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# Foundation Works Risk Assessment

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At: Woodcote Grove,  
Ashley Road, Epsom,  
Surrey, KT18 5BW

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For: Canbury Construction  
Ltd

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Report Reference: LP2353/FWRA

Report Date: 7<sup>th</sup> December 2020

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## TABLE OF CONTENTS

A	INTRODUCTION .....	1
1	Authority and Terms of Reference .....	1
2	Objective and Scope of Works.....	1
3	Proposed Re-development.....	2
B	ENVIRONMENTAL SETTING.....	3
4	Introduction.....	3
5	Site Location and Description .....	3
5.1	Location and Site Description .....	3
6	Site History.....	3
7	Ground Conditions .....	4
7.1	Geology, Hydrogeology and Hydrology.....	4
7.2	Groundwater.....	4
7.3	Ground Contamination .....	5
C	CONCEPTUAL SITE MODEL .....	7
8	Environmental Risk Assessment.....	7
8.1	Conceptual Site Model .....	7
8.2	Sources .....	7
8.3	Receptors .....	7
9	Proposed Foundation Solutions .....	8
9.1	Piled Foundations .....	8
D	FOUNDATION RISK ASSESSMENT AND CONCLUSIONS.....	9
10	Environmental Risk Assessment.....	9
10.1	Pollution Scenario 1 - Creation of preferential pathways through an aquitard to allow potential contamination of an aquifer.....	9
10.2	Pollution Scenario 2 – Creation of preferential pathways through a low permeability surface layer allowing migration of landfill gas, soil gas or contaminant vapours to surface.....	9
10.3	Pollution Scenario 3 – Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface .....	9
10.4	Pollution Scenario 4 – Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of materials.....	10

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10.5	Pollution Scenario 5 – The pushing of solid contaminants down into an aquifer during pile driving.....	10
10.6	Pollution Scenario 6 – Contamination of groundwater and, subsequently, surface waters by wet concrete, cement paste or grout.....	10
10.7	Pollution Scenario 7 – Off-site human health impacts.....	10
10.8	Summary.....	11
11	Mitigation Measures.....	12
12	Waste Disposal.....	12

## Appendix A - Figures

Figure 1 – Site Location Plan

Figure 2 – Proposed Development Plan

Figure 3 – Trial Hole Location Plan

Figure 4 – Provisional Pile Layout Plan

## Appendix B – Screening Table: Soil Test Results

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## EXECUTIVE SUMMARY

Leap Environmental Ltd (hereafter referred to as **LEAP**) was appointed by Canbury Construction Ltd to undertake a foundation works risk assessment for the proposed redevelopment of the land at Woodcote Grove located off Ashley Road in Epsom, Surrey, KT18 5BW.

It is proposed to redevelop the site with 98 residential properties. The geology comprises Made Ground over Lambeth Group (clay, silt and sand) in the west, Thanet Formation (sand) in the central region and Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation in the east. No superficial deposits are mapped. Groundwater is present at c. 1.6m bgl within the chalk. The Chalk is classified as a Principal Aquifer and the overlying strata are classified as Secondary (A) Aquifers. The site lies on the boundary between an inner and an outer groundwater source protection zone (SPZ 1 and 2).

The circa 1.13 ha irregular 'L' shaped site is located in a primarily residential area. The site has a history of use as a Manor House and stables prior to becoming the offices and conferencing facilities of engineering and management consultants, Atkins. The consultants new offices are sited to the immediate north of the site.

The site has been subjected to a phase of intrusive site investigation in 2020. The site investigation undertaken to date has identified lead, benzo-a-pyrene and a single instance of arsenic present in the made ground soils at concentrations in excess of the adopted assessment criteria for the protection of human health. However, only a single, minor lead exceedance was recorded in the region of the site where piling is proposed. Very minor exceedances of the adopted tier 1 assessment criteria for PAH and TPH in groundwater were identified. No risks from land gases or hydrocarbon vapours have been identified.

The designer has indicated that 312 No. Continuous Flight Auger (CFA) piles of circa 15m length and 350mm diameter are proposed.

