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24th December 2020

BDW Southern Counties

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For the attention of M Brooks

Dear Megan,

DROVE LANE, YAPTON – ADDITIONAL INVESTIGATIONS

1. BACKGROUND

RSK Environment Limited (RSK) was commissioned by BDW Southern Counties (the client) to carry out additional investigations at the above named site:

Geo-environmental site assessments have previously been undertaken at the site, which are outlined in the following reports:

- BRD Phase 2 Site investigation ref BRD 2934-OR2 – B dated 14 November 2017; and
- Campbell Reith Site Investigation Ref 13024 – dated August 2019.

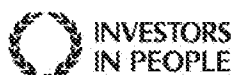
The additional works included the following:

1. Appraisal of the available historical site investigation information with respect to the contamination potential
2. Carry out additional geotechnical investigations to determine the foundation strategy for the proposed development.
3. Undertake topsoil analyses to confirm its suitability for re-use.

This letter report is subject to the service constraints laid out in **Appendix A**.

2. SITE SETTING

The development site, which excludes the field in the northern part of the site containing the former canal, has since the first historical OS records in 1876 been a single field used for agricultural purposes. Surrounding land to the west, east and south have also always been agricultural.



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3. HISTORIC SITE INVESTIGATION

In BRD's investigation in 2017 a total of 10 window sample holes (WS01-WS10) and 18 trial pits (TP1 to TP18) were sunk/excavated at the locations are shown on **Figure 1**. The probehole records are attached within pages 103 to 122 of the appended report within **Appendix B** and the descriptions describe all the soils encountered (apart from WS02 located in the area of the former canal to the north of the development site), as being natural and undisturbed.

In Campbell Reith's 2019 investigation 11 window sample holes and seven trial pits were sunk/excavated at the locations shown on the site plan extract – together with the probehole records found within **Appendix C**.

3.1 Historic Contamination analyses

BRD 2017

The following testing was carried out on representative soil samples from depths ranging from 0.10m to 1.00m.

- 20No. Metals Suite - As, Cd, Cr, CrVI, Hg, Pb, Se, Cu, Ni and Zn.
- 20No. Inorganics Suite – water soluble sulphate, pH, organic matter.
- 20No. Speciated Polycyclic Aromatic Hydrocarbons (PAH).
- 5No. Banded aliphatic/aromatic Total Petroleum Hydrocarbons (TPH).
- 5No. Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Methyl Tertiary Butyl Ether (MTBE) compounds.
- 5No. Asbestos screen and quantification (if present).
- 4No. Semi-Volatile Organic Compounds (SVOC) suite.
- 4No. Pesticide screen.

The results of the contamination analyses, given on Pages 25 and 26 of the BRD report, indicate no exceedences of contaminants above the Generic Acceptance Criteria (GAC) for residential with gardens land use.

CAMPBELL REITH 2019

No contamination testing was carried out as this investigation was for geotechnical assessment, however the descriptions/observations confirm the conditions encountered by BRD – i.e. encountering all natural strata, albeit they do describe the thin layer of topsoil as made ground due to historical isolated brick fragments.

3.2 RSK Appraisal of Contamination information

RSK have appraised both SI reports and have also observed all of the archaeological trench excavations that were opened up during the summer of 2020, and conclude that there is no evidence of contamination upon the development site that has a potential risk to human health, buried pipes or controlled waters.

4. RSK ADDITIONAL GEOTECHNICAL INVESTIGATION

Further to previous appraisals of the 2 historical site investigations where conflicting ground conditions were recorded (considered to be due to misinterpretation of in situ tests in probehole investigations in silt/clay and environmental descriptions instead of geotechnical), RSK have carried out an additional trial pitting exercise to determine the more confidently the ground conditions in the top 3m. Also a borehole investigation was undertaken to provide geotechnical parameters to inform pile design.

4.1 Trial Pit Investigation

The investigation was carried out at the end of a relatively dry summer and the ground conditions reflected this with what may be considered at 1.25m-1.35m temporarily desiccated top layer (primarily from the crops that were grown on the site this spring/summer). Seven trial pits (TP113 – TP119) were excavated at the approximate positions shown on the attached plan. Their descriptions are given in the trial pit records (Appendix D). The archaeological team recorded the exact positions of the trial pits and these are shown on their site plan, Figure 2.

The ground conditions may be summarised as follows with detailed descriptions attached:

TOPSOIL – present in all trial pits to depths ranging from 0.20m to 0.35m

CLAYEY SILT/SILTY CLAY – present in all trial pits to depths ranging from 1.50m to >2.50m, in some pits slightly sandy. Based upon inspection of the soils and the interim laboratory results it is considered that the soils were slightly desiccated to depths ranging from 1.25m to 1.35m. Nevertheless the consistency remained as stiff to very stiff below these depths and only in one pit became firm to stiff below 2.20m.

CLAYEY SILT/SILTY FINE SAND/REMOULDED CHALK with f-c chalk flint gravel – present in all pits except TP117 to the full depth of investigation (~2.50m). These soils were intermixed at some locations and were of a firm, or firm to stiff, or stiff consistency where cohesive.

Groundwater was not encountered within any trial pits during excavation. The sides of all the trial pits remained stable during excavation.

4.2 Borehole Investigation

Two boreholes were sunk to depths of 20m at the location shown on the site plan. The borehole records are given in Appendix D.

4.3 Comments on Ground Conditions in relation to Foundation Design

Based upon the ground conditions encountered on 16 September 2020, the proposed low rise house may be placed upon conventional strip foundations founded upon the clayey silt/silty clay at a minimum depth of 1.35m below final or existing ground level whichever is the lower. Such foundations may be designed to an allowable bearing pressure of 100kN/m². It is further recommended that these foundations are lightly reinforced with a layer of mesh at the top of the foundation to compensate for any slight change in ground conditions.

These soils are of low to medium shrinkability and therefore a medium shrinkability classification should be used to determine the depth of foundation for any units within the vicinity of past, present or future shrubs or trees in accordance with NHBC Chapter 4.2.

However, **it is strongly recommended that such foundations are excavated/constructed during the period from mid March to mid September** as the clay/silt will become highly susceptible to saturation and if left open formations will soften during inclement weather and the sides of any trench excavations likely to become unstable. Should foundation excavations be attempted outside these drier periods (or even within these periods if there has been heavy prolonged rain), then excavations may be feasible if a reduced level dig is undertaken over the plan area (+1m) as this will reduce the overburden weight and reduce the instability, however great care/planning will be required to not excavate when conditions are not suitable.

These recommendations are known to have been made on two similar sites in Barnham (approximately 1 mile away) where the same ground conditions occur. One of those sites has had to revert to piled foundations from October 2020 onwards, whilst the other site has employed localised dewatering, which potentially may be an option to consider, if a specialist contractor assesses the ground conditions suitable and it is cost effective

The alternative, should foundation construction be required to be carried out during the winter months, is that units should be piled. If this was to be considered then the use of CFA piles would be considered suitable.

5. LABORATORY TESTING

Laboratory testing was undertaken on representative soil samples at a number of trial pit locations (Appendix E) and these indicated the soils at likely foundation formation level ranged from non plastic (1 location) to low shrinkability (1 location) to medium shrinkability (3 locations). On this basis, the foundation depths for houses/garages to be located close to trees/shrubs (past, present or future) should be deepened based upon medium shrinkability, in accordance with Chapter 4.2, NHBC Standards.

Topsoil testing in accordance with British Standard BS 3882 was carried out upon 2 representative samples, and the results given in Appendix E, indicate that the topsoil may be classified as Low Fertility. It does, however also conform physically to a Multi Purpose Topsoil classification, although it has a deficiency in nitrogen, phosphorous and magnesium, which can be rectified with the addition of the

appropriate fertiliser by the landscaper when the topsoil has been placed in garden/public open space areas.

Please note that just because it conforms to a BS Standard, the correct method of handling, stockpiling and subsequent placement of topsoil (as well as the preparation of the underlying subsoil) is essential to avoid any waterlogging situation. Careful scrutiny of the groundworker/landscapers method statements should be undertaken to ensure these will deliver an acceptable finish to the home buyer.

We trust this is sufficient for your immediate needs, however if there are any queries please do not hesitate to contact the undersigned.

Yours sincerely,

For RSK Environment Limited



Nigel Austin

Director

Enc.

Figures:

Figure 1 Site Location Plan

Figure 2 Archaeological Site Plan (with Trial Pit and Borehole Locations)

Appendices:

Appendix A Service Constraints

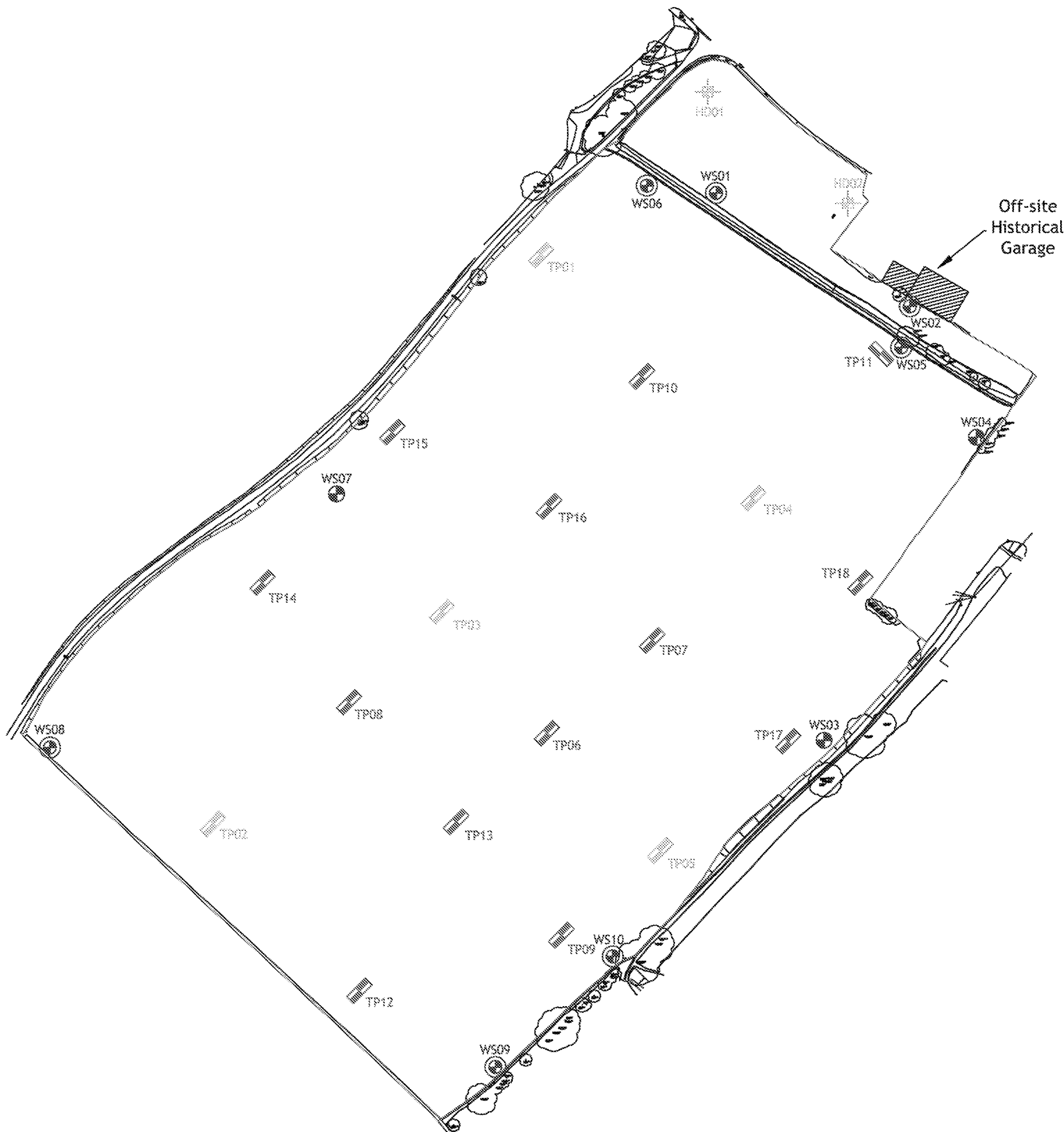
Appendix B BRD 2017 Report

Appendix C Campbell Reith Exploratory Window Sample Records and Site Plan

Appendix D Trial Pit and Borehole Records

Appendix E Laboratory Testing (Physical and Topsoil)

FIGURES



LEGEND:

- BRD Windowless Sample Borehole (GPS Location)
- BRD Windowless Sample Borehole With Monitoring Well Installation (GPS Location)
- BRD Trial Pit (GPS Location)
- BRD Soakage Test Pit (GPS Location)
- BRD Hand Dug Pit (GPS Location)
- Site Boundary (Approximate Location)

Drawing reproduced from Digital Terrain Surveys LLP 'Site Survey - Land at Drove Lane, Yapton', Ref No: DT5240417-700B, Drawing No: 1 to 8, Dated: April 2014.

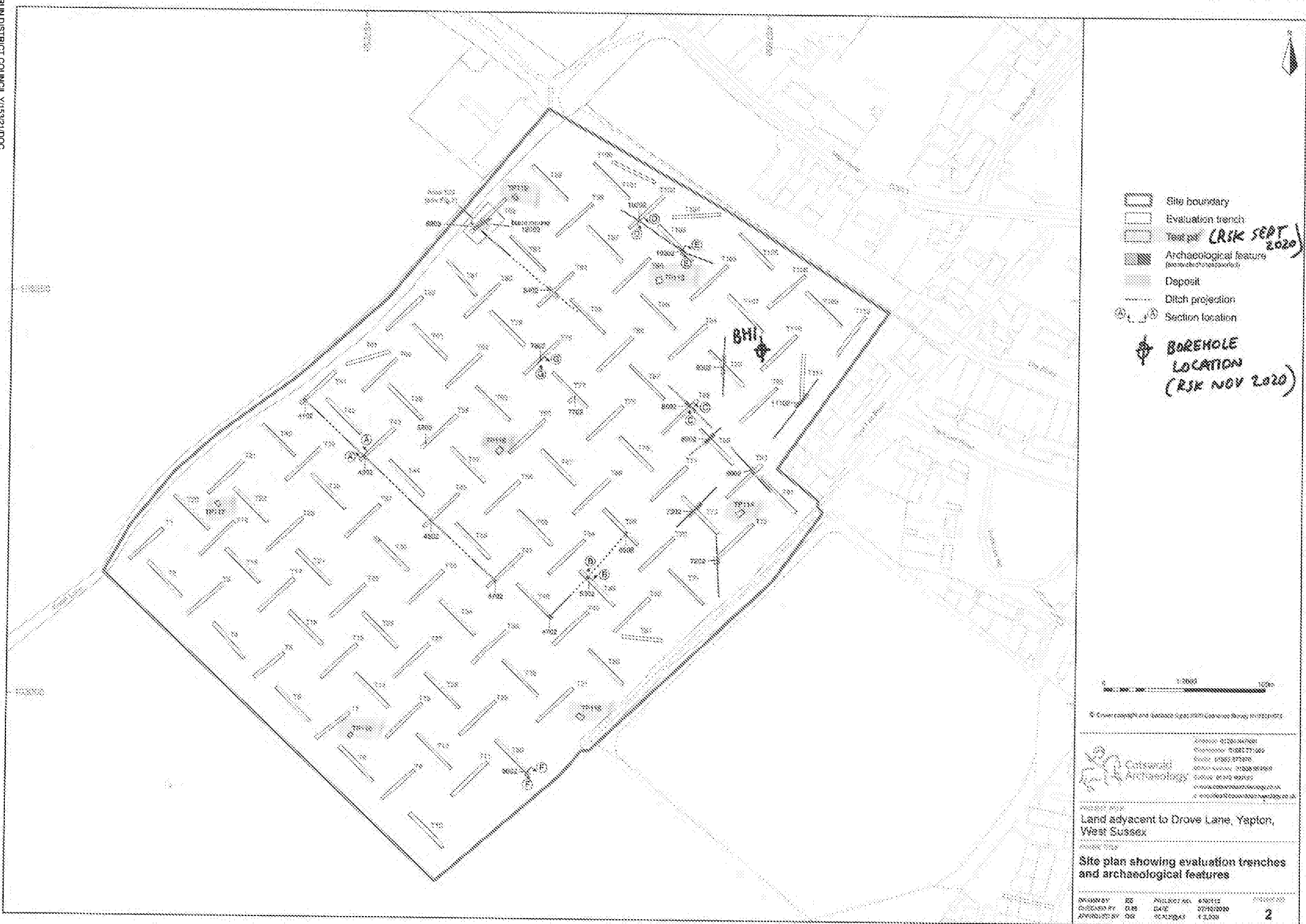
A	26.02.20	FIRST ISSUE	HD	NA	NA
REV	DATE	DESCRIPTION	BY	CHD	APR
Dimensions		Projection	Scale	Orig Size	
m			NTS	A3	

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CLIENT		BARRATT DAVID WILSON			
PROJECT		DROVE LANE, YAPTON			
TITLE		EXPLORATORY AND MONITORING POSITIONS			
JOB No.:		DRAWING FILE:			
1921081		1921081-Fig 1			
BY:	DATE:	CONTRACT NO.	REV:		
HD	26.02.20		FIGURE 1		A



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Land adjacent to Drove Lane, Yapton,
 West Sussex

Site plan showing evaluation trenches
 and archaeological features

Drawn by: [Name] Date: 07/10/2020
 Checked by: [Name] Date: 07/10/2020
 Approved by: [Name] Date: 07/10/2020



APPENDIX A

SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Barratt David Wilson (the "Client") in accordance with the terms of a contract [RSK Environment Standard Terms and Conditions] between RSK and the Client. The Services were performed by RSK with the reasonable skill and care ordinarily exercised by an environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the Client.
2. Other than that, expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the Client. RSK is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the Client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the Client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, invasive plants, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials, unless specifically identified in the Services.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a visual inspection of the site together with RSK's interpretation of information, including documentation, obtained from third parties and from the Client on the history and usage of the site, unless specifically identified in the Services or accreditation system (such as UKAS ISO 17020:2012 clause 7.1.6):
 - a. The Services were based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely.
 - b. The Services were limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the visual inspection.
 - c. The Services did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services.

RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the Client and RSK.

8. The intrusive environmental site investigation aspects of the Services are a limited sampling of the site at pre-determined locations based on the known historic / operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the properties of the materials adjacent and local conditions, together with the position of any current structures and underground utilities and facilities, and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters (as stipulated



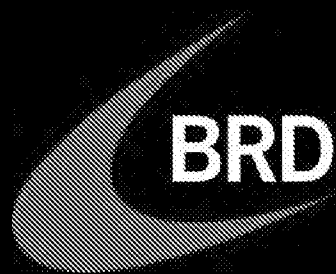
in the scope between the client and RSK, based on an understanding of the available operational and historical information) and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.
10. The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows, may vary from those reported due to seasonal, or other, effects and the limitations stated in the data should be recognised.
11. Asbestos is often observed to be present in soils in discrete areas. Whilst asbestos-containing materials may have been locally encountered during the fieldworks or supporting laboratory analysis, the history of brownfield and demolition sites indicates that asbestos fibres may be present more widely in soils and aggregates, which could be encountered during more extensive ground works.
12. Unless stated otherwise, only preliminary geotechnical recommendations are presented in this report and these should be verified in a Geotechnical Design Report, once proposed construction and structural design proposals are confirmed.



APPENDIX B

BRD 2017 REPORT



Report
Title:

Phase 2 Geo-Environmental Site Investigation

Project
Name:

Land at Drove Lane, Yapton



Report Reference: BRD2934-OR2-B

Date: November 2017

REPORT CONTROL SHEET

REPORT TITLE	PHASE 2 GEO-ENVIRONMENTAL SITE INVESTIGATION
PROJECT	LAND AT DROVE LANE, YAPTON
CLIENT	TRUSTEES OF THE LANGMEAD PENSION SCHEME

REPORT REFERENCE	ISSUE DETAIL	DATE	PREPARED BY	CHECKED BY
BRD2934-OR2-A	Interim First Issue	17/10/2017	A Plant	B Devonshire
BRD2934-OR2-B	Final issue with update for ground gases	08/11/2017	A Plant	J Brockwell

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The information and advice contained within this report is provided by BRD Environmental Limited (BRD) for the sole use and reliance by its Client in performance of BRD's duties under its contract with the Client. Any advice, opinions or recommendations within this report should be read and relied upon only in the context of the report as a whole. The advice within the report is based upon the information made available to BRD within the financial and timeframe constraints imposed. BRD relied on the accuracy of the information contained in the third party documents consulted and is in no circumstances responsible for the accuracy of such information or data supplied. The report is prepared with reasonable skill and care based generally on UK standards, codes and common practice current at the time of writing. When considering this report due regard should be given to the terms and conditions of BRD's contract with the Client under which the report was prepared. The copyright of this report is held by BRD. Should the Client wish to release this report to a Third Party for that party's reliance, BRD agree to such release provided that BRD assumes no duties, liabilities or obligations to the Third Party, that the Third Party does not acquire any rights whatsoever against BRD, and BRD accepts no responsibility for any loss incurred by the Client through the Client's release of the report to the Third Party. Following final issue of this report, BRD has no further obligation to advise the Client on any matters such as changes in legislation or codes of practice that may affect the advice contained within the report.

