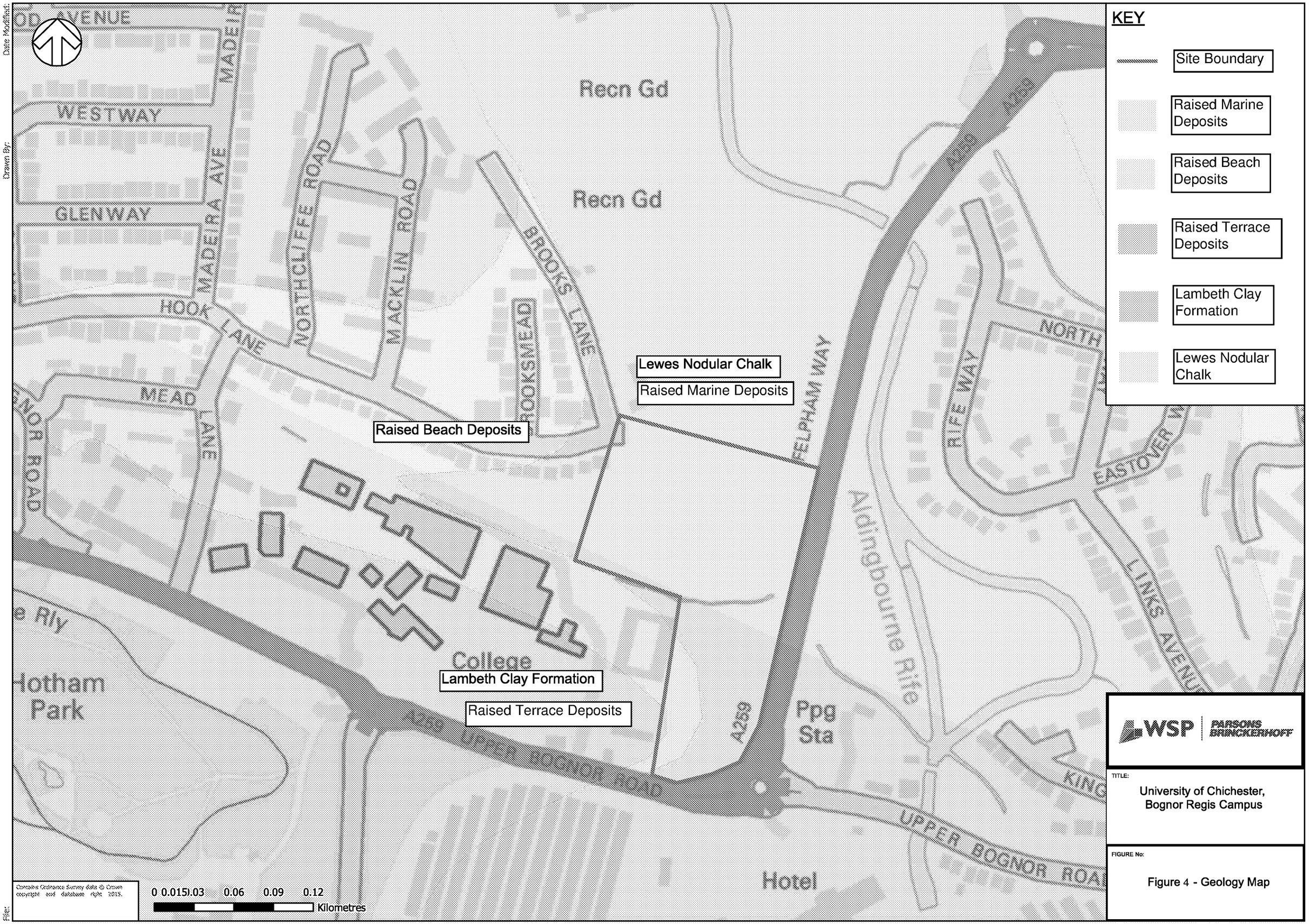
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M:_SOIL & GROUNDWATER_PROJECTS\Geotech\70013264 - UoC Bognor Tech Park\(5) Project Data\Drawings\EHLP-B.dwg

ARUN DISTRICT COUNCIL BR/54/15/PEL

Date Modified:

Drawn By:



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WSP | PARSONS BRINCKERHOFF

TITLE:

University of Chichester, Bognor Regis Campus

FIGURE No:

Figure 4 - Geology Map

Filter:



Proposed Site Plan
1 : 500

A1 Signed Sheet Size

University Ownership Boundary

Proposed Development Zone
3.25 hectares
8.03 acres

Proposed Phase 1 Development Zone
0.47 hectares
1.16 acres

Conservation Area

Stride Treglown

University of Chichester
Bognor Regis Campus - Engineering and Digital Technology Park

Proposed Site Plan

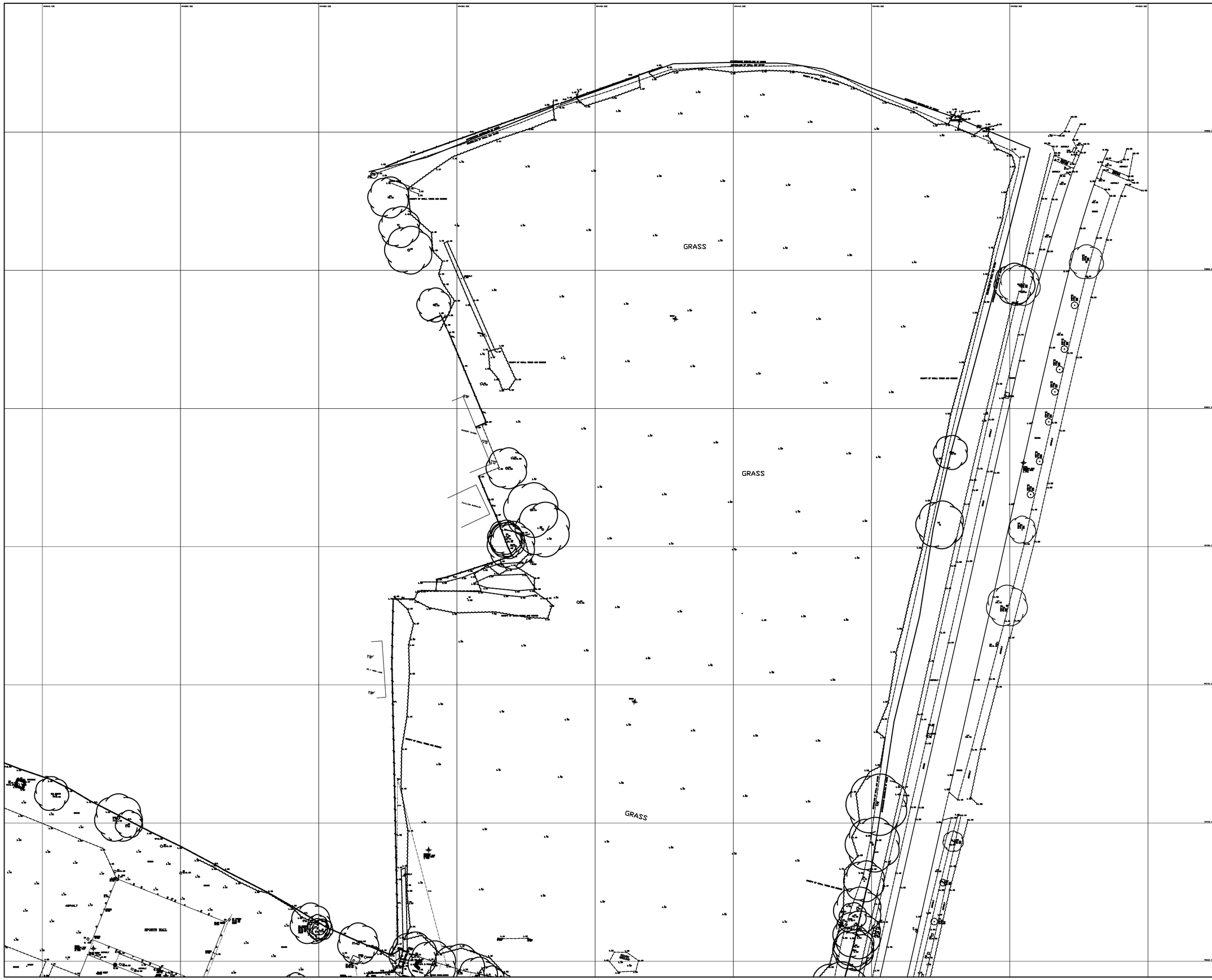
SKETCH

1 : 500 | 70066-STR | MN | RC

50136 | SK_007 | E

ARUN DISTRICT COUNCIL BR/311/18/PL

ARUN DISTRICT COUNCIL BR/54/16/PL



NOTES :

ALL LEVELS RELATIVE TO O.S. DATUM (FROM G.P.S)
SURVEY GRID ORIENTATED TO OS NATIONAL GRID

WHILE ALL POSSIBLE EFFORT HAS BEEN MADE TO IDENTIFY SERVICES, WE ARE UNABLE TO DETAIL COVERS BURIED OR OBSCURED AT THE TIME OF SURVEY.

ALL LEVELS AND DIMENSIONS SHOULD BE CHECKED ON SITE PRIOR TO THE COMMENCEMENT OF WORKS.

TREES SHOWN IDENTIFIED TO BEST OF SURVEYORS ABILITY, SEEK CONFIRMATION IF SPECIES CRITICAL

KEY :

BB	- BELISHA BEACON	OHW	- OVERHEAD WIRE
BIN	- LITTER BIN	O/H	- OVERHEAD
BL	- BED LEVEL	PIL	- PILLAR
BOLL	- BOLLARD	PL	- PAVEMENT LIGHT
BRW	- BRICK WALL	POT	- TELECOM
BS	- BUS STOP	R.EYE	- RODDING EYE
CATV	- CABLE TELEVISION	RS	- ROAD SIGN
CL	- COVER LEVEL	RTW	- RETAINING WALL
CONC.	- CONCRETE	RWP	- RAIN WATER PIPE
ELEC	- ELECTRIC	SAP	- SAPLING
EP	- ELECTRICITY POLE	SB	- SIGN BOARD
FB	- FLOWER BED	SL	- SILT LEVEL
FFL	- FINISHED FLOOR LEVEL	SU	- SPECIES UNKNOWN
FH	- FIRE HYDRANT	SVP	- SOIL VENT PIPE
FP	- FLAG POLE	TBM	- TEMPORARY BENCH MARK
G	- GULLY	TCB	- TELEPHONE CALL BOX
GL	- GROUND LEVEL	TF	- TOP OF FENCE
GV	- GAS VALVE	TH	- TOP OF HEDGE
HT	- HEIGHT	TL	- TRAFFIC LIGHT
IC	- INSPECTION COVER	TP	- TELEGRAPH POLE
IL	- INVERT LEVEL	TT	- TOP OF TREE
LB	- LETTER BOX	TW	- TOP OF WALL
LP	- LAMP POST	U/S	- UNDERSIDE CEILING
LT	- LIGHT	UTL	- UNABLE TO LIFT
MH	- MANHOLE	WL	- WATER LEVEL
MKR	- MARKER	WV	- WATER VALVE

FENCE TYPES :

B/W	- BARBED WIRE	I/R	- IRON RAILING
C/B	- CLOSE BOARD	P/R	- POST & RAIL
C/L	- CHAIN LINK	P/W	- POST & WIRE
C/P	- CHESTNUT PALING		

STN1 SURVEY STATION

ANCILLARY BUILDING

SLOPE DIRECTION

GATE

EAVES +17.66 ROOF LEVELS

ASH G=0.30 S=8.00 TREE SPECIES GIRTH (diameter) SPREAD (radius)

FENCE
WALL
BANK/PATH
OVERHEAD
SHRUBBERY
BUILDING
O/H WIRE
SECTION
KERB
TRACK/
DROP KERB

DRAINAGE :

FOUL DRAINAGE

STORM (SURFACE WATER DRAINAGE

100Ø = 100mm DIAMETER PIPE

N

ISO 9001 REGISTERED FIRM

0m 1 2 3 4 5 6 7 8 9 10m
SCALE BAR

Shaw Colegate
LAND & BUILDING SURVEYORS

Unit 9B, The Old Flour Mill, Queen Street, Emsworth, Hants. PO10 7BT
Tel : (01243) 371472 Email : mail@shawcolegate.com
Fax: (01243) 376940 Web : www.shawcolegate.com

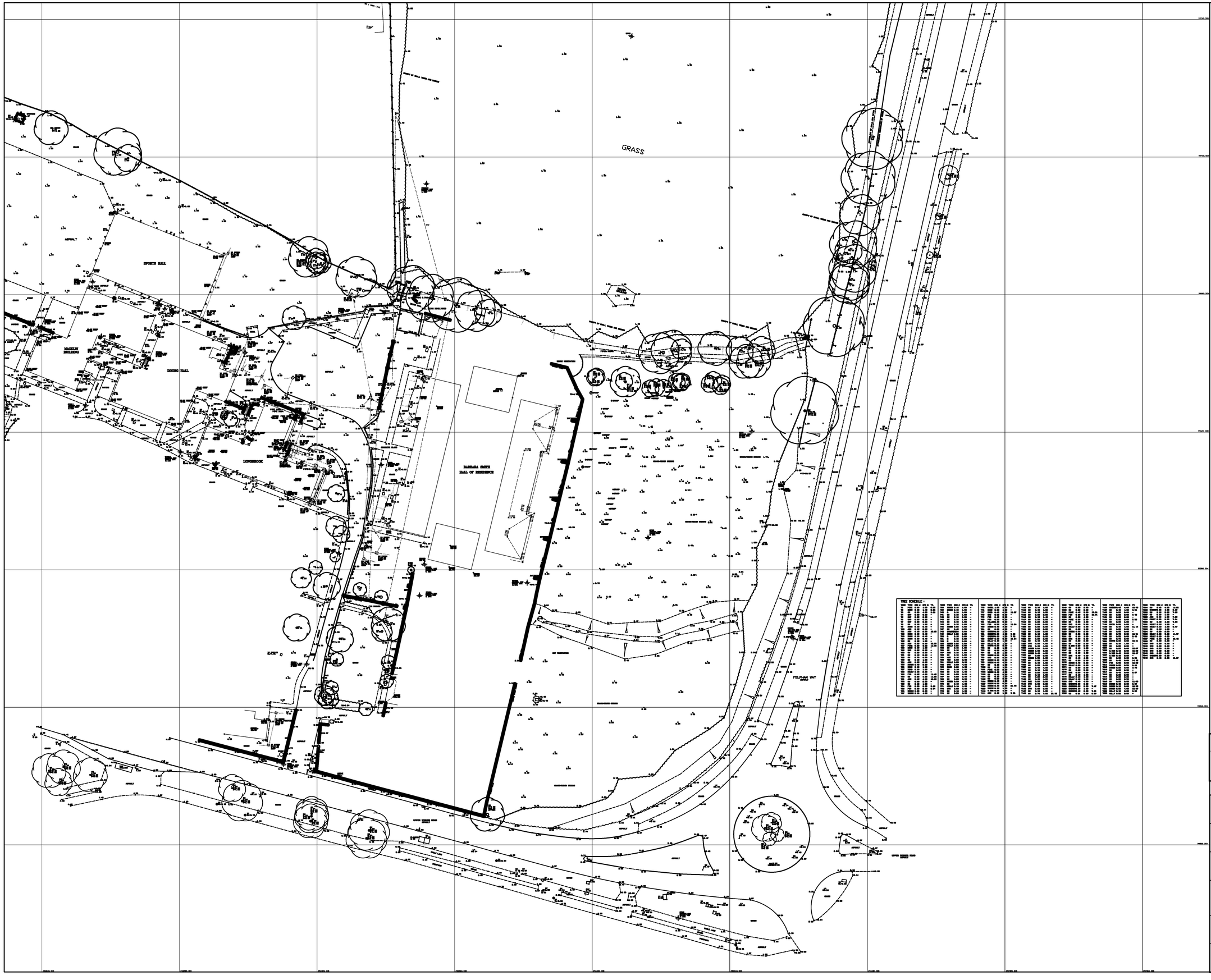
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TOPOGRAPHIC SURVEY - UPDATED

Job No. : 05515_TOPO_REV A
Original Scale : 1: 200
Sheet Size : OVERSIZED

Surveyed By : Various Date : 2009 / 2010 / May 2015
Drawn By : Various Date : 2009 /2010 / May 2015

Client: University of Chichester
Bishop Otter Campus, College Lane, Chichester
West Sussex, PO19 6PE

ARUN DISTRICT COUNCIL BR/54/08/PL



NOTES :

ALL LEVELS RELATIVE TO O.S. DATUM (FROM G.P.S)
SURVEY GRID ORIENTATED TO OS NATIONAL GRID

WHILE ALL POSSIBLE EFFORT HAS BEEN MADE TO IDENTIFY SERVICES, WE ARE UNABLE TO DETAIL COVERS BURIED OR OBSCURED AT THE TIME OF SURVEY.

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FH	- FIRE HYDRANT	SVP	- SOIL VENT PIPE
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C/P	- CHESTNUT PALING		

STN1 SURVEY STATION

ANCILLARY BUILDING

SLOPE DIRECTION

GATE

EAVES +17.68 ROOF LEVELS

ASH GIRTH 3.0 SPREAD 6.0 TREE SPECIES GIRTH (diameter) SPREAD (radius)

FENCE
WALL
BANK/PATH
OVERHEAD
SHRUBBERY
BUILDING
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ISO 9001 REGISTERED FIRM

0m 1 2 3 4 5 6 7 8 9 10m
SCALE BAR

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Job No. : 05515_TOPO_REV A
Original Scale : 1: 200
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Surveyed By : Various Date : 2009 / 2010 / May 2015
Drawn By : Various Date : 2009 /2010 / May 2015

Client: University of Chichester
Bishop Otter Campus, College Lane, Chichester
West Sussex, PO19 6PE

ARUN DISTRICT COUNCIL BR/54/2/6/PL

Appendix C

EXPLORATORY HOLE LOGS & FACTUAL REPORT

CC Ground Investigations Ltd

DRAFT

FACTUAL REPORT

SITE: University of Chichester – Bognor Regis Campus

CLIENT: University of Chichester

ORDER No: **3010066 dated 06/10/2015**

DATE: 21 January 2016

REPORT No: C4872

[redacted]

ARUN DISTRICT COUNCIL BR/5

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REPORT

1.		**INTRODUCTION**	**1**
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	2.1	Site Description	3
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APPENDICES

Appendix A – Site Plan

Appendix B – Exploratory Hole Data

Appendix C – Laboratory Test Results

Appendix D – SPT Calibration Data

ARUN DISTRICT COUNCIL BR/541/87/L

1. INTRODUCTION

This investigation was carried out by CC Ground Investigations Ltd (CCGI) on the instruction and on behalf of The University of Chichester (The Client) under the technical direction of WSP | Parsons Brinckerhoff (the Engineer)

The purpose of the ground investigation was to determine geotechnical properties, ground contamination status and groundwater regime to facilitate the design of access roads, car parks and multi-storey buildings associated with the proposed Engineering and Digital Technology Park at the University of Chichester Bognor Regis Campus

The scope of the ground investigation was defined in the Engineer's specification, reference: Report No 70013264-P01.

This report describes the work carried out by CC Ground Investigations Ltd and presents the findings.

All information, comments and opinions given in this report are based on the ground conditions encountered during the site work, and on the results of laboratory and field tests performed during the investigation. There may however be conditions at or adjacent to the site which have not been taken into account, such as unpredictable soil strata and water conditions between or below exploratory holes. A careful watch should be maintained during any future groundworks and the comments of this report reviewed as necessary.

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This report has been prepared for The University of Chichester and WSP | Parsons Brinckerhoff. This report shall not be relied upon or transferred to other parties without the written consent of CC Ground Investigations Ltd. Should any information contained within this report be used by any unauthorised third party it is done so at their own risk and shall not be the responsibility of CC Ground Investigations Ltd.

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2. SITE DESCRIPTION AND GEOLOGY

2.1 Site Description

The site is located in an area of dense scrubland and a flood plain to the north of Upper Bognor Road and west of Felpham Way at National Grid Reference 494414 099634. The proposed Engineering and Digital Technology Park will be located east of the current University Campus.

2.2 Geology

Geological Records (British Geological Survey (BGS), England and Wales sheet 332 1:50,000 scale) indicate the site is underlain by superficial geology comprising of raised marine and raised beach deposits (silt, sand and gravel). Underlying solid geology comprising the Lambeth Group and White Chalk Subgroup is recorded.

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3. GROUND INVESTIGATION

3.1 Fieldwork

Eighteen exploratory holes were carried out between 2nd and 20th November 2015. All exploratory hole locations are shown on the site plan (Appendix A). The exploratory hole locations were set out by CCGI as directed by the Client on site.

The fieldwork was carried out in general accordance with BS5930, Amendment 2 (2010).

Eleven boreholes, referenced BH101 to BH111 (Exploratory Hole Data – Appendix B) were formed using a track mounted Comacchio MC300 or Fraste PL(G) multi-purpose rig. Following CAT scanning hand tools were used to excavate an inspection pit to a depth of 1.20m to check for buried services. Bulk and environmental soil samples were taken and retained from the inspection pits. The boreholes were then advanced using percussive sampling techniques to produce continuous disturbed samples of 112mm diameter.

On refusal of percussive sampling the boreholes were continued by rotary core drilling techniques utilising a water flush. A double-tube swivel core barrel with a semi-rigid plastic liner was utilised to recover continuous cores of 123mm diameter.

Soil and rock samples were retained in semi-rigid plastic liners, which were capped on site to prevent moisture loss.

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Undisturbed samples of 100mm nominal diameter were taken in suitable cohesive material using an open drive sampler (U(T)100). The samples were wax sealed on site to prevent moisture loss.

Boreholes were monitored for groundwater ingress as they were advanced. Upon encountering water, sampling was temporarily stopped to allow the level to stabilise. Water levels were also recorded at the start and finish of each shift and on completion of the borehole. Water levels are presented on the relevant log.

On completion combined gas and water monitoring standpipes were installed in all boreholes. Each installation consisted of a 50mm ID HDPE slotted tube set in a filter response zone of limestone free gravel. The installation was sealed above (and below in the case of BH101, BH106, BH107, BH109 and BH110) with a bentonite pellet seal and accessed via a valve assembly. The installations were protected at the surface by a lockable, galvanised steel borehole helmet. Installation details are given on the relevant borehole log.

Following CAT scanning, seven trial pits, referenced TP101 to TP107, (Exploratory Hole Data – Appendix B) were excavated using a JCB 3CX mechanical excavator with a 0.45m wide backactor bucket.

Representative disturbed samples were taken and retained in sealed plastic bags and airtight containers to retain moisture content.

On completion all trial pits were backfilled with arisings. The ground surface was left slightly mounded to accommodate future settlement.

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Subsequent to fieldwork, all exploratory hole positions were surveyed and National Grid co-ordinates and levels are presented on the relevant log.

On completion of fieldwork all samples were brought to CCGI's office for storage.

3.2 In Situ Testing

Standard penetration tests (SPT) were carried out in general accordance with BS EN ISO 22476-3:2005. A split barrel or a solid cone was used depending upon the materials encountered and the split barrel samples retained as small disturbed samples. The SPT N value was taken as the number of blows to penetrate the 300mm test drive following a 150mm seating drive. Where low penetration was recorded the seating drive was terminated at 25 blows and the test drive completed after a further 50 blows. SPT results are summarised as uncorrected N values on the borehole logs. SPT hammer calibration data is presented in Appendix D.

Insitu hand shear vane tests were carried out in accordance with BS1377: Part 9:1990:4.4. Different vane sizes were used depending on the consistency of the soil encountered. The results are presented in on the exploratory hole logs (Appendix B).

Two infiltration tests were carried out in trial pits in accordance with BRE 365. The results and calculated infiltration rate are included in Appendix B following the relevant exploratory hole log.

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Six TRL DCP tests, referenced DCP-101, DCP-102, DCP-104 to DCP-107, (Exploratory Hole Data – Appendix B), were carried out by driving a 60˚; 20mm diameter steel cone into the ground using an 8kg weight dropped 575mm. The rate of penetration of the cone is recorded used to estimate the material CBR value through published empirical relationships.

The number of blows and depth of penetration are recorded throughout the test and are presented graphically. CBR values can be calculated for predetermined increments of penetration (usually 10mm) using the following equation: $\log_{10}(CBR) = 2.48 - 1.057 * \log_{10}$ (mm/blow).

3.3 Logging

Soil and rock samples from the exploratory holes were logged by an Engineering Geologist in general accordance with BS5930, Amendment 2 (2010) and Ciria 574 (2002) Bulk, small disturbed, core and environmental soil samples were taken retained at a range of depths. Environmental soil samples were stored on site in temperature controlled conditions. Soil and rock descriptions are presented in the borehole logs together with details of sampling, in situ testing and relevant comments on drilling techniques.

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3.4 Laboratory Testing

The following laboratory tests were carried out by Professional Soils Laboratory (UKAS No. 4043) in accordance with BS1377:1990, Parts 1 to 8, unless otherwise stated. The results are presented in Appendix C.

Test Type	No. of Tests	Remarks
Natural Moisture Content	157	The results are shown on the summary of soil classification and chalk tests.
Liquid and Plastic Limits	66	The results are shown on the plasticity chart and summary of soil classification tests.
Particle Size Distribution (wet sieving method)	26	The fine fractions of 3 of these tests were further analysed using the pipette method.
Optimum Moisture Content (compaction test)	9	2.5kg test
Bulk Density	4	Determined using the linear measurement method.
California Bearing Ratio	3	Carried out on remoulded bulk samples
Chalk Crushing value	17	
Intact Dry Density	65	
Saturated Moisture Content	65	
Quick Undrained Triaxial Test	3	Multi stage tests
Uniaxial Compressive Strength	19	ISRM Part 2
Point Load Strength	64	ISRM RTH 325-89 SR12
BRE SD1 chemical testing suite for soil	21	Testing carried out by Chemical Testing Laboratories in accordance with BRE Special Digest 1.

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A range of chemical tests were carried out on soil and water samples by i2 Analytical (UKAS No. 4041). Testing was carried out in accordance with ISO 17025. The results are tabulated and presented in Appendix C.

CC GROUND INVESTIGATIONS LIMITED

Christopher Scrivens BSc (Hons) FGS Rob Clarke. BSc (Hons) MSc (Eng) FGS
Senior Engineering Geologist **Director**

ARUN DISTRICT COUNCIL BR/541/87/L

4. REFERENCES

British Geological Society, Solid and Drift Sheet 332, Bognor Regis, 1:50,000 scale

BRE Special Digest 1:2003: Concrete in aggressive ground. Part 1.

BRE Digest 365 (2007), Soakaway Design.

BS 5930+A2:1999 (2010), Code of Practice for Site Investigations

BS 1377: Parts 1 to 9 (1990), Methods of Tests of Soils for Civil Engineering Purposes

BS EN ISO 14688: Part 1: (2002), Identification and description of soil.

BS EN ISO 14688: Part 2: (2004), Principles for a classification of soil.

BS EN ISO 14689: Part 1: (2003), Identification and description.

BS EN ISO 22475: Part 1: (2006), Technical principles for execution.

BS EN ISO 22476: Part 3: (2005), Standard penetration test.

CIRIA 574 (2002): Engineering in Chalk

ISRM (International Society for Rock Mechanics), Part 2, Suggested Methods Uniaxial Compressive Strength of Rock Material.

ISRM RTH 325-89 SR12, Suggested Method for Determining Point Load Strength.

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APPENDIX A

Appendix A – Site Plan

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APPENDIX B

Appendix B – Exploratory Hole Data

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CC Ground Investigations Ltd

KEY TO EXPLORATORY HOLE LOGS

Logging

The logging of soils and rocks has been carried out in general accordance with BS 5930:1999 (Amendment No.2, 2010).

Sample no/type

C	Core run / sample
X	Dynamic sample
D	Small disturbed sample
B	Large disturbed sample
U	Undisturbed sample
UT	Thin walled undisturbed sample
W	Water sample
ES	Environmental
SPT	Standard Penetration Test carried out
CPT	Solid Cone Penetration Test carried out

Water levels

Initial Water Strike

Level after monitoring

3.00m Standing Level

Insitu Tests

S 30	Split spoon sampler (SPT) followed by N Value (EN ISO 22476-3:2005)
C 30	Solid cone (CPT) followed by N Value (EN ISO 22476-3:2005)
*240	Where full test drive not completed, linearly extrapolated N value reported.
**	No effective penetration
H 30	Hand Vane – direct reading in kPa. Re* denotes refusal (i.e. >140 kPa)

Sample range

Undisturbed sample

Core run

U(T)100 Undisturbed sample

Rotary core sub-sample

Installation Details

Porous Tip

Screened Standpipe

Bentonite seal

Plain standpipe

Granular response zone

Concrete

Grout

Arisings backfill

Soils	Rocks		
	Sedimentary	Metamorphic	Igneous
Made ground	Chalk	Coarse-grained	Coarse-grained
Boulders and cobbles	Limestone	Medium-grained	Medium-grained
Gravel	Conglomerate	Fine-grained	Fine-grained
Sand	Breccia		
Silt	Sandstone		
Clay	Siltstone		
Peat	Mudstone		
NOTE. Composite soil types will be signified by combined symbols, e.g.,	Shale		
Silty sand	Coal		
	Pyroclastic (volcanic ash)		
	Gypsum, Rocksalt etc.		

Arenaceous / Argillaceous

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ROTARY BOREHOLE LOG

Borehole No. **BH101**

Sheet 1 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494426 N 99580	Hole Type DS+RC
Location: Bognor Regis		Level: 2.44mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 17/11/2015 End: 20/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		ES	0.10					TOPSOIL: Very soft brown mottled orangish brown and grey slightly sandy slightly gravelly silty CLAY with frequent rootlets. Gravel is sub-angular fine and medium flint. (Topsoil)	(0.30)		
		B	0.20						0.30	2.14	
		B	0.50					Soft orangish brown mottled grey slightly sandy slightly gravelly silty CLAY. Gravel is angular and sub-angular fine to coarse flint. (Superficial Deposits)			
		ES	0.60								
1		B	1.00						(1.30)		1
		SPT	1.20 - 1.65	S 1							
								Firm grey mottled orangish brown, yellowish brown and reddish brown slightly sandy silty CLAY. (Superficial Deposits)	1.60	0.84	
2		D	2.40								2
		ES	2.50	S 5							
		SPT	2.50 - 2.95								
3											3
		D	3.90						(4.65)		
4		ES	4.00	S 12							4
		SPT	4.00 - 4.45								
5								4.90-6.25m: Becoming stiff.			5
		D	5.20								
		SPT	5.30 - 5.75	S 20							
6								5.80-6.25m: Becoming yellowish brown mottled grey and orangish brown.			6

DRAFT

REMARKS:

EQUIPMENT: Hand digging tools. Fraste PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-6.50m. Waterflush rotary core drilled (146mm diam) 6.50-35.00m.
CASING: SW to 8.80m.
GROUNDWATER: None encountered prior to using water flush to advance casing to 5.30m.
INSTALLATION: Bentonite pellet seal: 7.00-35.00m, 50mm ID HDPE slotted pipe with washed gravel response zone: 2.00-7.00m, plain pipe with washed gravel response zone: 1.90-2.00m; and with bentonite pellet seal: 0.20-1.90m, raised borehole helmet set in concrete 0.00-0.20m. Gas valve fitted.
REMARKS: Dynamic sampled (128mm) to recover dropped core: 8.80-10.00m.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

Borehole No. **BH101**

Sheet 2 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494426 N 99580	Hole Type DS+RC
Location: Bognor Regis		Level: 2.44mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 17/11/2015 End: 20/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								Stiff grey locally silty CLAY. (Superficial Deposits)	6.25	-3.81	
		D C SPT	6.40 6.50 - 7.30 6.50 - 6.95	S 22		100% 0% 0%		6.35-6.60m: Frequent light yellowish brown silty sand lenses (<50mm).	(0.35)		
								Medium dense yellowish brown silty SAND. (Superficial Deposits)	6.60	-4.16	
7									(0.30)		7
								Soft grey mottled yellowish brown and orangish brown slightly sandy gravelly CLAY with low cobble content. Gravel is angular to sub-rounded fine to coarse flint. Cobbles are sub-angular to sub-rounded flint. (Superficial Deposits)	6.90	-4.46	
		D C SPT	7.20 7.30 - 8.80 7.30 - 7.75	S 46		99% 9% 9%			(0.50)		
								Structureless white stained orangish brown and yellowish brown CHALK composed of slightly sandy silty GRAVEL. Gravel is sub-angular to sub-rounded fine to coarse low density chalk. (White Chalk Subgroup Grade Dc)	7.40	-4.96	
									(0.60)		
8									8.00	-5.56	8
		D	8.30					Very weak and weak medium density white mottled orangish brown CHALK locally structureless. Discontinuities are randomly orientated very closely and closely spaced infilled with comminuted chalk (<12mm) stained orangish brown and grey. (White Chalk Subgroup Grade C4-Dc)			
		C	8.80 - 9.50			79% 0% 0%		8.80-10.00m: Drilling disturbed. Limited recovery. Recovered as slightly sandy silty gravel. 8.80-8.85m: Band of angular to sub-angular fine to coarse rinded flint gravel and sub-angular cobble.			
9											9
		D	9.30						(2.45)		
		C	9.50 - 10.00			70% 0% 0%					
10		C SPT	10.00 - 11.50 10.00 - 10.45	S 32		100% 41% 35%		10.00-10.45m: Drilling disturbed. Recovered as slightly sandy silty gravel.			10
								Very weak and weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal closely spaced infilled with comminuted chalk (<3mm). (White Chalk Subgroup Grade B3)	10.45	-8.01	
11								10.90-11.20m: Drilling disturbed. Recovered as slightly sandy silty gravel. 11.00-11.05m: Band of angular to sub-angular fine to coarse rinded flint gravel and sub-angular cobble.			11
		D C	11.40 11.50 - 13.00			93% 61% 39%		11.50-11.75m: Discontinuities are sub-horizontal to horizontal extremely closely to very closely spaced infilled with comminuted chalk (<1mm). [Grade B4-B5] 11.75-13.00m: Discontinuities are sub-horizontal to horizontal closely to medium spaced infilled with comminuted chalk (<1mm). [Grade B2-B3] 12.10-12.20m: Band of angular to sub-angular fine to coarse rinded flint gravel and sub-angular cobble. 12.20-12.40m: Drilling disturbed. Recovered as slightly sandy silty gravel.			
12									(3.75)		12
		D CS	12.60 12.70 - 13.00								
13		C SPT	13.00 - 14.50 13.00 - 13.45	S 33		89% 13% 13%		13.00-14.20m: Discontinuities are randomly orientated extremely closely and very closely spaced infilled with			13

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
17/11/2015	7.30	5.30	1.10
18/11/2015	7.30	5.30	1.25

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ROTARY BOREHOLE LOG

Borehole No. **BH101**

Sheet 3 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494426 N 99580	Hole Type DS+RC
Location: Bognor Regis		Level: 2.44mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 17/11/2015 End: 20/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								comminuted chalk (<3mm). Very weak and weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal closely spaced infilled with comminuted chalk (<3mm). (White Chalk Subgroup Grade B3) *(continued from previous sheet)*			
14								13.43-13.45m: Band of angular to sub-angular fine to coarse rinded flint gravel. 13.70-14.10m: Discontinuity is sub-vertical infilled with comminuted chalk (<1mm) stained orangish brown and grey. 14.10-14.15m: Band of angular to sub-angular fine to coarse rinded flint gravel.	14.20	-11.76	14
		D	14.30								
		C	14.50 - 16.00			100% 75% 55%					
		D	14.70					Very weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal closely to medium spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade A2-B3)			
15								14.83-14.87m: Band of angular to sub-angular fine to coarse rinded flint gravel. 15.30-15.35m: Band of angular to sub-angular fine to coarse rinded flint gravel.			15
16		C SPT	16.00 - 17.50 16.00 - 16.40	S*65		80% 52% 38%		16.00-16.05m: Band of angular to sub-angular fine to coarse rinded flint gravel.			16
17		D	17.00					17.00-17.10m: Flint cobble (cored). 17.10-17.50m: Drilling disturbed. Recovered as slightly sandy silty gravel.			17
		C	17.50 - 19.00			73% 35% 33%		17.60-17.62m: Band of angular to sub-angular fine to coarse rinded flint gravel.			
18								18.20-18.35m: Band of angular to sub-angular fine to coarse rinded flint gravel.			18
		D	18.50					18.45-19.00m: Discontinuities stained orangish brown.			
19		C SPT	19.00 - 20.30 19.00 - 19.40	S*70		108% 55% 28%		19.00-19.60m: Drilling disturbed. Recovered as slightly sandy silty gravel.	(9.45)		19
20								19.65-19.70m: Discontinuity is 45° infilled with grey silty clay (<5mm) (possible marl). 19.70-20.30m: Mottled grey and orangish brown.			20
		D	20.20								
		C	20.30 - 21.80			100% 88%		20.24-20.25m: 10mm horizontal band of grey Marl. 20.25-20.30m: Indistinctly thinly laminated.			

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
18/11/2015	20.30	8.80	1.50
19/11/2015	20.30	8.80	1.55

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ROTARY BOREHOLE LOG

[redacted]

Borehole No. **BH101**

Sheet 4 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494426 N 99580	Hole Type DS+RC
Location: Bognor Regis		Level: 2.44mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 17/11/2015 End: 20/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
						79%		Very weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal closely to medium spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade A2-B3) *(continued from previous sheet)*			
21		CS	21.15 - 21.40					20.90-20.97m: Discontinuities are very closely spaced.			21
		D	21.70					21.60-21.64m: Discontinuities are extremely closely spaced.			
		C	21.80 - 23.30	S*130		97%					
22		SPT	21.80 - 22.25			83% 78%					22
23								23.00-23.20m: Indistinctly thickly laminated, mottled grey.			23
		D	23.20								
		C	23.30 - 24.80			94% 83% 39%					
									23.65	-21.21	
24								Weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal very closely to medium spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade B2-B4) 23.66-23.68m: 20mm band of grey Marl. 24.15-24.65m: Discontinuities are vertical to sub-vertical extremely closely to very closely spaced infilled with comminuted chalk (<1mm).			24
		D	24.70								
		C	24.80 - 26.30	S*115		40%		24.80-26.30m: Drilling disturbed. Recovered as slightly sandy silty gravel locally mottled orangish brown. 24.80-24.82m: Band of angular to sub-angular fine to coarse rinded flint gravel.			
25		SPT	24.80 - 25.00			0% 0%			(3.20)		25
								25.30-25.32m: Band of angular to sub-angular fine to coarse rinded flint gravel.			
26											26
		C	26.30 - 28.00			88% 65% 58%		26.30-26.40m: Band of angular to sub-angular fine to coarse rinded flint gravel.			
								26.85-26.87m: Band of angular to sub-angular fine to coarse rinded flint gravel.	26.85	-24.41	
27								Very weak to weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal closely spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade B3)			27
		D	27.30								
		D	27.50								

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

[redacted]

Borehole No. **BH101**

Sheet 5 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494426 N 99580	Hole Type DS+RC
Location: Bognor Regis		Level: 2.44mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 17/11/2015 End: 20/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
28		CS	27.80 - 28.00		C			Very weak to weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal closely spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade B3) *(continued from previous sheet)*			28
		C	28.00 - 29.50	S*54		97% 51% 39%					
		SPT	28.00 - 28.43								
		D	28.50					28.00-28.40m: Drilling disturbed. Recovered as slightly sandy silty gravel. 28.55-28.75m: Drilling disturbed. Recovered as slightly sandy silty gravel mottled orangish brown. 28.65-28.75m: Band of angular to sub-angular fine to coarse rinded flint gravel and sub-angular cobble.	(3.75)		
29					C						29
								29.25-29.30m: Flint cobble (cored). 29.35-29.65m: Mottled orangish brown.			
		C	29.50 - 30.60			100% 15% 0%		29.50-30.60m: Drilling disturbed. Recovered as slightly sandy silty gravel. 29.55-29.65m: Band of angular to sub-angular fine to coarse rinded flint gravel.			
30					C			30.00-30.30m: Mottled grey.			30
		D	30.10								
		C	30.60 - 32.10	S*65		97% 55% 44%		Very weak to weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal closely to medium spaced. No infill. (White Chalk Subgroup Grade A2-A3)	30.60	-28.16	
		SPT	30.60 - 31.00								
31		CS	31.00 - 31.30		C						31
								31.60-31.70m: Drilling disturbed. Recovered as slightly sandy silty gravel. 31.60-31.65m: Band of angular to sub-angular fine to coarse rinded flint gravel.	(2.80)		
		D	31.70								
32		C	32.10 - 33.60	S*63		100% 84% 79%					32
		SPT	32.10 - 32.50								
		CS	32.80 - 33.10		C			32.73-32.77m: Discontinuity is sub-horizontal stained grey. No infill. 32.77-33.15m: Mottled grey.			
33								33.13-33.35m: Drilling disturbed. Recovered as slightly sandy silty gravel. 33.15-33.25m: Band of angular to sub-angular fine to coarse rinded flint gravel. 33.30-33.35m: Band of angular to sub-angular fine to coarse rinded flint gravel.	33.40	-30.96	33
		C	33.60 - 35.00			100% 71% 49%		Very weak to weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal very closely to closely spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade A3-B4)			
34					C						34
		D	34.40						(2.00)		
								34.50-34.55m: Band of angular to sub-angular fine to coarse rinded flint gravel.			
35		SPT	35.00 - 35.40	S*63							35

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
19/11/2015	30.60	8.80	1.60
20/11/2015	30.60	8.80	1.65

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ROTARY BOREHOLE LOG

Borehole No. **BH101**

Sheet 6 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494426 N 99580	Hole Type DS+RC
Location: Bognor Regis		Level: 2.44mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 17/11/2015 End: 20/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								Borehole completed at 35.40m	35.40	-32.96	

DRAFT

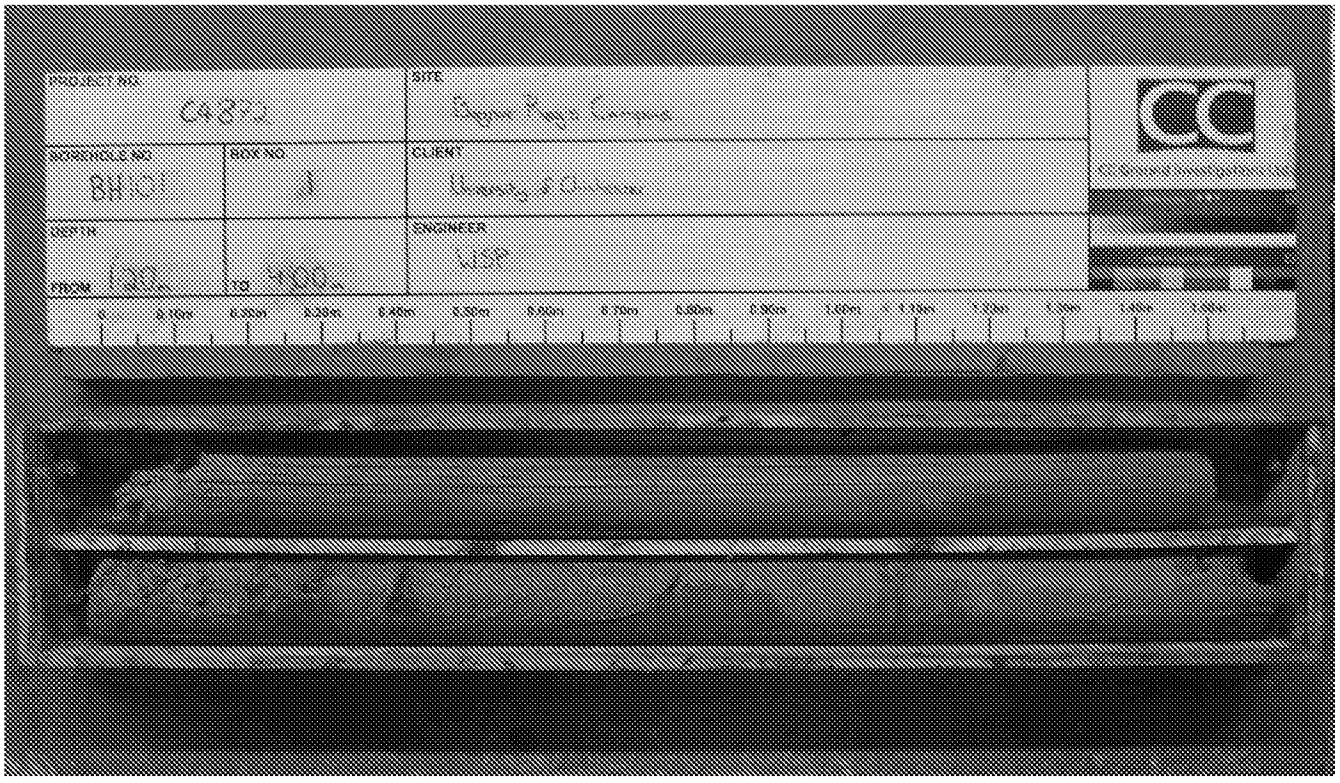
Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
20/11/2015	35.40	8.80	1.55

Borehole Photograph



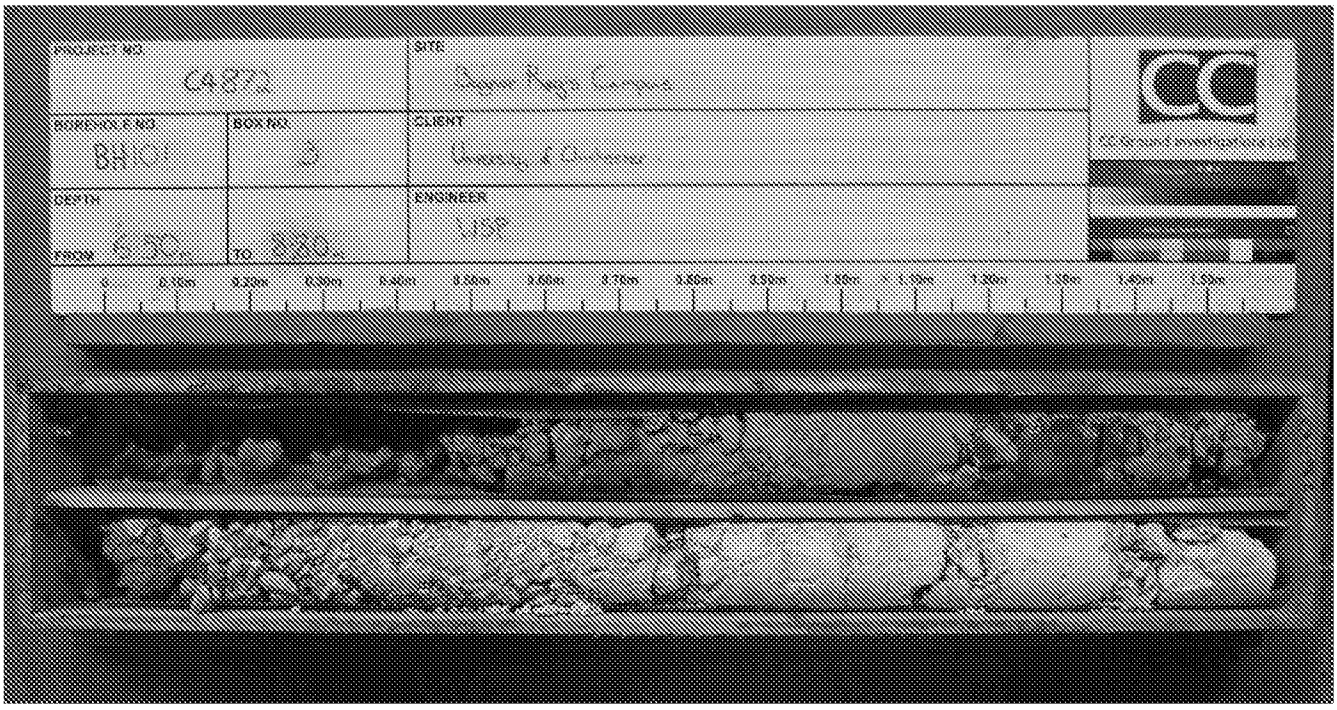


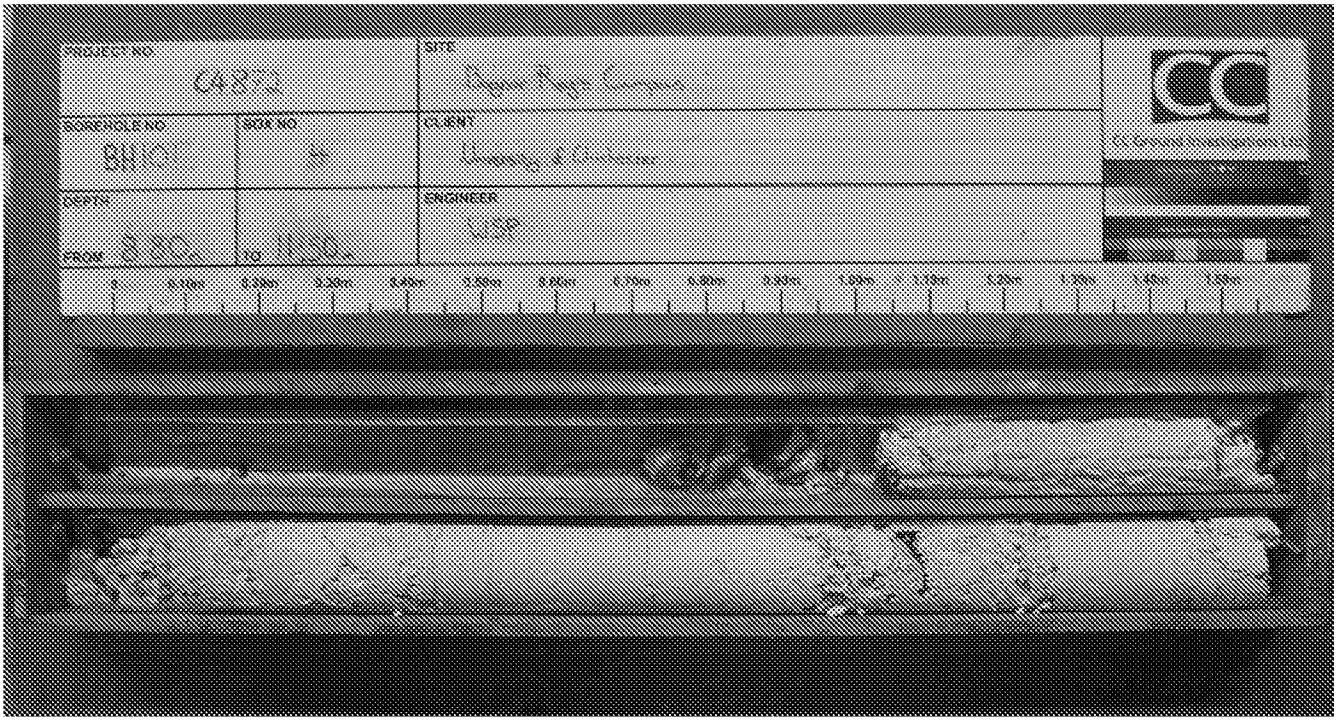
CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH101

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Borehole Photograph



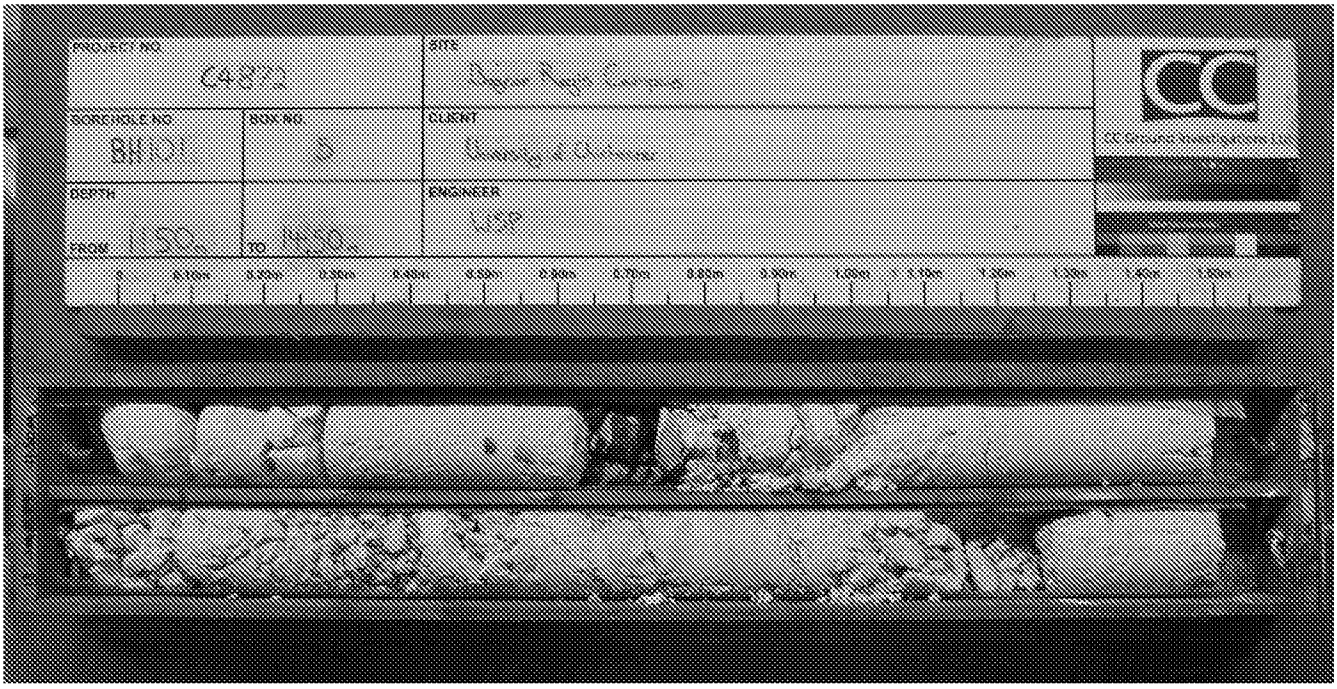


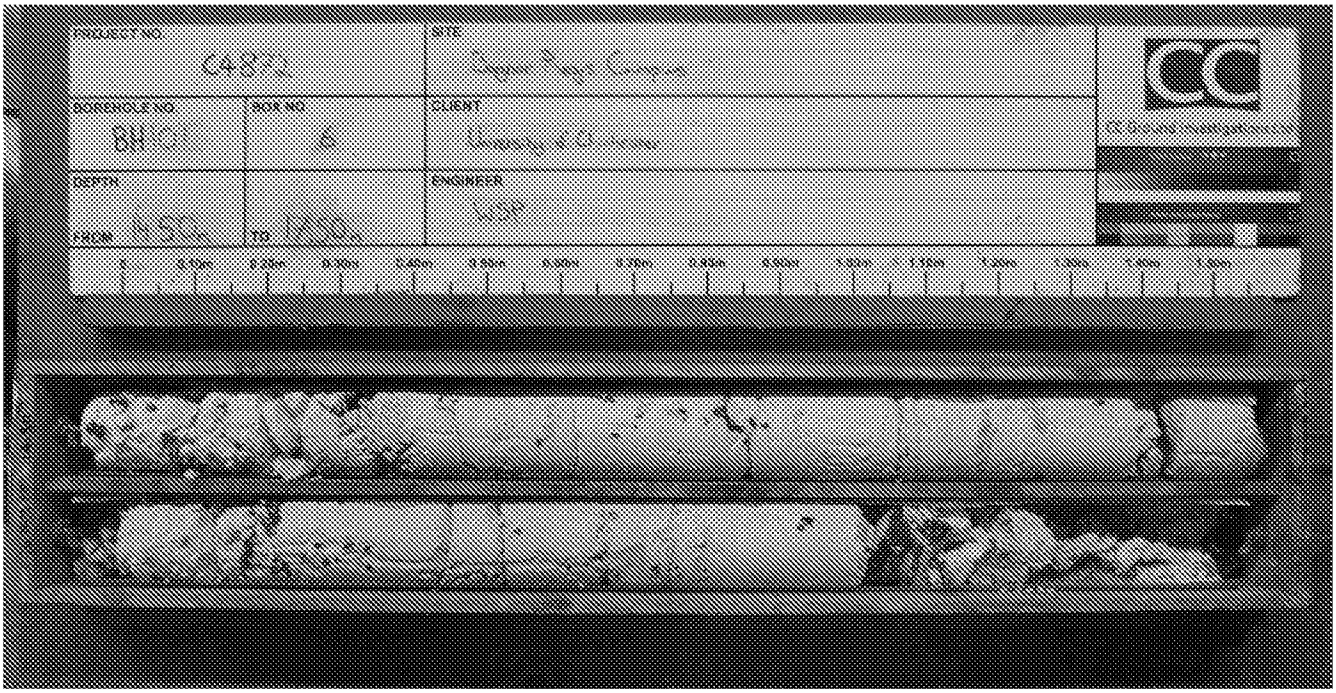
CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH101

ARUN DISTRICT COUNCIL BR/54/19/PL

Borehole Photograph



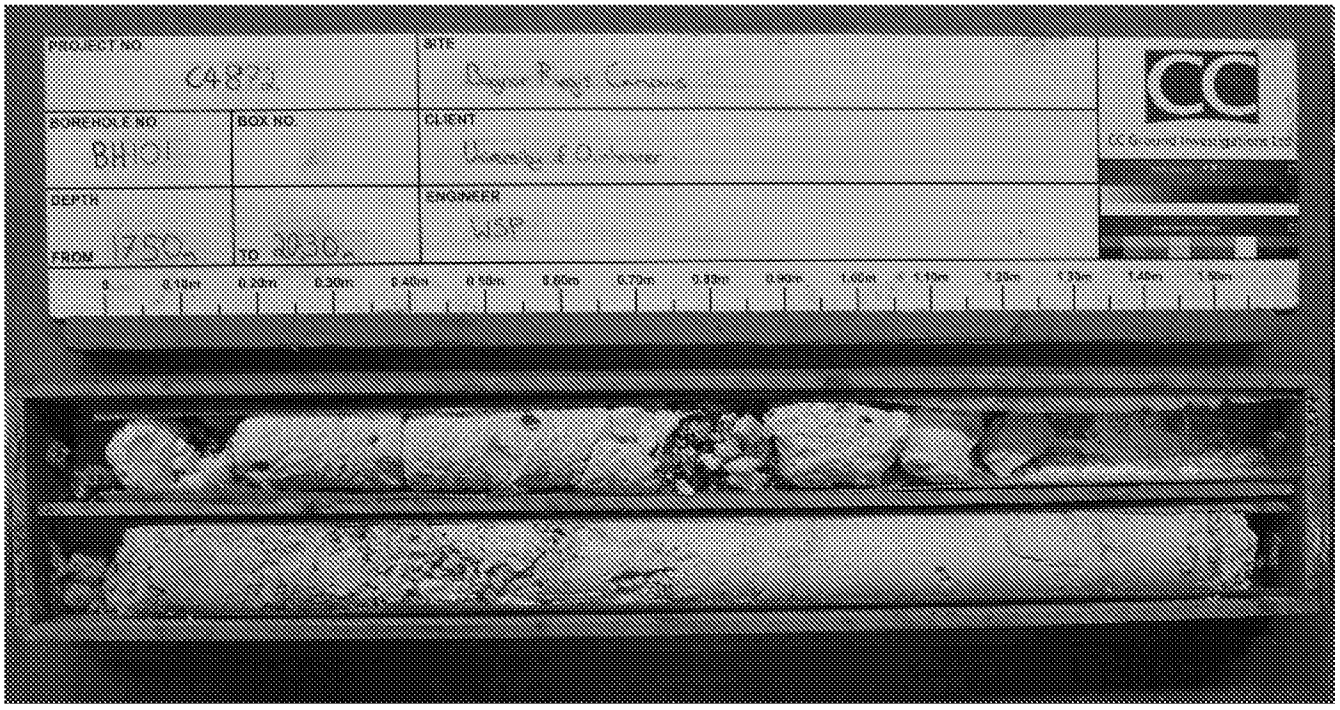


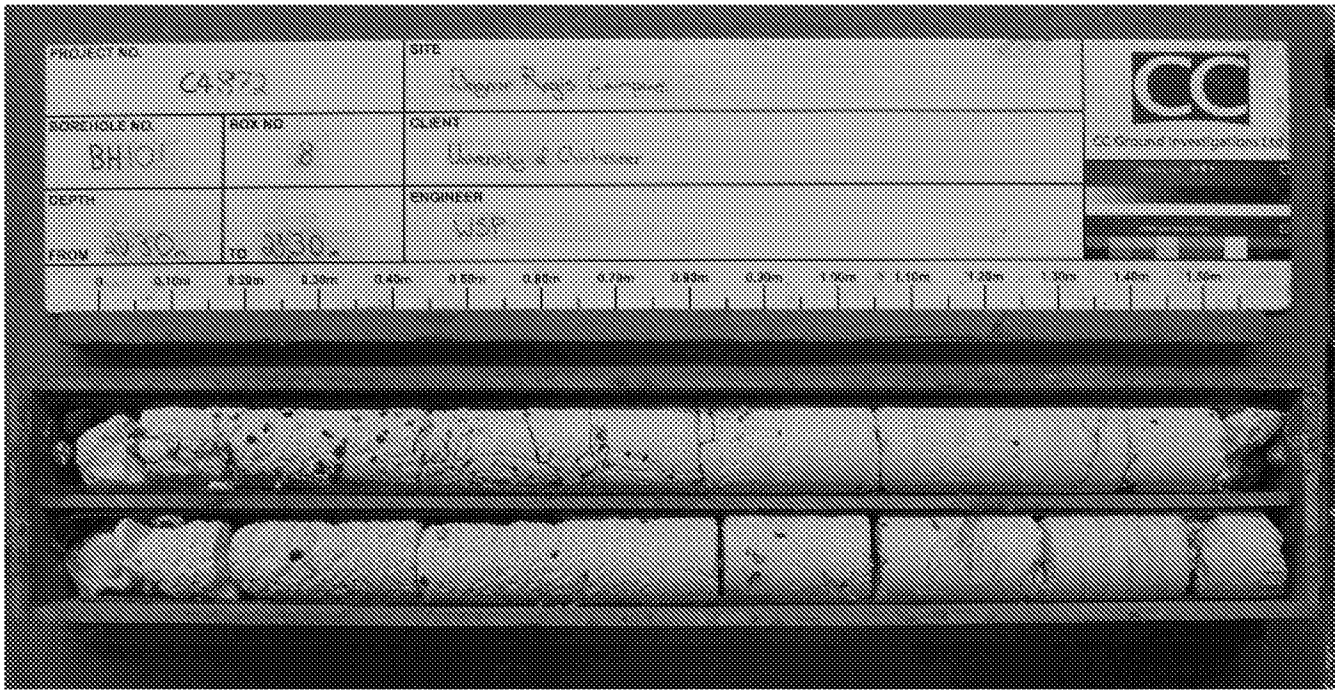
CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH101