The FWRA presents a conceptual site model and assesses the risks posed by the proposed piling operations in line with the scenarios presented in the Environment Agencies' guidance. Primarily low risks have been identified given the absence of any significant contamination and the proposed piling technique. This is despite the absence of a naturally occurring aquitard and the high sensitivity of the groundwater.

## **Limitations**

*This report has been prepared by Leap Environmental Ltd on the basis of information received from a variety of sources which Leap Environmental Ltd believes to be accurate. Nevertheless, Leap Environmental Ltd cannot and does not guarantee the authenticity or reliability of the information it has obtained from others. It is noted that Leap Environmental Ltd has not visited the site nor carried out any investigations of its own in preparation of this report.*

*Leap Environmental Ltd has used all reasonable skill, care and diligence in the design and execution of this report, taking into account the manpower and resources devoted to it in agreement with the Client. Although every reasonable effort has been made to obtain all relevant information, all potential contamination, environmental constraints or liabilities associated with the site may not necessarily have been revealed.*

*The conclusions reached in this report are necessarily restricted to those which can be determined from the information consulted and may be subject to amendment in the light of additional information becoming available. These conclusions may not be appropriate for alternative schemes.*

*This report is confidential to the Client, and Leap Environmental Ltd accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by Leap Environmental Ltd beforehand. Any such party relies upon the report at their own risk.*

Signed:	 Paul Adams BSc PhD MEnvSc CSci
Countersigned:	 Tim Thorpe MSci ARSM FGS
Date:	7 <sup>th</sup> December 2020
Revision:	Issue 2

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## A INTRODUCTION

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### I Authority and Terms of Reference

Leap Environmental Ltd (hereafter referred to as **LEAP**) was appointed by Canbury Construction Ltd to undertake a foundation works risk assessment (FWRA) for the proposed redevelopment of a portion of the land at Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW.

#### Previous Reports

The site has been the subject of a previous investigation (by **LEAP**). A desk study has also been produced by a third party. The following reports should be read in conjunction with this report:

- Phase I Environmental Site Assessment (for Stonegate Homes Ltd). WDE Consulting Ltd. Document Ref: 20907RI, dated July 2019.
- Phase 2 Site Investigation Report. **LEAP** Environmental Ltd. Ref: LP2353/Phase 2, dated December 2020.

Based on the results of the previous work it was concluded that the made ground in the west of the site was locally contaminated with lead and the PAH compound, benzo[a]pyrene. No contamination has been recorded in the southern region of the site.

At the time of writing the remediation strategy for the current development has yet to be prepared but will specify clean cover systems of 600mm thickness in the rear gardens of the low density development (Buildings C and D – plots 13-26 in the west of the site) and 300mm in the communal green space area between Buildings A and B (apartments) in the northwest of the site. Alternatively, the made ground could be removed in its entirety and clean cover of 300mm and 150mm applied respectively to each area.

No land gas protection measures or groundwater remediation will be specified.

### 2 Objective and Scope of Works

Planning Condition 17 of Planning Permission 19/00999/FUL requires the production of a piling / foundation works risk assessment to ensure the protection of groundwater during piling operations.

This assessment has been completed in line with Environment Agency best practise<sup>1</sup> and assesses the following hazards:

- Avoidance of below ground services;
- Creation of preferential pathways through low permeability strata to allow vertical migration into an underlying aquifer;
- Creation of preferential pathways through low permeability strata to allow upwards migration of ground gas and vapour phase contamination;
- Direct contact between construction workers and contaminated arisings;
- Direct contact between the foundation structure and contaminated ground, leading to degradation of the structure;
- Direct mobilisation of contaminated material deeper into the aquifer;
- Generation of airborne contamination and subsequent impact to off-site human health receptors; and
- Contamination of groundwater and/ or surface waters by the pile fabric (cement, grout etc.).

### 3 Proposed Re-development

The proposed -redevelopment comprises 98 new residential dwellings across six buildings, two of which will comprise conversions of existing, Grade II listed buildings. The redevelopment applies to the western and southern regions of the Woodcote Grove site (only). Atkins is retaining the central and northern regions of the site. Furthermore, this assessment applies only to the southern region of the of the subject site (Building F) as all other proposed structures (Buildings A-E in the western region of the subject site) are not anticipated to require piled foundations.