REPORT LAYOUT

This report is divided into the following four sections: Summary Report, Technical Report, Supporting Information and Appendices.

SUMMARY REPORT

This expanded executive summary provides the main findings of the work undertaken in brief non-technical language. This section provides an overview of the key outcomes for the benefit of non-specialists and concludes with the main recommendations. This section should only be relied upon in the context of the whole report and the Technical Report should be referred to with respect to any design decisions.

TECHNICAL REPORT

The main report section is intended to provide the technical detail of the investigation and is intended to provide the level of information required by current guidance documents and practice. The Technical Report is written in a language that, in part, assumes knowledge of subject matter so that it can be written in as concise a form as possible. Its intended audience is peers, regulators and other professionals in related disciplines.

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SUPPORTING INFORMATION

This section of the report provides background details of a generic nature together with specific technical approaches adopted by BRD and details of the guidance documents that are commonly referenced in the report. The section also includes explanations of technical terms to assist non-specialist readers in understanding the Technical Report. It should be noted that not all the information within this section is necessarily applicable to this specific report.

APPENDICES

The final section of the report presents the factual data collected and employed as part of the investigation.

APPENDIX 1 SITE PLANS & PHOTOGRAPHS

Site Location Plan	Ref. BRD 2934-OP1-A
Revised Conceptual Site Model	Ref. BRD 2934-OP4-A
Exploratory Hole Location Plan	Ref. BRD 2934-OD1-A

APPENDIX 2 EXPLORATORY HOLE & MONITORING RECORDS

Logs of trial pits.	Ref. TP01-18
Photographic records of trial pits.	Ref. BRD2934-OP5-A
Logs of boreholes.	Ref. WS01-10
Logs of hand dug pits.	Ref. HD01 ' HD02
BRE365 soakage test records.	15 x A4 pages
Gas monitoring records.	6 x A4 pages
Groundwater monitoring records.	6 x A4 pages

APPENDIX 3 LABORATORY TEST RESULTS

QTS reports 17-64372 and 17-64373	25 x A4 pages
SPT report S31804	16 x A4 pages

SUMMARY REPORT - GENERAL INFORMATION

SUBJ ECT	COMMENTS
CURRENT USE & DESCRIPTION	The site consists of two fields which are separated by a hedgerow and a public footpath. The larger of the two fields lies to the south-west and is currently used to grow wheat. The smaller field to the north east is used to graze sheep and an old canal crosses from north-west to south-east in the form of an elongated depression in the field.
PROPOSED USE	It is proposed that the site will be developed as residential housing estate of approximately 400 units. At the time of writing, no proposed layout is available.
HISTORICAL SUMMARY	Most of the site has remained undeveloped throughout its history and it has remained as an agricultural field since at least 1876. However, the former Chichester and Arundel Canal crosses the smaller, north-eastern field. It is shown on the earliest map, but it had fallen into disuse by the 1850s. Since then, the canal may have been partially infilled, although a depression remains noticeable to the present day.
PUBLISHED GEOLOGY	The most recent published information indicates the site to be underlain by some 4m of superficial deposits comprising silts with sand and clays of River Terrace Deposits that in turn are underlain by Raised Marine Deposits, although until recently the deposits were assigned as Aeolian Deposits (Brickearths). The superficial deposits are shown to be underlain by the Lewes Nodular Chalk Formation (Upper Chalk) comprising hard, nodular chalk with flint.
ACTUAL GROUND CONDITIONS	The investigation has proved the River Terrace Deposits soils typically comprised firm, stiff, orange brown becoming light brown slightly gravelly slightly sandy silty clay. As expected, the Chalk bedrock was encountered at depth.
HYDROGEOLOGY	The site is situated upon superficial deposits designated a Secondary A Aquifer. The underlying bedrock geology is designated a Principal Aquifer. The site is not located within a groundwater Source Protection Zone.
HYDROLOGY	The closest water feature to the site is a drainage ditch along the eastern boundary which eventually flows into the Ryebank Rife, some 1.2km to the south. The site is not in an area indicated to be at risk of flooding.
PREVIOUS GROUND REPORTS	BRD is not aware of any previous ground investigations having been conducted at the site. However, BRD has undertaken geo-environmental desk study research and this has been reported separately.

SUMMARY REPORT - GEOTECHNICAL

SUBJECT	COMMENTS
EXCAVATIONS	It should be possible to forward excavations employing normal equipment. Limited groundwater control in the form of pumping from sumps is likely to be required. It is unlikely that requirements of the Party Wall Act will apply to the development.
SLOPE STABILITY	It is considered that slope stability is unlikely to be a concern at this site.
SUB-SURFACE CONCRETE	Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete class of AC-1 applies.
SOAKAWAYS	Site is marginally suitable for surface water disposal to soakaways or other forms of infiltration device.
PAVEMENT DESIGN	A preliminary design California Bearing Ratio (CBR) of 3% has been recommended.
FOUNDATIONS	
LIKELY FOUNDATION TYPE	Given the local pockets of low strength River Terrace Deposits, lightly loaded reinforced strip/trench fill footings could be adopted for the site. Where footings would need to be in excess of 1.5m then a piled foundation should be considered as footings may not be acceptable due to the likely settlement characteristics of the low strength soils.
VOLUME CHANGE POTENTIAL	Medium i.e. moderate swelling or shrinking with moisture content changes.
ESTIMATED FOUNDATION DEPTHS	The minimum footing depth required is 0.90m, but 1.25m where required to allow for restricted new tree planting. Pile lengths to be determined by specialist piling contractor who are likely to require cable percussion boreholes.
HEAVE PROTECTION	Will be required for any structure within the potential influence of existing trees predominantly aligned along the northern and eastern site boundaries.

SUMMARY REPORT - CONTAMINATION ISSUES

SUBJ ECT	COMMENTS
SOIL RISKS TO HUMAN HEALTH	No unacceptable contamination in respect of human health have been identified by this investigation.
LANDFILL GAS	The gas monitoring has shown that landfill gas protection measures are not required.
RADON GAS	The site is in an area where no radon protection measures are required in new dwellings.
RISKS TO THE WATER ENVIRONMENT	No unacceptable contamination risks to water resources have been identified by this investigation.
RISKS TO BUILDING MATERIALS AND SERVICES	No unacceptable contamination risks to building materials and services have been identified by this investigation.
REMEDIATION	No remedial works are considered necessary to facilitate the development at this stage.
ASBESTOS	No asbestos has been detected in the soil samples tested. No suspected asbestos containing materials was observed in the soil samples inspected during the site investigation.
WASTE SOIL DISPOSAL	The topsoil is suitable for use on other developments. Made Ground and natural sub-soils can be disposed of to landfill as inert waste.

SUMMARY REPORT - KEY RECOMMENDATIONS

RECOMMENDATIONS
Once the layout for the proposed development has been finalised it is recommended that additional site investigation works are undertaken in order to establish the variation in the extent and thickness of the low strength deposits first encountered at depths of around 2.0m bgl. Where foundations are required to be deepened in excess of 1.5m due to tree influence or other factors such as nearby drainage, the use of traditional footings may not be satisfactory. However, a supplementary site investigation would assist in providing further site specific information beneath the site. Such investigation would also provide information for potential pile designs within the underlying Chalk Formation. It is suggested that these additional investigation works should comprise at least one day of Cone Penetration Testing (CPT) with a combination of numerous shallow probes (5m) together with a few deeper tests (18m or refusal). Test locations should be spread over the site, although concentrated along the northern section of the main field and along the eastern site boundary where foundations are likely to be deepened due to the influence of the existing trees.

1. INTRODUCTION TO TECHNICAL REPORT

1.1. CONTRACT DETAILS

CLIENT	Trustees of the Langmead Pension Scheme.
SITE	Land situated at Drove Lane in the village of Yapton, West Sussex.
CLIENT'S ADVISORS	BRD Environmental Limited (BRD) has been commissioned by Landlink Estates Ltd on behalf of the Client.
REPORT CONTEXT	It is understood that the site is proposed for residential redevelopment.
REPORT TYPE	Phase 2, geo-environmental site investigation (i.e. combined geotechnical ground investigation and Phase 2 contamination assessment).
REPORT OBJECTIVES	The site has been the subject of a desk study referenced as follows: • 'Phase 1 Geo-Environmental Desk Study ' Land at Drove Lane, Yapton', BRD Environmental Ltd, report ref. BRD2934-OR1-A, dated April 2017. The purpose of the report is to present the findings of a ground investigation and present a geotechnical assessment of the conditions revealed.

1.2. SCOPE OF WORKS

The agreed scope of works was:

- Mobilisation to site and production of health and safety documentation.
- Delivery of 20mm granular material to site for backfilling the pits and supply of 75-100mm diameter perforated pipes for the inspection well in each soakage test pit.
- Two days of trial pitting using a mechanical excavator to provide approximately 18-20No. trial pits to a nominal depth of 3m, ground conditions permitting.
- Performance of soakage tests based upon BRE Digest 365 at 5No. of the trial pit locations. Supply of water to site via a water tanker/bowser unit on three consecutive days for the repeat filling of each test pit. A Geo-Environmental Technician will monitor the soakage tests.
- Removal of pipework at the end of the third day and reinstatement of trial pit surfacing. The surplus soil from excavating the pits will be neatly stockpiled on site. We have not allowed for any disposal of this soil.
- Two days of windowless sampling using a percussive drilling rig to provide approximately 10-12No. boreholes to a nominal depth of 3m-5m, ground conditions permitting. Undertake Standard Penetration Tests (SPT) at 1m intervals. Installation of a 4m depth combined gas and groundwater monitoring well (nominal 50mm diameter) into 7No. boreholes. Installations will be finished with a flush fitting metal stopcock cover.

- All exploratory points will be logged and sampled in general accordance with BS5930:2015 by supervising Geo-Environmental Consultant. In-situ geotechnical testing of any fine soils using a Hand Shear Vane and/or Pocket Penetrometer.
- Determination of the location of exploratory points by tape measurements or the use of a handheld recreational GPS unit.
- Geo-Environmental Technician to undertake a total of 6No. combined gas, vapour and groundwater monitoring visits. For gas, the determination of oxygen, carbon dioxide, methane, hydrogen sulphide and carbon monoxide concentrations, together with atmospheric pressure and flow rates, using portable equipment. For vapours, determination of the concentration of volatile organic compounds by photo ionisation detector. For groundwater, the determination of groundwater levels.
- Chemical testing of soil samples with the budget based on the following testing schedule:
 - o 20No. Metals Suite - As, Cd, Cr, CrVI, Hg, Pb, Se, Cu, Ni and Zn.
 - o 20No. Inorganics Suite - water soluble sulphate, pH, organic matter.
 - o 20No. Speciated Polycyclic Aromatic Hydrocarbons (PAH).
 - o 5No. Banded aliphatic/aromatic Total Petroleum Hydrocarbons (TPH).
 - o 5No. Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Methyl Tertiary Butyl Ether (MTBE) compounds.
 - o 5No. Asbestos screen and quantification (if present).
 - o 4No. Semi-Volatile Organic Compounds (SVOC) suite.
 - o 4No. Pesticide screen.
- Chemical testing of 1No. soil sample for Waste Acceptance Criteria (WAC) to assist in establishing the waste classification of the soil for disposal purposes.
- Geotechnical testing as appropriate to the nature of the ground conditions encountered, but the budget is based on the following testing schedule:
 - o 8No. Moisture content.
 - o 8No. Plasticity indices.
 - o 4No. Particle size distribution by wet sieve and with 2No. by follow on hydrometer.
 - o 8No. pH and water soluble sulphate analysis.
 - o 8No. Total sulphate and sulphur analysis.

Provision of a combined factual and interpretative investigation report. Factual findings to include all exploratory point records, monitoring and test results. Interpretative reporting to include a summary of information from desk study research, a Generic Quantitative Contamination Risk Assessment (GQRA), waste classification and a Geotechnical Assessment providing comments on pavement design, concrete classification, soakaway feasibility, foundation design recommendations.

1.3. REPORT LIMITATIONS

Any site boundary lines depicted on plans included within this report are approximate only and do not imply legal ownership of land. Any observations of tree species, asbestos containing materials within structures or invasive weeds, such as Japanese Knotweed, does not constitute a formal survey of such features. The identification of such features is therefore tentative only. The report does not consider whether sensitive ecology or archaeology is present as these require consideration by professionals specialising in these matters. It should be recognised that the collection of desk study information may not be exhaustive and that other information pertinent to the site may be available.

The recommendations, interpretations and conclusions of this report are based solely on the ground conditions found at the exploratory holes. Due to the variability in the nature of ground, conditions between exploratory holes can only be interpreted and not defined. The description of the site and the ground conditions is accurate only for the dates of the field works. In particular, groundwater levels can vary due to seasonal and other effects.

The assessment and interpretation of contamination risks is based on the scope of works agreed with the Client together with the budgetary and programme constraints imposed. Further investigation, analysis and assessment of contamination may be required by regulators or other third parties with an interest in the site. An ecological risk assessment of contaminated soils is beyond the scope of this report. This report is concerned with assessing those contamination risks which apply to the future use of the site through the proposed development as part of the planning regime. The assessment does not consider the risk to current site users or continued future use of the site in its current state. If development of the site should occur that differs from that proposed, then the findings of the contamination assessment would need to be re-evaluated.

At the time of writing, detailed information on the proposed structure, such as detailed layout, loadings and serviceability limits, was not available. Accordingly, where geotechnical design advice is provided it is on the prescriptive basis allowed for by Eurocode 7: employing conventional and conservative design rules. The scope of this investigation excludes a formal slope stability study and any observations made regarding slopes are for information only.

2. SITE CHARACTERISTICS

2.1. SITE SETTING

SITE ADDRESS AND POST CODE	Land at Drove Lane, Yapton, Arundel, West Sussex. The nearest post code is BN18 0EB (Drove Lane Farm).
NATIONAL GRID REFERENCE	The centre of the site is approximately located at 497354E, 103152N

2.2. SITE SUMMARY

SUBJECT	COMMENTS
CURRENT SITE DESCRIPTION	The site comprises two adjoining agricultural fields with a combined near rectangular shape, although the north eastern section of the site comprises two indentations around existing residential developments. The site is typically aligned north eastwards and has a total extent of some 12.92 hectares. During the walkover survey of April 2017, the larger southern field was used to grow wheat while the smaller northern field was used to graze sheep. The two fields were separated by a predominantly hawthorn hedgerow.
SURROUNDING LAND USE	The site is set in a predominately agricultural area on the western fringes of a rural village.
PROPOSED DEVELOPMENT	It is proposed that the site will be developed as residential housing estate of approximately 400 units. At the time of writing, no proposed layout is available.

HISTORICAL SUMMARY	From the previous desk study report, the following summary of the site's history is presented, as follows:- 1876: Site is shown within a larger agricultural field with the northernmost section cross-cut in an east to west direction by a canal. The alignment of which is similar the modern day hedgerow and public footpath that separates the two fields. The adjacent and surrounding land is predominantly agricultural. 1897: The map is the first to show the canal as being unused. Land some 200m to the east is shown in use as 'brickfields'. 1912: The eastern section of the canal is shown as having been in-filled during the intervening years, although the remainder of the site is shown little changed from the 1870s. 1913 to 2017: The site area is shown little changed from the 1870s. The available maps dated from 1913 indicate the following developments or notable features over the surrounding ground: The maps dated between 1938 to 1974 show a car repair garage located centrally adjacent and to the north of the in-filled section of canal, and adjacent to the northern site boundary. Maps dated from 1940s show extensive residential development firstly to the south east of the site, and then from the 1990s onwards to the north and east of the site. The maps dated between 1974 and 1989 indicate a farm with a storage tank located to the north of the historical car repair garage and on the opposite side of Main Road.
PUBLISHED GEOLOGY	The most recent published BGS information indicates the site to be underlain by some 4m of superficial deposits comprising silts with sand and clays of River Terrace Deposits that in turn are underlain by Raised Marine Deposits, although until recently the deposits were assigned by the BGS as Aeolian Deposits (Brickearths). The superficial deposits are underlain by the Lewes Nodular Chalk Formation (Upper Chalk) comprising hard, nodular chalk with flint.
RADON	Radon protection measures are not required.
HYDROGEOLOGY	The site is situated upon superficial deposits designated a Secondary A Aquifer. The underlying bedrock geology is designated a Principal Aquifer. The site is not located within a groundwater Source Protection Zone.
HYDROLOGY	The closest water feature to the site is a drainage ditch along the eastern boundary which eventually flows into the Ryebank Rife, some 1.2km to the south. The site is not in an area indicated to be at risk of flooding.
LANDFILL	A historical landfill is recorded as the 'Disused Canal at Barnham' aligned coincident to the canal located immediately to the west of the northern section of the site with an extent of some 1km by typically 30m width. The landfill relates to the early 1970s with accepted waste specified as 'deposited waste including inert waste' although no further information is easily available.

CONTEMPORARY TRADE DIRECTORY ENTRIES	There are two directory entries that relate to a small garage style building, which appeared to have sustained fire damage, centrally located adjacent and to the north of the eastern section of the canal alignment that cross-cuts the northern field. The historical records refer to G S Auto Recovery, that traded as 'Mechanical Engineers' and to Central Garage that operated as a fuel station.
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2.3. PREVIOUS INVESTIGATIONS

BRD is not aware of any previous ground investigations having been conducted at the site.

2.4. PRELIMINARY ASSESSMENTS

PRELIMINARY CONTAMINATION RISK ASSESSMENT

The vast majority of the site is unlikely to be significantly contaminated. However, low to moderate risks have been identified which relate to the possible infill of a section of the old canal with potentially contaminated waste. There is a potential for cross border contamination from an adjoining derelict garage. Finally, there is the potential for pesticide residues to be present within the near surface soils across the site associated with the agricultural use.

The potential contamination may be a cause for concern to human health, the water environment and water supply pipes.

PRELIMINARY GEOTECHNICAL ASSESSMENT

The anticipated near surface geology comprised superficial deposits of River Terrace Deposits underlain by Raised Marine Deposits that each may potentially comprise low strength soils, thereby making the stratum unlikely to be suitable for the adoption of standard trench fill/strip footings. Wider, reinforced strip footings could be employed to spread loads over a wider area, or ground improvement may be required. Alternatively, a piled foundation solution could be considered.

Depending on the composition of the superficial deposits, i.e. should fine soils (clay or silts) be encountered at a shallow depth, the trees and hedges along the site boundaries may cause the soils to be seasonally desiccated, and foundations in close proximity to existing or proposed trees may need to be deepened to accommodate any ground movements.

Soakaways may be viable at the site, depending on whether granular deposits are encountered within the superficial deposits. If the Chalk bedrock is relatively shallow and/or fractured, deeper borehole-style soakaways may be feasible.

3. GROUND INVESTIGATION

3.1. INVESTIGATION DESIGN

METHODOLOGY	Trial pits were selected as they expose more soils which enables a more reliable record of the ground conditions encountered and to enable the performance of soakage tests based upon BRE Digest 365. Windowless sampling boreholes were considered the most appropriate method of investigation to establish the geological profile down to depth over the site. This method could be used to undertake Standard Penetration Tests (SPTs) at regular intervals during boring to determine the presence of any weak superficial deposits or may indicate the potential presence of any chalk dissolution features. The methodology also allowed for the installation of a combined gas and groundwater monitoring installations to establish ground gas values and standing groundwater levels over the site. Hand dug pits were undertaken at selected locations that were not accessible by mechanical plant or equipment. The use of the above excavation techniques each allow for the collection of soil samples for both contamination and geotechnical assessment purposes.
DATES OF SITE WORKS	The main field works were undertaken between the 11th and 14th September 2017. Monitoring visits were undertaken on the 26th September, and 3rd, 11th, 17th, 25th and 31st October 2017.
CONSTRAINTS TO EXPLORATORY HOLE LAYOUT	The northern field was subject to window sampling techniques alone due to the narrow available entrance located within the south western corner of the field adjacent to Drove Lane. In turn, the northernmost section of the same field was accessible by foot alone due to the alignment of a relatively steep slope marking the historical bank of the canal. Within that section of the site, excavations were restricted to the use of hand held equipment alone. The utility service records indicated the presence of a local potable water supply aligned within the eastern highway verge along Drove Lane. Therefore, excavations were restricted to at least 10m into the site and away from the service.
EXPLORATORY HOLE SPACING	Approximately 75m grid.