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Borehole Photograph



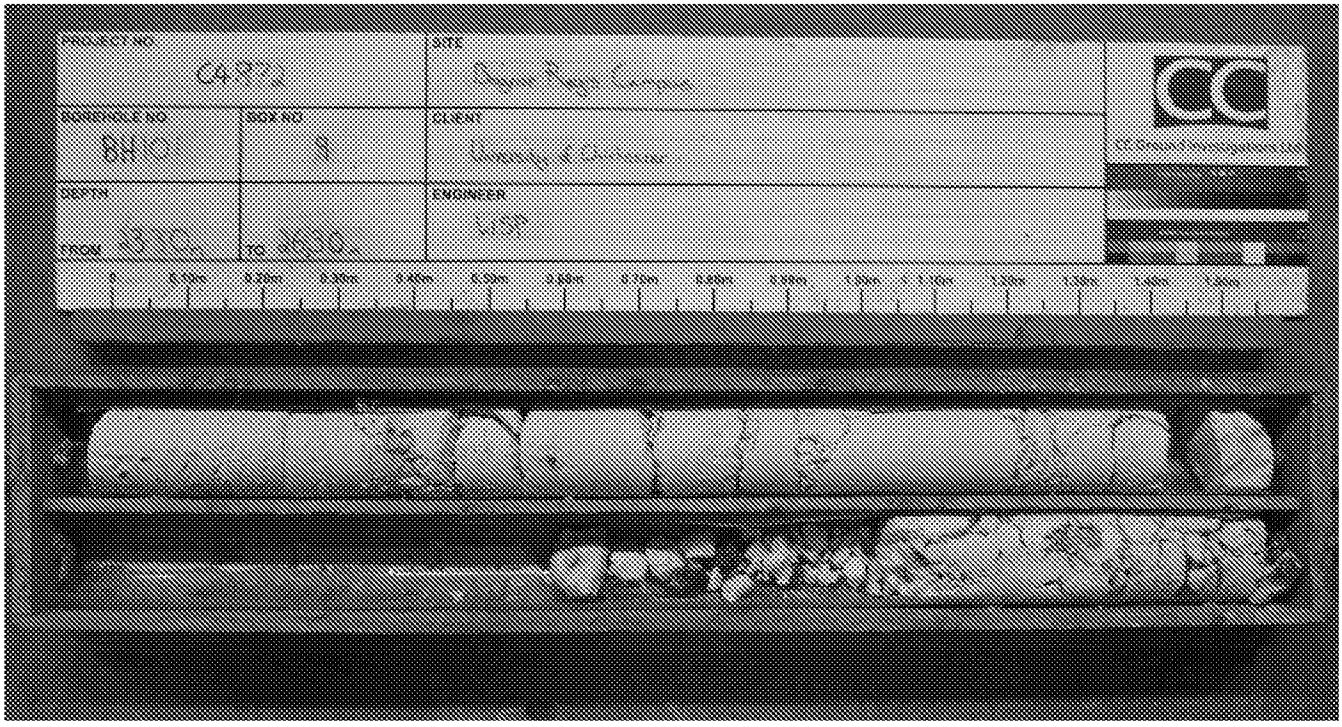


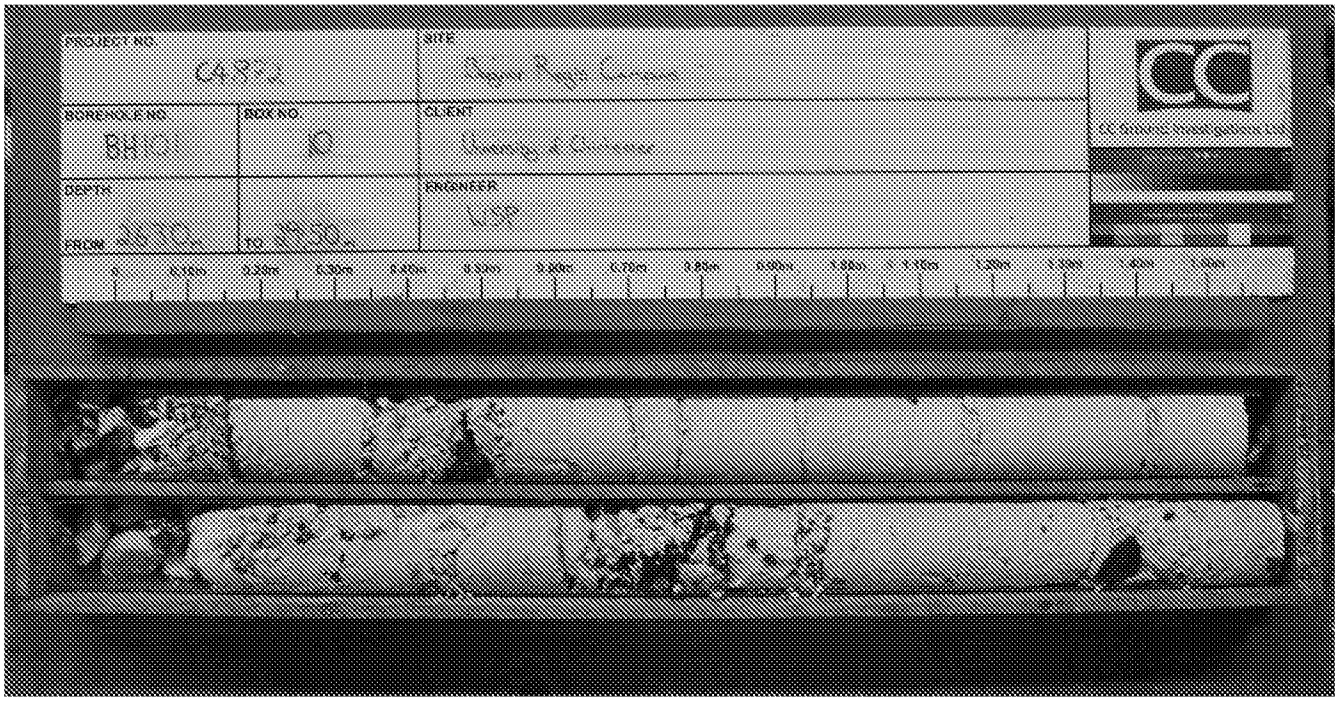
CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH101

ARUN DISTRICT COUNCIL BR/54/15/PL

Borehole Photograph





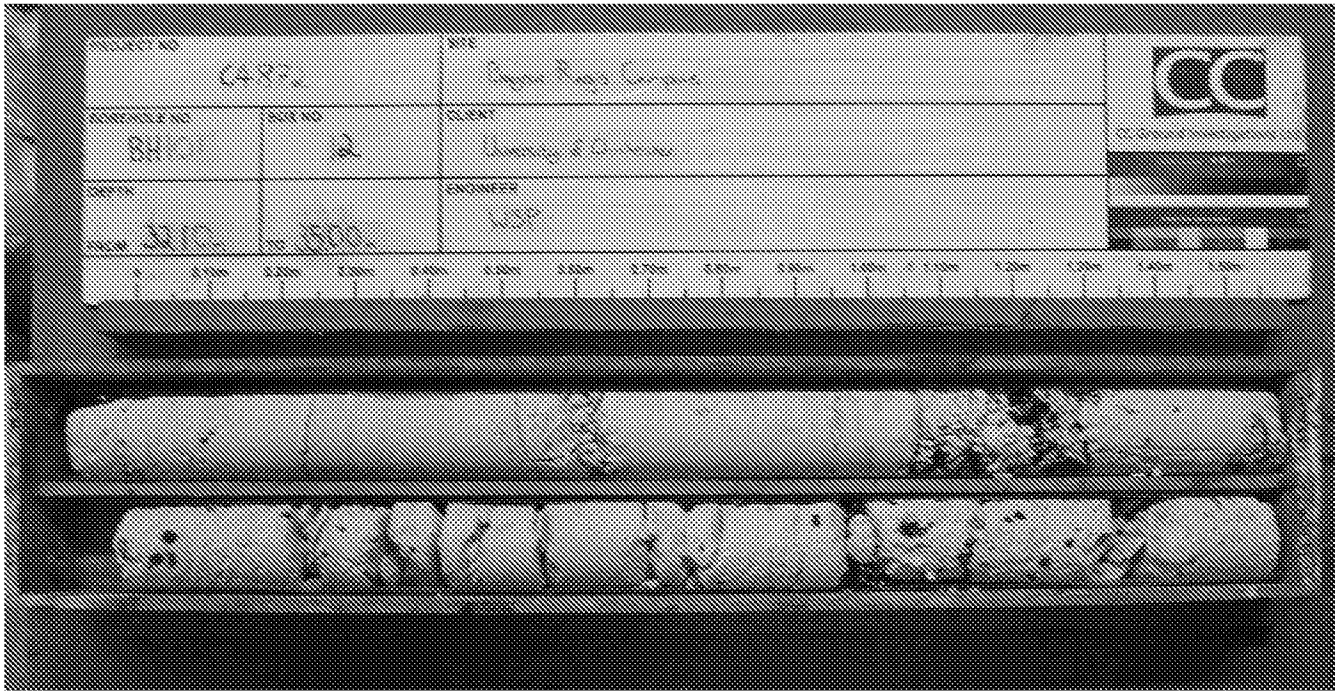
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH101

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Borehole Photograph





Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH101

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ROTARY BOREHOLE LOG

Borehole No. **BH102**

Sheet 1 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494421 N 99543	Hole Type DS+RC
Location: Bognor Regis		Level: 2.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 16/11/2015 End: 19/11/2015	Logged By RS/SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		ES	0.10					TOPSOIL: Very soft brown mottled orangish brown and grey slightly sandy slightly gravelly silty CLAY with frequent rootlets. Gravel is subangular fine and medium flint. (Topsoil)	(0.30)		
		B	0.30						0.30	1.88	
		B	0.50					Soft orangish brown mottled grey slightly sandy slightly gravelly silty CLAY. Gravel is angular and subangular fine to coarse flint. (Superficial Deposits)			
1		B	1.00						(1.40)		1
		ES	1.20	S 3							
		SPT	1.20 - 1.65								
								Firm orangish brown and light grey mottled reddish brown slightly sandy silty CLAY. (Lambeth Group)	1.70	0.48	
2		D	1.90	H 70					(0.60)		2
		H									
								Stiff reddish brown mottled orangish brown and light grey slightly sandy silty CLAY. (Lambeth Group)	2.30	-0.12	
		D	2.50	H 101							
		H									
		SPT	2.70 - 3.15	S 5							
3									(2.20)		3
		D	3.50	H 100							
		H									
4		D	4.00	H 119				4.00-4.20m: Slightly gravelly. Gravel is sub-rounded fine and medium sandstone.			4
		H									
		SPT	4.20 - 4.65	S 9							
								Stiff and very stiff reddish brown light greenish grey and orangish brown slightly sandy silty CLAY. (Lambeth Group)	4.50	-2.32	
5		D	5.00								5
		SPT	5.20 - 5.65	S 9							
6		D	5.90								6

DRAFT

REMARKS:

EQUIPMENT: Hand digging tools. Fraste ML/PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-7.60m. Waterflush rotary core drilled (146mm diam) 7.60-35.00m.
CASING: SW to 12.00m.
GROUNDWATER: None encountered prior to using water flush to advance casing.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 10.50-33.50m, plain pipe with bentonite pellet seal: 0.20-10.50m, raised borehole helmet set in concrete 0.00-0.20m. Gas valve fitted.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

CC GROUND INVESTIGATIONS LTD

ROTARY BOREHOLE LOG

Borehole No. **BH102**

Sheet 2 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494421 N 99543	Hole Type DS+RC
Location: Bognor Regis		Level: 2.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 16/11/2015 End: 19/11/2015	Logged By RS/SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								Stiff and very stiff reddish brown light greenish grey and orangish brown slightly sandy silty CLAY. (Lambeth Group) *(continued from previous sheet)*			
		D SPT	6.50 6.60 - 7.05	S 22					(3.90)		
7		D	7.40								7
		C SPT	7.60 - 8.50 7.60	S*61		100% 10% 0%		7.50-7.90m: Slightly gravelly. Gravel is sub-angular to sub-rounded fine to medium low density chalk.			
8		D	8.00					7.90-8.30m: Gravelly. Gravel is angular to sub-angular fine to coarse flint.			8
		C CPT	8.50 - 10.00 8.50	C*300		97% 30% 0%		8.30-8.40m: Yellowish brown calcareous cobble. (possible cored boulder).	8.40	-6.22	
								Stiff bluish grey mottled yellowish brown slightly sandy slightly gravelly sandy CLAY. Gravel is angular to sub-rounded fine to medium low density chalk and flint. (Lambeth Group)	8.60	-6.42	
9								Structureless white stained orangish brown and yellowish brown CHALK composed of slightly sandy silty GRAVEL. Gravel is sub-angular to sub-rounded fine to coarse low density chalk. (White Chalk Subgroup Grade Dc)	(0.70)		9
								9.00-9.20m: Locally indistinctly structured. Discontinuities are extremely closely spaced randomly orientated infilled with comminuted chalk (<10mm). [Grade C5]	9.30	-7.12	
10		D C	9.90 10.00 - 11.50			100% 56% 51%		Very weak and weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal very closely and closely spaced infilled with comminuted chalk (<5mm). (White Chalk Subgroup Grade C4-C5) 9.30-10.40m: Discontinuities are sub-vertical and vertical extremely closely and very closely spaced stained orangish brown locally infilled with comminuted chalk (<1mm). 10.00-10.55m: Drilling disturbed. Recovered as slightly sandy silty cobbly gravel. Gravel is sub-angular to sub-rounded fine to coarse. Cobbles are sub-rounded.			10
11								10.40-10.42m: Band of angular and sub-angular fine to coarse rinded flint gravel. 10.50-10.55m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-angular cobble.	(3.90)		11
		D C CPT	11.40 11.50 - 13.00 11.50	C*300		97% 38% 22%		10.90-11.90m: Discontinuities are sub-vertical and vertical very closely and closely spaced locally infilled with comminuted chalk (<1mm). 11.50-11.55m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-angular cobble.			
12								11.90-12.30m: Discontinuities are sub-vertical to 45° closely spaced infilled with grey silty clay (<10mm).			12
								12.30-13.80m: Discontinuities are sub-vertical and vertical very closely and closely spaced locally stained orangish brown. No infill. 12.50-12.52m: Band of angular and sub-angular fine to coarse rinded flint gravel. 12.65-12.67m: Band of angular and sub-angular fine to coarse rinded flint gravel.			
13		D C	12.90 13.00 - 14.50			85% 75% 71%		13.10-13.15: Band of angular and sub-angular fine to	13.20	-11.02	13

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
16/11/2015	7.60	4.20	0.80
17/11/2015	7.60	4.20	2.30

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ROTARY BOREHOLE LOG

Borehole No. **BH102**

Sheet 3 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494421 N 99543	Hole Type DS+RC
Location: Bognor Regis		Level: 2.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 16/11/2015 End: 19/11/2015	Logged By RS/SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								coarse rinded flint gravel and sub-angular cobble (<100mm). Weak medium density white locally mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal closely to medium spaced infilled with comminuted chalk (<3mm). (White Chalk Subgroup Grade B3-A2) *(continued from previous sheet)*	(1.60)		
14		D CS	13.80 13.88 - 14.30								
		C CPT	14.50 - 16.00 14.50	C*750		100% 21% 21%			14.80	-12.62	
15		D	14.90					Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal very closely and closely spaced infilled with comminuted chalk (<3mm). (White Chalk Subgroup Grade B4-B5) 15.10-15.12m: Band of angular and sub-angular fine to coarse rinded flint gravel. 15.65-15.70m: Band of angular and sub-angular fine to coarse rinded flint gravel. 15.80-15.82m: Band of angular and sub-angular fine to coarse rinded flint gravel.	(1.90)		
16		C	16.00 - 17.50			100% 77% 61%		16.40-16.45m: Band of angular and sub-angular fine to coarse rinded flint gravel.	16.70	-14.52	
		CS	16.75 - 17.15					Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal medium spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade A2-B2)			
17		D	17.40								
		C CPT	17.50 - 19.00 17.50	C*750		68% 55% 40%		17.50-17.55m: Band of angular and sub-angular fine to coarse rinded flint gravel. 17.55-17.80m: Drilling disturbed. Recovered as slightly sandy silty gravel. 17.65-17.70m: Band of angular and sub-angular fine to coarse rinded flint gravel. 17.90-18.20m: Mottled grey. 18.10-18.12m: Band of angular and sub-angular fine to coarse rinded flint gravel. 18.12-18.25m: Discontinuities are sub-horizontal to horizontal very closely and closely spaced infilled with comminuted chalk (<1mm). [Grade B3-B4]			
18		D	18.50								
19		C	19.00 - 20.50			93% 86% 73%		19.15-19.20m: Band of angular and sub-angular fine to coarse rinded flint gravel. 19.27-19.30m: Band of angular and sub-angular fine to coarse rinded flint gravel.			
		CS	19.50 - 19.85					19.82-19.85m: Discontinuity infilled with comminuted chalk stained brown (30mm).			
20		D	20.40					20.10-20.25m: Indistinctly thinly laminated mottled grey.			

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
17/11/2015	19.00	4.20	0.80
18/11/2015	19.00	4.20	1.20

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ROTARY BOREHOLE LOG

Borehole No. **BH102**

Sheet 4 of 6

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Project Name: University of Chichester | Project No.: **C4872** | Co-ords: E 494421 N 99543 | Hole Type DS+RC

Location: Bognor Regis | Level: 2.18mAOD | Scale 1 : 37.50

Client: University of Chichester | Dates: Start: 16/11/2015 End: 19/11/2015 | Logged By RS/SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
21		C CPT	20.50 - 22.00 20.50	C*300		99% 85% 81%		Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal medium spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade A2-B2) *(continued from previous sheet)* 20.87-20.90m: Discontinuity infilled with comminuted chalk stained grey (30mm).	(8.30)		
		CS	21.40 - 21.77								
22		D C	21.90 22.00 - 23.50			100% 73% 68%		22.10-22.15m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-angular cobble. 22.40-22.60m: Drilling disturbed. Recovered as angular to sub-angular fine to coarse rinded flint and chalk gravel and sub-angular cobble.			
23		CS	22.85 - 23.25								
		D C CPT	23.40 23.50 - 25.00 23.50	C*500		93% 80% 61%		23.50-23.55m: Band of angular and sub-angular fine to coarse rinded flint gravel.			
24		CS	23.93 - 24.20					24.15-24.50m: Indistinctly thinly laminated mottled grey. 24.30-24.50m: Discontinuity is sub-vertical and vertical stained grey infilled with comminuted chalk (<5mm).			
25		D C	24.90 25.00 - 26.50			85% 51% 36%		Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal very closely and closely spaced infilled with comminuted chalk (<3mm). (White Chalk Subgroup Grade B3-B4) 25.30-25.32m: Band of angular and sub-angular fine to coarse rinded flint gravel.	25.00 (0.80)	-22.82	
26		D C CPT	26.40 26.50 - 28.00 26.50	C*300		99% 65% 55%		Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal very closely and closely spaced infilled with comminuted chalk (<3mm). (White Chalk Subgroup Grade B4-B5) 25.80-25.82m: Band of angular and sub-angular fine to coarse rinded flint gravel. 26.00-26.10m: Drilling disturbed. Recovered as sub-angular slightly sandy silty gravel. 26.05-26.07m: Band of angular and sub-angular fine to coarse rinded flint gravel.	25.80 (1.00) 26.80	-23.62 -24.62	
27		CS	26.90 - 27.22					Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal medium spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade A2-B3) 27.60-27.64m: Flint cobble (cored).			

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
18/11/2015	23.50	12.00	0.80
19/11/2015	23.50	12.00	1.40

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ROTARY BOREHOLE LOG

Borehole No. **BH102**

Sheet 5 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494421 N 99543	Hole Type DS+RC
Location: Bognor Regis		Level: 2.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 16/11/2015 End: 19/11/2015	Logged By RS/SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
28		D C	27.90 28.00 - 29.50			91% 51% 37%		Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal medium spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade A2-B3) *(continued from previous sheet)* 28.30-28.45m: Drilling disturbed. Recovered as slightly sandy silty gravel and cobbles.			28
									(3.85)		
29								28.90-29.25m: Drilling disturbed. Recovered as slightly sandy silty gravel.			29
		D C CPT CS	29.40 29.50 - 31.00 29.50 29.80 - 30.15	C*300		100% 63% 63%		29.50-29.60m: Flint cobble (cored). 29.60-29.80m: Drilling disturbed. Recovered as slightly sandy silty gravel and cobbles.			
30								30.15-30.35m: Drilling disturbed. Recovered as slightly sandy silty gravel and cobbles. 30.35-30.37m: Band of angular and sub-angular fine to coarse rinded flint gravel. 30.60-30.65m: Drilling disturbed. Recovered as sub-angular slightly sandy silty gravel.	30.65	-28.47	30
31		D C	30.90 31.00 - 32.50			100% 81% 68%		Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal medium spaced. No infill. (White Chalk Subgroup Grade A2-A3) 31.10-31.15m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-angular cobble.			31
									(2.10)		
32											32
		D C CPT CS	32.40 32.50 - 34.00 32.50 32.75 - 33.29	C*500		97% 83% 66%		32.40-32.60m: Discontinuities are sub-vertical and vertical very closely and extremely closely spaced locally infilled with comminuted chalk (<1mm). 32.55-32.57m: Band of angular and sub-angular fine to coarse rinded flint gravel.	32.75	-30.57	
33								Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal medium spaced. No infill. (White Chalk Subgroup Grade A2)	(0.55) 33.30	-31.12	33
								Weak medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal closely to medium spaced locally infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade A2-B3) 33.40-33.45m: Flint cobble (cored).			
34		D C	33.90 34.00 - 35.00			80% 45% 41%			(1.78)		34
								34.35-34.45m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-angular cobble.			
35		D CPT	34.90 35.00 - 35.08	C*300							35

Borehole completed at 35.08m

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
19/11/2015	35.08	12.00	0.80

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ROTARY BOREHOLE LOG

Borehole No. **BH102**

Sheet 6 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494421 N 99543	Hole Type DS+RC
Location: Bognor Regis		Level: 2.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 16/11/2015 End: 19/11/2015	Logged By RS/SM

(m)	Water Levels	Core Run, Samples & Testing			Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		No/Type	Depth (m)	Result					35.08	-32.90	

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Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

Borehole No. **BH103**

Sheet 1 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494386 N 99532	Hole Type DS+RC
Location: Bognor Regis		Level: 2.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 13/11/2015 End: 18/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B ES	0.50					MADE GROUND: Soft and firm greyish brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is sub-angular fine to coarse brick flint and concrete. 0.25m: Concrete boulder.	(0.80)		
									0.80	2.11	
1		B ES	1.00					Firm orangish brown mottled white and grey slightly sandy gravelly CLAY. Gravel is sub-angular and sub-rounded fine to coarse flint. (Lambeth Group)	(0.40)		1
		SPT	1.20 - 1.65	S 1					1.20	1.71	
		ES	1.30					Soft light grey mottled orangish brown slightly sandy silty CLAY. (Lambeth Group)	1.40	1.51	
								Firm light grey mottled orangish brown and reddish brown slightly sandy silty CLAY. (Lambeth Group)	(0.90)		
2		D H	1.90	H 51							2
									2.30	0.61	
		D H	2.50	H 79				Stiff light grey, orangish brown and reddish brown slightly sandy silty CLAY. (Lambeth Group)			
		SPT	2.70 - 3.15	S 6							
3											3
		D H	3.60	H 84					(2.70)		
4		D H	4.00	H 103							4
		ES	4.20	S 16							
		SPT	4.20 - 4.65								
		D	4.70								
5								Very stiff light grey reddish brown and orangish brown slightly sandy silty CLAY. (Lambeth Group)	5.00	-2.09	5
		D	5.30								
		C SPT	5.50 - 7.00 5.50 - 5.95	S 31		100% 0% 0%					
6											6

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REMARKS:

EQUIPMENT: Hand digging tools. Comacchio MC300 multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-5.50m. Waterflush rotary core drilled (146mm diam) 5.50-35.00m.
CASING: SW to 5.50m.
GROUNDWATER: None encountered prior to using water flush to advance casing.
INSTALLATION: Arisings: 30.00-35.00m. 50mm ID HDPE slotted pipe with washed gravel response zone and geosock: 30.00-13.00m. Plain 50mm ID HDPE pipe with gravel surround: 12.80-13.00m and bentonite pellet seal: 0.20-12.80m. Raised 150mm steel cover set in concrete: 0.00-0.20m. Gas valve fitted.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
13/11/2015	5.00	4.20	3.20
16/11/2015	5.00	4.20	2.20

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ROTARY BOREHOLE LOG

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Borehole No. **BH103**

Sheet 2 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494386 N 99532	Hole Type DS+RC
Location: Bognor Regis		Level: 2.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 13/11/2015 End: 18/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		D	6.20					Very stiff light grey reddish brown and orangish brown slightly sandy silty CLAY. (Lambeth Group) *(continued from previous sheet)*	(2.50)		
7		D C SPT	6.90 7.00 - 8.50 7.00 - 7.45	S 21		100% 0% 0%			7.50	-4.59	7
								Hard friable reddish brown locally light grey and orangish brown slightly sandy slightly gravelly silty CLAY. Gravel is sub-angular and sub-rounded fine and medium sandstone. (Lambeth Group)			
8		D	7.80						(1.50)		8
		C SPT	8.50 - 9.70 8.50 - 8.95	S 20		100% 0% 0%					
9		B	9.00 - 9.35						9.00	-6.09	9
								Hard light grey mottled orangish brown slightly gravelly sandy CLAY. Gravel is sub-angular fine to coarse flint. Locally tending to gravelly very clayey fine and medium sand. (Lambeth Group)	(0.35)		
		B	9.35 - 9.70						9.35	-6.44	
								Orangish brown and grey clayey very sandy GRAVEL. Gravel is angular to sub-rounded fine to coarse flint. Low cobble content of angular flint. (Lambeth Group)	(0.55)		
		C CPT ES	9.70 - 11.20 9.70 - 9.91 9.70	C*250		97% 45% 26%					
10								Strong white LIMESTONE with sub-horizontal very closely and closely spaced undulating rough discontinuities with a little brown staining on discontinuity surfaces. (Lambeth Group)	9.90	-6.99	10
		ES	10.50						(1.40)		
		B	10.70								
11		D	11.00					10.90-11.10m: Sub-vertical undulating rough discontinuity.			11
		C	11.20 - 12.60			100% 59% 23%			11.30	-8.39	
		D	11.40					Very weak and weak medium density white with occasional orangish brown staining CHALK. Discontinuities are extremely and very closely spaced (20/40/60) locally infilled with (0/0/1) white comminuted chalk, moderately orangish brown stained. (White Chalk Subgroup Grade B4-5)	(0.35)		
									11.65	-8.74	
12		B	12.20					Very weak medium and high density white CHALK. Discontinuities are closely and medium spaced locally very closely spaced (50/200/430) locally infilled with (0/0/1) white comminuted chalk, slightly orangish brown stained. (White Chalk Subgroup Grade A2-3) 12.20-12.47m: Sub-vertical undulating rough discontinuity with orangish brown staining on discontinuity surface.			12
		D C CPT	12.50 12.60 - 13.90 12.60 - 12.89	C*107		98% 68% 51%					
13		CS	13.08 - 13.31								13

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
16/11/2015	11.20	5.50	1.80
17/11/2015	11.20	5.50	2.40

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ROTARY BOREHOLE LOG

Borehole No. **BH103**

Sheet 3 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494386 N 99532	Hole Type DS+RC
Location: Bognor Regis		Level: 2.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 13/11/2015 End: 18/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B	13.50					Very weak medium and high density white CHALK. Discontinuities are closely and medium spaced locally very closely spaced (50/200/430) locally infilled with (0/0/1) white comminuted chalk, slightly orangish brown stained. (White Chalk Subgroup Grade A2-3) *(continued from previous sheet)*	(3.75)		
		D	13.80					13.70-13.80m: Band of angular and sub-angular fine to coarse rinded flint gravel.			
14		C	13.90 - 15.20			96% 81% 15%		14.20-14.23m: Band of angular and sub-angular fine to coarse rinded flint gravel.			14
		CS	14.25 - 14.64								
15		D	15.00								15
		B	15.10								
		C	15.20 - 16.60	C*115		100% 39% 20%					
		CPT	15.20 - 15.48						15.40	-12.49	
								Weak low and medium density white locally orangish brown stained CHALK. Discontinuities are extremely closely and very closely spaced (10/30/60) and sub-vertical closely spaced locally infilled with (1/2/3) white comminuted chalk, slightly orangish brown stained (White Chalk Subgroup Grade B4/B5)	(0.30)		
									15.70	-12.79	
16								Weak medium density white CHALK. Discontinuities are closely and medium spaced locally very closely spaced (50/200/430) locally infilled with (0/0/1) white comminuted chalk, slightly orangish brown stained. (White Chalk Subgroup Grade A2-3)			16
		D	16.40					15.70-16.00m: Sub-vertical undulating rough discontinuity with orangish brown staining on fracture surface.			
		C	16.60 - 18.00			100% 41% 37%		16.00-18.00m: 2 no. parallel very closely spaced sub-vertical undulating rough discontinuities with orangish brown staining on fracture surface.			
17		B	17.02					16.00-16.18m: 60° undulating rough discontinuity.			17
		D	17.47					16.50-16.92m: Sub-vertical undulating rough discontinuity with orangish brown staining on discontinuity surface.			
								16.80-16.85m: Band of sub-angular coarse rinded flint gravel.			
18		C	18.00 - 19.50	C*150		92% 69% 54%		16.93-17.02m: Band of angular and sub-angular fine to coarse rinded flint gravel.			18
		CPT	18.00 - 18.25					17.02-17.45m: Sub-vertical undulating rough discontinuity with orangish brown staining on discontinuity surface.			
		CS	18.40 - 18.65					17.45-17.47m: Band of angular and sub-angular fine to coarse rinded flint gravel.			
								17.47-18.60m: Sub-vertical and randomly orientated extremely and very closely spaced intersecting discontinuities.			
19		D	19.00					18.00-18.40m: Sub-vertical undulating rough discontinuity with orangish brown staining on discontinuity surface.			19
								18.65-18.95m: Sub-horizontal and randomly orientated extremely closely and very closely spaced intersecting discontinuities.			
		C	19.50 - 20.80			100% 38% 0%					
		CS	19.70 - 19.95								
20								20.22-20.35m: Band of angular and sub-angular coarse rinded flint gravel and cobbles.			20
								20.40-20.45m: Band of angular and sub-angular fine to			

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

Borehole No. **BH103**

Sheet 4 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494386 N 99532	Hole Type DS+RC
Location: Bognor Regis		Level: 2.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 13/11/2015 End: 18/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								coarse rinded flint gravel. Weak medium density white CHALK. Discontinuities are closely and medium spaced locally very closely spaced (50/200/430) locally infilled with (0/0/1) white comminuted chalk, slightly orangish brown stained. (White Chalk Subgroup Grade A2-3) *(continued from previous sheet)*			
21		C CPT	20.80 - 22.20 20.80 - 21.04	C*167		100% 72% 63%		20.56-20.61m: Band of angular and sub-angular fine to coarse rinded flint gravel. 21.35-21.47m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-rounded cobbles.			21
22		CS D C	21.80 - 22.10 22.00 22.20 - 23.60			89% 85% 73%		22.40-22.65m: Mottled grey. 22.49-22.51m: Discontinuity is sub-horizontal infilled with comminuted chalk (possible Marl).			22
23		D C CPT	23.50 23.60 - 25.00 23.60 - 23.84	C*167		100% 81% 51%		23.95-24.10m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-rounded cobbles. 24.05-24.65m: Discontinuities are vertical and sub-vertical extremely closely and very closely spaced infilled with comminuted chalk (<1mm) locally stained orangish brown. 24.39-24.40m: Discontinuity is subhorizontal infilled with grey sandy clay (10mm) (possible Marl). 24.80-27.00m: Mottled grey.			23 24
24		D CS	24.60 24.68 - 25.00								
25		C	25.00 - 26.40			100% 66% 54%			(19.30)		25
26		D C CPT	26.30 26.40 - 27.40 26.40 - 26.65	C*150		100% 74% 61%		25.65-25.83m: Indistinctly thinly laminated mottled grey (probable Marl).			26
27		D CS C	27.10 27.13 - 27.40 27.40 - 28.90			95% 71% 53%		27.55-27.60m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-rounded cobbles.			27

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
17/11/2015	26.40	5.50	2.30
18/11/2015	26.40	5.50	2.40

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ROTARY BOREHOLE LOG

Borehole No. **BH103**

Sheet 5 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494386 N 99532	Hole Type DS+RC
Location: Bognor Regis		Level: 2.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 13/11/2015 End: 18/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
28								27.70-27.72m: Band of angular and sub-angular fine to coarse rinded flint gravel. 27.80-27.95m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-rounded cobbles. Weak medium density white CHALK. Discontinuities are closely and medium spaced locally very closely spaced (50/200/430) locally infilled with (0/0/1) white comminuted chalk, slightly orangish brown stained. (White Chalk Subgroup Grade A2-3) *(continued from previous sheet)*			28
		D	28.80					28.20-28.90m: Discontinuity is vertical and sub-vertical infilled with comminuted chalk (<1mm) locally stained orangish brown.			
29		C CPT	28.90 - 29.40 28.90 - 29.13	C*188		60% 60% 46%		28.50-28.55m: Band of angular and sub-angular fine to coarse rinded flint gravel. 28.70-28.90m: Chalk recovered non-intact as silty gravel. 29.14-29.22m: Rinded flint cobble or boulder (cored through). 29.22-29.40m: Drilling disturbed. Recovered as sub-angular rinded flint and chalk gravel.			29
		C	29.40 - 30.90			96% 79% 62%		29.60-32.40m: Discontinuities are sub-horizontal and horizontal closely to medium spaced locally infilled with comminuted chalk (<5mm). [Grade A2-B3]			
30		D B	30.40 30.50								30
								30.63-30.72m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-rounded cobbles.			
31		C CPT	30.90 - 32.30 30.90 - 31.15	C*158		96% 74% 51%					31
								31.65-31.72m: Band of angular and sub-angular fine to coarse rinded flint gravel and sub-rounded cobbles.			
32											32
		D C	32.20 32.30 - 33.80			97% 86% 88%		32.15-32.23m: Sub-angular to sub-rounded rinded flint cobble. 32.40-35.00m: Discontinuities are sub-horizontal to horizontal medium spaced locally closely spaced with no infill. [Grade A2-A3] 32.40-34.70m: Mottled grey.			
33											33
		D CS	33.20 33.30 - 33.65								
		C CPT	33.80 - 35.00 33.80 - 34.05	C*150		100% 80% 54%		33.80-33.90m: Band of angular and sub-angular fine to coarse rinded flint gravel.			
34											34
								34.70-34.72m: Band of angular and sub-angular fine to coarse rinded flint gravel.			
35		D	34.90					34.80-34.85m: Band of angular and sub-angular fine to	35.00	-32.09	35

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
18/11/2015	35.00	5.50	2.80

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ROTARY BOREHOLE LOG

Borehole No. **BH103**

Sheet 6 of 6

[redacted]

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494386 N 99532	Hole Type DS+RC
Location: Bognor Regis		Level: 2.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 13/11/2015 End: 18/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								coarse rinded flint gravel.			
								Borehole completed at 35.00m			

36 37 38 39 40 41 42

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Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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BOREHOLE LOG

Borehole No. **BH104**

Sheet 1 of 2

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494380 N 99657	Hole Type DS
Location: Bognor Regis		Level: 1.53mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 10/11/2015 End: 10/11/2015	Logged By SM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		ES	0.10				MADE GROUND: Very soft dark brown mottled black and yellowish brown slightly gravelly silty CLAY with frequent roots and rootlets (<3mm). Gravel is angular to sub-angular fine to medium brick.	(0.30)		
		B	0.20					0.30	1.23	
		B	0.50				Soft grey mottled orangish brown, yellowish brown and brown slightly sandy silty CLAY. (Superficial Deposits) 0.70-1.80m: Tending to orangish brown mottled grey.			
1		B	1.00					(1.50)		1
		ES								
		SPT	1.20 - 1.65	S 1						
								1.80	-0.27	
2							Very soft grey slightly sandy silty CLAY locally tending to clayey silt with frequent orangish brown stained root traces and occasional part decomposed plant remains (<3mm). (Superficial Deposits)			2
		D	2.20							
		H	2.40	H 11						
		SPT	2.50 - 2.95	S<1						
3		H	3.00	H 11			3.00-7.20m: Locally with black mottling.			3
		H	3.50	H 12						
		D	3.70							
4		SPT	4.00 - 4.45	S<1				(5.00)		4
5		H	5.00	H 7						5
		D	5.20							
		SPT	5.50 - 5.95	S 5						
6							5.90-6.80m: Slightly gravelly. Gravel is angular to sub-rounded			6

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REMARKS:

EQUIPMENT: Hand digging tools. Fraste PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-12.00m.
GROUNDWATER: None encountered prior to using water flush to advance casing to 5.50m.
CASING: SW to 8.50m.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 9.00-12.00m. 50mm ID HDPE plain pipe with washed gravel response zone: 8.90-9.00m, and bentonite pellet seal: 0.30-8.90m, and flush 150mm steel cover set in concrete: 0.00-0.30m Gas valve fitted.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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BOREHOLE LOG

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Borehole No. **BH104**

Sheet 2 of 2

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494380 N 99657	Hole Type DS
Location: Bognor Regis		Level: 1.53mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 10/11/2015 End: 10/11/2015	Logged By SM

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
							fine to medium flint. Very soft grey slightly sandy silty CLAY locally tending to clayey silt with frequent orangish brown stained root traces and occasional part decomposed plant remains (<3mm). (Superficial Deposits) *(continued from previous sheet)*			
							Yellowish grey and light grey slightly sandy very gravelly SILT. Gravel is sub-angular to sub-rounded fine to coarse chalk. (Superficial Deposits)	6.80 (0.40)	-5.27	
7		D SPT	6.90 7.00 - 7.45	S 5			Structureless CHALK composed of white mottled grey slightly sandy silty GRAVEL. Gravel is sub-angular to rounded fine to coarse medium density chalk and flint. (White Chalk Subgroup Grade Dc)	7.20	-5.67	7
8							8.20-8.50m: Locally tending to structured chalk [Grade C5].			8
		D SPT	8.40 8.50 - 8.95	S 12			8.50-11.50m: Limited recovery of structureless chalk [Grade Dm].			
9		D	9.10							9
								(5.25)		
10		SPT	10.00 - 10.45	S 19			10.00-10.10m: Sub-angular to sub-rounded rinded flint cobble (~130mm).			10
		D	10.70							
11										11
		SPT	11.50 - 11.95	S 19			11.50-12.00m: Locally tending to structured chalk [Grade C4-C5].			
12		D SPT	11.95 12.00 - 12.45	S 18						12
							Borehole completed at 12.45m	12.45	-10.92	
13										13

Groundwater:

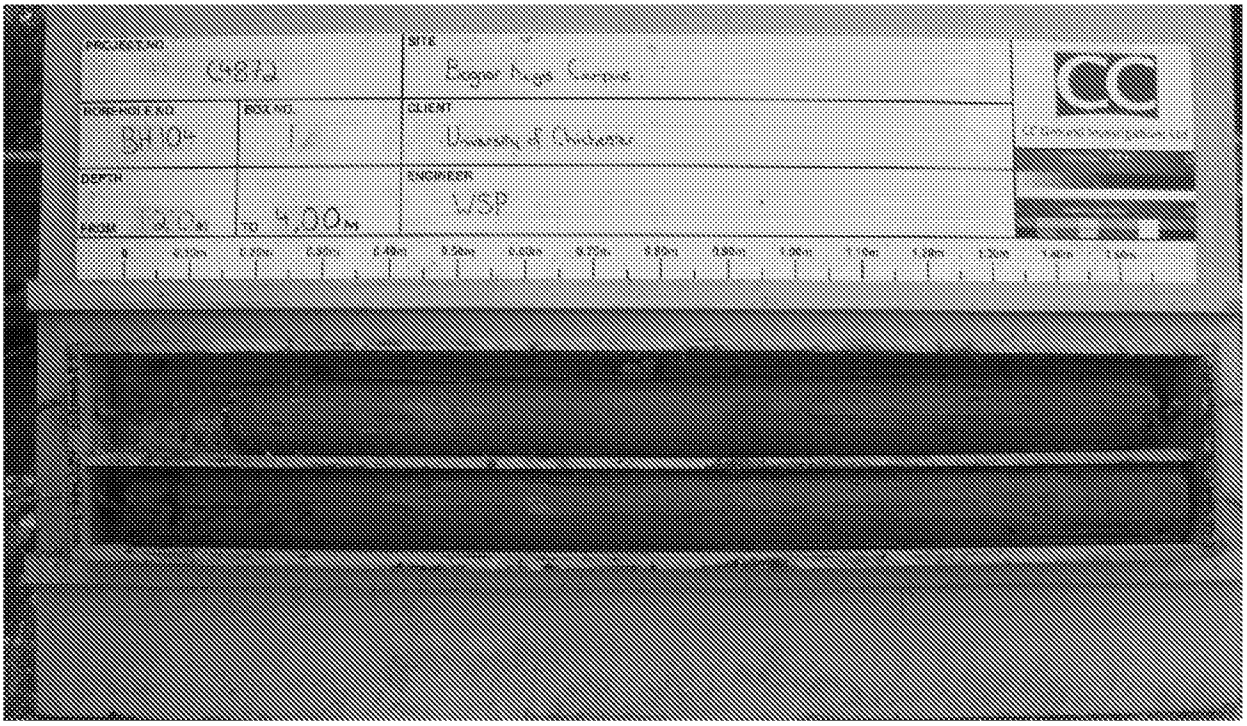
Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

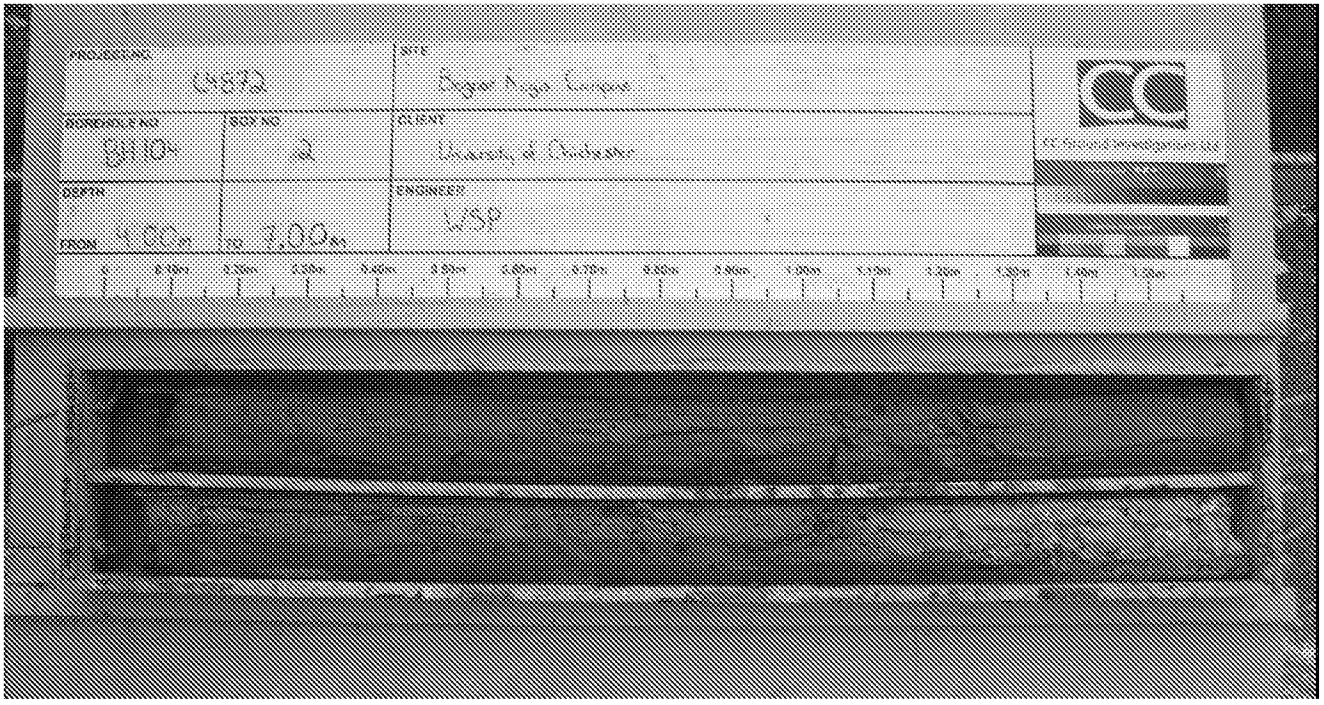
Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
10/11/2015	12.45	8.50	1.00

DRAFT

Borehole Photograph



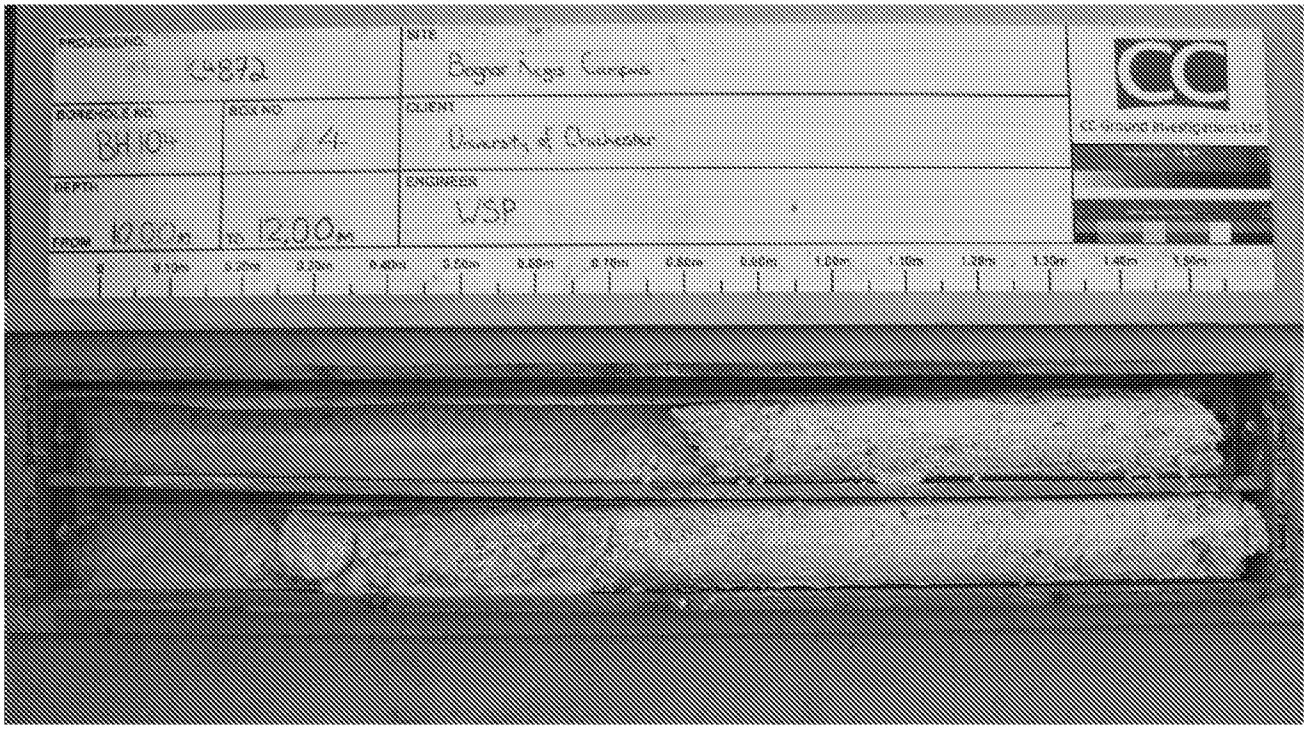


CC Ground Investigations Ltd	
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH104

ARUN DISTRICT COUNCIL BR/54/15/PL

Borehole Photograph





CC Ground Investigations Ltd	
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH104

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BOREHOLE LOG

[redacted]

Borehole No. **BH105**

Sheet 1 of 3

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494427 N 99736	Hole Type DS
Location: Bognor Regis		Level: 1.39mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 04/11/2015 End: 05/11/2015	Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.30				MADE GROUND: Stiff friable orangish brown mottled dark grey and reddish brown slightly sandy slightly gravelly CLAY with frequent rootlets. Gravel is sub-angular fine and medium brick.	0.20	1.19	
		B	0.50				MADE GROUND: Stiff orangish brown mottled reddish brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is sub-angular fine brick.	(0.60)		
								0.80	0.59	
1		B	1.00				Firm orangish brown slightly sandy silty CLAY. (Superficial Deposits)	(0.30)		1
		SPT	1.20 - 1.65	S<1				1.10	0.29	
							Very soft light grey and orangish brown silty CLAY. (Superficial Deposits)	(1.10)		
		D	1.70							
2		H	2.00	H 17						2
								2.20	-0.81	
		D	2.50	H 16			Very soft light grey silty CLAY with frequent 1mm diameter vertical dead rootlets. (Superficial Deposits)	(0.50)		
		H SPT	2.70 - 3.15	S<1				2.70	-1.31	
3							Very soft grey silty CLAY with rare sub-angular fine gravel sized and 1mm diameter partially decomposed organic fragments and dead rootlets. (Superficial Deposits)			3
		H	3.40	H 12				(2.10)		
4		D H SPT	4.00 4.20 - 4.65	H 16 S 1						4
							Very soft grey silty CLAY. (Superficial Deposits)	4.80	-3.41	
5										5
		D H SPT	5.50 5.70 - 6.15	H 13 S 1				(1.60)		
6										6

REMARKS:

EQUIPMENT: Hand digging tools. Fraste PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-14.70m.
GROUNDWATER: None encountered prior to use of water flush to advance casing to 4.20m..
CASING: 160mm diam casing to 14.70m.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 13.20-14.70m. 50mm ID HDPE plain pipe with bentonite pellet seal: 0.20-13.20m and flush 150mm steel cover set in concrete: 0.00-0.20m Gas valve fitted.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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BOREHOLE LOG

Borehole No. **BH105**

Sheet 2 of 3

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494427 N 99736	Hole Type DS
Location: Bognor Regis		Level: 1.39mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 04/11/2015 End: 05/11/2015	Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
							Very soft grey silty CLAY. (Superficial Deposits) *(continued from previous sheet)*			
		H	6.40	H 9				6.40	-5.01	
							Very soft indistinctly thinly laminated dark grey slightly sandy silty CLAY. (Superficial Deposits)			
7		D	7.00	H 9						7
		H								
		SPT	7.20 - 7.65	S 2				(2.00)		
8										8
								8.40	-7.01	
							Very soft grey silty CLAY. (Superficial Deposits)			
		D	8.50	H 10						
		H								
		SPT	8.70 - 9.15	S 2						
9										9
10		D	10.00	H 12						10
		H								
		SPT	10.20 - 10.65	S 4						
								(4.30)		
11										11
		SPT	11.70 - 12.15	S 12						
12										12
								12.70	-11.31	
							Structureless CHALK composed of white gravelly SILT. Gravel is extremely weak and very weak low and medium density white fine to coarse with occasional black specks. (White Chalk Subgroup Grade Dm)	(0.30)		
13		D	13.00					13.00	-11.61	13
							(continued on next sheet)			

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Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
04/11/2015	11.70	10.20	0.60
05/11/2015	11.70	10.20	2.60

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BOREHOLE LOG

[redacted]

Borehole No. **BH105**

Sheet 3 of 3

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494427 N 99736	Hole Type DS
Location: Bognor Regis		Level: 1.39mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 04/11/2015 End: 05/11/2015	Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		SPT	13.20 - 13.65	S 9			Structureless CHALK composed of silty angular and sub-angular fine to coarse GRAVEL. Clasts are very weak, low and medium density white with occasional black specks. (White Chalk Subgroup Grade Dc) *(continued from previous sheet)*			
14								(2.15)		
		D	14.50							
		SPT	14.70 - 15.15	S 8						
15							Borehole completed at 15.15m	15.15	-13.76	
16										
17										
18										
19										
20										

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Groundwater:

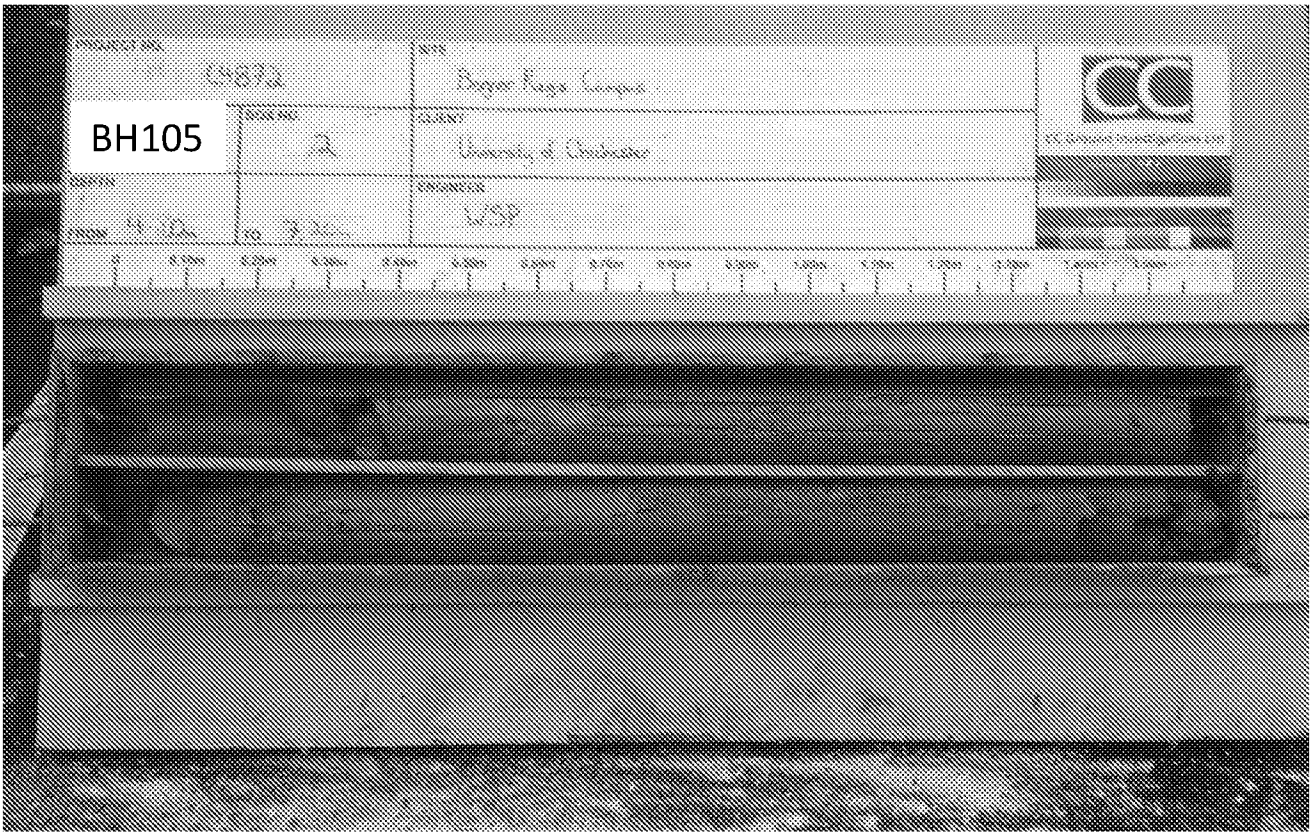
Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
05/11/2015	15.15	14.70	0.60

Borehole Photograph





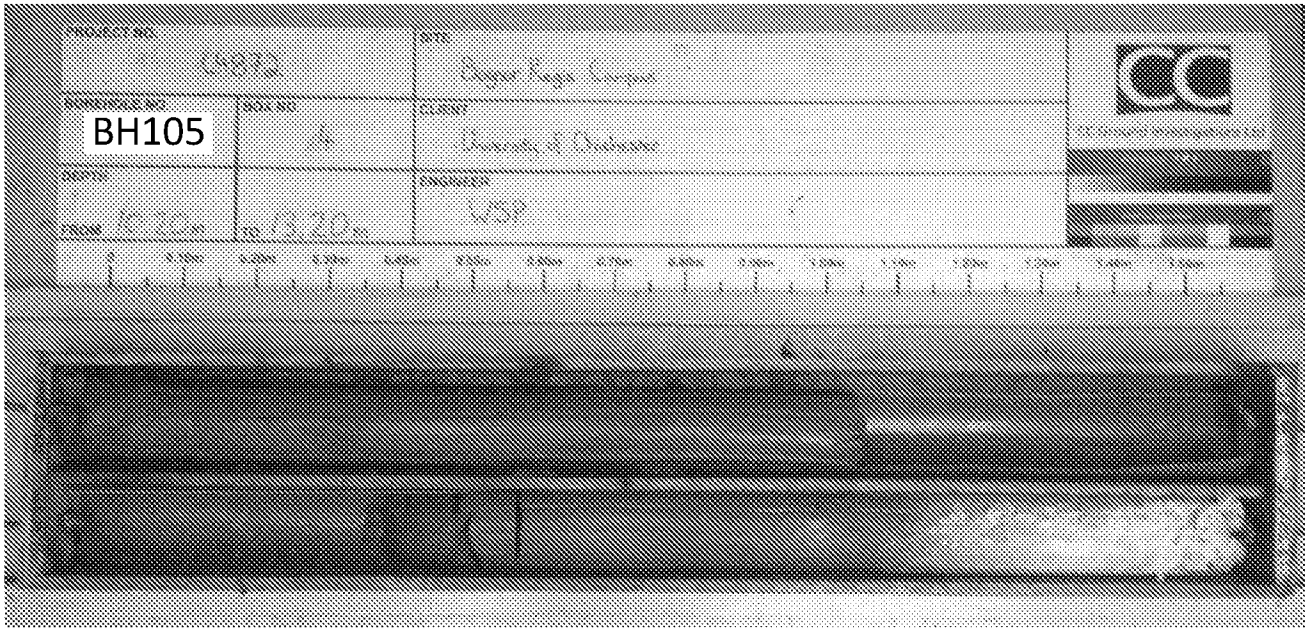
CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH105

ARUN DISTRICT COUNCIL BR/54/15/PEL

Borehole Photograph

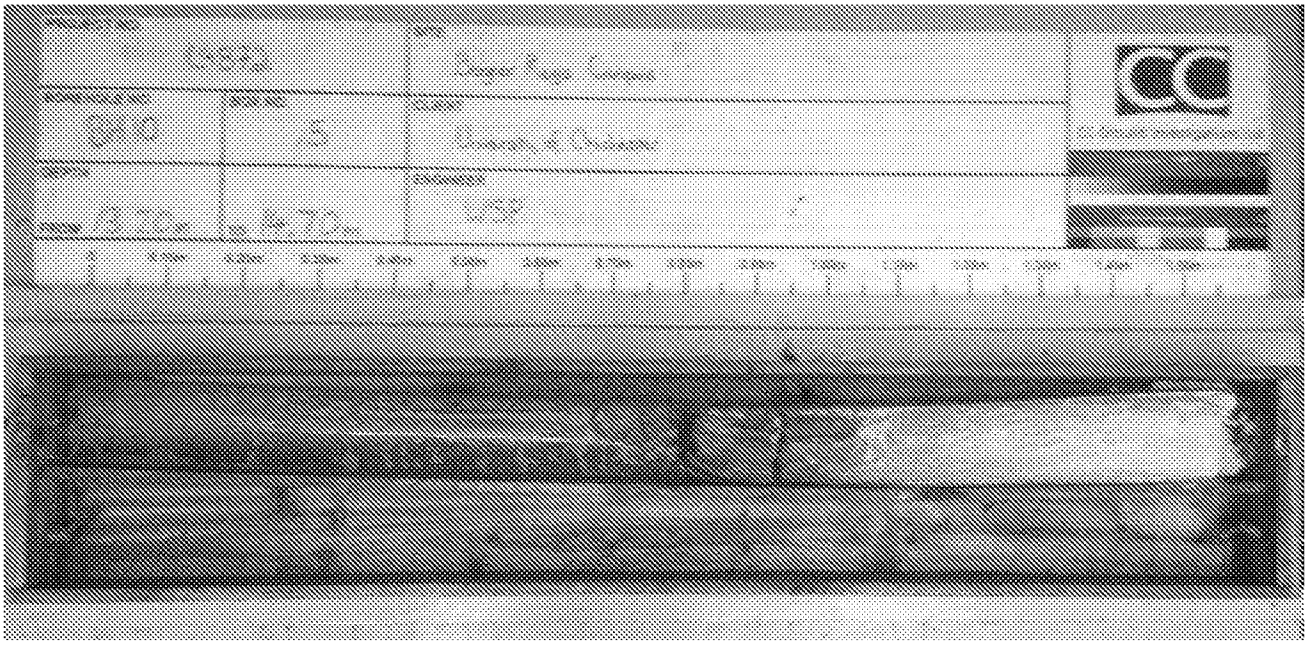




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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH105

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Borehole Photograph



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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH105

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ROTARY BOREHOLE LOG

Borehole No. **BH106**

Sheet 1 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494433 N 99598	Hole Type DS+RC
Location: Bognor Regis		Level: 2.24mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 11/11/2015 End: 17/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.20					MADE GROUND: Rough vegetation over very soft brown slightly sandy slightly gravelly silty CLAY with frequent roots and rootlets (<5mm). Gravel is angular to sub-rounded fine to coarse brick, sandstone, flint and siliceous material.	(0.40)		
									0.40	1.84	
		B	0.50					Soft yellowish brown mottled orangish brown and grey slightly sandy silty CLAY. (Lambeth Group)	(0.30)		
									0.70	1.54	
1		B	1.00					Soft yellowish brown mottled grey, orangish brown and reddish brown slightly sandy slightly gravelly silty CLAY with frequent orangish brown stained root traces and occasional partially decomposed roots and rootlets (<2mm). Gravel is sub-rounded to rounded fine to coarse flint and siliceous material. (Lambeth Group)	(0.80)		1
		SPT	1.20 - 1.65	S 4							
									1.50	0.74	
		H	1.70	H 84				Firm locally becoming stiff indistinctly thinly laminated slightly sandy silty CLAY with frequent orangish brown stained root traces. (Lambeth Group) 1.50-5.60m: Firm locally tending to stiff. Indistinctly laminated. Gravel absent.			
2		D	2.10								2
		H	2.30	H 116							
		ES	2.40								
		SPT	2.50 - 2.95	S 10							
3											3
		D	3.50						(4.10)		
		SPT	3.80 - 4.25	S 16							
4								4.00-5.60m: Occasional silty sand lenses (<30mm). 4.05-4.80m: Locally slightly gravelly. Gravel is sub-rounded to rounded fine to coarse chalk and flint.			4
		D	4.50								
		SPT	4.80 - 5.25	S 19							
5											5
									5.60	-3.36	
								Firm grey silty CLAY. (Lambeth Group)	5.70	-3.46	
		D	5.80					*(continued on next sheet)*			
6											6

SPECIMEN

REMARKS:

EQUIPMENT: Hand digging tools. Fraste PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-15.70m. Waterflush rotary core drilled (146mm diam) 15.70-34.40m.
GROUNDWATER: None encountered prior to using water flush to advance casing.
CASING: SW casing to 6.00m.
INSTALLATION: Bentonite pellet backfill: 1.60-35.00m. 50mm ID HDPE slotted pipe with washed gravel response zone: 0.60-1.60m, plain pipe with washed gravel response zone: 0.50-0.60m, and bentonite pellet seal: 0.20-0.50m, raised borehole helmet set in concrete 0.00-0.20m. Gas valve fitted.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