The large former office building in the south of the site has recently been demolished. This will be the site of the new apartment block with basement (Building F housing 65 apartments) which will require piled foundations.

The proposed development is shown as Figure 2, Appendix A.

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<sup>1</sup> Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, National Groundwater & Contaminated Land Centre report NC/99/73, 2001.

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## B ENVIRONMENTAL SETTING

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### 4 Introduction

Section B of this report presents a summary of the environmental setting for the site and a conceptual site model, which is itself based on the previous reports detailed above.

### 5 Site Location and Description

#### 5.1 Location and Site Description

The c. 1.13ha, irregular 'L' shaped site is located off Ashley Road in Epsom, Surrey, KT18 5BW. The site is located within a primarily residential area as shown in Figure 1, Appendix A.

The approximate National Grid Reference of the site is 520829, 159758. The site lies at an estimated elevation of 59-62m Above Ordnance Datum (mAOD).

The south of the site has recently been cleared. In the west of the site are a mixture of buildings some of which are scheduled for demolition and some of which are listed and scheduled to be retained for conversion into apartments. The western region of the site does not form part of this assessment.

To the north of the site is the new (replacement) Atkins office building and associated parking facilities (with a junior school to the further northeast), to the east / southeast is woodland with open fields beyond. To the south and west are residential properties.

### 6 Site History

The Manor House has been present since at least 1840. Historically, there were some buildings of undisclosed nature in the northwest. These were demolished to make way for the commercial buildings constructed along with the office building in the south in the late 1960's / early 1970s. No significant changes were evident thereafter.

## 7 Ground Conditions

### 7.1 Geology, Hydrogeology and Hydrology

The geology at the site is mapped as comprising Lambeth Group (clay, silt and sand) in the west, Thanet Formation (sand) in the central region and Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation in the east. No superficial deposits are mapped. The Lambeth Group and Thanet Formation are classified as Secondary (A) Aquifers whilst the Chalk is classified as a Principal Aquifer. The site is located within an Inner Source Protection Zone I (the Chalk in the east) and an Outer SPZ II (Lambeth Group and Thanet Formation areas). The nearest drinking water abstraction is c. 1,350m to the north. There are no surface water features within 250m. The site is reportedly at low risk of flooding.

Ground conditions encountered by LEAP Environmental comprised made ground over a silty sand with localised, narrow horizons of clay at the extents of the stratum. The silty sand was underlain by fine sand of the Thanet Formation which, in turn, was underlain by Chalk.

Made ground was encountered to a maximum depth of 2.9m although the thickness of made ground was more typically around 1.0m. Instances where deeper made ground was encountered was reworked natural soils with anthropogenic inclusions as a result of the removal of building foundations and the presence of a sewer. Narrow horizons (typically less than 0.5m) of stiff sandy and/or silty clay were locally encountered at the upper and lower boundaries of the silty sand. The silty sand had a highly variable flint gravel content. The Thanet Sands were encountered at a shallower depth in the south of the site (c. 1.5-2.0m) than in the western site regions (2.2- c. 4.0m deepening towards the north). The fine Thanet Sands were devoid of gravel. The Chalk was encountered only in the cable percussion borehole in the south of the site at 5m to beyond the extent of the boring at 23.0m.

### 7.2 Groundwater

Groundwater is present at significant depth within the chalk. Only one deep borehole was sunk during the recent intrusive site investigation. Groundwater was struck at 12.90m (slight seepage) and then at 20.60m (slow inflow rising to 18.5m after 20 minutes). The depth to groundwater during the return monitoring visits was c. 16m bgl.

## 7.3 Ground Contamination

### 7.3.1 Soil Contamination

During the 2020 intrusive site investigation, LEAP took a total of twenty-one soil samples across both the western and southern regions of the site. The samples were tested for a range of potential contaminants including heavy metals, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH) and asbestos.

In the western region of the site, a number of exceedances for the both the residential with home-grown produce and public open space (residential) assessment criteria were recorded for lead (10) and benzo-a-pyrene (7). A single exceedance of the residential with home-grown produce criteria was also recorded for arsenic.

