

Method Summary

Report No.: 19-22286, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Water					
Aliphatic/Aromatic hydrocarbons in water	N		27/03/2019		GC-FID
Aromatic hydrocarbons in water	N		27/03/2019		GC-FID
Phenols in waters	N		20/03/2019		HPLC
Alkalinity in waters	N		20/03/2019	100	Titrimetry
Dissolved metals by ICP in waters	U		20/03/2019	101	ICPMS
Dissolved organic carbon	U		21/03/2019	102	IR
pH of waters	U		20/03/2019	113	Electromeric
Chromium Hexavalent in waters	U		20/03/2019	123	Colorimetry
Sulphide in water	N		22/03/2019	134	Colorimetry
PAHs and/or PCBs in waters	N		22/03/2019	135	GC-MS
Electrical conductivity of water	U		20/03/2019	138	Electromeric
BOD	N		25/03/2019	142	5 Day
COD (Chemical Oxygen Demand in waters)	N		25/03/2019	143	Colorimetry
Ammonia in waters	N		21/03/2019	151	Colorimetry
Suspended Solids in waters	N		21/03/2019	155	Gravimetry
SVOC in waters	N		22/03/2019	167	GC-MS
PAHs and/or PCBs in waters	N		22/03/2019	170	GC-MS
Low range Aliphatic hydrocarbons water	N		21/03/2019	200	GC-MS
Low range Aromatic hydrocarbons water	N		21/03/2019	200	GC-MS
VOC in waters	U		19/03/2019	200	GC-MS
Elemental Sulphur by HPLC in waters	N		21/03/2019	206	HPLC
Aliphatic hydrocarbons in water	N		25/03/2019	215	GC-FID
Aromatic hydrocarbons in water	N		25/03/2019	215	GC-FID
Anions	U		20/03/2019	270	Ion Chromatography

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-22286, Issue number 1

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C)

ELAB are unable to provide an interpretation or opinion on the content of this report.

The results relate only to the sample received.

PCB congener results may include any coeluting PCBs

Uncertainty of measurement for the determinands tested are available upon request

Unless otherwise stated, sample information has been provided by the client

Deviation Codes

-
- | | |
|---|--|
| a | No date of sampling supplied |
| b | No time of sampling supplied (Waters Only) |
| c | Sample not received in appropriate containers |
| d | Sample not received in cooled condition |
| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month

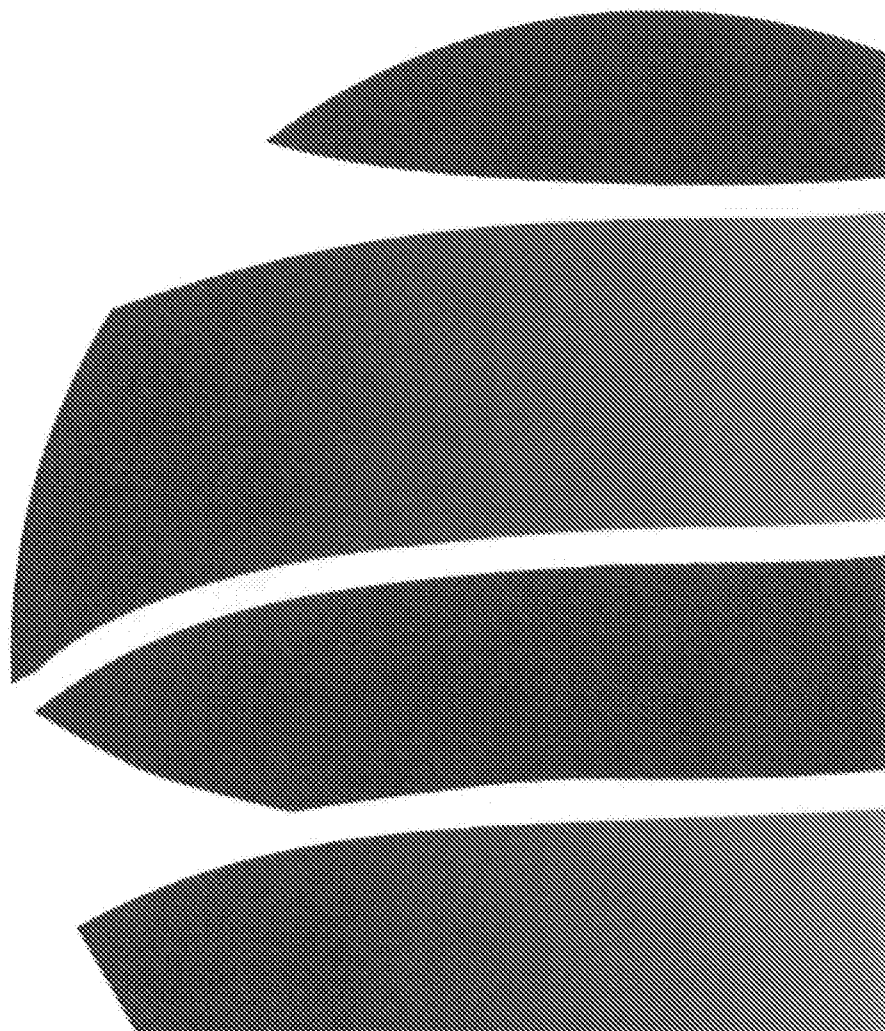
All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage



APPENDIX D

Piling Risk Assessment





Geo-Environmental

QUALITATIVE PILING RISK ASSESSMENT

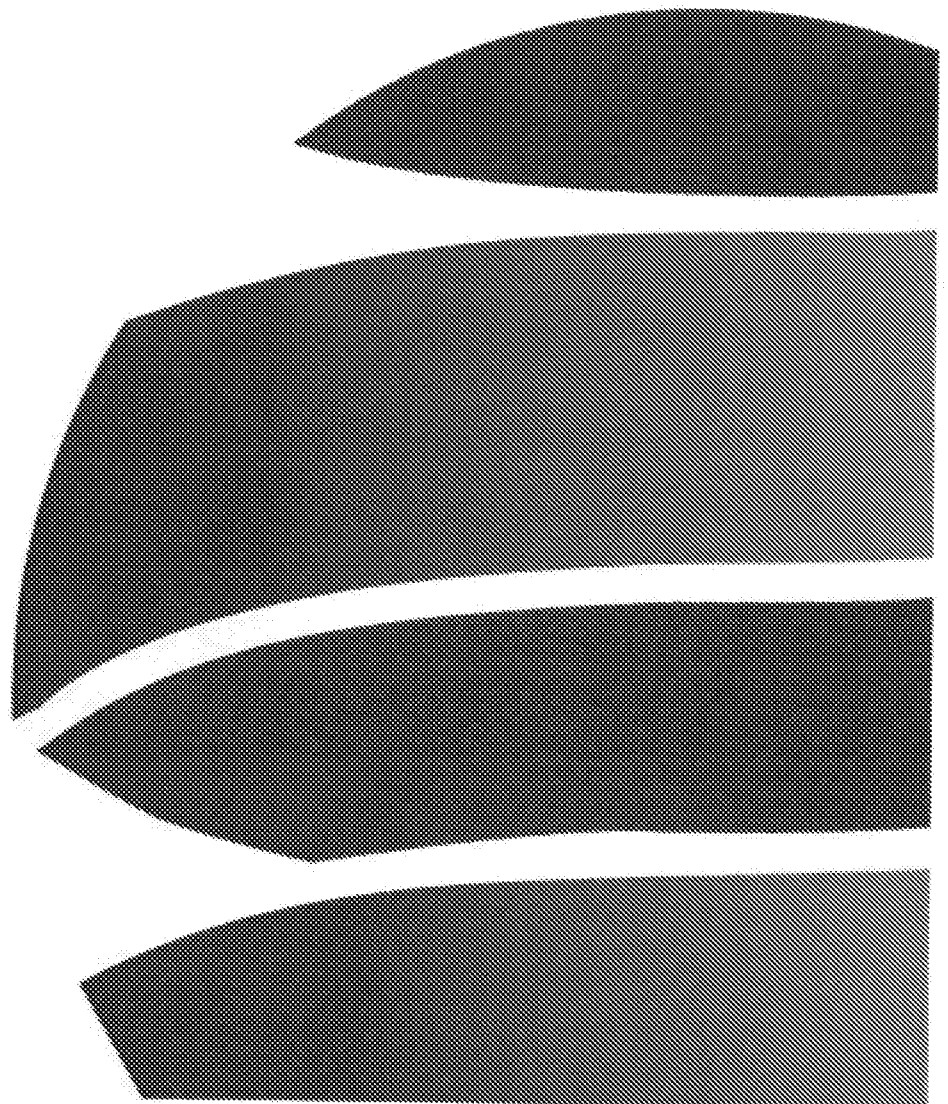
for the land

**SOUTH OF CORNFIELD CLOSE,
LITTLEHAMPTON, WEST SUSSEX**

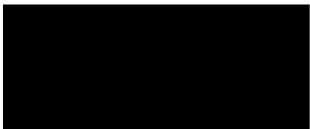
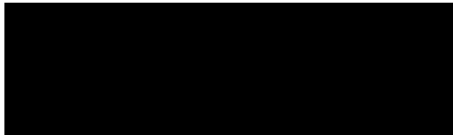
BN17 6LD

on behalf of

THAKEHAM CLIENT LIMITED





Report:	QUALITATIVE PILING RISK ASSESSMENT
Site:	LAND SOUTH OF CORNFIELD CLOSE, LITTLEHAMPTON, WEST SUSSEX, BN17 6LD
Client:	THAKEHAM CLIENT LIMITED
Date:	10/07/2019
Reference:	GE18103-QPRA-JUL19
Version:	1.0
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AMENDMENT RECORD

Revision ref.	Date	Reasons for amendment	Author	Reviewed by	Authorised by
1.0	11/07/2019	Initial issue	LL	VB	JT



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APPENDIX A	Cross Sections of site
APPENDIX B	Abbey Pynford Piling Method Statement, ref: MS01464 Rev: 1, dated 17/06/2019

1.0 INTRODUCTION

1.1 General

Geo-Environmental Services Limited (Geo-Environmental) was instructed by Thakeham Client Limited to undertake a qualitative piling risk assessment for the proposed foundation option on land south of Cornfield Close, Littlehampton, West Sussex, BN17 6LD (herein referred to as 'the site'). The site's location is presented in Figure 1.

1.2 Form of Development

It is understood that the site is proposed to be re-developed with works comprising the demolition of the existing buildings and the construction of 77No. residential homes with private garden, areas of soft landscaping, associated access, car parking, cycle parking, refuse/recycling storage, landscaping, earthworks and associated development infrastructure.

1.3 Objectives

This report has been prepared to provide a qualitative piling risk assessment in accordance with the Environment Agency Document Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination Guidance on Pollution Prevention ref NC/99/73. The objective is to assess potential risks associated with proposed piling works and, if appropriate, to provide justification for the foundation methodology selected and control measures required to mitigate any associated risk.

The report has been prepared in order to satisfy planning condition No. 11 of planning permission LU/330/18/PL issued by Arun District Council which states:

Condition 11

Piling & investigation boreholes using penetrative methods shall not be carried out other than with the written consent of the Local Planning Authority. The development shall be carried out and completed in accordance with details so approved.

Reason: To prevent pollution of groundwater in accordance with Arun Local Plan policy W DM1.

This report has been prepared with reference to the following reports undertaken by Geo-Environmental and should be read in conjunction with the full reports:

- Phase 1 desk study (ref: GE16903-DSR-DEC17) dated December 2017;
- Baseline ground investigation (ref: GE16903BGIR-JAN18) dated January 2018;
- Preliminary soakage testing letter report (ref: GE17106/AP01/180413) dated April 2018;
- Phase 2 ground investigation report (ref: GE17106-GAR/AP01/231018) dated November 2018;
- Remedial Strategy and Verification Plan (ref: GE17106-RSVP-GE-NOV18) dated November 2018;
- Earthworks Appraisal Report for the proposed pavement construction (ref: GE18102-GAR-MAR-19) dated March 2019;
- Further winter soakage testing letter report (ref: GE18021/GE01/180319) dated March 2019;

1.4 Conditions

The data collected from the investigations have been used to provide an interpretation of the geotechnical and/or environmental conditions pertaining to the site. The recommendations and opinions expressed in this report are based on the data obtained. Geo-Environmental takes no responsibility for conditions that either have not been revealed in the available records, or that occur between or under points of physical investigation. Whilst every effort has been made to interpret the conditions, such information is only indicative and liability cannot be accepted for its accuracy.

It should be noted that in particular the concentrations and levels of mobile liquid and gaseous materials are likely to vary with time. The results obtained may therefore only be representative of the conditions at the time of sampling. This report should not be taken as any guarantee that a site is free of hazardous or potentially contaminative materials.

Information contained in this report is intended for the use of the Client and Geo-Environmental can take no responsibility for the use of this information by any party for uses other than that described in this report. Geo-Environmental makes no warranty or representation whatsoever express or implied with respect to the use of this information by any third party. Geo-Environmental does not indemnify the Client or any third parties against any dispute or claim arising from any finding or other result of this investigation report or any consequential losses.

Assessment criteria or other parameters developed for the evaluation of contamination on this site are based on a number of assumptions regarding exposure and toxicology. Exposure to contaminants and levels of adverse effects may therefore vary. Whilst reasonable care and expertise has been employed in the development of such criteria, no liability is accepted in this respect. Other criteria or guidance on the development of assessment criteria may be published in the future and no liability is accepted in this respect.

2.0 THE SITE

2.1 Site Location

The site comprised a generally flat and level grass covered former caravan and camp site which extended to c.2.71Ha. Through the process of completing the desk study and intrusive investigation, it was discovered that the majority of the site comprised an infilled former brick quarry.

The site was bounded by cattle fencing and mature trees. The surrounding area comprised residential properties to the north and east, and two different schools to the south and west. Site access was via Cornfield Close to the north.

2.2 Geology

British Geological Survey (BGS) geological mapping indicated the geology underlying the site to comprise sand and gravel of the River Terrace Deposits over the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Cuiver Chalk Formation and Portsdown Chalk Formation. Whilst no worked or Made Ground was marked on the British Geological Survey mapping for the site, it was understood that part of the site had formerly been subject to landfilling and as such areas of Made Ground were expected to be present overlying natural strata.

It was understood that the Made Ground was formed of Household waste including glass, metal, household rubbish and organic matter.

The rivers of the south of England have been subject to at least three changes of level since Pleistocene times. One result has been the formation of a complex series of River Terrace Deposits. The deposits are generally found at an elevation close to or higher than that of the existing rivers, and generally comprise sand and gravel of roughly bedded flint or chert.

The White Chalk Subgroup is a soft white friable microporous limestone composed of coccolith biomicrites with a varying proportion of larger shell fragments. Flint characterises the White Chalk Subgroup, occurring as nodular courses, tabular beds and linings to fractures.

At various levels clay sized material occurs as marl seams and partings. Close to the surface the upper few metres are invariably discoloured brown, due to leaching from the overlying strata. The interface with any overlying stratum is invariably extremely irregular as a result of localised weathering and general solution. Weathering by frost action may extend to a depth of several metres.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually infilled with drift deposits, are found in the chalk, sometimes manifesting themselves at the surface as shallow circular depressions. Solution features may be reactivated by the concentrated ingress of water from leaking drains or soakaways. Reactivation may lead to surface collapse.

Within the Chalk outcrop on the south coast of England the traditional three-fold division into Lower, Middle and Upper Chalk is impractical for mapping purposes and only two divisions are mapped, these being the Grey Chalk Subgroup (formerly known as the Lower Chalk) and the White Chalk Subgroup (formerly the undivided Middle & Upper Chalk).

In general, the ground conditions encountered from the investigation works can be summarised as follows:

Beneath the turf, hardstanding or capping material Made Ground comprising landfilled material was encountered within all locations to depths of between 1.70m and 2.90m bgl and was of a mixed composition comprising sandy clay and silty sand with brick, glass, plastics, metal, china, ash, coal, concrete, black organic matter, shoes, fabric, timber, and flint gravel.



Underlying the Made Ground, River Terrace Deposits were encountered within all locations with the exception of TP207 to depths of between 2.0m and 7.0m bgl and generally comprised medium dense orange brown sandy clay becoming orange brown sand with flint gravel with slight traces of chalk at depth. Organic malodours were noted within BH105 only, at a depth of between 6.50m and 7.00m bgl. TP207 was advanced within the Made Ground only and was terminated prematurely at a depth of 2.2mbgl.

Underlying the River Terrace Deposits, the Lewes Nodular Chalk was encountered within the cable percussion boreholes to depths of between 10.00m and 15.00m bgl (maximum depth of the investigation) and was generally recovered as structureless CHALK composed of sub-angular to rounded gravel. Clasts are weak, medium, high and very high density, off-white within an off-white matrix. For further details of the ground conditions encountered, reference should be made to the information presented in Appendix A, which includes four sections across the site. All deeper investigation positions undertaken as part of the main phase of the site investigation works on site utilised the use of clean drilling techniques.

2.3 Hydrogeology

The groundwater regime on site is characterised by two aquifers the superficial deposits (Head, River Terrace Deposits) are classified as a Secondary 'A' Aquifer, with the underlying bedrock geology (Chalk) is classed as a Principal Aquifer.

Secondary 'A' aquifers comprise permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

Principal Aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

According to information provided from the Environment Agency the site was indicated to be outside of any Source Protection Zone with regard to the protection of groundwater for potable supply. Whilst a number of groundwater abstractions have been identified within 500m of the site boundary these are all recorded to be for spray irrigation and/or agricultural watering.