Borehole No. **BH106**

Sheet 2 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494433 N 99598	Hole Type DS+RC
Location: Bognor Regis		Level: 2.24mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 11/11/2015 End: 17/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		C SPT	6.00 - 7.50 6.00 - 6.28	S*75		100% 0% 0%		Structureless CHALK composed of yellowish brown mottled grey and orangish brown slightly sandy slightly gravelly SILT. Gravel is sub-angular to sub-rounded fine to coarse extremely weak and very weak low density chalk and rinded flint. (White Chalk Subgroup Grade Dm) *(continued from previous sheet)* 6.25-6.45m: Sub-angular flint cobbles (<110mm). 6.45-6.50m: Weak medium density sub-rounded chalk cobble.	(0.80) 6.50	-4.26	
7		D C	7.30 7.50 - 9.00			97% 77% 0%		Extremely weak and very weak low to medium density white mottled grey CHALK. Discontinuities are sub-horizontal and horizontal locally randomly orientated extremely closely spaced infilled with comminuted chalk (<30mm) locally stained orangish brown. (White Chalk Subgroup Grade C5-Dc) 7.00-7.60m: White mottled orangish brown.	(1.10) 7.60	-5.36	7
8								Extremely weak and very weak low to medium density white mottled orangish brown CHALK. Discontinuities are sub-horizontal to horizontal very closely to closely spaced infilled with comminuted chalk (<3mm). (White Chalk Subgroup Grade B3-B4) 8.35-12.80m: Widely spaced thin beds of rinded flint cobbles and gravel (<130mm). Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			8
9		D C SPT	8.80 9.00 - 10.50 9.00 - 9.45	S 23		82% 38% 26%					9
10		CS D C	9.95 - 10.25 10.30 10.50 - 12.00			92% 43% 13%		9.80-10.10m: Discontinuities are horizontal extremely closely and very closely spaced infilled with comminuted chalk (<1mm). [Grade B4-B5]	(5.25)		10
11								11.00-11.20m: Discontinuities are randomly orientated extremely closely spaced infilled with comminuted chalk (<5mm). Possibly drilling disturbed. [Grade C5-Dc] 11.40-11.50m: Discontinuities are randomly orientated extremely closely spaced infilled with comminuted chalk (<5mm). Possibly drilling disturbed. [Grade C5-Dc] 11.50-12.00m: Discontinuities are horizontal closely spaced infilled with comminuted chalk (<1mm). [Grade B3]			11
12		D C SPT	11.80 12.00 - 12.50 12.00 - 12.45	S 21		100% 16% 0%		11.80-11.85m: Indistinctly thinly laminated, mottled grey. 12.00-12.85m: Discontinuities are randomly orientated extremely closely spaced infilled with comminuted chalk (<5mm). Possibly drilling disturbed. [Grade C5-Dc]			12
13		C	12.50 - 14.00			99% 52% 31%		*(continued on next sheet)*	12.85	-10.61	13

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
11/11/2015	12.00	6.00	1.80
12/11/2015	12.00	6.00	1.50

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ROTARY BOREHOLE LOG

Borehole No. **BH106**

Sheet 3 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494433 N 99598	Hole Type DS+RC
Location: Bognor Regis		Level: 2.24mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 11/11/2015 End: 17/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		D	13.50					Very weak low to medium density white locally mottled brown and orangish brown CHALK. Discontinuities are sub-horizontal to horizontal very closely to closely spaced infilled with comminuted chalk (<1mm) stained orangish brown. (White Chalk Subgroup Grade B3-B3) *(continued from previous sheet)*			
14		C SPT	14.00 - 14.30 14.00 - 14.45	S 23		83% 50% 0%		13.30-14.20m: Closely to medium spaced thin beds of rinded flint cobbles and gravel (<70mm). Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			14
		C	14.30 - 15.80			89% 50% 8%		13.50-13.60m: Discontinuities are randomly orientated extremely closely spaced infilled with comminuted chalk (<3mm). Possibly drilling disturbed. [Grade B5-Dc] 13.80-13.85m: Discontinuities are randomly orientated extremely closely spaced infilled with comminuted chalk (<3mm) stained orangish brown and yellowish brown. Possibly drilling disturbed. [Grade B5-Dc]			
15		D	15.00					13.85-14.30m: Discontinuity is sub-vertical, clean stained orangish brown. 14.30-15.70m: Discontinuities are sub-vertical and sub-horizontal extremely closely and very closely spaced infilled with comminuted chalk (<1mm). [Grade B4-B5]			15
		C	15.80 - 17.30			88% 37% 29%		15.95-23.70m: Medium to widely spaced thin beds of rinded flint cobbles and gravel (<100mm). Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			
16		D	16.50					16.60-16.70m: Discontinuities are sub-horizontal extremely closely spaced infilled with comminuted chalk (<3mm). [Grade B5]	(7.20)		16
17								16.70-17.90m: Discontinuities are vertical to sub-vertical very closely spaced infilled with comminuted chalk (<1mm).			17
		C SPT	17.30 - 18.80 17.30 - 17.75	S 44		100% 43% 33%		17.30-17.60m: Locally with brown mottling.			
18		D	18.00					18.00-19.20m: Discontinuities are sub-horizontal and horizontal closely to medium spaced infilled with comminuted chalk (<1mm). [Grade B2-B3]			18
		CS	18.40 - 18.64					18.10-18.50m: Indistinctly thinly laminated locally mottled grey.			
		C	18.80 - 20.30			99% 42% 33%					
19								18.90-19.20m: Discontinuity is sub-vertical to 45°, with infill of comminuted chalk (<1mm) locally stained orangish brown.			19
		D	19.50					19.50-19.75m: Discontinuities are vertical to sub-vertical extremely closely and very closely spaced infilled with comminuted chalk (<1mm) stained yellowish brown.			
20								19.90-20.10m: Discontinuities are randomly orientated extremely closely spaced infilled with comminuted chalk (<1mm) stained orangish brown and yellowish brown. Possibly drilling disturbed. [Grade B5-Dc]	20.05	-17.81	20
		C SPT	20.30 - 21.80 20.30 - 20.75	S 45		100% 67%		*(continued on next sheet)*			

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

[redacted]

Borehole No. **BH106**

Sheet 4 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494433 N 99598	Hole Type DS+RC
Location: Bognor Regis		Level: 2.24mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 11/11/2015 End: 17/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
21		D	20.90			44%		Very weak to weak medium density white locally mottled orangish brown CHALK. Discontinuities are sub-horizontal and horizontal closely spaced infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade B3) *(continued from previous sheet)* 20.40-20.65m: Very closely spaced thin beds of rinded flint cobbles and gravel (<140mm). Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded. 21.00-21.80m: Discontinuities are sub-horizontal to horizontal medium spaced infilled with comminuted chalk (<3mm). [Grade B2]	(2.05)		
		CS	21.35 - 21.70								
		C	21.80 - 23.30			100% 81% 76%					
22		CS	22.05 - 22.45						22.10	-19.86	
								Weak medium density white locally mottled orangish brown CHALK. Discontinuities are sub-horizontal and horizontal medium spaced infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade B2-B3) 22.40-22.50m: Mottled grey. 22.50-22.60m: Discontinuities infilled with very soft indistinctly thinly laminated grey clayey silt. [Marl] 22.54m: Sub-horizontal discontinuity infilled with yellowish brown sand (<2mm). 22.87m: Sub-horizontal discontinuity infilled with yellowish brown sand (<5mm).			
23		D	23.20								
		C	23.30 - 24.60	S*97		71% 6% 6%		23.30-23.70m: Drilling disturbed.			
		SPT	23.30 - 23.65								
								23.70-23.80m: Locally mottled orangish brown and reddish brown.	(3.20)		
24								24.00-24.20m: Discontinuities are randomly orientated extremely closely and very closely spaced infilled with comminuted chalk (<3mm). [Grade B4-Dc] 24.05-25.35m: Closely spaced thin beds of rinded flint cobbles and gravel (<100mm). Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			
		D	24.40								
		C	24.60 - 26.10								
25						107% 53% 28%			25.30	-23.06	
								Very weak to weak medium density white locally mottled orangish brown CHALK. Discontinuities are sub-horizontal and horizontal closely spaced to medium spaced infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade B2-B3) 25.75-26.10m: Discontinuities are randomly orientated extremely closely and very closely spaced infilled with comminuted chalk (<5mm). 26.10-28.95m: Very closely to closely spaced thin beds of rinded flint cobbles and gravel (<100mm) locally mottled orangish brown. Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			
26		D	26.00								
		C	26.10 - 27.60			86% 51% 41%					
27											
		CS	27.40 - 27.60								
		C	27.60 - 28.70	S*120		95% 27%		27.60-27.75m: Drilling disturbed recovered as slightly gravelly silty sand. Gravel is angular to sub-angular fine			
		D	27.60								

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
12/11/2015	23.30	6.00	1.60
13/11/2015	23.30	6.00	1.55

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ROTARY BOREHOLE LOG

Borehole No. **BH106**

Sheet 5 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494433 N 99598	Hole Type DS+RC
Location: Bognor Regis		Level: 2.24mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 11/11/2015 End: 17/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
28		SPT	27.60 - 27.85			18%		to medium chalk and flint. Very weak to weak medium density white locally mottled orangish brown CHALK. Discontinuities are sub-horizontal and horizontal closely spaced to medium spaced infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade B2-B3) *(continued from previous sheet)*			
		D	28.60					27.90-28.20m: Discontinuity is sub-vertical infilled with comminuted chalk (<1mm).			
		C	28.70 - 30.20			97% 66% 27%		28.10-28.20m: 1no. sub-rounded rinded flint cobble (<140mm).			
29								28.90-31.50m: Closely to medium spaced thin beds of rinded flint cobbles and gravel (<140mm). Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			
30		D	30.10								
		C	30.20 - 31.70	S*111		100% 73% 65%			(9.85)		
		SPT	30.20 - 30.46								
		CS	30.55 - 30.85								
31											
		D	31.60								
		C	31.70 - 33.20			97% 91% 83%					
32		CS	32.00 - 32.25					32.20-34.70m: Closely to medium spaced thin beds of rinded flint gravel. Gravel is sub-angular to rounded fine to coarse.			
								32.65-32.70m: Discontinuity is sub-horizontal infilled with comminuted chalk (50mm). Discontinuity surfaces mottled grey.			
33		D	33.10								
		C	33.20 - 34.70	S*136		100% 35% 32%					
		SPT	33.20 - 33.37								
34											
		D	34.60								
		C	34.70 - 35.00			0% 0% 0%					
35		SPT	35.00 - 35.15	S*150							

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Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
13/11/2015	33.20	6.00	1.60
17/11/2015	33.20	6.00	1.65

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ROTARY BOREHOLE LOG

[redacted]

Borehole No. **BH106**

Sheet 6 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494433 N 99598	Hole Type DS+RC
Location: Bognor Regis		Level: 2.24mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 11/11/2015 End: 17/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing			Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		No/Type	Depth (m)	Result							
								Borehole completed at 35.15m	35.15	-32.91	

36 37 38 39 40 41 42

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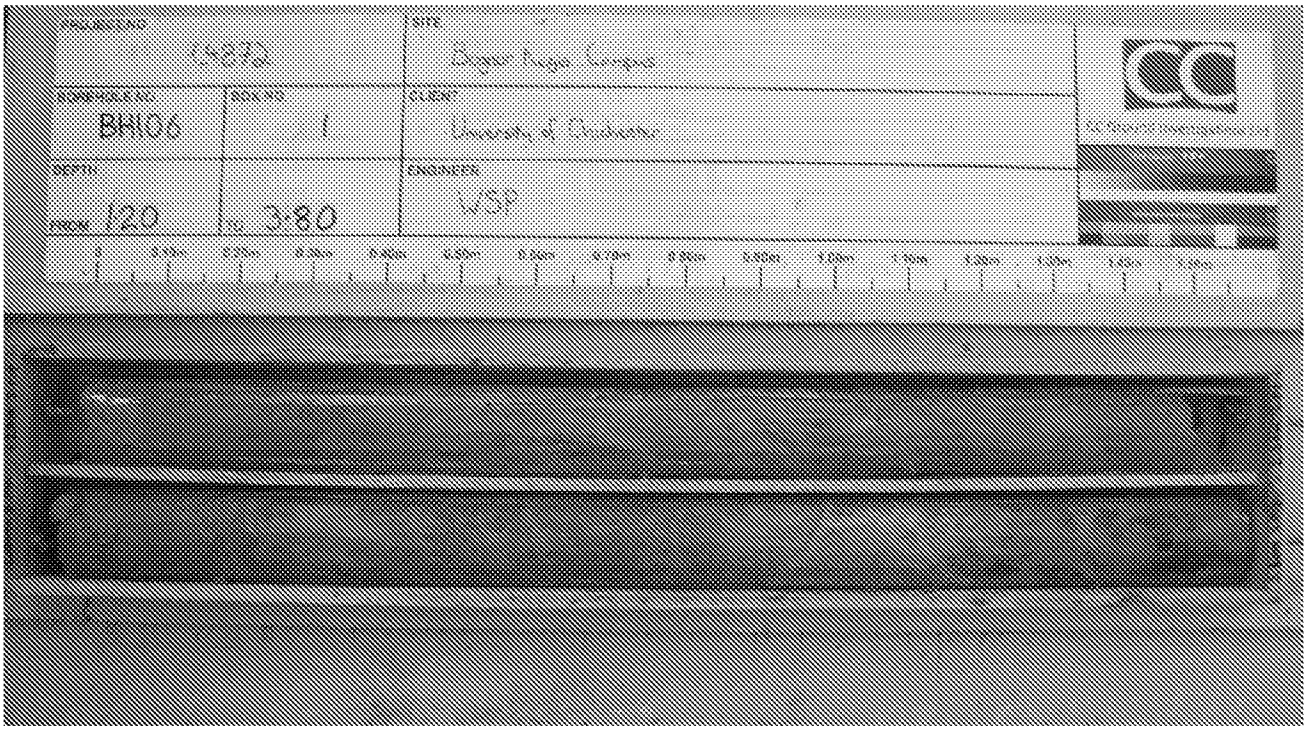
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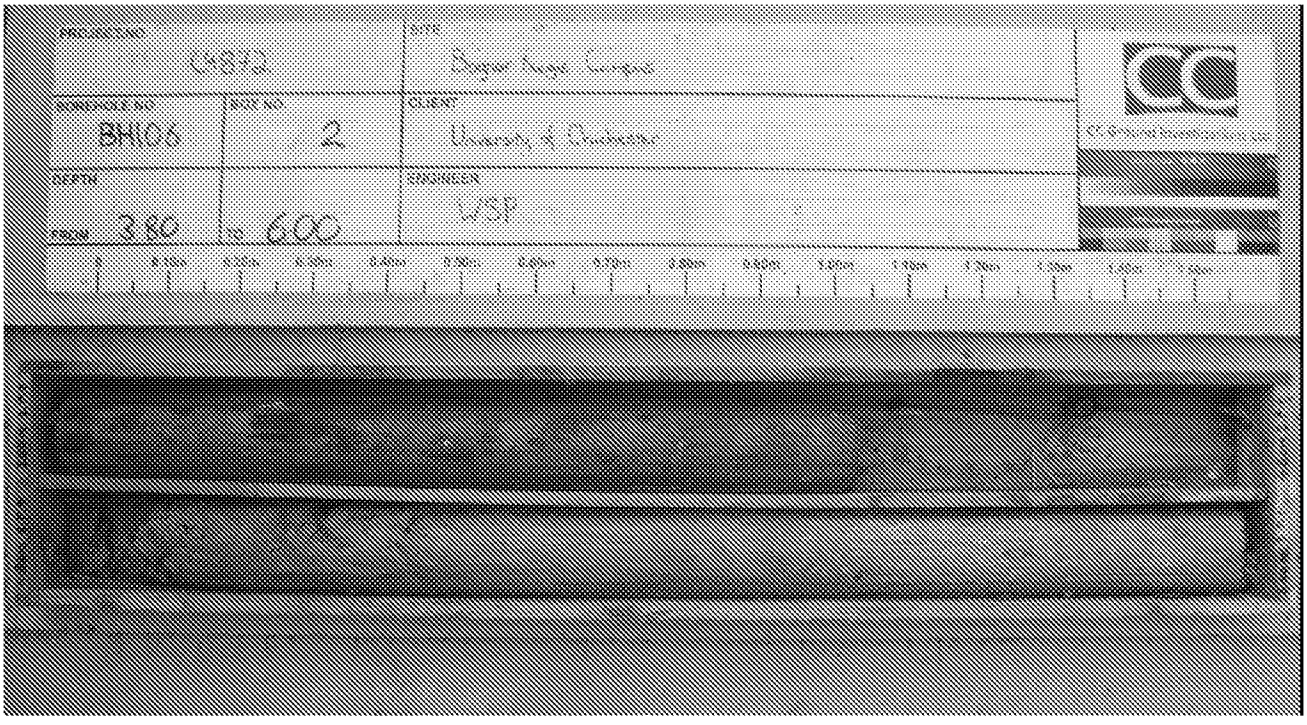
Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
17/11/2015	35.15	6.00	1.70

Borehole Photograph



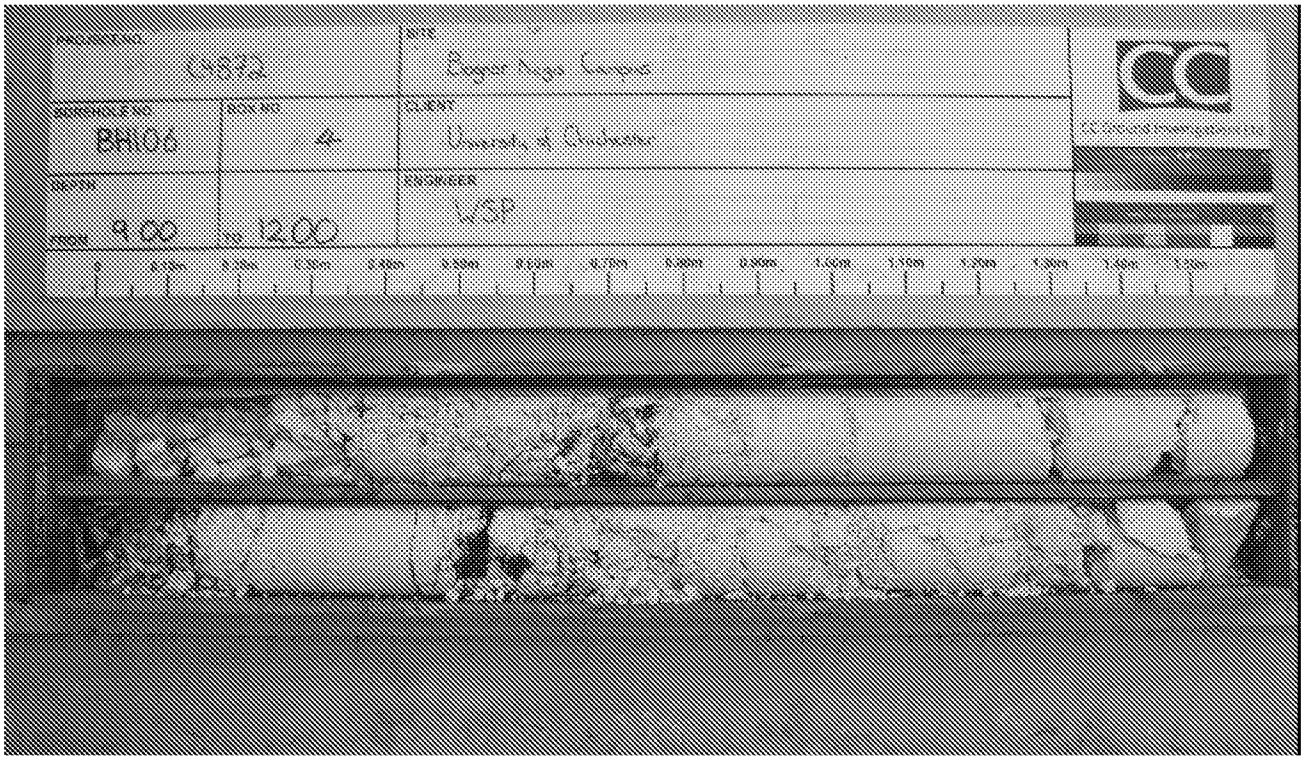


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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH106

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Borehole Photograph

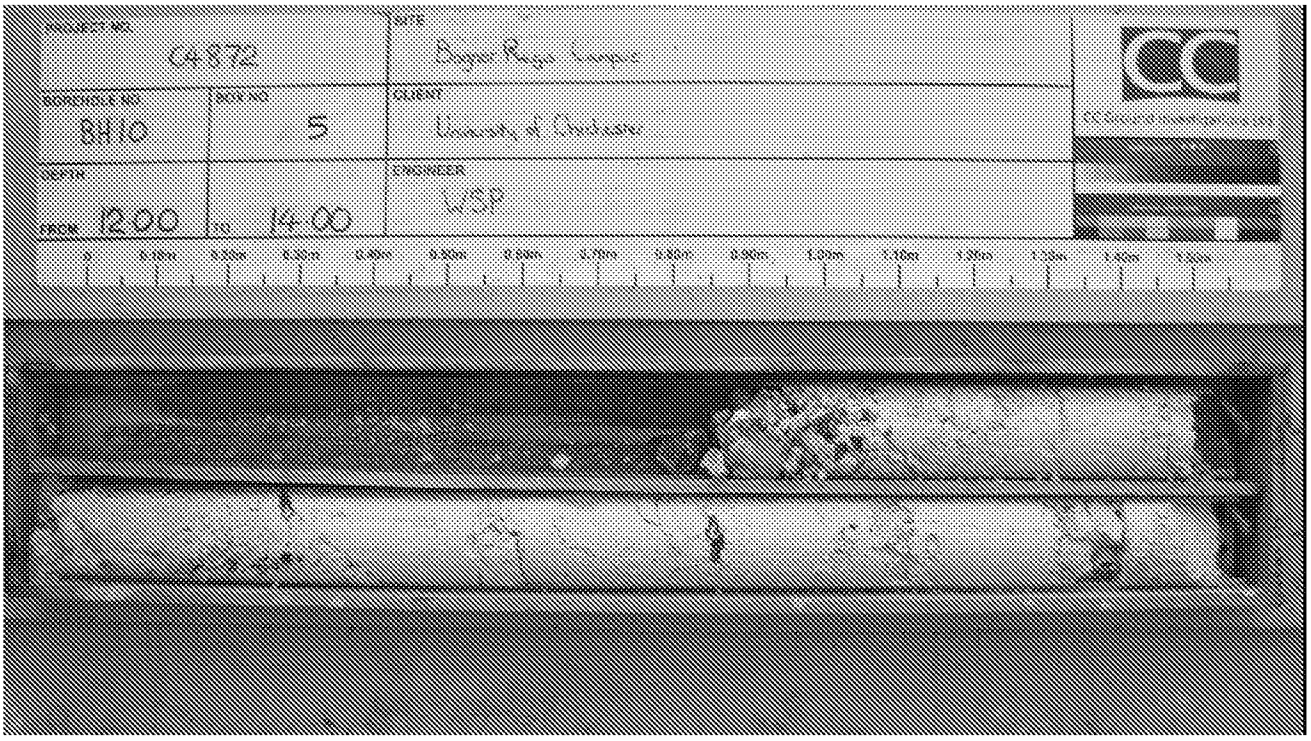




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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH106

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Borehole Photograph



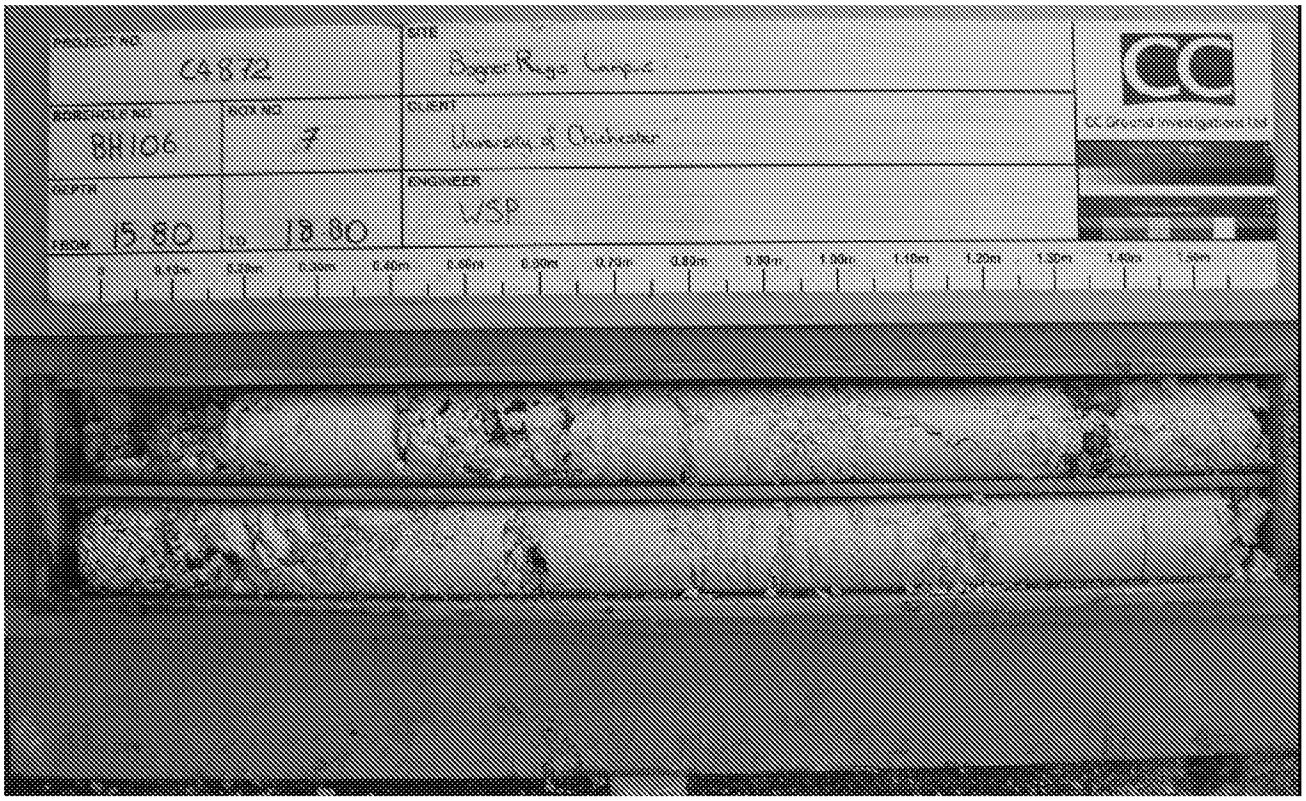


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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH106

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Borehole Photograph



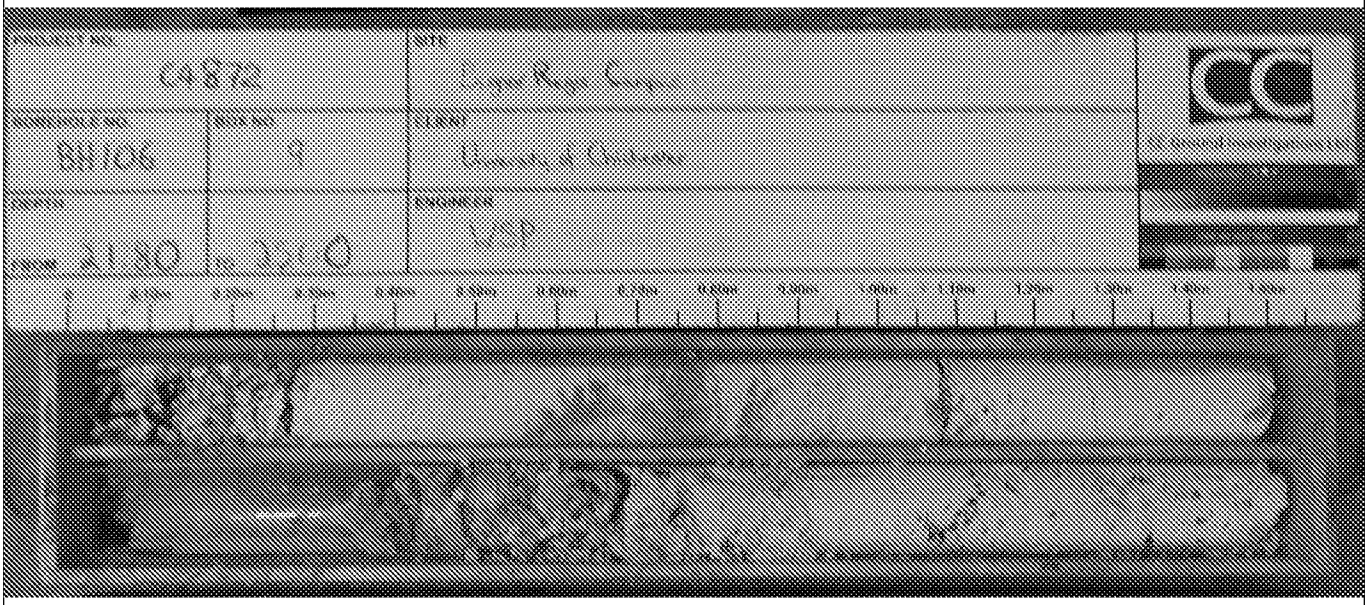


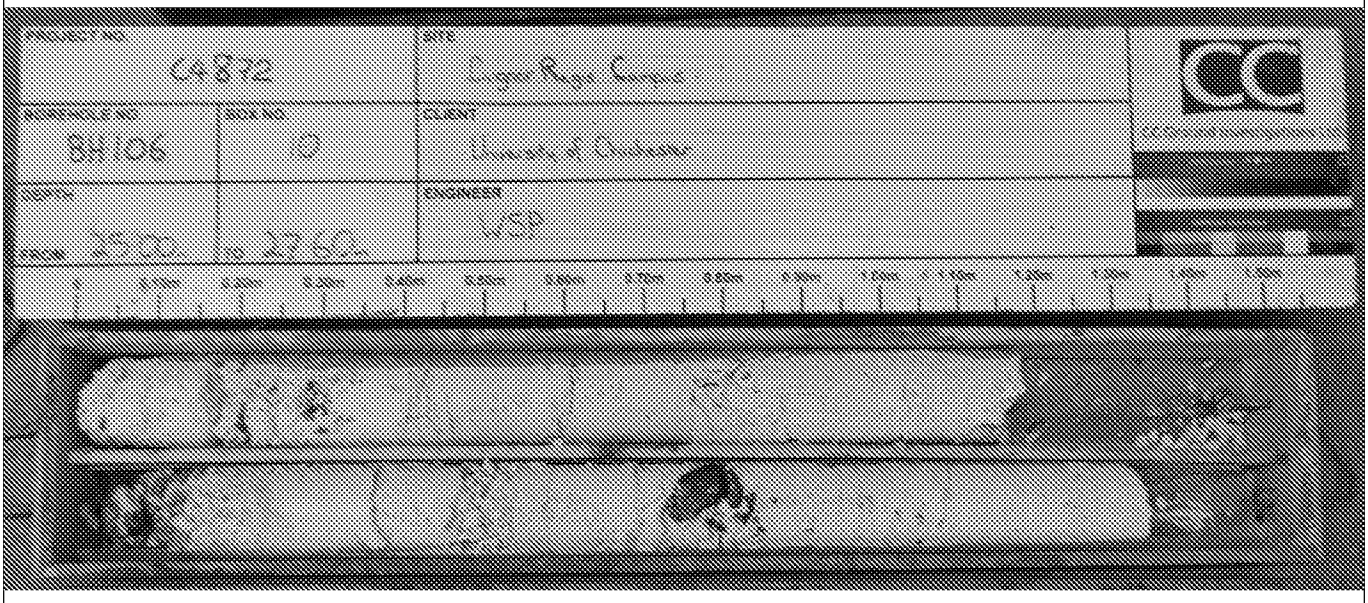
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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH106

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Borehole Photograph



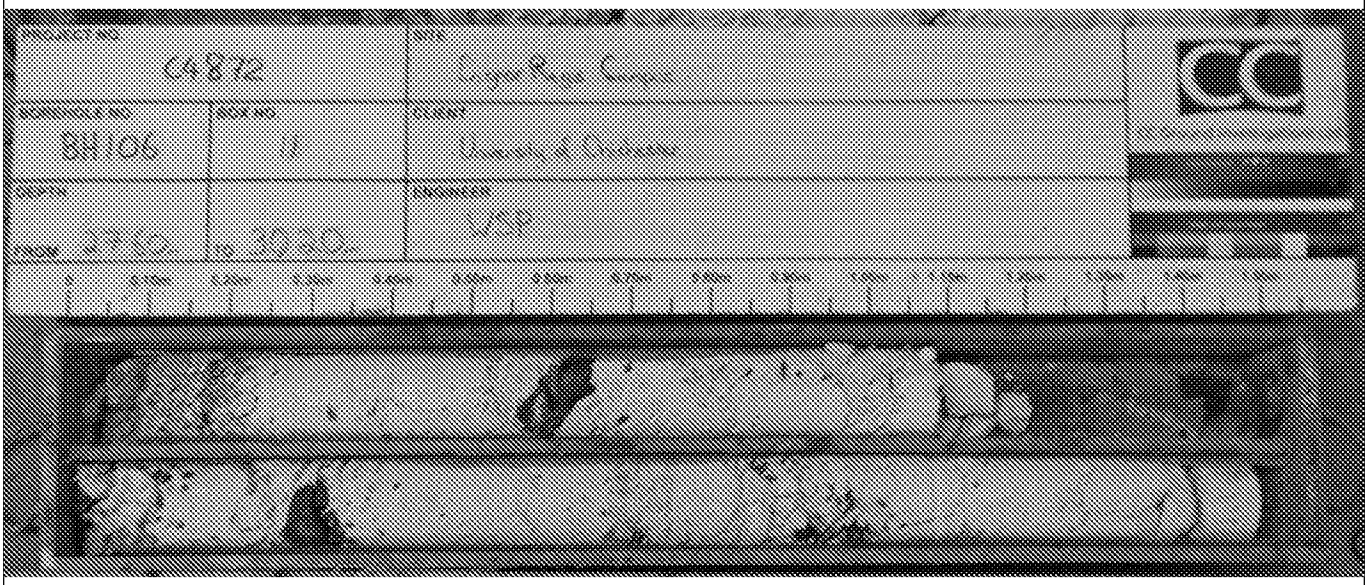


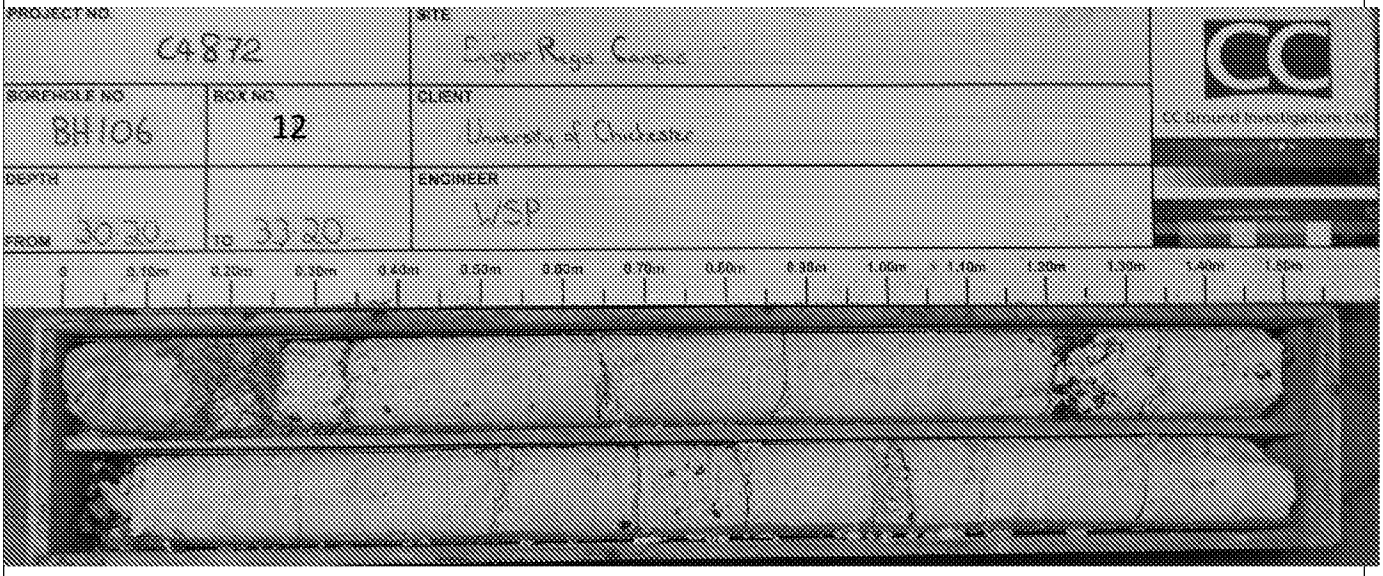
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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH106

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Borehole Photograph

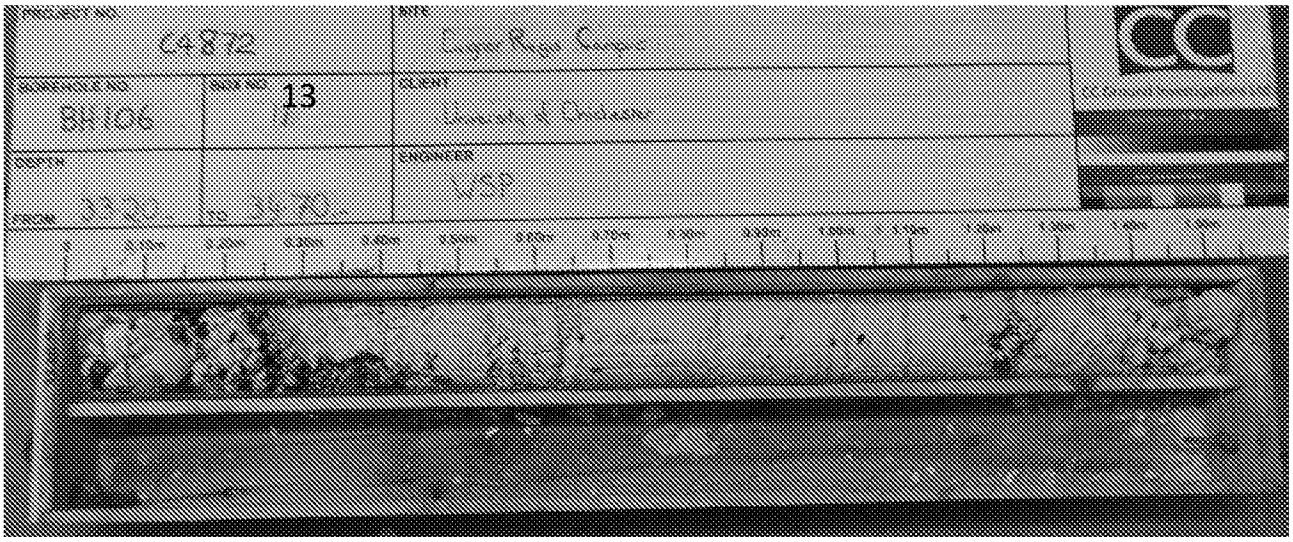




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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH106

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Borehole Photograph



Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH106

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ROTARY BOREHOLE LOG

Borehole No. **BH107**

Sheet 1 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494418 N 99623	Hole Type DS+RC
Location: Bognor Regis		Level: 1.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 09/11/2015 End: 12/11/2015	Logged By DM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.20					MADE GROUND: Grass over soft brown mottled orangish brown slightly sandy slightly gravelly silty CLAY with frequent rootlets (<1mm). Gravel is angular to sub-rounded fine to medium brick, sandstone, mudstone and siliceous material.	(0.40)		
		ES							0.40	1.51	
		B	0.50					Soft grey mottled yellowish brown and orangish brown slightly sandy silty CLAY. (Superficial Deposits)	(0.50)		
		ES	0.60						0.90	1.01	
1		B	1.00					Grey mottled orangish brown clayey sandy GRAVEL with occasional pockets of clay (<10mm). Gravel is sub-rounded to rounded fine to coarse flint. (Superficial Deposits)	(0.30)		1
		ES	1.10						1.20	0.71	
	1	B	1.20 - 2.20	S 18				Medium dense brown and reddish brown slightly silty slightly sandy GRAVEL. Gravel is sub-rounded to rounded fine to coarse of flint. (Superficial Deposits)	(1.00)		
	1	SPT	1.20 - 1.65								
2		B	2.20 - 2.50					Light greenish grey silty gravelly SAND. Gravel is sub-angular to sub-rounded fine to coarse of flint (Superficial Deposits)	2.20	-0.29	2
									(0.30)		
		SPT	2.70 - 3.15	S 35				Dense brown, reddish brown and light greenish grey silty sandy GRAVEL. Gravel is sub-rounded to rounded fine to coarse of flint. (Superficial Deposits)	2.50	-0.59	
3		B	3.00 - 3.50						(1.00)		3
		D	3.50 - 3.55					Orange brown silty slightly gravelly SAND. Gravel is sub-rounded to rounded fine to coarse of flint. (Superficial Deposits)	3.50	-1.59	
		D	3.55 - 3.60						3.55	-1.64	
		B	3.60 - 3.90						3.60	-1.69	
		D	3.90 - 4.10					Light bluish grey sandy slightly gravelly clayey SILT with rootlets (Superficial Deposits)	(0.30) 3.90	-1.99	
4		H	4.10	H 45				Brown, reddish brown and light greenish grey silty very sandy GRAVEL. Gravel is sub-rounded to rounded fine to coarse of flint. (Superficial Deposits)			4
		SPT	4.20 - 4.65	S 5							
		H	4.50	H 65				Soft to firm dark reddish brown CLAY. (Lambeth Group)	(1.10)		
		H	4.80	H 40				4.70m: Becoming mottled reddish brown. 4.80m: Becoming grey.			
		H	4.90	H 60							
5		D	5.00 - 5.15					Stiff orangish brown mottled grey and brown slightly sandy slightly gravelly silty CLAY. Gravel is sub-rounded to rounded fine to coarse of flint. (Lambeth Group)	5.00	-3.09	5
		SPT	5.20 - 6.15	S 34					5.15	-3.24	
		D	5.65					Orangish brown, reddish brown and white slightly sandy gravelly to gravelly CLAY with occasional cobbles. Gravel is sub-angular to sub-rounded fine to coarse of chalk and flint. Cobbles are sub-angular to sub-rounded of chalk.	(0.45)		
								(continued on next sheet)	5.60	-3.69	
6									(0.60)		6

REMARKS:

EQUIPMENT: Hand digging tools. Fraste PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-15.50m. Water flush rotary coring using T6-146 coring barrel: 15.50-35.00m.
GROUNDWATER: Standing at 1.50m following sample run 1.20-2.70m. Rising and settling at 1.30m following five minute monitoring period.
CASING: 160mm diameter casing to 16.00m.
INSTALLATION: Bentonite pellet seal: 34.75-35.00m. 50mm ID HDPE slotted pipe with washed gravel response zone: 6.75-34.75m. 50mm ID HDPE plain pipe with bentonite pellet seal: 0.20-6.75m. Flush 150mm steel cover set in concrete 0.00-0.20m Gas valve fitted.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)
09/11/15	1.50	Nil	1.30

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
09/11/2015	5.10	4.20	2.20
10/11/2015	5.10	4.20	1.50

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ROTARY BOREHOLE LOG

Borehole No. **BH107**

Sheet 2 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494418 N 99623	Hole Type DS+RC
Location: Bognor Regis		Level: 1.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 09/11/2015 End: 12/11/2015	Logged By DM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								Structureless CHALK composed of firm to stiff white mottled light orange brown slightly sandy slightly gravelly to gravelly SILT. Clasts are extremely weak low density. (White Chalk Subgroup Grade Dm) *(continued from previous sheet)*	6.20	-4.29	
								Structureless CHALK composed of white mottled light yellow and light orangish brown silty to very silty very sandy angular to sub-angular fine to coarse GRAVEL with occasional sub-angular cobbles. Flints are dark brown to very dark brown sub-rounded to rounded coarse gravel size nodular (White Chalk Subgroup Grade Dc)	(1.30)		
7		D	7.00								7
		SPT	7.20 - 7.65	S 16					7.50	-5.59	
8								Extremely weak low density locally very weak low to medium density white CHALK. Discontinuities are randomly orientated extremely closely spaced rough undulating and stepped tight to moderately wide with comminuted silt infill within open to moderately wide discontinuities. Flints are very dark brown coarse gravel size nodular medium to widely spaced. (White Chalk Subgroup Grade C4/5) 7.70m: Light orangish brown staining with slight sand smear along discontinuity. 8.15m: Soft light brown clayey silt (<5mm) around very dark brown with light grey rinded nodular flint.			8
		D	8.40								
		SPT	8.60 - 9.05	S 42							
9											9
		D	9.70					9.70m: <10mm comminuted silt infill around very dark brown / black nodular flint.			
		SPT	9.90 - 10.35	S 17				9.80m: <10mm comminuted silt infill around very dark brown / black nodular flint.			
10								10.20m: Light grey marl lens and some orange brown discolouration along discontinuity.			10
11		D	11.10								11
		SPT	11.30 - 11.75	S 49				11.50-11.70m: Very closely to closely spaced coarse gravel size very dark brown / black nodular flints.	(8.00)		
12								12.20m: Very dark brown / black with light grey / white rinded coarse gravel size flint. 12.20m: Flints becoming very widely spaced.			12
		D	12.60								
		SPT	12.70 - 13.15	S 22							
13											13

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

Borehole No. **BH107**

Sheet 3 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494418 N 99623	Hole Type DS+RC
Location: Bognor Regis		Level: 1.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 09/11/2015 End: 12/11/2015	Logged By DM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
14		D SPT	14.00 14.10 - 14.55	S 31				Extremely weak low density locally very weak low to medium density white CHALK. Discontinuities are randomly orientated extremely closely spaced rough undulating and stepped tight to moderately wide with comminuted silt infill within open to moderately wide discontinuities. Flints are very dark brown coarse gravel size nodular medium to widely spaced. (White Chalk Subgroup Grade C4/5) *(continued from previous sheet)*			
15		D C SPT	15.40 15.50 - 17.00 15.50 - 15.74	S*167		100% 57% 42%		15.40m: Very dark brown / black nodular flint (recovered as fine to coarse gravel size fragments - drilling induced fracturing).	15.50	-13.59	
16		C CS	16.20 - 17.00 16.40 - 16.59					Very weak medium density white CHALK with medium spaced flints. Bedding discontinuities are sub-horizontal closely to medium spaced (110/210/380) rough undulating tight to partly open predominantly clean with occasional silt smear. Flints are very dark brown with light grey rind coarse gravel size to cobble size nodular. (White Chalk Subgroup Grade B2/3). 15.50-15.95m: Non-intact. Disturbed by SPT. 16.10-16.22m: Locally discontinuities are extremely to very closely spaced rough stepped and undulating with comminuted silt infill >3mm around coarse gravel size flint. (Locally Grade C5) 16.35m: Light brown discolouration along 30° discontinuity. 16.85m: Light grey brown discolouration along sub-horizontal discontinuity.	(1.98)		
17		D C	16.95 - 17.00 17.00 - 18.50			100% 66% 27%		17.00-17.10m: Locally extremely weak low density with extremely closely spaced thin marl laminations of light grey marl. 17.00m-17.48m: Sub-vertical to 80° rough undulating and stepped closed discontinuity. From 17.30m: Discontinuity becoming tight with light brown discolouration along surface. 17.30m-17.35m: White calcite mineralisation (<2mm thick) along discontinuity.	17.48 17.70	-15.57 -15.79	
18		CS D	17.70 - 17.90 18.19 - 18.26								
19		C CPT CS	18.50 - 20.00 18.50 - 18.87 18.97 - 19.14	S*68		93% 21% 7%		Extremely weak to very weak low to medium density white CHALK with extremely closely spaced thin light grey marl laminations and very closely spaced fossil shell fragments. Discontinuities are sub-horizontal very closely spaced (50/150) rough undulating tight to moderately wide with light grey silt infill (degraded marl) <10mm. (White Chalk Subgroup Grade C3/4) 17.48m: White calcite mineralisation (<2mm thick) along sub-horizontal discontinuity.	(2.82)		
20		D C	19.80 - 19.85 20.00 - 21.50			100% 43% 7%		Very weak medium density white CHALK with very closely spaced very light grey marly lenses. Bedding discontinuities are sub-horizontal closely to medium spaced (80/210/380) rough undulating predominantly tight clean with occasional silt smear. Flints are very dark brown with white rind nodular recovered as medium to coarse gravel size and cobble size fragments. (White Chalk Subgroup Grade B2/3) 17.90-18.00m: Discontinuities are sub-horizontal to sub-vertical very closely spaced (30/40/50) rough stepped tight clean (probably drilling induced). 18.20-19.65m: Sub-vertical rough undulating closed to			

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
10/11/2015	15.50	15.10	1.50
11/11/2015	15.50	15.10	1.50

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ROTARY BOREHOLE LOG

Borehole No. **BH107**

Sheet 4 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494418 N 99623	Hole Type DS+RC
Location: Bognor Regis		Level: 1.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 09/11/2015 End: 12/11/2015	Logged By DM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		CS	20.52 - 20.67					tight discontinuity with light brown and dark brown mottled discolouration along joint surface. 18.50-18.95m: Non-intact. Disturbed by SPT. 18.85-19.00m: Locally extremely weak low density with comminuted infill (<10mm) around flint cobble. 19.40-19.70m: Locally very weak with extremely closely to very closely spaced randomly orientated discontinuities with some comminuted silt infill (10mm) around flint cobble. (Locally grade C4/5) 19.80-20.00m: Light yellow brown discolouration along sub-horizontal discontinuities. 20.00-20.15m: Locally extremely weak to very weak around coarse gravel size fragments of flint. Discontinuities are randomly orientated extremely closely to very closely spaced tight with silt smear and occasional dark brown discolouration. 20.25-20.52m: 70° rough to smooth undulating discontinuity with light grey and dark brown surface discolouration. 20.40m: Orange brown discolouration along sub-horizontal discontinuity. 20.51-20.52m: Orange brown discolouration along sub-horizontal discontinuity.	20.52	-18.61	
21		D	21.45 - 21.50	S*67		100%			(1.28)		21
		C	21.50 - 23.00			39%					
		CPT	21.50 - 21.88			26%					
		CS	21.80 - 22.10						21.80	-19.89	
22		D	22.30								22
23		C	23.00 - 24.50			100%		Very weak medium density locally extremely weak to very weak low to medium density preferentially along bedding discontinuities white CHALK with close to medium spaced thin marl laminations. Bedding discontinuities are sub-horizontal closely spaced (90/120/200) rough undulating tight to partly open with some comminuted infill (<3mm). (White Chalk Subgroup Grade B3) *(continued from previous sheet)* 20.68-21.10m: Sub-vertical to 80° rough undulating discontinuity with light brown staining. 21.00-21.10m: 45° rough striated discontinuity with light grey and dark brown staining. 21.20-21.35m: Locally extremely weak low density with extremely closely spaced thin marl laminations. Discontinuities are randomly orientated extremely closely spaced. 21.35m: Dark orangish brown staining. 21.50-21.80m: Non-intact. Disturbed by SPT.	(2.85)		23
		CS	23.10 - 23.30			65%					
		D	23.40			25%					
24		D	24.40								24
		C	24.50 - 26.00	S 31		87%			24.65	-22.74	
		CPT	24.50 - 24.95			8%					
						0%					
25		D	25.00					Very weak medium density white CHALK with closely spaced very light grey thin to thick marl lenses and medium spaced flints. Bedding discontinuities are sub-horizontal predominantly closely spaced (60/120/150) rough undulating partly open with silt smear. Flints are very dark brown with white rind <50mm thick nodular. (White Chalk Subgroup Grade B3) 21.80-22.15m: Medium spaced discontinuities. 22.65-23.00m: Sub-vertical rough undulating and stepped discontinuity with slight silt smear. Preferentially very weak with extremely closely to very closely spaced discontinuities along joint. 23.30-23.75m: Closely spaced very dark brown flint bands (<30mm thick). 24.15m: Extremely closely spaced discontinuities around flint. 24.65-25.00m: Non-intact. Disturbed by SPT.	(1.35)		25
26		D	25.95 - 26.00			100%			26.00	-24.09	26
		C	26.00 - 27.50			75%					
		CS	26.40 - 26.71			54%					
27		C	27.50 - 29.00	S*94		97%		Very weak medium density white CHALK with closely spaced very light grey thin to thick marl lenses and medium spaced flints. Bedding discontinuities are sub-horizontal predominantly closely spaced (60/100/200) rough undulating. (White Chalk Subgroup Probable Grade B3) 25.40-25.90m: Sub-vertical rough undulating discontinuity with extremely closely spaced dark brown specs.	(1.50)		27
		CPT	27.50 - 27.81			45%			27.50	-25.59	
						21%		Very weak medium density white CHALK with very closely to closely spaced thin light grey laminations and			

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
11/11/2015	27.50	16.00	3.40
12/11/2015	27.50	16.00	1.50

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ROTARY BOREHOLE LOG

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Borehole No. **BH107**

Sheet 5 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494418 N 99623	Hole Type DS+RC
Location: Bognor Regis		Level: 1.91mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 09/11/2015 End: 12/11/2015	Logged By DM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								lenses. Discontinuities are closely to medium spaced (65/280/350) rough undulating wide (<40mm) infilled with slightly silty slightly sandy angular to sub-angular fine to coarse gravel of chalk and flint. (White Chalk Subgroup GradeC2/3)	(0.67)		
28								26.00-26.10m: Non-intact. Recovered as slightly silty sandy fine to coarse gravel of chalk and flint (probable drilling induced disturbance).	28.17	-26.26	28
		B	28.70					26.50-26.75m: 45° rough undulating discontinuity with very pale brown silt smear. Preferentially fractured (extremely closely spaced) around joint.	(1.09)		
		D	28.90					26.80m: Becoming Grade A2/3. Discontinuities becoming tight to partly open clean.			
29		C	29.00 - 30.50			100% 97% 75%		27.50-27.58m: Drilling disturbed; chalk cobble recovered. 27.58-27.76m: Band of sub-angular and sub-rounded fine to coarse gravel and cobbles of flint. Very weak medium density white with occasional orangish brown staining CHALK. Discontinuities are very closely and closely spaced spaced (20/40/80) infilled with (1/2/5) white comminuted chalk, lightly orangish brown stained. (White Chalk Subgroup Grade C4-5) *(continued from previous sheet)*	29.26	-27.35	29
		CS	29.75 - 30.10					28.12-28.17m: Band of structureless grade Dc chalk.			
30								Weak medium density white CHALK. Discontinuities are very closely and closely spaced (NI/60/130) locally infilled (0/3/20) with white comminuted chalk. (White Chalk Subgroup Grade B2-3)			30
		C	30.50 - 32.00	S*107		97%		28.38-28.40m: Band of sub-angular coarse flint gravel.			
		CPT	30.50 - 30.79			73% 58%					
		D	30.90					Very weak medium density white CHALK. Discontinuities are closely and medium spaced locally extremely closely and very closely spaced (10/120/340) rarely locally infilled (0/0/2) with white comminuted chalk. (White Chalk Subgroup Grade A2-3)			
31								30.22-30.35m: Band of sub-rounded fine and medium flint gravel.			31
		CS	31.30 - 31.56					30.50-30.55m: Band of sub-rounded fine and medium flint gravel.			
		B	31.56					30.60-30.80m: sub-vertical to 60° undulating rough fracture.			
								31.18-31.30m: Band of low and medium density grade B4-5 chalk.			
32		C	32.00 - 33.50			87% 67% 39%		31.60-31.80m: With occasional sub-angular and sub-rounded fine to coarse gravel sized light grey staining.	(5.74)		32
		D	32.50					31.85-31.90m: Band of sub-angular and sub-rounded medium and coarse flint gravel.			
								32.10-32.20m: Band of sub-angular and sub-rounded fine to coarse flint gravel.			
33		CS	32.97 - 33.15					32.68-32.75m: Drilling disturbed; recovered non intact as sub-angular fine to coarse gravel sized fragments.			33
		B	33.18					33.20-33.25m: Band of angular and sub-angular fine to coarse flint gravel.			
		C	33.50 - 35.00	S*103		92%		33.38-33.50m: Band of angular and sub-angular fine to coarse flint gravel.			
		CPT	33.50 - 33.79			57% 51%		33.55-33.60m: Band of sub-angular and sub-rounded fine to coarse flint gravel.			
								33.75-33.80m: Band of sub-angular and sub-rounded fine to coarse flint gravel.			
34											34
		CS	34.20 - 34.53					34.12-34.21m: Band of medium density grade B5 chalk.			
		B	34.67					34.62-34.66m: sub-rounded coarse gravel sized flint nodule.			
		D	34.90					34.82-35.00m: 2 no. sub-vertical very closely spaced parallel undulating rough Discontinuities.	35.00	-33.09	
35								Borehole completed at 35.00m			35

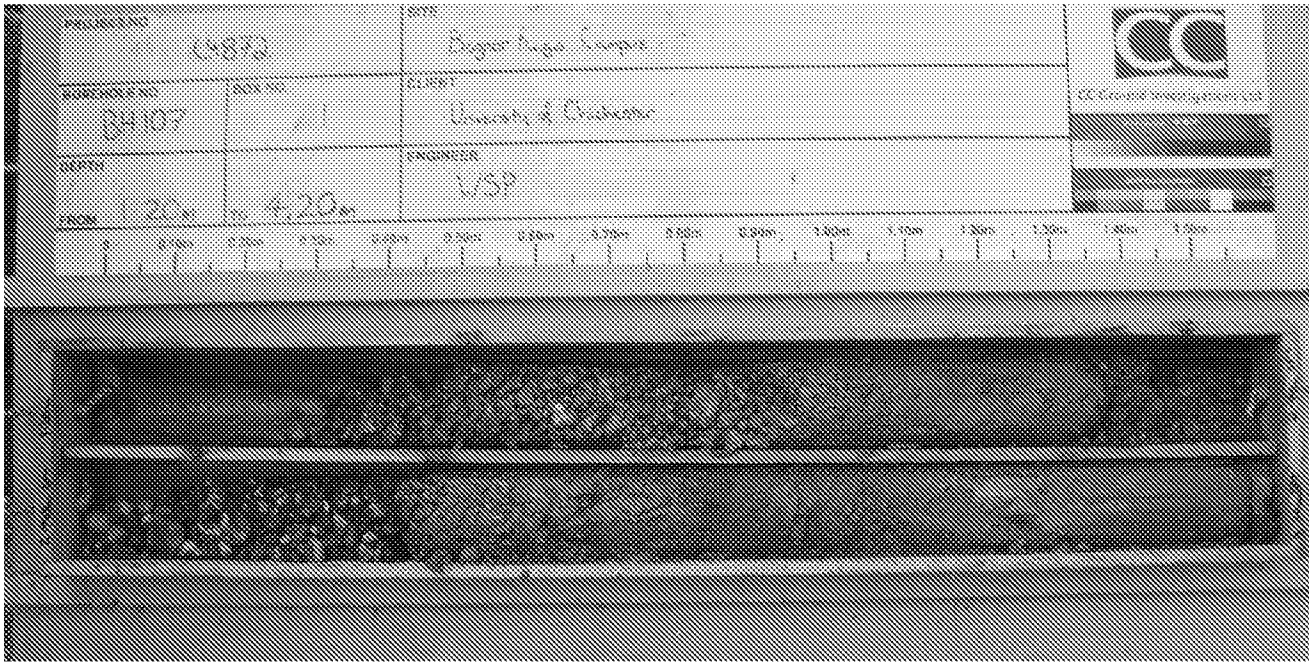
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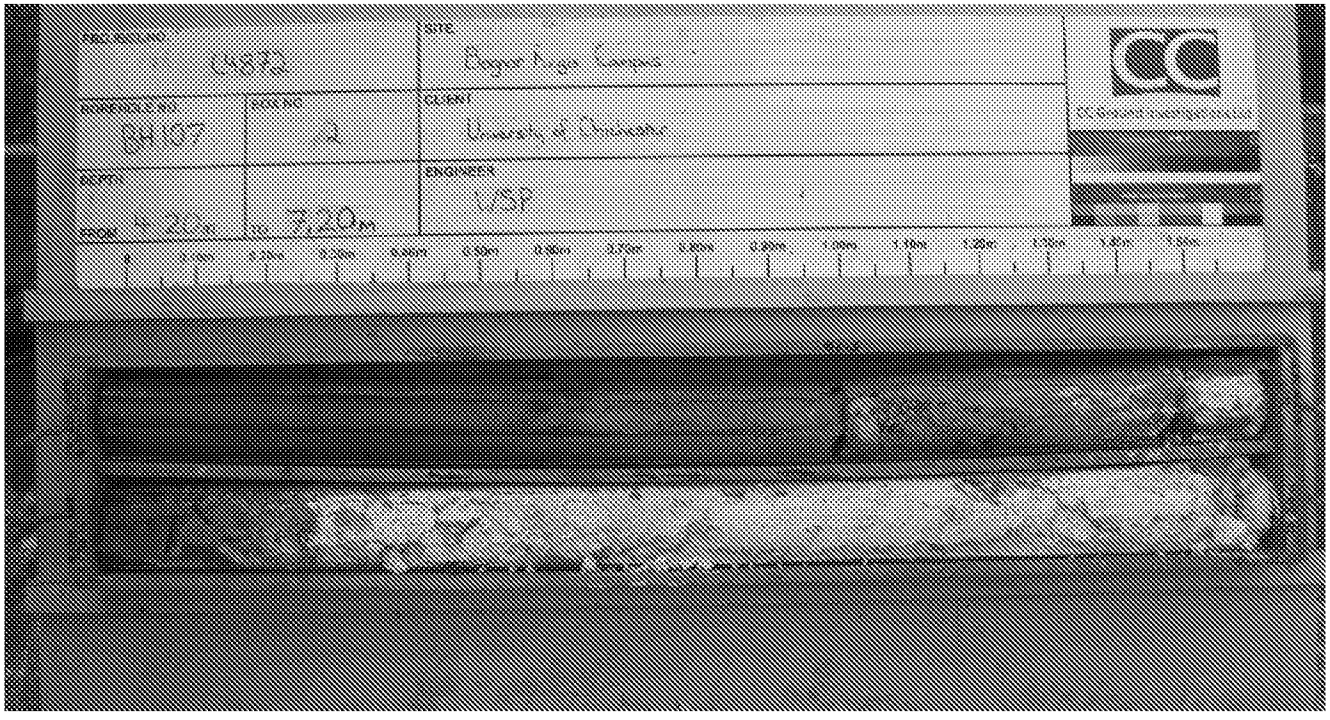
Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
12/11/2015	35.00	16.00	3.70

Borehole Photograph





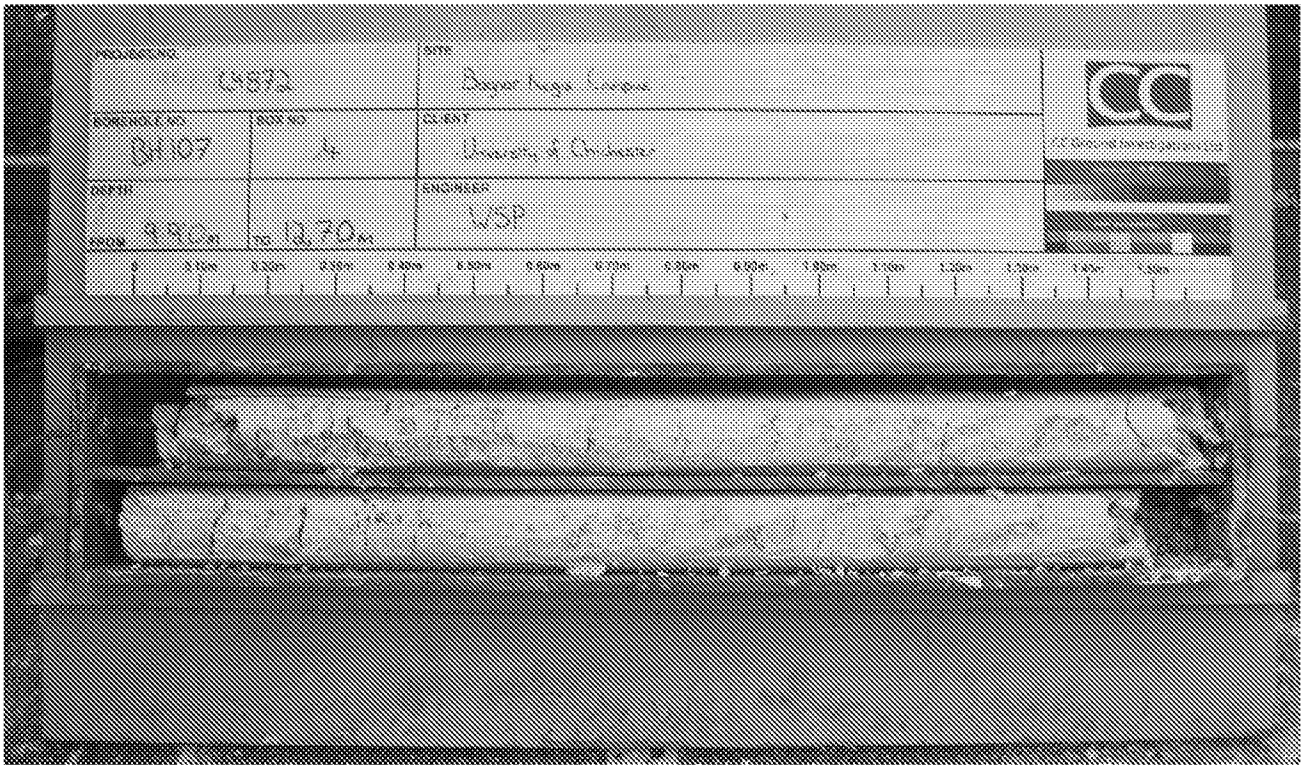
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH107