In the southern region of the site (the proposed location for Building F which will require piled foundations), just a single, marginal exceedance of the residential with home-grown produce criteria was recorded for lead (219 mg/kg vs. a GAC of 200 mg/kg in WS9 at 0.3-0.6m). Refer to the intrusive location plan (Figure 3, Appendix A) and the screening table (Appendix B) for further detail.

### 7.3.2 Groundwater Contamination

Due to the significant depth to groundwater and lack of any significant potential risks to groundwater identified within the CSM, only a single groundwater sample was collected from the standpipe installed to monitor groundwater level in the region of proposed Building F. The sample was analysed for heavy metals, PAH, TPH, BTEX compounds and cyanide. Very minor exceedances were recorded against the drinking water standards as follows:

**Table 1: Exceedances in Groundwater**

Determinant (Total, unless otherwise specified)	Measured Conc <sup>n</sup> (µg/l)	Tier I Assessment Criteria (µg/l)
		UK Drinking Water Standard <sup>1</sup>
Total Petroleum Hydrocarbons (TPH)	10.2	10 <sup>2</sup>
Benzo(a)pyrene	0.02	0.01
Total PAHs	0.27	0.1

Notes to Table

1. UK Drinking Water Standards, unless otherwise stated
2. Assessment Criterion based on former target concentration for dissolve or emulsified hydrocarbons – now withdrawn.

These results were not considered to be indicative of any significant contamination.

### 7.3.3 Ground gas and Vapour Contamination

No risks from ground gases or vapours have been identified (refer to the site investigation report for further details).

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## C CONCEPTUAL SITE MODEL

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### 8 Environmental Risk Assessment

#### 8.1 Conceptual Site Model

The purpose of the Conceptual Site Model, in this instance, is to identify the potential pollutant linkages related to the proposed development in order that an assessment can be made of the potential impact on those pollutant linkages from proposed foundation solutions.

#### 8.2 Sources

On-site sources of contamination with the potential to impact the site include: hydrocarbons from anecdotal evidence of vehicle maintenance in the former stable block and from the former fuel tank and below ground fuel lines in and around the former switch house (located in quite close proximity to proposed Building F), heavy metals, PAHs and asbestos within made ground from cut and fill activities and potential PCBs or mineral oil from the electrical substations.

These sources are considered to pose a low to moderate risk to human receptors and a low to moderate risk to controlled waters.

No off-site potential contamination sources have been identified.

The site investigation undertaken to date has identified lead and benzo[a]pyrene present in the made ground soils at concentrations in excess of the adopted assessment criteria for the protection of human health. Very minor exceedances of the adopted tier I assessment criteria for TPH and PAH in groundwater were identified. No ground gas or vapour risks have been identified.

#### 8.3 Receptors

Receptors that could be impacted by foundation works include the following:

- Future residents;
- Construction workers;
- Secondary (A) Aquifers – Lambeth Group and Thanet Formation
- Principal Aquifer – White Chalk Subgroup
- Material construction of buildings and infrastructure; and
- Neighbouring residents/properties

### 8.3.1 Pathways and Potential Pollutant Linkages

The proposed re-development in the southern region of the site comprises a new 65 unit apartment block with basement parking and surrounding communal soft landscaping. Therefore, the direct contact, ingestion and dust inhalation pathways are active. Indoor and outdoor vapour/ground gas and ingestion of water carried by plastic water pipes through contaminated ground are also active but the ingestion of home-grown produce and soil attached to home-grown produce pathways are not.

Ground workers (including service maintenance engineers) will be at acute risk from dermal contact, soil ingestion and dust ingestion for the duration of the development.

The site is underlain by the White Chalk Subgroup which is a principal aquifer and the site lies on the boundary of a groundwater source protection zone 1 and 2 (inner and outer catchment zones). There is a thin layer of Thanet Sand Formation overlying the Chalk which is in turn overlain by silty, locally gravelly sands which may or may not comprise The Lambeth Group. However, there is no groundwater residing in either of these two upper strata.

None of these deposits are clay rich and hence, there is a potential pathway for leachate from soil pollutants and for mobile liquid contaminants to enter the groundwater. The water table is known to be around 1.6m bgl (residing within the chalk). Given the absence of any identified surface water features, the underlying principal aquifer has been identified as the principal controlled waters receptor.