Based on the monitoring undertaken groundwater flow was noted to vary locally but was general in a slight north westerly and eastern trend

2.4 Hydrology

The closest surface water feature (58m NW) comprised an unknown feature (comprising a possible pond or stream). It was considered that this was unlikely to be in continuity with the underlying ground waters (within the superficial deposits, groundwater at depth).

2.5 Historic Land Uses

Historic mapping from 1876 has shown that the site formed part of a field network, prior to forming a brick field c.1911. The site was subsequently developed as a caravan site c.1980, suggesting the brick field had subsequently been infilled. The most recent mapping layout appeared to be consistent with the layout observed during the site walkover survey.

The land in the immediate vicinity of the site appeared to have formed field's c.1876 with the north-western area forming part of the brick field c.1911 to c.1932. From c.1932 to date the surrounding area was developed for a mixture of residential and educational uses.

Landfill records indicate that the site comprised a historical landfill site where inert, commercial and household wastes had been accepted, known as Worthing Road, Littlehampton.

An environmental search request was sent to Arun District Council asking for any information they made hold for the site, and in particular any information held on the landfill.

Records held for the site comprised a landfill gas monitoring report which it is believed to have been prepared in 1995 although no date or reference were provided. The monitoring based on the standards at that time comprised eleven standpipes being installed and monitored over a two year period, initially the visits were weekly for the first four months before becoming monthly. Methane was recorded within the range of 0.1% v/v to 7.8% v/v with the higher readings recorded within position SP9 only. Carbon Dioxide levels ranged between 0.0% v/v and 13.6% v/v. It was recommended that further monitoring be undertaken until Carbon Dioxide concentrations dropped and to install further monitoring wells adjacent to wells SP6, SP9 and SP10. In addition, it was recommended that a gas barrier in the form of a trench be installed with venting along with the installation of continuous gas monitoring equipment. It is not known if these historical recommendations were followed, however additional gas assessment has subsequently been undertaken by Geo-Environmental in relation to the site.

The BGS Geology of Britain Viewer borehole scan records identified eighteen shallow boreholes undertaken across the site, these were drilled in November 1978 by Norwest Holst Soil Engineering Ltd. Samples identified Made Ground to depths of between 1.10m and 3.30m bgl. The Made Ground generally comprised friable brown silty sandy gravelly clay overlying brown silty clay with domestic refuse with brick, wood, concrete and ash. Underlying the Made Ground, River Terrace Deposits were encountered to depths of between 3.70m and 6.35m bgl and generally comprised orange brown silty fine sandy clay with chert gravel, clayey sand and gravel and brown sand.

Underlying the Made Ground and River Terrace Deposits, Chalk was encountered within ten locations to depths of between 5.00m and 10.00m bgl (maximum depth of the investigation). The chalk was described as Greyish white structureless chalk within a chalky clayey matrix.

2.6 Contamination

The desk study has identified the presence of a thickness of Made Ground/infilled ground on the site associated with the infilling of a former brick field, records from which suggest that household and potentially biodegradable waste was accepted. As such, these materials are considered to represent a potential source of degrading materials for the generation of ground gases and vapours. Information reviewed as part of the desk study indicated that the waste body did not benefit from any in-ground engineering or barriers and thus would presumably be a 'dilute and disperse' type body.

The intrusive investigation works identified that the shallow soils (capping material) on site were impacted by elevated concentrations of lead with the landfilled materials impacted by elevated concentrations of lead, arsenic, PCBs, SVOCs and ACMs for which remedial measures were required with respect to human health. In addition the investigation identified that the near surface soils encountered and the recorded use of the site as receiving variable wastes, including domestic and inert was such that these materials were unsuitable for inclusion within private gardens or areas of soft landscaping due to the presence of asbestos, metal, glass, brick and putrescible wastes.

The groundwater analysis undertaken from the site suggested that as the landfill materials were degrading beneath the site, and with unrestricted rainfall infiltration likely across the site, this was potentially resulting in contaminants being leached from the landfill materials and this was indicated via groundwater sampling to have impacted the shallow groundwater beneath the site, primarily in relation to TPH and PAH. It should be noted that due to the variable nature of the waste and in particular the putrescible waste identified that soil sampling undertaken may not represent the highest concentrations of contaminants within the waste materials beneath



the site.

As such it was considered that further assessment of the shallow groundwater on site was required in order to assess any impact to groundwater beneath the site from the onsite source and from potential neighbouring land and also to assess the risks controlled waters in the vicinity of the site from contaminants identified within the shallow, groundwater beneath the site.

2.8 Groundwater

Groundwater was encountered within the boreholes with strike depths between 7.50m and 9.00m bgl, after twenty minutes groundwater was standing at depths of between 7.00m and 9.00m bgl. During the return monitoring visits on 28th August 2018 and 19th October 2018, groundwater depths were recorded within the range of 6.00m and 7.10m bgl.

The hydraulic gradient was calculated to be generally towards the northwest, with variation to the east and southeast throughout the monitoring, based on the recorded groundwater levels (m AOD) within the standpipes and referenced to a survey of the topographic levels of the boreholes

Whilst groundwater monitoring across the site identified low levels of contaminants, from the analysis undertaken a clear trend in contaminant concentrations in relation to site location has not been identified and this is considered to be due to the variable composition of the waste materials encountered within the shallow Made Ground across the site and possibly due to variations in rainfall and associated leaching. As such it is considered that the waste materials *en-masse* represent a potential source of contamination, which could result in the production of leachate and contamination of the shallow groundwater beneath the site.

2.7 Ground Gas

Records held for the site comprised a landfill gas monitoring report which it is believed to have been prepared in 1995 although no date or reference were provided. The monitoring based on the standards at that time comprised eleven standpipes being installed and monitored over a two year period, initially the visits were weekly for the first four months before becoming monthly. Methane was recorded within the range of 0.1% v/v to 7.8% v/v with the higher readings recorded within position SP9 only. Carbon Dioxide levels ranged between 0.0% v/v and 13.6% v/v. It was recommended that further monitoring be undertaken until Carbon Dioxide concentrations dropped and to install further monitoring wells adjacent to wells SP6, SP9 and SP10. In addition, it was recommended that a gas barrier in the form of a trench be installed with venting along with the installation of continuous gas monitoring equipment.

Additional investigation identified that the Made Ground identified on the site contains a significant amount of organic matter or organic contamination, this could have the potential to represent a further source of ground gases/vapours in addition to degrading materials.

As such a period of additional gas monitoring was undertaken to comprise a combination of continuous and 'spot' ground gas monitoring. Ten cable percussive boreholes were installed with two monitoring standpipes within each location (BH101 through to BH110). These locations were selected to provide general coverage of the site, whilst ensuring ongoing access for monitoring. Spot ground gas monitoring was undertaken within all of the installed standpipes on one single occasion.

Continuous ground gas monitoring was undertaken within ten gas monitoring standpipes, BH101 through to BH110, for a period of 3 weeks from 26th September 2018 to 17th October 2018, with the locations being sited within the former landfill area. This monitoring was undertaken during the autumn months to try and target periods of low and/or falling pressures to target a worst case scenario. The continuous ground gas monitors

utilised were Ambisense monitors which provided continuous data relating to both gas concentration and gas flow rates.

Spot Monitoring

The spot monitoring undertaken to date has detected methane at concentrations in the range 0-8.5%, carbon dioxide in the range 0-19.4%, and oxygen in the range 0-19.4%. VOCs have been detected up to 3.2ppm. Borehole flow rates were only detected within two of the monitoring standpipes, BH101d and BH102s and ranged from 0.9 to 3.0l/hr. Atmospheric pressure was recorded as being between 1014-1017mb during the visits undertaken.

The recorded gas flow data has also been compared with monitored groundwater levels within the boreholes. In general it was found that groundwater levels did not particularly fluctuate within BH101d or BH102s, and therefore groundwater is not thought to have an impact on gas flows within these boreholes.

The continuous gas monitoring was undertaken during periods of low and falling pressure in order to target a worst case scenario. The continuous monitoring identified gas concentrations for methane in the range 0%-6.53%, carbon dioxide in the range 0.52%-25.2% and oxygen in the range 0.06%- 18.53%. Carbon monoxide was detected in the range 0-19.43ppm, hydrogen sulphide in the range 0-3.89ppm and VOC's in the range 0-1.7ppm. Positive gas flow rates, and marginally negative gas flow rates were identified within all of the monitoring locations during the continuous monitoring. A maximum flow rate of 1.24l/hr was detected within BH108.

Gas screening values (GSV) have been calculated for both methane and carbon dioxide in accordance with the recommendations contained within C665. The highest reported positive gas flow rate was recorded during the spot monitoring, 3.0l/hr. The worst case, i.e. the highest concentration value, of recorded methane and carbon dioxide have been used. Therefore a value of 8.5% v/v has been utilised for methane and a value of 25.2% v/v has been used for carbon dioxide. Using these worst case values a GSV of 0.255 has been calculated for methane and a GSV of 0.756 has been calculated for carbon dioxide. This would classify the site as representative of Characteristic Situation 3 (BS and CIRIA) and Amber 2 (NHBC), across the site. The site only just falls within the classification for Characteristic Situation 3 based on the GSV calculated for carbon dioxide being greater than 0.7.

The GSV's have been calculated using the worst case results collected from both the 'spot' and the continuous monitoring undertaken, and are therefore considered to be conservative. If the results of the continuous monitoring are treated in isolation then a GSV for carbon dioxide calculated based on the maximum concentration (25.2%), and the highest flow rate (1.24l/hr) recorded during this monitoring period would be 0.312 for carbon dioxide.

This initial assessment has been fed back into the conceptual site model. An onsite source of ground gas has been established, a former landfill site, and residential development is proposed across the site. The ground conditions encountered on site comprise a combination of clays, sands and gravels. These ground conditions do not represent continuous migration pathways although they will contain isolated migration pathways for ground gases. The Made Ground encountered during the intrusive investigation works comprised clayey sandy silt and silty sandy clay with brick and concrete fragments, with a mix of brick, glass, plastics, metal, china, ash, coal, concrete, black organic matter, shoes, fabric, timber, and flint gravel below. This type of material has a limited gassing potential and given the likely age of the landfill the gassing potential of this material will be reduced further.

Given the above assessment it was therefore considered representative of the sites gassing conditions to utilise the GSV calculated for carbon dioxide solely from the continuous gas monitoring, therefore classifying the site as Characteristic Situation 2 and Amber 2.

The proposed piling method is not considered to alter the gas risk assessment that has been undertaken to date.



3.0 SUMMARY OF CONCEPTUAL SITE MODEL

Based on the review and findings of the previous investigations for the site, the following sections refine the conceptual site model for the proposed development site to consider the plausible pollutant linkages of significant to piling works on the site.

3.2 Preliminary Conceptual Site Model & Risk Assessment

3.2.1 Methodology

A Preliminary Risk Assessment ('PRA') and Conceptual Site Model ('CSM') have been prepared in accordance with CLR11 and the Environment Agency Guidance on Piling based on information obtained as part of the previous investigation. Possible risks associated with potential sources of contamination and sensitive receptors identified have been qualitatively assessed following a source-pathway-receptor ('Pollutant Linkage') approach in accordance with current UK protocols. For full details on the site conceptual model with respect to contamination reference should be made to the Phase 2 ground investigation report (ref: GE17106-GAR/AP01/231018) dated November 2018.

		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	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

Table 3.1 Risk Ratings Matrix

Risk Rating	Definitions
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not already undertaken) and remediation are likely to be required.
High risk	Harm is likely to arise to a designated receptor from an identified hazard Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not already undertaken) is required and remediation works may be necessary in the short term and are likely over the longer term.
Moderate risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
Moderate to low risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is unlikely that any such harm would be severe, or if any harm were to occur it is probable that the harm would be relatively mild.
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very low risk	There is low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Table 3.2 Risk Rating Definitions



Table 3.3 summarises the identified plausible pollution linkages and a qualitative assessment of the risks based on the previous investigations undertaken.

Site workers involved in the preparation and construction of the development have not been considered further in this assessment as the Principal Contractor is duty bound under the current CDM Regulations to undertake their own risk assessments with respect to their employees.



Potential Source/Media	Potential Receptors	Potential Pathways	Probability	Consequence	Risk and Justification
Soil Contamination	End user	Direct contact of contaminated soils, ingestion and inhalation of soils, dust and vapours	Likely	Medium	Moderate Pile arisings where methods such as CFA are used will be brought to the surface as part of the process. Where these materials are to be re-used on site this will be beneath any capping systems to be installed on site with respect to human health, thereby reducing the probability of contact, pile arisings will not be suitable for re-use within the capping systems to be installed within private gardens or areas of soft landscaping.
	Adjacent land users	Direct contact of contaminated soils, ingestion and inhalation of soils, dust and vapours	Low	Mild	Low Adjacent site users are unlikely to come into direct contact with soils. Appropriate mitigation measure such as dampening down will be undertaken during development works to minimise the release of dust generated on the site.
	Groundwater	Vertical migration	Likely	Medium	Moderate Impacted soil and groundwater has been identified on the site. The use of CFA piles are proposed to minimise the risk of vertical migration beneath the site.
Groundwater (Shallow and Deep Aquifer)	Groundwater (Secondary 'A' Aquifer – River Terrace Deposits)	Groundwater leaching and migration	Likely	Medium	Moderate Shallow groundwater (<5m bgl) may be present within the Made Ground and superficial River Terrace Deposits on the site although in places this may represent perched water due to the more cohesive bands beneath the site. with deeper groundwater within the 'bedrock' Lewes Nodular Chalk Formation. The strata beneath the site are classified as a Secondary 'A' Aquifer over a Principal Aquifer strata. Natural fluctuations and variations in groundwater levels and flow are likely to occur on site seasonally and in response to rainfall events which could result in migration of contaminants vertically and of mobile contaminants laterally. However, it is considered that vertical migration would be limited by the interbedded nature of superficial strata and weathered condition of the upper profile of chalk. The Principal Aquifer at depth is considered to form a separate groundwater body with limited connectivity due to the presence of the more cohesive parts of the River Terrace Deposits and weathered upper chalk profile. The waste mass has been identified as a potential source of contaminants on the site which is potentially mobile in nature and as such



Potential Source/Media	Potential Receptors	Potential Pathways	Probability	Consequence	Risk and Justification
Ground Gases and Vapours					Piled methodologies will be selected to minimise the likelihood of creation of preferential flow paths and migration of contaminants to depth. Moderate
	Groundwater (Principal Aquifer – Chalk)	Groundwater leaching and migration	Likely	Medium	Contaminants were identified in low concentrations within the upper portion of the Lewes Nodular Chalk Formation beneath the site are primarily within the weathered upper zone of the chalk which is considered to have limited vertical migration. Piled methodologies will be selected to minimise the likelihood of creation of preferential flow paths and migration of contaminants to depth. Moderate to Low
	Surface Water	Vertical and lateral Migration	Low	Medium	The closest surface water feature (58m NW) comprised an unknown feature (comprising a possible pond or stream). It was considered that this was unlikely to be in continuity with the underlying ground waters (within the superficial deposits, groundwater at depth). The proposed founding option may result in slight horizontal displacement of ground/groundwater during construction however this is likely to be limited and pile methods have been selected to minimise such displacement in proximity to adjacent surface water bodies. Moderate
	End users	Inhalation	Likely	Medium	Ingress of hazardous ground gas into buildings on or in proximity to any landfilled area or ground gas/vapour source could occur and could result in significant harm where ground gases are identified on site. Incorporation of gas protection measures could mitigate the risk of harm. On-site service routes should be constructed in line with best practice to prevent the creation of preferential pathways off site. The proposed use of piled foundations would not create or exacerbate any potential pollutant linkages in this respect. Moderate to Low
	Adjacent land users	Inhalation	Low	Medium	It is considered low probability that adjacent land users will come into contact with ground gases and vapours originating on site. Should ground gases and vapours be identified on-site service routes should be constructed in line with best practice to prevent the creation of preferential pathways off site. The



Potential Source/Media	Potential Receptors	Potential Pathways	Probability	Consequence	Risk and Justification
	Buildings and infrastructure	Gas accumulation and potential explosion of flammable gases	Unlikely	Minor	proposed use of piled foundations would not create or exacerbate any potential pollutant linkages in this respect. Very Low Foundations and utilities will be constructed in/through Made Ground soils, with appropriate design for the gas and vapour conditions identified. The proposed use of piled foundations would not create or exacerbate any potential pollutant linkages in this respect.

Table 3.3 Plausible Pollutant Linkages & Qualitative Risk Assessment

4.0 PILING RISK ASSESSMENT

4.1 General

Based on the ground conditions encountered within the trial holes (i.e. a thickness of Made Ground to depths of between 1.70m and 2.90m bgl, it is considered that traditional strip or pad foundations are unsuitable for the proposed development.

As such the use CFA pile solution is proposed. Piles are proposed to extend through the capping materials and Made Ground, waste materials and River Terrace Deposits to terminate within the underlying Lewes Nodular Chalk Formation.

The Piling Risk Assessment has been undertaken in accordance with guidance by the Environment Agency, namely, Piling and Penetrative Ground Improvement Methods on Land Affected by contamination: Guidance on Pollution Prevention NC/99/73 (EA, 2001). In particular this risk assessment refers to the six pollution scenarios detailed within NC/99/73 which are summarised in Table 4.1.