LAYOUT RATIONALE	SOURCE / FEATURE	EXPLORATORY HOLE
CONTAMINATION SOURCES TARGETED	On site agricultural fields	All exploratory holes.
	On site and off site canal infill	On site WS01, WS02, WS05, and WS06. Off site WS01 and WS06.
	Off site historical vehicle servicing garage and tank at farm yard to the north east of the garage on the northern side of Main Road.	WS02, WS05 and TP11.
GROUND FEATURES TARGETED	Potential for Made Ground associated with former infilling of the canal and historical construction of the canal.	WS01, WS02, WS05 and WS06.
	General site coverage with a very low risk of the potential for chalk dissolution features remaining in the ground.	All exploratory holes.
CONTAMINATION SAMPLING PLAN	Based on the proposed end use, the sampling and analysis plan is more positively biased towards near surface samples as these represent the soils most likely to be available to future site users.	
ANALYSIS PLAN	Testing was based on the potential contaminants identified within the Hazard Identification section of the Phase 1 contamination assessment, and BRD has scheduled a general suite of contaminants. Pesticide screening was non targeted within near surface samples taken spread over the large agricultural field. The analytical frequency has been increased for Made Ground samples identified within or adjacent to the canal for these represent the most likely area for contamination. Based on the Phase 1 contamination assessment, these also coincided with the most likely areas, if any, to be affected by the off site sources including in filled canal to the west, and historical fuel garage and former farm tank centrally located along the north eastern site boundary. For the assessment of potable water supply pipes, soil samples were tested at depths of between 0.5m and 1.0m and within one Made Ground soil sample, a wider range of contaminants were tested including benzene, toluene, ethylbenzene and xylene (BTEX) compounds and Semi-Volatile Organic Compounds (SVOCs) to meet the requirements of the water supply companies pipe specification assessment.	

3.2. BRD FIELDWORK

TRIAL PITS	
REFERENCES	TP01 to TP18.
DEPTH RANGE	From 2.00m to 3.45m, typically 3.00m.
EXCAVATOR	J CB 3CX style wheeled backactor.
BACKFILL	Five of the trial pits (TP01 to TP05) were utilised for soakage test based upon BRE 365 and were each backfilled with some 3m³ of gravel, followed by arisings on completion of the tests. The remaining thirteen of the trial pits (TP06 to TP18) were backfilled with arisings upon completion and compacted with rams of the excavator bucket.

WINDOWLESS SAMPLING BOREHOLES	
REFERENCES	WS01 to WS10.
DEPTH RANGE	Each to 5.45m.
RIG TYPE	Premier Drilling Rig.
INSTALLATION / BACKFILL	Three boreholes (WS03, WS04, and WS07) were backfilled with arisings. Seven boreholes (WS01, WS02, WS05, WS06, WS08, WS09 and WS10) had monitoring wells installed. These comprised 50mm nominal diameter standpipes fitted with a gas tap plain cap finished with a flush metal cover. The slotted response length of the well is shown on the individual logs. Bentonite seals are also indicated on the logs. The filter medium used was pea gravel.

HAND DUG PITS	
REFERENCES	HD01 and HD02.
DEPTH RANGE	Excavated down to a maximum depth of 0.75m.
EQUIPMENT	Hand held excavation tools.
INSTALLATION / BACKFILL	The boreholes were backfilled with arisings upon completion.

MONITORING	
TYPE	Ground gases and vapour. Groundwater monitoring.
DATES	Monitoring visits were undertaken on the 26 th September, and the 3 rd , 11 th , 17 th , 25 th and 31 st October 2017.

3.3. LABORATORY TESTING

GEOTECHNICAL TESTING	
The soil samples for geotechnical testing were forwarded to the laboratory of Soil Property Testing Ltd with pH and sulphate analysis undertaken at the laboratory of QTS Environmental Ltd. The geotechnical testing suite is detailed below. The UKAS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
TEST	NUMBER OF SAMPLES TESTED
Moisture content	8
Liquid and plastic limits	8
Particle size distribution by wet sieve	2
Particle size distribution by wet sieve and hydrometer	2
pH and Water soluble Sulphate	20
Total Sulphur and Sulphate	8

SOIL CHEMICAL TESTING	
The soil samples for contamination and/or chemical geotechnical testing were forwarded to the laboratory of QTS Environmental Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
SOIL TESTS	NUMBER OF SAMPLES TESTED
Arsenic, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Selenium, Zinc	20
Speciated Polycyclic Aromatic Hydrocarbons (PAH)	20
Total Petroleum Hydrocarbons (TPH) with full carbon banding and aliphatic/aromatic split	5
Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) plus Methyl Tert Butyl Ether (MTBE)	5
Asbestos Identification	5
Semi-Volatile Organic Compounds (SVOCs)	4
Pesticide screen	4
Waste Acceptance Criteria (WAC) testing	1

4. GROUND CONDITIONS

4.1. OVERVIEW

Ground conditions were as anticipated from the review of recent published BGS information with superficial deposits comprising River Terrace Deposits underlain by bedrock of the Lewes Nodular Chalk Formation. Locally, the alignment of the canal was reduced in level by 1m to 2m. The south eastern half of the canal centred on borehole WS02 was shown to have been partially and only locally in-filled with raised Made Ground of some 1.1m. Based on the observed soils, the River Terrace Deposits could not be separated with certainty from any underlying Raised Marine Deposits.

Groundwater was encountered during the site works within five exploratory holes at depths of between 2.80m and 4.80m. Each of the groundwater strikes were within the Lewes Nodular Chalk Formation.

Details of the various stratigraphic units are given in the following sections.

4.2. ARTIFICIAL GROUND

SURFACE HARDSTANDING	Not encountered in exploratory points.
BURIED STRUCTURES	Not encountered in exploratory points.
BURIED SERVICES	Not encountered in exploratory points.

MADE GROUND - HISTORIC CANAL			
LOCATION	Within or close to the depression marking the former canal alignment in the north eastern part of the site. WS01, WS02 and WS05		
DEPTH TO BASE	0.27m to 1.10m	THICKNESS	0.27m to 1.10m
DESCRIPTION	Comprised a friable brown slightly gravelly silty topsoil onto firm brown slightly gravelly slightly sandy silty clay. The gravel fraction comprised angular fragments of coal, coal ash or brick fragments with occasional sub rounded flint. Thin surface layer of the base of the historical canal excavation with topsoil developed at borehole WS01 where the depression of the former canal was clearly visible. Locally, the south eastern half of the canal (some 10m by 60m) had an irregular ground surface suggesting some limited fill as found in WS02. The Made Ground in borehole WS05 may be related to the original clay liner to the canal rather than infilling.		
COMMENTS	GEOTECHNICAL	The depth of Made Ground is not particularly significant.	
	CONTAMINATION	No visual or olfactory evidence of contamination.	
	GROUNDWATER	Groundwater was not observed in this stratum.	

4.3. TOPSOIL

TOPSOIL			
LOCATION	Virtually site wide. WS03, WS04, WS07 to WS10, TP01 to TP18, HD01 and HD02		
DEPTH TO BASE	0.25m to 0.30m	THICKNESS	Typically 0.30m
DESCRIPTION	Topsoil comprised friable brown slightly humic sandy silty topsoil.		
COMMENTS	GEOTECHNICAL	Nothing significant noted.	
	CONTAMINATION	No visual or olfactory evidence of contamination.	
	GROUNDWATER	Groundwater was not observed in this stratum.	

4.4. SUPERFICIAL DEPOSITS

RIVER TERRACE DEPOSITS			
LOCATION	Site wide.		
DEPTH TO BASE	2.00m to 4.70m, and >3.2m.	THICKNESS	1.7m to 4.4m, typically 2.3m.
DESCRIPTION	The deposits were of variable composition, although were predominantly stiff friable orange brown, below 1.7m becoming light brown, locally slightly gravelly, slightly sandy silty clay. The sand fraction was typically fine-sized. The gravel fraction comprised fine- and medium-sized angular to sub rounded flint and chalk. Locally, the light brown soils comprised soft, firm light brown silty clay/ clayey silt. Locally, pockets of sand and gravel were encountered.		
COMMENTS	GEOTECHNICAL	Nothing significant noted.	
	CONTAMINATION	No visual or olfactory evidence of contamination.	
	GROUNDWATER	Groundwater was not observed in this stratum.	

4.5. BEDROCK

LEWES NODULAR CHALK FORMATION			
LOCATION	Site wide.		
DEPTH TO BASE	>5.45m	THICKNESS	Unproven, BGS indicates Formation present to at least 35m bgl.
DESCRIPTION	The Chalk Formation comprised white off-white chalk of slightly clayey gravelly silt or silty gravel of flint and chalk rock fragments. Locally, rock quality Formation was encountered at depth although was typically recovered as a mix of gravel and silt. The Formation was typically assigned to CIRIA, 2002, Chalk grade Dm or grade Dc.		
COMMENTS	GEOTECHNICAL	Nothing significant noted.	
	CONTAMINATION	No visual or olfactory evidence of contamination.	
	GROUNDWATER	Groundwater was observed in the boreholes as relatively moist soil horizons encountered at depth.	

4.6. GROUNDWATER MONITORING

DATE	RESTING GROUNDWATER RANGE	COMMENTS
26/09/17	From 2.64m to 3.68m bgl or dry down to the base of installations to a depth of 4.00m.	Standing groundwater levels within the Chalk Formation except WS08 that appears to be associated with a coarse soil horizon within the River Terrace Deposits.
03/10/17	From 2.48m to 3.55m bgl or dry down to the base of installations to a depth of 4.00m.	As above. Two of the installations (WS05 and WS06) remain dry.
11/10/17	From 2.53m to 3.54m bgl or dry down to the base of installations to a depth of 4.00m.	As above. Two of the installations (WS05 and WS06) remain dry.
17/10/17	From 2.58m to 3.60m bgl or dry down to the base of installations to a depth of 4.00m.	As above. Two of the installations (WS05 and WS06) remain dry.
25/10/17	From 2.52m to 3.58m bgl or dry down to the base of installations to a depth of 4.00m.	As above. Two of the installations (WS05 and WS06) remain dry.
31/10/17	From 2.57m to 3.54m bgl or dry down to the base of installations to a depth of 4.00m.	As above. Two of the installations (WS05 and WS06) remain dry.

Two of the boreholes (WS01 and WS02) were located within the lowered ground of the historical canal excavation. During the fieldwork period, the two boreholes encountered groundwater at depths of 3.6m and 3.8m below existing ground level (m bgl).

Groundwater was encountered during the site work period in three (WS03, WS05, and WS09) of the remaining exploratory hole locations at depths of between 2.8m and 4.8mbgl.

Monitoring of one installation (WS08) indicates perched groundwater within a pocket of sand within the River Terrace Deposits. Four installations (WS01, WS02, WS09, and WS10) revealed standing groundwater within the chalk aquifer. Two installations (WS05 and WS06) have remained dry each down to a depth of 4.00m bgl.

5. GEOTECHNICAL PROPERTIES

5.1. COARSE SOIL PARAMETERS

5.1.1. Standard Penetration Tests

Standard Penetration Tests were undertaken within each of the exploratory holes at 1.0m centres.

Coarse soils were encountered within one of the boreholes (WS10) with recorded SPT N-values of 7 and 15, indicative of loose and medium dense soils.

5.1.2. Particle Size Distribution

The grading curves of the four coarse soils samples of River Terrace Deposits subject to PSD determination revealed these to comprise fine sized sandy silt, silty very gravelly fine-sized sand or predominantly fine-sized sand and fine to coarse sized gravel. The determinations were used to assist in the preparation of the relevant engineering logs.

A further soil sample was analysed for index tests associated with fine soils. However, the analysis revealed the sample to be non-shrinkable and has been assigned as a fine-sized sandy silt soil.

5.2. FINE SOIL PARAMETERS

5.2.1. Index Property Testing

SOIL TYPE	River Terrace Deposits
PLASTICITY INDEX (PI)	13%to 24%(5No. results).
MODIFIED PI	6%to 14%(3No. tests revealed).
NHBC CLASS	Variable soil type from non-shrinkable to Low to Medium volume change potential.

5.2.2. Undrained Shear Strength

This section discusses all of the laboratory and in-situ tests that produce either direct or indirect measures of undrained shear strength.

5.2.2.1. Hand Shear Vane

SOIL TYPE	River Terrace Deposits
CORRECTION FACTOR γ	1.0
JUSTIFICATION	Professional judgement. After Bjerrum 1972, employing Plasticity Index, PI ~20 so $\gamma=1.0$.
DISCUSSION OF CORRECTED RESULTS	The recorded undrained shear strength was in the range 80kN/m ² to over 140kN/m ² at depths of between 0.6m and 1.0m bgl. The results are indicative of high strength soils, although several of the tests were in shallow soils recorded as being desiccated due to the proximity of trees or the recently removed wheat crop within the agricultural field.

5.2.2.2. Hand Penetrometer

SOIL TYPE	River Terrace Deposits
DISCUSSION OF CORRECTED RESULTS	The hand penetrometer tests were undertaken at depths of between 0.5m and 4.5m bgl within the boreholes. Recorded values were between 0.50 kg/cm ² and 4.5 kg/cm ² which are indicative of low, medium and high strength soils. The results are considered to agree with the inspection of field specimens that indicated typically medium and high strength deposits, although locally at depth with pockets of low strength fine-sized sandy silt, silty clay or clayey silt soils.

5.2.2.3. Standard Penetration Test Correlations

In situ Standard Penetration Tests (SPTs) were undertaken in each of the boreholes at 1.0m centres. Within the fine soils of the River Terrace Deposits, the recorded SPT N-values ranged from 3 to 17. Using the recorded SPT N-values and the methodology of Stroud, equivalent undrained shear strengths of between 15kN/m² and 85kN/m² have been estimated, although predominantly within medium strength soils. The low SPT values were typically recorded within the local pockets of sandy silt, silty clay/ clay silt encountered at depths of between 2m and 4m bgl.

Within the underlying Lewes Nodular Chalk Formation, recorded SPT n-values ranged between 4 and 29 indicative of CIRIA 2002 Chalk Grades Dm, Dc or locally (>25N) rock quality chalk Formation.

5.3. WATER SOLUBLE SULPHATE AND PH

	RIVER TERRACE DEPOSITS			
	Sulphate		pH	
Characteristic Value	100 mg/l		6.5 units	
Justification	Maximum result rounded up to nearest 100mg/l.		Mean of lowest 20% results.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	14	<10 mg/l to 66 mg/l	14	6.4 to 8.1 units
Groundwater	No samples tested.		No samples tested.	
Total Potential Sulphate	6	Pyrite geologically unlikely and not indicated in samples tested.		

6. GEOTECHNICAL ASSESSMENT

6.1. INTRODUCTION

The following advice and recommendations are based on the construction of two storey houses. The proposed development layout plan is included in Appendix 1. From assessment of the nature of the ground conditions and the type of proposed structures, it is considered that the situation falls within EC7 Geotechnical Category 1.

Should the nature of the development be changed then the results of this investigation would need to be reviewed and reassessed.

6.2. EXCAVATIONS

STABILITY	Any excavation requiring man entry should be battered back to a safe angle, supported by an appropriate proprietary trench support system or adequately shored to provide safe working conditions. Shoring to any excavation requiring man entry must be designed by a suitably qualified and experienced engineer. Any support system will require regular inspection as detailed in published guidelines to ensure the excavation support is adequate and appropriate for the ground conditions present. It is anticipated that narrow trench excavations will remain relatively stable and open for short periods, but minor spalling of side walls could still occur.
EQUIPMENT	It should be possible to progress excavations with conventional equipment.
GROUNDWATER CONTROL	Within the main agricultural field the standing groundwater levels are anticipated to be at depths greater than 2.5m and so for the majority of construction excavations will not require specific groundwater control. Limited pumping from sumps are likely to be required to deal with slight seepages during the wetter times of the year or surface water ingress during periods of inclement weather. For deeper excavations (>2.5m), groundwater control through pumping from sumps alone may not be sufficient. Consultation with groundwater control contractors is recommended as specialist measures such as 'well pointing' may be required. Any groundwater control system should be designed and operated to minimise the loss of fines from the soil matrix as this could adversely affect settlement.
PARTY WALL ISSUES	As there are no nearby third party structures, the Party Wall Act is unlikely to apply to the development.

6.3. SLOPE STABILITY

The BGS national landslide database indicates no recorded landslides or mass movement deposits (Head) over or surrounding the site of similar anticipated geological profile.

The site itself is relatively flat lying and no significant changes in level are anticipated as part of the development. Therefore, slope stability is considered unlikely to be a concern at this site.

6.4. SUBSURFACE CONCRETE

RIVER TERRACE DEPOSITS	
SITE / SOIL CATEGORY	Natural ground.
DESIGN SULPHATE CLASS	DS-1
GROUNDWATER REGIME	Mobile.
AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASS	AC-1
COMMENTS	Perched waters may be encountered at foundation depths within the coarse horizons of the River Terrace Deposits, although standing groundwater levels are anticipated to be within the underlying Lewes Nodular Chalk Formation.

6.5. SOAKAWAYS

6.5.1. Soil Infiltration Rate

The records of the soakage tests are presented in the Appendices that includes the calculation of the soil infiltration rate. A summary of results are presented in the table below:

TRIAL PIT	SOIL INFILTRATION RATE		STRATUM TESTED
TP01	Test 1	1.44×10^{-5} m/s	River Terrace Deposits: Firm, stiff, friable, orange brown, slightly sandy silty clay. The sand is fine-sized.
	Test 2	1.46×10^{-5} m/s	
	Test 3	1.17×10^{-5} m/s	
TP02	Test 1	2.94×10^{-6} m/s	River Terrace Deposits: Stiff, orange brown, slightly sandy silty clay. Sand is fine-sized. Becoming below 1.80m, loose, orange brown, slightly gravelly fine-sized very sandy silt.
	Test 2	3.84×10^{-6} m/s	
	Test 3	4.51×10^{-6} m/s	
TP03	Test 1	1.84×10^{-5} m/s	River Terrace Deposits: Stiff, friable, orange brown, slightly sandy silty clay. Sand is fine-sized. Becoming below 1.90m, stiff, orange brown, slightly gravelly slightly sandy silty clay.
	Test 2	9.40×10^{-6} m/s	
	Test 3	1.33×10^{-5} m/s	
TP04	Test 1	3.84×10^{-5} m/s	River Terrace Deposits: Stiff, friable, orange brown, slightly gravelly slightly sandy silty clay.
	Test 2	5.54×10^{-5} m/s	
	Test 3	5.03×10^{-5} m/s	

TRIAL PIT	SOIL INFILTRATION RATE		STRATUM TESTED
TP05	Test 1	$3.21 \times 10^{-6} \text{ m/s}$	River Terrace Deposits: Stiff, friable, orange brown, slightly sandy silty clay. Sand is fine-sized. Becoming below 2.00m, stiff, orange brown, slightly gravelly slightly sandy silty clay.
	Test 2	$5.63 \times 10^{-6} \text{ m/s}$	
	Test 3	$9.14 \times 10^{-6} \text{ m/s}$	

Some of the results are extrapolated, but generally this is not for any great timeframe as the data was close to the 25% head required for the calculation.

6.5.2. Soakaway Design Advice

The results of soakage tests undertaken within the River Terrace Deposits show that this stratum has typically relatively low soil infiltration rate which would be expected given the predominant fine soil (cohesive) nature.

The disposal of collected surface water to conventional soakaways are considered marginally feasible and additional near surface storage capacity is recommended for anticipated storm water inflows.

Groundwater monitoring indicated the underlying Chalk Aquifer is saturated. Therefore, deep soakaways will not be permitted by the Environment Agency as direct discharge to groundwater is not allowed.

Any soakaways should be located well away from foundations for buildings or roads. The guidance on this issue presented in CIRIA C574 is that where the density of the chalk is unknown, soakaways should be sited at least 10m away from any foundation. Given the monitored standing groundwater levels have indicated the bedrock to be saturated and a new phase of chalk solution is unlikely to be significant. Therefore, the siting of soakaways may be reduced to at least 5m away from any foundations.

6.6. PAVEMENT CONSTRUCTION

From consideration of the observed ground conditions and the plasticity of the clay, it is recommended that a preliminary design California Bearing Ratio (CBR) of 3% is assumed. The cohesive deposits will be prone to rapid degradation during wet weather working and this should be avoided where possible.

6.7. PRELIMINARY FOUNDATION RECOMMENDATIONS

6.7.1. Introduction

Ground conditions were similar to the recently published BGS information with superficial deposits comprising River Terrace Deposits underlain by bedrock of the Lewes Nodular Chalk Formation.

Within the northern field, existing ground levels were reduced in elevation coincident to the historical alignment of a local canal. The south eastern half of which has been locally partially in-filled with historical Made Ground of 1.1m depth.