Based on this assessment and the findings of the site investigation, the risk posed to all identified receptors in this region of the site is low.

## 9 Proposed Foundation Solutions

Continuous Flight Auger (CFA) piles of average 15m length are proposed.

The information provided specified that the piles will be 350mm in diameter. A total of 312 piles are proposed at the spacings indicated in the proposed layout included in Figure 4, Appendix A.

### 9.1 Piled Foundations

CFA piles offer the advantage that they are less likely than smooth sided piles to enhance the downward migration of leachate. However, they will generate some spoil, which may increase the potential exposure of site workers to contaminated materials and may increase lorry movements and volumes disposed of to landfill if it is not possible to re-use the material on-site. CFA piles may also result in localised ground disturbance and agitation of contaminated soils.

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## D FOUNDATION RISK ASSESSMENT AND CONCLUSIONS

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### 10 Environmental Risk Assessment

The Conceptual Site Model set out in Section C indicates that the earthworks at the site could potentially have an adverse impact on the future residents, construction workers, the Chalk subgroup (a principal aquifer) and the built environment (above and below ground). However, the risk is perceived to be low. The risks posed via the hazards identified in Section C are considered in the following sections and summarised in the subsequent table for the identified viable foundation option.

#### 10.1 Pollution Scenario 1 - Creation of preferential pathways through an aquitard to allow potential contamination of an aquifer

There are no natural clay-rich strata present at the site which could be considered to act as an aquitard and hence, there is no natural aquitard present between the made ground, silty sands, Thanet Sands and the Chalk across this region of the site. This feature therefore, cannot be breached by piling. Rainwater infiltration and vertical migration will therefore have been occurring in all areas of the site not covered by hardstanding for an extended period of time.

#### 10.2 Pollution Scenario 2 – Creation of preferential pathways through a low permeability surface layer allowing migration of landfill gas, soil gas or contaminant vapours to surface

As outlined in section 10.1, there is no consistent natural confining geological layer present at the site. (Any) gases will have therefore been venting readily to surface except for in areas where hardstanding has been historically present (prior to its recent removal when the historical office building was demolished). No offsite sources of land gases have been identified and the made ground at the site has been concluded to be insufficiently thick to present a meaningful potential source. Chalk can present a low-level source of carbon dioxide but is present at c. 5.0m bgl. No elevated concentrations of volatile TPH fractions have been detected anywhere on site. The proposed building encompasses a basement; the necessary ventilation measures are typically equivalent to Characteristic Situation 3 land gas protection measures.

#### 10.3 Pollution Scenario 3 – Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface

Only a single detection of lead marginally exceeding the residential with home-grown produce assessment criteria has been detected in this region of the site. Adopting risk assessment and industry best practice procedures will minimise any risk to construction workers. No significantly elevated concentrations of TPH were recorded in the location of the former

switch house and no asbestos has been detected within any soil samples taken to date. Therefore, the likelihood of contamination being present in pile arisings brought to surface is considered to be extremely low.

#### 10.4 Pollution Scenario 4 – Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of materials

With reference to Sections 7.3 and 10.3, the likelihood of encountering any significant contamination within the soils or groundwater is considered to be extremely low.

During the intrusive site investigation 6 No. samples were tested for sulphate content and pH. In accordance with the BRE methodology and the number of samples tested, the site has been classified on the highest measured sulphate content.

Based on the results, the soils are classified by the BRE as sulphate design class DS-1, and, assuming a mobile groundwater table, the ACEC class is AC-1d. Hence, the natural soils at the site are not considered to be overly aggressive to concrete.

#### 10.5 Pollution Scenario 5 – The pushing of solid contaminants down into an aquifer during pile driving

The proposed piling methodology (CFA) minimises the potential for contaminated material to be migrated to depth during the piling process. Furthermore, as the boring is filled with concrete as the auger is withdrawn, there is minimal potential for vertical contaminant migration especially given that all work will be undertaken above the water table and no significant soil contamination is anticipated at any depth.