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Borehole Photograph



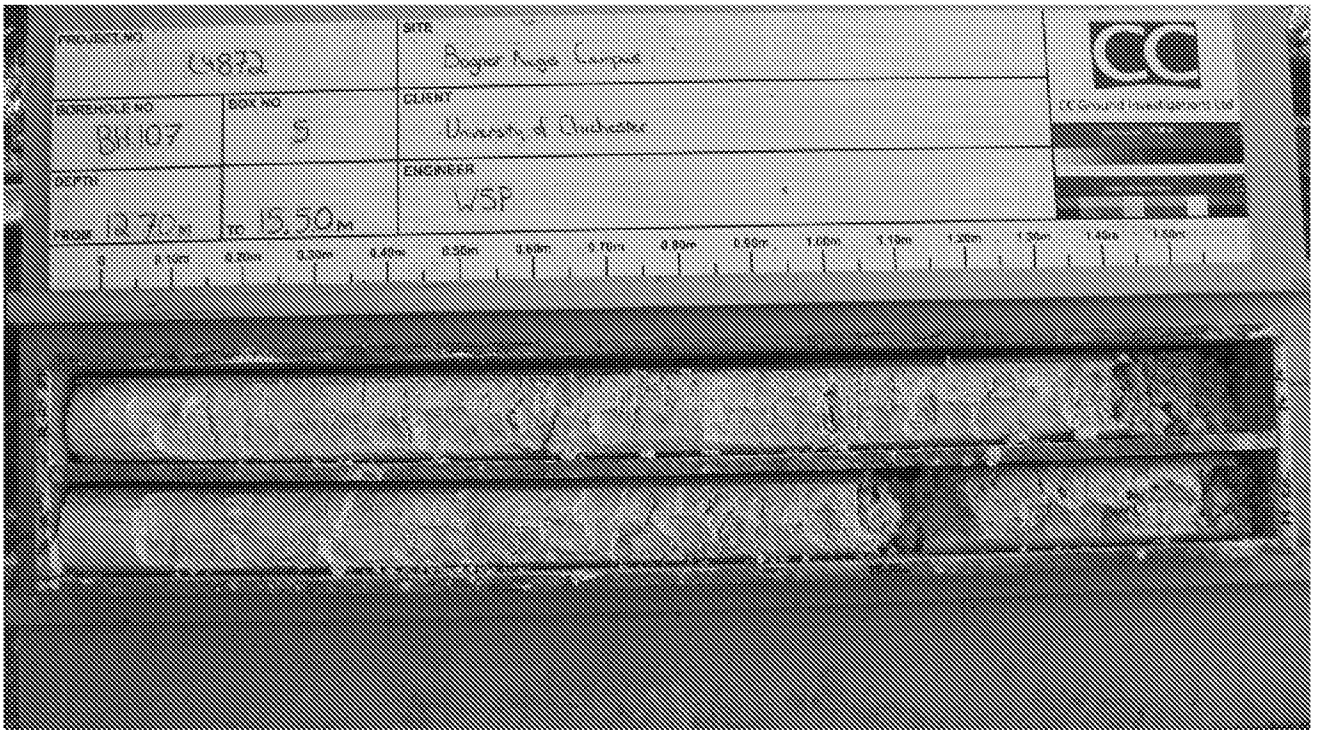


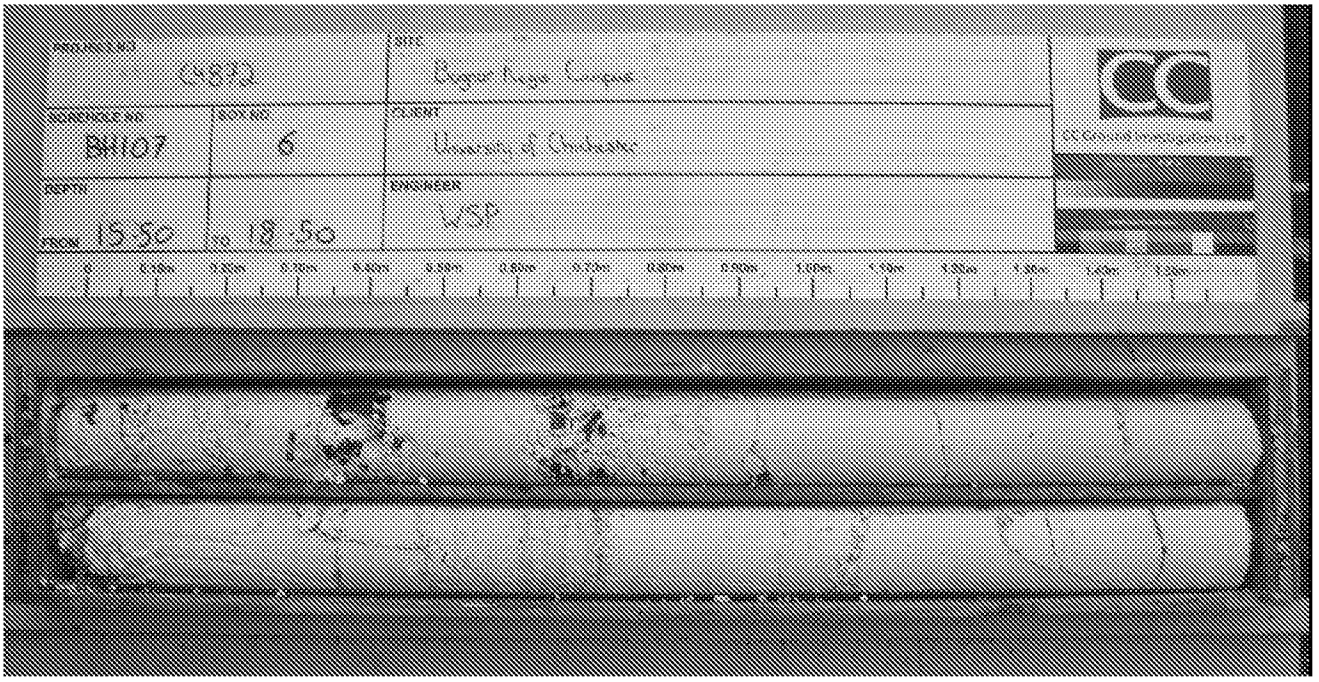
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH107

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Borehole Photograph



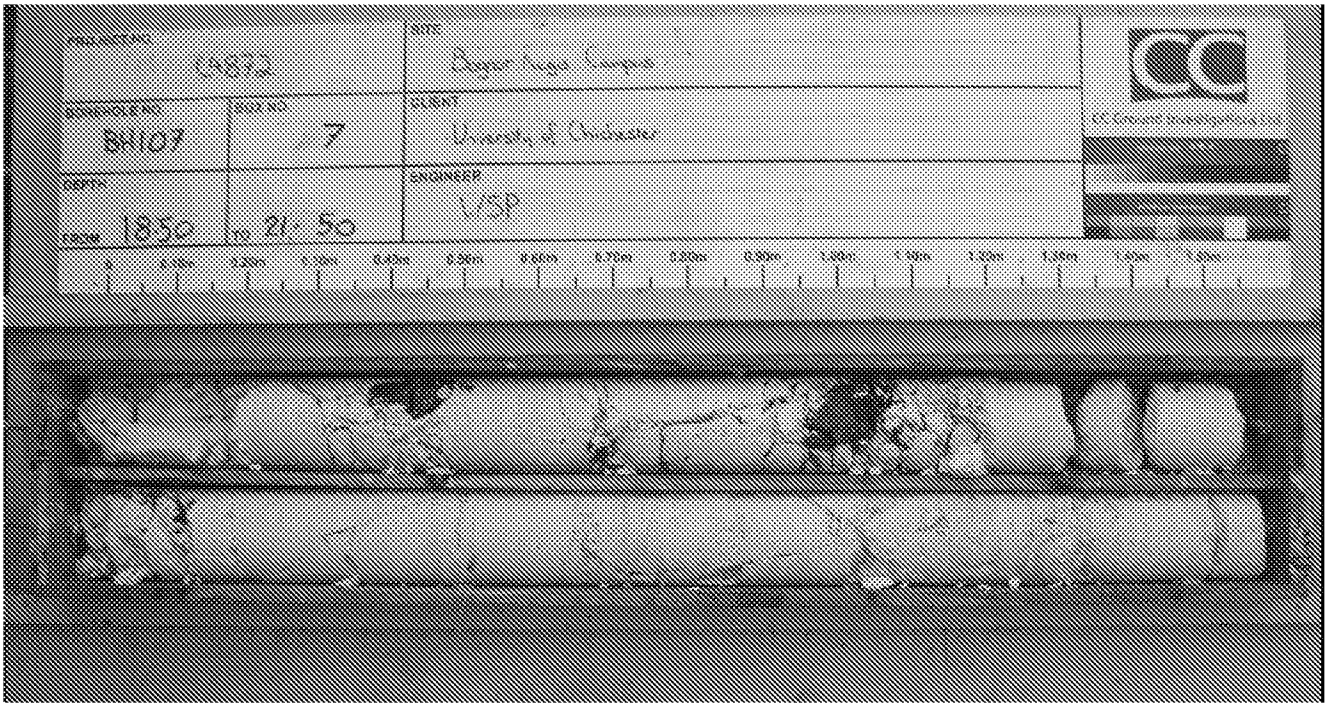


Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH107

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Borehole Photograph



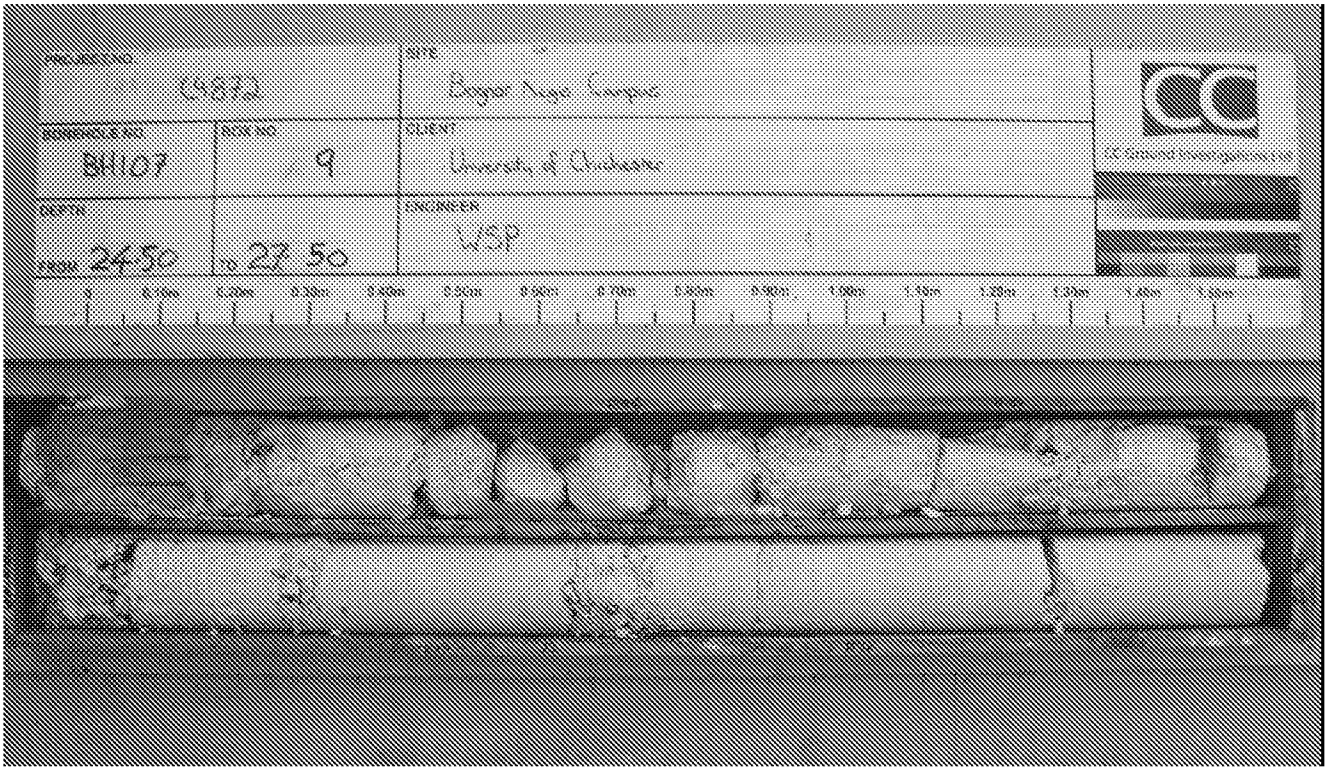


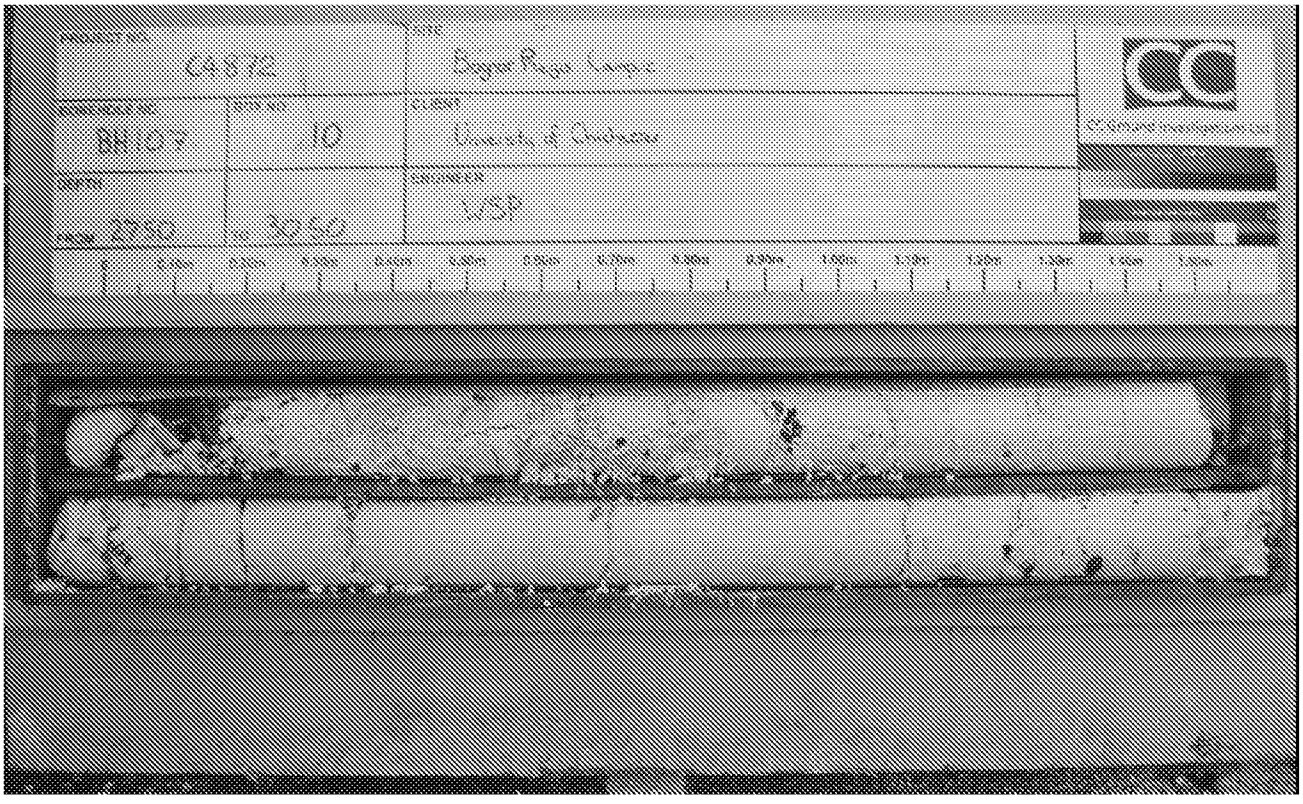
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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH107

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Borehole Photograph



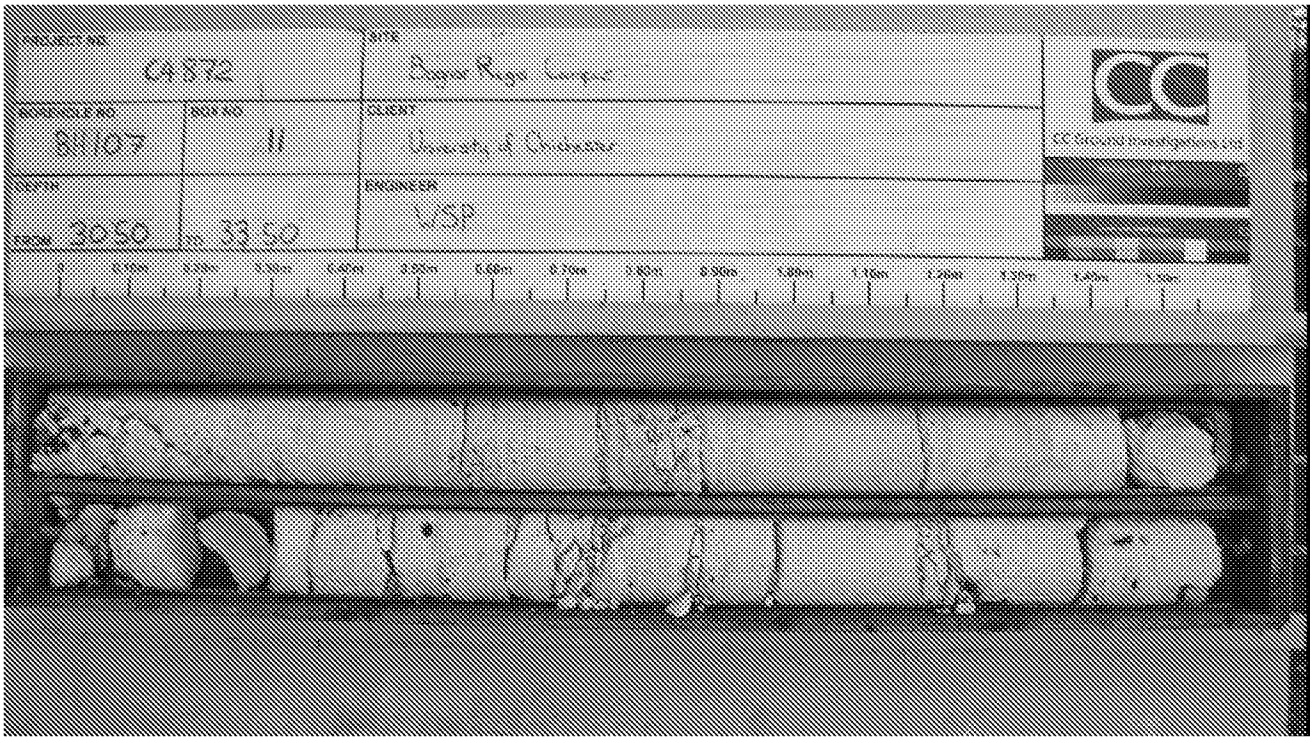


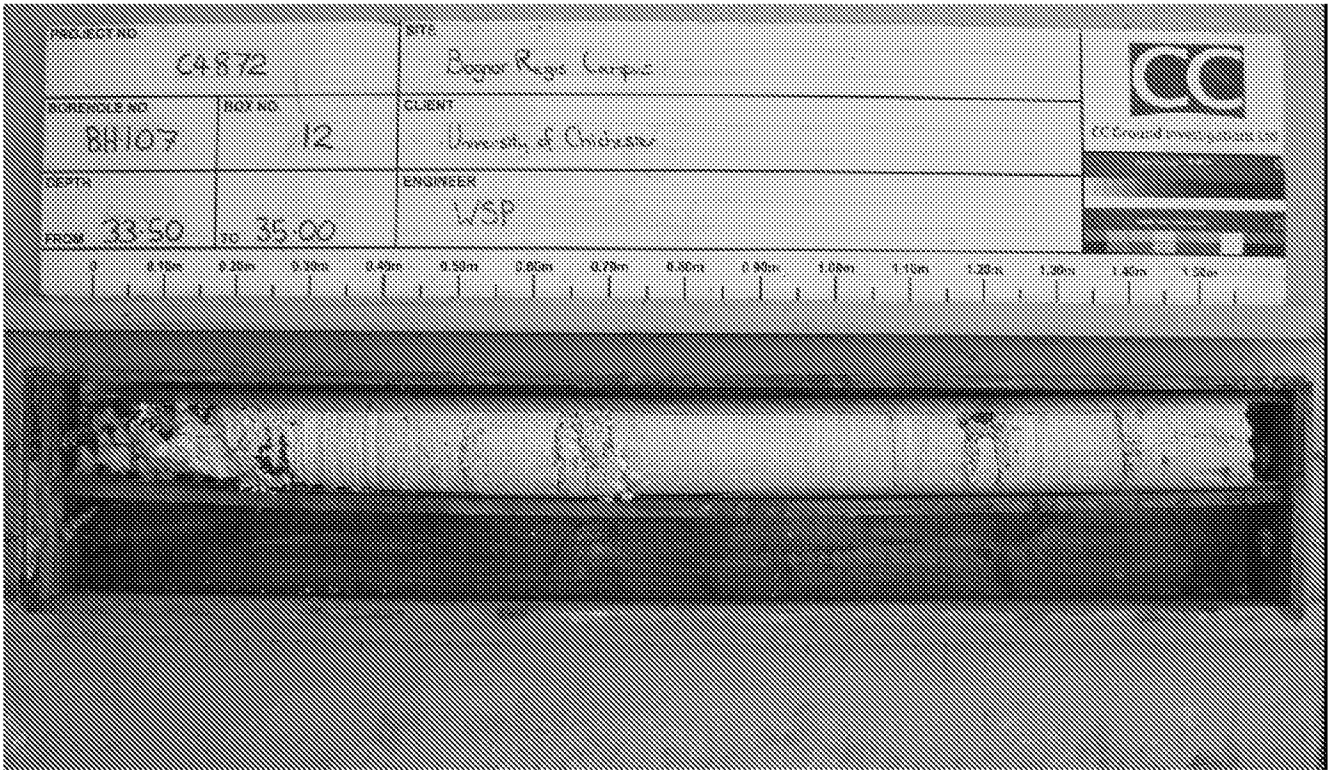
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH107

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Borehole Photograph





Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH107

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ROTARY BOREHOLE LOG

Borehole No. **BH108**

Sheet 1 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494417 N 99666	Hole Type DS+RC
Location: Bognor Regis		Level: 1.36mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 02/11/2015 End: 09/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.20					MADE GROUND: Grass over soft brown mottled yellowish brown, orangish brown and grey slightly sandy slightly gravelly silty CLAY with frequent rootlets (<1mm). Gravel is angular to sub-rounded fine to coarse brick and siliceous material.	0.10	1.26	
		ES	0.40						(0.30)		
		B	0.50						0.40	0.96	
1		B	1.00					Soft becoming firm yellowish brown mottled orangish brown and grey slightly gravelly silty CLAY with occasional rootlets (<1mm). Gravel is angular to sub-rounded fine to coarse siliceous material. (Superficial Deposits)			1
	▼1.1	UT100	1.20 - 1.65					Soft grey mottled orangish brown and yellowish brown slightly sandy silty CLAY. (Superficial Deposits) 0.40-1.00m: Locally firm.	(1.35)		
		D	1.65 - 1.75						1.75	-0.39	
2		D	2.00	H 14				Very soft grey mottled black slightly sandy silty CLAY. (Superficial Deposits) 1.90-4.00m: Sand absent.			2
		H						2.20-2.70m: Frequent black partially decomposed roots and rootlets (<3mm).			
		SPT	2.50 - 2.95	S 1							
3									(2.25)		3
		D	3.50	H 12							
		H									
4		UT100	4.00 - 4.45						4.00	-2.64	4
		D	4.45 - 4.55					Very soft to soft grey slightly sandy locally sandy silty CLAY. (Superficial Deposits)			
								4.80-6.40m: Occasional shell fragments (<50mm).			
5		D	5.00	H 13							5
		H									
		SPT	5.50 - 5.95	S 5							
6											6

DRAFT

REMARKS:

EQUIPMENT: Hand digging tools. Fraste PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-15.70m. Waterflush rotary core drilled (146mm diam) 15.70-34.40m.
GROUNDWATER: Water seepage at 1.20m. No rise recorded.
CASING: SW casing to 15.70m.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 10.00-34.40m, plain pipe with washed gravel response zone: 9.90-10.00m, and bentonite pellet seal: 0.30-9.90m, flush 150mm steel cover set in concrete 0.00-0.30m. Gas valve fitted.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)
03/11/15	1.20		1.20

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

Borehole No. **BH108**

Sheet 2 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494417 N 99666	Hole Type DS+RC
Location: Bognor Regis		Level: 1.36mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 02/11/2015 End: 09/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								Very soft to soft grey slightly sandy locally sandy silty CLAY. (Superficial Deposits) *(continued from previous sheet)*	(4.40)		
		D	6.30					6.40-7.00m: Limited recovery.			
7		SPT	7.00 - 7.45	S 2							7
								7.40-7.80m: Occasional wood fragments (<20mm).			
								7.80-8.40m: Frequent wood fragments (<50mm).			
8		D	8.00								8
								8.20-8.40m: Slightly gravelly. Gravel is angular to sub-rounded fine to coarse flint and charcoal.	8.40	-7.04	
		SPT	8.50 - 8.95	S 6				Structureless CHALK composed of yellowish brown mottled grey and white slightly sandy gravelly SILT. Gravel is sub-angular to sub-rounded fine to coarse, very weak, low density chalk. (White Chalk Subgroup Grade Dm)	(0.40)		
									8.80	-7.44	
9								Structureless CHALK composed of white mottled grey slightly sandy silty GRAVEL with a strong sulphurous odour. Gravel is sub-angular to sub-rounded fine to coarse, very weak, low density chalk. (White Chalk Subgroup Grade Dc)	(0.30)		9
									9.10	-7.74	
		D	9.50					Structureless locally indistinctly structured CHALK composed of white mottled grey slightly sandy silty GRAVEL with slight sulphurous odour. Gravel is sub-angular to sub-rounded fine to coarse, very weak, low density chalk. (White Chalk Subgroup Grade Dc locally tending to C5)	(1.30)		
10		SPT	10.00 - 10.45	S 5							10
									10.40	-9.04	
		D	10.70					Extremely weak to very weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal extremely closely and very closely spaced infilled with comminuted chalk (<20mm). (White Chalk Subgroup Grade C4-C5)			
11								10.90-13.90m: Widely spaced very thin to thin beds of rinded flint gravel and cobbles. Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			11
								11.00-11.30m: Structureless. Recovered as slightly sandy gravelly silt. Possibly drilling disturbed.			
12											12
								12.25-12.40m: Discontinuity surfaces locally stained orangish brown.			
		D	12.50								
		B	12.60 - 13.00								
13		SPT	13.00 - 13.45	S 21				12.90-13.30m: Discontinuity surfaces locally stained orangish brown.			13

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
04/11/2015	11.50	11.50	1.10

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ROTARY BOREHOLE LOG

Borehole No. **BH108**

Sheet 3 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494417 N 99666	Hole Type DS+RC
Location: Bognor Regis		Level: 1.36mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 02/11/2015 End: 09/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								Extremely weak to very weak medium density white CHALK. Discontinuities are sub-horizontal and horizontal extremely closely and very closely spaced infilled with comminuted chalk (<20mm). (White Chalk Subgroup Grade C4-C5) *(continued from previous sheet)*	(6.30)		
								13.60-15.10m: Extremely weak low to medium density chalk.			
14		D	14.00					14.00-15.10m: Discontinuities are sub-horizontal to horizontal very closely spaced stained orangish brown infilled with comminuted chalk (<15mm). [Grade C4]			14
								14.20-14.50m: Limited recovery.			
								14.50-14.80m: Structureless. Recovered as slightly sandy silty gravel. Possibly drilling disturbed.			
15											15
								15.10-15.40m: Locally mottled orangish brown and grey.			
								15.40-15.60m: Discontinuities are sub-horizontal to horizontal extremely closely spaced stained grey infilled with comminuted chalk (<5mm). [Grade C5]			
		C	15.70 - 16.80	S 45		100%					
		SPT	15.70 - 16.15			6% 0%		15.85-15.90m: Mottled grey.			
16											16
								16.10-16.15m: Mottled orangish brown.			
		D	16.50					16.50-16.65m: Rinded flint gravel and cobbles (<70mm). Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.	16.70	-15.34	
		C	16.80 - 18.30			100%		Extremely weak to very weak medium density white locally mottled grey and orangish brown CHALK. Discontinuities are sub-vertical to sub-horizontal very closely to closely spaced clean or infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade A3-B4)			
17		CS	17.10 - 17.35			43% 26%			(1.30)		17
								16.80-17.45m: Closely to medium spaced very thin to thin beds of rinded flint gravel and cobbles. Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			
								17.00-17.08m: Possibly drilling disturbed.			
18								17.30-17.45m: Possibly drilling disturbed.	18.00	-16.64	18
		CS	18.10 - 18.30					Extremely weak to very weak medium density white locally mottled orangish brown and grey CHALK. Discontinuities are 45° to sub-horizontal closely spaced infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade B3)			
		C	18.30 - 19.80	S 37		100%					
		SPT	18.30 - 18.75			51% 35%		18.65-18.70m: Possibly drilling disturbed.			
		CS	18.80 - 19.10					18.80-19.10m: Discontinuities are sub-horizontal medium spaced (300mm) with smear of comminuted chalk (<1mm). [Grade B2]			
19								19.10-21.30m: Discontinuities are sub-horizontal and horizontal closely and very closely spaced locally infilled with comminuted chalk (<1mm). [Grade A3-B4]			19
		D	19.50								
		C	19.80 - 21.30			100%					
20						52% 24%		19.80-21.50m: Closely to medium spaced very thin to thin beds of rinded flint gravel and cobbles. Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			20

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

Borehole No. **BH108**

Sheet 4 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494417 N 99666	Hole Type DS+RC
Location: Bognor Regis		Level: 1.36mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 02/11/2015 End: 09/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
21		CS	20.82 - 21.00					Extremely weak to very weak medium density white locally mottled orangish brown and grey CHALK. Discontinuities are 45° to sub-horizontal closely spaced infilled with comminuted chalk (<1mm). (White Chalk Subgroup Grade B3) *(continued from previous sheet)*			
									(6.30)		
		C	21.30 - 22.80	S 30		96%					
		SPT	21.30 - 21.75			53% 21%					
22								21.90-22.80m: Discontinuities are sub-horizontal and horizontal closely spaced infilled with comminuted chalk (<1mm). [Grade B3]			
		D	22.30					22.30-22.85m: Closely to medium spaced very thin to thin beds of rinded flint gravel and cobbles. Gravel is sub-angular to rounded fine to coarse. Cobbles are sub-rounded.			
		CS	22.60 - 22.80								
		C	22.80 - 24.10			98% 39% 31%		22.85-23.50m: Discontinuities are randomly orientated very closely and extremely closely spaced infilled with comminuted chalk (<1mm). [Grade B4-B5]			
23											
		D	23.40					23.50-24.30m: Discontinuities are sub-horizontal and horizontal medium and closely spaced locally infilled with comminuted chalk (<1mm). [Grade B2-B3]			
		CS	23.85 - 24.10								
24		C	24.10 - 25.60	S 43		100%					
		SPT	24.10 - 24.55			43% 29%		24.25-24.75m: Possibly drilling disturbed. Discontinuities are randomly orientated extremely closely and very closely spaced infilled with comminuted chalk (<5mm) with occasional sub-angular to sub-rounded fine to coarse flint gravel. [Grade C4-C5]	24.30	-22.94	
								Very weak to weak medium density white mottled yellowish brown and orangish brown CHALK. Discontinuities are sub-horizontal closely spaced locally infilled with comminuted chalk (<1mm). Very widely and widely spaced rinded flints recovered as angular to sub-rounded gravel and cobbles (<300mm). (White Chalk Subgroup Grade B3-A3)			
25		D	25.10					24.75-25.00m: Discontinuities are sub-vertical to sub-horizontal closely spaced infilled with comminuted chalk (<1mm). [Grade B3]			
		CS	25.30 - 25.50					25.00-25.15m: Possibly drilling disturbed. Discontinuities are randomly orientated extremely closely and very closely spaced infilled with comminuted chalk (<5mm). [Grade C4-C5]			
		C	25.60 - 27.10			100% 85% 67%		25.25-25.30m: Possibly drilling disturbed. Discontinuities are randomly orientated extremely closely and very closely spaced infilled with comminuted chalk (<5mm). [Grade C4-C5]			
26								25.30-31.60m: Discontinuities are sub-horizontal to horizontal closely to medium spaced with smear of comminuted chalk (<1mm). [Grade B2-B3]			
		D	26.60					25.85-26.20m: Discontinuity is sub-vertical to 45° clean.			
		CS	26.85 - 27.10					26.30-26.40m: Possibly drilling disturbed. Discontinuities are randomly orientated extremely closely and very closely spaced infilled with comminuted chalk (<5mm). [Grade C4-C5]			
27		C	27.10 - 28.60	S 39		100%					
		SPT	27.10 - 27.55			97% 97%		27.60-31.40m: Occasional grey mottling.			

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
04/11/2015	24.10	15.70	1.00
05/11/2015	24.10	15.70	1.10

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ROTARY BOREHOLE LOG

Borehole No. **BH108**

Sheet 5 of 5

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494417 N 99666	Hole Type DS+RC
Location: Bognor Regis		Level: 1.36mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 02/11/2015 End: 09/11/2015	Logged By SM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
28		D	27.80					Very weak to weak medium density white mottled yellowish brown and orangish brown CHALK. Discontinuities are sub-horizontal closely spaced locally infilled with comminuted chalk (<1mm). Very widely and widely spaced rinded flints recovered as angular to sub-rounded gravel and cobbles (<300mm). (White Chalk Subgroup Grade B3-A3) *(continued from previous sheet)*			
		CS	28.30 - 28.60		C						
		C	28.60 - 30.10			95% 81% 63%					
		CS	28.80 - 29.20								
29					C			29.20-29.25m: Possibly drilling disturbed. Discontinuities are randomly orientated extremely closely and very closely spaced infilled with comminuted chalk (<5mm). [Grade C4-C5]	(10.50)		
								29.70-29.80m: Possibly drilling disturbed. Discontinuities are sub-horizontal extremely closely and very closely spaced infilled with comminuted chalk (<3mm). [Grade B4-B5]			
30		D	30.00								
		C	30.10 - 30.60	S 44		98%					
		SPT	30.10 - 30.55			94%					
		D	30.20		C	60%					
		C	30.60 - 32.10			100% 67% 47%					
31								31.15-31.60m: Possibly drilling disturbed. Discontinuities are sub-horizontal to horizontal locally randomly orientated extremely closely and very closely spaced infilled with comminuted chalk (<3mm). [GradeB4-B5]			
		CS	31.30 - 31.50		C			31.30-31.35m: Possibly drilling disturbed. Discontinuities are randomly orientated extremely closely spaced infilled with comminuted chalk (<1mm). [Grade B4-B5]			
								31.60-31.70m: Possibly drilling disturbed. Discontinuities are randomly orientated extremely closely spaced infilled with comminuted chalk (<1mm). [Grade B4-B5]			
32		D	31.90					32.10-32.30m: Discontinuity is sub-vertical to 45° clean, striated and mottled grey.			
		C	32.10 - 33.60	S*57		85%		32.30-34.40m: Indistinctly thinly laminated.			
		SPT	32.10 - 32.50			57% 49%					
		CS	32.70 - 33.00		C						
33		D	33.00								
		C	33.60 - 34.40			100% 66% 41%					
34					C			33.90-34.20m: Discontinuities are sub-vertical to 45° very closely to closely spaced infilled with comminuted chalk (<1mm), striated and mottled grey.			
		D	34.20								
		SPT	34.40 - 34.80	S*64							
35								Borehole completed at 34.80m	34.80	-33.44	

Groundwater:

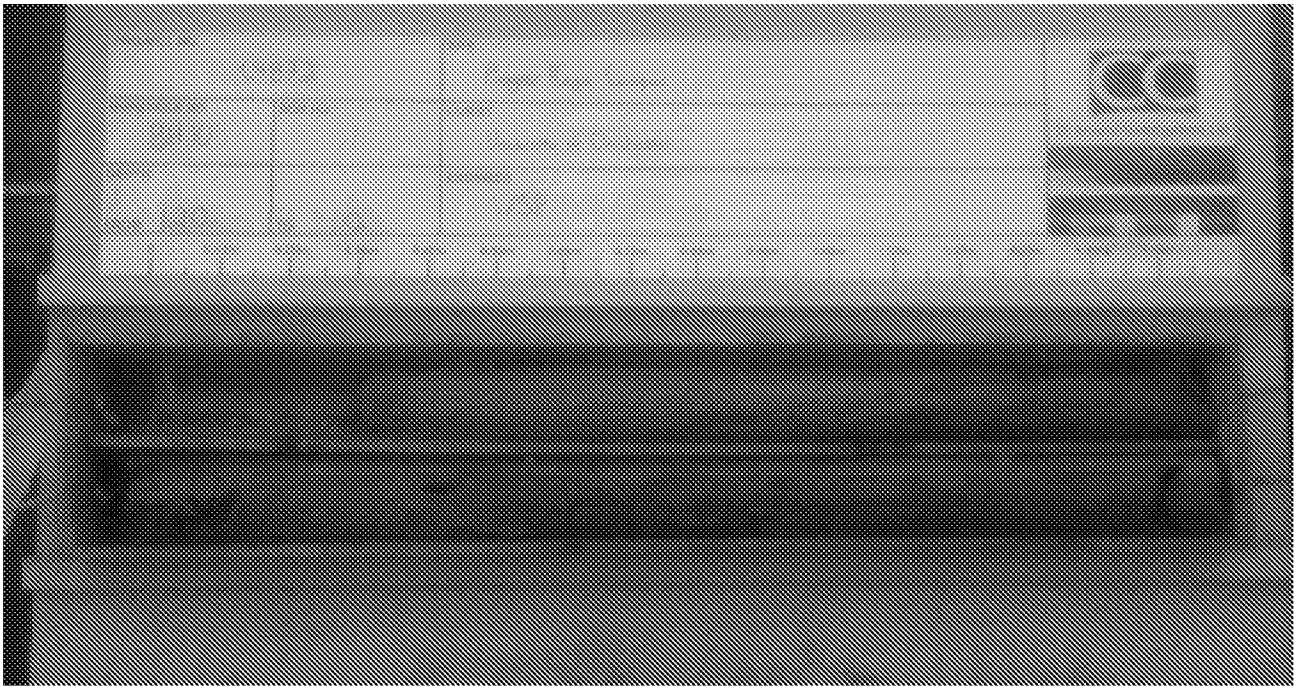
Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

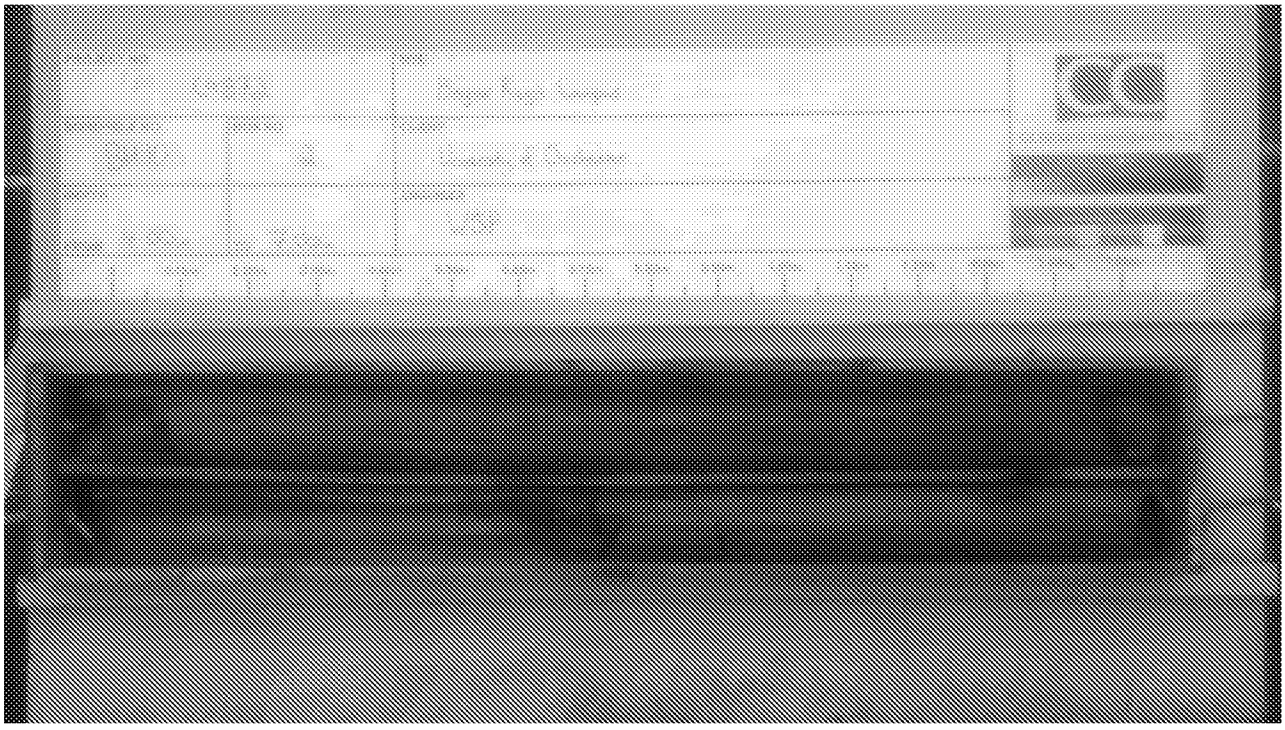
Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
05/11/2015	34.80	15.70	1.00

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Borehole Photograph



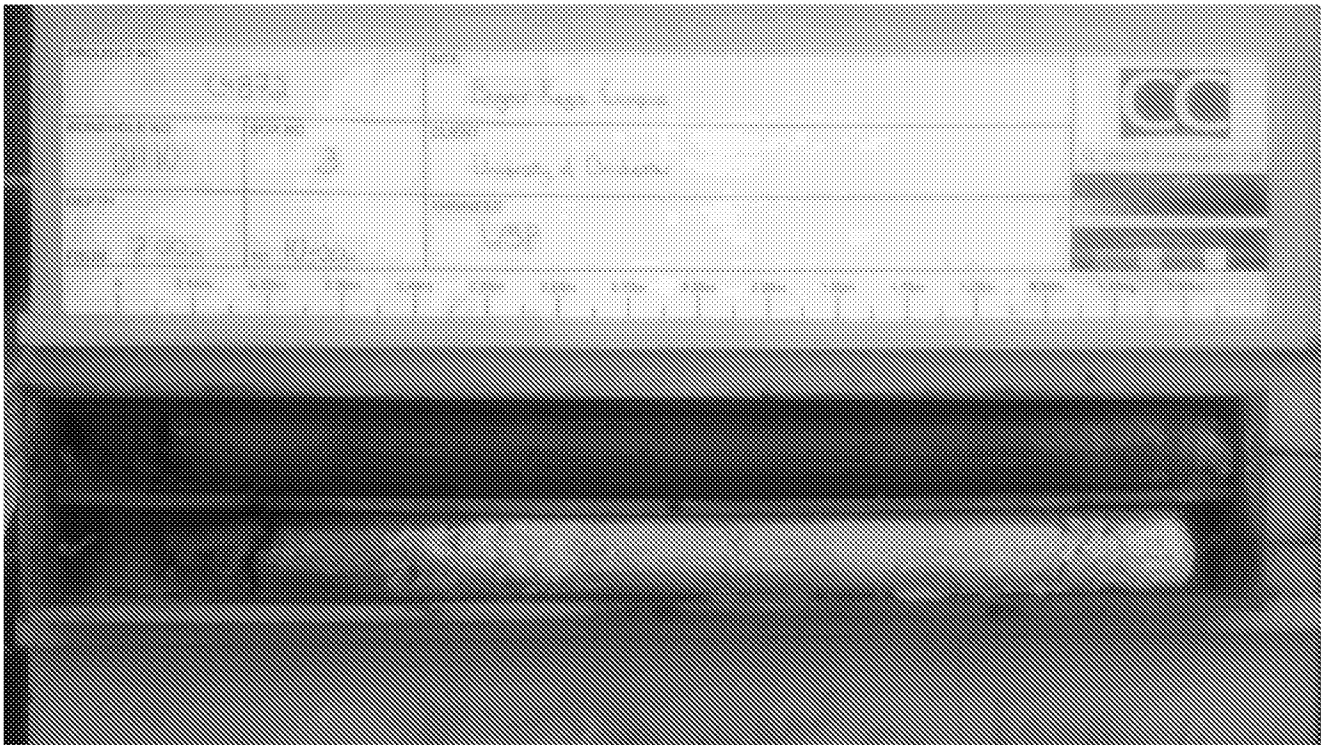


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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH108

ARUN DISTRICT COUNCIL BR/54/15/PL

Borehole Photograph



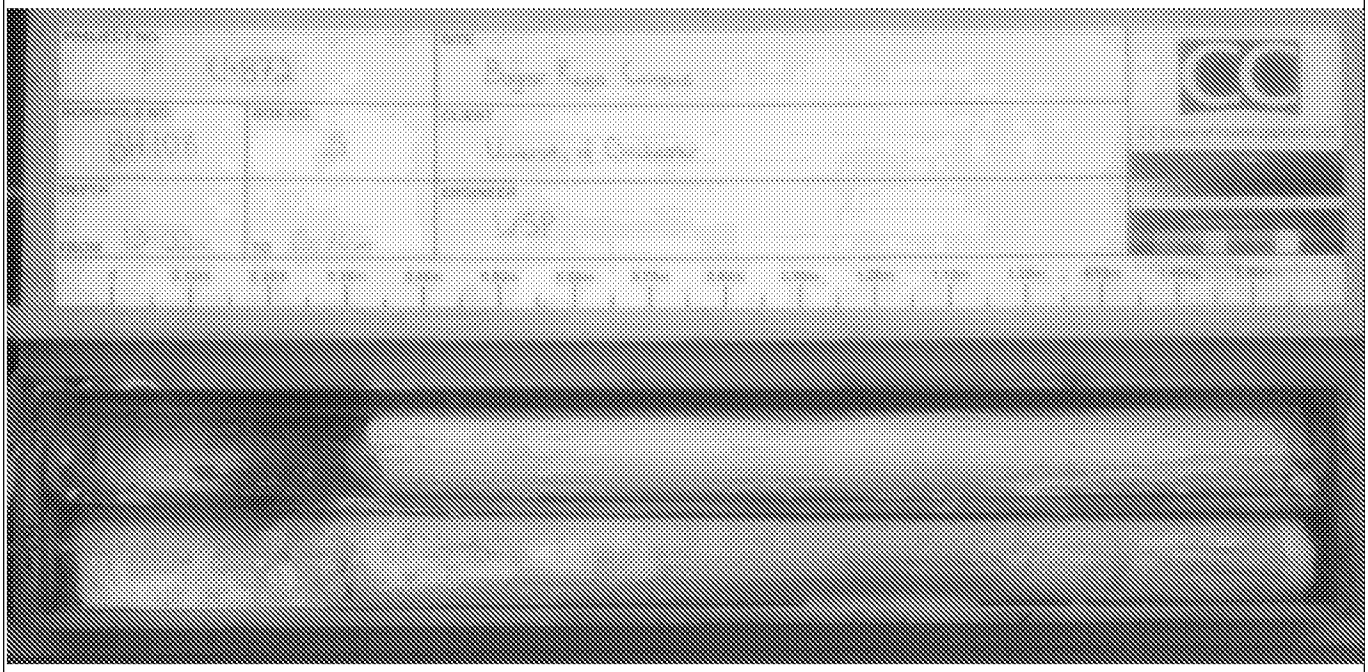


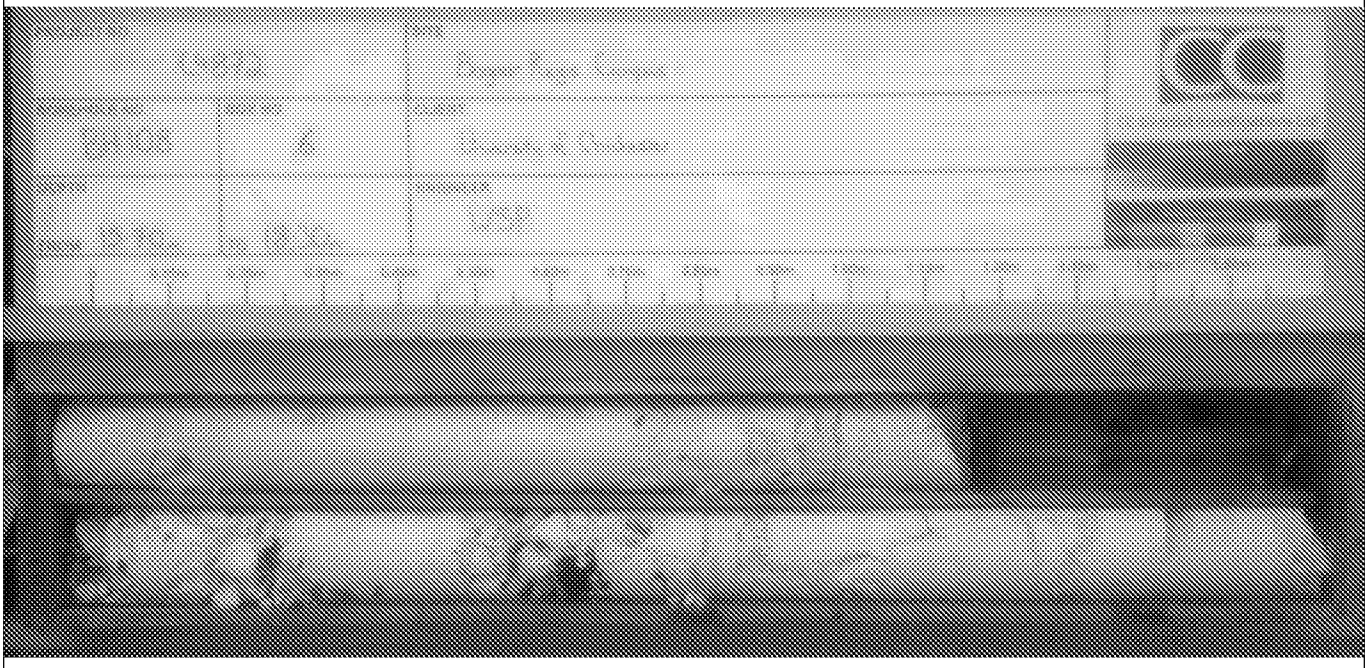
CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH108

ARUN DISTRICT COUNCIL BR/54/15/PL

Borehole Photograph



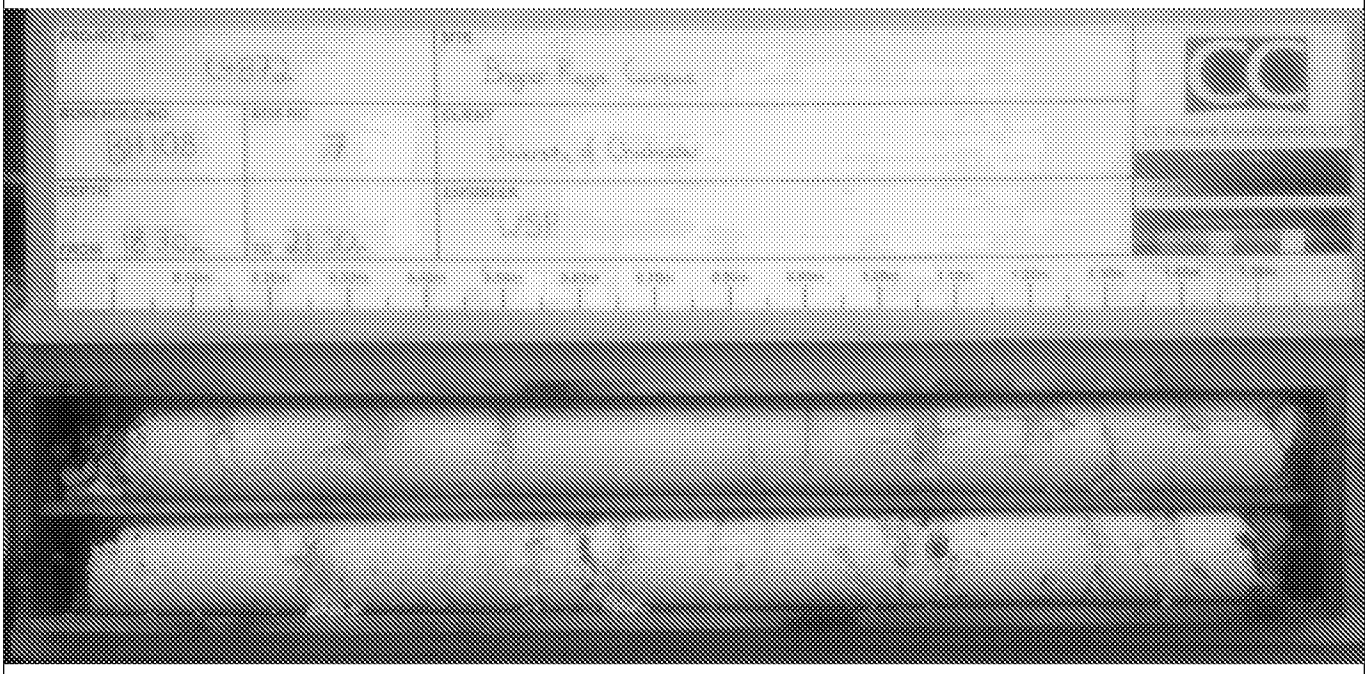


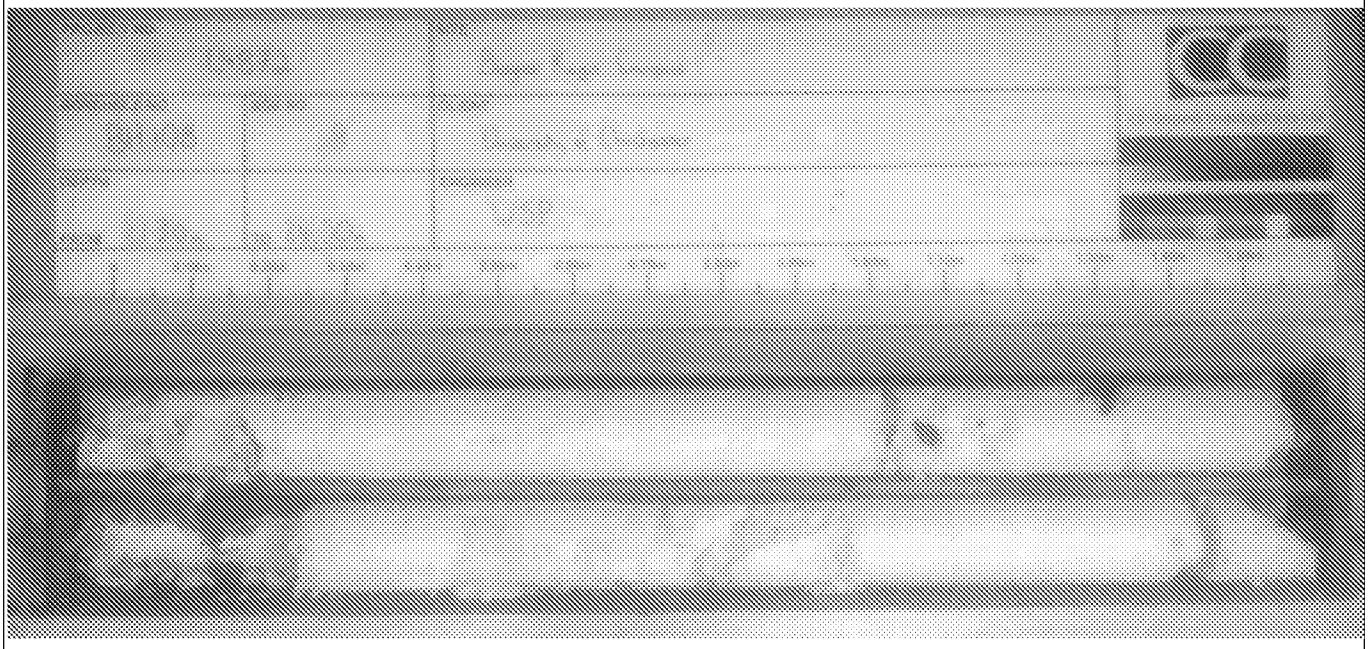
CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH108

ARUN DISTRICT COUNCIL BR/54/15/PL

Borehole Photograph



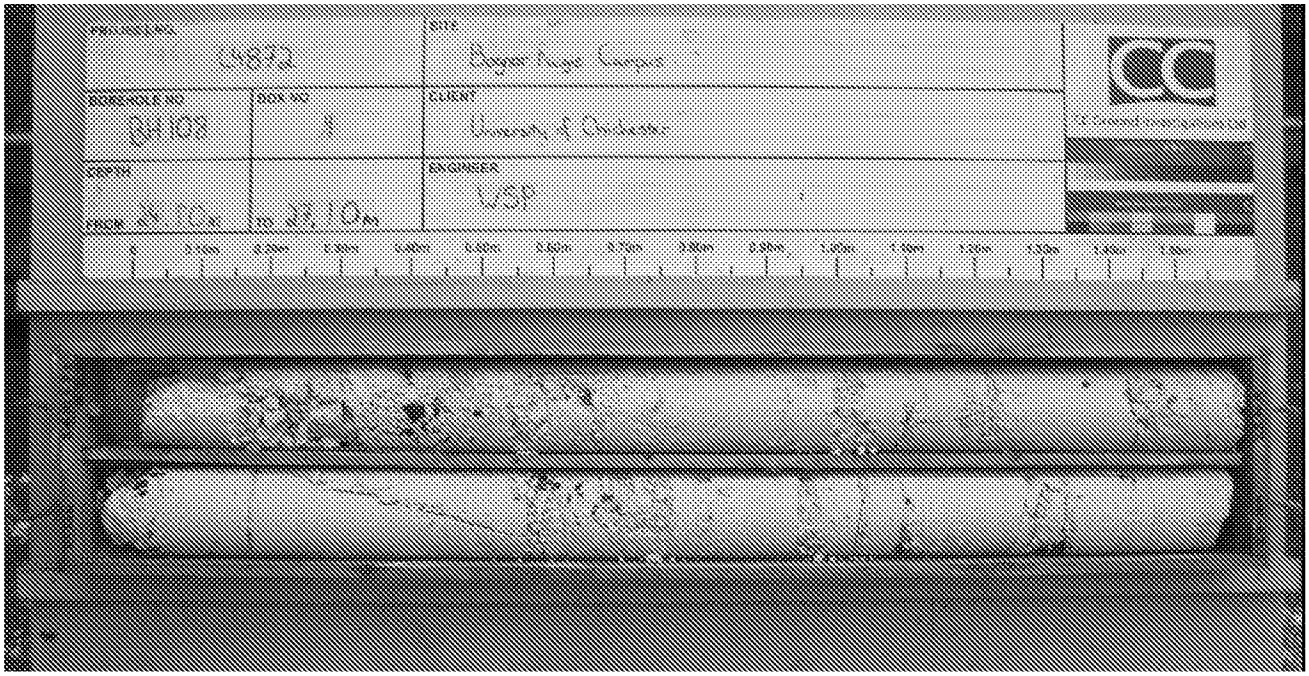


CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH108

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Borehole Photograph



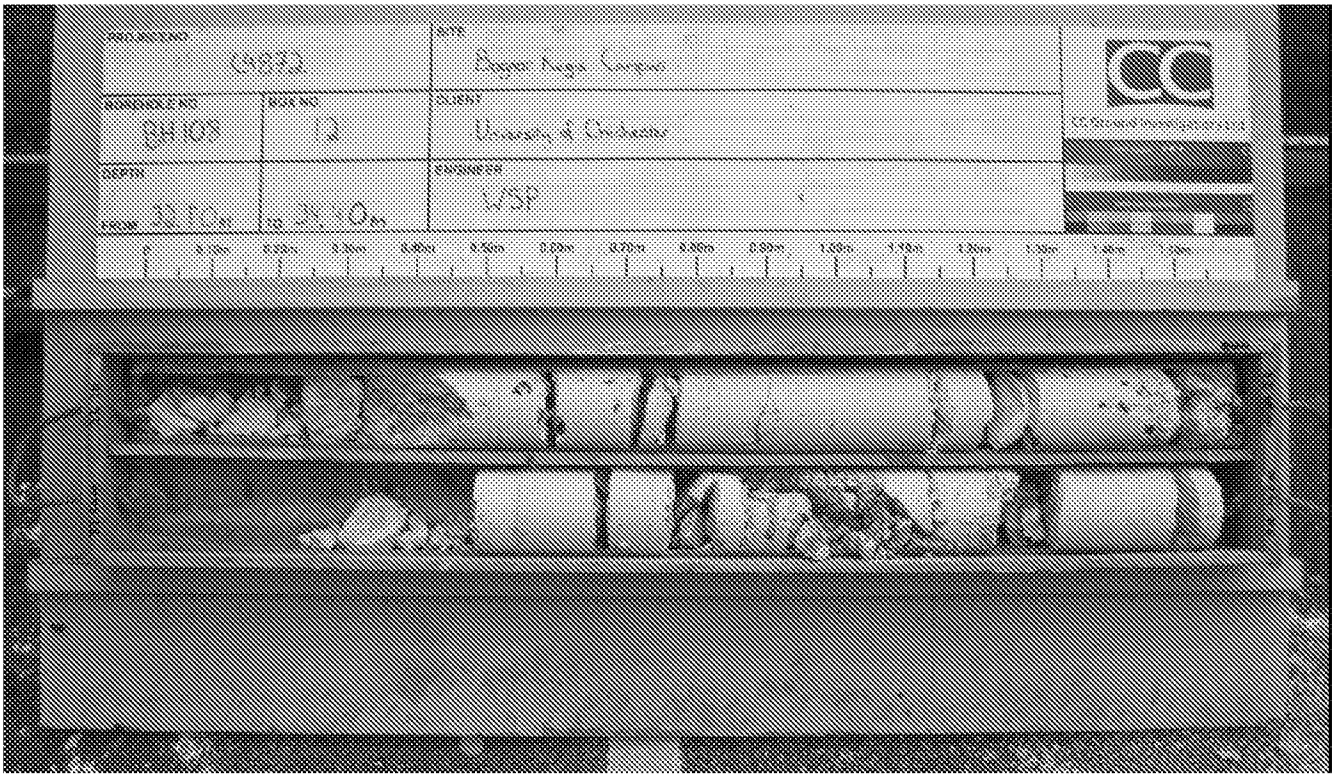


CC Ground Investigations Ltd	
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH108

ARUN DISTRICT COUNCIL BR/54/15/PL

Borehole Photograph





CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH108

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CC GROUND INVESTIGATIONS LTD

ROTARY BOREHOLE LOG

Borehole No. **BH109**

Sheet 1 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494446 N 99713	Hole Type DS+RC
Location: Bognor Regis		Level: 1.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 05/11/2015 End: 05/11/2015	Logged By RS/DM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		B	0.20					MADE GROUND: Firm friable brown mottled orangish brown and grey slightly sandy slightly gravelly silty CLAY with frequent rootlets. Gravel is sub-angular fine and medium brick.	(0.30)		
								0.20m: 1 No. 120mm x 25mm diameter steel tube.	0.30	0.88	
		B	0.50	H 80				MADE GROUND: Stiff friable orangish brown mottled reddish brown slightly sandy slightly gravelly silty CLAY with occasional rootlets. Gravel is sub-angular fine and medium brick.	(0.40)		
		ES							0.70	0.48	
		H							(0.50)		
1		B	1.00	H 45				Firm orangish brown mottled light grey slightly sandy silty CLAY. (Superficial Deposits)			1
		H							1.20	-0.02	
		ES	1.20	S<1				Very soft orangish brown and light grey silty CLAY. (Superficial Deposits)			
		SPT	1.20 - 1.65						(0.80)		
2		D	1.90	H 32				Very soft grey mottled orangish brown silty CLAY. (Superficial Deposits)	2.00	-0.82	2
		H									
		ES	2.10								
		D	2.50	H 19							
		H									
		SPT	2.70 - 3.15	S 2							
3											3
									(3.10)		
4		D	4.00	H 9							4
		H									
		SPT	4.20 - 4.65	S 2							
5								Very soft grey slightly sandy silty CLAY. (Superficial Deposits)	5.10	-3.92	5
		H	5.35	H 10							
									(0.90)		
		D	5.60								
		SPT	5.70 - 6.15	S 1							
6											6

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REMARKS:

EQUIPMENT: Hand digging tools. Fraste PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-22.20m. Water flush rotary coring using T6-146 coring barrel: 22.20-35.20m.
GROUNDWATER: None encountered prior to use of water flush to advance casing to 4.20m..
CASING: 160mm diameter casing to 27.50m.
INSTALLATION: Bentonite pellet seal: 3.00-35.20m, 50mm ID HDPE slotted pipe with washed gravel response zone: 1.00-3.00m, plain pipe with bentonite pellet seal: 0.20-1.00m, flush 150mm steel cover set in concrete 0.00-0.20m. Gas valve fitted.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
05/11/2015	5.70	5.70	0.80
06/11/2015	5.70	5.70	2.30

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ROTARY BOREHOLE LOG

Borehole No. **BH109**

Sheet 2 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494446 N 99713	Hole Type DS+RC
Location: Bognor Regis		Level: 1.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 05/11/2015 End: 05/11/2015	Logged By RS/DM

(m)	Water Levels	Core Run, Samples & Testing No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
								Very soft grey slightly sandy clayey SILT. (Superficial Deposits)	6.00	-4.82	
		H	6.80	H 8							
7		D	7.00								7
		SPT	7.20 - 7.65	S<1					(2.30)		
8		H	8.10	H 10							8
		D	8.50					Very soft grey slightly sandy silty CLAY. (Superficial Deposits)	8.30	-7.12	
		SPT	8.70 - 9.15	S<1							
9											9
		H	9.70	H 12							
		D	9.80								
10		SPT	10.20 - 10.65	S 2							10
11		H	11.20	H 14					(6.00)		11
		D	11.50								
		SPT	11.70 - 12.15	S 2							
12											12
		H	12.60	H 16							
13		D	13.00								13

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Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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ROTARY BOREHOLE LOG

Borehole No. **BH109**

Sheet 3 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494446 N 99713	Hole Type DS+RC
Location: Bognor Regis		Level: 1.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 05/11/2015 End: 05/11/2015	Logged By RS/DM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		SPT	13.20 - 13.65	S 4				Very soft grey slightly sandy silty CLAY. (Superficial Deposits) *(continued from previous sheet)*			
14		H	14.20	H 16				Soft to firm grey slightly sandy silty CLAY with occasional brown and dark brown pseudo-fibrous to fibrous plant remains/rootlets. (Superficial Deposits)	14.30	-13.12	
		SPT	14.70 - 15.15	S 9					(1.10)		
15		D	15.30						15.40	-14.22	
		D	15.50					Firm plastic dark brown slightly sandy slightly gravelly amorphous PEAT. Gravel is sub-angular to sub-rounded fine to coarse of chalk and flint. (Superficial Deposits)	(0.35)		
								Firm to stiff dark greyish green slightly sandy gravelly silty CLAY with occasional dark brown rootlets. Gravel is sub-angular to rounded fine to coarse of chalk and occasional flint. (Superficial Deposits)	15.75	-14.57	
16		D	16.10						(0.85)		
		SPT	16.20 - 16.65	S 20					16.60	-15.42	
								Structureless CHALK composed of slightly silty slightly sandy to sandy angular to sub-rounded fine to coarse GRAVEL with low cobble content and occasional flints. Clasts are very weak to weak medium to high density white. Matrix is soft to firm white. Flints are dark grey medium to coarse gravel size nodular. (White Chalk Subgroup Grade Dc)			
17		D	17.20								
		SPT	17.70 - 18.15	S 20					(2.30)		
18											
									18.90	-17.72	
19		D	19.10					Extremely weak to very weak low to medium density white CHALK with closely to medium spaced dark brown nodular flints. Discontinuities are sub-horizontal to sub-vertical extremely closely to very closely spaced rough undulating and stepped with comminuted slightly sandy silt infill (<10mm). (White Chalk Subgroup Grade C4/5)			
		SPT	19.20 - 19.65	S 21					(0.75)		
								19.15m: Light grey staining along sub-horizontal discontinuity.	19.65	-18.47	
20								*(continued on next sheet)*			
		D	20.40						(1.05)		

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
06/11/2015	14.70	14.70	0.00
09/11/2015	14.70	14.70	0.00

CC GROUND INVESTIGATIONS LTD

ROTARY BOREHOLE LOG

Borehole No. **BH109**

Sheet 4 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494446 N 99713	Hole Type DS+RC
Location: Bognor Regis		Level: 1.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 05/11/2015 End: 05/11/2015	Logged By RS/DM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		SPT	20.70 - 21.08	S 21				Very weak to weak medium to high density locally extremely weak low density along discontinuities white CHALK with occasional light grey thin marl laminations and medium spaced dark brown nodular flints. Discontinuities are sub-horizontal very closely to closely spaced rough undulating with partly open to wide open (<60mm) infilled with comminuted slightly sandy gravelly silt with some light brown discolouration. Sub-vertical discontinuities are extremely closely to very closely spaced rough undulating and stepped tight to partly open occasionally with light brown sand smear. Flints are medium to coarse gravel size. (White Chalk Subgroup Grade C3/5) *(continued from previous sheet)*	20.70	-19.52	
21									(1.00)		21
									21.70	-20.52	
22		D	22.00					Structureless CHALK composed of white slightly gravelly SILT. Gravel is very weak low density white sub-angular fine to coarse with occasional black specks and occasional orangish brown staining. (White Chalk Subgroup Grade Dm Possibly drilling disturbed)	(0.90)		22
		C	22.20 - 23.70	S 41		100%					
		SPT	22.20 - 22.58			8% 5%					
								Structureless CHALK composed of silty sub-angular fine to coarse GRAVEL. Clasts are extremely weak and very weak low and medium density white with occasional black specks. Matrix is white. (White Chalk Subgroup Grade Dc) 22.05-22.10m: Band of sub-angular coarse flint gravel. 22.20-22.30m: Flint cobble. 22.30-22.48m: Band of sub-angular coarse flint gravel. 22.48-22.60m: Flint boulder? (solid core).	22.60	-21.42	
23		D	23.20								23
								Very weak and weak medium density white with occasional orangish brown staining CHALK. Discontinuities are extremely and very closely spaced (10/40/60) infilled with (1/2/5) white comminuted chalk, moderately orangish brown stained. (White Chalk Subgroup Grade C4-5) 23.70-24.35m: Band of sub-angular fine to coarse gravel and cobbles of flint.			
		C	23.70 - 25.20			80% 5% 0%					
24											24
		B	24.60 - 24.67					24.60-24.67m: Band of medium density grade B3 chalk.			
								24.75-24.90m: Band of angular and sub-angular fine to coarse flint gravel.			
25		D	25.00								25
		C	25.20 - 26.70	S*59		77%			(5.40)		
		SPT	25.20 - 25.61			0% 0%					
								25.65-25.75m: Band of sub-angular coarse flint gravel.			
								25.82-25.90m: Band of sub-angular coarse flint gravel.			
26											26
								26.12-26.26m: Band of sub-angular coarse flint gravel.			
		D	26.50								
		C	26.70 - 28.20			80%		26.70-27.30m: Band of structureless grade Dc chalk.			
						7% 7%		26.90-27.18m: Band of structureless grade Dc chalk.			
27											27
								27.30-27.70m: Band of flint cobbles.			