River Terrace Deposits were encountered from below a surface cover of Topsoil down to depths of between 2.0m and 4.7m or to the base of the excavations down to a maximum depth of 3.2m bgl. The encountered soils typically comprised firm, stiff, orange brown becoming light brown slightly gravelly slightly sandy silty clay. Shear vane and hand penetrometer tests revealed the soils to be of medium and high strength. Although, locally within five of the boreholes (WS04, WS05, WS07, WS09 and WS10) and a number of trial pit excavations, pockets of low strength soils of variable thickness were first encountered at depths of some 2.0m bgl. The available information reveals the low strength soils do not form a sheet-like deposit beneath the entire site although may have done so in the geological past. The recorded near surface high strength soils are considered to indicate desiccation of the ground due to the proximity of trees or the recently removed agricultural wheat crop.

The shallowest groundwater has been monitored at depth of about 2.5m.

Using a conservative approach, the local presence of low strength soils will limit the available allowable bearing capacity.

Once the footprint of the development is known, consideration of undertaking a supplementary ground investigation to establish the typical lateral extent and thickness of the low strength soils are likely to assist with final foundation designs for the site.

6.7.2. Floor Slabs

In consideration of the near surface clay soils, fully suspended floor slabs designed and constructed in accordance with NHBC Standards are recommended at this development.

The floor construction will not have to incorporate any gas protection measures.

6.7.3. Traditional Footings

The site is considered suitable for the adoption of shallow strip/trench fill footings founded within the River Terrace Deposits although, due to the presence of local low strength soils, foundations should be reinforced.

An allowable bearing value of 80kN/m² is considered appropriate for foundations up to 1m wide bearing upon the clay soils of the River Terrace Deposits. Away from the influence of trees, immediate and long term settlement should be within tolerable limits and take place over several years.

The use of widened strip footing may be considered, although these may result in increased settlements for similar line loads.

The clay soils have been shown to have a varied volume change potential when assessed against NHBC Standards. Using a conservative approach, a medium volume change potential should be assumed and, therefore, a minimum foundation depth of 0.90 m is required, but

deepened to 1.25 m where required to allow for restricted new tree planting. Under the NHBC Standards, foundation depths have to be increased if they are within the influence zone of felled trees, existing trees or proposed tree planting. It should be noted that where trees are in groups the resulting competition for resources can lead to deeper root systems than allowed for in the NHBC Standards. In any event, foundations should be taken below any roots encountered in foundation trench excavation. Where the required foundation depth varies around a structure, this can be accommodated by forming steps in the foundation as per NHBC Standards.

Due to the local presence of low strength soils at depth, the use of traditional footings below 1.50m should be subject to further assessment after the completion of a supplementary ground investigation. This is because there is a concern that these low strength soils could result in unacceptable settlement for deeper footings. Currently, where foundations are required to be deepened beyond this depth to accord with NHBC Standards for tree influence or other factors such as nearby drainage, the use of piled foundation should be considered.

Trees and hedgerows are present along the northern perimeter of the main field and locally along the eastern site boundary. Prior to commencing with the development, it will be necessary to remove all unwanted trees and root balls in the ground. Any resultant void should be backfilled accordingly with respect to the preferred foundation design.

During construction, any soft spot found at foundation level should be excavated and replaced with lean mix concrete. Foundation excavations should be kept dry and left open for the minimum amount of time possible. Where foundations cannot be completed immediately, a blinding layer of concrete should be placed.

6.7.4. Raft Foundations

For small isolated lightly loaded structures, such as detached domestic garages, consideration could be given to employing reinforced raft foundations bearing on the River Terrace Deposits.

6.7.5. Piling

As described above, where footing depths in excess of 1.5m would be required then due to the local low strength soils the use of piled foundations should be considered. Alternatively, piled foundations may be preferred for structures imposing high loads or to eliminate any concerns with the presence of low strength soils, with foundation loads transmitted to the underlying Lewes Nodular Chalk Formation.

Due to the partial granular nature of the soil and the position of perched water, traditional bored piles may be difficult to construct unless they are cased through to the underlying Chalk Formation. The need for casing could be avoided through the use of Continuous Flight Auger (CFA) piling techniques and this may be the best method to construct cast insitu piles.

Driven pre-cast concrete piles would be a viable option. However, the proximity of neighbouring structures within the north eastern section of the site may make them unsuitable in those areas due to noise and vibration considerations.

For the purposes of pile design it is recommended that skin friction from the River Terrace Deposits is treated conservatively, and that the working load is primarily calculated from a combination of skin friction and end bearing within the underlying Chalk Formation.

The existing trees may cause soil heave. In the influence zone of trees, pile caps and ground beams will have to be separated from the soil by a suitable void former on the sides and in the case of ground beams, underneath. Piles will have to be designed to withstand the

seasonal movements exerted by the remaining and proposed vegetation either by the use of suitable reinforcement or by the provision of sleeving through the swelling zone. Such precautions against heave should be designed and constructed in accordance with NHBC Standards.

It is recommended that consultation with a specialist piling contractor is undertaken in order to evaluate likely pile loads, diameter and depths based upon the ground conditions revealed within the context of the specified technical requirements of the chosen piling method. In any event, positive contractual assurances should be sought from the piling contractor in respect of the performance of their proprietary system.

6.8. RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK

Once the layout for the proposed development has been finalised it is recommended that additional site investigation works are undertaken in order to establish the variation in the extent and thickness of the low strength deposits first encountered at depths of around 2.0m bgl.

Where foundations are required to be deepened in excess of 1.5m due to tree influence or other factors such as nearby drainage, the use of traditional footings may not be satisfactory. However, a supplementary site investigation would assist in providing further site specific information beneath the site. Such investigation would also provide information for potential pile designs within the underlying Chalk Formation.

It is suggested that these additional investigation works should comprise at least one day of Cone Penetration Testing (CPT) with a combination of numerous shallow probes (5m) together with a few deeper tests (18m or refusal). Test locations should be spread over the site, although concentrated along the northern section of the main field and along the eastern site boundary where foundations are likely to be deepened due to the influence of the existing trees.

7. RISK ESTIMATION - SOILS

7.1. HUMAN HEALTH

The Generic Assessment Criteria (GAC) employed below are for residential land use as this is appropriate to the proposed form of development.

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
Arsenic	mg/ kg	20	16	37	0
Cadmium	mg/ kg	20	0.3	22	0
Chromium (hexavalent)	mg/ kg	20	<2	21	0
Chromium (total)	mg/ kg	20	26	910	0
Copper	mg/ kg	20	38	2,400	0
Lead	mg/ kg	20	81	200	0
Mercury	mg/ kg	20	<1	11	0
Nickel	mg/ kg	20	20	180	0
Selenium	mg/ kg	20	<3	250	0
Zinc	mg/ kg	20	106	3,700	0
pH	Units	28	5.9 - 8.2	<5-10>	0
Naphthalene	mg/ kg	20	<0.1	2.3	0
Acenaphthylene	mg/ kg	20	<0.1	170	0
Acenaphthene	mg/ kg	20	<0.1	210	0
Fluorene	mg/ kg	20	<0.1	170	0
Phenanthrene	mg/ kg	20	0.16	95	0
Anthracene	mg/ kg	20	<0.1	2,400	0
Fluoranthene	mg/ kg	20	0.46	280	0
Pyrene	mg/ kg	20	0.39	620	0
Benzo(a)anthracene	mg/ kg	20	0.23	7.2	0
Chrysene	mg/ kg	20	0.27	15	0
Benzo(b)fluoranthene	mg/ kg	20	0.32	2.6	0
Benzo(k)fluoranthene	mg/ kg	20	0.12	77	0
Benzo(a)pyrene	mg/ kg	20	0.20	2.2	0
Indeno(1,2,3-cd)pyrene	mg/ kg	20	0.11	27	0
Dibenzo(a,h)anthracene	mg/ kg	20	<0.1	0.24	0
Benzo(ghi)perylene	mg/ kg	20	0.14	320	0
TPH Aliphatic C5-C6	mg/ kg	5	<0.01	42	0
TPH Aliphatic C6-C8	mg/ kg	5	<0.05	100	0
TPH Aliphatic C8-C10	mg/ kg	5	<2	27	0
TPH Aliphatic C10-C12	mg/ kg	5	<2	130	0
TPH Aliphatic C12-C16	mg/ kg	5	<3	1,100	0
TPH Aliphatic C16-C35	mg/ kg	5	<10	65,000	0
TPH Aliphatic C35-C44	mg/ kg	5	<10	65,000	0

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
TPH Aromatic C5-C7	mg/ kg	5	<0.01	70	0
TPH Aromatic C7-C8	mg/ kg	5	<0.05	130	0
TPH Aromatic C8-C10	mg/ kg	5	<2	34	0
TPH Aromatic C10-C12	mg/ kg	5	<2	74	0
TPH Aromatic C12-C16	mg/ kg	5	<2	140	0
TPH Aromatic C16-C21	mg/ kg	5	<3	260	0
TPH Aromatic C21-C35	mg/ kg	5	<10	1,100	0
TPH Aromatic C35-C44	mg/ kg	5	<10	1,100	0
Benzene	mg/ kg	5	<0.002	0.87	0
Toluene	mg/ kg	5	<0.005	130	0
Ethylbenzene	mg/ kg	5	<0.002	47	0
Xylene (total of all types)	mg/ kg	5	<0.002	56	0
Methyl Tert Butyl Ether (MTBE)	mg/ kg	5	<0.005	49	0
Semi-Volatile Organic Compounds (SVOCs)	mg/ kg	4	<LOD	LOD*	0
Pesticides	mg/ kg	4	<LOD	LOD*	0
Asbestos	Presence	5	<0.0001%V/V	Fibres Present	0

Notes: *Limit of detection: Given the large amount of compounds in this group, coupled with the lack of GAC for certain compounds, any concentrations above the limit of detection will be highlighted in the first instance.

RESULTS EXCEEDING HUMAN HEALTH ASSESSMENT CRITERIA

None of the samples record any contaminants at concentrations exceeding their respective assessment criteria.

7.2. WATER ENVIRONMENT

It is not appropriate to consider human health assessment criteria for human health in relation to the risk to the water environment, but currently there are no generic soil assessment criteria in respect of the water environment. In the absence of any groundwater sampling data, the soil results are assessed on the basis of professional judgement.

The contaminant concentrations recorded in the soils at the site are not considered to be at such levels that they would present any significant risk to the underlying water environment.

7.3. BUILDING MATERIALS

Contaminant	Units	Number of tests	Maximum Concentration	GAC	Number exceeding GAC
pH	units	28	5.9 ' 8.2	<5.5	
Sulphate (w/s)	mg/l	28	153	500	
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	mg/kg	4	<LOD	2	
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	mg/kg	5	<LOD	10	
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	mg/kg	5	<LOD	500	
Sum of BTEX + MTBE above detection limits	mg/kg	5	<LOD	0.1	
Phenols	mg/kg	4	<0.1	2	
Cresols and chlorinated phenols	mg/kg	4	<0.1	2	
Naphthalene	mg/kg	20	<0.1	0.5	
Benzo(a)pyrene	mg/kg	20	0.2	0.5	

RESULTS EXCEEDING BUILDING MATERIALS ASSESSMENT CRITERIA

None of the samples record any contaminants at concentrations exceeding their respective assessment criteria.

8. RISK ESTIMATION ' GROUND GAS

RESULTS SUMMARY			
Parameter	Minimum	Maximum	Comments
Methane	0.0%	0.1%	No significant concentrations recorded.
Carbon Dioxide	0.1%	4.1%	The concentrations recorded are likely to be due to the Chalk Formation occurring beneath the site and within the installation response zones.
Oxygen	16.4%	20.9%	The oxygen levels were typically depleted as carbon dioxide concentrations increased.
Hydrogen Sulphide	0ppm	0ppm	No concentrations recorded.
Carbon Monoxide	0ppm	1ppm	Background concentrations recorded.
Atmospheric pressure	1014mB	1028mB	The six monitoring visits were each undertaken where ambient pressures were greater than 1000mB. The third visit was undertaken during falling atmospheric pressure trends.
Groundwater levels	2.48m	3.69m	The shallowest groundwater levels were recorded in the reduced ground levels of the historical canal. The deepest groundwater levels were recorded in the north whereby groundwater was not encountered down to depths of 4.0m bgl.
Flow rate	<0.0 l/hr	0.3l/hr	Low flow rates are as anticipated given a natural carbonate bedrock source.

GAS GENERATION POTENTIAL OF SOURCE		
GAS SOURCE	GENERATION POTENTIAL	COMMENTS
On site/ off site former infilling of historical canal within the northern section of the site.	Low	The monitoring boreholes (WS01, WS02, WS05 and WS06) revealed no obvious evidence to suggest any additional ground gas source except for the natural carbonate Chalk bedrock at depth.
Off site Made Ground associated with a historical car repair garage	Low	The nearest monitoring boreholes (WS02 located adjacent to the garage and WS05 located just to the south within the main development field) revealed no significant ground gases other than those anticipated with a carbonate Chalk bedrock source.
Carbonate Deposits (e.g. Chalk, Limestone)	Low	CIRIA 152 provides a risk ranking of gas sources with natural soils with a low organic content deemed to pose the lowest risk in terms of gas generation. CIRIA 152 placed the presence of carbonate deposits (e.g Chalk) relatively high in terms of gas generation risk order. However, Wilson and Card argued that such soils should be reclassified as low gas generation potential on the basis that thousands of homes have been built on such soils without any protection measures and without any recorded build-up of Carbon Dioxide within these homes. This reclassification has been accepted by other authors.
Natural soils with low organic content	Negligible	Whilst the gas generation potential is low, it is common for natural soils to record low concentrations of Carbon Dioxide due to limited organic or carbonate content.

Sensitivity of development	High (Residential with gardens)	
	Idealised	Actual
Monitoring period	3 months	2 months
Total number of visits	6 visits	6 visits
Number of visits during falling pressure trends	At least two visits	one
Comment	A total of six gas visits have been completed which is considered sufficient for characterisation of the gas regime at the site. Although only one of the monitoring visits (the 11th October 2017) was undertaken during a period of falling atmospheric pressure, given the low levels of carbon dioxide and the natural source of the ground gases with associated low flow rates, it is not considered that any further ground gas monitoring is warranted.	

GAS REGIME CHARACTERISATION			
Radon protection measures required?	No.	Vapour protection measures required?	No.
	Characteristic Gas Concentration (fraction)	Characteristic Gas Flow Rate (l/hr)	Gas Screening Value (l/hr)
Methane	0.001	0.3	0.0003
Carbon Dioxide	0.041	0.3	0.0123
Methodology	Situation A - All development types except low rise housing with gardens.		
Gas Regime	Characteristic situation 1 - Very low risk.		
Gas Protection Measures	Negligible gas regime identified and gas protection measures are not considered necessary.		

9. RISK EVALUATION

9.1. REVISED CONCEPTUAL MODEL

The revised conceptual site model plan is presented in the Appendices.

ADDITIONAL POLLUTANT LINKAGES	During the ground investigation, no additional sources of contamination were identified.
INVALID POLLUTANT LINKAGES	Within the near surface soils over the site, no pesticide residues or asbestos fibres were recorded. Therefore, there are considered to be negligible risks to future residents or groundwater environment from pesticides. Site investigation and chemical testing of soil samples taken for the on site and off site canal infill indicate the site is uncontaminated from this source. Site investigation and chemical testing of soil samples taken for the on site and off site canal infill indicate the site is not contaminated. Site investigation and chemical testing of soil samples taken for the off site historic vehicle servicing and farm tank located to the north east of the site indicate the site is not contaminated.
LIMITATIONS AND UNCERTAINTIES	All of the potential contamination sources have been targeted by the exploratory holes and therefore it is considered that a sufficient number of exploratory points and monitoring visits have been completed for contamination assessment purposes.

9.2. UPDATED CONTAMINATION RISK ASSESSMENT

The pollutant linkages identified in the revised conceptual site model will now be evaluated as to their severity.

SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	POTENTIAL RISK
On site agricultural fields: Pesticide residues	Direct contact. Ingestion. Inhalation. Consumption of home grown produce.	Future residents	Negligible risk
	Horizontal & vertical migration.	Groundwater	Negligible risk
On site and off site canal infill: Metals Hydrocarbons Asbestos containing	Direct contact. Ingestion. Inhalation. Consumption of home grown produce.	Future residents	Negligible risk

SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	POTENTIAL RISK
materials Landfill gases (mainly carbon dioxide and methane) Landfill leachate (polluted groundwater)	Horizontal & vertical migration.	Groundwater	Negligible risk
	Direct contact.	Building materials and services	Negligible risk
Off site historic vehicle servicing garage: Petroleum hydrocarbons (diesel, lubricating oils, greases and/or petrol), Solvents, Asbestos containing materials (e.g. brake linings), Ethylene glycol (antifreeze), Metals, Methyl tert-butyl ether	Migration to site leading to: Direct contact. Ingestion. Inhalation. Consumption of home grown produce.	Future residents	Negligible risk
	Migration to site leading to Direct contact.	Building materials and services	Negligible risk

The contamination risks that are presented to the various receptor groups are discussed further in the following sections:

RISK TO HUMAN HEALTH

None of the soil samples recorded any contaminants at concentrations exceeding their respective assessment criteria for human health.

With regards to the off-site canal infill source and the potential for gas migration, no evidence of a gas risk was identified by the investigation. Six monitoring visits were undertaken that all indicate the risk of gas migration is negligible.

RISK TO WATER ENVIRONMENT

No significant risks to the water environment have been identified by this investigation.

RISK TO BUILDING MATERIALS AND SERVICES

No significant risks to the water environment have been identified by this investigation.

9.3. RISK MANAGEMENT

GENERAL	The ground investigation has identified there to be no significant contamination from any on-site sources that would require remediation prior to development for human health, groundwater or the wider environment. It is recommended that this report is submitted to the planning department of the Local Authority, the organisation undertaking the Building Control function and warranty providers to confirm that the investigation completed to date is satisfactory.
FURTHER INVESTIGATION	No further investigation is considered necessary at this time.
OUTLINE REMEDIATION SOLUTION	Due to the absence of contamination risks, no remediation is considered necessary, although subject to agreement with the local regulators.
WASTE SOILS CLASSIFICATION	Topsoil should be viewed as a resource rather than a waste and as it is suitable for residential garden use, the topsoil at the site should be stripped and the surplus reused on other developments. It should be noted that topsoil, even if uncontaminated, is unlikely to constitute 'inert waste' due to its high organic matter content. The local Made Ground (WS01, WS02, and WS05) is considered likely to be undisturbed during any development of the site. If encountered, any Made Ground materials should be separated. If disposed of from site, the Made Ground materials are likely to classify as 'non-hazardous waste' and be able to be disposed of to landfill as 'inert waste'. It is considered that any sub-soils (natural River Terrace Deposits) disposed of from the site would be classified as 'non-hazardous waste' and be able to be disposed of to landfill as 'inert waste'. Waste Acceptance Criteria (WAC) testing of the soils will also be required where the soil is to be disposed of at a landfill permitted to accept inert waste. Such WAC testing has been completed (River Terrace Deposits taken from WS02 at a depth of 1.00m) and the results are in the Appendices which confirm the soil tested complies with the inert waste limits. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 04 'Soil and Stones, not containing dangerous substances'. However, the chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils.

10. HEALTH AND SAFETY FILE INFORMATION

10.1. INTRODUCTION

The aim of the following sections is to present pertinent Health and Safety information that has arisen from the current investigation/survey works discussed in this report. The aim is to identify health and safety controls that may be necessary during any subsequent maintenance, refurbishment, demolition or construction works.

Where BRD has been appointed as a Principal Contractor, then this information shall form the Health and Safety Files as required by the Construction Design and Management (CDM) Regulations 2015.

Reports are always forwarded to the Client and they shall be responsible for ensuring this safety information is disseminated to those who need it.

10.2. WORK UNDERTAKEN

Detail on the works undertaken and the information gained about the site are discussed in previous sections of this report.

In summary, BRD's work comprised the excavation of 18No. trial pits down to a maximum depth of 3.45m and 10No. window sample boreholes each to a depth of 5.45m below existing ground levels.

10.3. HAZARDS

The investigation has revealed the following hazards:

10.3.1. Contamination

Although no contamination has been identified, as with any construction site, if any anomalous material is encountered during the redevelopment then expert environmental advice should be sought.

10.3.2. Asbestos

Within the near surface soil samples, asbestos quantification down to a level of 0.001% by mass recorded no asbestos fibres.

10.3.3. Other Issues

During the BRD works the following safety hazards were identified:

- During the ground investigation, a public footpath aligned along Drove Lane was frequently used by walkers to gain access to the public footpaths aligned adjacent to the large southern field. The section of Drove Lane aligned south westwards of Main Road to the site was locally relatively narrow. Measures to secure the site and maintain safety of pedestrians on Drove Lane should be taken in to account during development works.

10.4. HAZARDOUS MATERIALS USED

BRD did not construct anything with hazardous materials.

Any soils to be imported to the site, in particular topsoil, should be tested to confirm their suitability in the development.