Scenario	Details
1	Creating of preferential pathways through a low permeability layer/shallow layer to allow potential contamination of an aquifer (shallow or at depth).
2	Creation of preferential pathways through a low permeability surface layer to allow migration of landfill gas, soil gas or vapours to the surface.
3	Direct contact of site workers and others with contaminated soils arising that have been brought to the surface.
4	Direct Contact of the pile of engineered structures with contaminated soil or leachate causing degradation of the pile materials.
5	Driving of solid/mobile contaminants down to an aquifer during pile driving.
6	Contamination of groundwater and subsequently surface waters by wet concrete cement paste or grout.

Table 4.1 – Generic Pollution Scenarios

4.2 Risk Assessment

The risk associated with a proposed CFA piled solution for the residential development on land south of Cornfield Close, Littlehampton, West Sussex is provided in Table 4.2 below.

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Risk and Justification
Creation of preferential pathways through a low permeability layer to allow potential contamination of an aquifer	S	Contaminated Made Ground and/or Cohesive parts of the River Terrace Deposits and weathered Chalk	Low The proposed pile methods include CFA piling, which is a non-displacement method of piling. Pile construction times are generally short, with the pile bore being supported by the flight auger throughout the boring process, arising being drawn up to the surface on the flight auger and concrete is then pumped under pressure into the pile bore from the base upwards as the flight auger is withdrawn. As such, any disturbance to the ground is minimal and there should be no formation of preferential pathways as concrete is cast in intimate contact with the surrounding soils.
	P	Pile/Soil Interface	
	R	Secondary 'A' Aquifer and Principal Aquifer	

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Risk and Justification
Creation of preferential pathways, through a low permeability surface layer to allow migration of landfill gas or vapours to surface	S	Soil Gas/Vapours	Low The proposed development will incorporate gas protection measures in line with the requirements of Characteristic Situation 2 (CS2/Amber 2) to include high level ground gas protection as prescribed in BRE414. This will include a suspended floor slab and suitable membrane with all joints and penetrations sealed. In addition, the CFA piling techniques proposed are not considered to create any additional migration pathways which could circumvent or diminish the gas/vapour mitigation measures.
	P	Pile/soil interface	
	R	Buildings and End Users	
Direct contact with contaminated soil arisings that have been brought to the surface	S	Contaminated Soils	Low CFA piling results in the generation of arising at the surface which could include potentially contaminative material (including soils impacted by asbestos and household waste materials). The volume of impacted arisings is likely to be low for any given pile. The management, storage and disposal (if necessary) of pile arisings will be covered within the Piling Contractor's Risk Assessment and Method Statement, in conjunction with the RMS, MMP and other relevant documentation. Health and safety precautions e.g. method statements, personal protective equipment (PPE) and respiratory protective equipment (RPE) will be adopted by the contractor during piling works. Dust suppression measures will be utilised if required to minimise dust generation which could impact neighbouring land uses. Any contaminated arisings will be stockpiled then disposed off-site at a suitably licensed facility under an appropriate duty of care, or where deemed suitable for re-use, re-used under a Material Management Plan in line with the Definition of Waste Code of Practice.
	P	Direct Contact, inhalation and ingestion of Dust	
	R	Site workers, adjacent land users	
Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of the pile material	S	Contaminants in Soils and Groundwater	Low Potentially aggressive ground conditions have been established (Made Ground and waste materials) following the results of the ground investigation. As such below ground concrete will be designed in accordance with design sulphate (DS) and aggregate concrete environment classification (ACEC) of DS2 and AC1, in line with the recommendation of the November 2018 GIR. The concrete mix used will be required to account for the presence of soil and water based contaminants as identified from ground investigations in order to mitigate potential risks associated with curing time, concrete degradation of the like.
	P	Direct Contact and Aggressive Attack	
	R	Below Ground Structures i.e. piles	
The driving of solid contaminants down into an aquifer during pile	S	Contaminated Made Ground and/or River Terrace Deposits	Low The proposed pile methods include CFA piling throughout the development, which is a non-

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Risk and Justification
driving	P	Pile/Soil Interface	displacement method and thus solid contaminants would be drawn up the flight auger during pile formation or remain in-situ within the soil mass.
	R	Secondary Aquifer and Principal Aquifer	
Contamination of groundwater and subsequently surface waters by wet concrete, cement paste or grout.	S	Construction materials and/or contaminated Groundwater	Low The site has not been identified as being located in a Source Protection Zone. Whilst contamination by wet concrete or grout cannot be completely discounted the impact is assessed as low as both concrete and grout have low mobility potential. In addition, the methods of piling proposed (CFA and driven displacement) have been selected in order to minimise the creation of potential preferential flow paths to prevent migration of groundwater contamination identified beneath the site. In addition, ground level control measures would be adopted as standard protocol to minimise concrete spillage at any given CFA pile location and this would be required to include run-off prevention to protect surface water.
	P	Migration via permeable strata	
	R	Groundwater	

Table 4.2 Piling risk assessment for proposed residential development

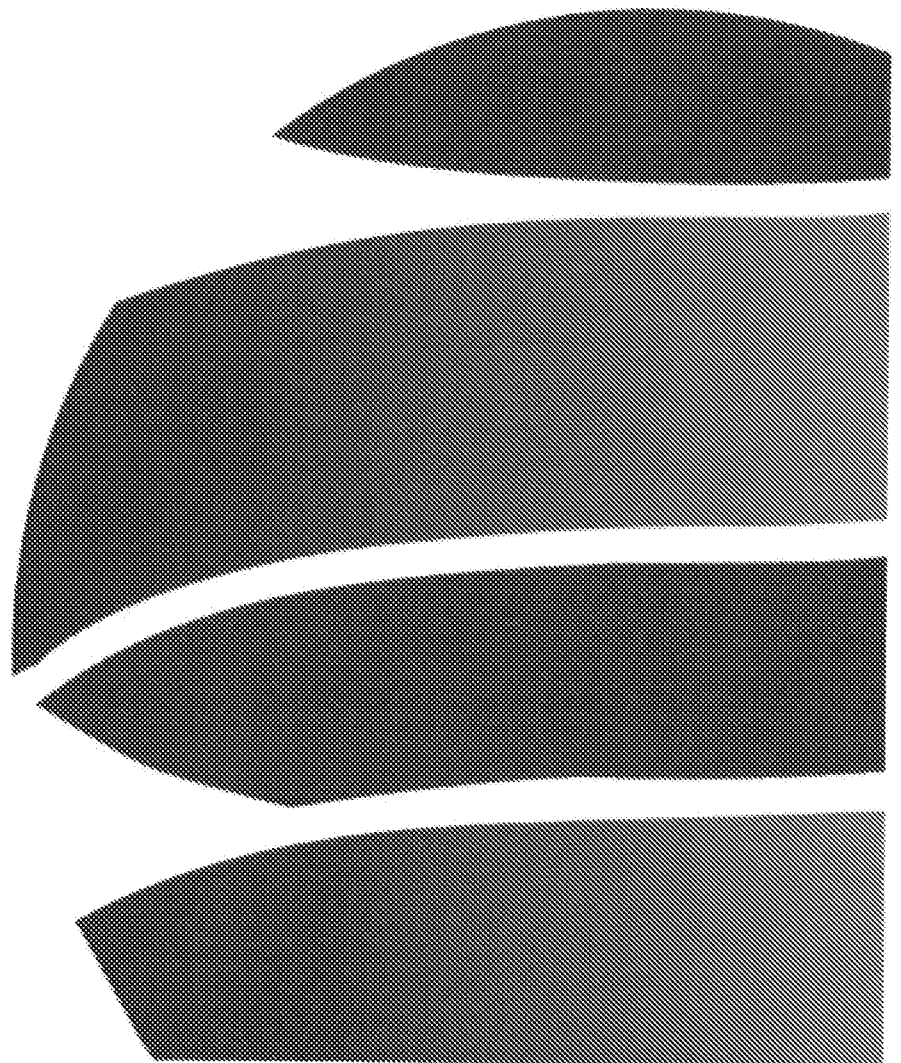
4.3 Conclusion

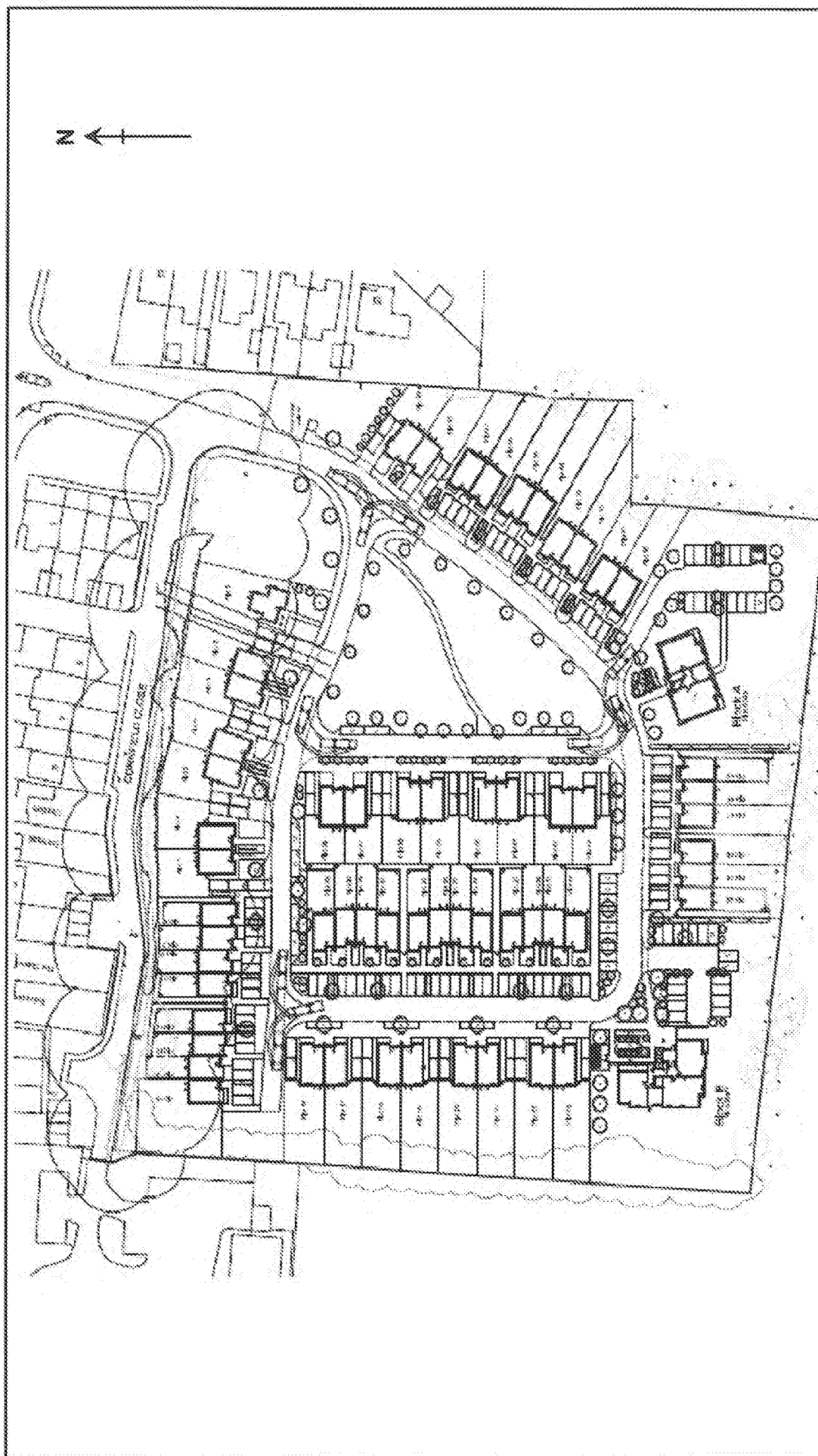
The foundation solution for the proposed residential development on the site comprises the use of CFA, with piles extending through the Made Ground, River Terrace Deposits and in some cases the weathered chalk, to found within Chalk (to a maximum depth of 11mbgl in the majority of locations <10m bgl). Piles are proposed to extend to maximum of 11m bgl with the majority of the piles terminating at depths <10m bgl. Piling is proposed to be undertaken for an approximate five-week duration (subject to site constraints). Piling works on site are to be undertaken by Abbey Pinford and their method statement for the works is provided in Appendix B.

As part of the assessment a number of potential adverse environmental impacts have been considered and assessed on a qualitative basis. The overall risks associated with the proposed foundation works are considered to be low and the use of CFA is considered appropriate based on the ground and groundwater conditions encountered through various phase of intrusive investigation at the site.

CFA piling has been selected specifically as it was designed for use in sites where contamination has been identified. The use of CFA avoids contamination of water supply or groundwater bodies when properly managed because the contaminated sub soil is drilled and removed from the bore rather than being dragged down into the water bearing layer, as would be the case with a driven pile. In addition as part of the site works a Water Quality Plan (WQP) will be in place for the site and the proposed development with groundwater monitoring sampling and analysis to be undertaken prior to, during and post piling works.

FIGURES

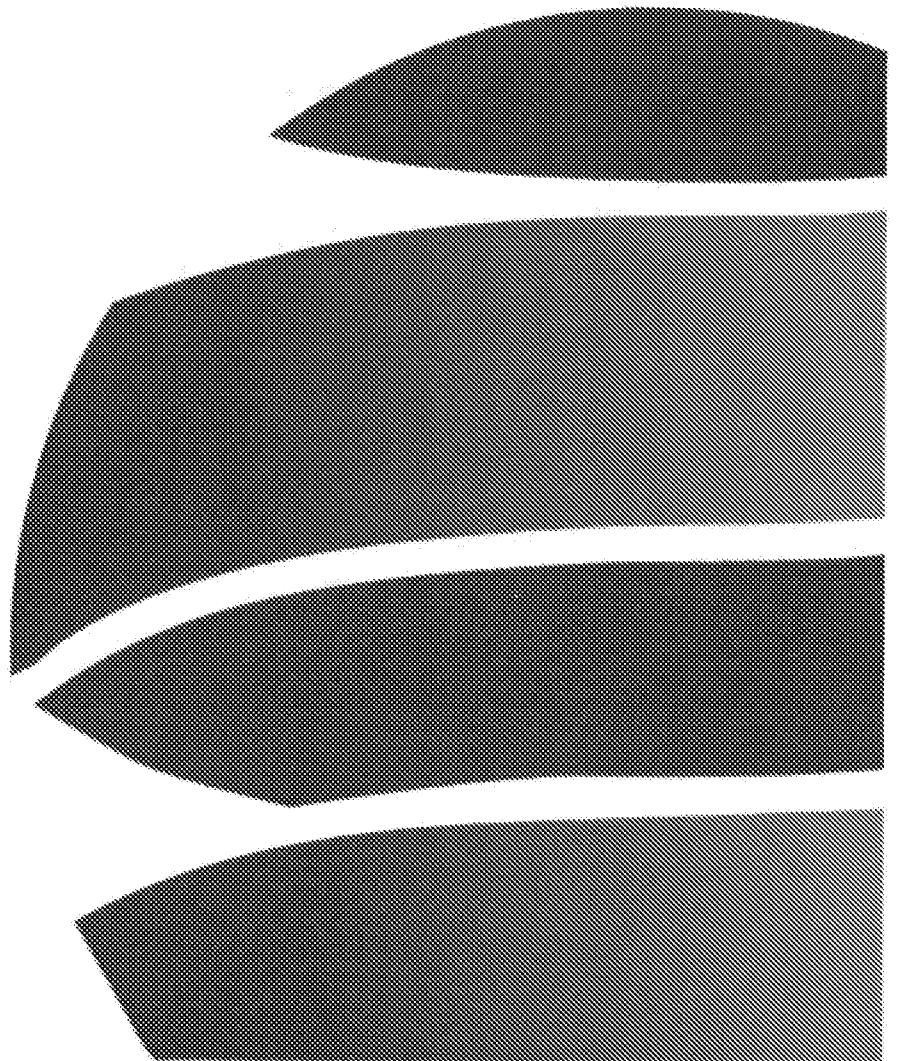


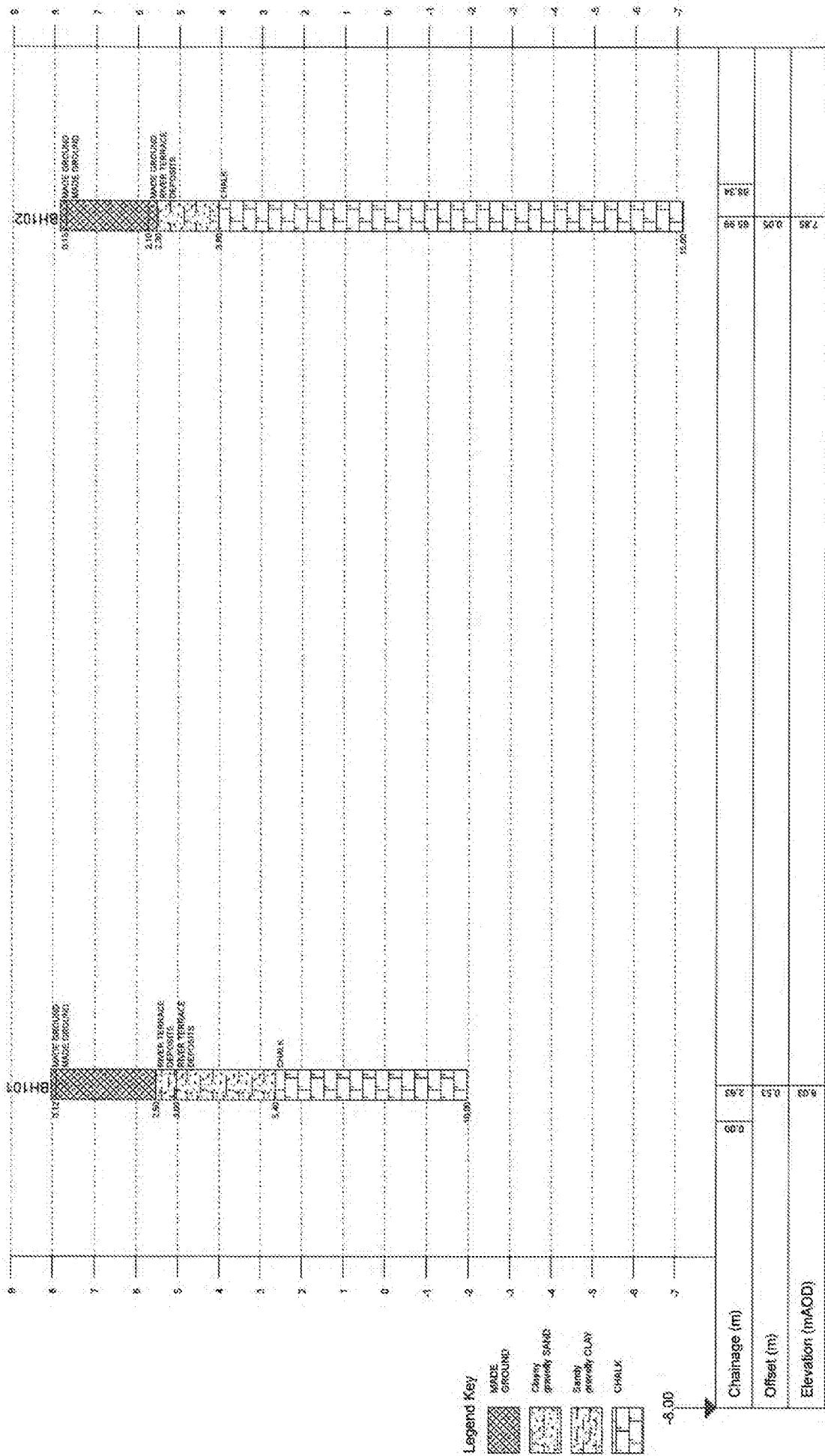


Project:	Cornfield Close, Littlehampton	Title	Proposed Development Plan
Client:	Thakeham Client	Geo-Environmental Services Ltd	
Ref No:	GE18103	Revision:	v1
Drawn:	UL	Date:	11/07/2019
Figure:	1	Scale:	Not To Scale
		Unit 7 Danworth Farm, Cuckfield Road Hurstpierpoint, West Sussex BN6 9GL +44(0)1273 832972 www.gesl.net	
		 Geo-Environmental	