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
09/11/2015	20.70	17.70	0.00
10/11/2015	20.70	17.70	0.80
10/11/2015	22.20	21.00	0.90
11/11/2015	22.20	21.00	0.80

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ROTARY BOREHOLE LOG

Borehole No. **BH109**

Sheet 5 of 6

[redacted]

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494446 N 99713	Hole Type DS+RC
Location: Bognor Regis		Level: 1.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 05/11/2015 End: 05/11/2015	Logged By RS/DM

(m)	Water Levels	Core Run, Samples & Testing: No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
28								27.85-27.95m: Band of sub-angular fine to coarse gravel and cobbles of flint.	28.00	-26.82	28
		C CS	28.20 - 29.20 28.20 - 28.45			100% 73% 68%		Very weak medium density white CHALK. Discontinuities are closely and medium spaced locally very closely spaced (30/100/300) rarely locally infilled (0/0/1) with white comminuted chalk. (White Chalk Subgroup Grade B2-3) 28.48-28.56m: Drilling disturbed; Band of sub-angular fine and medium chalk gravel with sub-angular fine to coarse flint gravel. 28.87-29.00m: Sub-vertical undulating rough fracture with greyish brown staining of fracture surface.			
29		D	29.00								29
		C	29.20 - 30.70			77% 62% 59%		29.20-29.50m: No recovery. 29.50-29.60m: Band of angular and sub-angular fine to coarse flint gravel.			
		CS	29.60 - 29.83								
		B	29.84 - 30.08								
30											30
								30.25-30.30m: Band of sub-angular and sub-rounded fine to coarse gravel and cobbles of flint.			
		D	30.50								
		C CPT	30.70 - 32.20 30.70 - 30.91	C*143		100% 60% 33%					
31								30.89-30.96m: Band of angular and sub-angular fine to coarse flint gravel.			31
		B	31.13 - 31.32					31.12-31.32m: Sub-vertical undulating rough fracture.			
								31.35-31.42m: Band of angular and sub-angular fine to coarse flint gravel.	(7.35)		
								31.73-31.80m: Band of sub-angular coarse flint gravel.			
32		D	32.00					31.80-32.15m: Non intact zone with parallel very closely spaced sub-vertical stepped rough discontinuities intersecting closely spaced sub-horizontal to 20° undulating rough discontinuities.			32
		C	32.20 - 33.70			83% 40% 21%		32.40-32.50m: Flint cobble.			
								32.80-32.84m: Band of angular and sub-angular fine to coarse flint gravel.			
33								33.06-33.20m: Drilling disturbed; recovered as silty gravel.			33
		D	33.50								
		C CPT	33.70 - 35.20 33.70 - 33.84	C*500		100% 62% 32%		33.70-33.75m: Band of sub-angular coarse flint gravel.			
34								34.05-34.15m: Band of silty sub-angular fine to coarse chalk gravel. Possibly drilling disturbed. 34.15-34.25m: 80° undulating smooth brown stained fracture.			34
								34.72-34.90m: Non intact zone with parallel very closely spaced sub-vertical stepped rough discontinuities intersecting very closely spaced sub-horizontal			
35		D	34.90								35

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
11/11/2015	28.20	25.50	0.80
12/11/2015	28.20	25.50	0.80

CC GROUND INVESTIGATIONS LTD

ROTARY BOREHOLE LOG

Borehole No. **BH109**

Sheet 6 of 6

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494446 N 99713	Hole Type DS+RC
Location: Bognor Regis		Level: 1.18mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 05/11/2015 End: 05/11/2015	Logged By RS/DM

(m)	Water Levels	Core Run, Samples & Testing No/Type	Depth (m)	Result	Core Run & Sample	TCR SCR RQD	Install	Description	Depth (m)	Level (mAD)	Legend
		CPT	35.20 - 35.35	C*375				undulating rough discontinuities.			
								Borehole completed at 35.35m	35.35	-34.17	

36 37 38 39 40 41 42

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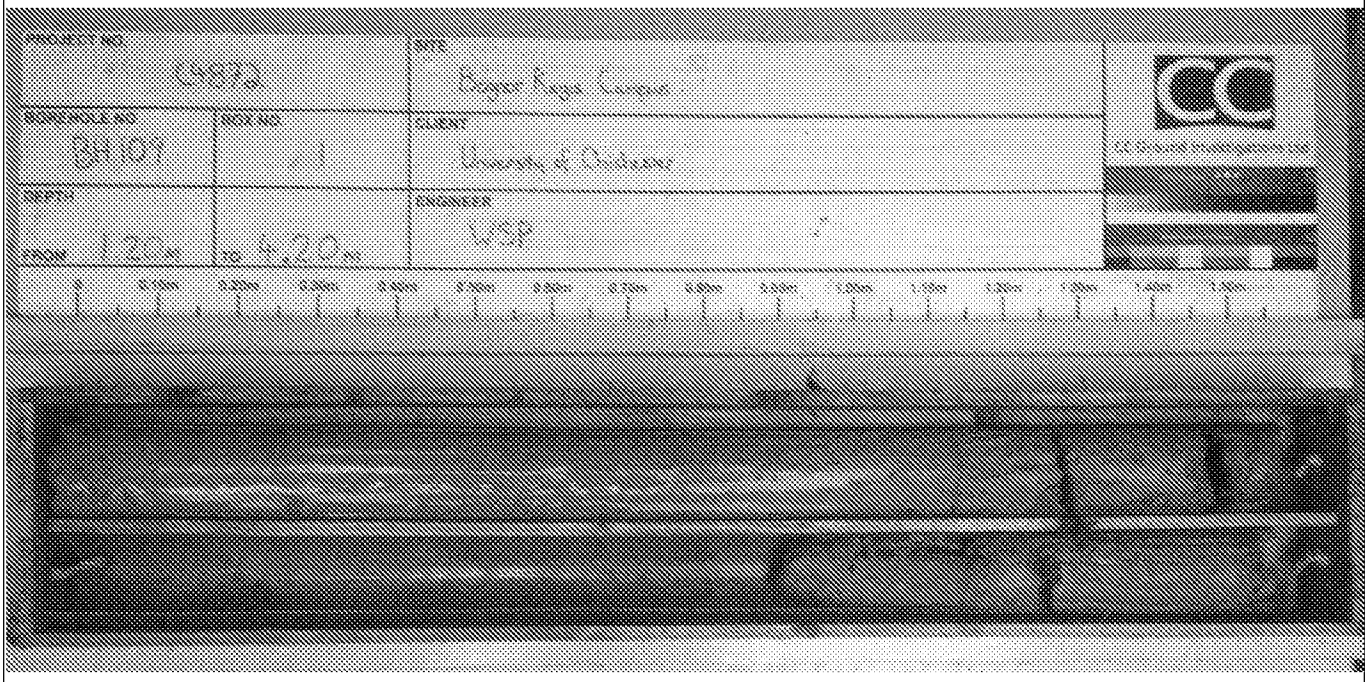
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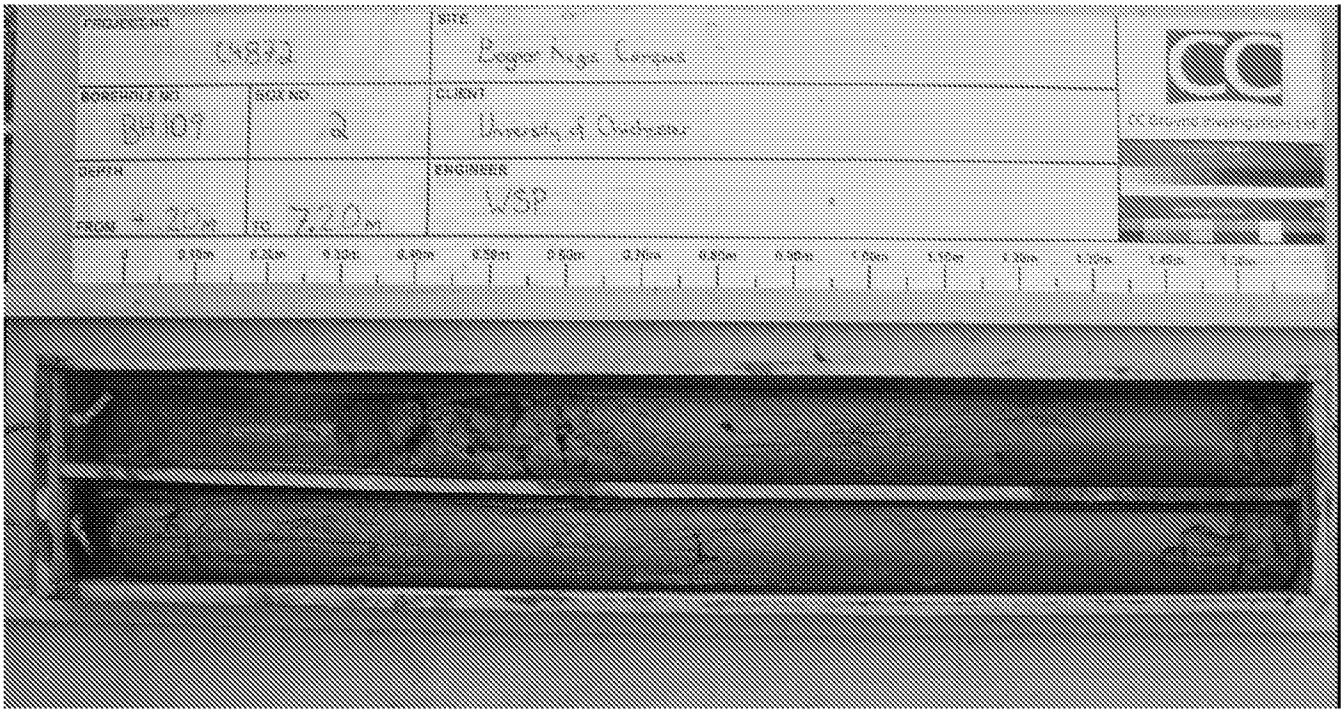
Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
12/11/2015	35.35	27.50	0.40

Borehole Photograph



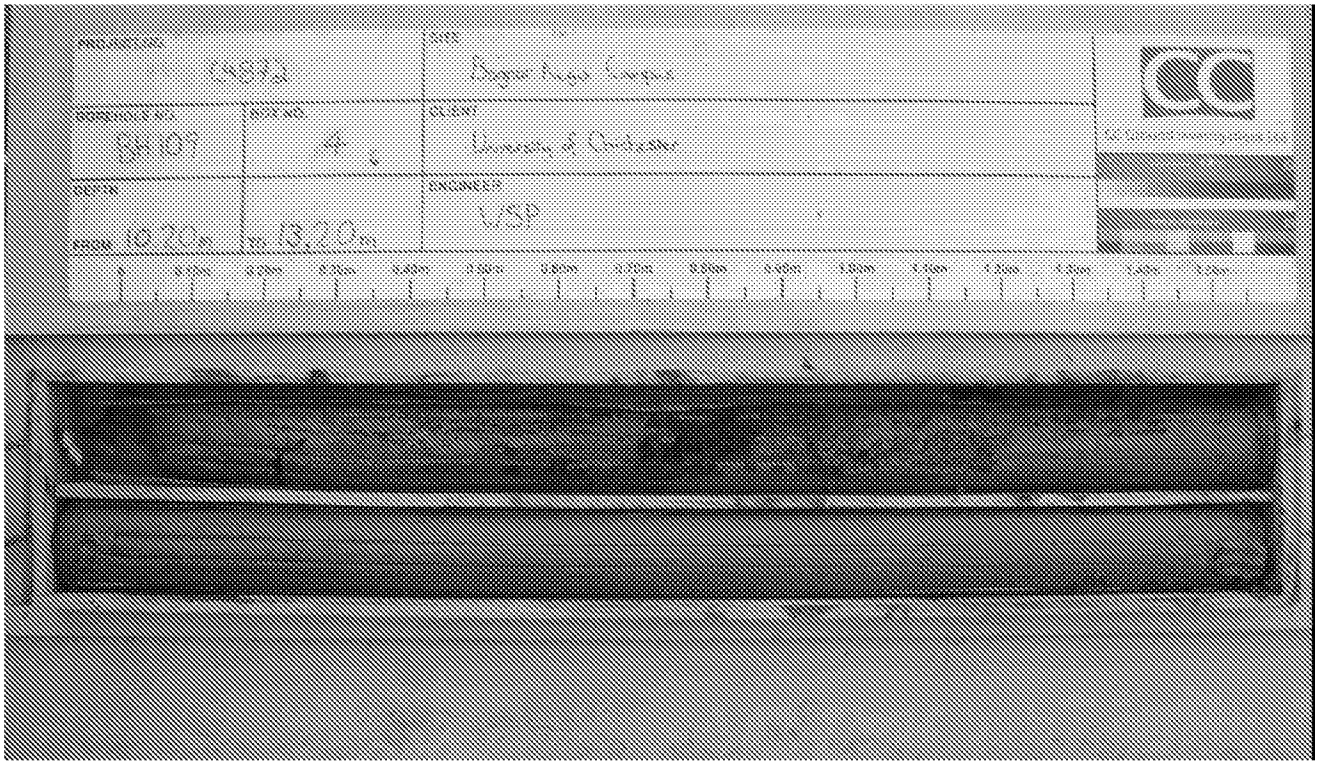


CC Ground Investigations Ltd	
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH109

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Borehole Photograph



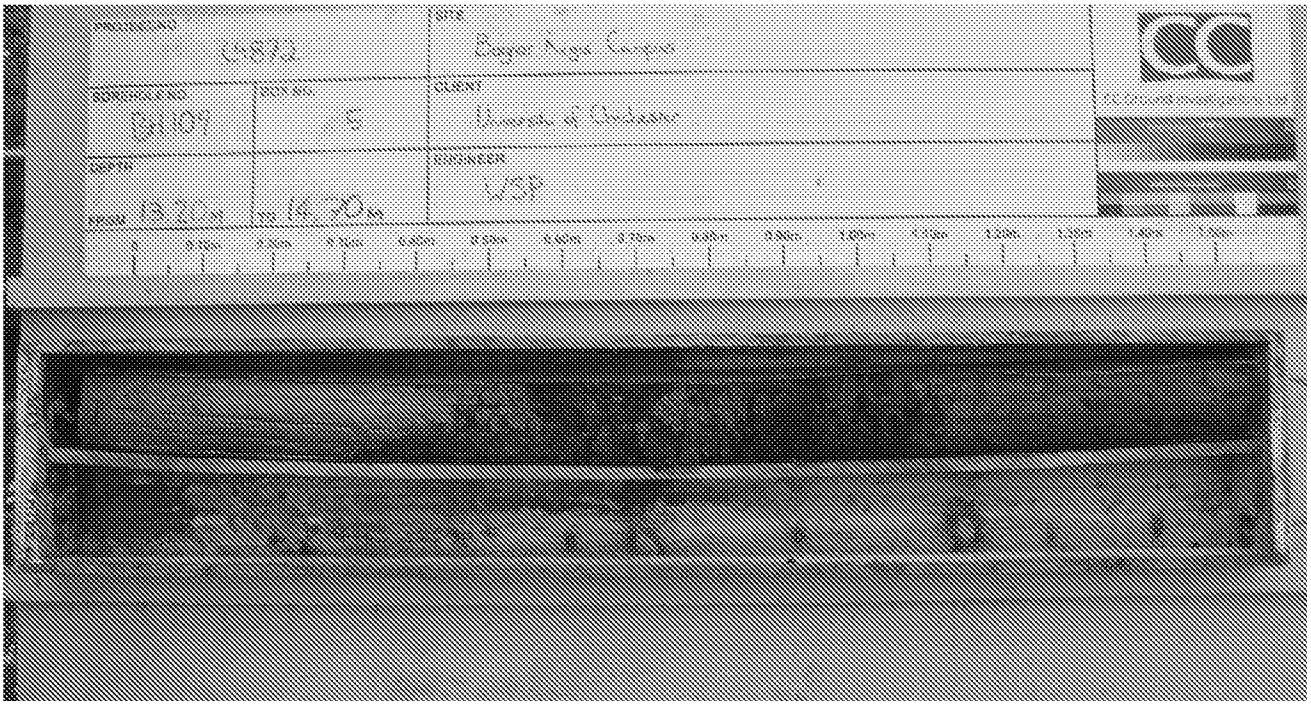


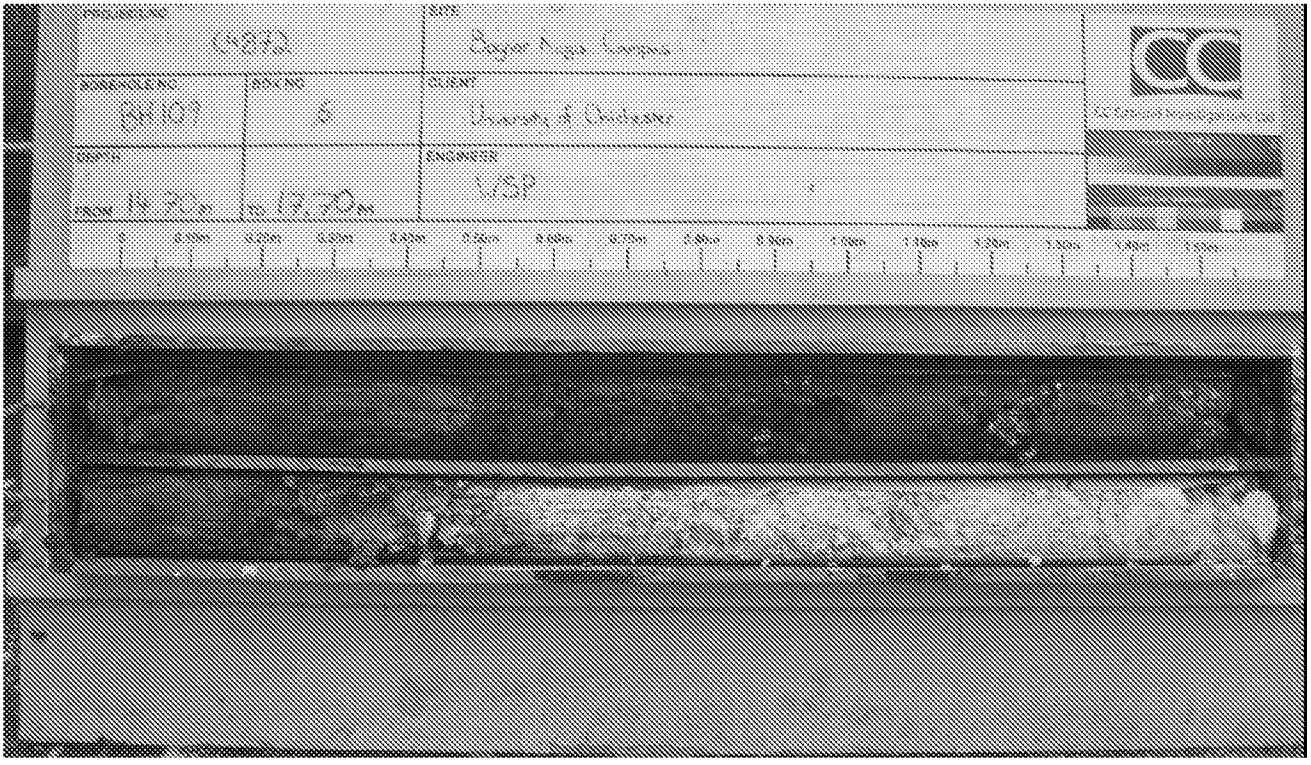
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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH109

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Borehole Photograph



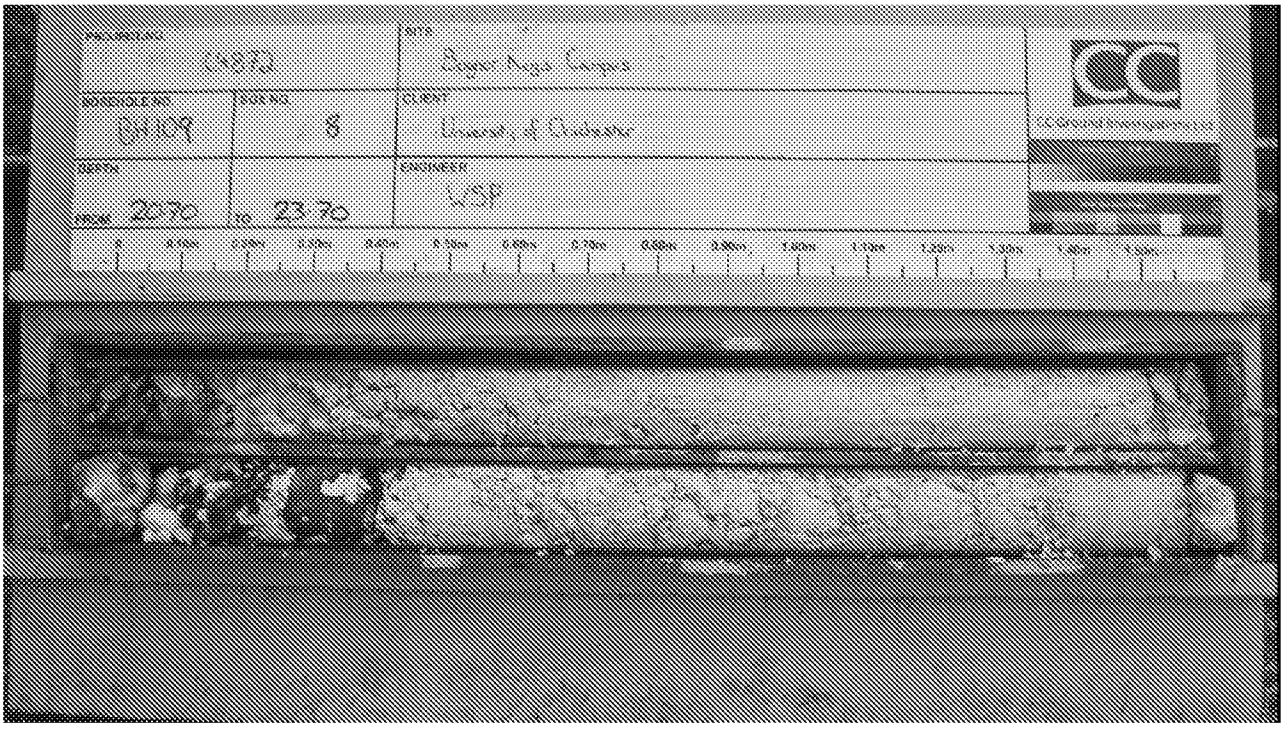


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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH109

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Borehole Photograph



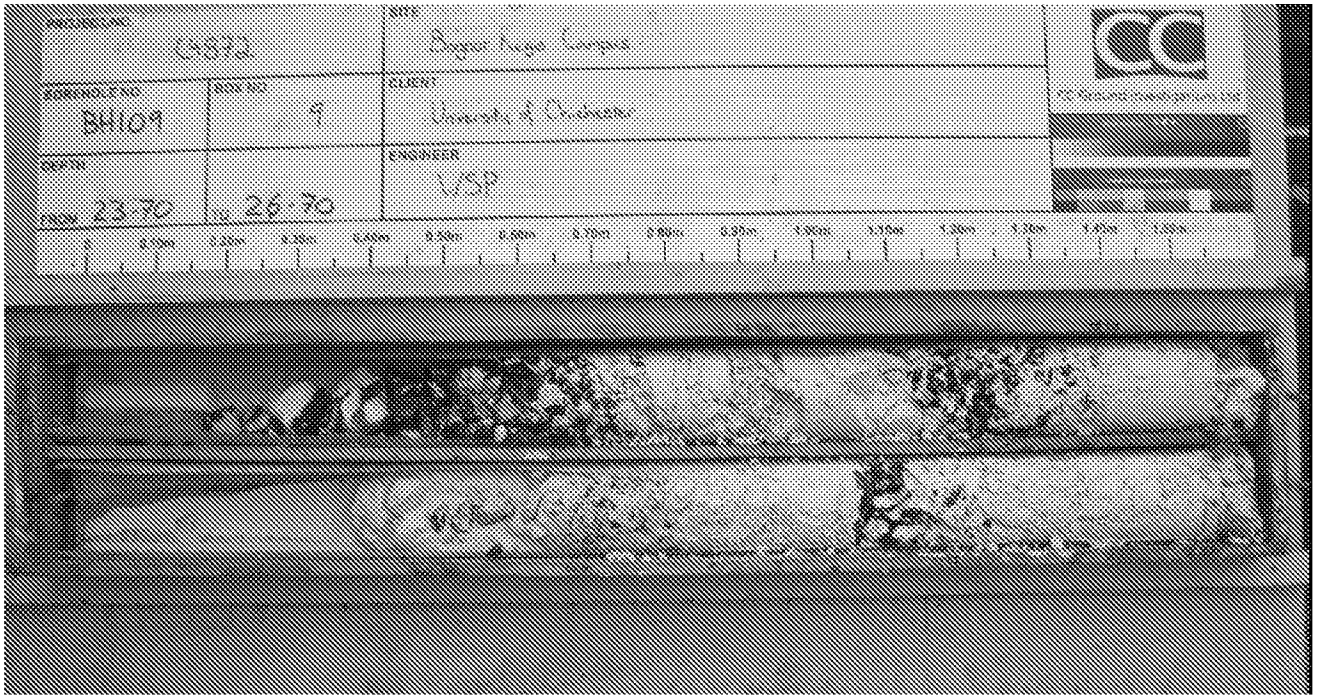


CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH109

ARUN DISTRICT COUNCIL BR/54/15/PL

Borehole Photograph

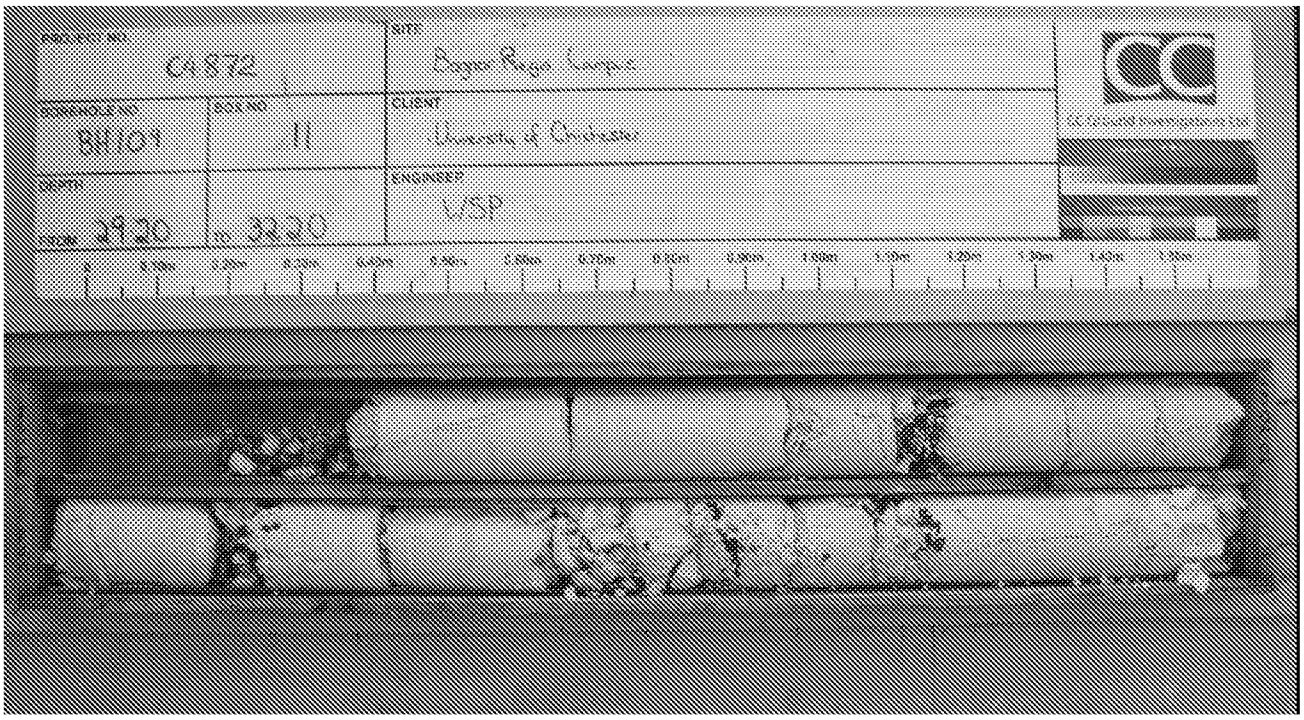


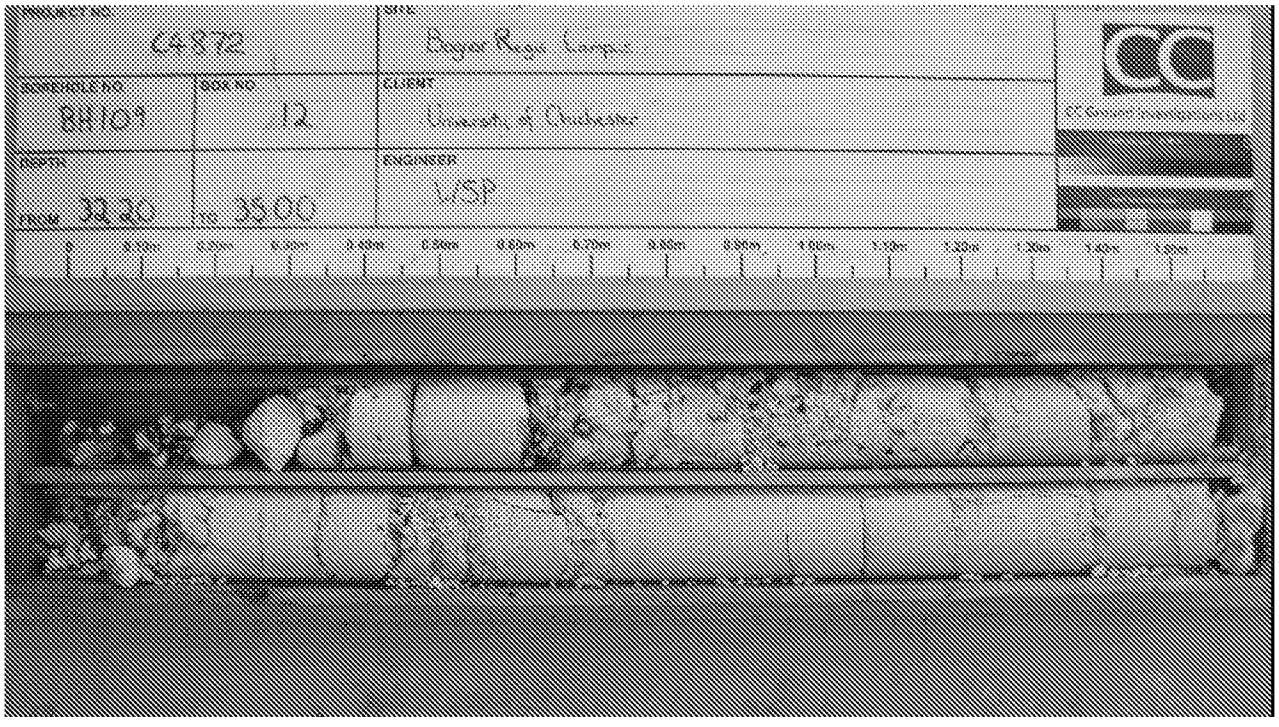


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Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH109

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Borehole Photograph





CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH109

ARUN DISTRICT COUNCIL BR/54/15/PL

CC GROUND INVESTIGATIONS LTD

BOREHOLE LOG

Borehole No. **BH110**

Sheet 1 of 2

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494365 N 99726	Hole Type DS
Location: Bognor Regis		Level: 1.42mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 03/11/2015 End: 04/11/2015	Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
		ES	0.20				MADE GROUND: Stiff friable orangish brown mottled dark grey and reddish brown slightly sandy slightly gravelly CLAY with frequent rootlets. Gravel is sub-angular fine to medium brick with rare ash.	0.20	1.22	
		B	0.30							
		B	0.50	H 88			MADE GROUND: Stiff orangish brown mottled reddish brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is sub-angular fine to coarse of brick.	(0.60)		
		H						0.80	0.62	
1							Firm to stiff orangish brown slightly sandy silty CLAY. (Superficial Deposits)	(0.30)		1
		B	1.00	H 77				1.10	0.32	
		ES					Very soft light grey mottled orangish brown silty CLAY. (Superficial Deposits)			
		H	1.20							
		B	1.20 - 1.65							
		UT100						(0.95)		
		D	1.80	H 9						
2		H						2.05	-0.63	2
							Very soft to soft grey mottled orangish brown and black silty CLAY with occasional fine gravel sized partially decomposed organic fragments. (Superficial Deposits) 2.05-2.10m: With occasional fine gravel sized partially decomposed wood fragments.			
		D	2.50	H 17						
		H								
		ES	2.70	S<1						
		SPT	2.70 - 3.15							
3							3.20-3.60m: Orangish brown locally light grey mottled black.			3
								(2.85)		
		H	3.80	H 8						
4		D	4.00							4
		UT100	4.20 - 4.65							
								4.90	-3.48	
5							Very soft grey mottled black silty CLAY with occasional fine gravel sized partially decomposed organic fragments. (Superficial Deposits)			5
		D	5.50	H 7						
		H								
		SPT	5.70 - 6.15	S 7						
6										6

REMARKS:

EQUIPMENT: Hand digging tools. Fraste PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-7.20m.
GROUNDWATER: Water strike at 1.00m remained at 1.00m after 20 minutes monitoring period.
CASING: 160mm diam casing to 7.20m.
INSTALLATION: Bentonite pellet seal: 5.00-7.20m. 50mm ID HDPE slotted pipe with washed gravel response zone: 0.50-5.00m. 50mm ID HDPE plain pipe with bentonite pellet seal: 0.20-0.50m. Flush 150mm steel cover set in concrete 0.00-0.20m Gas valve fitted.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)
03/11/15	1.00	Nil	1.00

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

CC BH LOG C4872.GPJ GINT STD AGS 3_1.GDT 21/1/16

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CC GROUND INVESTIGATIONS LTD

BOREHOLE LOG

Borehole No. **BH110**

Sheet 2 of 2

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494365 N 99726	Hole Type DS
Location: Bognor Regis		Level: 1.42mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 03/11/2015 End: 04/11/2015	Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
							Very soft grey mottled black silty CLAY with occasional fine gravel sized partially decomposed organic fragments. (Superficial Deposits) *(continued from previous sheet)*	(2.15)		
7		H	6.80	H 9						
		D	6.90							
		D	7.10					7.05	-5.63	
							Structureless CHALK composed of silty angular to sub-angular fine to coarse GRAVEL. Clasts are very weak, low and medium density white occasionally speckled black. (White Chalk Subgroup Grade Dc)	7.20	-5.78	
							Borehole completed at 7.20m			
8										
9										
10										
11										
12										
13										

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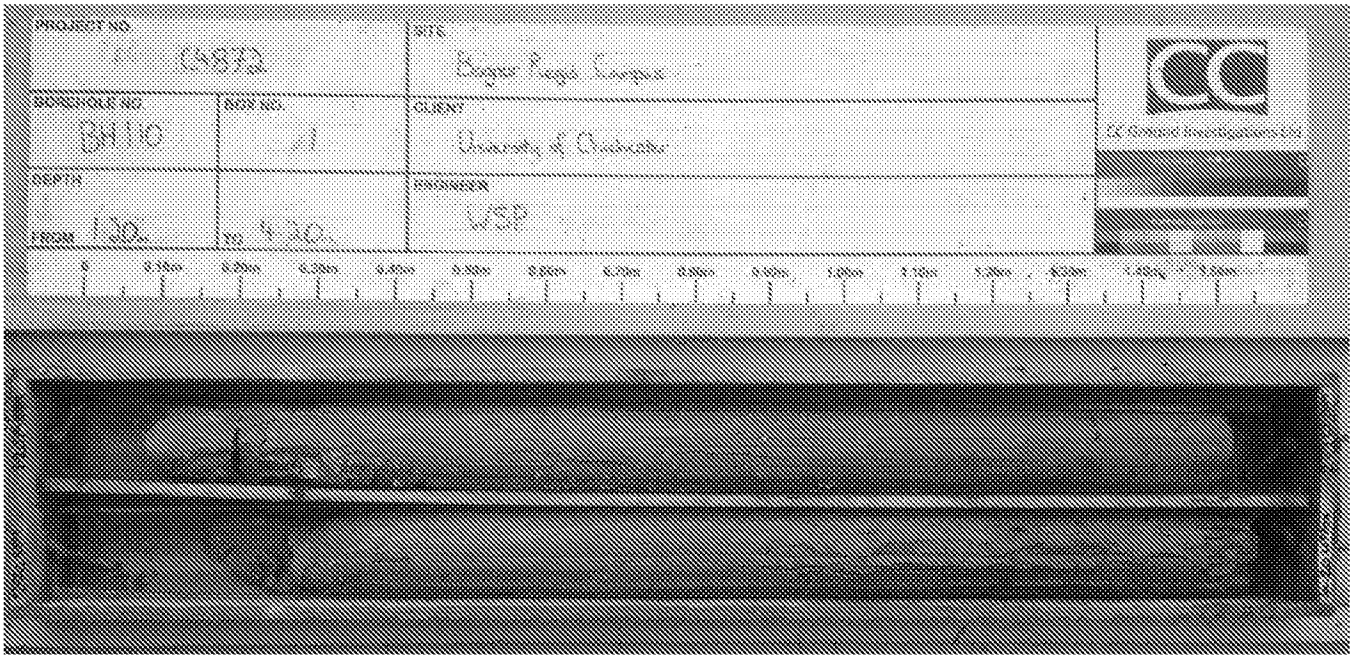
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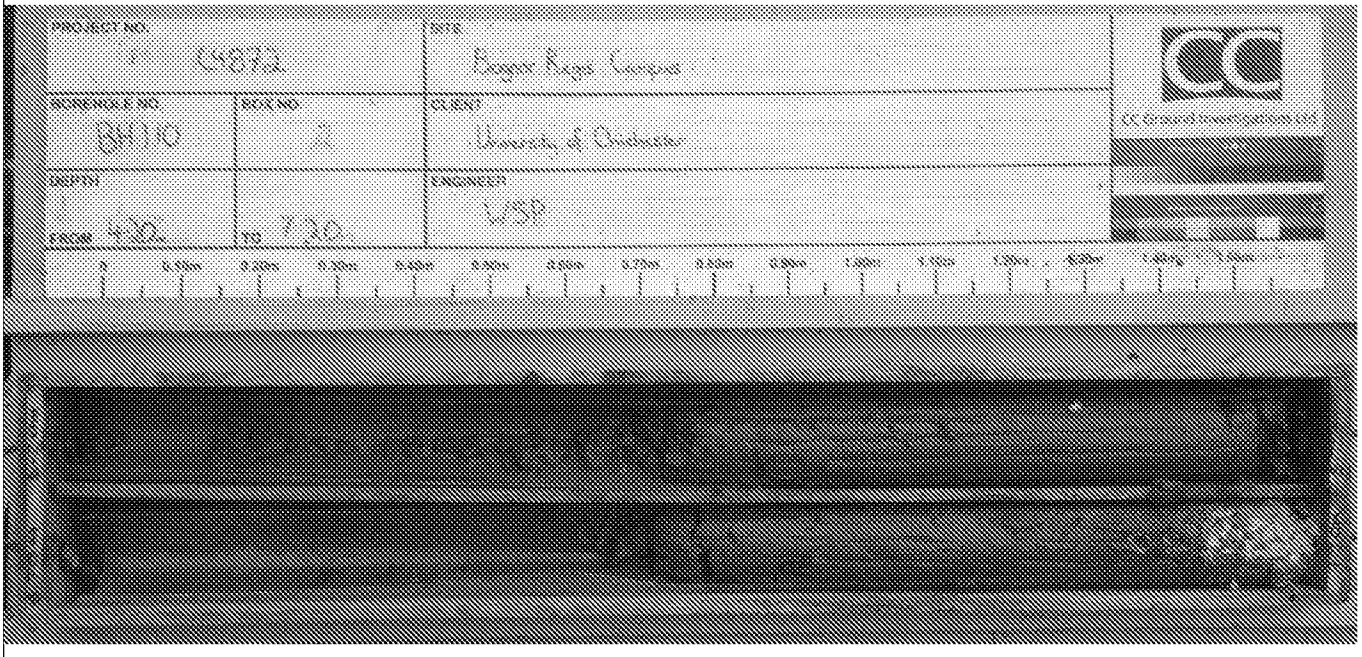
Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
03/11/2015	7.20	7.20	1.10
04/11/2015	7.20	7.20	0.80
04/11/2015	7.20	7.20	0.80

Borehole Photograph





Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH110

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ARUN DISTRICT COUNCIL BR/54/15/PL

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BOREHOLE LOG

Borehole No. **BH111**

Sheet 1 of 2

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494371 N 99734	Hole Type DS
Location: Bognor Regis		Level: 1.44mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 02/11/2015 End: 03/11/2015	Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
							Stiff light brown slightly sandy CLAY with frequent rootlets.			
		B	0.30				Stiff orangish brown mottled light grey slightly sandy silty CLAY. (Superficial Deposits)	0.20	1.24	
		B	0.50	H 96				(0.40)		
		ES						0.60	0.84	
		H					Firm light brown mottled light grey slightly sandy silty CLAY. (Superficial Deposits)	(0.40)		
1		B	1.00	H 49				1.00	0.44	1
	1	H					Very soft light grey mottled orangish brown silty CLAY. (Superficial Deposits)			
		B	1.20	S<1						
	1	SPT	1.20 - 1.65							
		D	1.50					(1.30)		
2		H	2.00	H 20						2
								2.30	-0.86	
		D	2.50	H 17			Very soft grey mottled orangish brown and black silty CLAY with occasional fine gravel sized partially decomposed organic fragments. (Superficial Deposits)			
		H								
		SPT	2.70 - 3.15	S<1						
3								(1.90)		3
4		D	4.00							4
		SPT	4.20 - 4.65	S<1			Very soft grey mottled black silty CLAY with occasional fine gravel sized partially decomposed organic fragments. (Superficial Deposits)	4.20	-2.76	
								(1.40)		
5										5
		H	5.30	H 9			5.35-5.55m: With frequent medium to coarse gravel sized partially decomposed wood fragments.			
		D	5.50					5.60	-4.16	
		SPT	5.70 - 6.15	S 8			*(continued on next sheet)*			
6										6

REMARKS:

EQUIPMENT: Hand digging tools. Fraste PL multi purpose track mounted rig.
METHOD: Hand dug inspection pit: 0.00-1.20m. Continuous dynamic sampled (128mm diam) 1.20-11.70m.
GROUNDWATER: Groundwater struck at 1.50m rose to 1.30m after 20 minutes monitoring period.
CASING: SW to 10.20m.
INSTALLATION: 50mm ID HDPE slotted pipe with washed gravel response zone: 7.40-11.70m. 50mm ID HDPE plain pipe with bentonite pellet seal: 0.20-7.40m, and flush 150mm steel cover set in concrete: 0.00-0.20m Gas valve fitted.
REMARKS: Borehole scanned by UXO engineer at surface and at 5.70m.

Groundwater:

Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)
02/11/15	1.50	Nil	1.30

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)

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BOREHOLE LOG

Borehole No. **BH111**

Sheet 2 of 2

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494371 N 99734	Hole Type DS
Location: Bognor Regis		Level: 1.44mAOD	Scale 1 : 37.50
Client: University of Chichester		Dates: Start: 02/11/2015 End: 03/11/2015	Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Sample	Install	Description	Depth (m)	Level (mAD)	Legend
							Structureless CHALK composed of silty angular and sub-angular fine to coarse GRAVEL. Clasts are very weak low and medium density white with occasional black speckling. (White Chalk Subgroup Grade Dc). *(continued from previous sheet)*			
								(2.50)		
7		D	7.00							7
		SPT	7.20 - 7.65	S 14						
8								8.10	-6.66	8
							Structureless CHALK composed of white gravelly SILT. Gravel is extremely weak and very weak low density white fine to coarse with occasional black speckling. (White Chalk Subgroup Grade Dm).	(0.40)		
		D	8.50					8.50	-7.06	
		SPT	8.70 - 9.15	S 11			Structureless CHALK composed of slightly sandy silty sub-angular medium to coarse GRAVEL. Clasts are extremely to very weak, low to medium density white with occasional black speckling. (White Chalk Subgroup Grade Dc)			
9								(1.30)		9
							9.73-9.75m: Coarse gravel sized flint.	9.80	-8.36	
10		D	10.00				Very weak low to medium density white occasionally speckled black CHALK. Discontinuities are extremely to very closely spaced (10/20/40), clean and infilled (0/1/2) with off-white comminuted chalk. (White Chalk Subgroup Grade C4-5)			10
		SPT	10.20 - 10.65	S 28				(1.10)		
								10.90	-9.46	
11		B	11.00				Structureless CHALK composed of slightly sandy silty sub-angular medium to coarse GRAVEL. Clasts are extremely to very weak, low to medium density white occasionally speckled black. (White Chalk Subgroup Grade Dc)	(0.30)		11
								11.20	-9.76	
		D	11.50				Very weak low to medium density white occasionally speckled black CHALK. Discontinuities are extremely to closely spaced (10/20/40), clean and infilled (0/1/2) with off-white comminuted chalk. (White Chalk Subgroup Grade C4-5)			
		SPT	11.70 - 12.15	S 25				(0.95)		
12										12
							Borehole completed at 12.15m	12.15	-10.71	
13										13

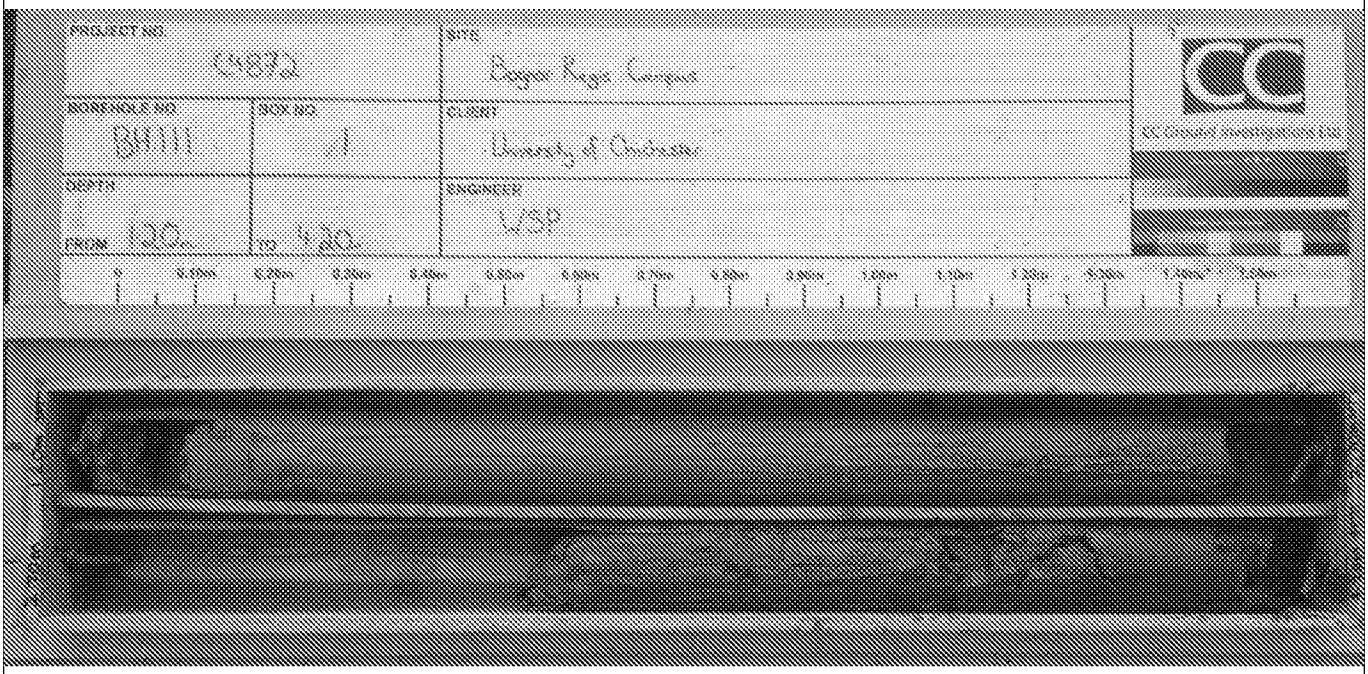
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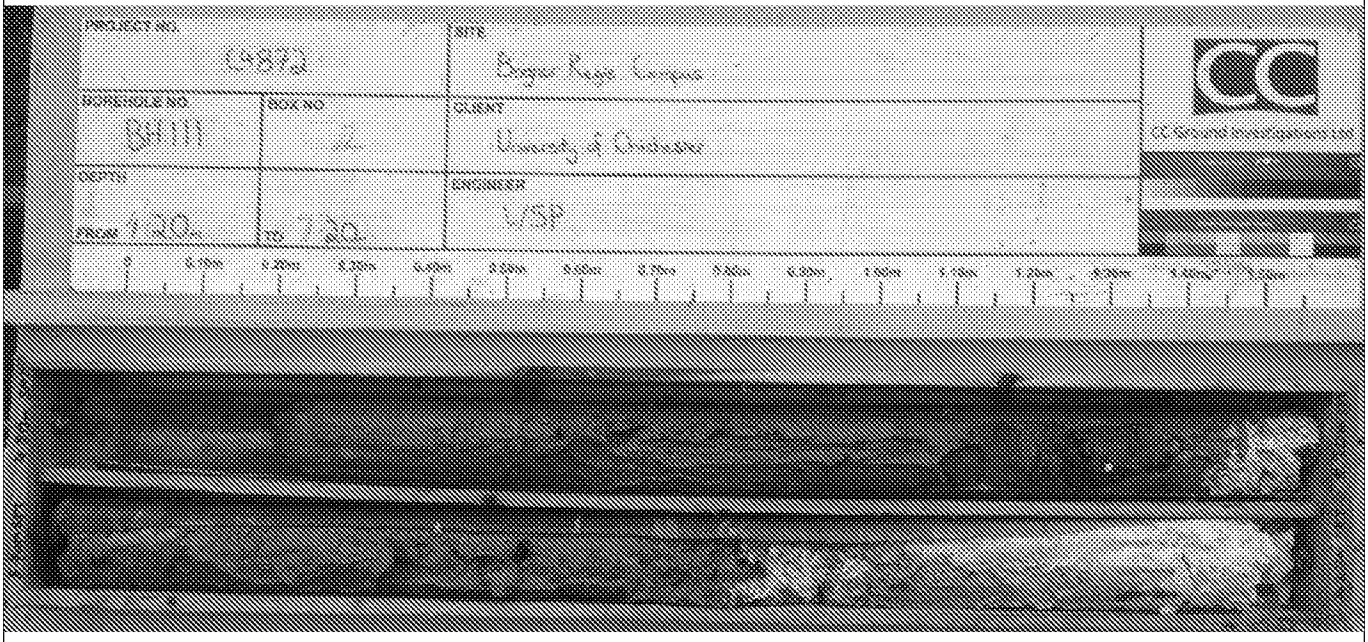
Date	Strike Depth (m)	Casing Depth (m)	Depth After Observation (m)

Hole Progress:

Date	Hole Depth (m)	Casing Depth (m)	Water Depth (m)
02/11/2015	10.20	10.20	1.50
03/11/2015	10.20	10.20	1.00
03/11/2015	12.15	10.20	0.60

Borehole Photograph

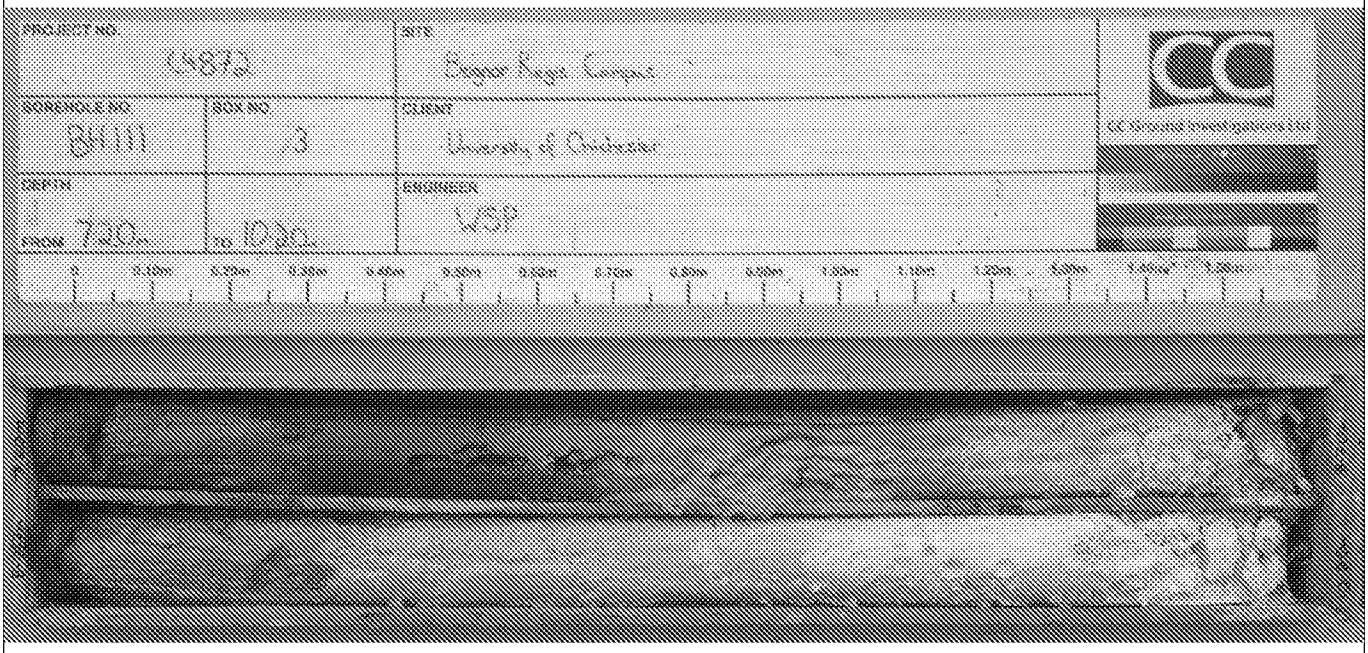


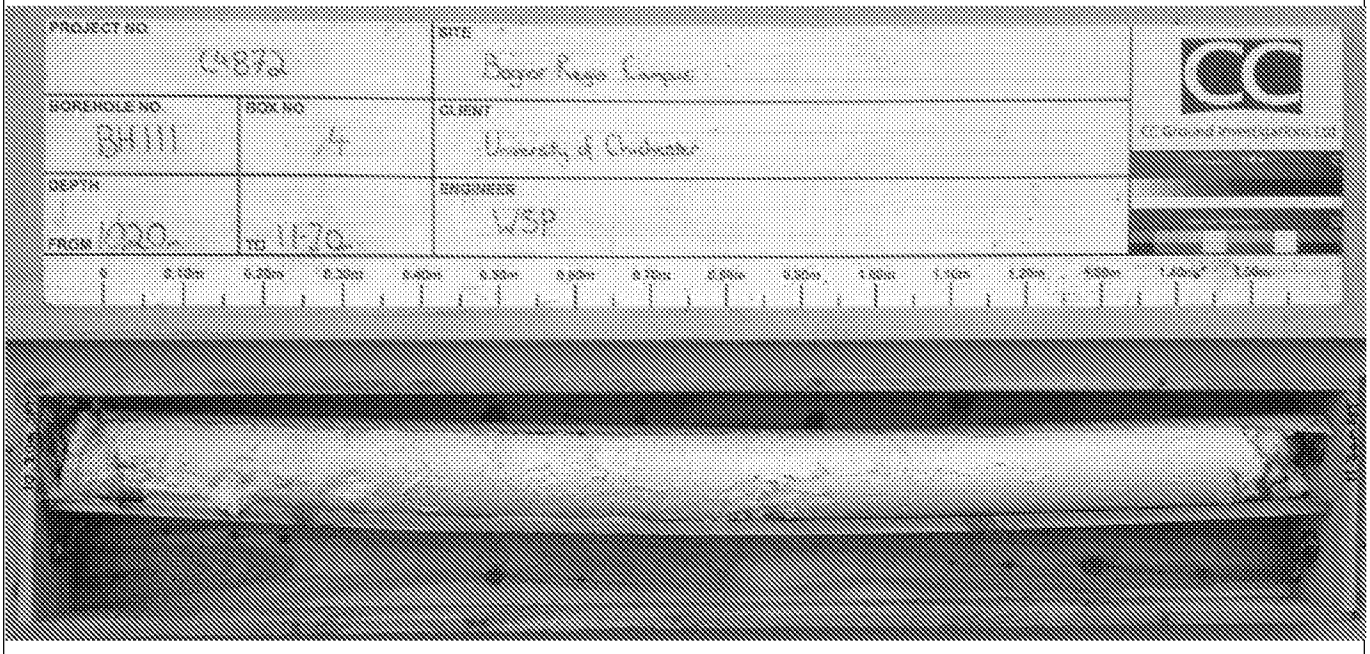


CC Ground Investigations Ltd	
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH111

ARUN DISTRICT COUNCIL BR/54/15/PL

Borehole Photograph





CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	BH111

ARUN DISTRICT COUNCIL BR/541/87/PL

CC GROUND INVESTIGATIONS LTD

TRIAL PIT LOG

Pit No **TP101**

Sheet 1 of 1

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494394 N 99578 Level: 2.89mAOD	Date 11/11/2015
Location: Bognor Regis		Dimensions: 2.00m Depth 3.20m 0.45m	Scale 1 : 37.5
Client: University of Chichester			Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
		B	0.10		MADE GROUND: Soft brown mottled orangish brown, grey and white slightly sandy slightly gravelly CLAY with frequent rootlets. Gravel is sub-angular fine and medium brick, chalk and clay tile fragments.	0.25	2.64	
		B D	0.40		MADE GROUND: Soft orangish brown locally light grey and brown slightly sandy slightly gravelly CLAY with rare rootlets. Gravel is sub-angular fine clay tile fragments, rare ash and flint.	(1.05)		
1		B D H	1.30	H 47	Firm orangish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is sub-angular and sub-rounded fine to coarse flint. (Lambeth Group)	1.30	1.59	
					Firm and stiff light grey mottled orangish brown, reddish brown and dark grey slightly sandy silty CLAY. (Lambeth Group)	1.50	1.39	
2		B D H	2.00	H 72		(1.00)		
					Stiff locally very stiff light grey mottled orangish brown and reddish brown silty CLAY. (Lambeth Group)	2.50	0.39	
						(0.70)		
3	Dry	B D H	3.00	H 100				
					Trial pit completed at 3.20m	3.20	-0.31	
4								
5								
6								

DRAFT

REMARKS:

EQUIPMENT: JCB 3CX.