#### 10.6 Pollution Scenario 6 – Contamination of groundwater and, subsequently, surface waters by wet concrete, cement paste or grout

The piles will be founded within the Chalk soils above the groundwater table. The Chalk has been shown to be hard and competent. Both these factors will minimise any migration of concrete. There are no surface water features on site or within 250m of the site. The groundwater abstraction to which the SPZ relates is located 1,350m to the north.

#### 10.7 Pollution Scenario 7 – Off-site human health impacts

There is the potential (albeit it a low risk given the proposed timing of the works in the wetter months of the year) that dust could be generated through the piling works, posing a risk to both on and off-site receptors. There is no evidence of asbestos being present in the soils at the site. The contractor will be required to ensure that dust in is minimised and waste is handled in accordance with the Duty of Care thusly significantly reducing the risk of dust nuisance.

## 10.8 Summary

**Table 2: Summary of Environmental Risks**

Hazard	Likelihood	Consequence	Risk	Comment
<b>Preferential pathway – increased risk to underlying aquifer</b>	Very Low	Moderate	Low	There is no natural aquitard present between the made ground, silty sands, Thanet Sands and the Chalk across this region of the site. This feature therefore, cannot be breached by piling. The CFA piling technique results in a boring being open for a minimal time period.
<b>Vertical Migration of Hydrocarbon Vapour and Ground Gas</b>	Very Low	High	Low	No offsite sources of land gas have been identified and the made ground thickness at the site has been deemed insufficient to present a potential source. No elevated volatile hydrocarbon fractions have been measured in soil or groundwater. The building comprises a basement and the ventilation measures will provide some inherent gas and vapour protection.
<b>Contaminated arisings</b>	Low	Moderate	Low to Moderate	Only a single, minor elevation of lead has been recorded in the soils in this region of the site.
<b>Degradation of pile fabric</b>	Very Low	Moderate	Low	No soil contamination anticipated based on laboratory test results. Natural soils not overly aggressive to concrete.
<b>Contamination of deeper aquifer</b>	Low	Moderate	Low	The selected piling technique and absence of soil contamination based on laboratory test results make this scenario unlikely to occur.
<b>Contamination of aquifer by pile material</b>	Low	Low	Low	No groundwater present at piling depths.
<b>Off-site human health impact</b>	Low	High	Low to Moderate	Generation of dust unlikely given the time of year during which the works will be undertaken and no asbestos detected in soil to date.

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## 11 Mitigation Measures

Required mitigation measures will comprise: ensuring that the pile mat is installed to sufficient thickness in accordance with the contractor's specification for H&S purposes, good construction site management to minimise the risk of any fuel spills which could present an environmental risk and dust suppression measures on standby in the unlikely event that they be required.

### Protection of Below Ground Services

Piling operations have the potential to damage services. It is understood that all services have been decommissioned and removed when the previous office building was recently demolished.

## 12 Waste Disposal

It is the duty of the waste producer, to ensure that all waste is disposed of appropriately and that any that is sent to landfill is sent to an appropriately licensed one. All waste sent to landfill must be classified and must be pre-treated. The form of pre-treatment should be documented in the Site Waste Management Plan. There are various forms of pre-treatment that are acceptable.