10.5. UTILITY SERVICES

The utility services plans held by the Client should be referred to.

REPORT SPECIFIC REFERENCES

- British Geological Survey, Research Report ICSO/87/2, published 1987, 'Applied geological mapping Southampton area'.
- British Geological Survey sheet 317/ 332, 'Chichester and Bognor', Solid and Drift edition (1:50,000) published 1996.
- British Geological Survey, Open Research CR/06/160N, published 2006, 'Guide to Permeability Indices'.

SUPPORTING INFORMATION

GROUND INVESTIGATION

Exploratory holes are logged by an experienced Geo-Environmental Consultant in general accordance with 'Code of practice for site investigations' BS5930:1999 +A2:2010, BSi, August 2010. Soil samples for chemical and geotechnical analysis are taken from the exploratory holes at intervals dictated by the nature of the soils and the objectives of the investigation.

Where stated on the logs of inspection pits, trial pits or boreholes (where insitu testing has not been undertaken), the relative density of coarse (sand and gravel) soils is tentative only. Such assessments of density are on the basis of visual inspection only taking into consideration such factors as drilling rates, stability of pit side walls, appearance and behaviour under excavation.

Where Chalk strata is encountered it is logged and graded in general accordance with CIRIA guidance 'C574 - Engineering in Chalk'. It should be recognised that where percussive drilling methods are employed, the structure of the Chalk is destroyed and therefore the grading stated on such logs is either tentative or absent where it is not possible to assess the grade.

Hand Dug Inspection Pits

Hand tools are used to forward shallow inspection pits as a cost effective method of describing and sampling near surface soils. The technique is also used where exposure of existing footings is required. The depth reached by such techniques is a function of the nature of the ground and generally does not exceed 1.5m

Trial Pits

Mechanically excavated trial pits allow detailed inspection of near surface ground due to the large volume of soil exposed. A wheeled backhoe loader is the usual machine for digging trial pits that are typically 3 to 4.5m deep, 0.5m wide and 3m long.

Windowless Sampling Boreholes

This type of borehole is formed by a small tracked dynamic percussion drilling rig with samples retrieved in thin plastic liners within the narrow diameter steel sampling tubes. Borehole depths of up to 5m are typical, but in exceptional circumstances up to 15m depth can be achieved. This is the smallest type of rig that is capable of undertaking Standard Penetration Tests (SPTs).

Hand Held Window Sampling

Hand held window sampling is a useful method of drilling narrow diameter boreholes particularly where access is difficult. Hand held mechanical percussive hammers are used to drive the sampling tube into the ground. The soil samples are collected within the hollow metal sampling tubes and inspected via the open window along one side. Window sampling boreholes can be forwarded to depths of 3m to 6m depending upon ground conditions.

Cable Percussive Boreholes

This form of drilling involves repetitive dropping of a tube into the soil under its own weight from a tripod support. The sample is obtained from the clay cutter head in fine soils or a bailer for wet granular soils. As the borehole progresses SPTs can be undertaken and relatively undisturbed samples can be obtained. Typically these boreholes are 15 to 25m

deep, but depths of double that can be achieved in soils, but only thin weak rock layers can be penetrated.

Rotary Boreholes

Where competent rock is required to be drilled then rotary drilling techniques are required. The drilling rigs can vary in size from small tracked units to larger units mounted on four wheel drive trucks. Rotary open hole drilling techniques break the rock into small fragments and so recovery of any samples is limited. In contrast, rotary coring retrieves excellent samples. Some rigs also allow windowless sampling to be undertaken through soil layers. There are no practical limits to the depths that this drilling method can achieve.

Dynamic Probing

Dynamic probing comprises a sectional rod with a sacrificial cone at the base of slightly larger diameter than the rod. The rod is driven into the ground by a constant mass falling through a set distance. The number of blows required to forward the rod per 100mm is then recorded and presented in a graph of N_{10} values. The standard applicable to dynamic probing is "BS EN ISO 22476-2:2005 Incorporating corrigendum no. 1, Geotechnical investigation and testing – Field testing – Part 2: Dynamic probing" BSi, February 2007.

Dynamic Penetrometer

The Transport Research Laboratory Dynamic Cone Penetrometer (TRL DCP) uses an 8 kg hammer dropping through a height of 575mm to drive a 60° cone of 20mm maximum diameter into the ground. The depth driven either per blow or per several blows is recorded. The strength of each of the soil layer encountered is then calculated by converting the penetration rate (mm per blow) into an approximate California Bearing Ratio (CBR) value employing the correlation proposed by TRL.

Gas Monitoring

Gas monitoring is undertaken with a portable gas monitor for oxygen, Methane, Carbon Dioxide, Hydrogen Sulphide and Carbon Monoxide together with recording of atmospheric pressure and any flow rate.

Vapour Monitoring

Headspace tests and monitoring for Volatile Organic Compounds (VOC) or Semi Volatile Organic Compounds (SVOC) is undertaken using a Photo Ionisation Detector (PID). The MiniRAE models used have a 10.6 eV lamp calibrated for isobutylene. The PID is useful tool to indicate the presence of a wide range of volatile compounds, but only provides semi-quantitative data as different compounds provide a different response and thus the reading is not a true reflection of the actual concentration present.

Low PID readings can be recorded in natural uncontaminated organic soils or even as a result of atmospheric pollution. It is generally accepted by consultants and regulators that recorded values in excess 50 parts per million (ppm) represents the presence of organic compound pollutants and in excess of 100 ppm such contamination may be significant.

The headspace test procedure involves the collection of a sample of suspected contaminated soils and placing within a sample bag. A tight seal to the bag is formed with a similar volume of air trapped to that of the soil and the sample is left for fifteen minutes to allow volatilisation of any contaminants. The bag is then pierced by, and sealed around, the sample probe of the PID and a reading taken.

Borehole well monitoring is undertaken by connecting the PID directly to the gas tap on the monitoring well installation.

Groundwater Level Monitoring

Groundwater levels are recorded with an electronic dip meter that has a detector end that is lowered into the borehole well. An audible signal is made when water is reached and the depth recorded from the graduated tape used to lower the detector. Where there is potential for a separate Light Non Aqueous Phase Liquid (LNAPL) to be present floating on the groundwater an oil/water interface meter is used in preference to a conventional dip meter so that any such floating product can be detected.

Geotechnical Sampling

BRD schedule a range of geotechnical testing as appropriate to the identified ground conditions, available budget and the proposed development. Different types of soil samples are obtained as appropriate to the ground conditions and planned testing.

SAMPLE TYPE	SYMBOL USED ON LOGS	DESCRIPTION
<i>Disturbed</i>	<i>D</i>	<i>Small disturbed soil samples of about 1 to 2 kg are collected in plastic bags.</i>
<i>Bulk</i>	<i>B</i>	<i>Large disturbed bulk samples up to about 30 kg are collected in plastic bags</i>
<i>Undisturbed</i>	<i>U</i>	<i>'Undisturbed' samples generally collected in plastic or metal tubes within cable percussive boreholes of 100mm diameter for samples of fine soils of firm to stiff consistency. Can also be representative of samples taken by cutting plastic sample liners from windowless sampling drilling methods. It is recognised that such samples do not generally meet Eurocode sample quality requirements for the tests commonly employed. However, given the wealth of experience with these sampling methods this continues to be common in United Kingdom practice particularly for less sensitive developments where more expensive sampling techniques are not economically justifiable.</i>
<i>Undisturbed</i>	<i>UT</i>	<i>A thin walled steel sampler developed by Archway Engineering called a UT100 in an attempt to gain better quality samples of soft to firm fine soils when using cable percussive drilling methods.</i>

Contamination Sampling

BRD schedule contamination testing as appropriate to the ground conditions, available budget, potential contaminants and the proposed development. Samples are collected in single use laboratory supplied containers.

Soil samples are retrieved in plastic containers and/or amber glass jars with a lined plastic cap. Contamination samples are indicated by a 'J' on exploratory hole logs.

Water samples are collected in plastic bottles and/or amber glass jars with a lined plastic cap then placed in cool boxes together with freezer packs. Water samples are indicated by a 'W' on exploratory hole records, but generally such samples are not tested as testing from dedicated monitoring wells is preferred for sample quality reasons.

Samples retrieved from the exploratory holes are dispatched to the laboratory by overnight courier. Where samples cannot be transported directly from site they are temporarily stored in the BRD dedicated sample storage facility which includes refrigeration where necessary. The individual accreditation of the test methods is detailed in the laboratory test report.

GEOTECHNICAL ASSESSMENT

Under Eurocode 7 (EC7) the following risk ranking is applied to geotechnical projects:

GEOTECHNICAL CATEGORY	DESCRIPTION
1	<i>Small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations with negligible risk. For example, straightforward ground conditions, local experience, no excavation below the water table unless this will be straight forward.</i>
2	<i>Conventional types of structures and foundations. No difficult soil or loading conditions. Quantitative geotechnical data and laboratory testing. Routine procedures for field and laboratory testing. Conventional structures and no exceptional geotechnical risk. For example, spread, raft and piled foundations, retaining walls, bridge piers and abutments, embankments, ground anchors, tunnels and excavations.</i>
3	<i>Those structures not in Categories 1 and 2 such as very large or unusual structures, structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions. Structures in highly seismic areas. Structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.</i>

GEOTECHNICAL PARAMETERS

Soakage Tests

Soakage tests comprise the filling of a test pit with water and recording the time taken for the water to drain away. The test are undertaken in general accordance with 'BRE Digest 365: Soakaway design', Building Research Establishment, 1991. Water is generally supplied by a tanker to allow fast filling of the pits with water. Repeat tests are undertaken where possible within the time available on site with the investigation budget.

Standard Penetration Tests

The standard penetration test (SPT) determines the resistance of soils at the base of a borehole to the dynamic penetration of a split barrel sampler and the recovering of disturbed samples for identification purposes. In gravelly soils and some soft rocks a solid cone is used in preference to the sampler.

The basis of the test consists in driving a sampler by dropping a hammer of 63.5 kg mass on from a height of 760 mm. The number of blows (N value) necessary to achieve a penetration of the sampler of 300 mm is recorded. The test is described in 'Geotechnical investigation and testing – Field testing – Part 3: Standard penetration test - BS EN ISO 22476-3:2005 Incorporating corrigendum no. 1', BSi, 2007.

The uncorrected N values of the SPT tests are recorded upon the borehole logs together with a record of blows for each 75mm test portion including the seating blows. Where the full test depth cannot be achieved due to refusal on hard stratum, the number of blows and the distance achieved is recorded and the N value given as >50. The abbreviation SPT(c) is used upon the logs indicates that the test was performed with a solid cone rather than a split spoon sampler.

It is necessary to apply a correction to the N values to account for the effects of energy delivery using the equation: $N_{60} = \frac{E_r}{60} N$ where E_r is the energy ratio of the specific test equipment.

In the case of tests in sand, for the effects of overburden and rod length the equation is modified to $N_{60} = \frac{E_r}{60} \times \lambda \times C_N \times N$ where λ is the correction factor for energy losses due to the rod length and C_N is the correction factor for vertical stress due to overburden of the soil.

Sulphate

In order to compare the laboratory soil test results with 'Concrete in aggressive ground. BRE Special Digest 1: 2005' (BRE, 2005) laboratory results are converted to SO_4 mg/l. QTS Environmental Ltd results are expressed as SO_4 g/l and so are multiplied by a factor of 1000 to convert to mg/l. Soil Property Testing Ltd laboratory results are expressed as SO_3 g/l and are multiplied by a factor of 1200 to express the results as SO_4 mg/l.

Index Property Tests

In accordance with National House Building Council (NHBC) Standards Chapter 4.2 - Building near trees, the laboratory plasticity indexes are assessed against their volume change potential. The Modified Plasticity Index is defined as the Plasticity Index of the soil multiplied by the percentage of particles with a nominal diameter of less than 425µm. Whilst the NHBC Standards were developed for residential buildings, the advice is equally applicable to a large number of other types of low rise structures.

Hand Shear Vane

The undrained shear strength of the fine (i.e. clay) soils at the site can be established using hand shear vane apparatus. Usually three readings are taken at every depth tested and the uncorrected results recorded on the exploratory point log. Shear vane readings from depths below 1.2m depth in trial pits are from tests performed on excavated soil. In accordance with Eurocode 7 – Geotechnical design – Part 2: Ground investigation and testing EN 1997-2:2007 the results should be corrected. BRD employ only simple correction methods as the more complex correction methodologies imply undue accuracy to a test that has distinct disadvantages and limitations.

Pocket Penetrometers

The Pocket Penetrometer is a lightweight instrument for use by field personnel to check visual classification of soils. It is a simple test and there is inherent uncertainty related to the small volume of soil being tested and so the results should be used with appropriate caution. Pocket penetrometers are calibrated in terms of unconfined compressive strength and once converted to undrained shear strength (divide by two) the results are further reduced by a factor of 1.5 - 2.0 as the device tends to overestimate strengths.

<i>Instrument Reading (uncompressive strength in kg/cm²)</i>	<i>Indicative Undrained Shear Strength (kN/m²)</i>	<i>Indicative Consistency</i>	<i>Indicative strength</i>
<i>1.0</i>	<i>25 - 33</i>	<i>Soft</i>	<i>Low</i>
<i>1.5</i>	<i>38 - 50</i>	<i>Soft to firm</i>	<i>Low to medium</i>
<i>2.0</i>	<i>50 - 67</i>	<i>Firm</i>	<i>Medium</i>
<i>2.5</i>	<i>63 - 83</i>	<i>Firm to stiff</i>	<i>Medium to high</i>
<i>3.5</i>	<i>88 - 116</i>	<i>Stiff</i>	<i>High</i>
<i>4.5</i>	<i>113 - 150</i>	<i>Stiff to very stiff</i>	<i>High to very high</i>

CONTAMINATION ASSESSMENT METHODOLOGY

UK Policy

The UK Government's policy in relation to land affected by historic contamination is based on a 'suitable for use' approach. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Contamination risks therefore need to be assessed on a site-by-site basis. The 'suitable for use' approach limits requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to either the current use or future use of the land.

The three main drivers for contamination assessment and remediation are:

- *Voluntary action.*
- *Development as part of the planning regime.*
- *Regulatory action to mitigate unacceptable risks e.g. Part 2A of the Environmental Protection Act 1990.*

Pollutant Linkages

For a contamination risk to exist there must be a 'pollutant linkage' from the contaminant (source) via a pathway (the route from contaminant to receptor) to a receptor (the entity that could be harmed). The absence of a contaminant, pathway or receptor breaks the pollutant linkage and therefore no contamination risk exists.

Contamination is typically present at a site (in the ground and/or in the underlying groundwater) as a result of a historic or current industrial use, usually as a result of leaks, spills or disposal of residues, wastes and excess raw materials from the industrial processes. Contamination may also be present due to:

- *The deliberate application of chemicals e.g. the spraying of herbicide/pesticide.*
- *Migration of pollutants from adjacent land.*

Naturally occurring processes e.g. elevated concentrations of particular heavy metals associated with specific geological strata.

Conceptual Site Model

The conceptual site model can be defined as a textual or graphical representation of the identified pollutant linkages for a given site. The model forms the basis for designing the investigation as the aim will be to target all of the potential pollutant linkages to determine, through the subsequent phases of risk assessment, whether or not they pose an actual risk.

It is important that the conceptual site model is updated with new information as the various investigation, risk assessment and remediation works are completed.

Technical Guidance

The technical and legal framework for contamination assessment is complex. The process adopted through this report for assessing contamination risks is in general accordance with the following guidance, as listed below:

- *'Investigation of Potentially Contaminated Sites - Code of Practice - BS 10175: 2011', BSi, 2011.*
- *'Model Procedures for the management of Land Contamination - CLR Document No. 11', Environment Agency, 2004.*
- *'Guidance for the safe development of housing on land affected by contamination - R&D66: 2008', NHBC/Environment Agency, 2008.*

Risk Assessment Methodology

In line with the technical guidance, the contamination risk assessment follows a series of phased stages for each particular site:

PHASE	DESCRIPTION	RISK ASSESSMENT STAGE
PHASE 1	<i>Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.</i>	Hazard Identification and Assessment <i>A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential pollutant linkages.</i>
PHASE 2	<i>This phase is concerned with establishing whether contamination is present, usually through intrusive ground investigation, and then evaluating the degree and magnitude of the associated risks.</i>	Risk Estimation <i>A stage concerned with estimating the likelihood that receptors will suffer adverse effects if they come into contact with, or are otherwise affected by, a hazardous substance or agent under defined conditions.</i> Risk Evaluation <i>A stage of risk assessment concerned with evaluating the acceptability of estimated risks, taking into account the nature and scale of the risk estimates, any uncertainties associated with the assessment and the broad costs and benefits of taking action to mitigate risks.</i>
PHASE 3	<i>The appraisal and selection of remediation techniques, their implementation and verification.</i>	Risk Management <i>The process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probabilities of occurrence.</i>

Risk Classification

The objective of risk assessment is to identify the nature and magnitude of the potential risks and should be based on a consideration of both:

- The likelihood/probability of an event [taking into account both the presence of the hazard and receptor and the integrity of the pathway].
- The severity of the potential consequence [taking into account both the potential severity of the hazard and the sensitivity of the receptor].

There is a need for a logical, transparent and repeatable system in defining the categories of severity of consequence and likelihood as well as for the risk itself and therefore the following risk rating matrix is employed:

		SEVERITY OF CONSEQUENCE			
		SEVERE	MEDIUM	MILD	MINOR
PROBABILITY	HIGH LIKELIHOOD	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	LIKELY	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	LOW LIKELIHOOD	Moderate Risk	Moderate/Low Risk	Low Risk	Negligible Risk
	UNLIKELY	Moderate/Low Risk	Low Risk	Negligible Risk	Negligible Risk

These risk classifications are defined as follows:

- **Very High Risk** - There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remediation action.
- **High Risk** - Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remediation action.
- **Moderate Risk** - It is possible that without appropriate remediation action harm could arise to a designated receptor. It is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such harm would be relatively mild.
- **Low Risk** - It is possible that harm could arise to a designated receptor from an identified hazard. It is likely that, at worst if any harm was realised any effects would be mild.
- **Negligible Risk** - The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.

This risk assessment matrix and classification system is based on guidance produced by Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency in connection with contaminated land assessment.

RISK ESTIMATION - SOILS

Introduction to Soil Human Health Generic Assessment Criteria (GAC)

The Environment Agency (EA) and Department of Environment Food and Rural Affairs (DEFRA) had previously issued revised guidance following the consultation about the DEFRA publication "Assessing risks from land contamination - a proportionate approach. Soil Guideline Values: the Way Forward". This resulted in a revised version of the Contaminated Land Exposure Model (CLEA) model (version 1.06) and a few of the previously published Soil Guideline Values (SGVs) were revised.

The main legislative driver for dealing with historical land affected by contamination is Part 2A of the Environmental Protection Act 1990. Revised Statutory Guidance to support Part 2A was published in April 2012. This Guidance introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health,¹ where Category 1 includes land where the level of risk is clearly unacceptable and Category 4 includes land where the level of risk posed is acceptably low. The impact assessment for the new Statutory Guidance stated "The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land". The C4SLs are still derived using the CLEA model, but adopt a slightly different approach to toxicological assessment and exposure modelling.

In March 2014, the outcome of "SP1010 - Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - Final Project Report" (CL:AIRE) was published. Due to slightly ambiguous wording within this report, Lord de Mauley, Parliamentary Under Secretary, DEFRA wrote to all local authorities on 3 September 2014 to confirm that the published C4SLs were final and that they can be used in risk assessment undertaken under the planning regime.

Whilst there are proposals for the industry to develop C4SLs for other contaminants, these have yet to produce any new values. BRD do not believe that C4SLs could be developed by a single organisation with sufficient confidence. BRD has therefore employed other, more conservative guidance based on the CLEA model (detailed below) within this assessment for compounds where C4SLs are not available. However, it should be noted that the results of this investigation may need to be reinterpreted as new C4SLs become available.

Due to the limited number of published C4SL values at this time, the Chartered Institute of Environmental health (CIEH) and Land Quality Management Ltd (LQM) have produced Generic Assessment Criteria (GAC) known as Suitable for Use Levels (S4ULs), for use in contaminated land human health risk assessment. These S4ULs (2014) have been derived for a large number of substances using the current CLEA model and are therefore consistent with current guidance. They also incorporate the revised exposure parameters as adopted by the C4SL programme, but have not adopted the revised toxicological approach adopted by the C4SLs and so remain a more conservative assessment criteria. The substances for which SGVs were previously published have also been revised as new S4ULs in light of the new exposure parameters proposed by the C4SL programme, and therefore effectively replace the existing SGVs.

In addition, in December 2009, other GAC for less common substances were produced by the Environmental Industries Commission (EIC), The Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments (CL:AIRE) using the CLEA model. These are referred to as the EIC/AGS/CLAIRE GAC.