METHOD: Machine excavated using 0.45m toothless bucket.

GROUNDWATER: Groundwater not encountered.

BACKFILL: On completion, trial pit backfilled with arisings compacted in layers with the machine bucket.

REMARKS: Soakaway test carried out at 1.60m depth. Trial pit refused at 3.20m terminated.

Trial Pit Photograph



CC Ground Investigations Ltd	
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP101

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP101

ARUN DISTRICT COUNCIL BR/54/16/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP101

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP101

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP101

ARUN DISTRICT COUNCIL BR/54/15/PL

CC GROUND INVESTIGATIONS LTD

SOAKAWAY TEST

[redacted]

Pit No **TP101**

Sheet 1 of 1

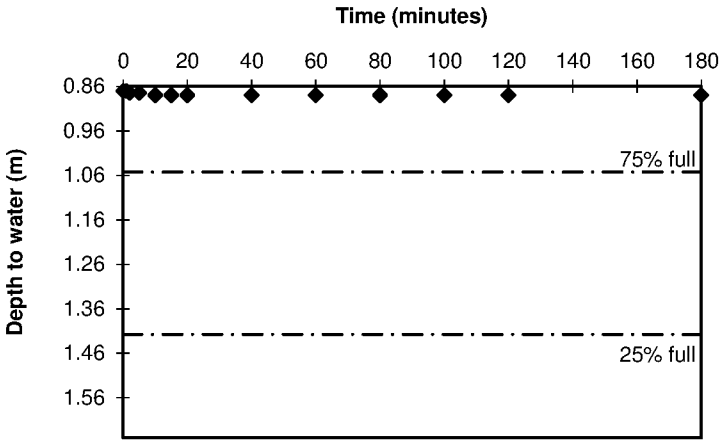
Project Name: University of Chichester Bognor Regis Campus	Project No: C4872	Co-ords: E N Level: mAD	11/11/2015
Location: Bognor Regis			Logged By DM
Client: WSP Remediation			Checked By MA

TEST 1:

LENGTH	1.60	m
BREADTH	0.45	m
DEPTH	1.60	m
WATER LEVEL	Dry	m
FILL LEVEL	0.87	m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

Insufficient soakaway to calculate infiltration rate



TEST 3:

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

TEST 3:

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

REMARKS:

Test carried out in general accordance with BRE 365 (2007).

ARUN DISTRICT COUNCIL BR/541/15/PL

CC Ground Investigations Ltd

DYNAMIC CONE PENETROMETER TESTING

CLIENT: Univeristy of Chichester

SITE: University of Chichester - Bognor Regis Campus

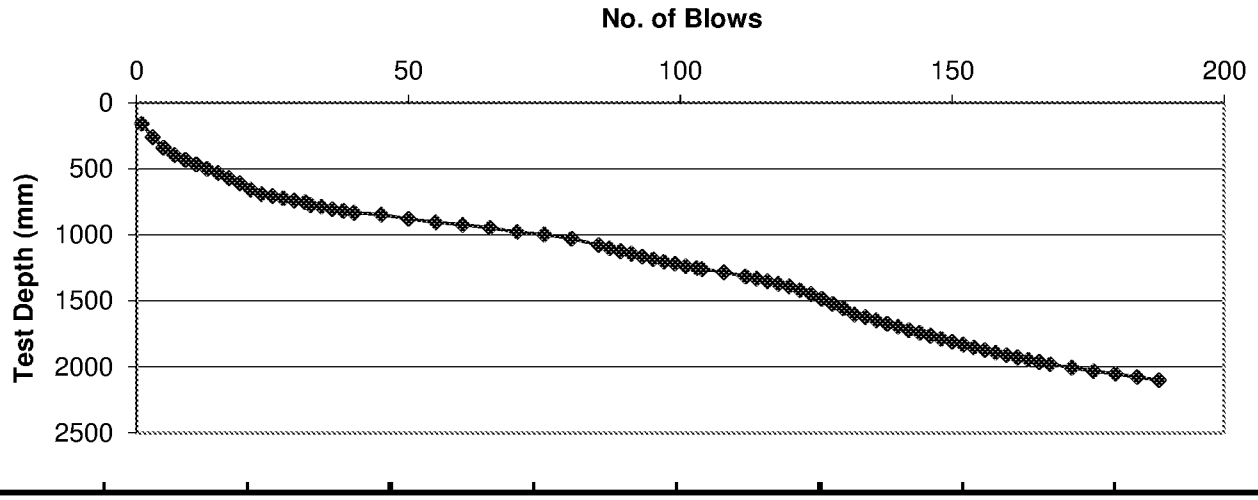
Test No. **DCP - 101**

Date: 18/11/2015

DCP Start Depth: (m) 0.00

DCP Completion Depth: (m) 2.1

No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm
2	1	158	5	75	999	2	138	1674
2	3	260	5	80	1030	2	140	1697
2	5	340	5	85	1079	2	142	1722
2	7	397	2	87	1103	2	144	1743
2	9	433	2	89	1124	2	146	1765
2	11	467	2	91	1144	2	148	1788
2	13	500	2	93	1165	2	150	1810
2	15	533	2	95	1184	2	152	1832
2	17	570	2	97	1203	2	154	1853
2	19	610	2	99	1219	2	156	1873
2	21	658	2	101	1237	2	158	1893
2	23	692	2	103	1253	2	160	1912
2	25	706	1	104	1260	2	162	1930
2	27	725	4	108	1284	2	164	1947
2	29	741	4	112	1315	2	166	1964
2	31	754	2	114	1333	2	168	1979
1	32	774	2	116	1351	4	172	2007
2	34	788	2	118	1371	4	176	2033
2	36	806	2	120	1391	4	180	2053
2	38	819	2	122	1419	4	184	2078
2	40	832	2	124	1450	4	188	2101
5	45	848	2	126	1485			
5	50	879	2	128	1523			
5	55	905	2	130	1558			
5	60	924	2	132	1603			
5	65	947	2	134	1623			
5	70	979	2	136	1648			



Remarks:

Instrument used : Transport Research Laboratory Dynamic Cone Penetrometer (TRL-DCP)

CONTRACT
C4872

ARUN DISTRICT COUNCIL BR/54/15/PL

CC GROUND INVESTIGATIONS LIMITED

DYNAMIC CONE PENETROMETER TESTING

CLIENT Univeristy of Chichester

SITE University of Chichester - Bognor Regis Campus

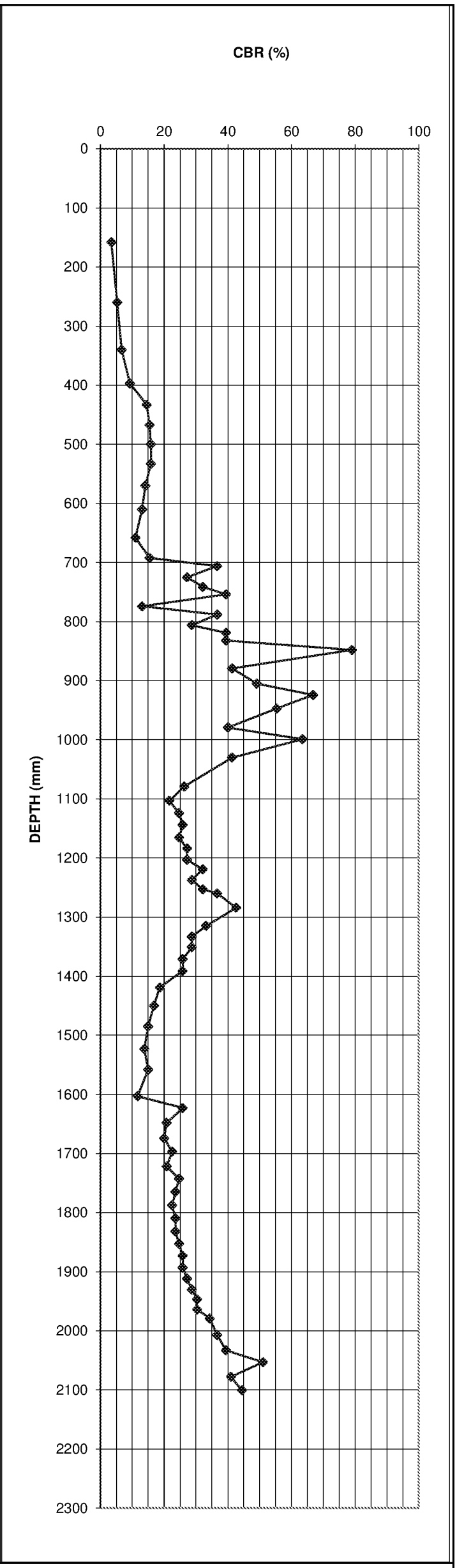
Test No. **DCP - 101**

Date: 18/11/2015

Initial scale reading (mm) 60

Datum - below ground level (bgl) (mm) 0

no. of Blows	scale reading (mm)	penetration - bgl (mm)	DCP (mm/blow)	CBR (%)
2	218	158	79	3.4
2	320	260	51	5.2
2	400	340	40	6.6
2	457	397	29	9.3
2	493	433	18	14.5
2	527	467	17	15.4
2	560	500	17	15.8
2	593	533	17	15.8
2	630	570	19	14.2
2	670	610	20	13.1
2	718	658	24	11.0
2	752	692	17	15.4
2	766	706	7	36.7
2	785	725	10	27.2
2	801	741	8	32.2
2	814	754	7	39.4
1	834	774	20	13.1
2	848	788	7	36.7
2	866	806	9	28.7
2	879	819	7	39.4
2	892	832	7	39.4
5	908	848	3	79.0
5	939	879	6	41.3
5	965	905	5	49.1
5	984	924	4	66.8
5	1007	947	5	55.4
5	1039	979	6	40.1
5	1059	999	4	63.5
5	1090	1030	6	41.3
5	1139	1079	10	26.4
2	1163	1103	12	21.6
2	1184	1124	11	24.7
2	1204	1144	10	25.9
2	1225	1165	11	24.7
2	1244	1184	10	27.2
2	1263	1203	10	27.2
2	1279	1219	8	32.2
2	1297	1237	9	28.7
2	1313	1253	8	32.2
1	1320	1260	7	36.7
4	1344	1284	6	42.7
4	1375	1315	8	33.2
2	1393	1333	9	28.7
2	1411	1351	9	28.7
2	1431	1371	10	25.9
2	1451	1391	10	25.9
2	1479	1419	14	18.6
2	1510	1450	16	16.8
2	1545	1485	18	14.9
2	1583	1523	19	13.8
2	1618	1558	18	14.9
2	1663	1603	23	11.7
2	1683	1623	10	25.9
2	1708	1648	13	20.8
2	1734	1674	13	20.0
2	1757	1697	12	22.6
2	1782	1722	13	20.8
2	1803	1743	11	24.7
2	1825	1765	11	23.6
2	1848	1788	12	22.6
2	1870	1810	11	23.6
2	1892	1832	11	23.6
2	1913	1853	11	24.7
2	1933	1873	10	25.9
2	1953	1893	10	25.9
2	1972	1912	10	27.2
2	1990	1930	9	28.7
2	2007	1947	9	30.3
2	2024	1964	9	30.3
2	2039	1979	8	34.3
4	2067	2007	7	36.7
4	2093	2033	7	39.4
4	2113	2053	5	51.0
4	2138	2078	6	41.0
4	2161	2101	6	44.5



REMARKS: CBR correlation based on correlation from Figure 4 of TRL Report TRL587 (2003) CBR = $247DCP^{0.98}$

CONTRACT

C4872

CC GROUND INVESTIGATIONS LTD

TRIAL PIT LOG

Pit No **TP102**

Sheet 1 of 1

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494436 N 99611 Level: 1.93mAOD	Date 11/11/2015
Location: Bognor Regis		Dimensions: 2.00m Depth 3.50m 0.45m	Scale 1 : 37.5
Client: University of Chichester			Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
					Soft light grey mottled orangish brown silty CLAY with frequent rootlets. (Topsoil)	(0.30)		
		B	0.40		Grey mottled orangish brown slightly sandy very clayey GRAVEL. Gravel is sub-angular and sub-rounded fine and medium flint. (Superficial Deposits)	0.30	1.63	
		B D H	0.70	H 58	Firm orangish brown and light grey slightly sandy slightly gravelly silty CLAY. Gravel is sub-angular and sub-rounded fine to coarse flint. (Superficial Deposits)	0.50	1.43	
1					1.00-1.50m: Stiff.	(1.00)		1
		B D	1.70		Soft light grey and orangish brown slightly sandy gravelly CLAY with rare 2mm thick sand lenses. Gravel is sub-angular and sub-rounded fine to coarse flint. Medium cobble content of flint. (Superficial Deposits)	1.50	0.43	
2						(0.70)		2
					Stiff light grey mottled orangish brown and reddish brown slightly sandy silty CLAY with occasional 2mm thick sand lenses. (Superficial Deposits)	2.20	-0.27	
		B D H	2.50	H 90		(0.60)		
	Seepage				Firm light grey silty CLAY with occasional vertical decomposed organic fragments up to 50mm long x 2mm diameter (Superficial Deposits)	2.80	-0.87	
3		B D H	3.00	H 60		(0.70)		3
		D	3.50		Trial pit completed at 3.50m	3.50	-1.57	
4								4
5								5
6								6

DRAFT

REMARKS:

EQUIPMENT: JCB 3CX.

METHOD: Machine excavated using 0.45m toothless bucket.

GROUNDWATER: Seepage noted at 2.80m.

BACKFILL: On completion, trial pit backfilled with arisings compacted in layers with the machine bucket.

REMARKS: Trial pit terminated at 3.50m.

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP102

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP102

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd	
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP102

ARUN DISTRICT COUNCIL BR/541/87/L

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP102

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP102

ARUN DISTRICT COUNCIL BR/54/15/PL

CC Ground Investigations Ltd

DCP - TRL Probe

CLIENT: Univeristy of Chichester

SITE: University of Chichester - Bognor Regis Campus

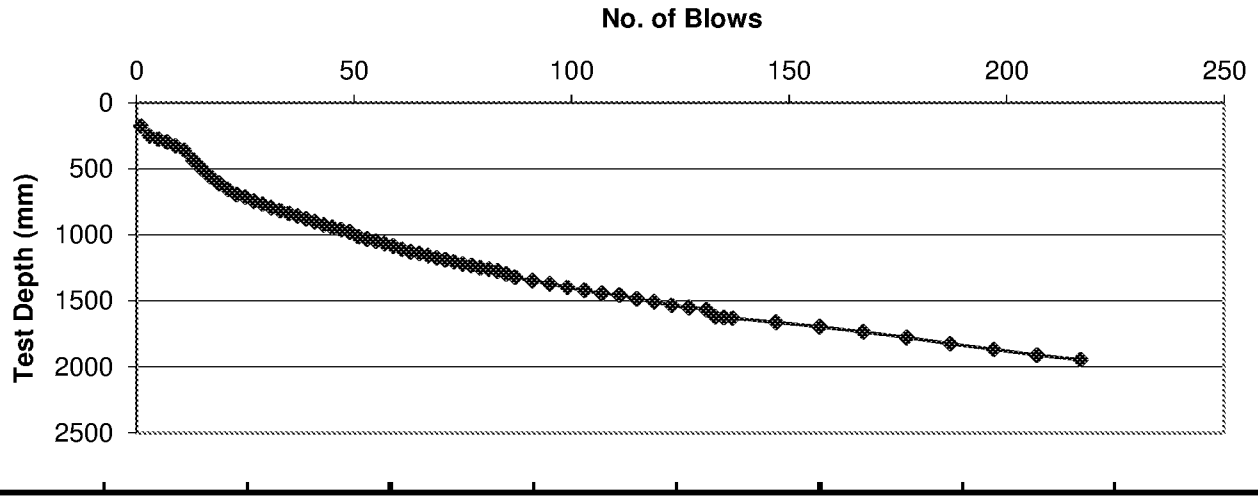
Test No. **DCP - 102**

Date: 18/11/2015

DCP Start Depth: (m) 0.00

DCP Completion Depth: (m) 0

No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm
2	1	175	2	55	1050	4	131	1568
2	3	250	2	57	1067	2	133	1621
2	5	275	2	59	1085	2	135	1627
2	7	298	2	61	1109	2	137	1632
2	9	325	2	63	1128	10	147	1663
2	11	360	2	65	1141	10	157	1697
2	13	432	2	67	1158	10	167	1736
2	15	499	2	69	1174	10	177	1778
2	17	559	2	71	1190	10	187	1825
2	19	609	2	73	1205	10	197	1868
2	21	655	2	75	1220	10	207	1911
2	23	695	2	77	1234	10	217	1947
2	25	715	2	79	1249			
2	27	745	2	81	1261			
2	29	767	2	83	1275			
2	31	794	2	85	1295			
2	33	815	2	87	1321			
2	35	837	4	91	1348			
2	37	858	4	95	1371			
2	39	880	4	99	1397			
2	41	901	4	103	1421			
2	43	925	4	107	1444			
2	45	944	4	111	1456			
2	47	962	4	115	1486			
2	49	979	4	119	1507			
2	51	1014	4	123	1535			
2	53	1031	4	127	1551			



Remarks:

Instrument used : Transport Research Laboratory Dynamic Cone Penetrometer (TRL-DCP)

CONTRACT
C4872

ARUN DISTRICT COUNCIL BR/54/16/PL

CC GROUND INVESTIGATIONS LIMITED

DYNAMIC CONE PENETROMETER TESTING

CLIENT Univeristy of Chichester

SITE University of Chichester - Bognor Regis Campus

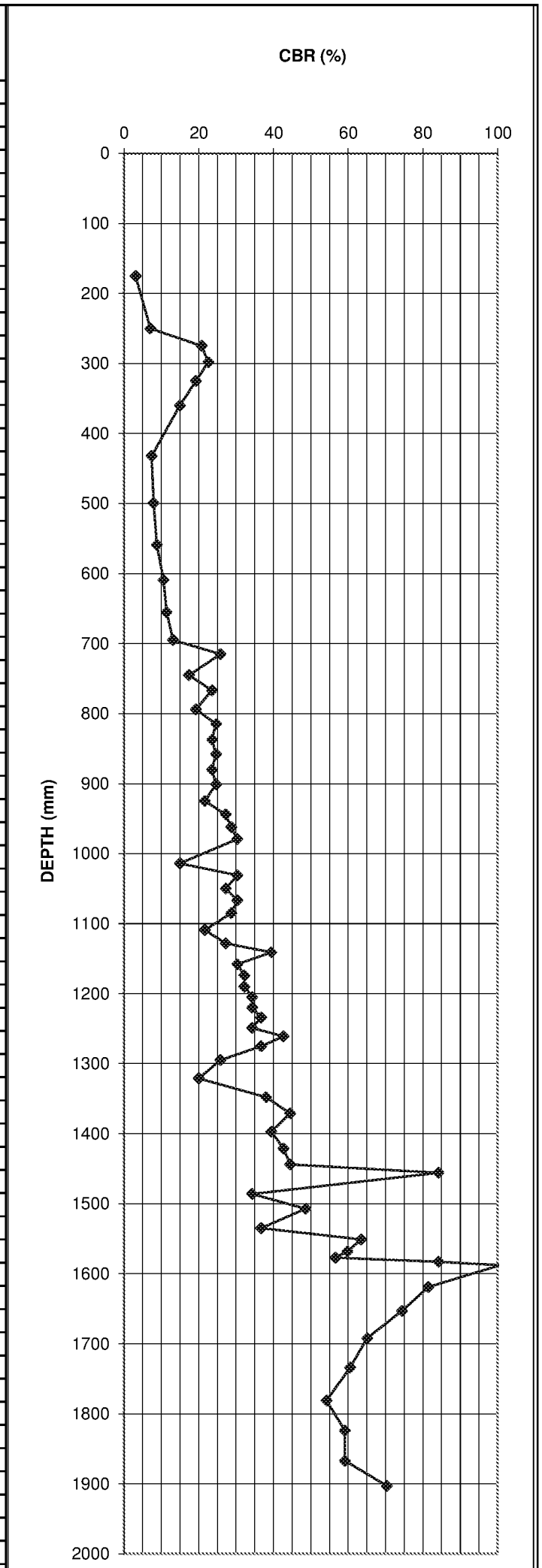
Test No. **DCP - 102**

Date: 18/11/2015

Initial scale reading (mm) 155

Datum - below ground level (bgl) (mm) 0

no. of Blows	scale reading (mm)	penetration - bgl (mm)	DCP (mm/blow)	CBR (%)
2	330	175	88	3.1
2	405	250	38	7.1
2	430	275	13	20.8
2	453	298	12	22.6
2	480	325	14	19.3
2	515	360	18	14.9
2	587	432	36	7.4
2	654	499	34	7.9
2	714	559	30	8.8
2	764	609	25	10.5
2	810	655	23	11.4
2	850	695	20	13.1
2	870	715	10	25.9
2	900	745	15	17.4
2	922	767	11	23.6
2	949	794	14	19.3
2	970	815	11	24.7
2	992	837	11	23.6
2	1013	858	11	24.7
2	1035	880	11	23.6
2	1056	901	11	24.7
2	1080	925	12	21.6
2	1099	944	10	27.2
2	1117	962	9	28.7
2	1134	979	9	30.3
2	1169	1014	18	14.9
2	1186	1031	9	30.3
2	1205	1050	10	27.2
2	1222	1067	9	30.3
2	1240	1085	9	28.7
2	1264	1109	12	21.6
2	1283	1128	10	27.2
2	1296	1141	7	39.4
2	1313	1158	9	30.3
2	1329	1174	8	32.2
2	1345	1190	8	32.2
2	1360	1205	8	34.3
2	1375	1220	8	34.3
2	1389	1234	7	36.7
2	1404	1249	8	34.3
2	1416	1261	6	42.7
2	1430	1275	7	36.7
2	1450	1295	10	25.9
2	1476	1321	13	20.0
4	1503	1348	7	38.0
4	1526	1371	6	44.5
4	1552	1397	7	39.4
4	1576	1421	6	42.7
4	1599	1444	6	44.5
4	1611	1456	3	84.2
4	1641	1486	8	34.3
4	1662	1507	5	48.6
4	1690	1535	7	36.7
4	1706	1551	4	63.5
4	1723	1568	4	59.8
2	1732	1577	5	56.6
2	1738	1583	3	84.2
2	1743	1588	3	100.6
10	1774	1619	3	81.5
10	1808	1653	3	74.4
10	1847	1692	4	65.1
10	1889	1734	4	60.5
10	1936	1781	5	54.2
10	1979	1824	4	59.1
10	2022	1867	4	59.1
10	2058	1903	4	70.4



REMARKS: CBR correlation based on correlation from Figure 4 of TRL Report TRL587 (2003) $CBR = 247DCP^{-0.98}$

CONTRACT

C4872

CC GROUND INVESTIGATIONS LTD

TRIAL PIT LOG

Pit No **TP103**

Sheet 1 of 1

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494411 N 99653 Level: 1.41mAOD	Date 10/11/2015
Location: Bognor Regis		Dimensions: 2.00m Depth 4.00m 0.45m	Scale 1 : 37.5
Client: University of Chichester			Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
		ES	0.05		MADE GROUND: Soft dark brown slightly sandy slightly gravelly CLAY with frequent rootlets. Gravel is sub-angular fine clay tile fragments.	0.20	1.21	
		B D ES	0.30		Stiff orangish brown mottled light grey slightly sandy silty CLAY with occasional rootlets. (Superficial Deposits)	(0.30) 0.50	0.91	
		B D H	0.70	H 10	Firm and stiff orangish brown and light grey silty CLAY. (Superficial Deposits)	(0.30) 0.80	0.61	
1		B D H	1.00	H 14	Soft light grey mottled orangish brown silty CLAY. (Superficial Deposits)	(0.60)		1
		B D ES H	1.50	H 61	Very soft light grey mottled orangish brown silty CLAY. (Superficial Deposits)	1.40	0.01	
2		B D H	2.00	H 10	Firm grey mottled orangish brown silty CLAY. (Superficial Deposits)	1.55 (0.65)	-0.14	2
3		B D H	3.00	H 15	Very soft grey mottled black slightly sandy silty CLAY with occasional decomposed organic fragments. (Superficial Deposits)	2.20 (1.80)	-0.79	3
4	Dry	H	4.00	H 15	Trial pit completed at 4.00m	4.00	-2.59	4
5								5
6								6

DRAFT

REMARKS:

EQUIPMENT: JCB 3CX.

METHOD: Machine excavated using 0.45m toothless bucket.

GROUNDWATER: Groundwater not encountered.

BACKFILL: On completion, trial pit backfilled with arisings compacted in layers with the machine bucket.

REMARKS: Soakaway test carried out at 1.55m depth. Trial pit terminated at 4.00m.

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP103

ARUN DISTRICT COUNCIL BR/54/15/PEL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP103

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP103

CC Ground Investigations Ltd

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP103

ARUN DISTRICT COUNCIL BR/541/67/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP103

ARUN DISTRICT COUNCIL BR/54/15/PL

CC GROUND INVESTIGATIONS LTD

SOAKAWAY TEST

[redacted]

Pit No **TP103**

Sheet 1 of 1

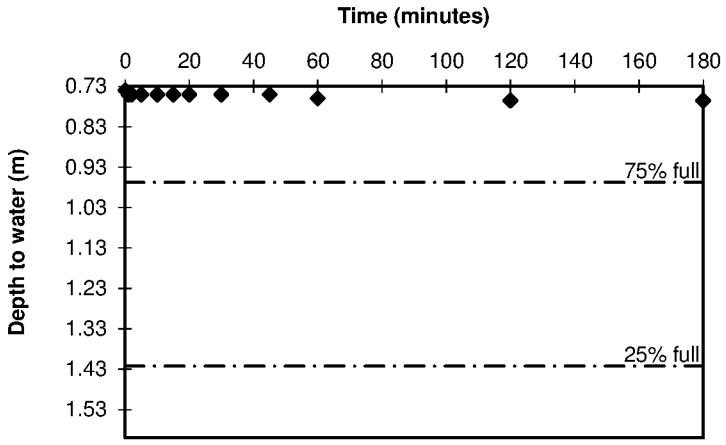
Project Name: University of Chichester Bognor Regis Campus	Project No: C4872	Co-ords: E N Level: mAD	11/11/2015
Location: Bognor Regis			Logged By DM
Client: WSP Remediation			Checked By MA

TEST 1:

LENGTH	1.60	m
BREADTH	0.45	m
DEPTH	1.65	m
WATER LEVEL	Dry	m
FILL LEVEL	0.74	m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

Insufficient soakaway to calculate infiltration rate



TEST 2:

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

TEST 3:

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

REMARKS:

Test carried out in general accordance with BRE 365 (2007).

ARUN DISTRICT COUNCIL BR/54/16/PL

CC GROUND INVESTIGATIONS LTD

TRIAL PIT LOG

[redacted]

Pit No **TP104**

Sheet 1 of 1

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494398 N 99676 Level: 1.36mAOD	Date 10/11/2015
Location: Bognor Regis		Dimensions: 2.00m Depth 4.00m 0.45m	Scale 1 : 37.5
Client: University of Chichester			Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
					MADE GROUND: Firm friable brown slightly sandy CLAY with frequent rootlets and rare gravel sized blue and white porcelain fragments.	(0.30)		
					Firm orangish brown mottled light grey silty CLAY. (Superficial Deposits)	0.30	1.06	
		B D H	0.50	H 60		(0.50)		
					Soft light grey mottled orangish brown silty CLAY. (Superficial Deposits)	0.80	0.56	
1		B D H	1.00	H 28		(0.50)		1
					Very soft grey mottled orangish brown and black silty CLAY. (Superficial Deposits)	1.30	0.06	
		B D H	1.50	H 16		(1.20)		
2								2
					Very soft grey mottled black silty CLAY. (Superficial Deposits)	2.50	-1.14	
3		B D H	3.00	H 12		(1.50)		3
4	Dry				Trial pit completed at 4.00m	4.00	-2.64	4
5								5
6								6

DRAFT

REMARKS:

EQUIPMENT: JCB 3CX.

METHOD: Machine excavated using 0.45m toothless bucket.

GROUNDWATER: Groundwater not encountered.

BACKFILL: On completion, trial pit backfilled with arisings compacted in layers with the machine bucket.

REMARKS: Trial pit terminated at 4.00m.

Trial Pit Photograph



Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP104

CC Ground Investigations Ltd

ARUN DISTRICT COUNCIL BR/541/87/PL

Trial Pit Photograph

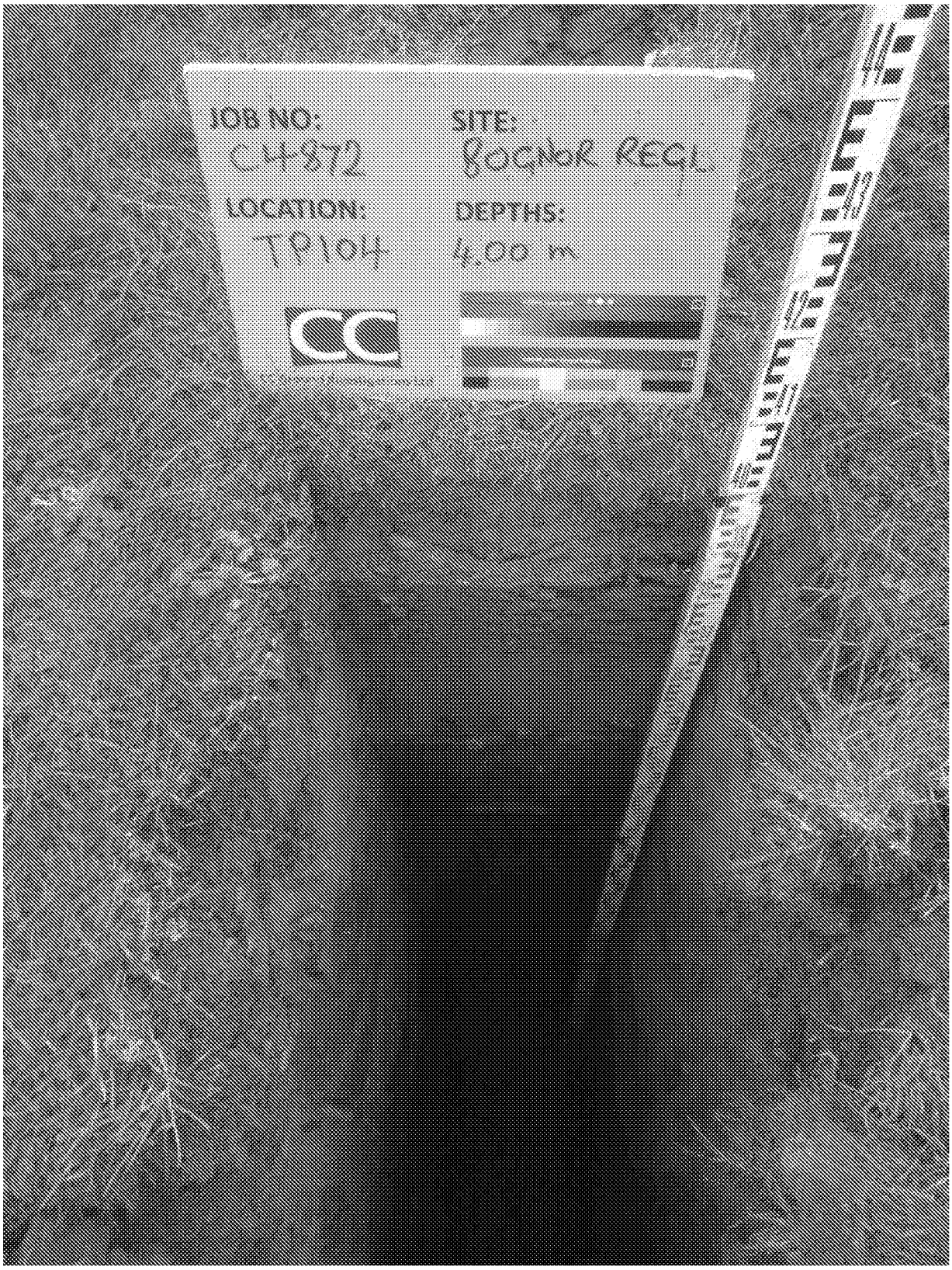


CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP104

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph

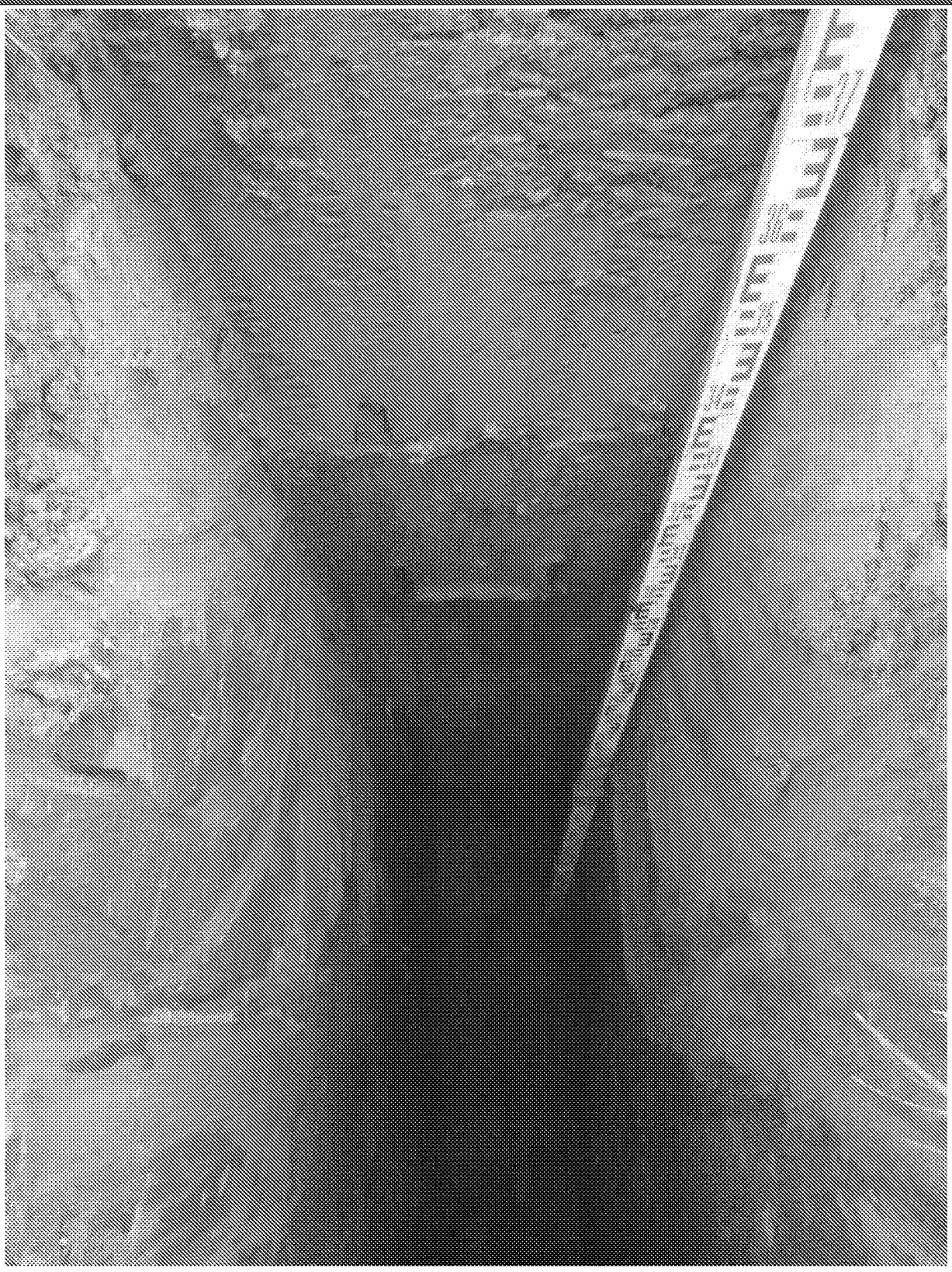


CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP104

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP104

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP104

ARUN DISTRICT COUNCIL BR/54/15/PL

CC Ground Investigations Ltd

DYNAMIC CONE PENETROMETER TESTING

CLIENT: Univeristy of Chichester

SITE: University of Chichester - Bognor Regis Campus

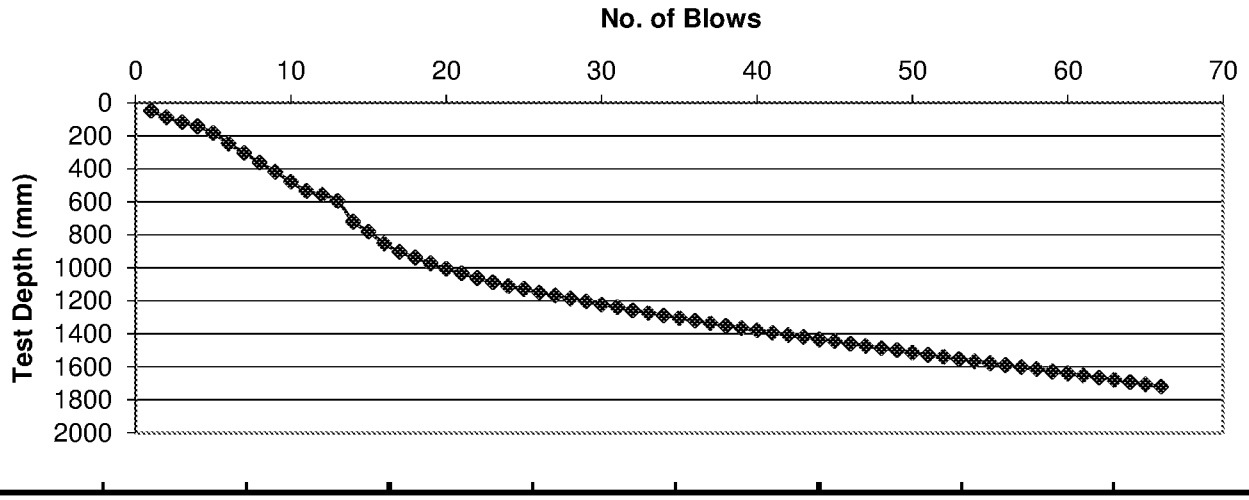
Test No. **DCP - 104**

Date: 18/11/2015

DCP Start Depth: (m) 0.00

DCP Completion Depth: (m) 1.87

No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm
1	1	48	1	28	1186	1	55	1578
1	2	88	1	29	1204	1	56	1590
1	3	118	1	30	1223	1	57	1602
1	4	143	1	31	1238	1	58	1614
1	5	184	1	32	1258	1	59	1628
1	6	248	1	33	1273	1	60	1641
1	7	304	1	34	1289	1	61	1652
1	8	362	1	35	1305	1	62	1665
1	9	418	1	36	1320	1	63	1679
1	10	478	1	37	1336	1	64	1693
1	11	535	1	38	1351	1	65	1706
1	12	558	1	39	1364	1	66	1720
1	13	594	1	40	1378	1	67	1734
1	14	720	1	41	1393	1	68	1748
1	15	780	1	42	1408	1	69	1762
1	16	853	1	43	1420	1	70	1776
1	17	903	1	44	1434	2	72	1804
1	18	938	1	45	1445	2	74	1833
1	19	973	1	46	1460	2	76	1859
1	20	1006	1	47	1473	2	78	1888
1	21	1033	1	48	1487	2	80	1927
1	22	1063	1	49	1499	2	82	1951
1	23	1088	1	50	1514	2	84	1974
1	24	1110	1	51	1528	2	86	1997
1	25	1129	1	52	1540	2	88	2019
1	26	1149	1	53	1553	2	90	2041
1	27	1166	1	54	1566	2	92	2065



Remarks:

Instrument used : Transport Research Laboratory Dynamic Cone Penetrometer (TRL-DCP)

CONTRACT

C4872

ARUN DISTRICT COUNCIL BR/54/15/PL

CC GROUND INVESTIGATIONS LIMITED

DYNAMIC CONE PENETROMETER TESTING

CLIENT Univeristy of Chichester

SITE University of Chichester - Bognor Regis Campus

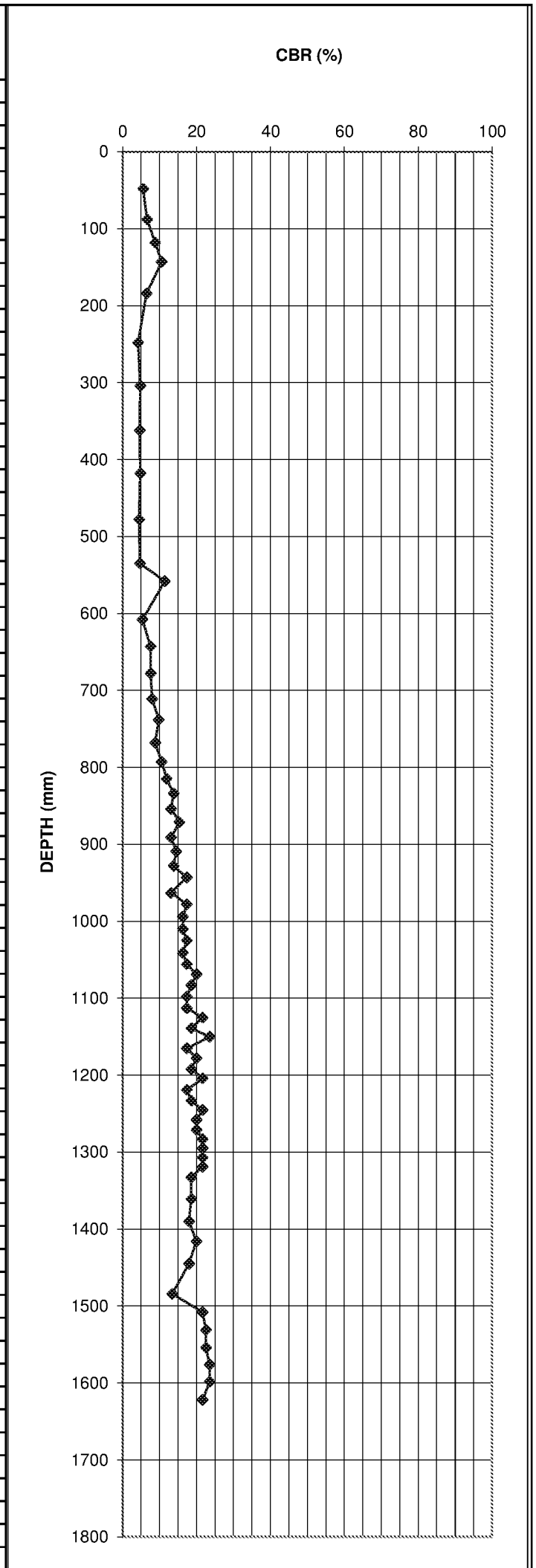
Test No. **DCP - 104**

Date: 18/11/2015

Initial scale reading (mm) 2

Datum - below ground level (bgl) (mm) 0

no. of Blows	scale reading (mm)	penetration - bgl (mm)	DCP (mm/blow)	CBR (%)
1	50	48	48	5.6
1	90	88	40	6.6
1	120	118	30	8.8
1	145	143	25	10.5
1	186	184	41	6.5
1	250	248	64	4.2
1	306	304	56	4.8
1	364	362	58	4.6
1	420	418	56	4.8
1	480	478	60	4.5
1	537	535	57	4.7
1	560	558	23	11.4
1	610	608	50	5.3
1	645	643	35	7.6
1	680	678	35	7.6
1	713	711	33	8.0
1	740	738	27	9.8
1	770	768	30	8.8
1	795	793	25	10.5
1	817	815	22	11.9
1	836	834	19	13.8
1	856	854	20	13.1
1	873	871	17	15.4
1	893	891	20	13.1
1	911	909	18	14.5
1	930	928	19	13.8
1	945	943	15	17.4
1	965	963	20	13.1
1	980	978	15	17.4
1	996	994	16	16.3
1	1012	1010	16	16.3
1	1027	1025	15	17.4
1	1043	1041	16	16.3
1	1058	1056	15	17.4
1	1071	1069	13	20.0
1	1085	1083	14	18.6
1	1100	1098	15	17.4
1	1115	1113	15	17.4
1	1127	1125	12	21.6
1	1141	1139	14	18.6
1	1152	1150	11	23.6
1	1167	1165	15	17.4
1	1180	1178	13	20.0
1	1194	1192	14	18.6
1	1206	1204	12	21.6
1	1221	1219	15	17.4
1	1235	1233	14	18.6
1	1247	1245	12	21.6
1	1260	1258	13	20.0
1	1273	1271	13	20.0
1	1285	1283	12	21.6
1	1297	1295	12	21.6
1	1309	1307	12	21.6
1	1321	1319	12	21.6
1	1335	1333	14	18.6
2	1363	1361	14	18.6
2	1392	1390	15	18.0
2	1418	1416	13	20.0
2	1447	1445	15	18.0
2	1486	1484	20	13.4
2	1510	1508	12	21.6
2	1533	1531	12	22.6
2	1556	1554	12	22.6
2	1578	1576	11	23.6
2	1600	1598	11	23.6
2	1624	1622	12	21.6



REMARKS: CBR correlation based on correlation from Figure 4 of TRL Report TRL587 (2003) $CBR = 247DCP^{-0.98}$

CONTRACT

C4872

CC GROUND INVESTIGATIONS LTD

TRIAL PIT LOG

Pit No **TP105**

Sheet 1 of 1

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494375 N 99720 Level: 1.40mAOD	Date 11/11/2015
Location: Bognor Regis		Dimensions: 1.90m Depth 3.70m 0.45m	Scale 1 : 37.5
Client: University of Chichester			Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
					MADE GROUND: Firm friable brown mottled reddish brown and grey slightly sandy slightly gravelly CLAY with frequent rootlets. Gravel is sub-angular fine brick and flint.	(0.30)		
					Firm light grey mottled orangish brown silty CLAY. (Superficial Deposits)	0.30	1.10	
		B D H	0.50	H 52		(0.90)		
1	Seepage							1
					Very soft light grey mottled orangish brown silty CLAY. (Superficial Deposits)	1.20	0.20	
		B D H	1.50	H 16		(0.90)		
2								2
					Very soft grey mottled black slightly sandy silty CLAY with occasional decomposed organic fragments. (Superficial Deposits)	2.10	-0.70	
	Seepage	B D H	2.50	H 14		(1.60)		
3								3
		B D H	3.50	H 13				
					Trial pit completed at 3.70m	3.70	-2.30	
4								4
5								5
6								6

DRAFT

REMARKS:

EQUIPMENT: JCB 3CX.

METHOD: Machine excavated using 0.45m toothless bucket.

GROUNDWATER: Seepage noted at 1.00m and 2.50m.

BACKFILL: On completion, trial pit backfilled with arisings compacted in layers with the machine bucket.

REMARKS: Trial pit terminated at 3.70m.

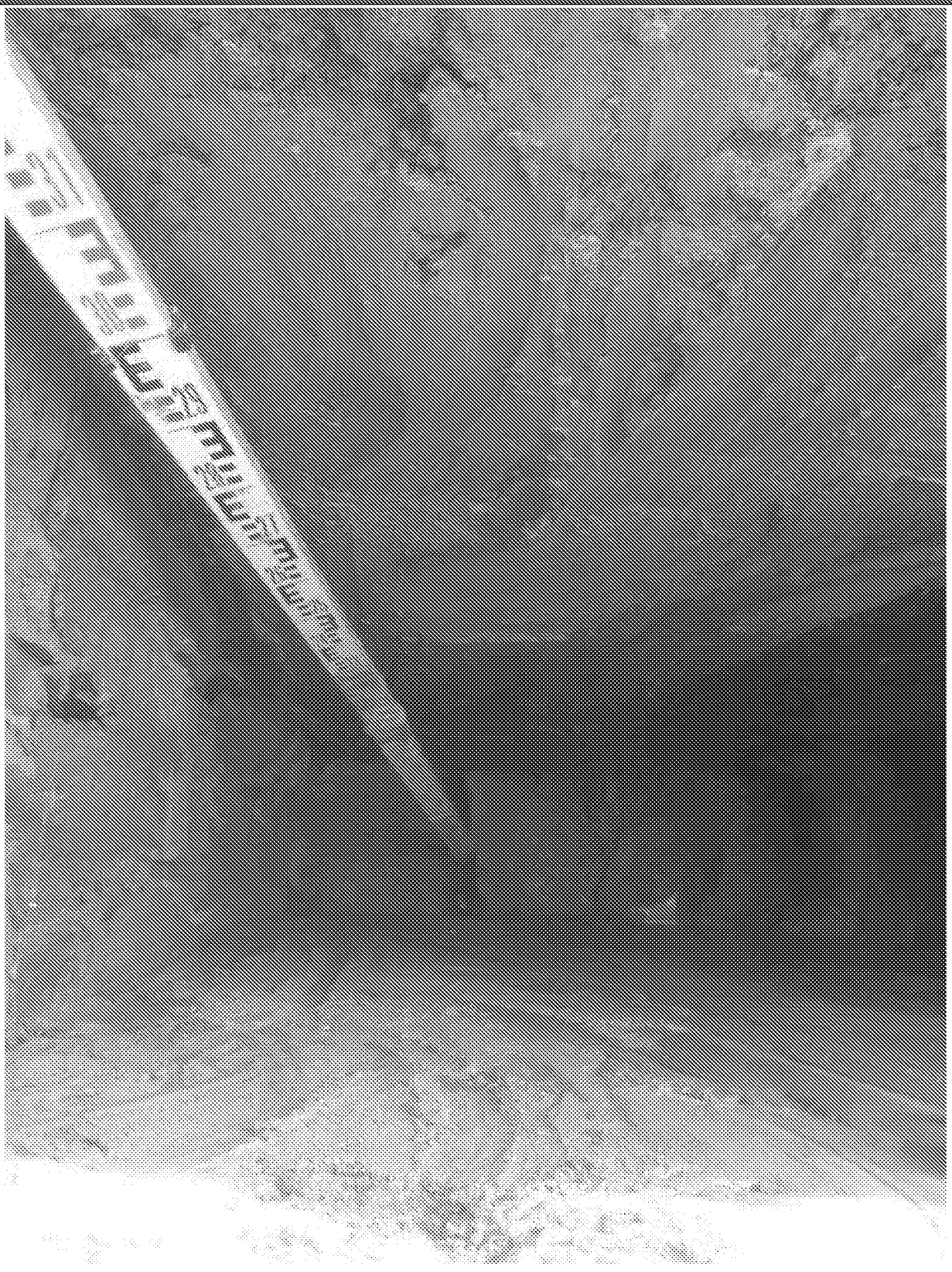
Trial Pit Photograph



CC Ground Investigations Ltd	
Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP105

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph

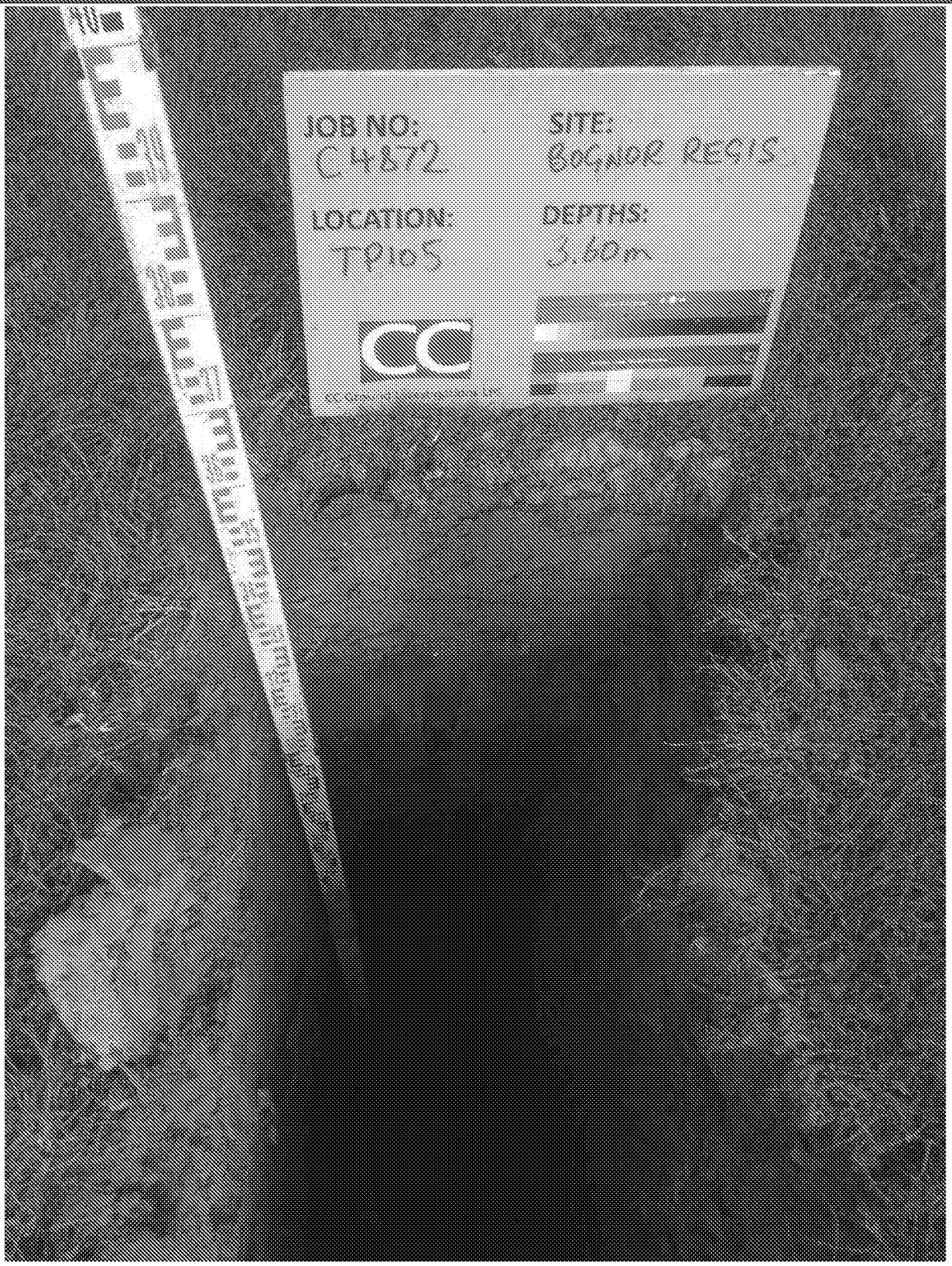


CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP105

ARUN DISTRICT COUNCIL BR/54/19/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP105

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP105

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP105

ARUN DISTRICT COUNCIL BR/54/15/PL

CC Ground Investigations Ltd

DYNAMIC CONE PENETROMETER TESTING

CLIENT: Univeristy of Chichester

SITE: University of Chichester - Bognor Regis Campus

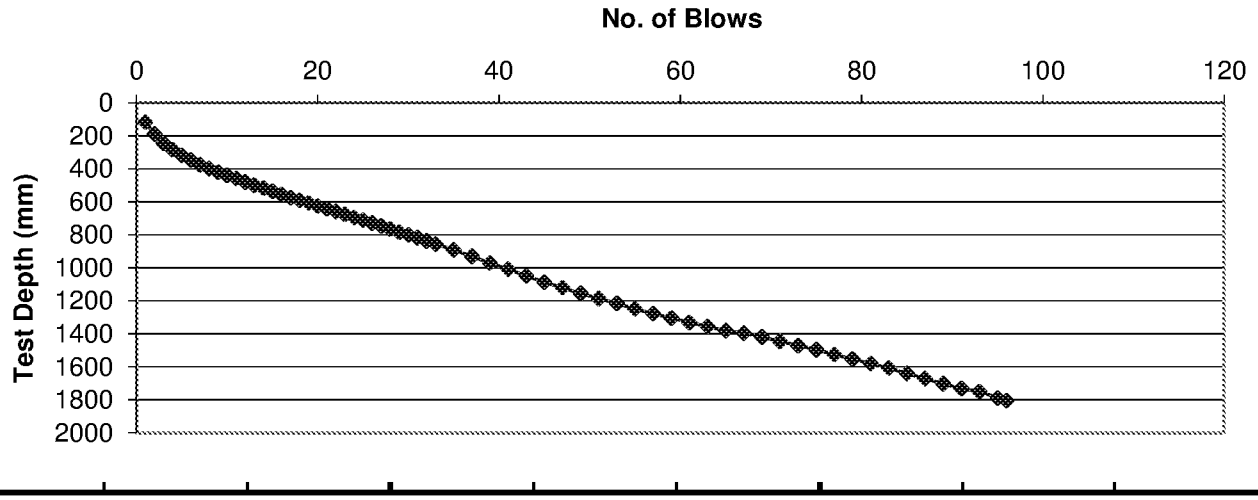
Test No. **DCP - 105**

Date: 18/11/2015

DCP Start Depth: (m) 0.00

DCP Completion Depth: (m) 1.81

No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm
1	1	117	1	28	765	2	77	1526
1	2	190	1	29	785	2	79	1553
1	3	245	1	30	800	2	81	1581
1	4	285	1	31	817	2	83	1608
1	5	320	1	32	837	2	85	1641
1	6	347	1	33	856	2	87	1671
1	7	375	2	35	891	2	89	1703
1	8	398	2	37	931	2	91	1732
1	9	420	2	39	971	2	93	1751
1	10	440	2	41	1008	2	95	1789
1	11	459	2	43	1049	1	96	1806
1	12	480	2	45	1087			
1	13	500	2	47	1121			
1	14	517	2	49	1156			
1	15	536	2	51	1186			
1	16	555	2	53	1216			
1	17	575	2	55	1249			
1	18	591	2	57	1278			
1	19	607	2	59	1304			
1	20	625	2	61	1331			
1	21	642	2	63	1356			
1	22	659	2	65	1381			
1	23	676	2	67	1396			
1	24	695	2	69	1420			
1	25	712	2	71	1446			
1	26	729	2	73	1471			
1	27	745	2	75	1496			



Remarks:

Instrument used : Transport Research Laboratory Dynamic Cone Penetrometer (TRL-DCP)

CONTRACT

C4872

ARUN DISTRICT COUNCIL BR/54/15/PL

CC GROUND INVESTIGATIONS LIMITED

DYNAMIC CONE PENETROMETER TESTING

CLIENT Univeristy of Chichester

SITE University of Chichester - Bognor Regis Campus

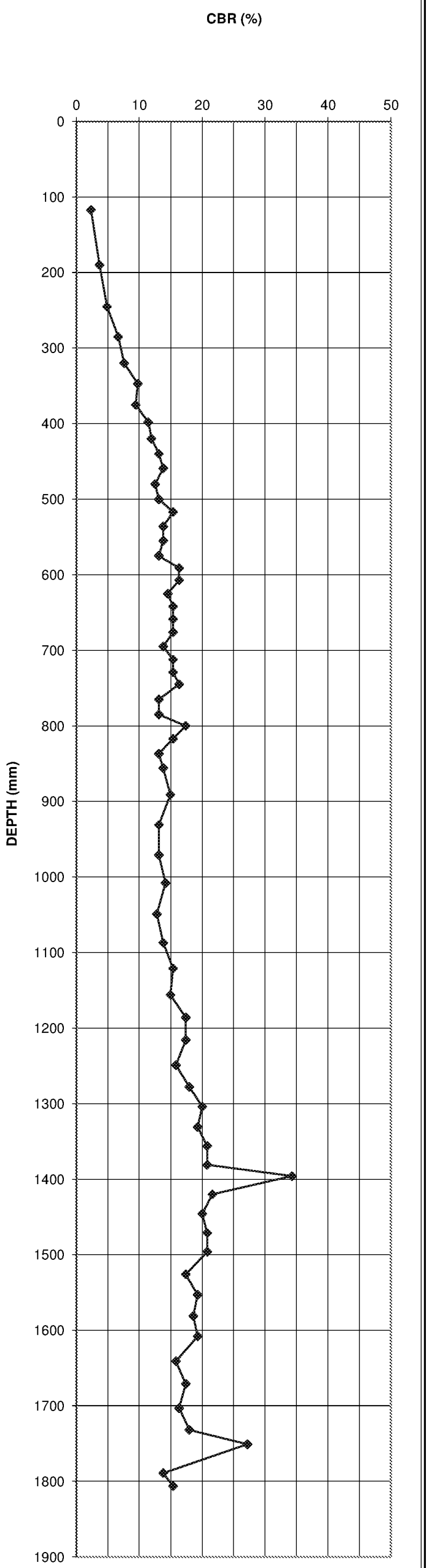
Test No. **DCP - 105**

Date: 18/11/2015

Initial scale reading (mm) 5

Datum - below ground level (bgl) (mm) 0

no. of Blows	scale reading (mm)	penetration - bgl (mm)	DCP (mm/blow)	CBR (%)
1	122	117	117	2.3
1	195	190	73	3.7
1	250	245	55	4.9
1	290	285	40	6.6
1	325	320	35	7.6
1	352	347	27	9.8
1	380	375	28	9.4
1	403	398	23	11.4
1	425	420	22	11.9
1	445	440	20	13.1
1	464	459	19	13.8
1	485	480	21	12.5
1	505	500	20	13.1
1	522	517	17	15.4
1	541	536	19	13.8
1	560	555	19	13.8
1	580	575	20	13.1
1	596	591	16	16.3
1	612	607	16	16.3
1	630	625	18	14.5
1	647	642	17	15.4
1	664	659	17	15.4
1	681	676	17	15.4
1	700	695	19	13.8
1	717	712	17	15.4
1	734	729	17	15.4
1	750	745	16	16.3
1	770	765	20	13.1
1	790	785	20	13.1
1	805	800	15	17.4
1	822	817	17	15.4
1	842	837	20	13.1
1	861	856	19	13.8
2	896	891	18	14.9
2	936	931	20	13.1
2	976	971	20	13.1
2	1013	1008	19	14.2
2	1054	1049	21	12.8
2	1092	1087	19	13.8
2	1126	1121	17	15.4
2	1161	1156	18	14.9
2	1191	1186	15	17.4
2	1221	1216	15	17.4
2	1254	1249	17	15.8
2	1283	1278	15	18.0
2	1309	1304	13	20.0
2	1336	1331	14	19.3
2	1361	1356	13	20.8
2	1386	1381	13	20.8
2	1401	1396	8	34.3
2	1425	1420	12	21.6
2	1451	1446	13	20.0
2	1476	1471	13	20.8
2	1501	1496	13	20.8
2	1531	1526	15	17.4
2	1558	1553	14	19.3
2	1586	1581	14	18.6
2	1613	1608	14	19.3
2	1646	1641	17	15.8
2	1676	1671	15	17.4
2	1708	1703	16	16.3
2	1737	1732	15	18.0
2	1756	1751	10	27.2
2	1794	1789	19	13.8
1	1811	1806	17	15.4



REMARKS: CBR correlation based on correlation from Figure 4 of TRL Report TRL587 (2003) $CBR = 247DCP^{-0.98}$

CONTRACT

C4872

CC GROUND INVESTIGATIONS LTD

TRIAL PIT LOG

[redacted]

Pit No **TP106** Sheet 1 of 1

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494419 N 99699 Level: 1.28mAOD	Date 10/11/2015
Location: Bognor Regis		Dimensions: 2.00m Depth 3.60m 0.45m	Scale 1 : 37.5
Client: University of Chichester			Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
		ES	0.10		MADE GROUND: Stiff friable brown mottled light grey slightly sandy slightly gravelly CLAY. Gravel is sub-angular fine and medium flint.	(0.40)		
		B D ES	0.50		Stiff light grey and orangish brown slightly sandy silty CLAY with occasional rootlets. (Superficial Deposits)	0.40 (0.30)	0.88	
					Firm orangish brown and light grey silty CLAY. (Superficial Deposits)	0.70	0.58	
1		B D H	1.00	H 50		(0.50)		1
					Soft light grey mottled orangish brown silty CLAY. (Superficial Deposits)	1.20	0.08	
		B D H	1.50	H 32		(0.60)		
					Very soft light grey mottled orangish brown slightly sandy silty CLAY. (Superficial Deposits)	1.80	-0.52	
2	Seepage	B D H ES	2.00 2.30	H 15		(0.40)		2
		B D H	2.50	H 17	Very soft dark grey slightly sandy silty CLAY. (Superficial Deposits)	2.20	-0.92	
3						(1.40)		3
		B D H	3.50	H 11	Trial pit completed at 3.60m	3.60	-2.32	
4								4
5								5
6								6

DRAFT

REMARKS:

EQUIPMENT: JCB 3CX.