APPENDIX A

Cross Sections of Site





Project Id: GE17106

Project Title: Cornfield Close, Littlehampton

Location: Littlehampton, West Sussex

Client: Thakeham Client

Title: Section line 2

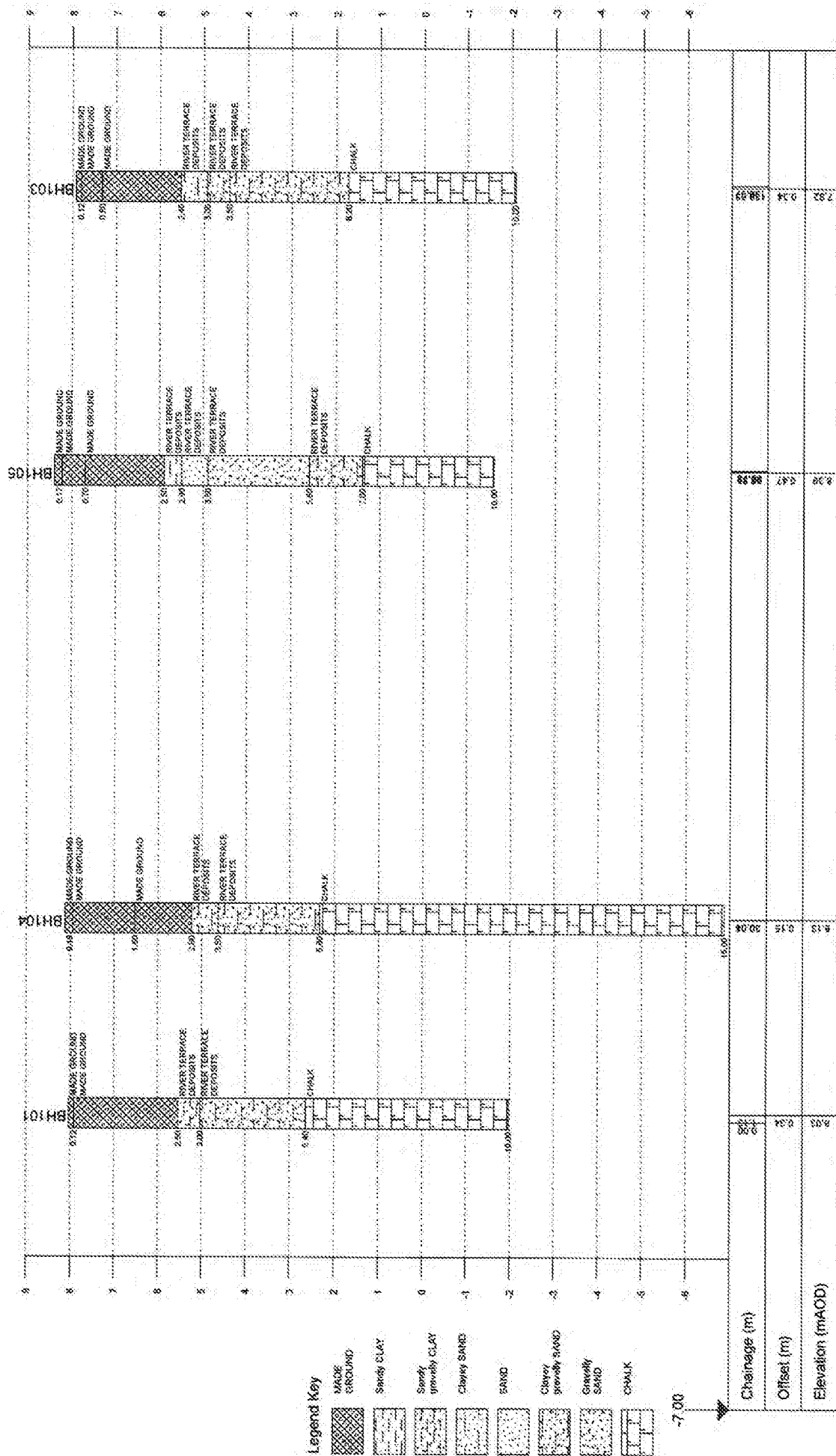
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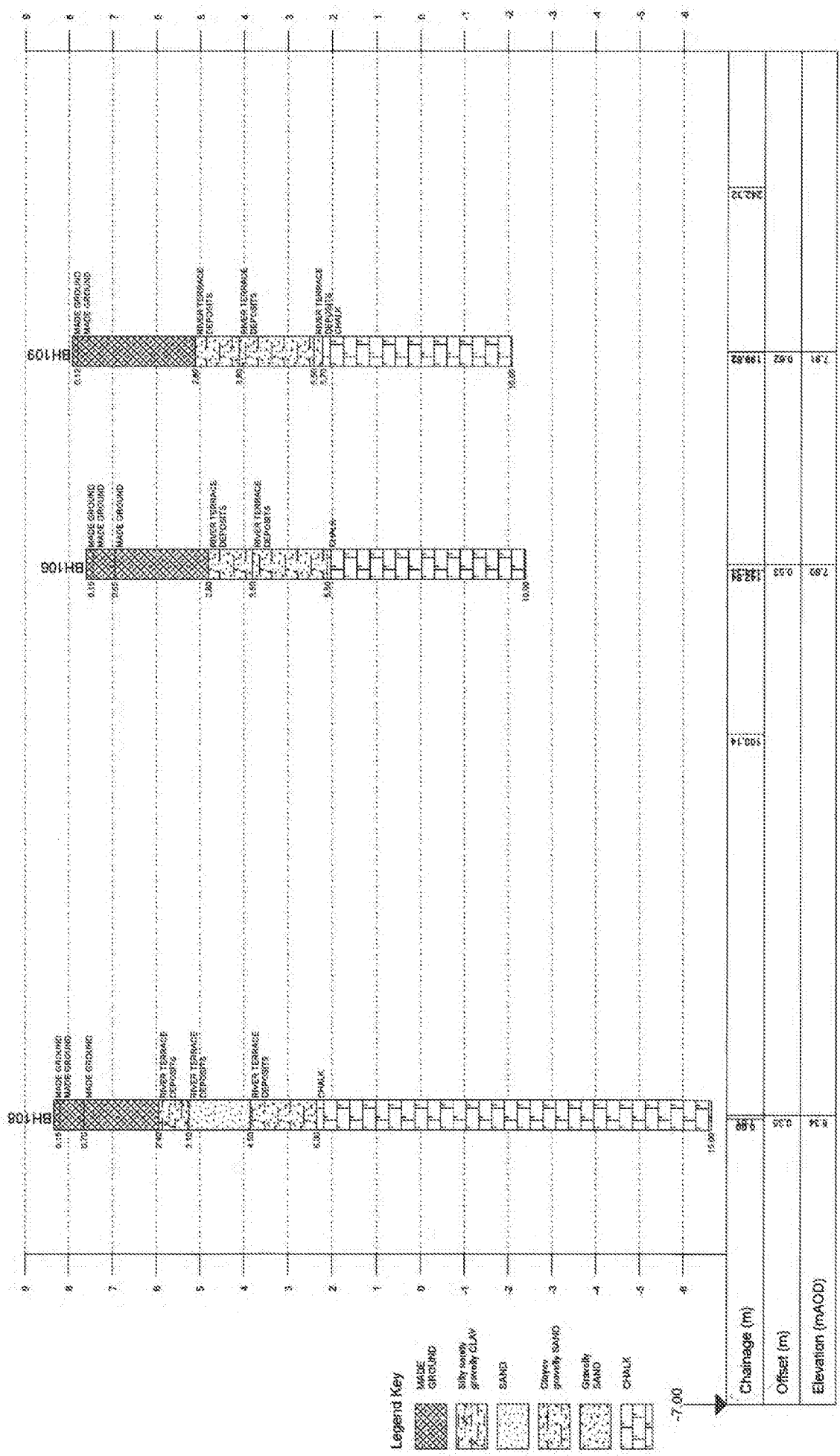
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Engineer: Anthony



Geo-Environmental





Project Id: GE17106

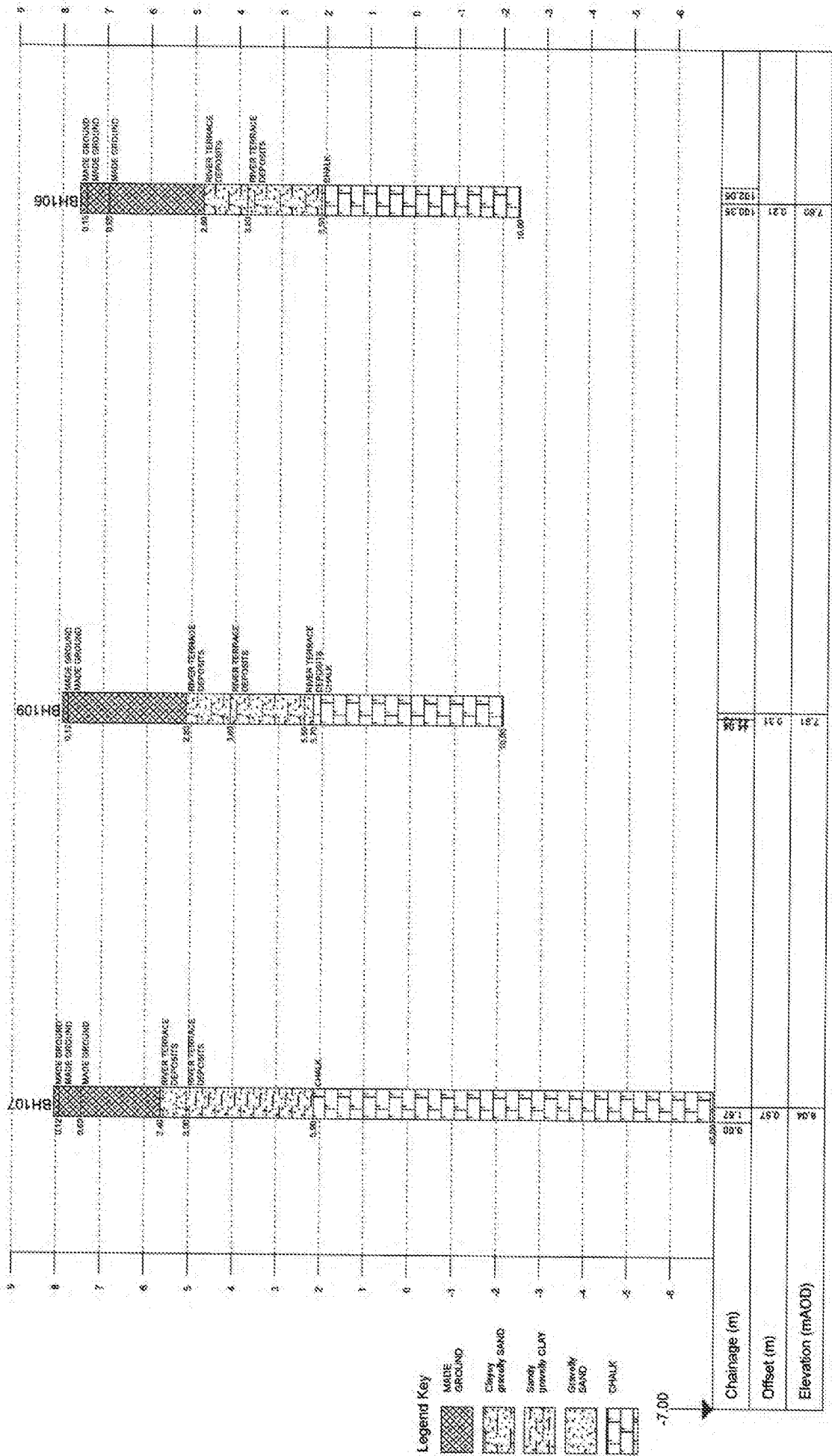
Project Title: Cornfield Close, Littlehampton
Location: Littlehampton, West Sussex