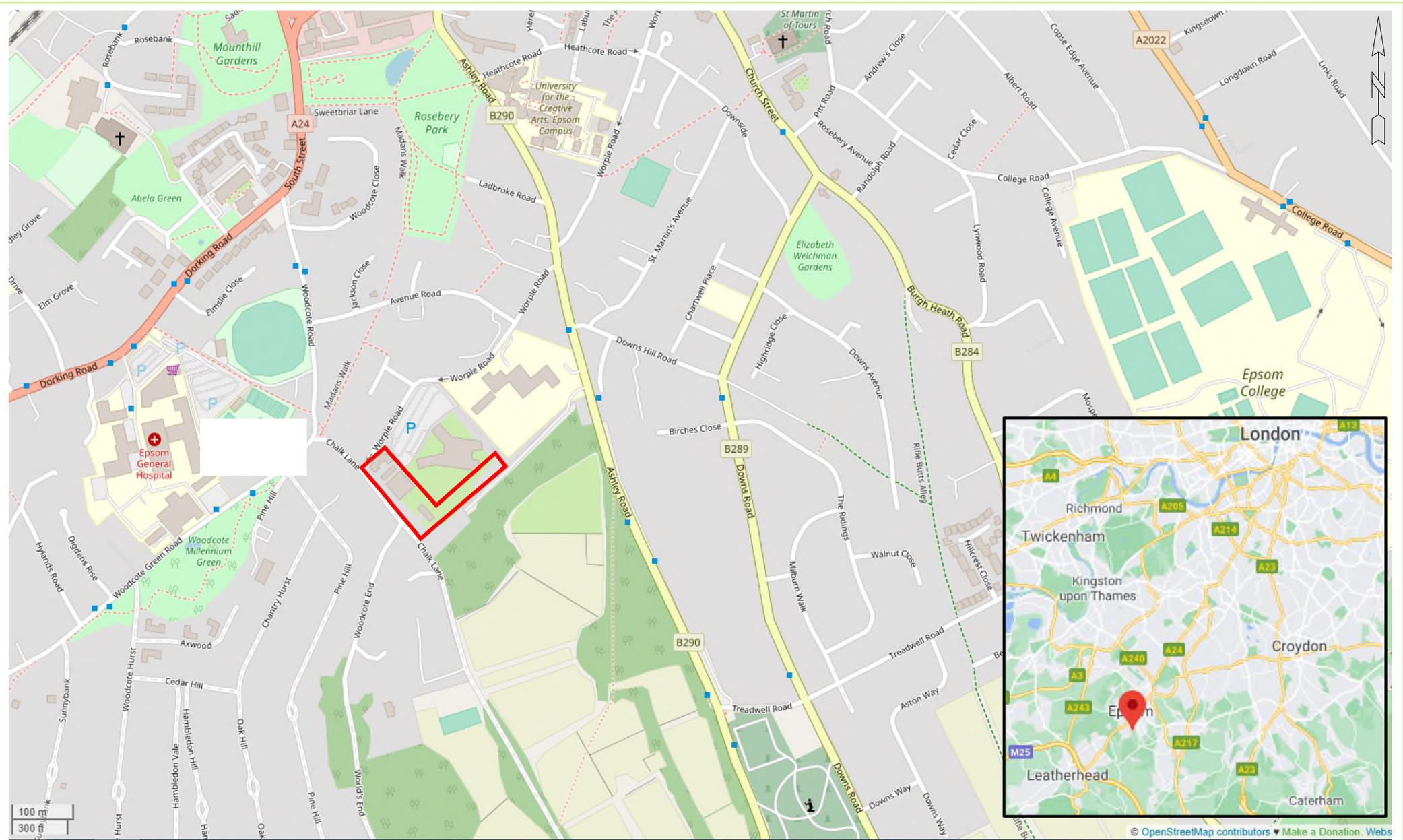
Waste soils awaiting testing, classification and disposal should be placed on plastic sheeting, segregated by fencing, covered and labelled appropriately.