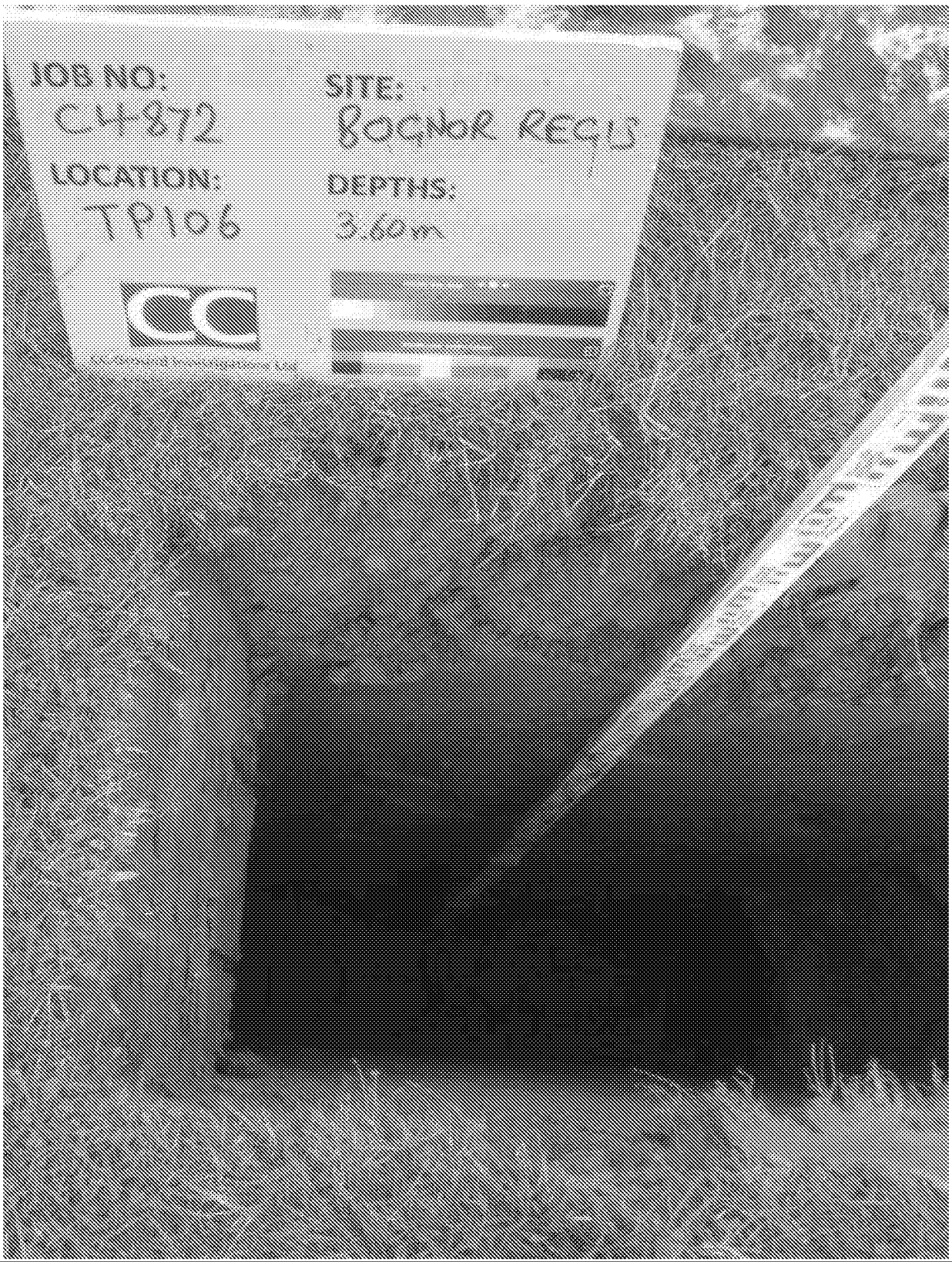
METHOD: Machine excavated using 0.45m toothless bucket.

GROUNDWATER: Groundwater seepage noted at 2.00m.

BACKFILL: On completion, trial pit backfilled with arisings compacted in layers with the machine bucket.

REMARKS: Trial pit terminated at 3.60m.

Trial Pit Photograph



Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP106

CC Ground Investigations Ltd

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP106

ARUN DISTRICT COUNCIL BR/54/19/PL

Trial Pit Photograph

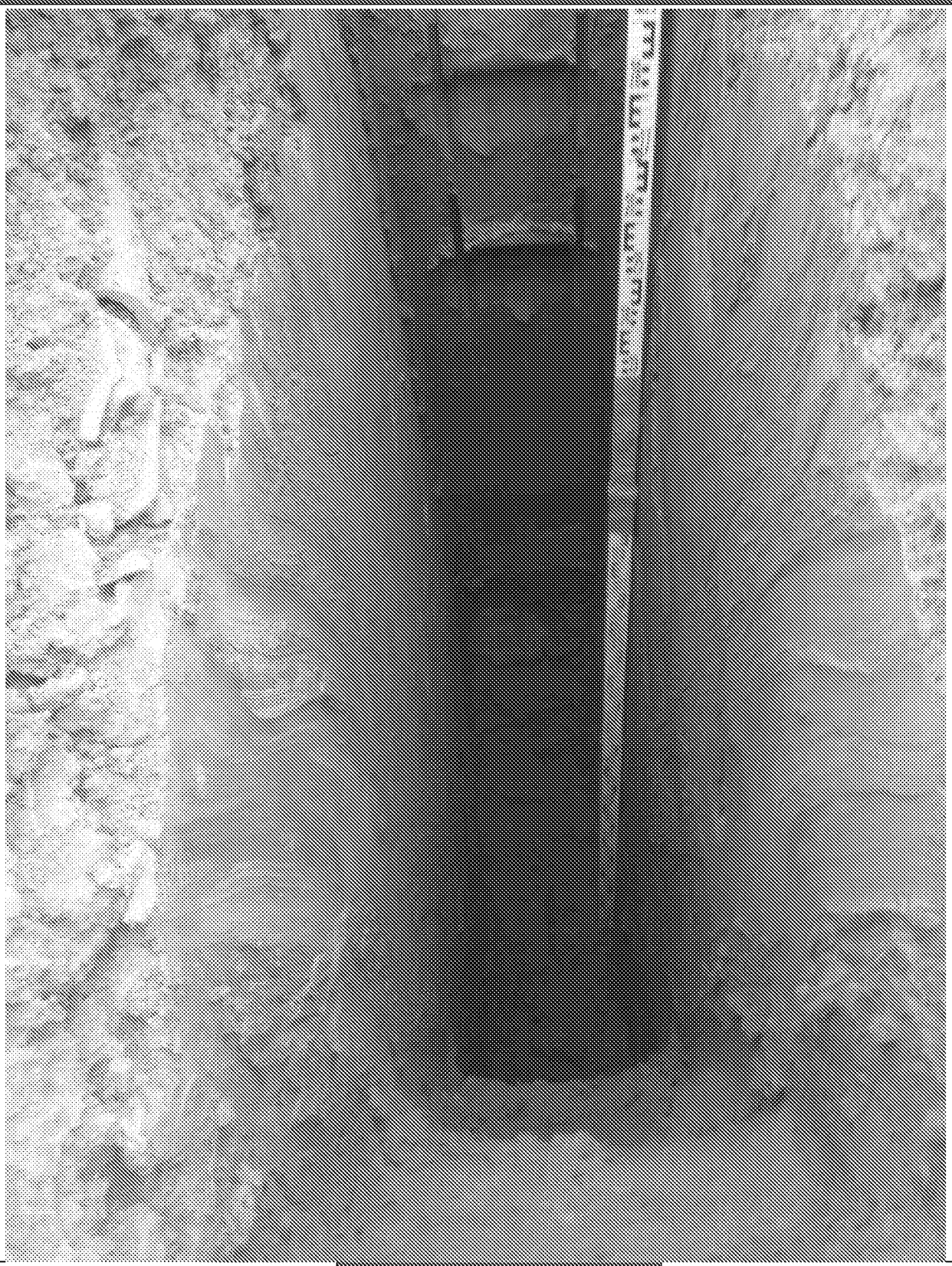


CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP106

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
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ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



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ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP106

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CC Ground Investigations Ltd

DYNAMIC CONE PENETROMETER TESTING

CLIENT: Univeristy of Chichester

SITE: University of Chichester - Bognor Regis Campus

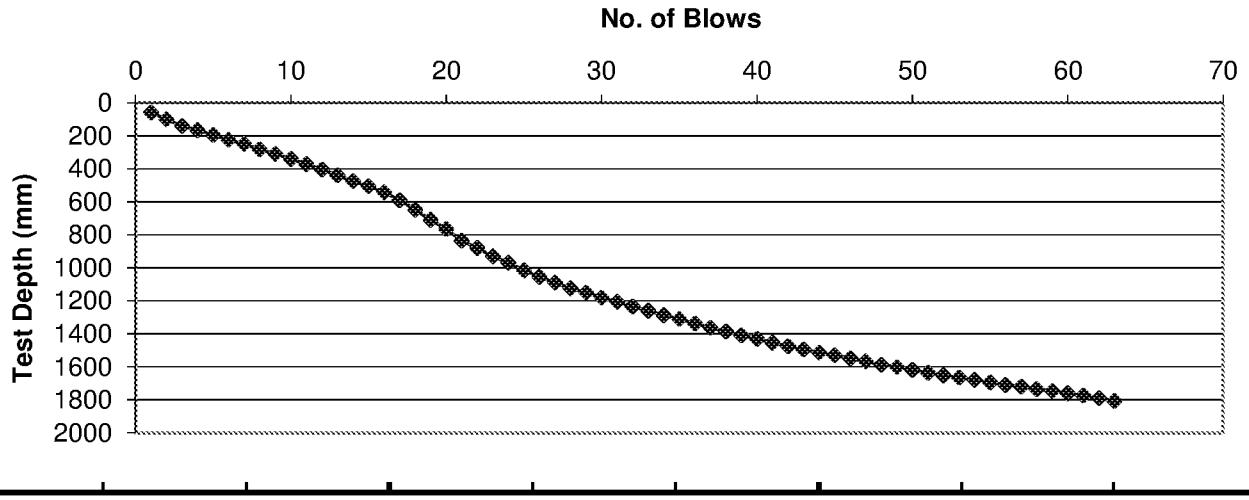
Test No. **DCP - 106**

Date: 18/11/2015

DCP Start Depth: (m) 0.00

DCP Completion Depth: (m) 1.81

No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm
1	1	60	1	28	1125	1	55	1695
1	2	100	1	29	1150	1	56	1710
1	3	140	1	30	1180	1	57	1720
1	4	165	1	31	1205	1	58	1735
1	5	195	1	32	1235	1	59	1747
1	6	225	1	33	1260	1	60	1760
1	7	250	1	34	1288	1	61	1775
1	8	282	1	35	1310	1	62	1789
1	9	310	1	36	1338	1	63	1807
1	10	340	1	37	1363			
1	11	372	1	38	1387			
1	12	405	1	39	1410			
1	13	440	1	40	1430			
1	14	475	1	41	1455			
1	15	505	1	42	1475			
1	16	543	1	43	1495			
1	17	590	1	44	1515			
1	18	647	1	45	1530			
1	19	710	1	46	1550			
1	20	765	1	47	1567			
1	21	835	1	48	1587			
1	22	880	1	49	1602			
1	23	930	1	50	1619			
1	24	970	1	51	1636			
1	25	1015	1	52	1651			
1	26	1055	1	53	1666			
1	27	1090	1	54	1680			



Remarks:

Instrument used : Transport Research Laboratory Dynamic Cone Penetrometer (TRL-DCP)

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ARUN DISTRICT COUNCIL BR/54/15/PEL

CC GROUND INVESTIGATIONS LIMITED

DYNAMIC CONE PENETROMETER TESTING

CLIENT Univeristy of Chichester

SITE University of Chichester - Bognor Regis Campus

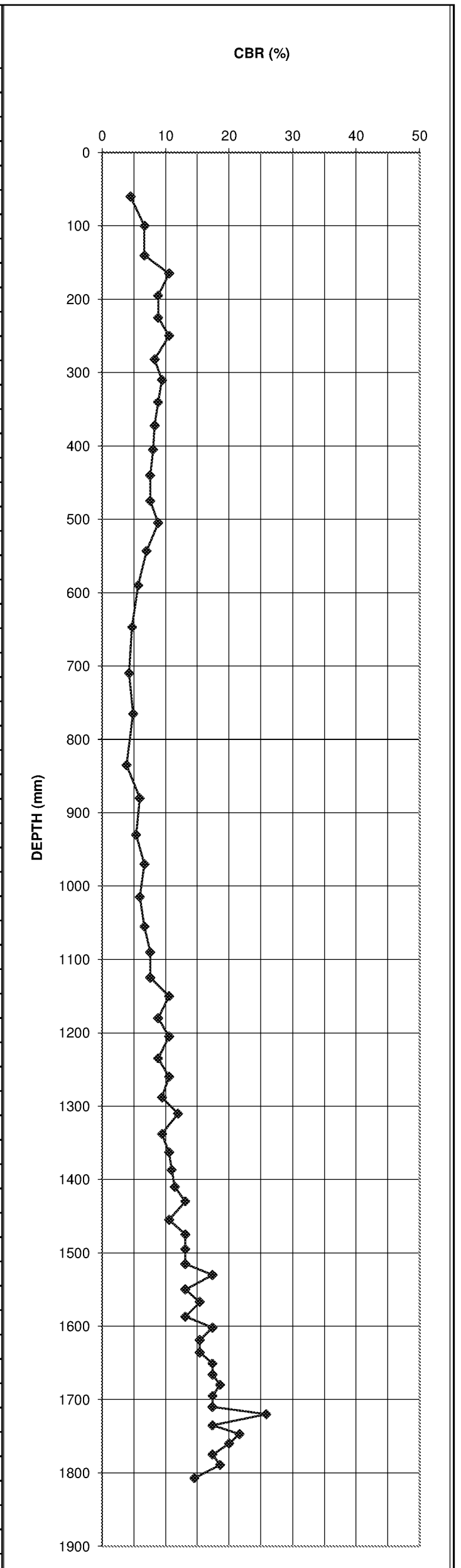
Test No. **DCP - 106**

Date: 18/11/2015

Initial scale reading (mm) 10

Datum - below ground level (bgl) (mm) 0

no. of Blows	scale reading (mm)	penetration - bgl (mm)	DCP (mm/blow)	CBR (%)
1	70	60	60	4.5
1	110	100	40	6.6
1	150	140	40	6.6
1	175	165	25	10.5
1	205	195	30	8.8
1	235	225	30	8.8
1	260	250	25	10.5
1	292	282	32	8.3
1	320	310	28	9.4
1	350	340	30	8.8
1	382	372	32	8.3
1	415	405	33	8.0
1	450	440	35	7.6
1	485	475	35	7.6
1	515	505	30	8.8
1	553	543	38	7.0
1	600	590	47	5.7
1	657	647	57	4.7
1	720	710	63	4.3
1	775	765	55	4.9
1	845	835	70	3.8
1	890	880	45	5.9
1	940	930	50	5.3
1	980	970	40	6.6
1	1025	1015	45	5.9
1	1065	1055	40	6.6
1	1100	1090	35	7.6
1	1135	1125	35	7.6
1	1160	1150	25	10.5
1	1190	1180	30	8.8
1	1215	1205	25	10.5
1	1245	1235	30	8.8
1	1270	1260	25	10.5
1	1298	1288	28	9.4
1	1320	1310	22	11.9
1	1348	1338	28	9.4
1	1373	1363	25	10.5
1	1397	1387	24	11.0
1	1420	1410	23	11.4
1	1440	1430	20	13.1
1	1465	1455	25	10.5
1	1485	1475	20	13.1
1	1505	1495	20	13.1
1	1525	1515	20	13.1
1	1540	1530	15	17.4
1	1560	1550	20	13.1
1	1577	1567	17	15.4
1	1597	1587	20	13.1
1	1612	1602	15	17.4
1	1629	1619	17	15.4
1	1646	1636	17	15.4
1	1661	1651	15	17.4
1	1676	1666	15	17.4
1	1690	1680	14	18.6
1	1705	1695	15	17.4
1	1720	1710	15	17.4
1	1730	1720	10	25.9
1	1745	1735	15	17.4
1	1757	1747	12	21.6
1	1770	1760	13	20.0
1	1785	1775	15	17.4
1	1799	1789	14	18.6
1	1817	1807	18	14.5



REMARKS: CBR correlation based on correlation from Figure 4 of TRL Report TRL587 (2003) $CBR = 247DCP^{-0.98}$

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C4872

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TRIAL PIT LOG

Pit No **TP107**

Sheet 1 of 1

[redacted]

Project Name: University of Chichester	Project No: **C4872**	Co-ords: E 494445 N 99727 Level: 1.31mAOD	Date 10/11/2015
Location: Bognor Regis		Dimensions: 2.00m Depth 3.60m 0.45m	Scale 1 : 37.5
Client: University of Chichester			Logged By RS

(m)	Water Levels	Samples & In Situ Testing No/Type	Depth (m)	Result	Description	Depth (m)	Level (mAD)	Legend
					MADE GROUND: Firm friable brown locally mottled reddish brown and white slightly sandy slightly gravelly CLAY with frequent rootlets. Gravel is sub-angular fine clay pipe fragments and chalk.	(0.40)		
		B D	0.50		Firm orangish brown mottled light grey slightly sandy silty CLAY with rare rootlets. (Superficial Deposits)	0.40 (0.40)	0.91	
1		B D H	1.00	H 65	Firm light grey mottled orangish brown slightly sandy silty CLAY. (Superficial Deposits)	0.80 (0.40)	0.51	1
		B D H	1.50	H 25	Soft light grey mottled orangish brown slightly sandy silty CLAY. (Superficial Deposits)	1.20 (0.80)	0.11	
2					Very soft grey mottled orangish brown silty CLAY. (Superficial Deposits)	2.00	-0.69	2
		B D H	2.50	H 13		(1.00)		
3					Very soft grey mottled black silty CLAY. (Superficial Deposits)	3.00 (0.60)	-1.69	3
	Dry	B D H	3.50	H 17	Trial pit completed at 3.60m	3.60	-2.29	
4								4
5								5
6								6

DRAFT

REMARKS:

EQUIPMENT: JCB 3CX.

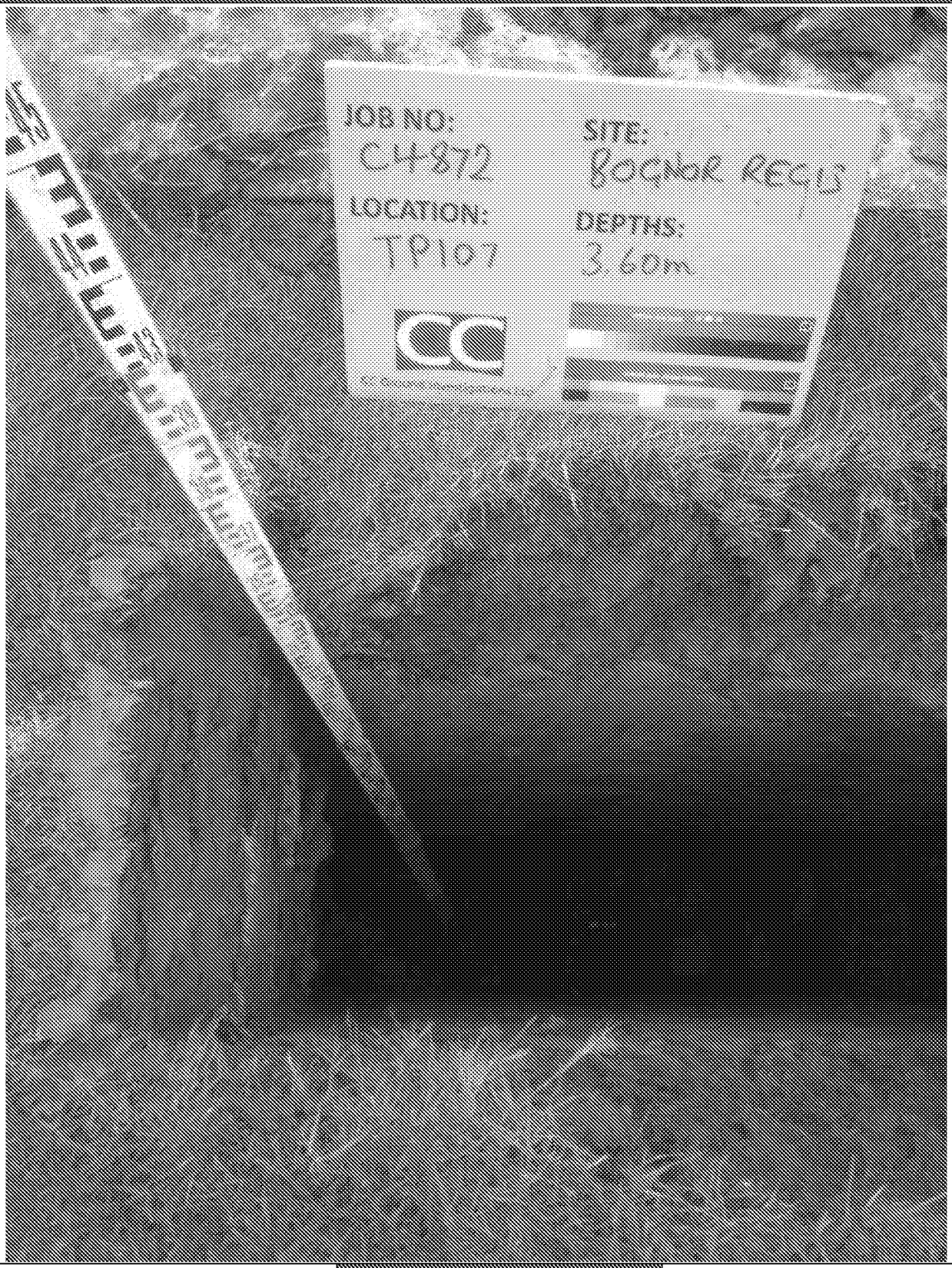
METHOD: Machine excavated using 0.45m toothless bucket.

GROUNDWATER: Groundwater not encountered.

BACKFILL: On completion, trial pit backfilled with arisings compacted in layers with the machine bucket.

REMARKS: Trial pit terminated at 3.60m.

Trial Pit Photograph

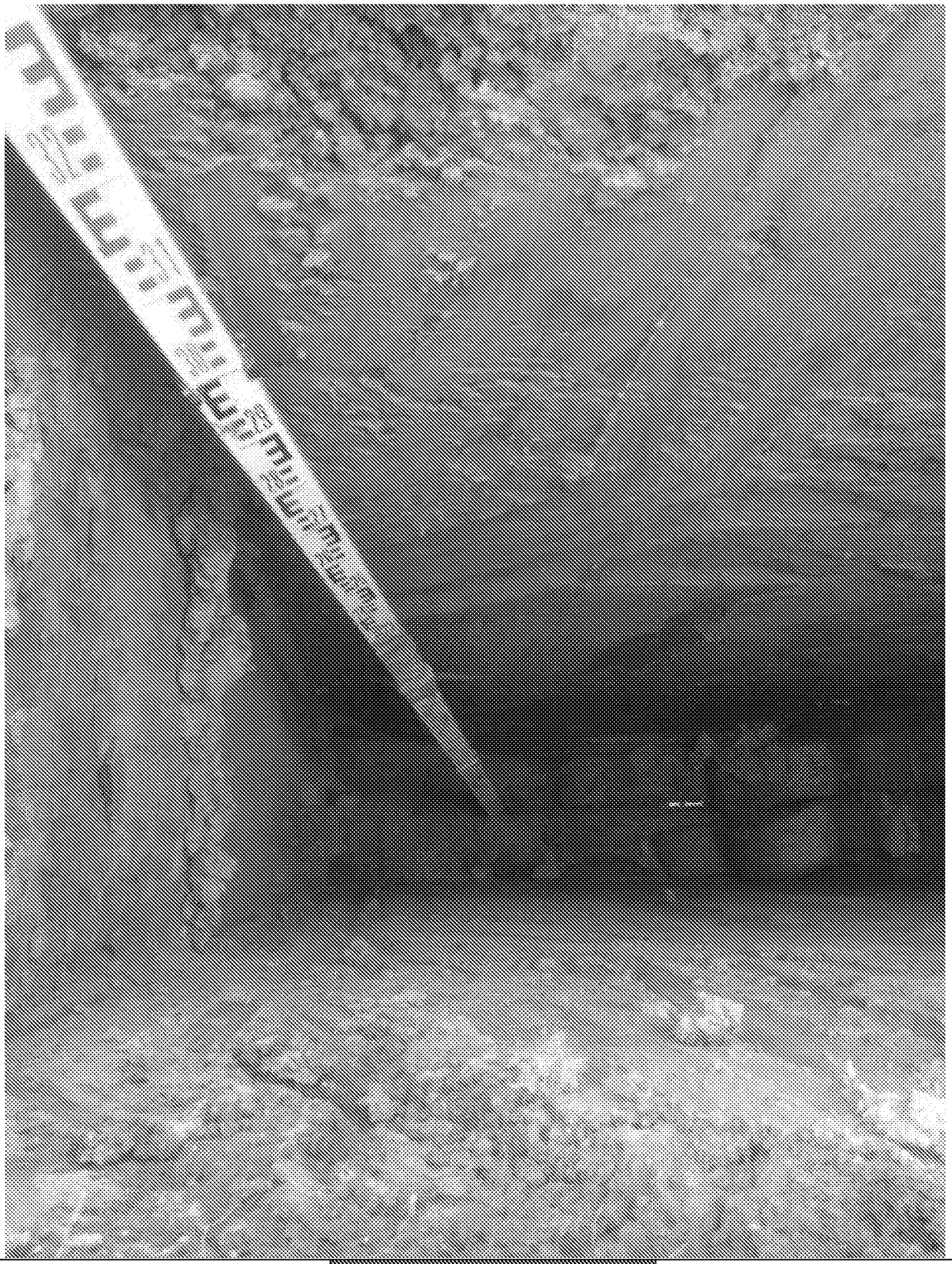


CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP107

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP107

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP107

ARUN DISTRICT COUNCIL BR/54/19/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP107

ARUN DISTRICT COUNCIL BR/54/15/PL

Trial Pit Photograph



CC Ground Investigations Ltd

Contract Name:	University of Chichester
Contract ID:	C4872
Client:	University of Chichester
Hole ID:	TP107

ARUN DISTRICT COUNCIL BR/54/15/PL

CC Ground Investigations Ltd

DYNAMIC CONE PENETROMETER TESTING

CLIENT: Univeristy of Chichester

SITE: University of Chichester - Bognor Regis Campus

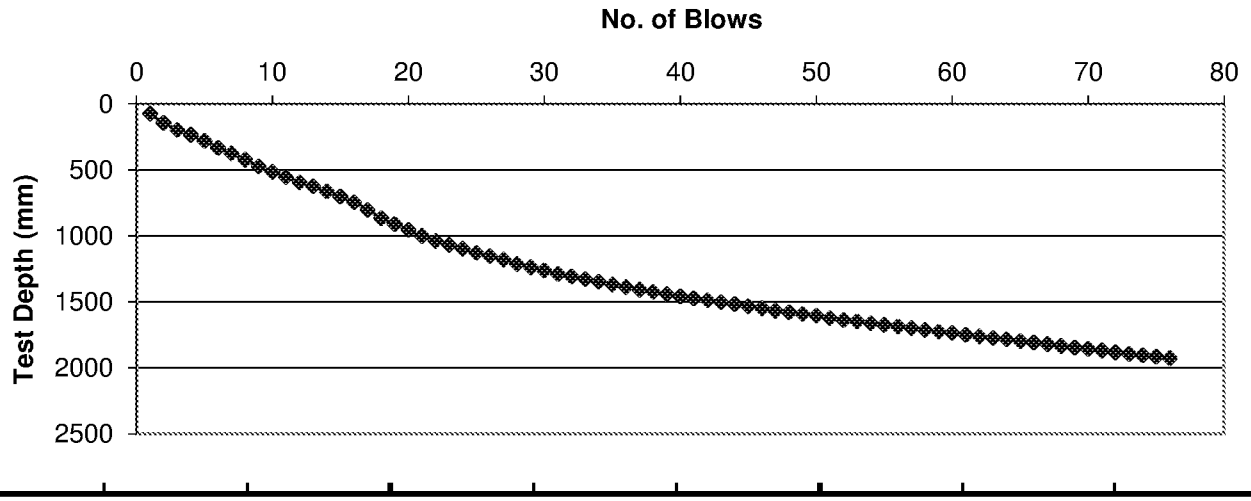
Test No. **DCP - 107**

Date: 18/11/2015

DCP Start Depth: (m) 0.00

DCP Completion Depth: (m) 1.96

No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm	No Blows	Total Blows	Reading mm
1	1	75	1	28	1213	1	55	1674
1	2	145	1	29	1239	1	56	1687
1	3	197	1	30	1263	1	57	1698
1	4	235	1	31	1288	1	58	1713
1	5	280	1	32	1309	1	59	1725
1	6	333	1	33	1328	1	60	1734
1	7	375	1	34	1348	1	61	1750
1	8	423	1	35	1369	1	62	1762
1	9	473	1	36	1388	1	63	1773
1	10	515	1	37	1408	1	64	1784
1	11	555	1	38	1425	1	65	1798
1	12	595	1	39	1442	1	66	1809
1	13	625	1	40	1459	1	67	1820
1	14	664	1	41	1474	1	68	1835
1	15	702	1	42	1488	1	69	1847
1	16	745	1	43	1503	1	70	1857
1	17	803	1	44	1517	1	71	1869
1	18	867	1	45	1533	1	72	1882
1	19	910	1	46	1549	1	73	1895
1	20	955	1	47	1567	1	74	1904
1	21	1001	1	48	1579	1	75	1915
1	22	1038	1	49	1593	1	76	1927
1	23	1068	1	50	1605	1	77	1938
1	24	1098	1	51	1623	1	78	1948
1	25	1128	1	52	1637	1	79	1962
1	26	1153	1	53	1648			
1	27	1180	1	54	1663			



Instrument used : Transport Research Laboratory Dynamic Cone Penetrometer (TRL-DCP)

Instrument used : TRL Probe

CONTRACT

C4872

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CC GROUND INVESTIGATIONS LIMITED

DYNAMIC CONE PENETROMETER TESTING

CLIENT Univeristy of Chichester

SITE University of Chichester - Bognor Regis Campus

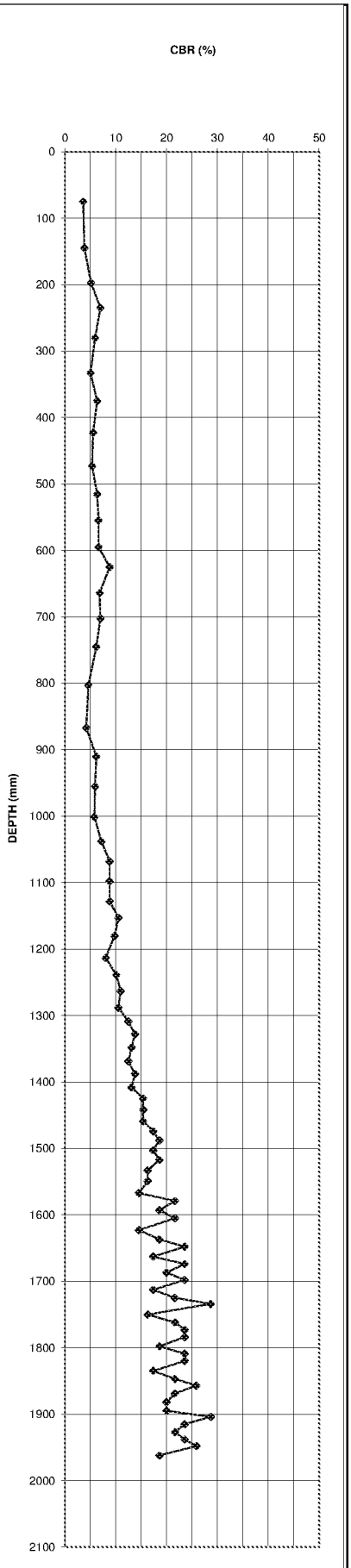
Test No. **DCP - 107**

Date: 18/11/2015

Initial scale reading (mm) 70

Datum - below ground level (bgl) (mm) 0

no. of Blows	scale reading (mm)	penetration - bgl (mm)	DCP (mm/blow)	CBR (%)
1	145	75	75	3.6
1	215	145	70	3.8
1	267	197	52	5.1
1	305	235	38	7.0
1	350	280	45	5.9
1	403	333	53	5.0
1	445	375	42	6.3
1	493	423	48	5.6
1	543	473	50	5.3
1	585	515	42	6.3
1	625	555	40	6.6
1	665	595	40	6.6
1	695	625	30	8.8
1	734	664	39	6.8
1	772	702	38	7.0
1	815	745	43	6.2
1	873	803	58	4.6
1	937	867	64	4.2
1	980	910	43	6.2
1	1025	955	45	5.9
1	1071	1001	46	5.8
1	1108	1038	37	7.2
1	1138	1068	30	8.8
1	1168	1098	30	8.8
1	1198	1128	30	8.8
1	1223	1153	25	10.5
1	1250	1180	27	9.8
1	1283	1213	33	8.0
1	1309	1239	26	10.1
1	1333	1263	24	11.0
1	1358	1288	25	10.5
1	1379	1309	21	12.5
1	1398	1328	19	13.8
1	1418	1348	20	13.1
1	1439	1369	21	12.5
1	1458	1388	19	13.8
1	1478	1408	20	13.1
1	1495	1425	17	15.4
1	1512	1442	17	15.4
1	1529	1459	17	15.4
1	1544	1474	15	17.4
1	1558	1488	14	18.6
1	1573	1503	15	17.4
1	1587	1517	14	18.6
1	1603	1533	16	16.3
1	1619	1549	16	16.3
1	1637	1567	18	14.5
1	1649	1579	12	21.6
1	1663	1593	14	18.6
1	1675	1605	12	21.6
1	1693	1623	18	14.5
1	1707	1637	14	18.6
1	1718	1648	11	23.6
1	1733	1663	15	17.4
1	1744	1674	11	23.6
1	1757	1687	13	20.0
1	1768	1698	11	23.6
1	1783	1713	15	17.4
1	1795	1725	12	21.6
1	1804	1734	9	28.7
1	1820	1750	16	16.3
1	1832	1762	12	21.6
1	1843	1773	11	23.6
1	1854	1784	11	23.6
1	1868	1798	14	18.6
1	1879	1809	11	23.6
1	1890	1820	11	23.6
1	1905	1835	15	17.4
1	1917	1847	12	21.6
1	1927	1857	10	25.9
1	1939	1869	12	21.6
1	1952	1882	13	20.0
1	1965	1895	13	20.0
1	1974	1904	9	28.7
1	1985	1915	11	23.6
1	1997	1927	12	21.6
1	2008	1938	11	23.6
1	2018	1948	10	25.9
1	2032	1962	14	18.6



REMARKS: CBR correlation based on correlation from Figure 4 of TRL Report TRL587 (2003) CBR = $247DCP^{-0.98}$

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APPENDIX C

Appendix C – Laboratory Test Results

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APPENDIX D

Appendix D – SPT Calibration Data

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Appendix F

HYDRAULIC MODELLING REPORT

UNIVERSITY OF CHICHESTER BOGNOR CAMPUS

FLOOD MODELLING REPORT



MARCH 2016

WSP | PARSONS BRINCKERHOFF

ARUN DISTRICT COUNCIL BR/54/16/PL

UNIVERSITY OF CHICHESTER BOGNOR CAMPUS

FLOOD MODELLING REPORT

Issue 1

Project no: 70013264
Date: March 2016

WSP | Parsons Brinckerhoff
WSP UK, Mountbatten House,
Basing View,
Basingstoke RG21 4HJ

[redacted]

ARUN DISTRICT COUNCIL BR/54/16/PL

QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
Remarks				
Date	March 2016			
Prepared by	Magdalena Grabowiecka			
Signature				
Checked by	Steven Brown			
Signature				
Authorised by	Stephen Riley			
Signature				
Project number	70013264			
Report number	1			
File reference	V:\Projects\70013264_University_of_Chichester\TUFLOW			

This Report is intended for the sole benefit of the parties named and shall not be capable of assignment. WSP shall not be liable for any use of the Report for any reasons other than that for which the report was originally prepared and provided. Although this Report was prepared using the degree of skill and care ordinarily exercised by engineers practicing under similar circumstances; please note that WSP cannot take responsibility for errors in the information provided by third parties.

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1.2 Site area description 2

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ARUN DISTRICT COUNCIL BR/54/16/PL

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APPENDIX B HYDRAULIC MODEL SCHEMATIC (FIGURE 3)

APPENDIX C RAINFALL HYETOGRAPHS

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APPENDIX G THE POST DEVELOPMENT FLOOD EXTENT MAPS (FIGURES 18 – 23)

APPENDIX H DIFFERENCE MAP FOR THE 1 IN 100 YEAR PLUS CLIMATE CHANGE SCENARIO (FIGURES 16 – 17).

APPENDIX I THE DRAFT DEVELOPMENT LAYOUT

ARUN DISTRICT COUNCIL BR/54/16/PL

1 PROJECT BACKGROUND

1.1 PROJECT SUMMARY, AIMS AND LIMITATIONS

PROJECT SUMMARY

Table 1-1 Project Summary

Project name:	University of Chichester EDTP – Bognor Campus.
Project type:	Numerical hydraulic modelling to establish the flood risk profile for the baseline surface water flood risk at the University of Chichester Bognor Campus. The main risk is from the unnamed tributary of the Aldingbourne Rife. The modelling has considered the pre-development and post development scenarios, whilst taking account of the predicted impacts of climate change over the next 100 years.
What is being modelled?	The unnamed tributary of the Aldingbourne Rife River which runs west-east direction through the southern portion of the Site, running under the A259 via 900 mm culvert.
What existing modelling exists?	There is no existing hydraulic model.
What modelling has been undertaken by this project and why was that approach chosen?	A combined 1D/2D ESTRY -TUFLOW modelling approach was chosen as it is an industry standard method for producing fluvial / direct rainfall models including one dimensional (1d) river channels, below ground 1d pipe networks and two-dimensional (2d) topography.
What prior hydrological analysis exists?	There is no existing hydrological analysis.
What hydrological analysis has been undertaken by this project?	Direct rainfall application on the modelled area.
What outputs have been produced?	Flood depth and hazard maps and flood level results for the: • 50% AEP (1 in 2 year return period); • 20% AEP (1 in 5 year return period); • 3.33% (1 in 30 year return period); • 1% AEP (1 in 100 year return period); and • 1% plus climate change AEP (1 in 100 years plus 20%, and 40% allowance for climate change).

PROJECT AMIS AND OBJECTIVES

1.1.1 The main objectives of the study are as follows:

- Assess flood risk at the proposed site, adjacent to the A259 road; and
- Preparation of a feasibility report setting out the results of the hydraulic modelling undertaken.

1.1.2 The main objectives of this detailed assessment are to:

- Undertake a full catchment analysis and hydrological assessment to quantify the rainfall generated over a range of return periods;
- Through the use of numerical hydraulic modelling, identify the sources and mechanisms of surface water flooding within the area of interest;

ARUN DISTRICT COUNCIL BR/54/16/PL

- Assess the current risk of surface water flooding in the area of interest to assist in the identification of flood mitigation measures.

1.2 SITE AREA DESCRIPTION

A site/area location plan can be found in Appendix A: Figure 1: General Site Location Plan and Figure 2: Detailed Site Location Plan.

Table 1-2 Site Description

Site National Grid Reference:	Catchment Centroid from Flood Estimation Handbook (FEH) CD-ROM 493431 100239.
Site area:	Site area location: adjacent to the west to the A259 road; University of Chichester Bognor Campus.
Current use:	The wider catchment according to the FEH CD-ROM is heavily urbanised, although the area of interest is currently un developed land.
Wider setting:	Bognor Regis is a coastal town in West Sussex, on the South coast of England. The University of Chichester, Bognor Regis Campus is located within the town, adjacent to the west to the A259 road, to the south-west side close to Hotham Park.
Existing water bodies:	The unnamed tributary of the Aldingbourne Rife which runs west-east direction through the south part of the area, running under the A259 via 900 mm culvert. The unnamed tributary joins the Aldingbourne Rife approximately 130 km south west of the culvert
Existing flood defences:	Bognor Regis benefits from formal tidal flood defences, which are maintained by the Environment Agency and are located along the coast. There are no formal flood defences on the site of interest.
Any other important comments:	None.

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2 KEY INPUT DATA

2.1.1 Multiple sources of information have been used for this project; some of the key datasets used are set out below:

Table 2-1 Key Input Data

DATASET	SOURCE	DATE	USE	QUALITY[1]
Site topographic survey	Shaw Colegate Land and Building Surveyors	Received October 2015	Provides land elevation information across the site of interest.	1
LiDAR	LiDAR data downloaded from Centremaps.	August 2015	Forms basis of ground model for hydraulic model.	1-2
Ordnance Survey Mastermap	Ordnance Survey (acquired from Emapsite)	August 2015	Used for detailed model roughness classifications and mapping purposes.	1
Sewer network information	Southern Water	August 2015	Used for the sewer network construction.	2-3
Any other important comments:	None			

[1] Data quality scoring taken from Multi-Coloured Manual (Flood Hazard Research Centre, 2005) – 1 = best possible, 2 = data with known deficiencies, 3 = gross assumptions, 4 = heroic assumptions

3 METHODOLOGY AND IMPLEMENTATION

3.1 HYDROLOGICAL ANALYSIS

Table 3-1 Hydrological Analysis

Summary of hydrological analysis required:	Design and Net rainfall hyetographs.
Number and location of flood estimation points:	Net rainfall hyetograph to be applied over rural areas. Design rainfall hyetograph to be applied over urbanised areas.
Peak flows, hydrographs or hyetographs?	Hyetographs.
Return periods:	- 50% AEP (1 in 2 year return period); - 20% AEP (1 in 5 year return period); - 3.33% (1 in 30 year return period); and, - 1% AEP (1 in 100 year return period).
Climate change estimation?	1% AEP year rainfall intensities increased by 20% and 40%
Choice of approach?	Rural Net rainfall hyetographs for rural areas using the losses model from the Revitalised Flood Hydrograph (ReFH) rainfall-runoff method. Losses are controlled by a single parameter, the maximum soil moisture storage capacity (Cmax), this was estimated from the BFIHOST and PROPWET, two of the FEH catchment descriptors. The initial starting value of the soil moisture, Cini, was also estimated from catchment descriptors. Urban A runoff coefficient of 70% was selected for the urban areas. This is considered an average for suburban areas (Environment Agency's "What is the updated Flood Map for Surface Water?" produced in December 2013). A rainfall reduction of 12mm/hr is applied to represent the effects of the drainage system outside of the area where the drainage system is included.
Reason for approach:	The advantage of the ReFH methodology is that it has been designed and calibrated from well-established long-term data sets with national coverage for rainfall, river flow and potential infiltration.
Comparison against other approaches undertaken?	No. Modelling approach of ESTRY-TUFLOW Direct Rainfall methodology has been undertaken as the best practice approach.

3.1.1 The design rainfall profiles were generated from the FEH (Flood Estimation Handbook)[2] DDF parameters derived from the catchment descriptors for the small right Aldingbourne Rife River tributary located north from the site of interest.

3.1.2 The DDF parameters were put into the Revitalized Flood Hydrograph module within ISIS software version 3.7[3] to produce rainfall hyetographs for the critical storm duration defined for the catchment.

3.1.3 The critical storm duration used for the model was taken from the suggested values within the ISIS ReFH module. The critical storm duration run for the baseline hydraulic model is 1.7 hours with a hyetograph interval of 0.1 hours.

3.1.4 Rainfall hyetographs for the design and net rainfall for each return period are included in Appendix C.

3.1.5 Key catchment(s) characteristics are listed below;

Table 3-2 FEH Catchment Descriptors

CATCHMENT:	DOWNSTREAM OF STUDY AREA
EASTING	494150
NORTHING	100500
AREA	0.56
FARL:	1
PROPWET:	0.34
BFIHOST:	0.683
DPLBAR (km):	0.91
DPSBAR (m/km):	2.3
SAAR (mm):	719
SPRHOST:	30.1
URBEXT1990	0.4867
Pumped watercourse?	No
Any unusual catchment features? In particular is BFIHOST>0.65, SPRHOST<0.20, URBEXT>0.125, FARL<0.90 or high FPEXT?	No unusual features

3.2 BASELINE HYDRAULIC MODELLING

GENERAL COMMENTS

Table 3-3 Summary of Baseline Hydraulic Model Build

What existing modelling is available?	There are no hydraulic models available for the area.
What modelling has been undertaken and why was that approach chosen?	ESTRY-TUFLOW combines an accurate, very stable 1D-2D channel solver able to model channels and culverted networks with a 2D floodplain model based on a finite grid approach. The two solvers are dynamically linked, such that water can flow from the channel to the floodplain, and vice-versa. Figure 3 in Appendix B shows the hydraulic model schematic.
What software version(s) have been used?	TUFLOW Build v2013-12-AC-iDP-w64 has been used. Double Precision modelling is necessary as the model is direct rainfall and is modelled on a relatively fine 2d grid/time step combination.
How have watercourse channels	ESTRY 'z' polyline channel and 'z' polyline banks have been

[2] FEH CD-ROM 3, CEH 2009
[3] 2013 CH2M HILL and others

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been represented?	constructed for the unnamed watercourse running west-east direction, based on the topographical survey. 2d_z layers are used for adjusting the closest Zpt elevations to lines representing various futures, i.e. roads, bank lines, railways, etc.
How have watercourse channel structures been represented?	In ESTRY the relevant channel type was selected depending on the type of structure being modelled. They were parameterised in line with the TUFLOW manual recommendations. Refer to Figure 3 in Appendix B for the hydraulic model schematic.
How have sewer networks been represented?	The 1D network was constructed using ESTRY based on sewer records obtained from Southern Water. Sewer and Manhole data has been interpolated in areas of missing data. In areas with no data, the pipes dimensions and invert levels were assumed to be 1 meter below the ground level. Refer to Figure 4 (Appendix D) for the 1D Sewer Network Data.
How has the floodplain/ground surface been represented?	The 2D domain was constructed using TUFLOW and based on the DTM data. A grid size of 2m was chosen to allow for modelling detailed pluvial flow paths. **Representation of the building feature** For the buildings, a 'stubby buildings' approach, where the footprint is raised up to the threshold level; in this case 300mm, was used. Another way of representing buildings is to significantly increase the roughness value within the model. The increased roughness method allows any depth of water to flow through a building. It is therefore considered that the 'stubby buildings' approach provides a more realistic representation of the buildings by blocking shallow flow whilst allowing deeper flow is permitted to flow through the buildings. **Representation of road feature** According to the Environment Agency guidance in "The Update for the Flood Map for Surface water", the road network is known to be a preferential flow route for storm water when it rains. While modeling, the road surfaces, selected from the OS Master Map data, were lowered by 0.125m (the height of a British Standard kerb) to better delineate the important pathways. Using this method to represent roads ensures that the principal flood pathways along the roads are better represented in the 2m model grid. This approach may overestimate the routing effect of roads in the rural areas, which is not the case in this model.
How have different models been linked?	The open channel boundary between the 1D and 2D models was chosen as appropriate for each individual cross section. A HX boundary (Head-eXchange or Head from eXternal source) was used for the link in TUFLOW which takes the water level from ESTRY and applies it along the boundary to allow flow into the 2D domain and vice versa. Care was also taken to ensure that the width of the 1D element was reflected in the width of the inactive 2D cells. **Manholes** If there is at least one incoming and one outgoing culvert, a culvert is type C and there is no open channel connected, by default the manholes are automatically created at all culvert junctions (nodes). Manholes are connected to the 2D domain using the SX parameter in the ESTRY "conn_2d" attribute (Source of flow from an eXternal model). Flow is allowed to 'pour' between the 1D ESTRY node and the 2D TUFLOW domain once levels are high enough. This is the recommended approach for pipe and manhole schematisations.
Have any adjustments to the raw DTM been made?	To ensure a better and more accurate link between the two models a thick Z line (a 3D polyline) was snapped along the river bank boundary based on surveyed levels to ensure the 2D domain levels match the ESTRY model.
How have flood defences been	No formal flood defences are present within the area of the model.

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represented?	The tidal flood defences do not have an influence on the area of interest.
What boundary conditions have been used?	The outfall to the sea consists of two separate structures incorporating a gravity fed system and a pumped system. In this case, a HQ (head verses flow) boundary based on slope (0.003) in TUFLOW was created to allow the floodplain flow to exit the model at the edge of the 2D domain. The pump was assumed to not be in operation.
What roughness values have been used?	Channel and floodplain roughness was represented within the model by using Manning's n values for roughness. Values were chosen with reference to standard values and using site visit photographs and judgement.

ESTRY	Manning's n
Culverts	0.020
TUFLOW	**Manning's n**
Grass	0.04
Woodland	0.01
Roads	0.02
Buildings	0.3
Water	0.03
Roadside	0.02
Manmade Surfaces	0.02
Rail	0.03

What structure coefficients have been used?	Manhole energy losses are calculated at every time step using the Engelhund loss approach which takes into account velocities at the entrance and the exit of the manhole. The parameterization of the culvert energy losses were set to default ESTRY values for circular and rectangular culverts.
Are there any changes to default model or run parameters? Why?	No changes to default parameters.
What time step has been used?	A 1 second TUFLOW time step was used for the 2D calculations. This is in accordance with the recommendations that the time step should be between half and a quarter of the 2D cell size. A 0.25 second time step was used for the 1D calculation as a small time step allows for better accuracy without compromising model run times.

4 MODEL VERIFICATION

4.1 MODEL CALIBRATION

4.1.1 Whilst no data was available for model calibration with respect to flows and corresponding flood levels/depths, the results were not compared against any data.

Table 4-1 Summary of Baseline Hydraulic Model Build

Was data available for calibration and verification?	No.
Is there an existing model that can be compared against?	No other hydrodynamic models exist for the area of interest.
Has sensitivity testing been undertaken?	Yes.
Has sensitivity testing been undertaken to support the calibration?	N/A.

4.2 SENSITIVITY ANALYSIS

4.2.1 The following section details the sensitivity analysis undertaken for the University of Chichester, Bognor Campus hydraulic model. Sensitivity analysis results are provided in Table 4-4. Sensitivity Analysis extents are presented in Appendix E, Figures 10 to 14.

Table 4-2 Sensitivity Summary

What sensitivity tests have been undertaken?	Following sensitivity tests were undertaken on the 1% AEP event - 1D downstream boundary +/- 20%; - +/-20% roughness on the ditches and sewer networks and 2D domain.
Are there any significant differences between the baseline and sensitivity tests?	- Downstream Boundary; the sensitivity test shows, that the downstream boundary has no effect on water levels within the area of interest. - Roughness; very insignificant water level fluctuations to changes within the Manning's values.
Is the model sensitive to key parameters tested?	Model is not sensitive to changes in the Manning's values and to the downstream boundaries changes.

4.3 BLOCKAGE ANALYSIS

Table 4-3 Blockage Summary

Was blockage analysis undertaken?	Yes on the 1% AEP scenario.
What scenarios were tested?	A 50 % blockage of the culvert under the A259 road. This structure was chosen, as it is the main flow route for the whole site. It also provides the constriction to flows within the area of interest, causing it to 'back-up'. Blockage could increase flood depths and possibly have an impact to the outfalls from the surface water sewage network directly upstream of the ditch.

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What were the key outcomes?	The hydraulic model shows that a 50% blockage of the culverts nominally increases the flood extents and increases flood depths on the site but no more than 25mm in the 1% AEP scenario. Flood depths and extents within the channel downstream of the culvert are lowered by approximately108mm.

Table 4-4 Maximum Water Depth Results (m) for 1% AEP

		MAXIMUM DEPTH FOR 1% AEP (m)					
Point location		**Baseline**	**DS boundary -20%**	**DS boundary +20%**	**Manning's n +20%**	**Manning's n -20%**	**50% Blockage**
1	Downstream of the sewage system culvert outlet	**1.78**	**1.78**	**1.78**	**1.78**	**1.78**	**1.80**
2	Ditch channel	1.60	1.60	1.60	1.60	1.60	1.63
3	Upstream of the A259 culvert - channel	1.93	1.93	1.93	1.93	1.93	1.96
4	Right site of the A259 culvert - floodplain	0.61	0.61	0.61	0.61	0.61	0.64
5	Downstream of the A259 culvert - channel	1.44	1.44	1.44	1.44	1.45	1.34
6	downstream of the A259 culvert - floodplain	0.03	0.03	0.03	0.03	0.02	0.02
7	Downstream of the A259 culvert – floodplain	0.08	0.08	0.08	0.08	0.08	0.07
8	In the centre of the proposed car park	0.09	0.09	0.09	0.09	0.09	0.12
9	In the centre of the proposed road between the Phase 1 and Phase 2 Development	0.29	0.29	0.29	0.30	0.29	0.32
10	In the centre of the proposed Phase 2 development	0.74	0.74	0.74	0.74	0.74	0.76
11	West from the proposed car park	0.07	0.07	0.07	0.07	0.07	0.09
12	North of the proposed development	0.16	0.16	0.16	0.16	0.16	0.19
13	North of the Phase 2 Development	0.38	0.38	0.38	0.38	0.38	0.401

Refer to Appendix F: Figure 15 for Key Points Location Plan.

4.4 RUN PERFORMANCE

Table 4-5 Run Performance Summary

Is the model stable?	Yes volume and mass balance checks are well within normal parameters, with no significant spikes or oscillations.
Is the mass balance error sensible?	Yes. For the 100yr run the cumulative mass balance errors reached a peak of 0.30% at 0.60 hours. The final Cumulative ME is 0.23%. Mass balance error is well within the +/-1% recommended the TUFLOW manual.
Are there any negative water depths?	No. No negative depths were encountered in 2D cells throughout the model run.
What warnings and checks does the model give? Are any systematic of problems?	All warnings and checks associated with non-critical checks by TUFLOW.
Any other comments?	None.
Is the model 'healthy'?	Yes. The model is stable, with good convergence and is stable. The model also has a low mass balance error.

4.5 SUMMARY

4.5.1 The hydraulic model is considered to be robust (run stable with good convergence and mass balance) and not particularly sensitive to changes in the downstream boundary conditions or roughness values within the area of interest. Flood extents and depths are more sensitive in open rural areas of the model.

5 MODEL RESULTS

5.1 BASELINE RESULTS

5.1.1 The baseline hydraulic model was run for the following rainfall intensities:

- 50% AEP (1 in 2 year return period);
- 20% AEP (1 in 5 year return period);
- 3.33% (1 in 30 year return period);
- 1% AEP (1 in 100 year return period);
- 1% AEP plus 20 % increase in rainfall intensities; and,
- 1% AEP plus 40 % increase in rainfall intensities.

5.1.2 The results of the modelling for the 1% AEP and 1% AEP with climate change allowance are presented in Table 5-1.

Table 5-1 Maximum Water Depth (m) and Water Levels (M AOD) Results for 1% AEP and 1% AEP plus 20% and 40% allowance for climate change

Point location		1% AEP		1% plus 20% AEP		1% plus 40% AEP	
		d (m)	h (m AOD)	d (m)	h (m AOD)	d (m)	h (m AOD)
1	Downstream of the sewage system culvert outlet	**1.78**	**1.50**	**1.83**	**1.56**	**1.86**	**1.59**
2	Ditch channel	1.60	1.50	1.65	1.54	1.98	1.58
3	Upstream of the A259 culvert - channel	1.93	1.49	1.98	1.54	2.01	1.57
4	Right site of the A259 culvert - floodplain	0.61	1.49	0.66	1.54	0.69	1.57
5	Downstream of the A259 culvert - channel	1.44	1.04	1.46	1.05	1.47	1.06
6	downstream of the A259 culvert - floodplain	0.03	1.36	0.03	1.36	0.03	1.36
7	Downstream of the A259 culvert – floodplain	0.08	1.37	0.08	1.38	0.08	1.38
8	In the centre of the proposed car park	0.09	1.49	0.13	1.54	0.17	1.57
9	In the centre of the proposed road between the Phase 1 and Phase 2 Development	0.29	1.49	0.34	1.54	0.37	1.57
10	In the centre of the proposed Phase 2 development	0.74	1.49	0.78	1.54	0.82	1.57
11	West from the proposed car park	0.07	1.50	0.11	1.54	0.15	1.57
12	North of the proposed development	0.16	1.49	0.21	1.54	0.24	1.57
13	North of the Phase 2 Development	0.38	1.49	0.42	1.54	0.45	1.57

5.1.3 A map cut-off depth in the model of 30mm was used to allow the extent of flooding to be clearly distinguishable from 'puddles' as a consequence of rainfall. As the model is a direct rainfall one, almost all the cells in the 2D domain would become wet and without a map cut-off depth, model results would unrealistically show flooding across the whole model.

5.1.4 The results were post processed to produce Flood Depth from the raw TUFLOW outputs using TUFLOW_to_GIS, a standard TUFLOW tool, to produce ASC grids of 2m cells.

5.1.5 Direct rainfall models can result in water being caught up in shallow depressions as a result of the representation of the ground terrain on a gridded system. These depressions are normally insignificant and should not be recorded as flooding on the model outputs, as this would create very "noisy" results maps. In line with the updated Flood Map for Surface Water methodology, areas less than or equal to $12m^2$ (equivalent to 3 model cells) were removed from the model or filled prior to conversion to banded shp'e files.

5.1.6 Refer to Appendix E, Figures 5 – 9a, for all the plans with the baseline model results for simulated peak depths.

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6 POST-DEVELOPMENT MODELLING

6.1 MODEL CHANGES

6.1.1 The baseline model was amended to reflect the proposed development alignment with the impact of this subsequently assessed.

6.1.2 No changes to the baseline model were made except of those to represent the development layout (Appendix I):

- Phase 1 Student Accommodation;
- Phase 2 Student Accommodation;
- Western crossing bridge;
- Central Bridge; and,
- Eastern crossing bridge.

6.2 DEVELOPMENT LAYOUT - HYDRAULIC MODELLING APPROACH

PHASE 1 AND PHASE 2 STUDENT ACCOMMODATION

6.2.1 Phase 1 and Phase 2 Student Accommodation scheme were modelled using flow constriction polygon approach, which allows flow to be modelled in 2D both under and over bridges, pipelines or other "horizontal" obstruction, which vary in height.

6.2.2 The scheme assumes 450 mm diameter piles extended above the ground to 1.88 m AOD to support a raised ground floor slab. The raised ground floor slab is higher than the baseline 1% AEP flood level, and therefore the ground floor slab should not impact on the flow conveyance.

6.2.3 The overall area of the Phase 1 Student Accommodation buildings are 920 m^2 and 245 m^2 which are supported by 106 and 30 piles respectively. In conclusion, the piles form 5.6% of each building.

6.2.4 The approximate area of the Phase 2 Student Accommodation building is 470 m^2 containing 57 piles. The piles form 5.5% of the building area.

6.2.5 It was assumed 15 percentage blockage of the cell to account for piles as well as for the architectural finish of the void area to prevent unauthorised access to the under-croft area.

WESTERN, CENTRAL AND EASTERN CROSSING BRIDGES.

6.2.6 **The Western crossing Bridge** is based on reusing existing Southern Water culvert. Estimated width is 6.9 m including 1.2 m for parapets and 1.2 m pedestrian link width.

6.2.7 Minimum bridge soffit elevation is 1.86m AOD.

6.2.8 The front slope is assumed to be 1:10 with side slopes for any raised road section to be 1:3.

6.2.9 The Western Bridge was modelled using 2d_zsh polygon which allows adjusting the ground elevation to match the proposed development height.

6.2.10 **Central Bridge** deck length is approximate. 22.5 m with allowance for the 8 meters deck from the top of the watercourse banks to the both sides. The bride width is 7.2 m including 1.2m for parapets width.

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6.2.11 The bridge deck elevation is 3.06m AOD assuming 1.2m AOD Bridge Construction. The front slope is assumed to be 1:20 with side slopes for any raised road section to be 1:3.