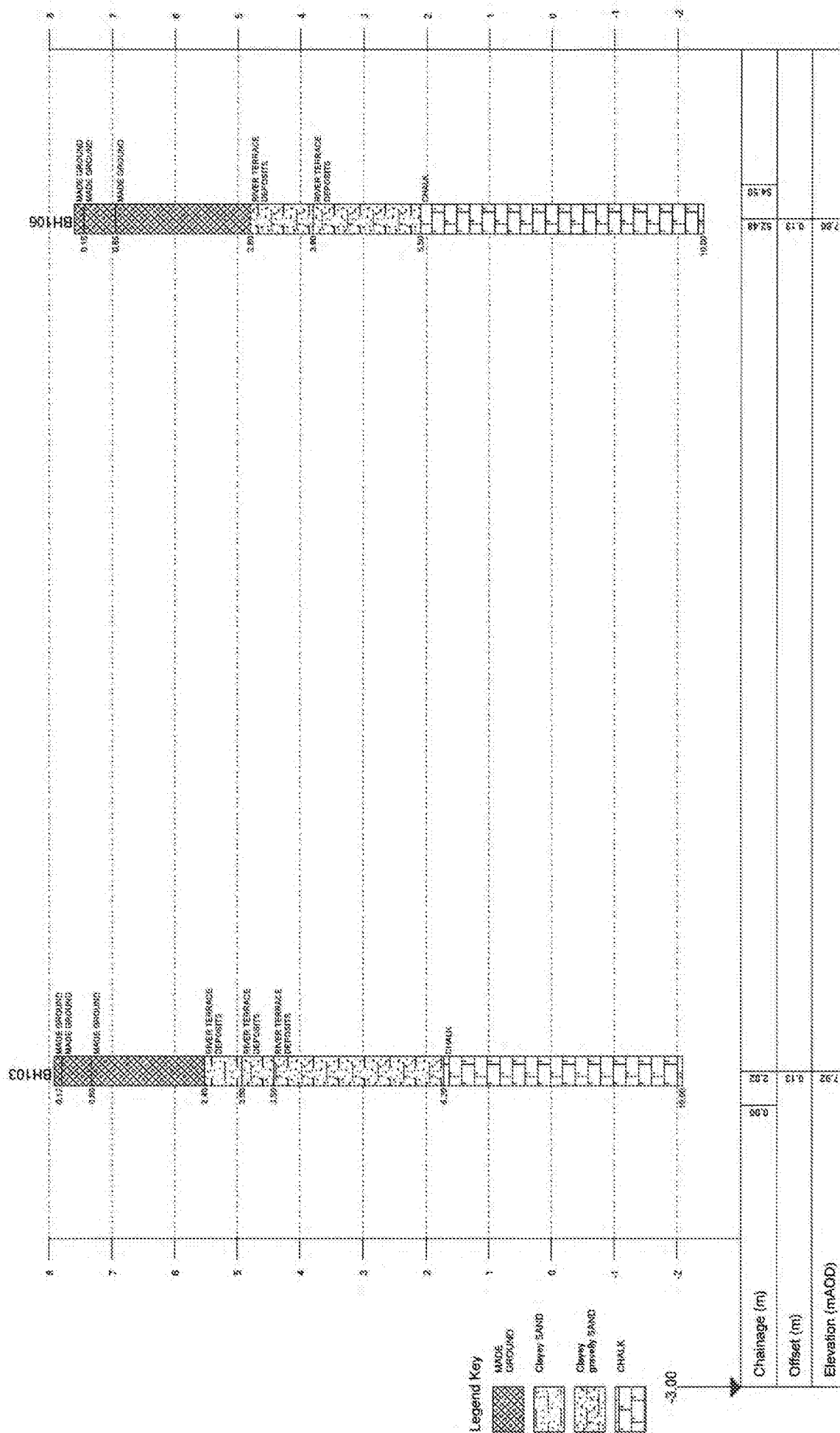
Client: Thakeham Client

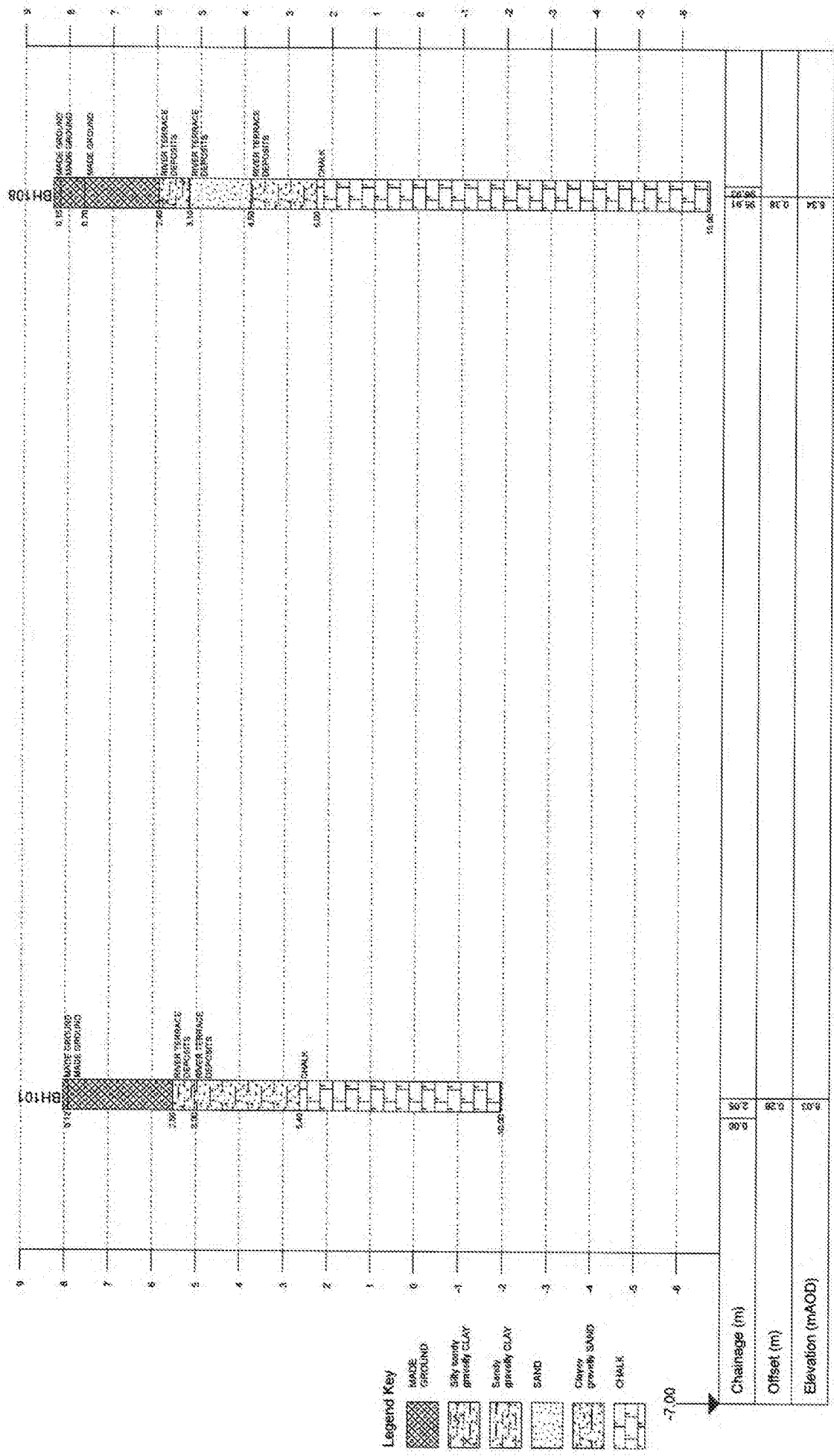
Title: Section line 3
Vertical Scale: 1:123
Horizontal Scale: 1:592
Engineer: Anthony



Geo-Environmental



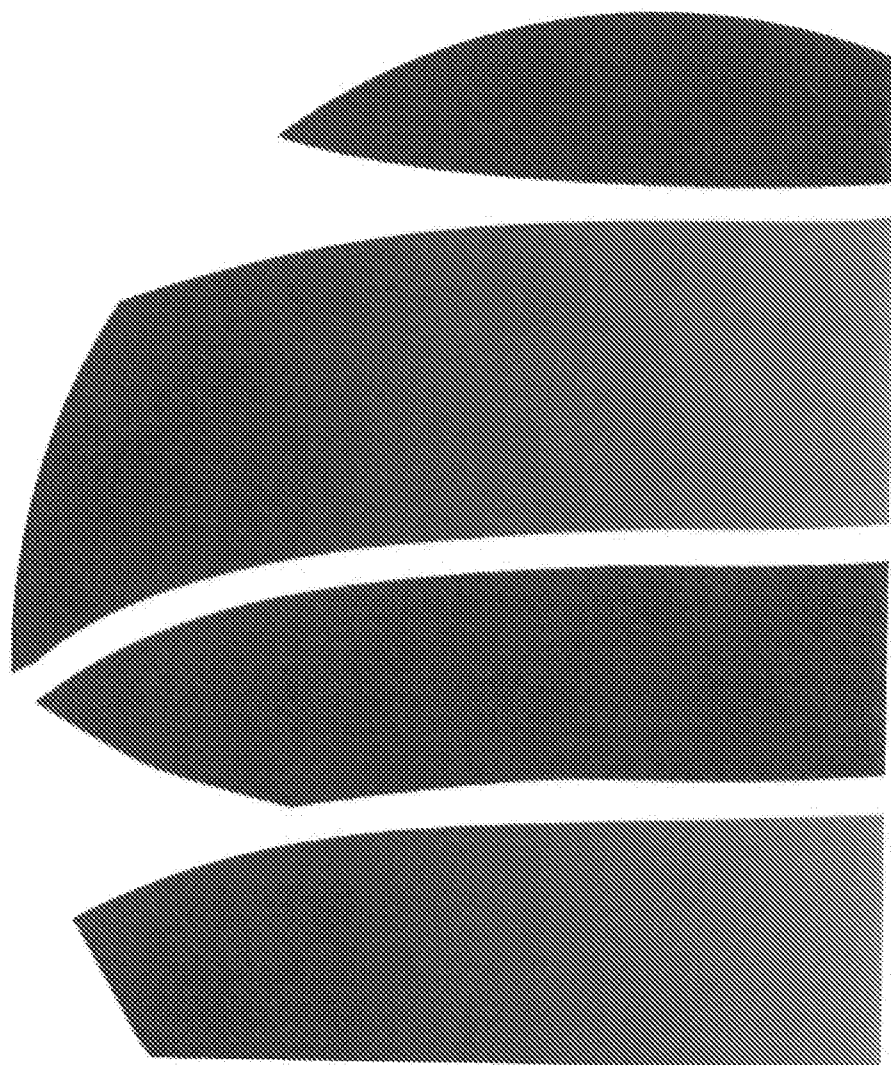






APPENDIX B

**Abbey Pynford Piling Method Statement,
ref: MS01464 Rev: 1, dated 17/06/2019**





METHOD STATEMENT MS01464 Rev: 1

Start Date 17/06/2019

CFA piling using a Hutte 204 longmast piling rig

End Date 17/08/2019

1.0-Method Statement Preparation

1.1-Completed On: 17 June 2019

1.2-Issued By: Paul March

On behalf of Abbey Pynford

1.3-Accepted By: Graham Martin

On behalf of Abbey Pynford

By signing below, I confirm I have verified and accepted the contents of this method statement and its associated risk assessments as listed in section 11 and that it is my responsibility to ensure all operatives carrying out work under my control are adequately briefed on their contents and requirements.

Signature: _____

Signature: _____

2.0-Project Details

2.1-Client Thakeham Ltd

2.2-Project Ref GA23666

2.3-Project Name Cornfield Close, Littlehampton, West Sussex, BN17 6HY

2.4-Description

Installation of CFA piles using a Hutte 204 (Long Mast) piling rig
Installation of CFA piles using a Hutte 204 (Long Mast) piling rig

2.5-Location

3.0-Persons Involved

3.1-Personnel Involved

Foreman

Site Operatives

Installation of CFA piles using a Hutte 204 (Long Mast) piling rig

Forman/Keyman

Site operatives

Hutte 204 (long Mast) piling rig-

Rig operator, Pump/Agitator operator, Spannerman, Excavator operator

3.2-Abbey Pynford Representative Paul March - 07973154927 - paulmarch@abbeypynford.co.uk

3.3-Sub-Contractor Supervisor Graham Martin - 07720998069 - grahammartin@abbeypynford.co.uk

3.4-Fire Wardens Supplied by client

3.5-First Aiders Supplied by client



4.0-Training / Competence

Training required	For the following operatives
First Aid Emergency - 1 day	One within the site crew
Manual Handling	All Operatives
SSP-SSSTS	Site Supervisor/Keyman
Working at Height Safety	All Operatives
Excavators 360 Degree below 10T	Plant Operator
Concrete Pump - Trailer Mounted	Pump Operator
Piling Rig Bored >15T	Rig Operator
AP Induction - Site Operative	All Operatives
Concrete Training	All Operatives
AP Induction - Site Specific	All Operatives
AP Induction - Site Operative Handbook	All Operatives
Noise Induced Hearing Loss	All Operatives
Piling Rig Attendant	One within the site crew or provide by PC
Dust in Construction	All Operatives
CSCS Card	All Operatives
Slips Trips and Falls	All Operatives
COSHH	All Operatives

The following list but not limited to, of TBTs have been identified as relevant to the works and tasks covered by this MS and can be used as a refresher to the hazards posed by these works. It is the supervisor/keyman's responsibility to ensure relevant TBTs are chosen and delivered to their workforce periodically.

TBT - COSHH (B17)

TBT - First Aid (B08)

TBT - Manual Handling (B19)

TBT - Slips, Trips and Falls (Housekeeping) (C04)

TBT - Abrasive Wheels (C11)

TBT - Lifting Operations (C19)

TBT - Plant and Equipment (C10)

TBT - Mobile Plant (C18)

TBT - Site transport and pedestrian segregation (C17)

TBT - Piling (F01)

TBT - Personal Protective Equipment (B09)

TBT - Accident and incident reporting (A13)

TBT AP Environment-Spillage Response Procedure (AP E02)

TBT AP Environment-Noise Pollution (AP E03)



TBT - Dust & Fumes (B12)
TBT - Underground Services (D11)
TBT - Lifting Equipment and Accessories (C20)
TBT - Petrol and Diesel (C07)
TBT - Emergency Spill Control (E03)
TBT - Cement, Concrete and Plaster (E04)
TBT - Pumping, Over-Pumping and Washing Down Plant (E05)
TBT - Silica Dust (B14)
TBT - Diamond Blades (C12)
TBT - Checks and Inspections (A12)
TBT - Noise (B15)
TBT - Working at Height (D01)
TRA 062 - Use of Excavator for lifting Operations

5.0-Plant, Tools and Materials

5.1-Plant, Tools and Materials

Installation of CFA piles using a Hutte 204 (Long Mast) piling rig

Plant and Equipment-

Hutte 204 (long Mast) piling rig / Static Concrete pump / Agitator / Compressor / Diesel Bowser / Mini Excavator

Materials-

Concrete, Reinforcement

5.2-Other Equipment

6.0-Operations and Hazards

6.1-Hazards identified

Installation of CFA piles using a Hutte 204 (Long Mast) piling rig

Hutte 204 (Long Mast) piling rig-

- Plant Overturning
- Contact with services
- Slips, trips and falls
- Cement burns
- Noise
- Manual handling
- COSHH

6.2-Means of Access/Egress

Via the main entrance



6.3-Asbestos

6.4-Sequence of Operations

Installation of CFA piles using a Hutte 204 (Long Mast) piling rig

SETTING OUT REQUIREMENTS

The Principal Contractor is to provide AP with a minimum of three base control stations and their co-ordinates to aid with setting out. These three base stations must be within the site boundary.

WELFARE FACILITIES

These are to be provided by Principal Contractor and are to be in line with the CDM Regulations (2015); it is anticipated that Abbey Pynford will have 4-6 No personnel on site at all times.

The requirements include:

- * Washing facilities, including hot and cold running water, soap and drying facilities.
- * Toilet facilities regularly cleaned and serviced.
- * Drinking Water and drinking vessels.
- * Suitable clothes changing and overnight drying facilities, including lockers for security.
- * Messing area. (Food preparation and heating and means for boiling water).

The CDM Regulations make the specific point that full welfare facilities are to be available prior to bringing subcontractors to site. No exemptions are available for small sites. If the supplied Welfare is deemed unacceptable the Abbey Pynford Foreman can cease piling operations until suitable Welfare has been provided.

Before any piling operations commence, the piling foreman is to:-

- a) Review the site specific risk assessment, noting any special requirements and ensure that all piling operatives have received the necessary training to carry out their work.
- b) Brief the piling operatives on the site health and safety requirements and check that they have all of the necessary PPE.
- c) Check that Principal Contractor are displaying all of the relevant HSE statutory notices.
- d) Carry out daily checks of all piling equipment and complete both the "Record of Inspections LOLER" and "Record of Inspections PUWER" books / SCL Forms on a weekly basis.
- e) Ensure the weekly workplace inspection and safety harness inspection forms are up to date.
- f) Check that the piling rig has been thoroughly inspected and certificated within the last 12 months and that the lifting equipment and fall arrest device have been thoroughly inspected and certificated within the last 6 months.
- g) Principal Contractor will carry out a Site Induction on arrival prior to any works taking place.
- h) Ensure the following documents are in place:
 - * Platform Certificate
 - * Permit to Work
 - * Approved Method Statement
 - * Permit to Dig (Provided by Abbey Pynford) with completed service checks.

Please Note- The Contract Manager is to ensure that all of above are completed to their satisfaction before piling operations commence.

Setting Out

The Pile positions are to be set out during the Piling by an Abbey Pynford Setting out Engineer. The setting out engineer is not to work in areas where piling operations are ongoing. The setting out engineer must also be included in the Abbey Pynford site safety induction if he is present on site. Engineer sets up total station (with reference to the base stations/site control) and by use of the 'stake out' mode on the total station commence setting out. With the engineer working at the 'prism end' the pile position is located to within 20mm accuracy. Setting out pin is driven into the ground. Pin position is recorded on the total station. Pile number is clearly written on plastic safety cap which is placed on the setting out pin.

Buried Services



The Principal Contractor are to notify Abbey Pynford of all known services and to accurately mark these if they fall within 1.0m of any pile position. All redundant services are to be physically disconnected and capped off by Principal Contractor at the site boundary. Abbey Pynford are to visually check all piling areas and confirm any changes or additions to the SSOW and highlight there on the PERMIT TO WORK.

Refuelling of Plant and Equipment

Fuel Storage and delivery

Prior accepting the delivery of any fuel on site ensure that container has the appropriate COSHH Signage Ensure that the following are undertaken at all times:

- * Correct manual handling techniques are followed when moving the fuel containers.
- * Fuel must be stored at a specified location on a fuel drip tray at all times.
- * The fuel storage location is not close to any emergency exits.
- * An appropriate fire extinguisher as per the site specific fire emergency plan is stored next to the fuel storage at all times.
- * No hot works operations are undertaken in proximity of the fuel storage area.
- * A spill kit is available next to the fuel storage area

Refuelling Operations

- * Plant and vehicles must have the engine stopped during refuelling operations
- * When refuelling plant and equipment ensure that the fuel pump is appropriately placed to the fuel container.
- * After finishing the refuelling operations ensure that the fuel pump is removed and the fuel cap is replaced.
- * At the end of a working day ENSURE that the fuel cap is tightened with a tool so it cannot be undone by hand.

Sequencing

- * Works to be sequenced so that site traffic does not cross the concrete hose. A crossover point can be prepared (if required) by either burying the hose or by the use of half sleepers on each side of the hose at the dedicated crossing point, thus minimising damage to concrete delivery hoses.

Trimming of piles to cut off level should be left a minimum of 7days from casting; this may be reduced subject to cube results. It should be noted that cutting down of the piles is at the discretion of the P/C.