In summary, C4SLs have been used where these are available. For those substances where C4SLs have yet to be issued, then the S4ULs have been adopted or in some cases, the EIC/AGS/CLAIRE GAC. All of the previously produced SGVs have now either been withdrawn, or superseded by the respective C4SLs or S4ULs.

The only exception to this approach is the PAH compound benzo(a)pyrene (BaP) where a C4SL guideline value has been produced, whereas BRD has adopted the S4UL value. The C4SL for BaP relates to its use as a surrogate marker compound representing all of the genotoxic PAH compounds as a mixture, rather than this individual compound. BRD has therefore adopted the compound specific S4UL value as the initial screening value, for consistency with the other PAH compounds before then employing the C4SL is necessary.

It should be noted that unless otherwise stated, all the assessment criteria adopted within this report have been derived based on a sandy loam soil at pH 7 and the values quoted are for a conservative soil organic matter content of 1% where applicable (i.e. organic contaminants).

Human Health - Soil Generic Assessment Criteria

The results of the soils analysis have been compared to generic assessment criteria for the default exposure scenarios comprising either residential land with plant uptake, residential land without plant uptake, or commercial/industrial land use. The criteria values selected are listed in the table below and full details on the source are referred to above. Where applicable, the results have also been assessed with reference to the required statistical tests presented within CLAIRE document "Guidance on comparing soil contamination data with a critical concentration".

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Arsenic	37	40	640	C4SL
Cadmium	22	150	410	
Chromium (total) ⁵	910	910	8,600	S4UL
Chromium VI	21	21	49	C4SL
Lead	200	310	2,330	
Mercury*	11	15	320	S4UL
Selenium	250	430	12,000	
Nickel	180	180	980	
Copper	2400	7,100	68,000	
Zinc	3,700	40,000	730,000	
pH	<5 - 10> units			Professional judgement
Naphthalene	2.3	2.3	190	S4UL
Acenaphthylene	170	2,900	83,000	
Acenaphthene	210	3,000	84,000	
Fluorene	170	2,800	63,000	
Phenanthrene	95	1,300	22,000	
Anthracene	2,400	31,000	520,000	
Fluoranthene	280	1,500	23,000	
Pyrene	620	3,700	54,000	
Benzo(a)anthracene	7.2	11	170	
Chrysene	15	30	350	
Benzo(b)fluoranthene	2.6	3.9	44	
Benzo(k)fluoranthene	77	110	1,200	
Benzo(a)pyrene	2.2	3.2	35	
Indeno(1,2,3-cd)pyrene	27	45	500	

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
<i>Dibenzo(a,h)anthracene</i>	0.24	0.31	3.5	S4UL
<i>Benzo(ghi)perylene</i>	320	360	3,900	
<i>TPH Aliphatic C5-C6</i>	42	42	3,200	
<i>TPH Aliphatic C6-C8</i>	100	100	7,800	
<i>TPH Aliphatic C8-C10</i>	27	27	2,000	
<i>TPH Aliphatic C10-C12</i>	130	130	9,700	
<i>TPH Aliphatic C12-C16</i>	1,100	1,100	59,000	
<i>TPH Aliphatic C16-C35</i>	65,000	65,000	1,600,000	
<i>TPH Aliphatic C35-C44</i>	65,000	65,000	1,600,000	
<i>TPH Aromatic C5-C7</i>	70	370	26,000	
<i>TPH Aromatic C7-C8</i>	130	860	56,000	
<i>TPH Aromatic C8-C10</i>	34	47	3,500	
<i>TPH Aromatic C10-C12</i>	74	250	16,000	
<i>TPH Aromatic C12-C16</i>	140	1,800	36,000	
<i>TPH Aromatic C16-C21</i>	260	1,900	28,000	
<i>TPH Aromatic C21-C35</i>	1,100	1,900	28,000	
<i>TPH Aromatic C35-C44</i>	1,100	1,900	28,000	
<i>Benzene</i>	0.87	3.3	98	C4SL
<i>Toluene</i>	130	880	56,000	S4UL
<i>Ethylbenzene</i>	47	83	5,700	
<i>Xylene[^]</i>	56	79	5,900	EIC/AGS/CL:AIRE GAC
<i>MTBE</i>	49	73	7,900	

Notes:

* The S4UL for methyl mercury has been adopted as the worst case mercury compound as generally there is no desk study evidence to suggest the potential for elemental mercury on the majority of sites.

[^] The lowest S4UL of either p-xylene, o-xylene or m-xylene has been adopted for each land use as a conservative measure.

[§] S4UL for Chromium III adopted, as in the absence of Chromium VI it is likely that all of the chromium will be in this form as these are the two most common and stable forms of chromium in the soil environment.

Where no GAC is available, any concentrations exceeding the laboratory limit of detection are identified and discussed in more detail.

Water Environment - Soil Generic Assessment Criteria

There are no UK published Generic Assessment Criteria for soil test results in respect of the risk to the water environment and therefore risk estimation is on the basis of the professional judgement and experience of BRD to employ values that are a reasonable concentration above which concern for water resources is valid.

The Total PAH GAC employed is the sum of the 16No. priority PAH compounds regularly tested for in contaminated land analysis (i.e. US EPA 16PAHs). BRD employ a soil screening based upon the total PAH limit for 'inert waste' of 100mg/kg. The rationale is based on PAHs are recognised to be generally of low solubility and the risk to the water environment is correspondingly low.

In respect of Total Petroleum Hydrocarbons, BRD employ a value of 500 mg/kg as a screening value in comparison to the sum of the component aliphatic and aromatic TPH carbon bands. The employed soil screening value is based upon:

- In common with some other consultants, the professional judgement and experience of BRD suggests that this value is a reasonable concentration above which concern for water resources is valid. The rationale is based on the fact that lower concentrations of fuel based contaminants are more likely to naturally degrade than migrate any great distance.*
- BRD is aware of regional Environment Agency groundwater and contaminated land teams that employ 500 mg/kg as a screening value for considering whether or not TPH could represent a risk to water resources.*
- The value mirrors the mineral oil Waste Acceptance Criteria limits for what is considered 'inert waste'.*

Should elevated contaminants that pose a potential risk to the water environment be identified then site specific assessment criteria should be developed.

Building Materials and Services - Soil Generic Assessment Criteria

Some hydrocarbon compounds are known to both attack and permeate through certain plastic pipe materials, with the primary concern being the degradation and tainting of water supplies. The UK Water Industry Research (UKWIR) has therefore produced a document 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' (ref. 10/WM/03/21) that specifies threshold criteria for the adoption of 'standard' polythene (PE) or PVC pipes, protective barrier pipe and ductile iron/steel/copper pipes.

The UKWIR threshold assessment criteria from Table 3.1 of this document for standard PE pipes have been employed. It should be noted that the approach taken by UKWIR is very conservative, and both the document and research are flawed. However, it is these values that are being using to specify water pipe materials and therefore it is appropriate to consider them.

The UKWIR guidance is particularly flawed in respect of the chemical analysis it expects as it seeks a limit of detection that is generally below limits that are reasonable or commonly employed in contaminated land assessment. The UKWIR seeks that where a substance is below the limit of detection it should be taken as being present at half this concentration. For the larger suite of chemicals where the limit is against a sum of compounds, this approach would mean that a sample of virgin sub-soil from a greenfield site with absolutely no contamination would actually fail the criteria for using standard PE pipes. To avoid this situation, BRD have adopted the approach of summing only those compounds detected above their respective limits of detection.

In terms of building materials, the primary concern is in respect of concrete as certain commonly occurring natural ground conditions can adversely impact on buried concrete as discussed in 'Special digest 1:2005 Concrete in aggressive ground', BRE, 2005.

ANALYSIS	GENERIC ASSESSMENT CRITERIA	SOURCE
pH	<5.5	BRE Special Digest 1:2005
Sulphate (w/s)	500 mg/l	BRE Special Digest 1:2005
Sum of any VOC above detection limits	0.5 mg/kg	Relevant compounds adapted from UKWIR Table 3.1
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	2 mg/kg	
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	10 mg/kg	
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	500 mg/kg	
Sum of BTEX + MTBE above detection limits	0.1 mg/kg	
Phenols	2 mg/kg	
Cresols and chlorinated phenols	2 mg/kg	
Naphthalene	0.5 mg/kg	
Benzo(a)pyrene	0.5 mg/kg	

RISK ESTIMATION ' GROUNDWATER

The initial assessment of the contamination risk to groundwater is by comparing dissolved groundwater concentrations with screening values that are protective of groundwater resources.

The reference source for the target concentrations is generally the EA's Environmental Quality Standards (EQS), the Water Supply (Water Quality) Regulations (WSR) 1989 / 2000 and the DW1/DW2 criteria from the Surface Water (Abstraction for drinking water)(classification) Regulations 1996. The target concentrations are outlined in the table overleaf.

ANALYSIS	GENERIC ASSESSMENT CRITERIA	SOURCE
Arsenic	50 µg/l	EQS
Cadmium	5 µg/l	EQS
Chromium (total)	50 µg/l	DW2
Copper	50 µg/l	DW2
Nickel	20 µg/l	WSR
Lead	50 µg/l	DW2
Mercury	1 µg/l	EQS
Selenium	10 µg/l	WSR
Zinc	5 mg/l	DW2
Cyanide	50 µg/l	WSR
pH	6 to 9 units	EQS
Benzene	30 µg/l	EQS
Toluene	50 µg/l	EQS
Ethylbenzene	30 µg/l	EQS for benzene as a guide
Xylene	30 µg/l	EQS for benzene as a guide
Naphthalene	2.4 µg/l	EQS
Benzo(a)pyrene	0.05 µg/l	EQS
Total PAH	0.2 µg/l	DW1
TPH (dissolved or emulsified hydrocarbons)	50 µg/l	DW1

There are no available generic assessment criteria for some of the analytical parameters which have been scheduled, for example hexavalent chromium, and individual TPH and PAH and some VOC compounds. These parameters will be assessed based on professional judgement should they exceed the limit of detection.

RISK ESTIMATION - GROUND GAS

Introduction

A variety of potentially hazardous gases occur in naturally in the ground environment. Microbial decay of organic matter under anaerobic conditions and geological processes can lead to the generation of Methane and Carbon Dioxide, but can also include traces gases such as Hydrogen sulphide and Carbon monoxide.

Methane is a colourless and odourless gas that has the hazardous properties of being flammable and, at certain air/Methane mixtures, explosive. Methane has a low toxicity, but can be a simple asphyxiant due to the displacement of oxygen.

Carbon Dioxide is a colourless, odourless and non-combustible gas that has the hazardous property of being a highly toxic chemical. At concentrations of 3% by volume, shortness of breath and headaches will occur becoming acute by 6%. At levels of above 10% by volume headache, visual distortion, tremors and rapid loss of consciousness occur. Concentrations of Carbon Dioxide above 22% by volume are likely to be fatal. The effects of Carbon Dioxide poisoning are made more severe if there is accompanying reduction in oxygen concentrations.

Hydrogen sulphide is a colourless and flammable gas that has an odour of rotten eggs. It is important to that the sense of smell is over powered at higher concentrations. The gas is toxic and can be an asphyxiant.

Carbon monoxide is a colourless, odourless and explosive gas in air mixtures that has the hazardous property of being a highly toxic chemical.

Radon is a naturally occurring colourless and odourless gas that is radioactive. It is formed by the radioactive decay of radium which in turn is derived from the radioactive decay of uranium, both of which are minerals that can be found in many soil types. Whilst it is recognised that the air inside every house contains radon, some houses built in certain defined areas of the country might have unacceptably high concentrations and require special precautions to be taken. The maps contained within BRE211:2007 'Radon: guidance on protective measures for new buildings' identify areas where no radon protection measures are necessary or where higher concentrations are present that either basic or full radon protection measures are required to be fitted to all new dwellings.

Basis of Gas Assessment

In order to classify the level of risk and need, if any, for gas protection measures at a site with the potential for a gas problem, consideration of each of the following is necessary:

- The source of the gas.*
- The generation potential of the gas.*
- The location of the source and the geological setting.*
- Boreholes flow rate and estimated surface emission rate.*

- *The nature of the proposed development.*
- *Confidence in the knowledge of the gas regime.*

The gas assessment is made with reference to 'C665 - Assessing risks posed by hazardous ground gases to buildings', Construction Industry Research and Information Association (CIRIA), 2007.

Gas Screening Value

The method within CIRIA C665 uses both the gas concentrations and borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flow for Methane and Carbon Dioxide. This limiting borehole gas volume flow is called the Gas Screening Value (GSV) and is expressed below:

$$\text{Gas Screening Value (l / hr)} = \text{borehole flow rate (l/hr)} \times \text{gas concentration (fraction)}$$

The calculation of GSV is completed for both Methane and Carbon Dioxide and then the 'worse case' maximum values are used in the assessment. The assessment is to determine the gas regime at the site is dependent upon the nature of the development.

Situation A - All development types except low rise housing with gardens.

The characteristic situation for many sites is determined from evaluation of the Gas Screening Value derived against the criteria in the following table.

Characteristic situation	Risk classification	Gas Screening Value (CH ₄ or CO ₂ l/hr)	Additional factors	Typical sources of generation
1	Very low risk	<0.07	Typically Methane ≤1% and/or Carbon Dioxide ≤5%. Otherwise consider an increase to characteristic situation 2.	Natural soils with low organic matter content and 'typical' made ground.
2	Low risk	<0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider an increase to characteristic situation 3.	Natural soil with high organic peat/organic content and 'typical' made ground.
3	Moderate risk	<3.5		Old landfill, inert waste and flooded mine working.
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protection measures.	Mine working susceptible to flooding and landfill completed to WMP 26B criteria.
5	High risk	<70		Mine working unflooded inactive with shallow workings near surface.
6	Very high risk	>70		Recent landfill site.

Situation B - Low rise housing with gardens - NHBC 'Traffic Lights'

The NHBC model for low rise housing development considered a typical residential house with a ground floor area of 64m², suspended floor and ventilated sub-floor void of height 150mm. Where the proposed development of a site is consistent with this model, the NHBC traffic light situation of the site is determined from evaluation of the Gas Screening Value against the criteria in the following table.

Traffic Lights	Methane		Carbon Dioxide	
	Typical maximum concentrations (%)	Gas Screening Value (l/hr)	Typical maximum concentrations (%)	Gas Screening Value (l/hr)
Green	≤1	≤0.16	≤5	≤0.78
Amber 1	1 > to ≤5	>0.16 to ≤0.63	>5 to ≤10	>0.78 to ≤1.56
Amber 2	5 > to ≤20	>0.63 to ≤1.56	>10 to ≤30	>1.56 to ≤3.13
Red	>20	>1.56	>30	>3.13

APPENDIX 1

Site Location Plan



Not to scale.

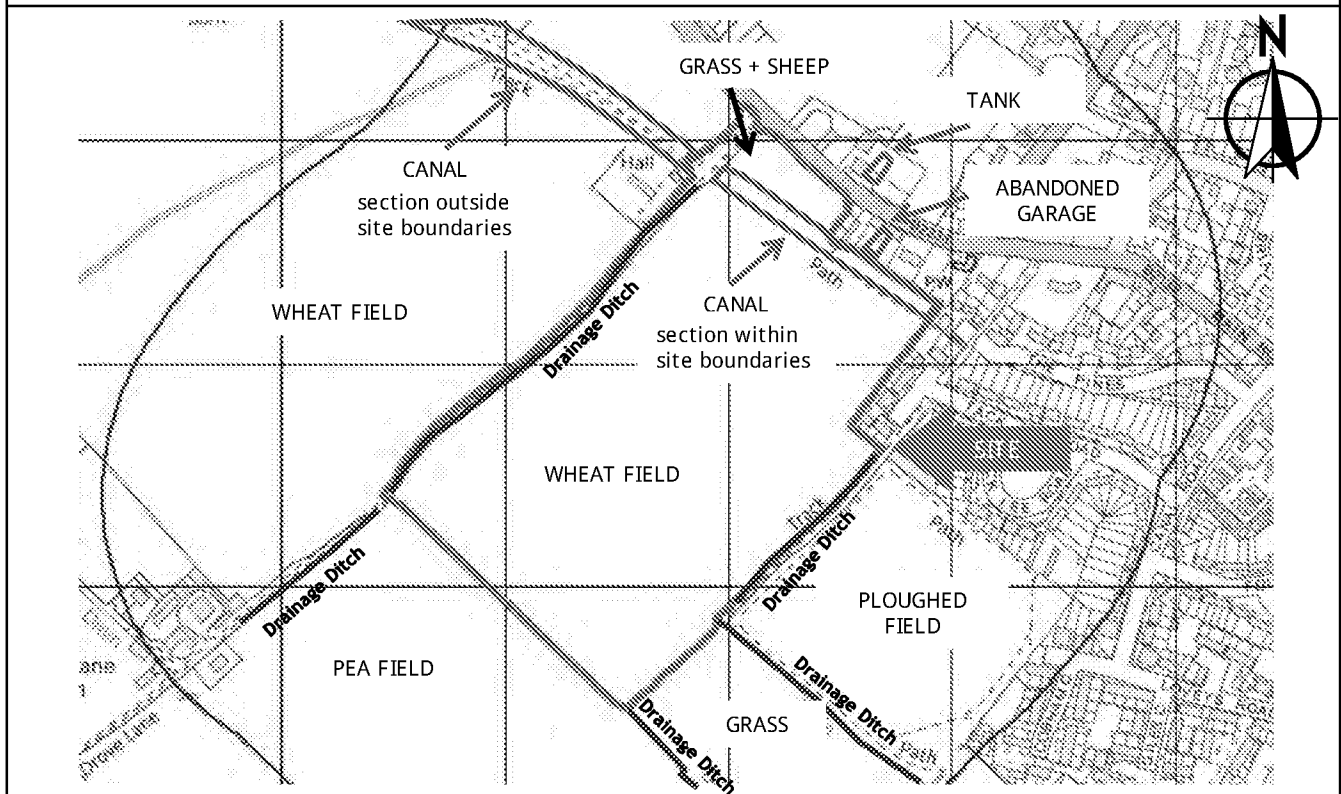
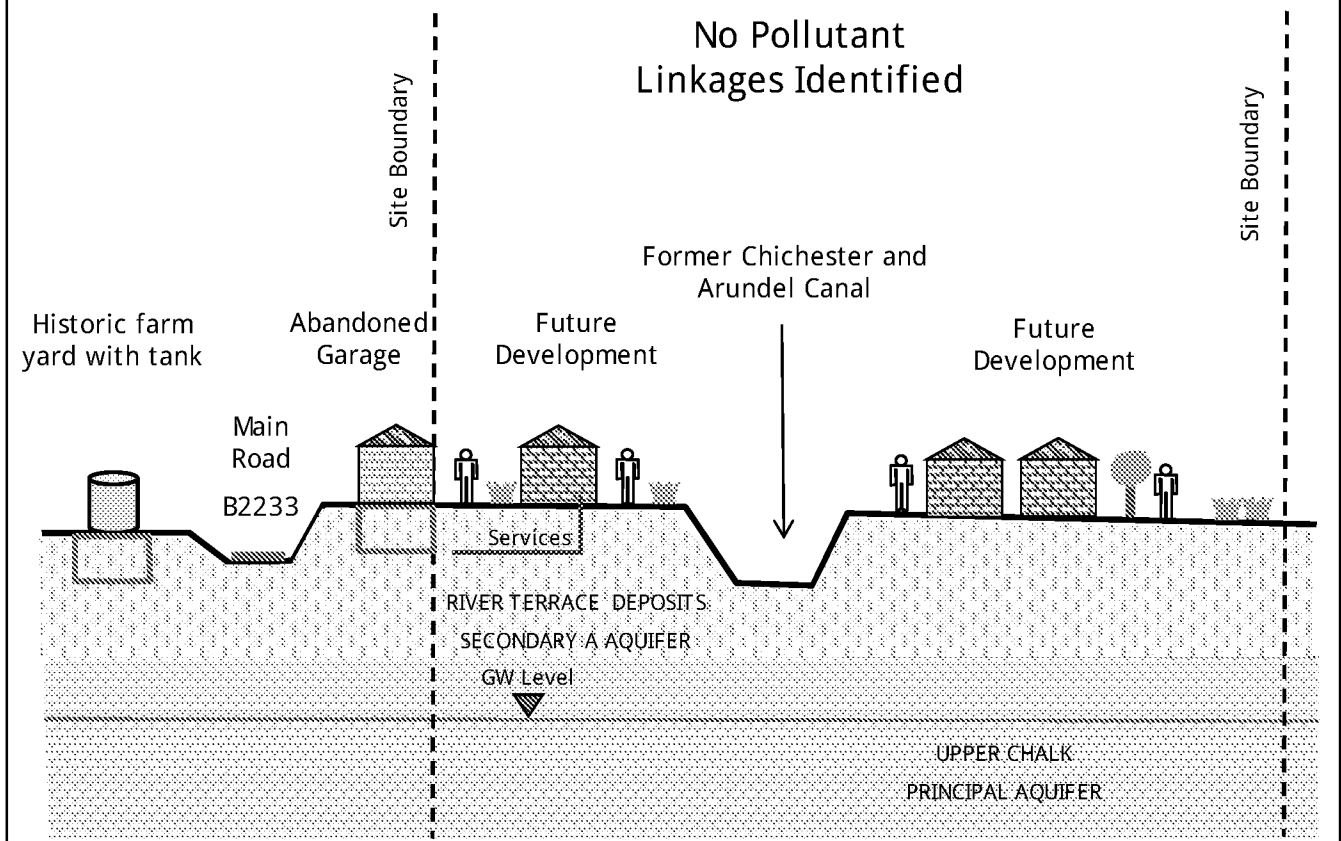
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Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP1-A
Date Issued: April 2017

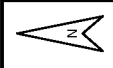

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info@brduk.com

Revised Conceptual Model



Project Title: Land at Drove Lane, Yapton
 Client: Trustees of the Langmead Pension Scheme
 BRD Reference: BRD2934-OP4-A
 Date Issued: April 2017


 01295 272244
 info@brduk.com



	BRD Windowless Sample Borehole (GPS Location)
	BRD Windowless Sample Borehole With Monitoring Well Installation (GPS Location)
	BRD Trial Pit (GPS Location)
	BRD Soakage Test Pit (GPS Location)
	BRD Hand Dug Pit (GPS Location)
	Site Boundary (Approximate Location)

Drawing reproduced from Digital Terrain Surveys LLP Site Survey - Land at
Drove Lane, Yapton¹, Ref No: DT5240417-7Q08, Drawing No: 1 to 8, Dated:
April 2014.