6.2.12 The Central Bridge was modelled using 2d_zsh polygons with underneath 1D rectangular culvert with diameter of 1.86 mAOD for soffit level and width of 5m.

6.2.13 **Eastern Bridge** deck length is approximate. 22.5 m with allowance for the 8 meters deck from the top of the watercourse banks to the both sides. The bride width is 5.7 m including 1.2m for parapets width.

6.2.14 The bridge deck elevation is 3.06m AOD assuming 1.2m AOD Bridge Construction. The front slope is assumed to be 1:10 with side slopes for any raised road section to be 1:3.

6.2.15 The bridge was modelled using 2d_zsh polygon which allows adjusting the ground elevation to match the proposed development height.

6.3 HYDRAULIC ROUGHNESS

6.3.1 The hydraulic roughness values were retained from the baseline model.

6.4 DESIGN RUNS

6.4.1 The hydraulic model was run for the all design events.

6.5 POST-DEVELOPMENT MODEL RESULTS

6.5.1 The stability of a model is critical to the understanding of the robustness and its ability to simulate a flood event accurately.

6.5.2 Stability in a TUFLOW model is assessed by examining the cumulative error (or mass balance) of the model as well as the warnings output by the model during the simulation. The final cumulative peak cumulative mass error of the model is 3.31% for the 1 in 100 year. No negative depths were encountered. 3.31% is higher than the recommended values within TUFLOW but is within accepted convention of +/- 5 % for direct rainfall models.

6.5.3 All TUFLOW warnings and checks within the site and surrounds were found to be of little consequence and were therefore considered acceptable.

6.6 FLOOD MECHANISM

6.6.1 In general the flood mechanism experienced in the baseline model is also evident in the proposed scenario. However, the new development layout leads to changes in flow paths around the bridges as the design bridge and roads levels are greater than the existing ground level. This only impacts the flow regime on-site and has no discernible off-site impact.

6.6.2 The resultant maps for all return periods are enclosed in Appendix G (Figure 18 - 23)

6.6.1 Difference maps for the 1 in 100 plus climate change return period events have also been enclosed and are shown in Appendix H (Figure 16 and 17). These shows the difference in water levels from this proposed scenario compared with the baseline scenario.

6.6.2 The difference mapping shows nominal adverse changes in flood depths within the area of interest, and these are localised towards the proposed bridge structures.

7 CONCLUSIONS

7.1.1 The following conclusions for the hydraulic modelling exercise are made:

- An ESTRY-TUFLOW model for the University of Chichester, Bognor Campus, was built as part of the Flood Risk Assessment. The hydraulic model was built in order to identify the magnitude of flooding issues on the site of interest.
- The model was run for the 1 in 2 year (50% AEP), 1 in 5 year (20% AEP), 1 in 30 year (3.33% AEP) and 1 in 100 year (1% AEP) to more accurately determine the flood risk within the study area. The model was also run for the 1 in 100 year event plus 20% and 40% increase to account for climate change so as to determine the potential flood risk in the future.
- Sensitivity testing was undertaken on the downstream boundary and roughness values for the 1D element (pipes, culverts) and 2d domain used within the model. This showed that downstream boundaries have no influence on the water levels within the area of interest. The model has no sensitivity to changes in roughness. Blockage modelling has also been undertaken on the culvert under the A259 which highlighted that culvert has minor impact on water levels however moderate impact on flood extents. The culvert is the key influence on the flooding mechanism within the site of interest.
- The baseline results confirmed, that during the 50% AEP (1 in 2 year) rainfall event or grater, water is predicted to back up at the A259 culvert. Consequently the A259 culvert is considered critical to the management of flooding in the area.
- The hydraulic model and associated hydrological analysis are accepted as best available source of information for quantifying surface water flood risk in University of Chichester, Bognor Regis campus.

7.1.2 The model is a robust model comprising 1D channel, pipe network and 2D domain. The outcomes of the model through generated results are sufficient to support the flood risk to the proposed development site and to support the proposed development through the planning application. The following limitations to the hydraulic modelling are noted:

- No hydrometric data exists for the ditches within the study area. Consequently, the model could not be calibrated against any observational datasets to confirm the predicted results;
- Assumptions were made on some pipe sizes, invert levels and manhole sizes of the Southern Water sewer network serving the area. No private sewers were incorporated into the model. The capacity of the sewer network has been conservatively assessed where data is not available, which may cause the predicted flood extents to be greater than would occur if the sewer network was determined. However, it is considered that for the more extreme storm events the impact of the sewer system will be nominal on overland flood flows.
- The Digital Terrain Model is comprised of the best available data including LiDAR and topographical survey data.
- Calibration/verification of the model was not undertaken due to a limited number of recorded summer storms.

7.1.3 The hydraulic modelling has been undertaken using appropriate methods and assumptions, and in accordance with best practice guidance. The results and impacts of the results are discussed in the Flood Risk Assessment (Document Reference).

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Appendix A

GENERAL AND DETAILED SITE LOCATION PLANS (FIGURES 1 AND 2)

Date Modified: 13/11/2015

Drawn By: ukmxg001

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Figure 1_Site location plan.mxd

Legend

Indicative site boundary

Eldridge

North Bersted

South Bersted

Felpham

BOGNOR REGIS

B2166

B2132

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WSP | PARSONS BRINCKERHOFF

TITLE:

UNIVERSITY OF CHICHESTER
GENERAL SITE LOCATION PLAN

FIGURE No:

FIGURE 1

ARUN DISTRICT COUNCIL BR/54/15/PL

Date Modified: 13/11/2015

Drawn By: akmxg001

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Figure 2_Detailed Site location plan.mxd

Legend

- Indicative site boundary
- Watercourse

College

GOODWOOD AVE

SOUTH RD

DRYGROUNDS LA

FELPHAM WAY

A259

PW

PO

WATERLOO RD

VICARAGE LA

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TITLE:

UNIVERSITY OF CHICHESTER
DETAILED SITE LOCATION PLAN

FIGURE No:

FIGURE 2

Appendix B

HYDRAULIC MODEL SCHEMATIC (FIGURE 3)

Drawn By: akmxg001 Date Modified: 13/11/2015

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Figure 3_Model Schematic.mxd

Legend

- A259 Culvert

Sewer Network

- Assumed
- Southern Water
- 2D Model Extent

Rainfall Extent

- Design
- Net

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TITLE:

UNIVERSITY OF CHICHESTER
HYDRAULIC MODEL SCHEMATIC

FIGURE No:

FIGURE 3

ARUN DISTRICT COUNCIL BR/54/17/PL

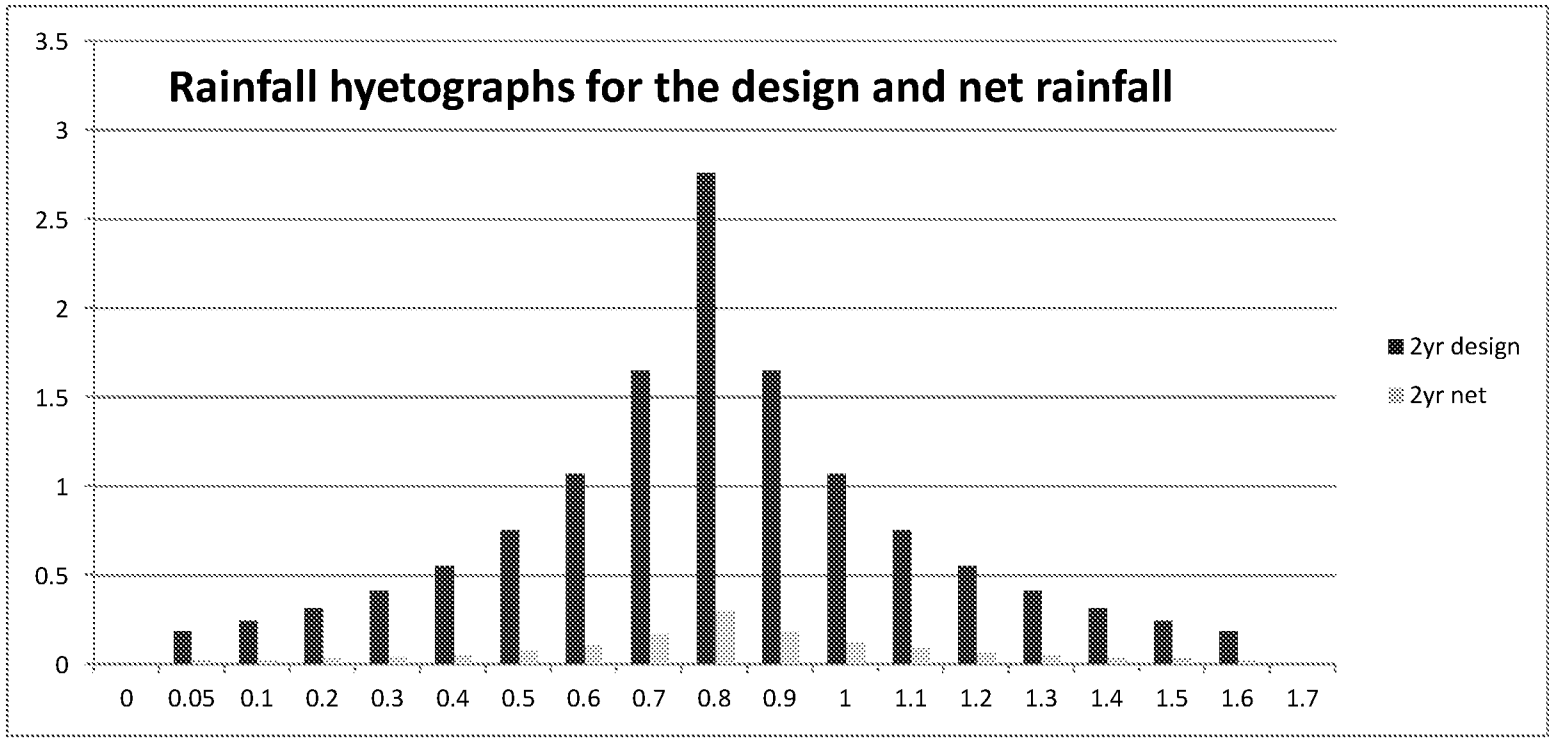
Appendix C

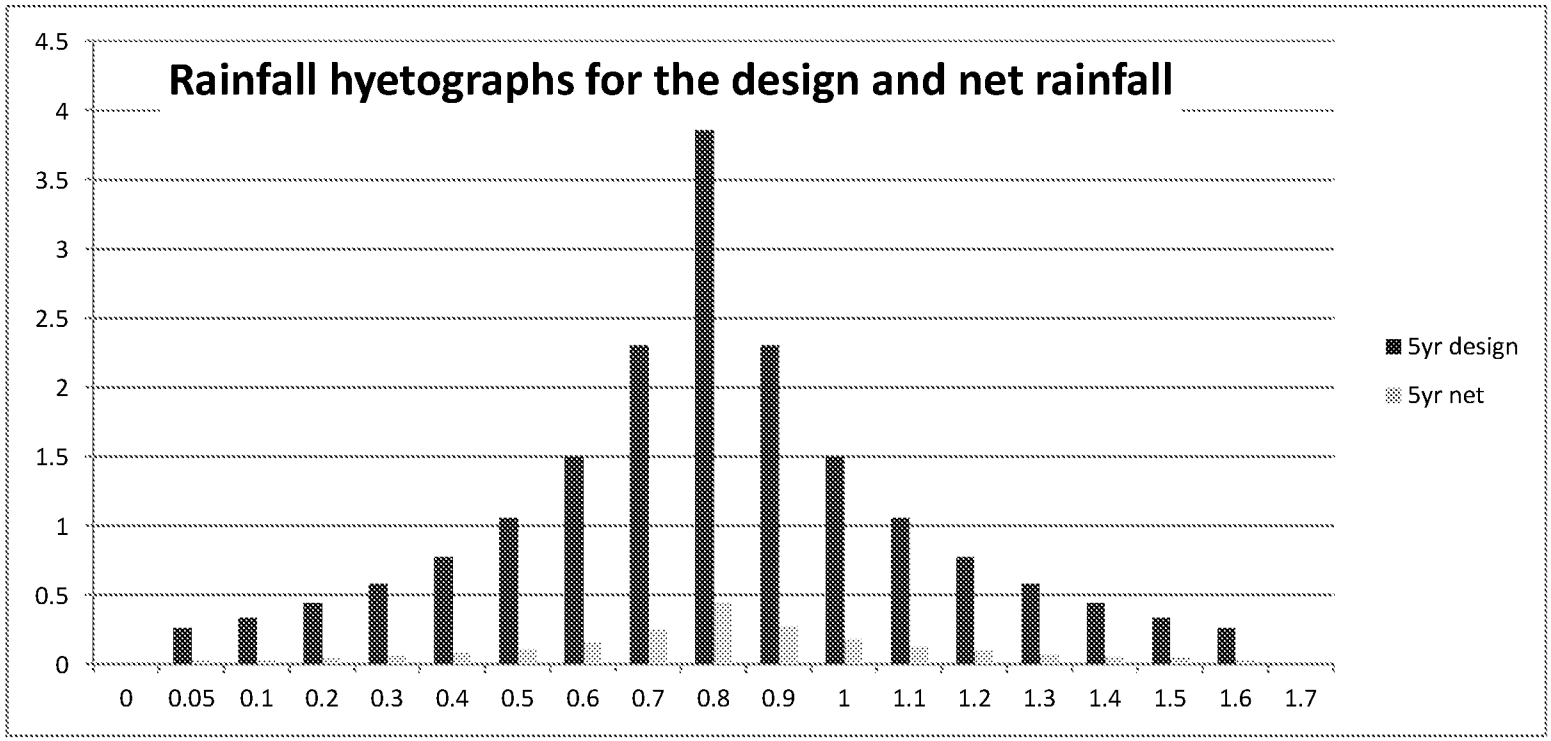
RAINFALL HYETOGRAPHS

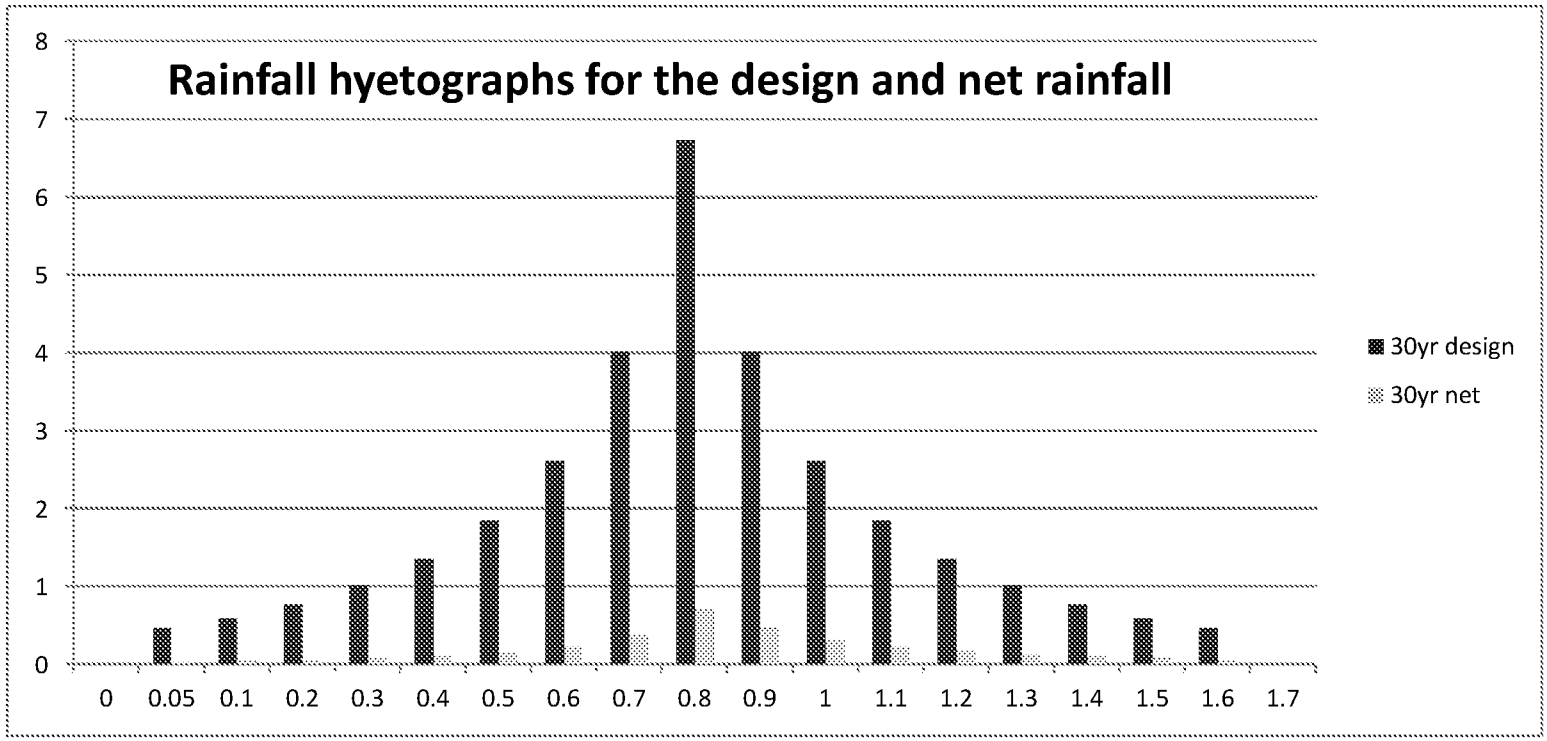
University of Chichester Bognor Campus - Rainfall Hyetographs

Time	2yr design	2yr net	5yr design	5yr net	30yr design	30yr net	100yr design	100yr net	100 20yrCC design	100 20yrCC net	100 40yrCC design	100 40yrCC net
0	0	0	0	0	0	0	0	0	0	0	0	0
0.05	0.19	0.018	0.265	0.026	0.462	0.035	0.662	0.041	0.7944	0.0492	0.9268	0.0574
0.1	0.244	0.024	0.34	0.033	0.594	0.045	0.85	0.054	1.02	0.0648	1.19	0.0756
0.2	0.316	0.031	0.441	0.043	0.77	0.06	1.102	0.071	1.3224	0.0852	1.5428	0.0994
0.3	0.415	0.041	0.58	0.058	1.011	0.08	1.447	0.097	1.7364	0.1164	2.0258	0.1358
0.4	0.554	0.055	0.773	0.078	1.349	0.11	1.931	0.136	2.3172	0.1632	2.7034	0.1904
0.5	0.756	0.076	1.057	0.108	1.843	0.156	2.639	0.197	3.1668	0.2364	3.6946	0.2758
0.6	1.073	0.11	1.5	0.157	2.616	0.232	3.746	0.302	4.4952	0.3624	5.2444	0.4228
0.7	1.65	0.173	2.305	0.249	4.02	0.382	5.756	0.514	6.9072	0.6168	8.0584	0.7196
0.8	2.761	0.301	3.858	0.44	6.73	0.707	9.635	0.999	11.562	1.1988	13.489	1.3986
0.9	1.65	0.187	2.305	0.276	4.02	0.462	5.756	0.679	6.9072	0.8148	8.0584	0.9506
1	1.073	0.124	1.5	0.185	2.616	0.317	3.746	0.475	4.4952	0.57	5.2444	0.665
1.1	0.756	0.089	1.057	0.133	1.843	0.231	2.639	0.35	3.1668	0.42	3.6946	0.49
1.2	0.554	0.066	0.773	0.098	1.349	0.173	1.931	0.265	2.3172	0.318	2.7034	0.371
1.3	0.415	0.05	0.58	0.074	1.011	0.132	1.447	0.203	1.7364	0.2436	2.0258	0.2842
1.4	0.316	0.038	0.441	0.057	0.77	0.102	1.102	0.157	1.3224	0.1884	1.5428	0.2198
1.5	0.244	0.029	0.34	0.044	0.594	0.079	0.85	0.123	1.02	0.1476	1.19	0.1722
1.6	0.19	0.023	0.265	0.035	0.462	0.062	0.662	0.096	0.7944	0.1152	0.9268	0.1344
1.7	0	0	0	0	0	0	0	0	0	0	0	0

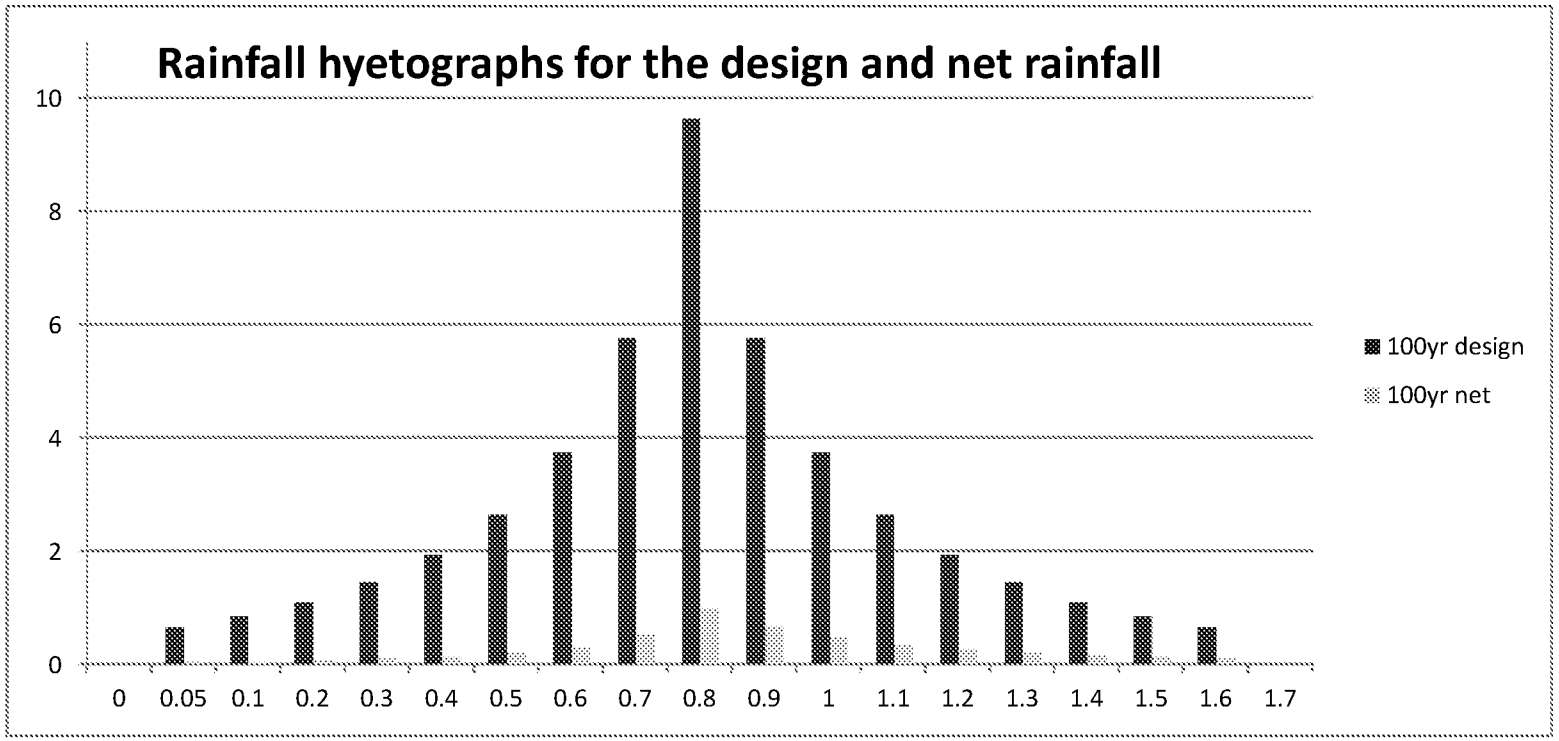
ARUN DISTRICT COUNCIL BR/54/15/PL

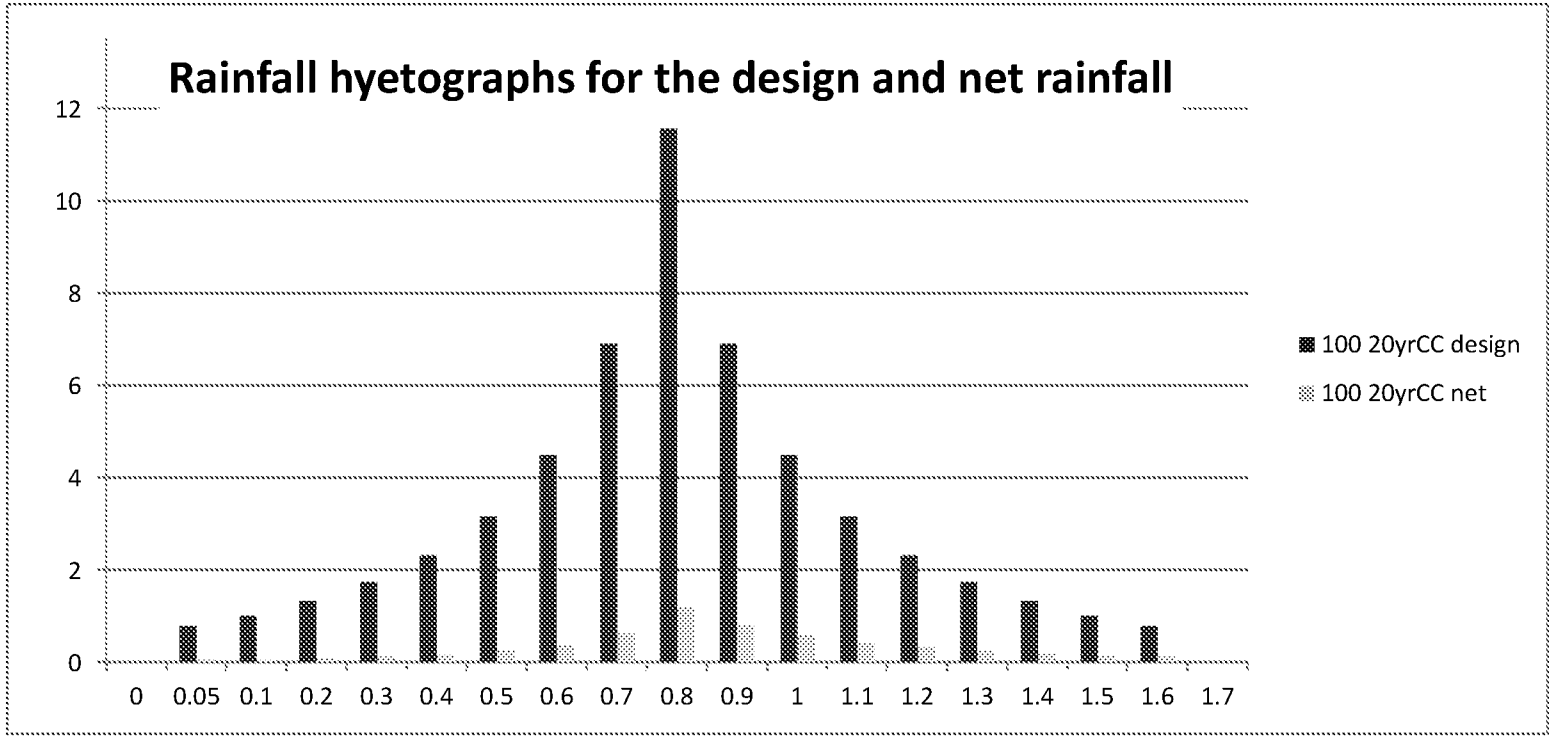

Rainfall hyetographs for the design and net rainfall
3.5
3
2.5
2
1.5
1
0.5
0
0
0.05
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
2yr design
2yr net

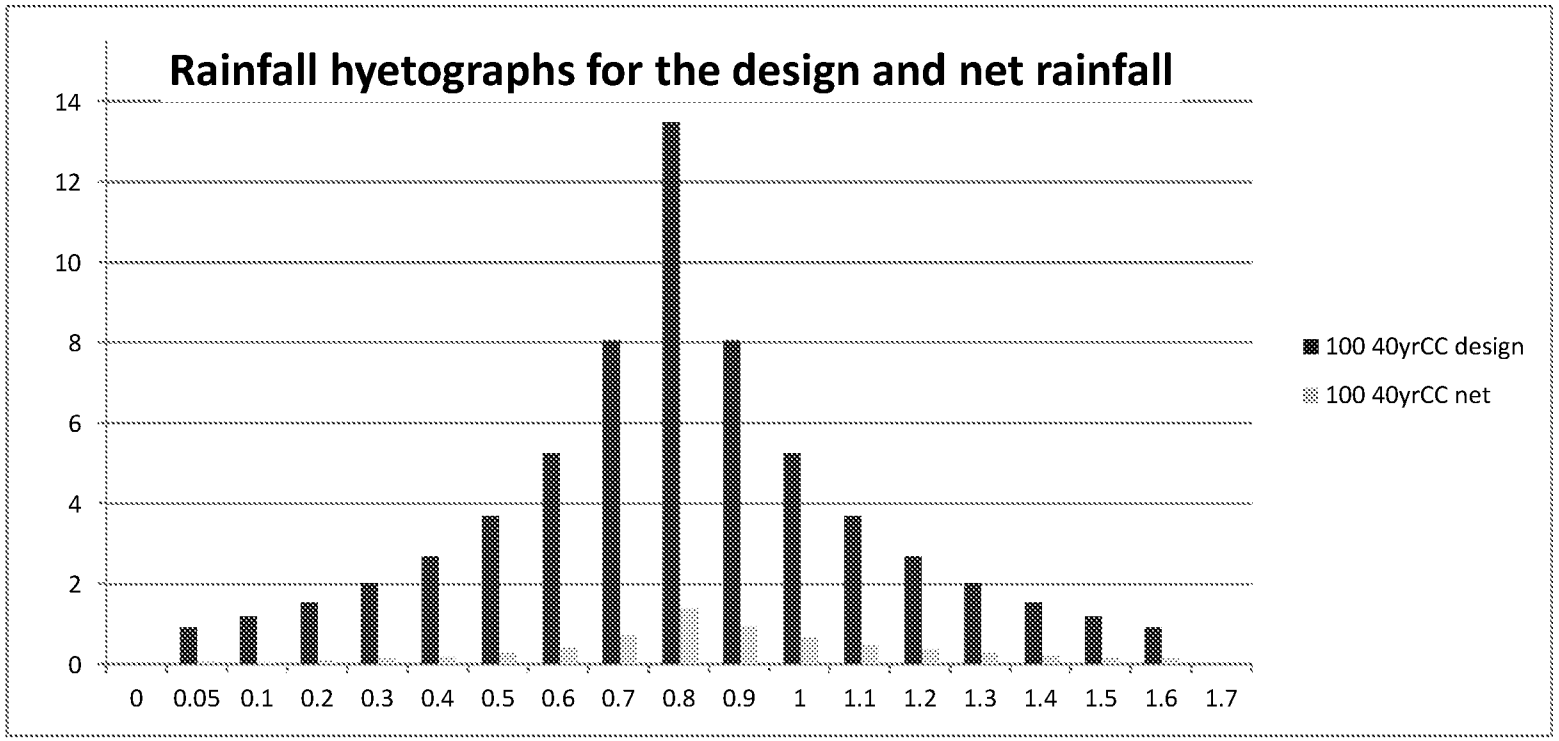

Rainfall hyetographs for the design and net rainfall
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.05
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
5yr design
5yr net



ARUN DISTRICT COUNCIL BR/54/15/PL


Rainfall hyetographs for the design and net rainfall
10
8
6
4
2
0
0
0.05
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
100yr design
100yr net


Rainfall hyetographs for the design and net rainfall
12
10
8
6
4
2
0
0
0.05
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
100 20yrCC design
100 20yrCC net


Rainfall hyetographs for the design and net rainfall
14
12
10
8
6
4
2
0
0
0.05
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
100 40yrCC design
100 40yrCC net

Appendix D

1D SEWER NETWORK DATA (FIGURE 4)

Date Modified: 13/11/2015

Drawn By: akmxg001

File: Q:\WSP_UK\WSP...D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Figure 4_1D Sewer network.mxd

Legend

- Watercourse

Source of Sewer Network Data

- Assumed
- Southern Water

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TITLE:

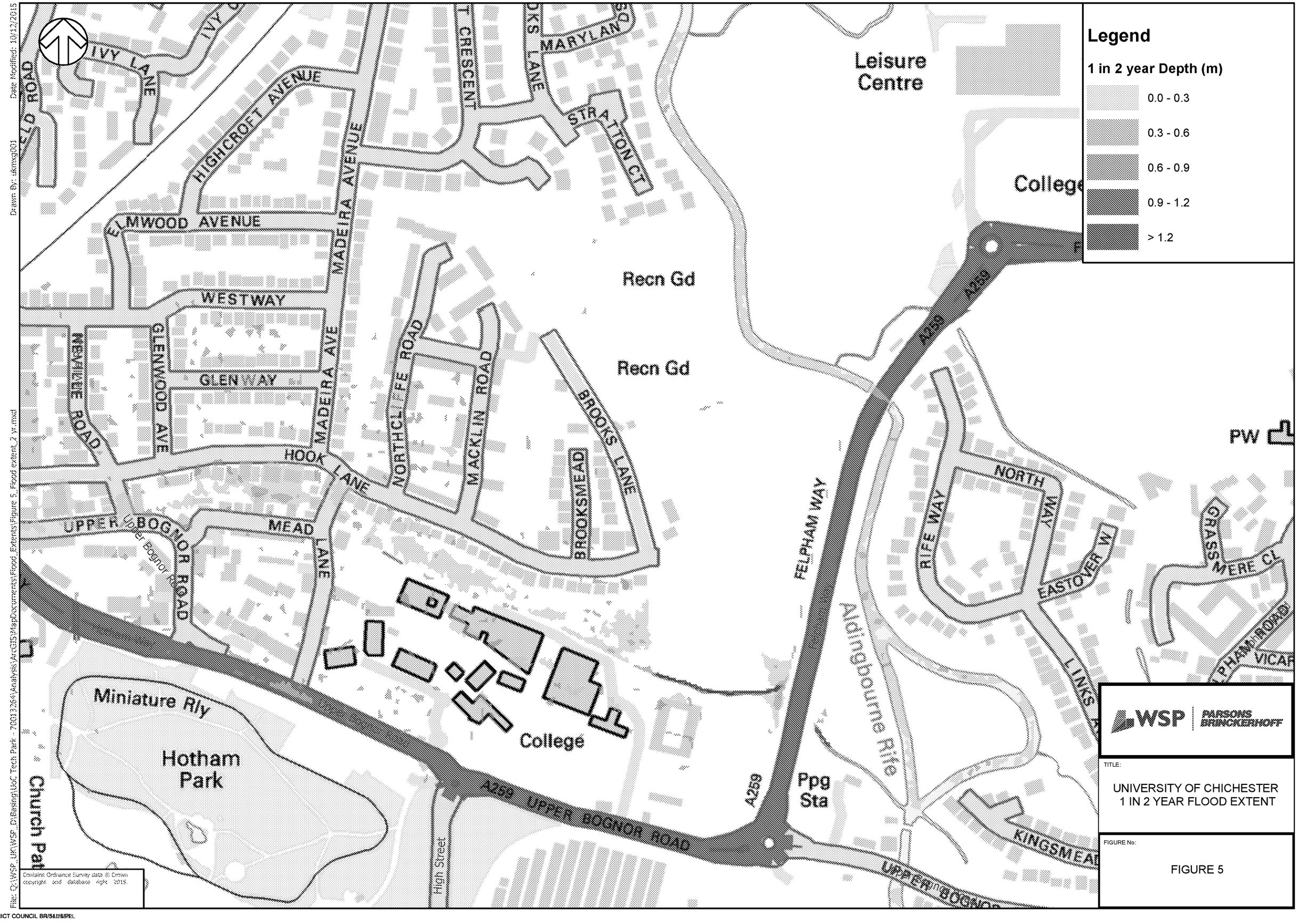
UNIVERSITY OF CHICHESTER
1D SEWER NETWORK DATA
INTERPOLATION OF MISSING DATA

FIGURE No:

FIGURE 4

Appendix E

FLOOD EXTENT MAPS (FIGURES 5 – 14)



Date Modified: 10/12/2015
Drawn By: ukmwg001
File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Flood_Extents\Figure 5_Flood extent_2 yr.mxd

Date Modified: 13/11/2015

Drawn By: ukmwg001

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\Map\Documents\Flood_Extents\Figure 6_Flood extent_5 yr.mxd

Legend

1 in 5 year Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

IVY LANE
IVY CLOSE
OLD ROAD
HIGHCROFT AVENUE
CRESCENT
MARYLAND
STRATTON CT
ELMWOOD AVENUE
MADEIRA AVENUE
WESTWAY
GLENWOOD AVE
GLENWAY
NEWHAVEN ROAD
MADEIRA AVE
NORTHCLIFFE ROAD
MACKLIN ROAD
HOOK LANE
BROOKS LANE
BROOKSMEAD
UPPER BOGNOR ROAD
MEAD LANE
Upper Bognor Road
Leisure Centre
Recn Gd
Recn Gd
College
College
Miniature Rly
Hotham Park
Church Path
A259 UPPER BOGNOR ROAD
A259
FELPHAM WAY
Aldingbourne Rife
Ppg Sta
PW
RIFE WAY
NORTH WAY
EASTOVER W
GRASSMERE CL
FELPHAM ROAD
VICAR
LINKS
KINGSMEAD
High Street

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 5 YEAR FLOOD EXTENT

FIGURE No:

Figure 6

Date Modified: 13/11/2015

Drawn By: akmwg001

File: Q:\WSP_UK\WSP...D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\Map\Documents\Flood_Extents\Figure 7_Flood extent_30 yr.mxd

Legend

1 in 30 year Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

IVY LANE
IVY CLOSE
OLD ROAD
HIGHCROFT AVENUE
CRESCENT
MARYLAND
STRATTON CT
ELMWOOD AVENUE
MADEIRA AVENUE
WESTWAY
GLENWAY
GLENWOOD AVE
NEWPIECE ROAD
MADEIRA AVE
HOOK LANE
NORTHCLIFFE ROAD
MACKLIN ROAD
BROOKS LANE
BROOKSMEAD
MEAD LANE
UPPER BOGNOR ROAD
Upper Bognor Road
Leisure Centre
Recn Gd
Recn Gd
College
College
Miniature Rly
Hotham Park
Church Path
A259
A259 UPPER BOGNOR ROAD
High Street
Aldingbourne Rife
PW
Ppg Sta
NORTH WAY
RIFE WAY
EASTOVER W
GRASSMERE CL
PHAM ROAD
VICAR
LINKS
KINGSMEAD
UPPER BOGNOR

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TITLE:

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1 IN 30 YEAR FLOOD EXTENT

FIGURE No:

FIGURE 7

Date Modified: 13/11/2015

Drawn By: ukmwg001

File: Q:\WSP_UK\WSP...01Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\Map\Documents\Flood_Extents\Figure 8_Flood extent_100 yr.mxd

Legend

1 in 100 year Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

IVY LANE
IVY CLOSE
OLD ROAD
HIGHCROFT AVENUE
ELMWOOD AVENUE
MADEIRA AVENUE
T CRESCENT
MARYLAND
KS LANE
STRATTON CT
WESTWAY
GLENWAY
GLENWOOD AVE
NEWLANDS ROAD
MADEIRA AVE
NORTHCLIFFE ROAD
MACKLIN ROAD
HOOK LANE
BROOKS LANE
BROOKSMEAD
MEAD LANE
UPPER BOGNOR ROAD
Upper Bognor Road
Leisure Centre
Recn Gd
Recn Gd
College
College
A259
A259
A259 UPPER BOGNOR ROAD
Miniature Rly
Hotham Park
Church Path
High Street
Aldingbourne Rife
PW
Ppg Sta
NORTH WAY
RIFE WAY
EASTOVER W
GRASSMERE CL
PHAM ROAD
VICAR
LINKS
KINGSMEAD
UPPER BOGNOR

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 FLOOD EXTENT

FIGURE No:

FIGURE 8

Date Modified: 24/03/2016

Drawn By: ukmwg001

File: Q:\WSP...UK\WSP...D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Flood_Extents\Figure 9_Flood extent_1 in 100_20CC yr.mxd

Legend

1 in 100 year 20% CC Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Leisure Centre

College

Recn Gd

Recn Gd

Miniature Rly

Hotham Park

College

Ppg Sta

PW

IVY LANE

HIGHCROFT AVENUE

ELMWOOD AVENUE

MADEIRA AVENUE

WESTWAY

GLENWOOD AVE

NEVILLE ROAD

HOOK LANE

NORTHLEE ROAD

BLACKLINE ROAD

MEAD LANE

BROOKSMEAD

BROOKS LANE

STRATTON CT

CRESCENT

MARYLAND

UPPER BOGNOR ROAD

A259

Aldingbourne Rife

RIFE WAY

NORTH WAY

EASTOVER W

GRASSMERE CL

KINGSME

PHAM ROAD

VICAR

High Street

Church Path

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 PLUS 20% CLIMATE CHANGE FLOOD EXTENT

FIGURE No:

FIGURE 9

Date Modified: 24/03/2016

Drawn By: akmwg001

File: Q:\WSP_UK\WSP_DI\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Flood_Extents\Figure 9a_Flood extent_100_40CC_v1.mxd

Legend

1 in 100 year 40% Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Leisure Centre

College

Recn Gd

Recn Gd

Miniature Rly

Hotham Park

College

Ppg Sta

IVY LANE

HIGHCROFT AVENUE

ELMWOOD AVENUE

MADEIRA AVENUE

WESTWAY

GLENWOOD AVE

NEVILLE ROAD

HOOK LANE

NORTHLEIGH ROAD

BROOKSMEAD

BROOKS LANE

MEAD LANE

UPPER BOGNOR ROAD

A259

Aldingbourne Rife

RIFE WAY

NORTH WAY

EASTOVER W

GRASSMERE CL

KINGSMEAD

High Street

Church Path

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 PLUS 40% CLIMATE CHANGE FLOOD EXTENT

FIGURE No:

FIGURE 9a

Date Modified: 13/11/2015

Drawn By: ukmwg001

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\Map\Documents\Flood_Extents\Figure 10_Flood extent_100 yr_p20m.mxd

Legend

1 in 100 year +20% n Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

IVY LANE
IVY CLOSE
OLD ROAD
HIGHCROFT AVENUE
T CRESCENT
KS LANE
MARYLAND
STRATTON CT
ELMWOOD AVENUE
MADEIRA AVENUE
WESTWAY
GLENWAY
GLENWOOD AVE
NEWLANDE ROAD
MADEIRA AVE
HOOK LANE
NORTHCLIFFE ROAD
MACKLIN ROAD
BROOKS LANE
BROOKSMEAD
MEAD LANE
UPPER BOGNOR ROAD
Upper Bognor Road
Leisure Centre
Recn Gd
Recn Gd
College
College
Miniature Rly
Hotham Park
Church Path
A259 UPPER BOGNOR ROAD
A259
Ppg Sta
TELHAM WAY
Aldingbourne Rife
RIFE WAY
NORTH WAY
EASTOVER W
GRASSMERE CL
PHAM ROAD
VICAR
LINKS
KINGSMEAD
UPPER BOGNOR
High Street
PW

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 FLOOD EXTENT
+20% ON MANNING VALUES

FIGURE No:

FIGURE 10

Date Modified: 13/11/2015

Drawn By: ukmwg001

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\Map\Documents\Flood_Extents\Figure 11_Flood extent_100 yr_m20n.mxd

Legend

1 in 100 year -20%n Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Leisure Centre

College

Recn Gd

Recn Gd

PW

IVY LANE

IVY CLOSE

OLD ROAD

HIGHCROFT AVENUE

ELMWOOD AVENUE

MADEIRA AVENUE

CRESCENT

MARYLAND

STRATTON CT

WESTWAY

GLENWAY

GLENWOOD AVE

NEWTIMBER ROAD

MADEIRA AVE

HOOK LANE

NORTHCLIFFE ROAD

MACKLIN ROAD

BROOKS LANE

BROOKSMEAD

MEAD LANE

UPPER BOGNOR ROAD

Upper Bognor Road

A259

TELHAM WAY

Aldingbourne Rife

NORTH WAY

RIFE WAY

EASTOVER W

GRASSMERE CL

PHAM ROAD

VICAR

LINKS

KINGSMEAD

Miniature Rly

Hotham Park

Church Path

High Street

College

Ppg Sta

A259 UPPER BOGNOR ROAD

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 FLOOD EXTENT
-20% ON MANNING VALUES

FIGURE No:

FIGURE 11

Date Modified: 13/11/2015

Drawn By: ukmwg001

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\Map\Documents\Flood_Extents\Figure 12_Flood extent_100 yr_p20db.mxd

Legend

1 in 100 year +20% on DS boundary Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

IVY LANE
IVY CRESCENT
HIGHCROFT AVENUE
MARYLAND CRESCENT
BROOKS LANE
STRATTON CT
Leisure Centre
ELMWOOD AVENUE
MADEIRA AVENUE
WESTWAY
Recn Gd
Recn Gd
GLENWAY
GLENWOOD AVE
NEWTIMBER ROAD
MADEIRA AVE
HOOK LANE
NORTHCLIFFE ROAD
MACKLIN ROAD
BROOKS LANE
BROOKSMEAD
A259
PW
NORTH WAY
RIFE WAY
EASTOVER W
GRASSMERE CL
UPPER BOGNOR ROAD
MEAD LANE
Upper Bognor Road
Miniature Rly
Hotham Park
College
A259 UPPER BOGNOR ROAD
A259
Ppg Sta
Aldingbourne Rife
PELHAM WAY
High Street
Church Path
KINGSME
UPPER BOGNOR

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 FLOOD EXTENT
+20% ON DOWNSTREAM BOUNDARY

FIGURE No:

FIGURE 12

Date Modified: 13/11/2015

Drawn By: akmwg001

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\Map\Documents\Flood_Extents\Figure 13_Flood extent_100 yr_m20db.mxd

Legend

1 in 100 year -20% on DS boundary Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Leisure Centre

Recn Gd

Recn Gd

IVY LANE

HIGHCROFT AVENUE

ELMWOOD AVENUE

MADEIRA AVENUE

WESTWAY

GLENWAY

GLENWOOD AVE

NEWLANDS ROAD

HOOK LANE

NORTHCLIFFE ROAD

MACKLIN ROAD

BROOKS LANE

BROOKSMEAD

MEAD LANE

UPPER BOGNOR ROAD

Upper Bognor Road

A259

Miniature Rly

Hotham Park

College

Church Path

High Street

Aldingbourne Rife

Ppg Sta

PW

RIFE WAY

NORTH WAY

EASTOVER W

GRASSMERE CL

PHAM ROAD

VICAR

KINGSM

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 FLOOD EXTENT
-20% ON DOWNSTREAM BOUNDARY

FIGURE No:

FIGURE 13

Legend

1 in 100 year +50% Blockage Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Leisure Centre

Recn Gd

Recn Gd

College

Miniature Rly

Hotham Park

Ppg Sta

IVY LANE

HIGHCROFT AVENUE

ELMWOOD AVENUE

MADEIRA AVENUE

WESTWAY

GLENWOOD AVE

GLENWAY

NEWMILNE ROAD

HOOK LANE

NORTHCLIFFE ROAD

MACKLIN ROAD

BROOKSMEAD

BROOKS LANE

MEAD LANE

UPPER BOGNOR ROAD

A259

Aldingbourne Rife

TELFORD WAY

RIFE WAY

EASTOVER W

GRASSMERE CL

LINKS

KINGSMEAD

High Street

Church Path

PW

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WSP | PARSONS BRINCKERHOFF

TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 FLOOD EXTENT
+50% BLOCKAGE SCENARIO

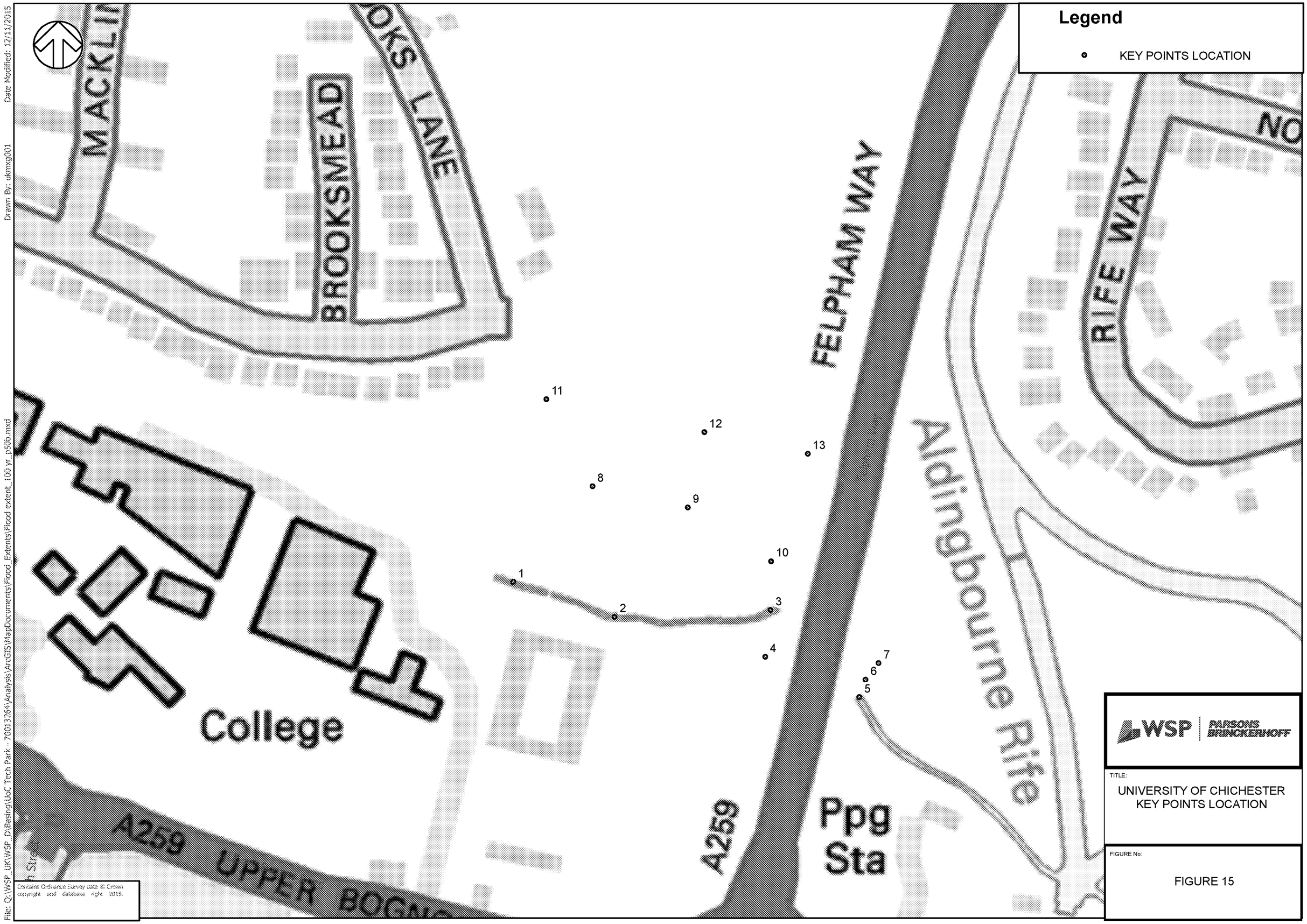
FIGURE No:

FIGURE 14

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Flood_Extents\Figure 14_Flood extent_100 yr_p50b.mxd Drawn By: ukmxg001 Date Modified: 13/11/2015

Appendix F

KEY POINTS LOCATION (FIGURE 15)



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TITLE:

UNIVERSITY OF CHICHESTER
KEY POINTS LOCATION

FIGURE No:

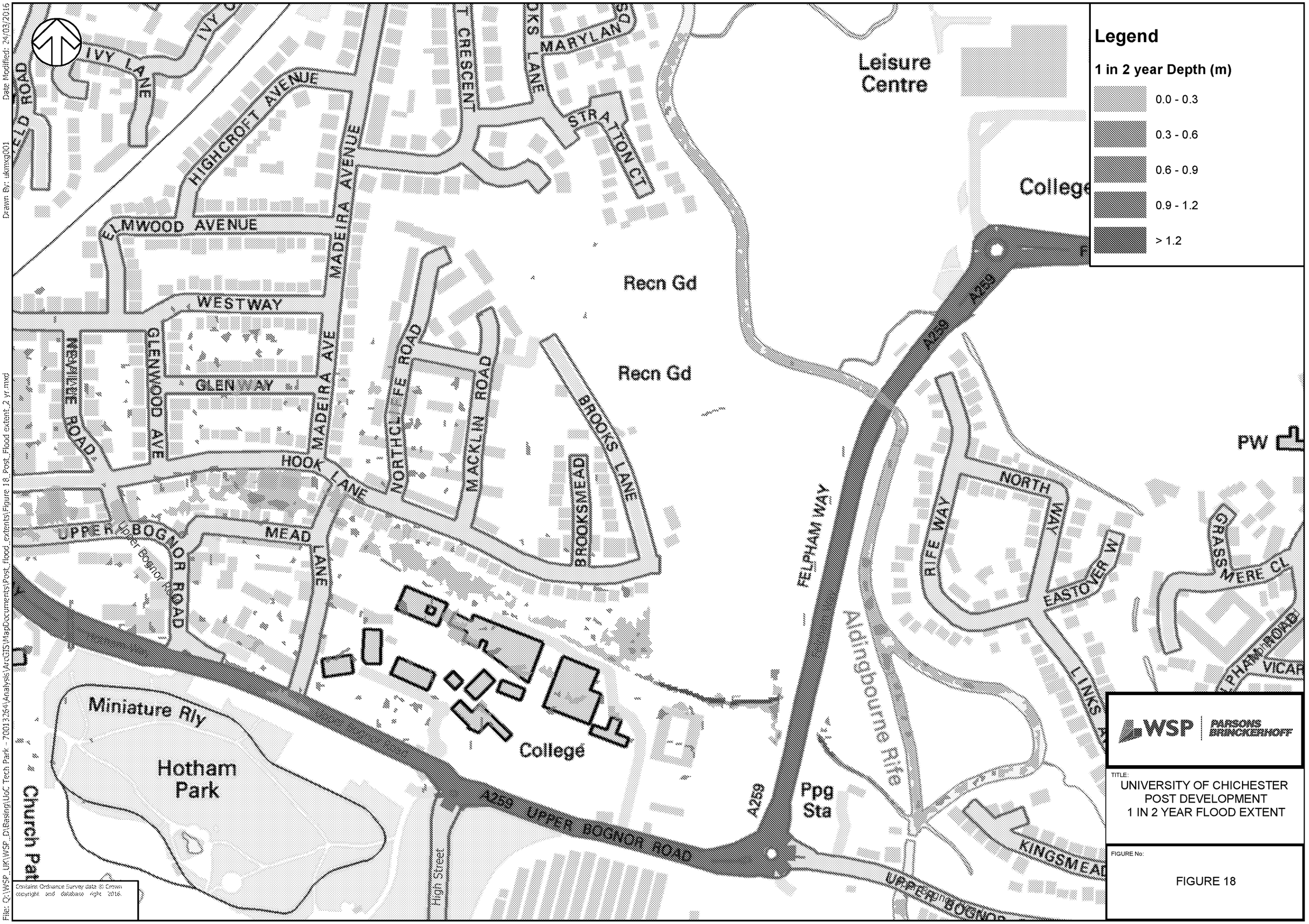
FIGURE 15

Drawn By: ukmxg001 Date Modified: 12/11/2015

File: C:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Flood_Extents\Flood extent_100 yr_p50b.mxd

Appendix G

THE POST DEVELOPMENT FLOOD EXTENT MAPS (FIGURES 18 – 23)



File: Q:\WSP...UK\WSP...D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Post_flood_extents\Figure 18_Post_Flood extent_2 yr.mxd Drawn By: ukmxg001 Date Modified: 24/03/2016

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TITLE:
UNIVERSITY OF CHICHESTER
POST DEVELOPMENT
1 IN 2 YEAR FLOOD EXTENT

FIGURE No:
FIGURE 18

Date Modified: 24/03/2016

Drawn By: ukmwg001

File: Q:\WSP...UK\WSP...D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Post_flood_extents\Figure 19_Post_Flood extent_5 yr.mxd

Legend

1 in 5 year Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

IVY LANE
IVY CRESCENT
HIGHCROFT AVENUE
MARYLAND CRESCENT
MARYLAND SQ
STRATTON CT
ELMWOOD AVENUE
MADEIRA AVENUE
WESTWAY
GLENWAY
GLENWOOD AVE
NORTHCLIFFE ROAD
MACKLIN ROAD
BROOKS LANE
BROOKSMEAD
HOOK LANE
MEAD LANE
UPPER BOGNOR ROAD
Upper Bognor Rly
Leisure Centre
Recn Gd
Recn Gd
College
College
Miniature Rly
Hotham Park
Church Path
High Street
A259
A259
A259 UPPER BOGNOR ROAD
FELPHAM WAY
Aldingbourne Rife
Ppg Sta
RIFE WAY
NORTH WAY
EASTOVER W
GRASSMERE CL
LINKS
KINGSMEAD
PW

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TITLE:

UNIVERSITY OF CHICHESTER
POST DEVELOPMENT
1 IN 5 YEAR FLOOD EXTENT

FIGURE No:

Figure 19

Date Modified: 24/03/2016

Drawn By: ukmwg001

File: Q:\WSP...UK\WSP...D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Post_flood_extents\Figure 20_Post_Flood extent_30 yr.mxd

Legend

1 in 30 year Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

IVY LANE
IVY CLOSE
FIELD ROAD
HIGHCROFT AVENUE
ELMWOOD AVENUE
MADEIRA AVENUE
T CRESCENT
KS LANE
MARYLAN SQ
STRATTON CT
Leisure Centre
College
Recn Gd
Recn Gd
WESTWAY
GLENWOOD AVE
CLENWAY
NEVILLE ROAD
MADEIRA AVE
NORTHCLIFFE ROAD
MACKLIN ROAD
BROOKS LANE
HOOK LANE
BROOKSMEAD
MEAD LANE
BOGNOR ROAD
Upper Bognor Road
A259
A259
A259 UPPER BOGNOR ROAD
Miniature Rly
Hotham Park
College
Church Path
High Street
Aldingbourne Rife
Ppg Sta
RIFE WAY
NORTH WAY
EASTOVER W
GRASSMERE CL
PW
KINGSMEAD
UPPER BOGNOR
LINKS
VICAR

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TITLE:
UNIVERSITY OF CHICHESTER
POST DEVELOPMENT
1 IN 30 YEAR FLOOD EXTENT

FIGURE No:
FIGURE 20

Legend

1 in 100 year Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Leisure Centre

College

Recn Gd

Recn Gd

College

Miniature Rly

Hotham Park

Ppg Sta

PW

IVY LANE

HIGHCROFT AVENUE

ELMWOOD AVENUE

MADEIRA AVENUE

WESTWAY

GLENWOOD AVE

NEWFIELDE ROAD

HOOK LANE

NORTHCOTE ROAD

MACKLIN ROAD

BROOKS LANE

MEAD LANE

UPPER BOGNOR ROAD

A259

High Street

Aldingbourne Rife

RIFE WAY

EASTOVER WAY

GRASSMERE CL

KINGSMEAD

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TITLE:

UNIVERSITY OF CHICHESTER
POST DEVELOPMENT
1 IN 100 FLOOD EXTENT

FIGURE No:

FIGURE 21

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Post_flood_extents\Figure 21_Post_Flood extent_100 yr.mxd Drawn By: ukmwg001 Date Modified: 24/03/2016

Legend

1 in 100 year 20% CC Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Leisure Centre

College

Recn Gd

Recn Gd

IVY LANE

HIGHCROFT AVENUE

ELMWOOD AVENUE

MADEIRA AVENUE

WESTWAY

GLENWOOD AVE

NEVILLE ROAD

HOOK LANE

NORTHCOTE ROAD

BLACKLIN ROAD

MARYLAND CRESCENT

BROOKS LANE

STRATTON CT

BROOKSMEAD

MEAD LANE

Upper Bognor Road

Miniature Rly

Hotham Park

College

A259 UPPER BOGNOR ROAD

A259

Aldingbourne Rife

Ppg Sta

High Street

Church Path

A259

RIFE WAY

NORTH WAY

EASTOVER W

GRASSMERE CL

PW

KINGSMERE

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 PLUS 20% CLIMATE CHANGE
FLOOD EXTENT
POST SCENARIO

FIGURE No:

FIGURE 22

Date Modified: 24/03/2016

Drawn By: ukmwg001

File: Q:\WSP_UK\WSP_D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Post_Flood_extents\Figure22_Post_Flood_extent_100_20CC_yr.mxd

Date Modified: 24/03/2016

Drawn By: ukmwg001

File: Q:\WSP...UK\WSP...D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Post_Flood_extents\Figure23_Post_Flood extent_100_40CC yr.mxd

Legend

1 in 100 year 40%CC Depth (m)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

IVY LANE
IVY CLOSE
HIGHCROFT AVENUE
ELMWOOD AVENUE
MADEIRA AVENUE
WESTWAY
GLENWOOD AVENUE
NEVILLE ROAD
HOOK LANE
NORTHLEIGH CLOSE
NORTHLEIGH ROAD
MARYLAND CRESCENT
BROOKS LANE
STRATTON CT
BROOKSMEAD
MEAD LANE
UPPER BOGNOR ROAD
A259
Leisure Centre
College
Recn Gd
Miniature Rly
Hotham Park
Church Path
High Street
Aldingbourne Rife
Ppg Sta
PW
NORTH WAY
RIFE WAY
EASTOVER W
GRASSMERE CL
KINGSMERE

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TITLE:

UNIVERSITY OF CHICHESTER
1 IN 100 PLUS 40% CLIMATE CHANGE
FLOOD EXTENT
POST SCENARIO

FIGURE No:

FIGURE 23

Appendix H

DIFFERENCE MAP FOR THE 1 IN 100 YEAR PLUS CLIMATE CHANGE SCENARIO (FIGURES 16 – 17).



Legend

Differences 100 yr 20%CC (m) (Post - Pre)

- < -0.5
- -0.5 - -0.4
- -0.4 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - 0.0
- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- > 0.5

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TITLE:

UNIVERSITY OF CHICHESTER
POST HYDRAULIC MODEL
1 IN 100 PLUS 20% CLIMATE CHANGE
DIFFERENCE MAP

FIGURE No:

FIGURE 16

Date Modified: 24/03/2016
Drawn By: ukmxg001
File: Q:\WSP_UK\WSP...D\Basing\UoC Tech Park - 70013326\Analysis\ArcGIS\MapDocuments\Difference Maps\Figure 16_Difference_map_100 20CC yr.mxd



Legend

Differences 100 yr 40%CC (m) (Post - Pre)

- < -0.5
- -0.5 - -0.4
- -0.4 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - 0.0
- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- > 0.5

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TITLE:

UNIVERSITY OF CHICHESTER
POST HYDRAULIC MODEL
1 IN 100 PLUS 40% CLIMATE CHANGE
DIFFERENCE MAP

FIGURE No:

FIGURE 17

File: Q:\WSP...UK\WSP...D\Basing\UoC Tech Park - 70013326\Analysis\ArcGIS\MapDocuments\Difference Maps\Figure 17_Difference_map_100 40CC yr.mxd

Drawn By: ukmxg001

Date Modified: 24/03/2016

Appendix I

THE DRAFT DEVELOPMENT LAYOUT

Date Modified: 30/03/2016

Drawn By: ukmxg001

File: Q:\WSP...UK\WSP...D\Basing\UoC Tech Park - 70013264\Analysis\ArcGIS\MapDocuments\Figure 24_ Draft layout.mxd

Legend

Draft Development Layout

BROOKS

FELPHAM W

Aldin

nabourne

RIEB

College

Ppg

Sta

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TITLE:

UNIVERSITY OF CHICHESTER
POST HYDRAULIC MODEL
DRAFT DEVELOPMENT LAYOUT

FIGURE No:

FIGURE 24