Installation of CFA piles using a Hutte 204 (Long Mast) piling rig-

- * Check competency tickets of attendant excavator driver. The driver cannot work in attendance if competency cannot be proved.
 - * Take delivery of the agitator and pump and set up in the agreed location. Take delivery of bunded diesel bowser and storage container and locate in designated area.
 - * Take delivery of piling rig, augers and ancillary items and set about commissioning the rig as follows: hoses are connected from the concrete pump to the rear of the piling rig using the integrated clips provided with the addition of whip checks; the rigs mast is raised to the vertical position. Lift the lead section of auger into position with the rig winch and connect to the drive sub on the rig using the auger pins. Drill into the ground. Disconnect and side shift the drill head. Lift the next auger section into position on the installed lead. Reposition the drive head, connect using pins and drill into the ground.
 - * Repeat this process to complete the standard auger string of 10.5m.
 - * Set out for the piles and ensure pile layout drawing; schedule and SI borehole logs are available for reference.
 - * Perform standard rig checks on fuel; lubricants; hydraulics; etc. and complete rig check form.
 - * Track the rig to the first pile position banked all the while by the banksman.
 - * Set up over pile with rig being banked into position by banksman. Drill to maximum single flight depth using CFA augers (i.e. 10.5m).
- For piles over 10.5m depth, knock out connecting pins, raise drill head and side shift clear of the auger and raise vertically by 2 m.
- * Using integral winch rope, sling next 2 m auger section and raise into position, connect using pins. Side shift drill



head back and lower on to add-on auger section and connect using pins. Drilldown additional 2 m and repeat process for adding on sections.

- * Ensure spoil is cleared using attendant excavator as the drilling proceeds. Check that first pile bore coincides with SI borehole info provided, notify contracts manager of any deviation.
- * Once target depth is reached, signal to pump operator to start pumping whereupon the pump pressure forces out auger bung from lead auger.
- * The augers are then retracted in 2 m increments with concrete halted temporarily as the added-on sections are removed in reverse order to which they were installed and stacked to one side.
- * When final 10.5m of auger depth is reached, concrete pumping can be completed continuously as the flight is withdrawn to pile mat level.
- * The rig is banked off the pile position to the next position.
- * The top of the pile is checked and any foreign matter removed from the concrete. The reinforcement is then lowered into the concrete and rebar protection caps placed atop. A cardboard sleeve is then placed in position and topped up to level (approx 150 mm above mat level for non voided slabs, 400mm for voided slabs).
- * The process is repeated for subsequent piles.
- * Once piling is completed, ensure excavator and operator in attendance clear and clean the concrete surface in preparation for following trades.
- * Ensure that rebar caps are fitted to all protruding bars.
- * All plant is cleaned and made ready for collection; Trucks collecting plant are banked onto site, loaded securely and the site cleared of all plant.
- * Site supervisor to ensure that PC project manager has signed all daily work sheets and pile logs. Ensure site works and cleanliness is to the satisfaction of the PC Site/Project manager.

Flash Set

In the unlikely event of a flash set the below process must be followed-

- * Split land line and remove pipe work from rig
- * Sections of flexible concrete hose to be held vertically with the excavator (ideally with a closed link collar chain) to allow gravity to clear the blockage; the hose may be agitated by either small oscillations from the excavator arm or by striking the hose coupling.
- * Flexible hose sections that cannot be cleared will be moved to one side for disposal/jetting at Abbey Pynford depot.
- * Steel sections of pipework on the rig will be 'rodded' to try to remove the blockage, if this is not possible they will be removed from the rig (replaced) and returned to Abbey Pynford depot for jetting.

Cleaning out of hoses

Where to blow out

- * The piling rig should be positioned in a suitable location facing away from the site boundary; walkways; site entrance; cabins; site huts; other plant. Where possible a suitable designated blow-out area is to be agreed on site.
- * If the only option is to blow out facing the site hoarding then the rig is to be positioned as far away as possible and the foreman is to ensure that the site boundary access is suitably protected (i.e. not heras fencing)
- * The rig foreman or supervisor is to contact the site manager to ensure that site access and site boundaries are suitably protected and to ensure a safe work area is provided.

Preparation prior to blowing out

- * Upon completion of the last pile of the day shift, any excess concrete held in the agitator concrete lorry will be pumped through to the piling rig.
- * The pump operator will then back pump the final hopper full of concrete to relieve pressure in the concrete hose.



- A wet sponge blow out ball will be placed into the concrete hose at the pump which has just been disconnected.
- A blow out cannon is then connected to the hose and then in turn connected to the compressor.
- The rig is tracked up to a heap of spoil ensuring that the auger is surrounded by sufficient spoil to ensure that the cementitious materials expelled when the sponge ball exits the auger during the blowing out is contained and does not eject from the spoil heap.

Please Note: A blow out shield / box may be utilised if the above is deemed unsafe).

When blowing out

- The foreman / banksman is to be located at the piling rig. The pump operator is to be located at the compressor next to the blow out cannon.
- A clear line of sight is required and must be maintained for communication between the pump operator and the site personnel attending the rig.
- The compressor is to be started and the air is gradually released to the blow out cannon. The blow out cannon valve is then released to move the concrete along the concrete hose
- The air pressure is to be controlled by the pump operator to allow the sponge ball to exit the auger tip in a controlled way.
- The concrete hose is to be monitored by the banksman / foreman and when the concrete has passed through the last hose in the line, the foreman / banksman will signal the pump operator to turn off the air supply to the blow out cannon.
- When the piling rig drop hose lifts and moves, the foreman is to signal the pump operator at the compressor and blow out cannon to release the remaining air in the concrete hose through the blow out cannon release valve, maintaining enough pressure to allow the sponge ball to pass through the auger and exit the tip. Any splashing / debris will be contained by the spoil / blow out shield.
- The concrete hoses and augers will now be empty of concrete.
- The foreman / banksman will communicate to the pump operator that the blowing out procedure is complete.

Once blowing out is complete

- The blow out cannon is to be disconnected from the concrete hose. Banksman
- Two or three buckets of water are to be poured into the open end of the concrete hose followed by a wet sponge ball.
- Repeat the above points if necessary .
- Disconnect the blow out cannon from the concrete hose
- Unpin and remove the blow out shield (if used) from the front of the auger, remove the tarpaulin and retrieve the sponge blow out balls.
- Wash down all equipment.

Housekeeping

- At the end of each shift site will be tidied.
- All excess materials will be loaded to vehicles.
- All waste will be bagged and loaded to vehicles to be recycled or disposed of in waste skip in the compound (supplied by the Principal Contractor).
- All excavations/unfinished areas will be fenced off
- Keyman/Supervisor will ensure that site is tidy and safe prior to leaving site.
- On completion of the project keyman/Supervisor will ensure that all equipment and waste is removed from site.

As-Built Records

- The as-built location of the pile is carried out directly after the piles have been installed. This is done by one of two methods-



1) either by a 'six point circumference'

Or

2) a template to record the centre of the pile.

- * It is important that the platform level is recorded at the time of the pile as built to ensure that the platform is not deteriorating through excessive scraping of pile arising from the head of the pile. If the as-built shows a pile to be out of tolerance (75mm in plan) or the platform level is more than 50mm low Abbey Pynford foreman must be informed.

- * If pile as-built is more than 75mm out of position, Abbey Pynford foreman is to contact head office as soon as possible to ensure that pile is suitable for inclusion into permanent works.

All 'as-built' pin and pile positions (including height) are to be e-mailed to Abbey Pynford on a weekly basis at minimum. Note that final as-built is ideally required prior to rig leaving site

Installation Records

Piling logs will be completed on a daily bases as piling progresses. All logs will be sent into the office at the end of the week by the keyman.

Change to planned Methodology or Tasks

- * If subsequent to acceptance approval of this Method Statement, any change to the planned methodology or task needs to be implemented then this must be discussed and agreed with the Client and AP Contracts Manager.
- * Where changes are required at short notice, the proposed change must be approved by the AP Keyman/Site Supervisor and the AP Contracts Manager. Once the change is approved the relevant briefing must be given to the team highlighting new risks and the necessary control measures. This will be documented and the client notified at the earliest opportunity.

Pile Testing Requirements-

Pile Load testing

Not Applicable unless specified by the design. If necessary the contract Manager will arrange and inform the PDR site management when this is scheduled to happen

Integrity Testing

It is normal practice to carry out a test on the integrity of the piles after they have been trimmed to cut-off level. To enable this test to be carried out, PC needs to note the below points-

- The pile need to be trimmed down to cut-off level.
- A safe access needs to be provided for the test technician to gain access to the head of each pile.
- The pile cap/ground beam excavations must be clear of any standing water.
- The pile cap or ground beam reinforcement must not be in place.
- Although a thin layer of blinding can be in place around the pile, it must neither cover the pile nor be greater than 75mm thick.

Relevant Method Statements and Risk Assessments shall be issued prior to the first visit; it is the responsibility of Principal Contractor to ensure that technician is inducted prior to allowing works to commence.

Please Note: Integrity testing of wall piles is not required.

7.0-Support and Lifting Equipment

8.0-Protective Measures

8.1-PPE required



Hard Hat

High visibility vest

Safety boots

plus:

Installation of CFA piles using a Hütte 204 (Long Mast) piling rig

Ear defenders

Safety glasses / goggles

Safety gloves

8.2-Fall protection measures

8.3-Other protection

9.0-Emergency

9.1-Fire system

Principal Contractor will provide a fire emergency system for the site.

9.2-First Aid system

Location of nearest hospital available on site.

Minimum of one day first aider on site at all times.

First aiders identified.

First aid stations available in welfare unit.

9.3-Nearest Hospital

10.0-Other Information



11.0-Attached Assessments

The list below identifies all task risk assessments (TRA), manual handling assessments (MH) and COSHH assessments relevant to the tasks required to complete the job identified by this method statement. You are required to understand and comply with every assessment. You must bring to the attention of your supervisor or line manager if any of the identified assessments is not attached to this method statement.

<u>Task Risk Assessments</u>		Residual Risk
TRA 003	5 Abrasive wheels	
TRA 006	8 Excavations	
TRA 010	9 Dumper	
TRA 013	7 Midi Piling Rig Operations	
TRA 019	4 Use of Hand Tools (non-powered)	
TRA 020	7 Use of Power Tools (Pneumatic, fuel, electric, cartridge operated)	
TRA 021	5 Concrete pumps - Stationary	
TRA 028	3 Pressure Washer	
TRA 034	3 P11 Grout Pump	
TRA 038	6 Refuelling Plant and Equipment	
TRA 040	5 Loading and unloading vehicles	
TRA 041	2 Cleaning up chemical spillages	
TRA 047	1 Concrete Agitator - Operation	
TRA 055	1 Concrete pumps - Mobile and truck mounted.	
TRA 057	1 Fork Lift Trucks and Telehandlers	
TRA 062	3 Use of Excavator for lifting Operations inc Pick and Carry	
TRA 063	5 Excavators and backhoe loaders	
TRA 078	1 Concrete Agitator - Cleaning	
<u>Manual Handling Assessments</u>		
MH 003	3 Auger, Casing and cages Handling	
MH 007	3 Concrete hoses	
MH 011	3 Tool boxes empty	
MH 014	3 Generic loads	
<u>COSHH Assessments</u>		
COSHH 004	2 Unleaded Petrol	
COSHH 007	2 Diesel Fuel Oil	
COSHH 008	2 Portland Cement and Ferrocrete	
COSHH 010	2 Ready Mixed Concrete	
COSHH 014	2 WD40	
COSHH 032	1 Concrete Pump Primer	
COSHH 038	1 Sprayline Paint	
COSHH 039	1 Kilfroast	



12.0-Sign Off

This section confirms you have been briefed, read and understood the requirements of this method statement and all identified task risk assessments (TRA), manual handling assessments (MH) and COSHH assessments.

I confirm I have read the above detailed method statement including the attached assessments and understand and accept the conditions detailed therein to carry out the work safely.

The person briefing this method statement must sign section 13 and then next to each operative they have briefed

Date	Print Name	Signature	Briefed by (Signature)

13.0-Site Manager / Supervisors / Keymen briefing this assessment

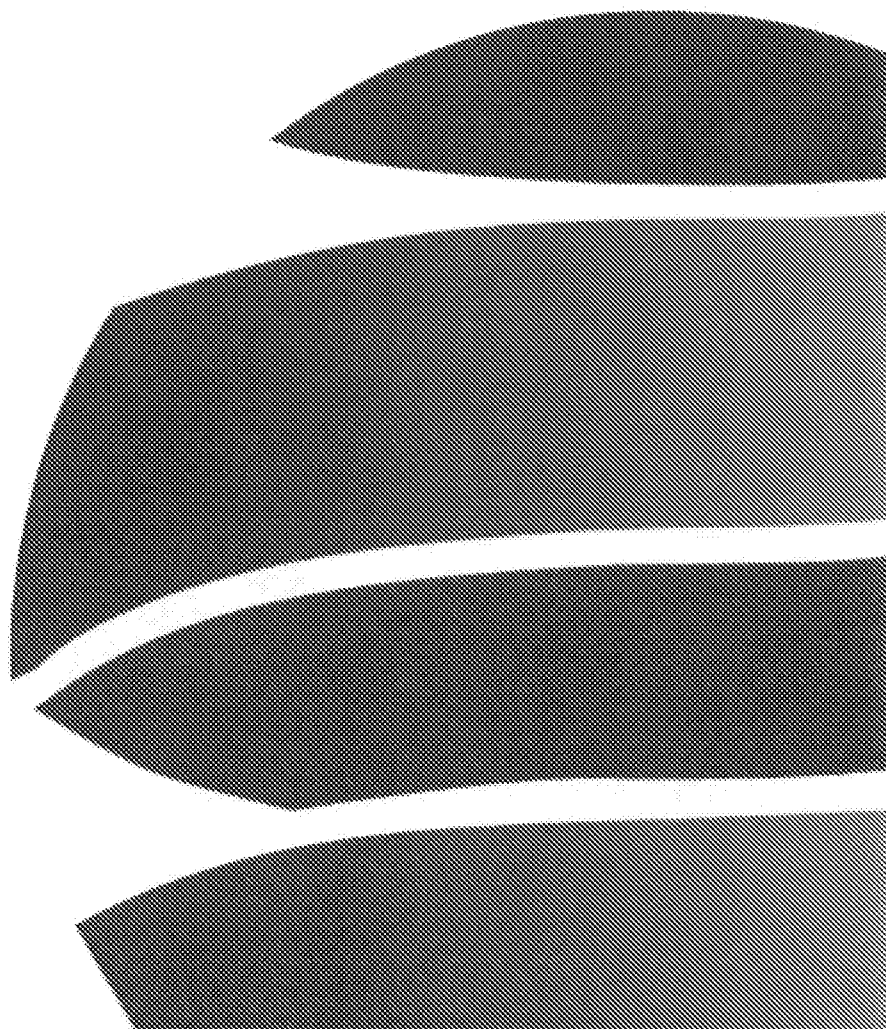
I, the undersigned, confirm the above countersigned operatives have been briefed on the requirements of this method statement and its associated risk assessments as listed in section 11.

Date	Print Name	Signature



APPENDIX E

Updated RSVP dated November 2019





Geo-Environmental

REMEDIATION STRATEGY & VERIFICATION PLAN

for the land at

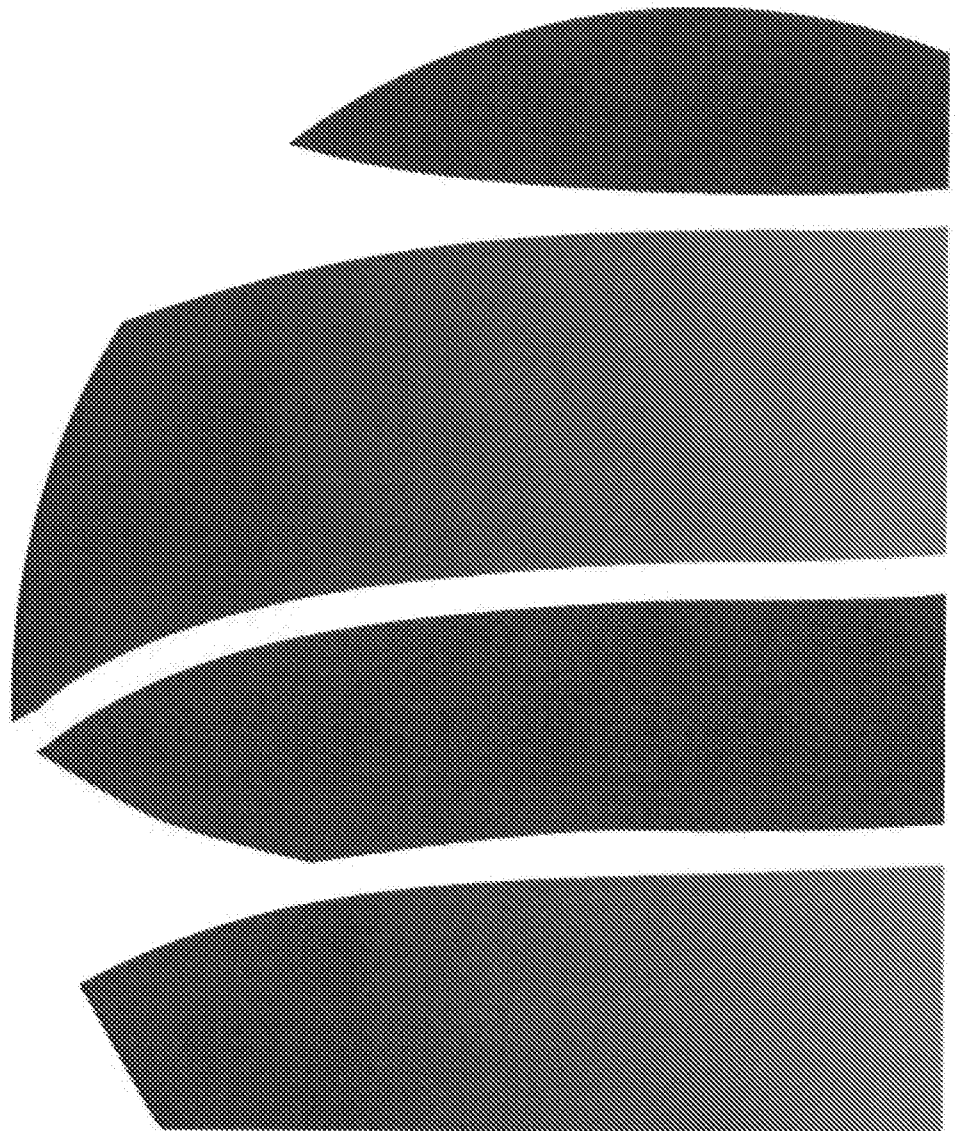
FORMER DAISYFIELDS CARAVAN PARK

CORNFIELD CLOSE, LITTLEHAMPTON

WEST SUSSEX, BN17 6LD

on behalf of

THAKEHAM CLIENT LIMITED





Report:	REMEDICATION STRATEGY & VERIFICATION PLAN
Site:	FORMER DAISYFIELDS CARAVAN PARK, CORNFIELD CLOSE, LITTLEHAMPTON, WEST SUSSEX, BN17 6LD
Client:	THAKEHAM CLIENT LIMITED
Date:	15/11/2019
Reference:	GE17106-RSVPv1.2-GE-NOV19
Version:	1.2
Prepared by:	 GLYN EVANS BSc, MSc, FGS, MIEEnvSc MANAGING DIRECTOR
Reviewed by:	 LAURA LEGATE CGeol, CSci, BSc (Hons) MSc, FGS REGIONAL MANGER - WEST

Geo-Environmental Services Limited

Unit 7, Danworth Farm, Cuckfield Road, Hurstpierpoint, West Sussex, BN6 9GL

AMENDMENT RECORD

Revision ref.	Date	Reasons for amendment	Author's Initials
1.0	28/11/2018	First issue	GE
1.1	06/12/2018	Updated to incorporate floor construction options	AP
1.2	15/11/2019	Updated details for capping system to clarify discrepancies noted between text and figures and to clarify variation in capping between areas of private gardens and communal open space/public open space.	LL

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FIGURES

FIGURE 1	Site Location Plan
FIGURE 2	Exploratory Hole Location Plan

APPENDICES

APPENDIX A	Exploratory Hole Logs and Cross Sections
APPENDIX B	Soil Import Criteria



1.0 INTRODUCTION

1.1 General

Following a Phase I and Phase II assessment of the site, detailed within reports listed below, Geo-Environmental was appointed by Thakeham Client Limited, to formulate a Remediation Strategy in relation to the proposed development at Former Daisyfields Caravan Park, Cornfield Close, Littlehampton, herein referred to as 'the site' (Figures 1 and 2).