[illegible]

EXPLORATORY POINT PLAN

LAND AT DROVE LANE, YAPTON

Client
TRUSTEES OF THE LANGMEAD PENSION SCHEME

Scale	1:2000	Original dwg. size/colour A3 / C	Date	20/09/2017
Drawn	DB	Checked	AP	Approved
Drawing Number			BD	Rev
BRD2934-OD1				A

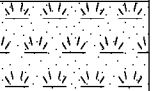
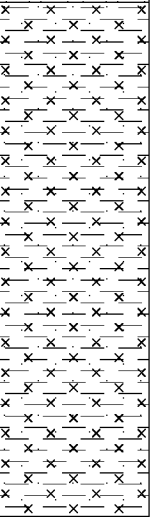
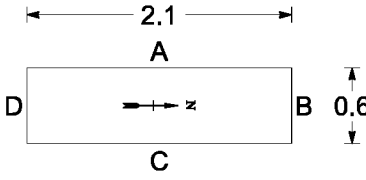
BRD Environmental Ltd



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APPENDIX 2

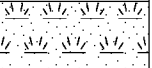
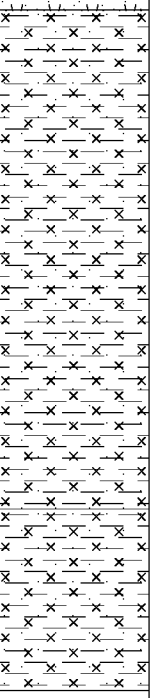
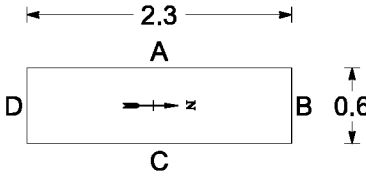
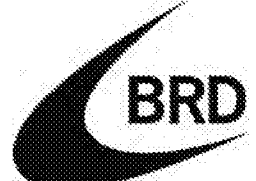
TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 11/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP01		
Sheet 1 of 1						
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		Friable, brown, slightly humic silty TOPSOIL.	0.30 ()	TS	
0.80 0.90	J2 SV D1	>140, >140, >140 kPa	Firm, stiff, friable, orange brown, slightly sandy silty CLAY. Sand is fine-sized.			
1.90	D2			2 2.00 ()	RIVER TERRACE DEPOSITS	
				3 4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 2.00 bgl.			
All dimensions in metres Log Scale 1:25						

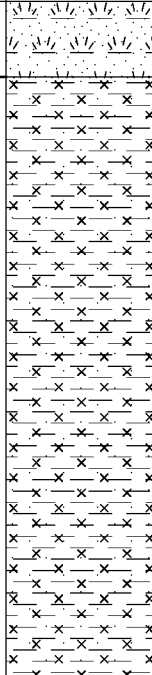
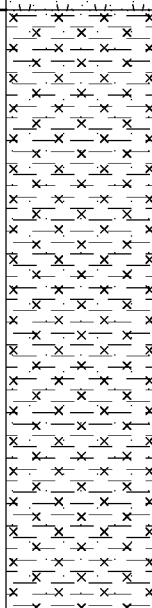
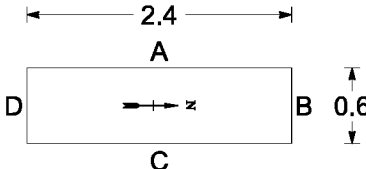
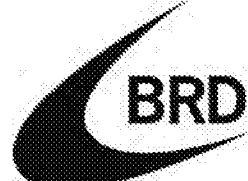
TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 11/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP02		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1	120,110,130 kPa	Friable, brown, slightly humic silty TOPSOIL.	0.30 ()	TS	
0.50	D1		Stiff, orange brown, slightly sandy silty CLAY. Sand is fine-sized.			
1.00	J2		1.40 m: Becomes slightly gravelly.	1 ()	RIVER TERRACE DEPOSITS	
1.10	SV					
1.50	D2					
2.00	D3	Loose, orange brown, slightly gravelly, very sandy SILT. Gravel is fine sized, angular to subangular chalk and flint. Sand is fine-sized.	1.80 ()			
			2 ()			
				2.20 ()		
				3 ()		
				4 ()		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 2.20 bgl.		All dimensions in metres Log Scale 1:25	

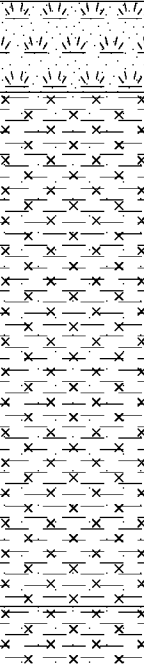
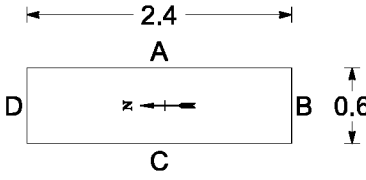
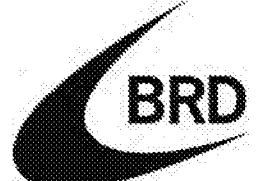
TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 11/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP03		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		Friable, brown, slightly humic silty TOPSOIL.	0.25 ()	TS	
0.60	SV	138,>140,>140 kPa	Stiff, friable, orange brown slightly sandy silty CLAY.			
1.00	SV B1 D1 J2	>140,>140,>140 kPa		1	RIVER TERRACE DEPOSITS	
			Stiff, orange brown, slightly gravelly, slightly sandy silty CLAY. Gravel is subangular flint and chalk.	1.90 ()		
				2.50 ()		
				3		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 2.50 bgl.		All dimensions in metres Log Scale 1:25	
						

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 11/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP04		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		Friable, brown, slightly humic silty TOPSOIL.	0.25 ()	TS	
0.50	J2		Stiff, friable, orange brown, slightly gravelly, slightly sandy silty CLAY. Gravel is fine sized subangular flint.			
0.70	SV	110,100,100 kPa		1	RIVER TERRACE DEPOSITS	
1.00	SV D1	>140,>140,>140 kPa	1.25 m: Cobble of flint (250 x 180 x 100mm).			
			1.50 m: Becoming locally firm.			
			2.00 m: Gravel fraction becomes flint and chalk.	2		
				2.25 ()		
				3		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 2.25 bgl.			All dimensions in metres Log Scale 1:25
						

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 11/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP05		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.50 0.70 1.00	J1 SV D1	130,>140,>140 kPa	Friable, brown, slightly humic, silty TOPSOIL.	0.30 () 1	TS	
			Stiff, friable, orange brown slightly sandy silty CLAY. Sand is fine-sized.			
			Stiff, locally firm, orange brown, slightly gravelly, slightly sandy silty CLAY. Gravel is fine to medium sized, angular and subangular flint and chalk.			
1.70	D2	>140,>140,>140 kPa		2 2.00 () 2.20 () 3 4	RIVER TERRACE DEPOSITS	
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 2.25 bgl.		All dimensions in metres Log Scale 1:25 	

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 11/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP06		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		Brown, friable, slightly humic silty TOPSOIL.	0.25 ()	TS	
1.00	SV D1	110,100,130 kPa	Stiff, friable, orange brown, slightly sandy silty CLAY. Sand is fine-sized.	1	RIVER TERRACE DEPOSITS	
2.10	D2		Firm, friable, pale brown, locally subvertical, orange brown mottling, silty CLAY.	2 2.00 ()		
3.00	D3		Firm, friable, orange brown, light brown, slightly sandy, slightly gravelly silty CLAY. Gravel is medium sized, subangular flint and chalk.	2.80 () 3 3.20 () 4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.20 bgl.			All dimensions in metres Log Scale 1:25

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 11/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP07		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.50	J1		Friable, brown, slightly humic, silty TOPSOIL.	0.30 ()	TS	
			Stiff, friable, orange brown, slightly gravelly, slightly sandy silty CLAY. Gravel is medium to coarse sized, elongated subangular flint.			
0.70	SV	110,100,120 kPa				
1.00	SV D1	140,140,140 kPa		1		
2.00	D2		Stiff, locally firm, light brown, mottled orange brown, often subvertical. Slightly gravelly, slight sandy, silty CLAY. Gravel is fine-sized flint and chalk.	1.90 ()		
3.00	D3		2.40 m: Cobbles of flint (maximum 150 x 130 x 120mm).	2	RIVER TERRACE DEPOSITS	
				3		
				3.20 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.20 bgl.		All dimensions in metres Log Scale 1:25 	

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 11/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP08		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		Friable, brown, slightly humic silty TOPSOIL.	0.25 ()	TS	
0.50	D1		Stiff, friable, orange brown, slightly sandy silty CLAY. Silt is fine-sized.			
0.90	SV	>140, >140, >140				
1.00	B1	kPa		1		
1.50	D2		Firm, friable, light brown, light orange brown silty CLAY/clayey SILT.	1.45 ()		
3.00	D3		Firm, friable, light brown, slightly gravelly, very sandy SILT. Gravel is fine sized, angular to subangular flint and chalk. Sand is predominantly fine-sized.	2.80 ()	RIVER TERRACE DEPOSITS	
				3.10 ()		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.10 bgl.			
			All dimensions in metres Log Scale 1:25 			

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 11/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP09		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		Friable, brown, slightly humic silty TOPSOIL	0.30 ()	TS	
0.50	J2		Stiff, friable, orange brown, slightly sandy silty CLAY. Sand is fine sized.			
0.90	SV	>140, >140, >140		1	RIVER TERRACE DEPOSITS	
1.00	D1	kPa				
2.00	D2		Stiff, friable, light brown, slightly gravelly, silty CLAY. With boulder-sized pockets of light brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is fine to medium sized, angular to subangular flint and chalk.	1.50 ()		
3.00	D3			2		
				3		
				3.20 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.20 bgl.		All dimensions in metres Log Scale 1:25	

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 12/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP10		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		Friable, brown, slightly humic, silty TOPSOIL.	0.25 ()	TS	
0.30	J2		Firm, stiff, friable, desiccated orange brown silty CLAY.			
0.60	SV	85,100,105 kPa			RIVER TERRACE DEPOSITS	
1.00	SV D1	140,140,140 kPa		1		
2.00	D2		Stiff, locally firm, light brown and orange brown, slightly gravelly, silty CLAY/clayey SILT. Gravel is subangular, fine-sized flint and chalk.	1.90 ()		
3.00	D3		Stiff, locally firm, light brown, orange brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is subangular, locally elongated, flint and chalk.	2.70 ()		
				3.20 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.20 bgl.		All dimensions in metres Log Scale 1:25 	

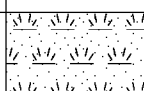
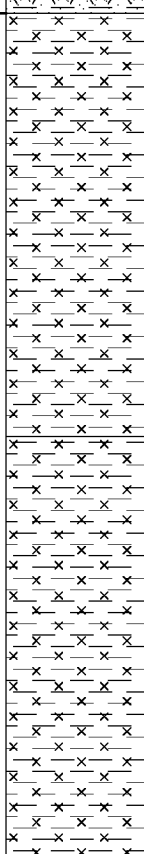
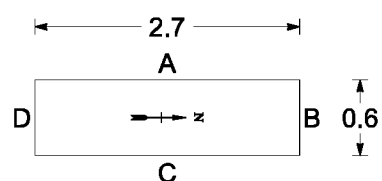
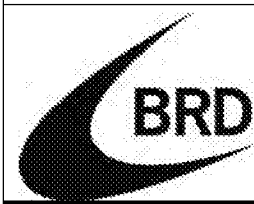
TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 12/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP11		
Sheet 1 of 1						
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1	86,80,86 kPa	Friable brown, slightly humic, silty TOPSOIL.	0.25 ()	TS	
0.40	J2		Stiff, locally firm, orange brown, silty CLAY.			
0.80	SV					
1.00	D1					
2.10	B1 D2		Medium dense, light brown, slightly clayey, very silty SAND and fine to coarse sized GRAVEL of chalk and flint.	2 2.00 ()	RIVER TERRACE DEPOSITS	
3.00	D3		Cream, off-white, light brown CHALK comprising slightly sandy gravelly SILT. Gravel (<5%) fine to medium sized subrounded flint. (CIRIA, 2002 Chalk Grade Dm). 3.00 m: Becomes off-white gravel (10%) of flint and very weak chalk lithorelicts.	2.60 ()	LNCF	
				3.45 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.45 bgl.			
All dimensions in metres Log Scale 1:25						

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 12/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP12		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		Friable, brown, slightly humic silty TOPSOIL.	0.30 ()	TS	
0.40	J2		Firm, stiff, friable, orange brown silty CLAY.			
0.90	D1			1	RIVER TERRACE DEPOSITS	
1.00	SV1	>140,>140,>140 kPa				
2.00	D2		Medium dense, light brown and orange brown, silty and gravelly, fine sized SAND. Gravel is subrounded to rounded flint. Local pockets of gravel to gravelly sandy clay.			
3.00	D3			2		
				3		
				3.20 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.20 bgl.		All dimensions in metres Log Scale 1:25	

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 12/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP13		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		Friable, brown, slightly humic, silty TOPSOIL.	0.30 ()	TS	
			Stiff, friable, orange brown, silty CLAY.			
0.80	SV	85,95,80 kPa		1		
1.00	SV D1	>140,>140,>140 kPa				
2.00	D2		Stiff, friable, light orange brown, slightly sandy silty CLAY. Sand is fine-sized. With occasional fine-sized subangular flint gravel (<2%).	1.70 ()	RIVER TERRACE DEPOSITS	
3.00	D3			3		
				3.10 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.10 bgl.		All dimensions in metres Log Scale 1:25	
						

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 12/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP14		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		Friable, brown, slightly humic, silty TOPSOIL.	0.30 ()	TS	
			Stiff, friable, orange brown, silty CLAY.			
0.80	SV J2	80,90,86 kPa		1		
1.00	SV D1	>140,>140,>140 kPa				
			Stiff, friable, orange brown, slightly gravelly, slightly sandy silty CLAY. Gravel is fine sized subangular flint.	1.60 ()	RIVER TERRACE DEPOSIT	
2.00	D2			2		
			Stiff, locally firm, light brown, locally subvertically stained orange brown, 2mm/5mm width, slightly sandy silty CLAY.	2.40 ()		
2.90	D3			3		
				3.00 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.00 bgl.			
All dimensions in metres Log Scale 1:25						

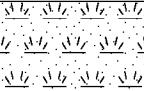
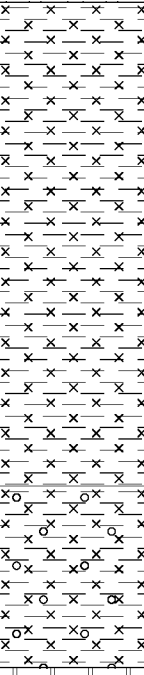
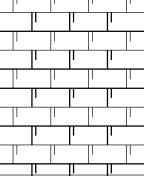
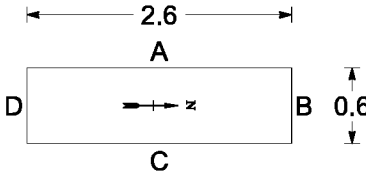
TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 12/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP15		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		Friable, brown, slightly humic, silty TOPSOIL. Very stiff, friable, orange brown, slightly sandy silty CLAY. Sand is fine grained.	0.25 ()	TS	
0.90 1.00	SV J2 SV D1	110,120,100 kPa >140,>140,>140 kPa		1	RIVER TERRACE DEPOSITS	
2.00	D2		Firm, light brown, locally brown, slightly gravelly, slightly sandy silty CLAY. Gravel is fine-sized, subangular flint and chalk.	1.80 ()		
3.00	D3		2.70 m: Becomes brown in colour.	3		
				3.10 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.00 bgl.		All dimensions in metres Log Scale 1:25 	

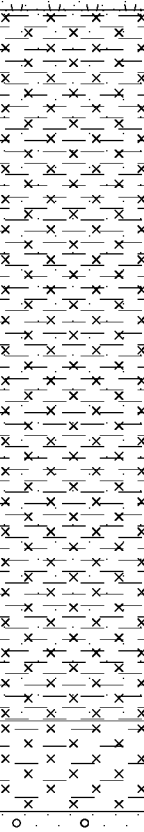
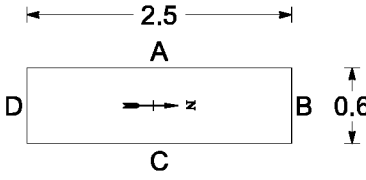
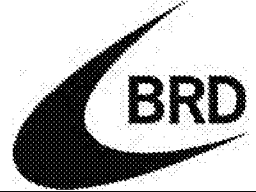
TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 12/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP16		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		Friable, brown, slightly humic silty TOPSOIL.	0.30 ()	TS	
0.60	J2		Stiff, friable, orange brown, slightly sandy silty CLAY.			
1.00	D1			1	RIVER TERRACE DEPOSITS	
1.50	D2		1.25 m: Frequent coarse sized gravel of subangular flint. Stiff, friable, orange brown, slightly gravelly, slightly sandy silty CLAY. Gravel (5%) is fine to coarse sized subangular flint.	1.30 ()		
2.50	D3		2.00 m: Becomes light brown, brown locally mottled orange brown. 2.50 m: Becomes slightly sandy, slightly gravelly silty CLAY.	2		
3.00	D4		2.70 m: Becomes off-white, brown, sandy gravelly silty CLAY. Increasing chalk content. Pale brown, off white CHALK comprising of slightly clayey gravelly (20%) SILT. Gravel is medium to coarse sized, subangular flint. Occasional weak chalky gravel (<5%). (CIRIA, 2002 Chalk Grade Dm).	2.90 ()		
				3	LNCF	
				3.20 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.20 bgl.			All dimensions in metres Log Scale 1:25

TRIAL PIT RECORD

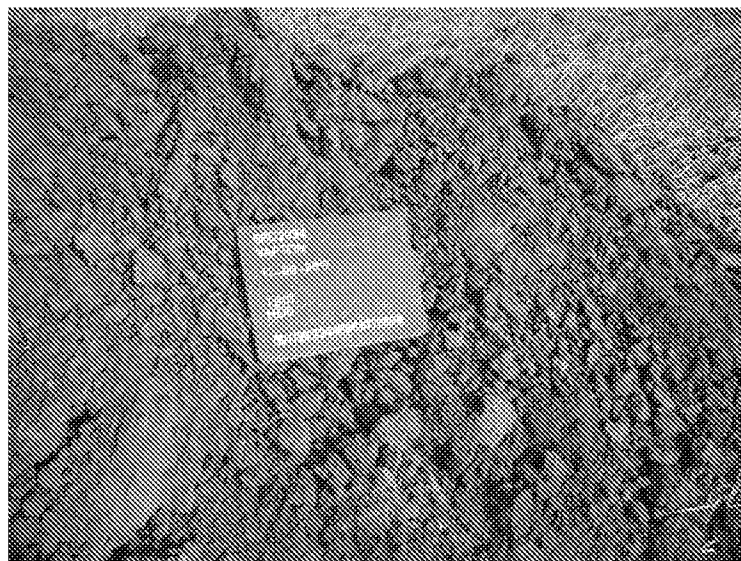
Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 12/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP17		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		Friable, brown, slightly humic, silty TOPSOIL.	0.30 ()	TS	
0.60	J2		Stiff, friable, orange brown and light brown silty CLAY. Locally silty CLAY/clayey SILT.			
0.80	SV	80,92,86 kPa		1	RIVER TERRACE DEPOSITS	
1.00	SV D1	>140,>140,>140 kPa				
1.70	D2		1.60 m: Becomes light brown mottled orange.	1.90 ()		
			Stiff, friable, light brown and brown, slightly sandy, slightly gravelly silty CLAY. Gravel is fine and medium sized subangular flint.			
2.50	D3		White, off-white, locally brown CHALK comprising of slightly gravelly SILT. Gravel is flint. (CIRIA Grade Dm). 2.50 m: Becomes flint and chalk	2.50 ()	LNCF	
				3		
				3.10 ()		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.10 bgl.		All dimensions in metres Log Scale 1:25	
						