Geo-Environmental was commissioned in November and December 2017 to undertake a standalone desk study (ref: GE16903-DSR-DEC17) and subsequent baseline ground investigation (ref: GE16903BGIR-JAN18) for the above mentioned site. An additional final phase of intrusive investigation was also commissioned in 2018 (ref GE17106 - GAR/AP01/231018) to support development of both the construction and remedial strategy and the findings are incorporated herein.

The remedial strategy presented herein has been developed to reflect the findings from all phases of the assessments undertaken on this site. Based on the findings of the investigations it is considered that remediation works would be required with respect to soil and ground gas contamination identified within the Made Ground.

1.2 Objectives

The Remediation Strategy & Verification Plan (RSVP) sets out the proposed remedial works to be undertaken on the subject site to support its development for a proposed residential end use with both private gardens and public open spaces.

2.0 BACKGROUND

This Remediation Strategy & Verification Plan (RSVP) has been developed from the findings of the various phases of assessment.

A brief overview of salient findings of the reports is presented below. For further information, the individual reports should be referred to directly.

2.1 Overview

The site comprised a generally flat and level grass covered former caravan and camp site. Through the process of completing the desk study and intrusive investigation, it was discovered that the majority of the site comprised an infilled former brick quarry.

In general, the ground conditions encountered can be summarised as follows:

Beneath the turf, hardstanding or capping material Made Ground comprising landfilled material was encountered within all locations to depths of between 1.70m and 2.90m bgl and was of a mixed composition comprising sandy clay and silty sand with brick, glass, plastics, metal, china, ash, coal, concrete, black organic matter, shoes, fabric, timber, and flint gravel.

Underlying the Made Ground, River Terrace Deposits were encountered within all locations with the exception of TP207 to depths of between 2.0m and 7.0m bgl and generally comprised medium dense orange brown sandy clay becoming orange brown sand with flint gravel with slight traces of chalk at depth. Organic malodours were noted within BH105 only, at a depth of between 6.50m and 7.00m bgl. TP207 was advanced within the Made Ground only and was terminated prematurely at a depth of 2.2mbgl.

Underlying the River Terrace Deposits, the Lewes Nodular Chalk was encountered within the cable percussion boreholes to depths of between 10.00m and 15.00m bgl (maximum depth of the investigation) and was generally recovered as structureless CHALK composed of sub-angular to rounded gravel. Clasts are weak, medium, high and very high density, off-white within an off-white matrix. For further details of the ground conditions encountered, reference should be made to the information presented in Appendix A, which includes four sections across the site.

2.2 Proposed Site Use

The proposed development is to consist of 77 residential units with private gardens, soft landscaping, amenity space, parking, roadways and associated infrastructure.

2.3 Conceptual Site model

Assessment of the investigation findings have identified particular hazards, or potential hazards which were considered to require intervention (remediation) to mitigate the risk of harm. Remediation works are proposed to break the identified plausible pollutant linkages associated with ground gases and in respect to soil contamination.

This would be undertaken as several phases of works on site:

- 1) Installation of a soil cover system in private garden areas and areas of soft landscaping to break the pollutant linkage for the contaminants identified within the Made Ground soils and to also provide



suitable growing media. The cover system shall incorporate a 150mm thick break layer formed of stone or crushed concrete with a geotextile membrane laid above and beneath, and overlain by a deterrent to dig geofabric to act as a visible deterrent overlain by a minimum 350mm thickness of subsoil and a minimum of 150mm of Topsoil within areas of private gardens and 300mm of Subsoil and 150mm of Topsoil within areas of communal landscaping and public open space.

- 2) It may be possible to re-use the impacted Made Ground on site where deemed suitable (geotechnically and geochemically without treatment) beneath proposed building footprints and areas of hardstanding in line with a Materials Management Plan (MMP), subject to the appropriate documentation, Definition of Waste Code of Practice (DoWCoP) assessment, Qualified Person (QP as defined in DoWCoP) declaration and agreement of the Regulators.
- 3) Installation of gas protection measures, within proposed properties in line with a CIRIA/BS8485 CS2 classification, to protect against elevated concentrations of methane and carbon dioxide identified.

The aim of the remediation is not to remove all contamination identified on site but to reduce the identified risk to an acceptable level with respect to human health, the built environment and controlled waters.

3.0 GROUND GAS

The ground investigation works identified the presence of a thickness of Made Ground/infilled ground on the site associated with the former landfill identified on the site. The Made Ground within the former landfilled area was found to comprise a thin capping layer of clayey sandy silt and silty sandy clay with brick and concrete fragments, with a mixture of brick, glass, plastics, metal, china, ash, coal, concrete, black organic matter, shoes, fabric, timber, and flint gravel below. This fill material was encountered to depths of between 1.70m and 2.90m bgl. Information reviewed as part of the desk study indicated that the waste body did not benefit from any in-ground engineering or barriers and thus would presumably be a 'dilute and disperse' type body.

As such a period of gas monitoring was recommended, this was to comprise a combination of continuous and 'spot' ground gas monitoring. As part of the intrusive investigation works completed by Geo-Environmental, standpipes were installed on site and ground gas monitoring was undertaken to assess the potential risk posed to end users of the proposed development.

Spot Monitoring

The spot monitoring undertaken to date has detected methane at concentrations in the range 0-8.5%, carbon dioxide in the range 0-19.4%, and oxygen in the range 0-19.4%. VOCs have been detected up to 3.2ppm. Borehole gas flow was detected within two of the monitoring standpipes, BH101d and BH102s and ranged from 0.9 to 3.0l/hr. Atmospheric pressure was recorded as being between 1014-1017mb during the visit undertaken to date.

Continuous Monitoring

Continuous ground gas monitoring was undertaken within ten gas monitoring standpipes, BH101 through to BH110, for a period of 3 weeks from 26th September 2018 to 17th October 2018, with the locations being sited within the former landfill area. This monitoring was undertaken during the winter months to try and target periods of low and/or falling pressures to target a worst case scenario. The continuous ground gas monitors utilised were Ambisense monitors which provided continuous data relating to both gas concentration and gas flow rates.

Ambisense continuous ground gas monitors were installed within boreholes, BH101-BH110 on the 26th September 2018, to provide coverage of the landfill gas source as well as to target likely gas migration pathways. The location of these continuous monitoring points are shown in Figure 2. The continuous monitors were set up to record gas concentrations (methane, carbon dioxide, oxygen, carbon monoxide, hydrogen sulphide and in selected locations VOC's), gas flows (peak and steady state), along with atmospheric pressure at hourly intervals over a 3 week period.

Table 1 below summarises the minimum and maximum gas concentrations encountered during the monitoring period.

Location	Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Carbon Monoxide (ppm)		Hydrogen Sulphide (ppm)		VOC (ppm)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
BH101	0	6.53	7.22	25.2	0.06	17.6	0	5.99	0	0.1	-	-
BH102	0	2.43	6.37	20.04	1.73	15.58	1.57	19.43	0.3	3.89	0	1.7
BH103	0	0	1.22	11	7.86	14.93	0	1.73	0	0.05	-	-
BH104	0	0.02	0.57	5.7	13.7	17.87	0.01	1.53	0	0.07	-	-
BH105	0.02	0.95	5.05	15.89	4.33	17.63	0.65	13.48	0.06	2.93	0	1.55
BH106	0.01	0.1	0.52	8.36	12.5	18.53	0	0.86	0	0	-	-

Location	Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Carbon Monoxide (ppm)		Hydrogen Sulphide (ppm)		VOC (ppm)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
BH107	0.01	0.35	1.41	6.17	14.7	18.48	0.02	6.63	0.03	0.76	0	0
BH108	0	0.8	4.38	10.07	11.8	16.54	0.69	8.9	0.06	3.37	0	0
BH109	0	0.03	0.96	11.73	3.62	16.23	0.21	1.83	0	0	-	-
BH110	0	0.18	3.23	20.55	3.02	18.53	1.02	5.56	0	2.35	0	1.33

Table 1 Summary of minimum and maximum gas concentrations through continuous monitoring

Table 2 below summarises the gas flow rates encountered during the monitoring period.

Location	Peak Flow (l/hr)		Steady State Flow (l/hr)	
	Min	Max	Min	Max
BH101	0	0.56	-0.11	0.03
BH102	0	0.63	-0.15	0.05
BH103	0	0.34	-0.06	0.01
BH104	0	1.19	-0.12	0.08
BH105	0	0.36	-0.1	-0.02
BH106	0	0.97	-0.06	0.24
BH107	0	0.51	-0.06	0.05
BH108	0	1.24	-0.09	0.19
BH109	0	0.29	-0.07	0.05
BH110	0	0.97	-0.15	0.33

Table 2 Summary of minimum and maximum flow rates through continuous monitoring

The continuous gas monitoring was undertaken during periods of low and falling pressure in order to target a worst case scenario. The continuous monitoring identified gas concentrations for methane in the range 0%-6.53%, carbon dioxide in the range 0.52%-25.2% and oxygen in the range 0.06%-18.53%. Carbon monoxide was detected in the range 0-19.43ppm, hydrogen sulphide in the range 0-3.89ppm and VOC's in the range 0-1.7ppm.

Positive gas flow rates, and marginally negative gas flow rates were identified within all of the monitoring locations during the continuous monitoring. A maximum flow rate of 1.24l/hr was detected within BH108.

A review of the occurrences of the peak concentrations of gas recorded during the continuous monitoring period has shown that these occurrences, in general, coincided with periods of low or falling atmospheric pressure.

Ground Gas Risk Assessment

A Tier 1 Ground Gas Risk Assessment (GGRA) incorporating the results of the desk study and ground investigation has been undertaken as part of this assessment.

Recommendations on acceptable gas concentrations recorded in the ground beneath or adjacent to buildings are given in a variety of publications. For the purpose of this assessment, the results have been evaluated in terms of British Standard BS8485, 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings' (2015); CIRIA C665, 'Assessing risks posed by hazardous ground gases to buildings' (2007) and NHBC report 10627-R01(04) 'Guidance on evaluation of development proposals where methane and carbon dioxide are present' (2007).



Gas screening values (GSV) have been calculated for both methane and carbon dioxide in accordance with the recommendations contained within C665. The highest reported positive gas flow rate was recorded during the spot monitoring, 3.0l/hr. The worst case, i.e. the highest concentration value, of recorded methane and carbon dioxide have been used. Therefore a value of 8.5% v/v has been utilised for methane and a value of 25.2% v/v has been used for carbon dioxide.

Using these worst case values a GSV of 0.255 has been calculated for methane and a GSV of 0.756 has been calculated for carbon dioxide. This would classify the site as representative of Characteristic Situation 3 (BS and CIRIA) and Amber 2 (NHBC), across the site. The site only just falls within the classification for Characteristic Situation 3 based on the GSV calculated for carbon dioxide being greater than 0.7.

The GSV's have been calculated using the worst case results collected from both the 'spot' and the continuous monitoring undertaken, and are therefore considered to be conservative. If the results of the continuous monitoring are treated in isolation then a GSV for carbon dioxide calculated based on the maximum concentration (25.2%), and the highest flow rate (1.24l/hr) recorded during this monitoring period would be 0.312 for carbon dioxide.

This initial assessment has been fed back into the conceptual site model. An onsite source of ground gas has been established, a former landfill site, and residential development is proposed across the site. The ground conditions encountered on site comprise a combination of clays, sands and gravels. These ground conditions do not represent continuous migration pathways although they will contain isolated migration pathways for ground gases. The Made Ground encountered during the intrusive investigation works comprised clayey sandy silt and silty sandy clay with brick and concrete fragments, with a mix of brick, glass, plastics, metal, china, ash, coal, concrete, black organic matter, shoes, fabric, timber, and flint gravel below. This type of material has a limited gassing potential and given the likely age of the landfill the gassing potential of this material will be reduced further.

Given the above assessment it is therefore considered representative of the sites gassing conditions to utilise the GSV calculated for carbon dioxide solely from the continuous gas monitoring, therefore classifying the site as Characteristic Situation 2 and Amber 2.

Ground Gas vs. Human Health

Based on the above assessment and the gas monitoring undertaken it is considered that the site's gassing regime, based on both hazardous gas flow and limiting concentrations, to be representative of Characteristic Situation 2 (BS and CIRIA) across the site. It was not deemed suitable to zone the site due to the fluctuations in recorded gas concentrations, gas flows and the variable nature of the underlying ground conditions. It is therefore recommended that gas protection measures are installed within all properties across the site in line with CIRIA CS2 in accordance with BS8485.

In accordance with BS8485, the proposed residential development is considered to comprise a Type A buildings (residential) and thus, with a gassing regime of CS2, any gas protection measures installed within the proposed buildings are required to achieve a cumulative score of at least 3.5 (Table 4 BS8485:2015).

As such and in accordance with BS8485 and CIRIA C665 the following gas protection measures, or a combination of a selection of the following gas protection measures will be required to be installed within all buildings of the proposed development:

- Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200g DPM and sufficient reinforcement to mitigate/control cracking and minimal services penetrations through (and



sealed to) the slab. (BS8485 gives this a score of 1.0-1.5 depending on reinforcement and services penetration. The 1200g DPM is likely to have a score of zero);

or

- * Beam and block or pre-cast concrete slab and minimum 2000g DPM/reinforced gas membrane (BS8485 gives this a score of 0 [zero] for the slab and 2 for a reinforced gas membrane);
 - * Possibly underfloor venting with either of the above floor construction types depending on use (BS8485 score of 0.5-1.5 is likely);
 - * Passive floor dispersal layer (good performance – BS8485 score 1.5), utilising any of the following media to provide the dispersal layer:
 - o Clear void
 - o Polystyrene void former blanket
 - o Geocomposite void former blanket
 - o No fines gravel layer with gas drains
 - o No fines gravel layer
- or
- * Suitable gas resistant (methane and carbon dioxide) membrane meeting the following criteria for a BS8485 score of 2:
 - o sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method)
 - o sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions
 - o sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab)
 - o sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc)
 - o capable, after installation, of providing a complete barrier to the entry of the relevant gas
 - o verified in accordance with CIRIA C735

Based on current development proposals it is yet to be decided as to whether a ventilated sub-floor void will be incorporated within the final construction. As such two floor construction options are set out below. Option 1 sets out the requirements based on a reinforced concrete floor slab construction and Option 2 sets out the requirements based on a ventilated floor construction. Both options demonstrate how the required cumulative score can be met in order to comply with CS2 and a Type A building.

Option 1 – Reinforced concrete floor slab

The floor construction will comprise a reinforced cast in-situ floor slab where service penetrations are reduced to a minimum and where possible are not brought through the floor slab. The floor slab will comprise sufficient reinforcement to mitigate/control cracking within the floor. This floor construction would achieve a score of 1.5 points.

In addition, a suitable gas resistant membrane meeting the criteria listed within BS8485 will also be installed within the floor. The membrane must be resistant to methane and carbon dioxide (and compliant with BS8485), suitably installed and independently validated. It should be noted that membranes made from recycled plastics are not acceptable as gas protection membranes and the installer must check to confirm that the membrane is not made from recycled plastics. Installation of a gas resistant membrane will give a score of 2 points.