TRIAL PIT RECORD

Client: Trustees of the Langmead Pension Scheme Project Title: Drove Lane, Yapton Project No: BRD2934 Logged By: A Plant Date Completed: 12/09/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP18		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		Friable, brown, slightly humic, silty TOPSOIL.	0.25 ()	TS	
			Stiff, friable, orange brown, slightly sandy silty CLAY. Sand is fine sized.			
0.50	J2				RIVER TERRACE DEPOSITS	
0.70	SV	80,80,84 kPa				
1.00	SV D1	>140,>140,>140 kPa		1		
2.00	D2			2		
2.80	D3		Stiff, friable, grey, locally mottled orange brown clayey SILT/silty CLAY.	2.60 ()		
2.95	B1		Orange brown and light brown silty, very gravelly, predominantly fine-sized SAND. Gravel is fine to coarse sized subrounded flint and chalk.	2.90 () 3.00 ()		
				3		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.00 bgl.			
			All dimensions in metres Log Scale 1:25			
						

Trial Pit Photographs

TP01



Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP5-A
Date Issued: October 2017



Trial Pit Photographs

TP02

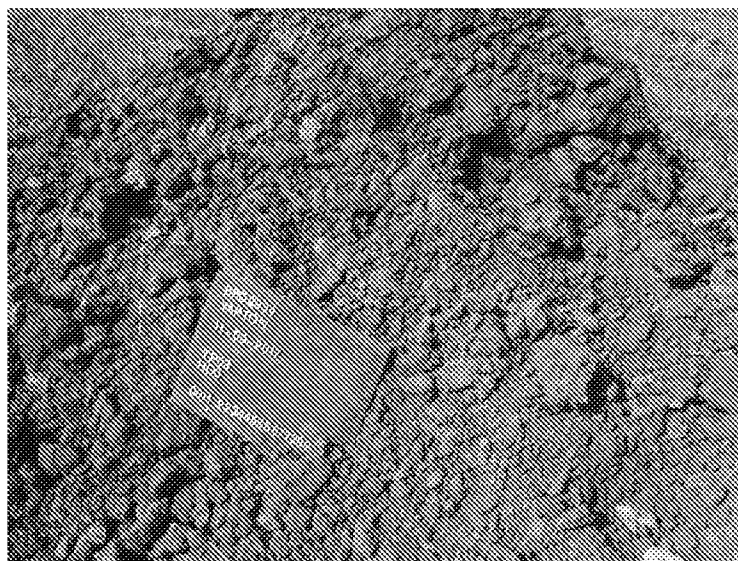
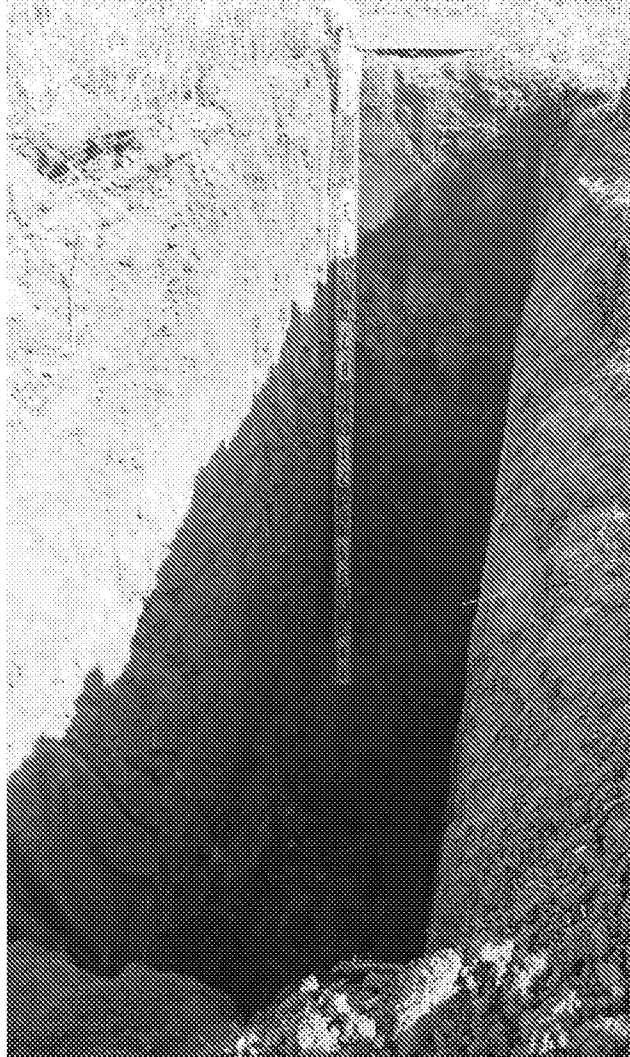


Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP5-A
Date Issued: October 2017



Trial Pit Photographs

TP03

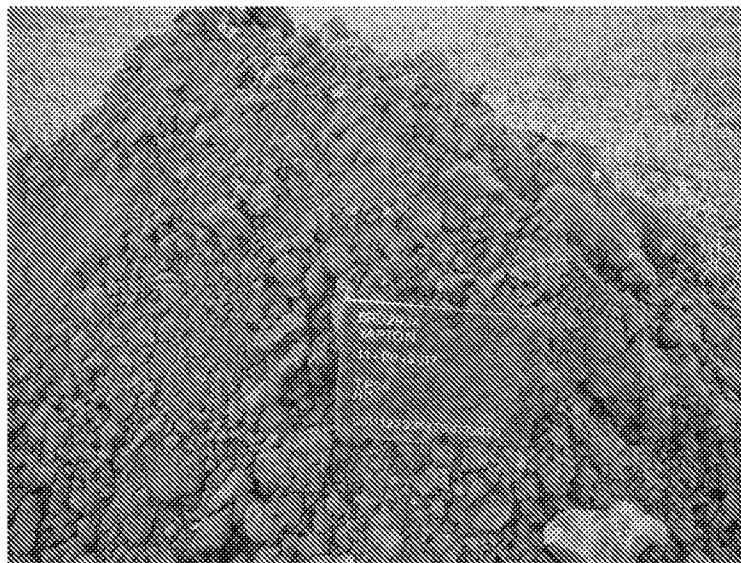


Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP5-A
Date Issued: October 2017



Trial Pit Photographs

TP04

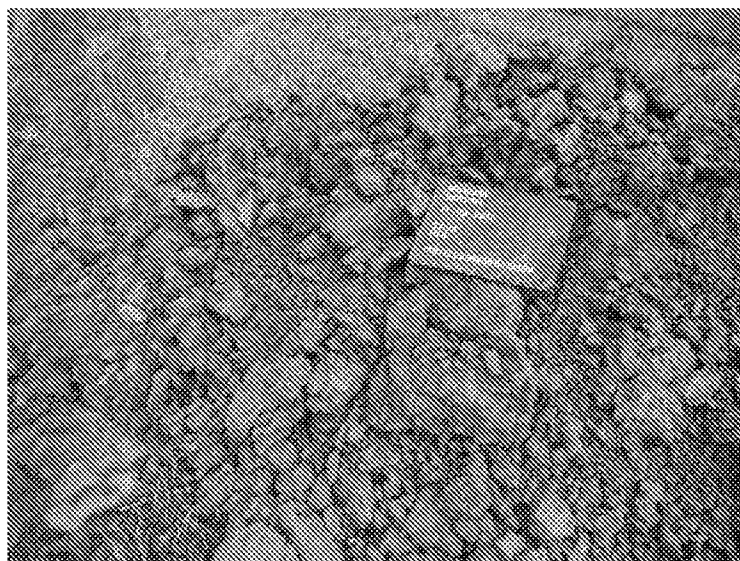
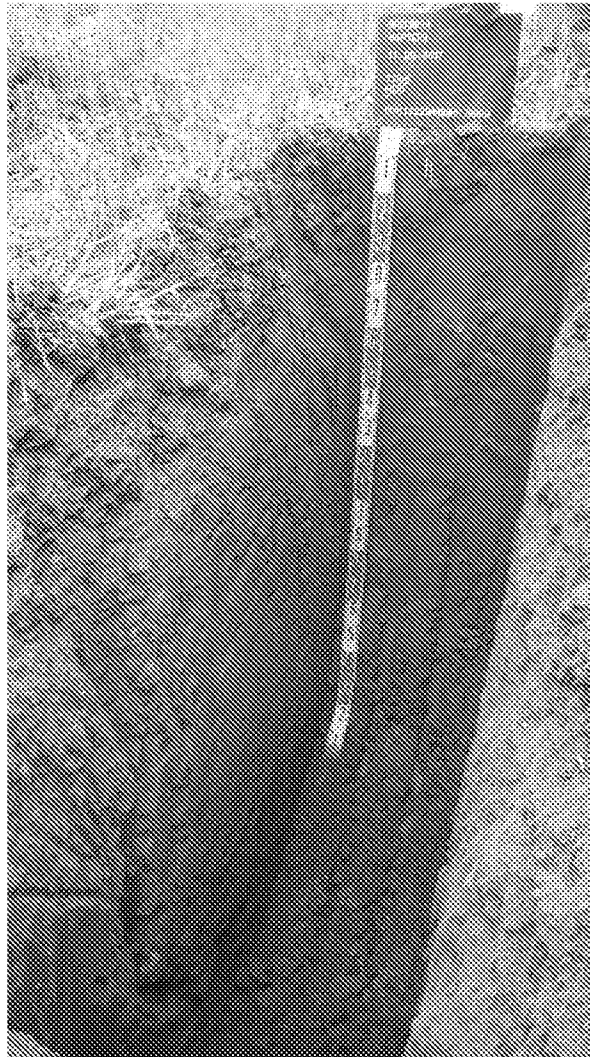


Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP5-A
Date Issued: October 2017



Trial Pit Photographs

TP05

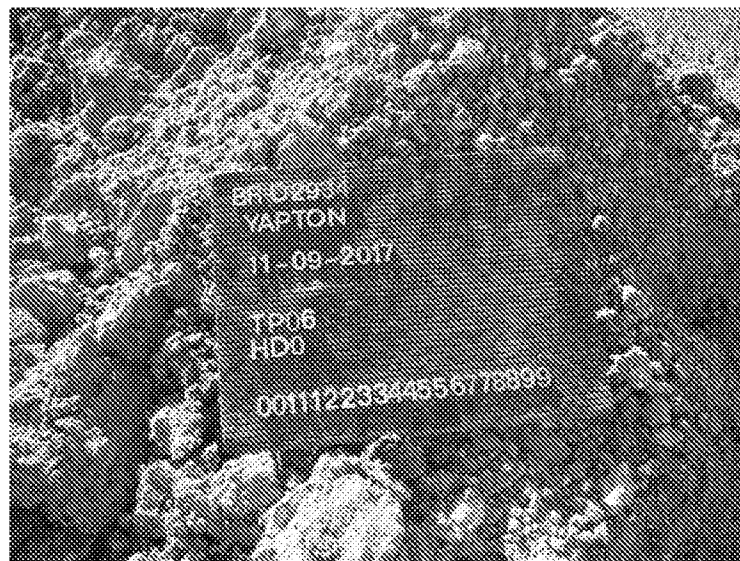
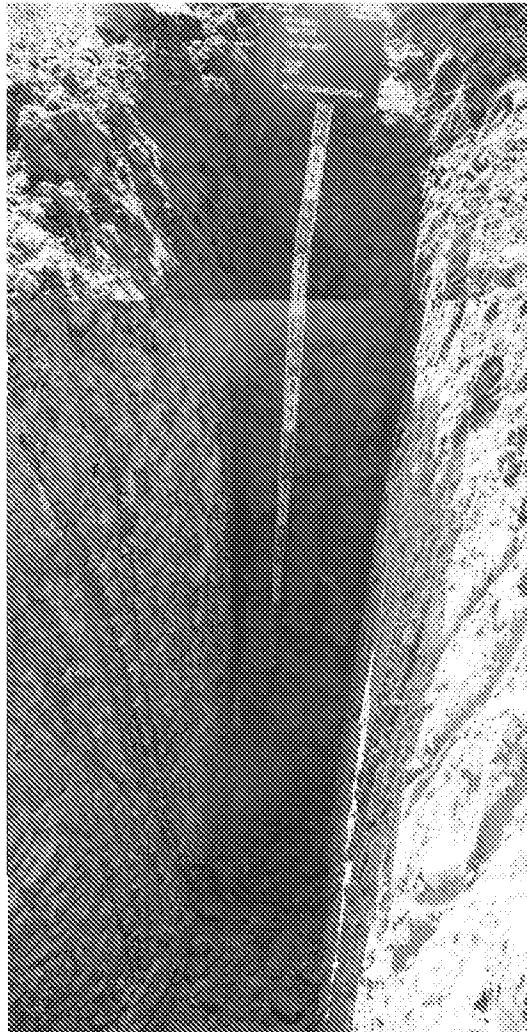


Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP5-A
Date Issued: October 2017



Trial Pit Photographs

TP06

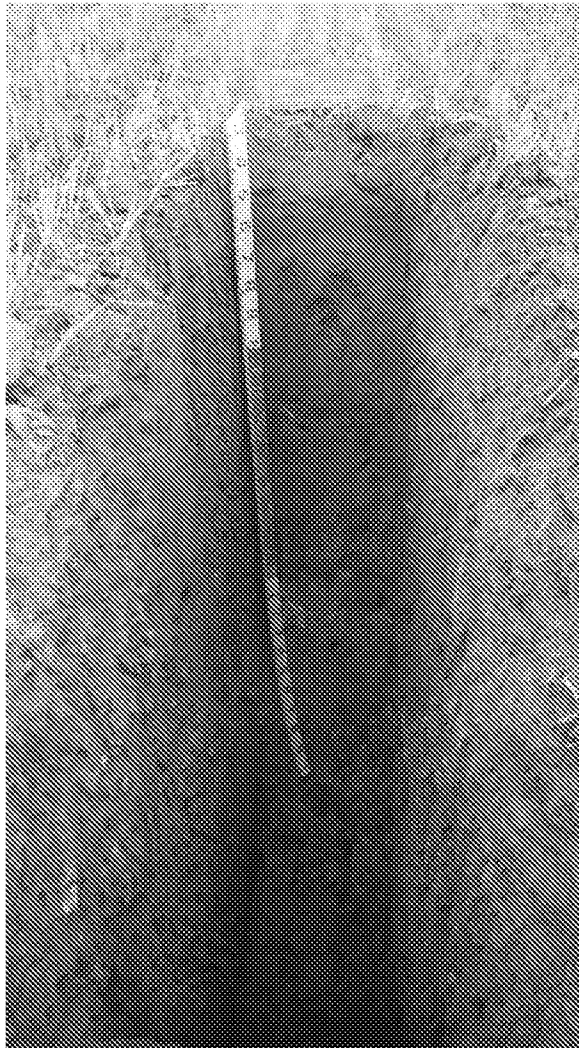


Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP5-A
Date Issued: October 2017



Trial Pit Photographs

TP07

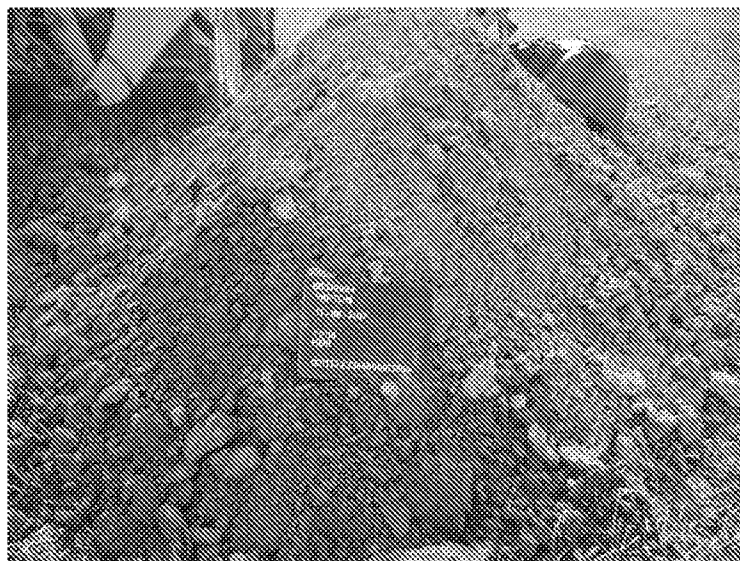
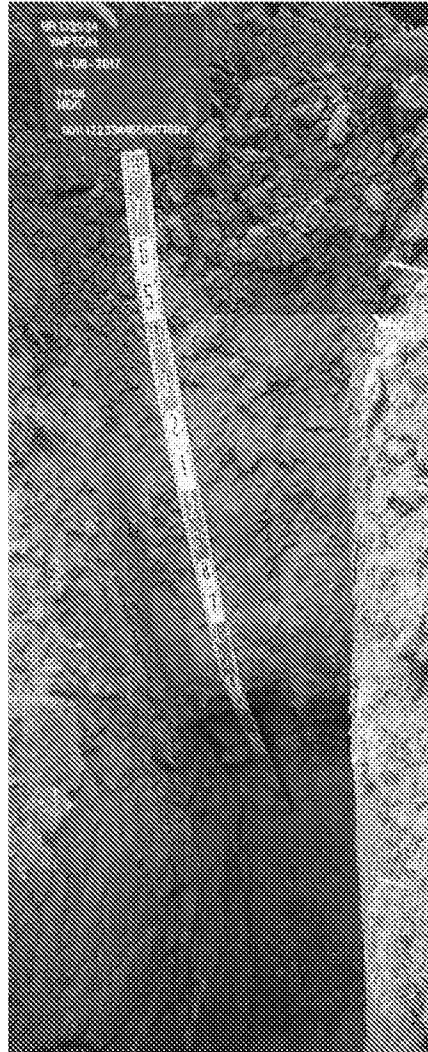


Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP5-A
Date Issued: October 2017



Trial Pit Photographs

TP08

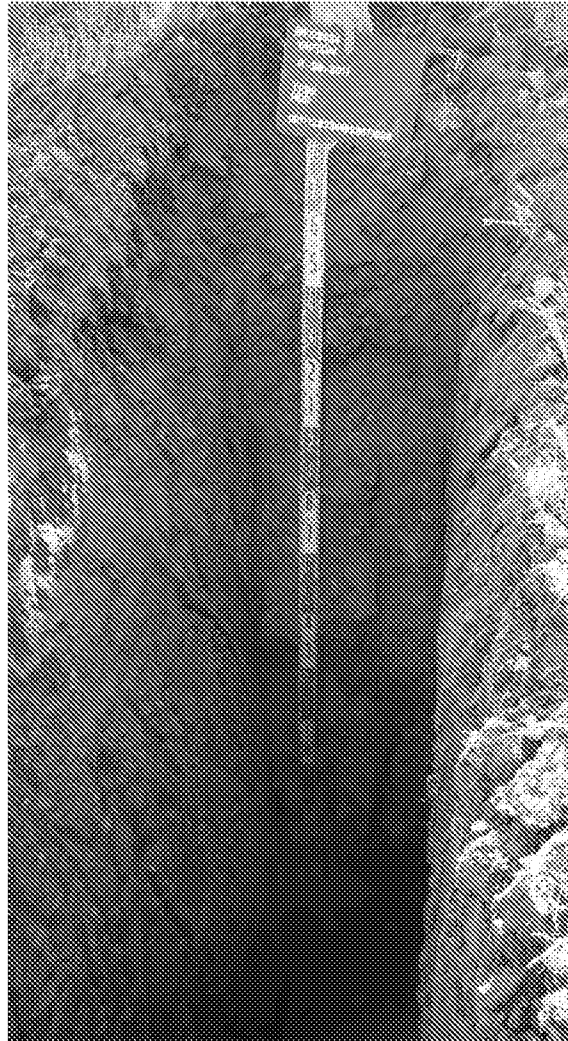


Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP5-A
Date Issued: October 2017



Trial Pit Photographs

TP09



Project Title: Land at Drove Lane, Yapton
Client: Trustees of the Langmead Pension Scheme
BRD Reference: BRD2934-OP5-A
Date Issued: October 2017