Installation of a reinforced floor slab and suitable gas resistant membrane would achieve a cumulative score of 3.5 points and therefore complying with the requirements of BS8485 for a CS2 classification for Type A buildings.

Option 2 – Ventilated Floor Slab

The floor construction will comprise a pre-cast concrete slab, this floor construction will achieve a score of 0 points. Underfloor venting will be incorporated within the floor construction, comprising a clear void and therefore achieving a score of 1.5 points.

In addition a suitable gas resistant membrane meeting the criteria listed within BS8485 will also be installed within the floor. The membrane must be resistant to methane and carbon dioxide (and compliant with BS8485), suitably installed and independently validated. It should be noted that membranes made from recycled plastics are not acceptable as gas protection membranes and the installer must check to confirm that the membrane is not made from recycled plastics. Installation of a gas resistant membrane will give a score of 2 points.

Installation of a pre-cast concrete slab with a clear void underfloor venting layer and suitable gas resistant membrane would achieve a cumulative score of 3.5 points and therefore complying with the requirements of BS8485 for a CS2 classification for Type A buildings.

The specific details of the specification of the gas protection measures installed will be provided within the Validation Report for the site. Validation of gas protection measures will be undertaken by the Environmental Consultant or other appropriate independent party. Inspection of the protection measures will include key stages of the build process for the proposed structures and will include photographic evidence of installation.

4.0 SOILS

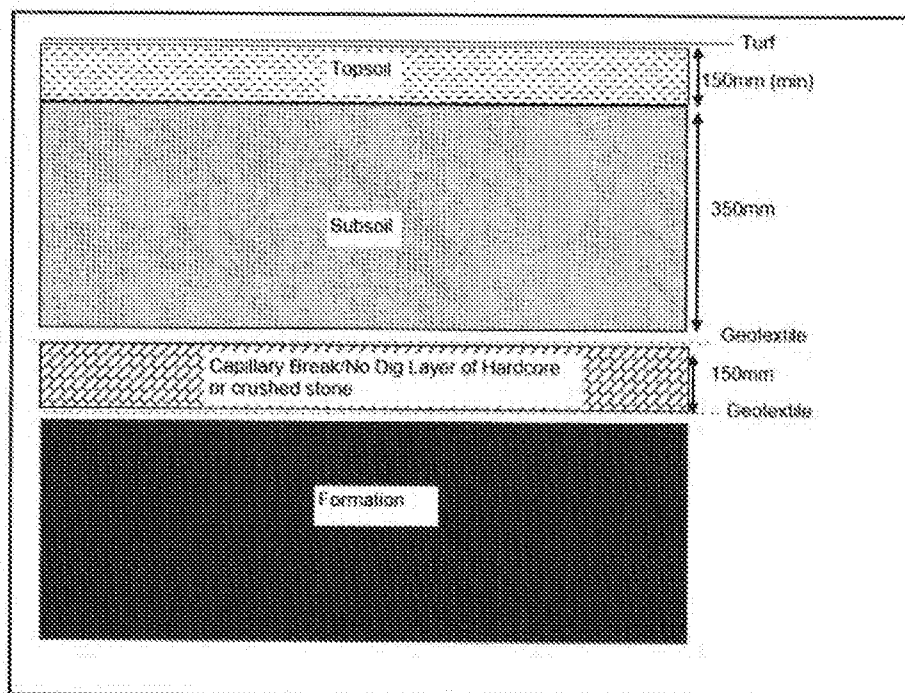
The ground conditions within the former caravan park have been established through several phases of intrusive investigation.

With reference to report **GE17106 - GAR/AP01/231018**, through a process of statistical analyses on the results of chemical analyses on both deeper and near surface soil samples, it was considered that the near surface soils have been impacted by Lead, Arsenic, PCBs, SVOCs, VOCs and ACMs and remedial measures were deemed necessary to protect end users of the proposed properties from soil contamination within private garden and soft landscaped areas. Furthermore, the physical quality of all near surface soils was deemed unsuitable for inclusion in private gardens due to the presence of concrete, brick, and tarmacadam. In addition, ACMs and asbestos fibres have been identified both visually and within chemical analysis to be present within the Made Ground.

4.1 Remedial Recommendations – End Users

Based on the proposed layout, all houses were to include private gardens whilst apartments were to include communal gardens. Soft landscaping around the development was also proposed.

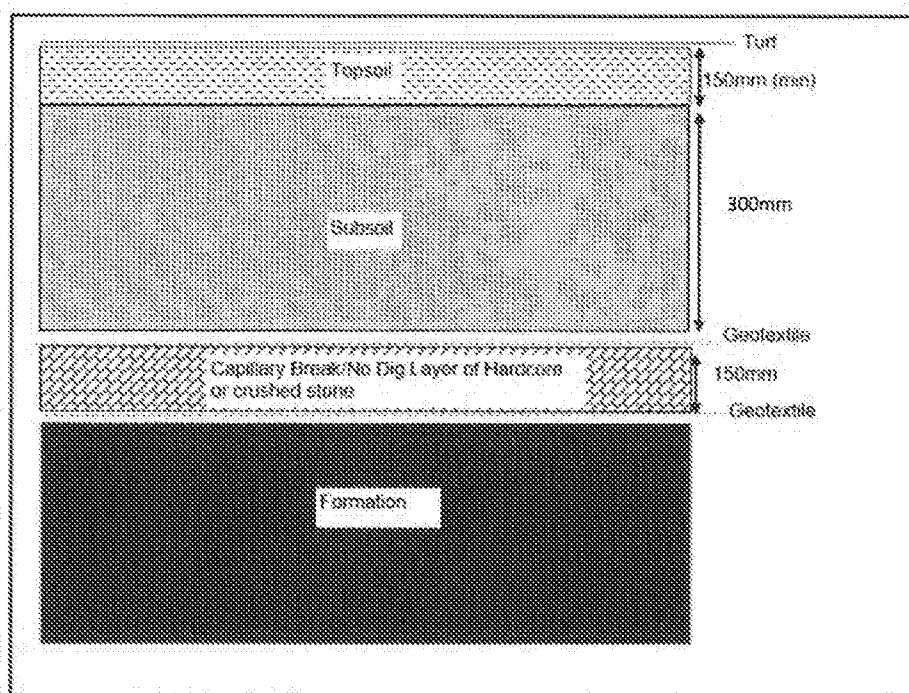
In areas remote from those designated for tree root protection it is recommended that the Made Ground beneath be removed or the site raised to a depth of 650mm and be replaced with chemically and geotechnically suitable material with a high visibility marker geotextile layer such as Terram High-Vis placed at the base between the imported soils and a capillary break layer comprising crushed stone or hardcore of 150mm and underlain by a further layer of Terram. An indicative diagram of the cover system construction for private gardens is shown within Schematic 1 below:



Schematic 1 – Private Gardens

An indicative diagram of the cover system construction for communal landscaping and public open space is

shown within Schematic 2 below:



Schematic 2 – Communal Gardens and Public Open Space

In areas designated for tree root protection, i.e. under the existing tree canopies, the Topsoil should be removed carefully by the use of hand tools to a depth of 150mm and replaced with clean certified imported Topsoil.

Any imported Topsoil or Subsoil should be of suitable chemical and physical quality for the proposed end use. Certification for both sub-soil and Topsoil should include laboratory analysis for determinands known to pose a risk to human health (i.e. heavy metals, poly-aromatic hydrocarbons [PAHs], total petroleum hydrocarbons [TPH] and asbestos) as well as broadly meeting the requirements of BS3882:2015 (Topsoil).

As a matter of good practice, it is recommended that the location, approximate extent and thickness of any imported topsoil are recorded and presented in the Validation/Verification Report to be prepared by the Environmental Consultant. Soil importation criteria is detailed in Appendix B.

In the event of dry spells, or where the exposed surface becomes dry, regular damping down of the surface of the site will be required to prevent the release of soil dust which could impact on site operatives or migrate off-site, thereby mitigating both off-site exposure and nuisance for neighbours.

Where soils are proposed to be located beneath building footprints or hard standing, the plausible pollutant linkage for direct contact is removed and thus risk of harm to end users from exposure to the contaminants is removed, as roads, buildings and permanent hard cover would sever the pollutant linkage and thus the impacted shallow soils could remain in these areas.

Any soils imported onto the site should be verified free from contamination with chemical testing undertaken to confirm their suitability for use within areas of soft landscaping.

Should any regrading works be required on site which propose re-use materials (to include Made Ground) on the site of origin a Materials Management Plan will be developed for the site under the Code of Practice where:

- 1.) They are suitable for use at the location in question (without prior treatment)
- 2.) They won't cause unacceptable risks to people or the environment
- 3.) They are used in the right quantities
- 4.) There is certainty of use

As such excavated soils on site will be removed from site for disposal, treatment at an appropriately licensed facility or re-used under the CL:AIRE Definition of Waste, Code of Practice where it can be demonstrated that there is a need for the use of the materials and where the risk is demonstrated to be acceptable under a Materials Management Plan.

Where contaminated soils are located in an area of permanent hard cover, e.g. building footprint, road, driveway or the like, then the hard cover would break the pollutant linkage and remediation would not be required in terms of the risk to human health, however limited works may be required in these areas to provide a suitable working platform for development to proceed.

4.2 Site Workers

It is the responsibility of the Principal Contractor and their appointed sub-contractors to implement and manage safe systems of work, prepare their own risk assessments in accordance with Health and Safety legislation in order to protect persons in their employ, as well as mitigate the risk of harm to others due to works in their control. Special consideration should be given to the provisions of the Construction (Design & Management) Regulations 2015, Health and Safety at Work Act and the Control of Substances Hazardous to Human Health regulations to protect the safety of persons in their employment. Additional guidance can be sought from the CIRIA publications entitled "A Guide for Safe Working on Contaminated Sites" and "Environmental Good Practice on site guide (fourth edition)".

In addition to the safe systems of works to be implemented alongside appropriate risk assessments and method statements, all site personnel shall benefit from on-site hygiene facilities including wash area, toilets and drying room. Separate canteen area and welfare facilities should be provided. All eating and drinking should be restricted to the canteen area and only once site personnel have removed outer PPE and washed exposed skin.

4.3 Inspection/Validation

Verification of remediation measures shall be required through regular inspection at key stages of the works to include:

- The removal of Made Ground, placement of a cover system, including verification of any additional subsoil and/or Topsoil in order to allow for the installation of the capping system required in private gardens and areas managed soft landscaping areas.
- Inspection and verification of gas protection and gas mitigation measures at key stages of construction.

It is likely that verification will be undertaken in stages, such as site preparation, reduced dig, subsoil placement and topsoil placement. As such, final verification of the completed cover system is likely to be at the end of construction.

Details of these works would be presented within a verification report for the site, to include the requirements of the Code of Practice should materials be proposed to be re-used under the Definition of Waste Code of Practice.

4.4 Built Environment

Buried plastics laid in contact with contaminated soils may be susceptible to attack by aggressive chemicals; therefore, potable water supplies may potentially become contaminated or tainted. Whilst the upper 650mm of impacted materials will be removed from garden and communal soft landscape areas, water supply pipes are likely to be installed within Made Ground soils.

The use of barrier pipe possibly with cast iron connections is likely to be required for potable water supplies through the site.

The utility company should be consulted in order to confirm their specific requirements in this respect. Potable supply pipe installation should be confirmed and verified through inspection during construction.

As a matter of good practice and to maximise the protection to maintenance workers, clean, granular backfill should be used in service runs and marker tapes for all buried services. This would not mitigate the requirement for the water supply pipe.

5.0 WASTE

5.1 Waste Classification and Segregation

Waste may be defined as any substance or object in Annex 1 of the Waste Framework Directive which the holder discards, intends to discard, or is required to discard. The holder of waste is anyone in possession of waste or generates it and therefore both the contractor and ultimately the developer are responsible for safe disposal of waste.

The following information is provided for preliminary guidance purposes, as different facilities or operators may have differing acceptance criteria and Waste Acceptance Criteria (WAC) analysis may be required to confirm the exact classification. In addition, if the intention is retain excess spoil/arislings on site for specific purposes, then these soils would not comprise waste, although this is subject to confirmation and relevant declaration under the Definition of Waste Code of Practice.

In the first instance forty-four laboratory results were uploaded to Atkins' waste soils characterisation assessment tool, 'CatWasteSoil' which determines whether a generated waste has any hazardous chemical properties based on standard laboratory analysis. The results for the analysed determinands did not exceed the relevant CatWasteSoil Hazard Class thresholds in thirty-seven of the forty four samples. Seven samples were identified with hazardous properties due to high zinc concentrations (ecotoxic). These are summarised in Table 3 below.

Location	Depth (m)	Hazardous Properties
TP4	1.00	Yes
TP205	2.00	Yes
TP206	1.50	Yes
TP209	1.50	Yes
BH102	1.00	Yes
BH110	0.30	Yes
BH110	1.00	Yes

Table 3 CAT Waste Analysis Results

In addition, ten representative samples were analysed for waste acceptance criteria testing, the results are summarised in Table 4:

Location	Depth (m)	Inert	Non-Hazardous	Hazardous
TP201	1.80			TOC, Loss on Ignition
TP203	1.50	Yes		
TP204	1.50		TOC	
TP205	0.50	Yes		
TP208	1.50		TOC, Antimony	Loss on Ignition
TP209	1.50			TOC, Loss on Ignition
BH103	0.50	Yes		
BH105	1.00		TOC	
BH106	0.30	Yes		
BH109	1.50		TOC	

Table 4 WAC Test Results



Three of the samples have fallen into the hazardous waste classification on account of marginal exceedances of TOC and loss on ignition (organic matter). It is possible that a receiving landfill operator will accept this material as non-hazardous, though this would require confirmation from the proposed operator.

Any waste soils which include asbestos will require asbestos quantification analysis to determine their disposal classification. Where the concentration of free asbestos fibres exceed 0.1% the material would be deemed hazardous. Furthermore, any material containing fragments of ACM containing more than 0.1% asbestos would also be deemed hazardous. It is recommended that the results be passed onto the landfill operator and company who are to remove any soils from site, as different landfill operators use different forms of classification.

Natural soils (River Terrace Deposits and Chalk) are likely be classified as Inert Waste (under the respective EWC codes for naturally occurring soils), suitable for disposal at an inert landfill facility.

6.0 DISCOVERY STRATEGY

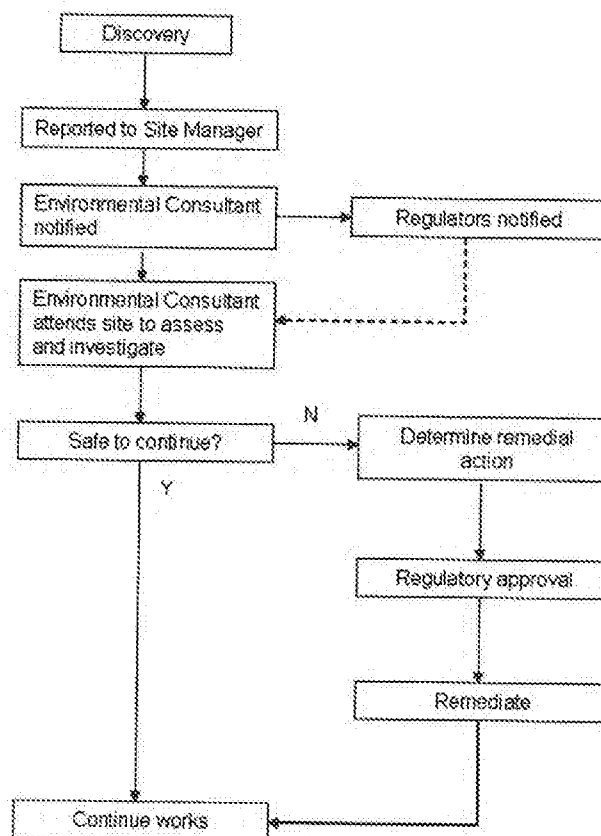
Whilst the site has been the subject of several phases of investigation and assessment, it remains possible that previously unexpected soil conditions may be encountered during the process of site preparation and construction.

Examples may include oily pockets within the soil, pockets of cement boarding or fibrous materials within the soil, black ashy materials, soils exhibiting strong odours, brightly coloured materials, and former structures or brickwork.

Should previously undiscovered contamination be encountered during the demolition/construction of the new buildings the following course of action should be adhered to:

- Works in the area of the suspected contamination should cease immediately. The ground workers should report any suspected contamination immediately to the Client's site supervisor. The supervisor should contact the Environmental Consultant, who should visit the site to assess the extent of the 'contamination'.
- The Environmental Consultant shall make records of their inspection, and pass details of these to the Local Authority.
- Where the conditions revealed differ from those previously anticipated, the Environmental Consultant shall take samples as deemed appropriate to be dispatched for appropriate chemical testing.
- Depending on the results of the testing either: 1) no further work will be required; 2) a further detailed risk assessment will be required; and/or 3) localised specific remedial measures will be necessary. Appraisal criteria will vary depending on the nature of the assessment.
- The results of any such testing will be sent to the Regulatory Authority for consultation. If further remediation is required, the Regulatory Authority will be informed of the date and time of the proposed works.
- Any further remediation will be undertaken in accordance with a method statement submitted to the Local Authority for approval. The works shall be supervised by the Environmental Consultant who shall provide a Verification Report for the Local Authorities purposes.

The process is summarised overleaf:



A copy of this strategy should be lodged on site, and provisions made to ensure that all workers are made aware of their responsibility to observe, report, and act on any potentially suspicious or contaminated materials they may encounter.