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## APPENDIX A

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Figures

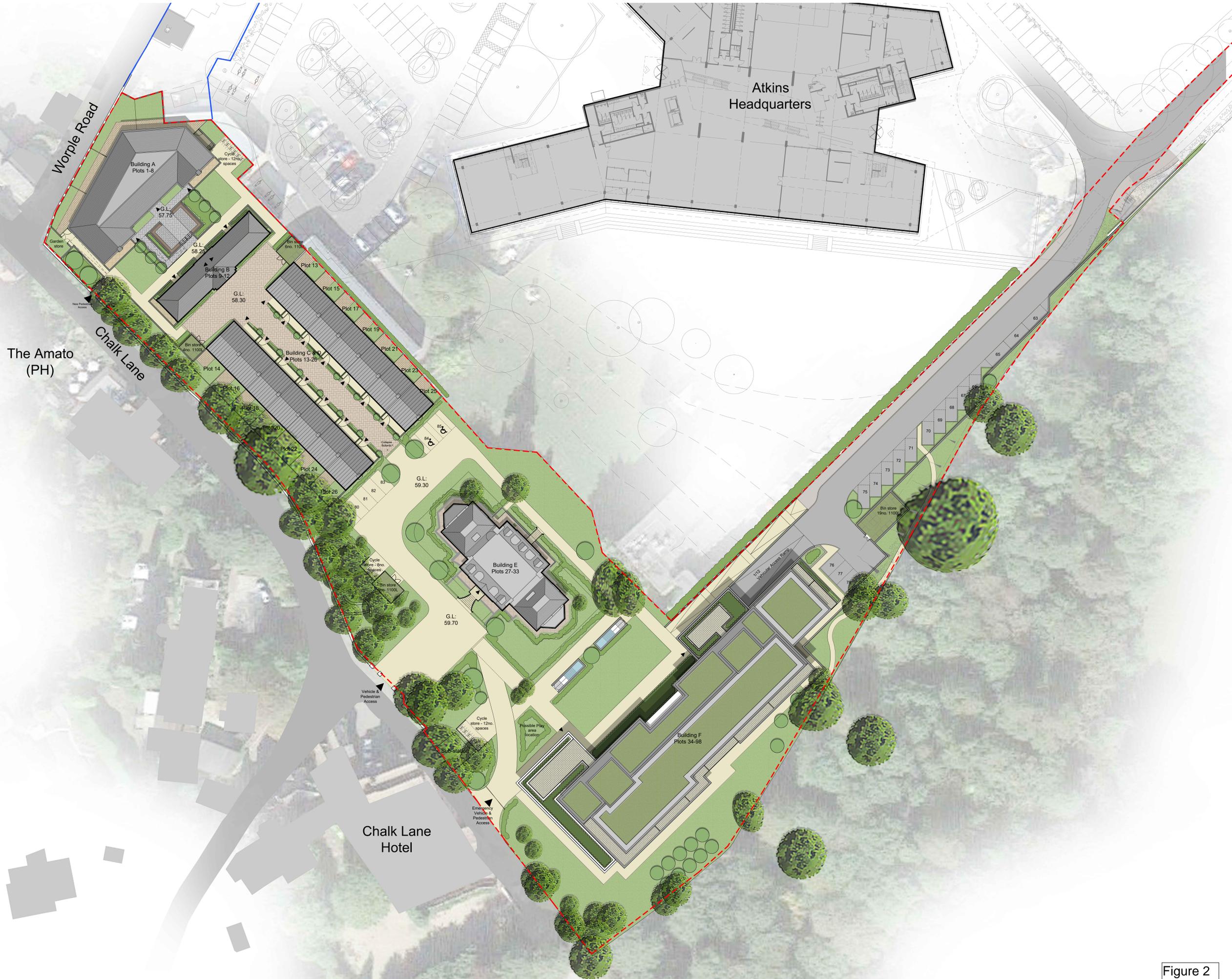


Basemap: © OpenStreetMap



Client:	Canbury Construction Ltd	Date:	29/10/2020	Project ID:	LP2353
Project:	Woodcote Grove, Epsom	Title:	Site Location Plan	Fig. No.	1

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Rev	Date	Revision Details	DR	CH
O	05.02.20	Updated landscaping	NK	NF
N	27.01.20	Updated layout	NK	NF
M	24.01.20	Updated layout	NK	NF
L	18.01.20	Update to Access road parking and path	NK	NF
K	17.12.19	Update to Block A ramps	NK	NF
J	16.12.19	Update to pedestrian footpath connections	NK	NF
I	11.12.19	Update to Block F roof plan	NK	NF
H	02.12.19	Updated to Planners comments	NK	NF
G	01.11.19	Updated to Planners comments	NK	NF
F	05.09.19	Updated Boundary Line	NF	NK
E	12.08.19	Updated Parking	NF	NK
D	31.07.19	Updated layout	NF	NK
C	24.07.19	Updated emergency access arrangement	NF	NK
B	11.07.19	Updated layout and building footprints	NF	PF
A	21.05.19	Revised Emergency Access Position	JR	NF

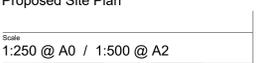
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Client's Name  
**Stonegate Homes**

Job Title  
**Woodcote Grive, Epsom**

Drawing Title  
**Proposed Site Plan**



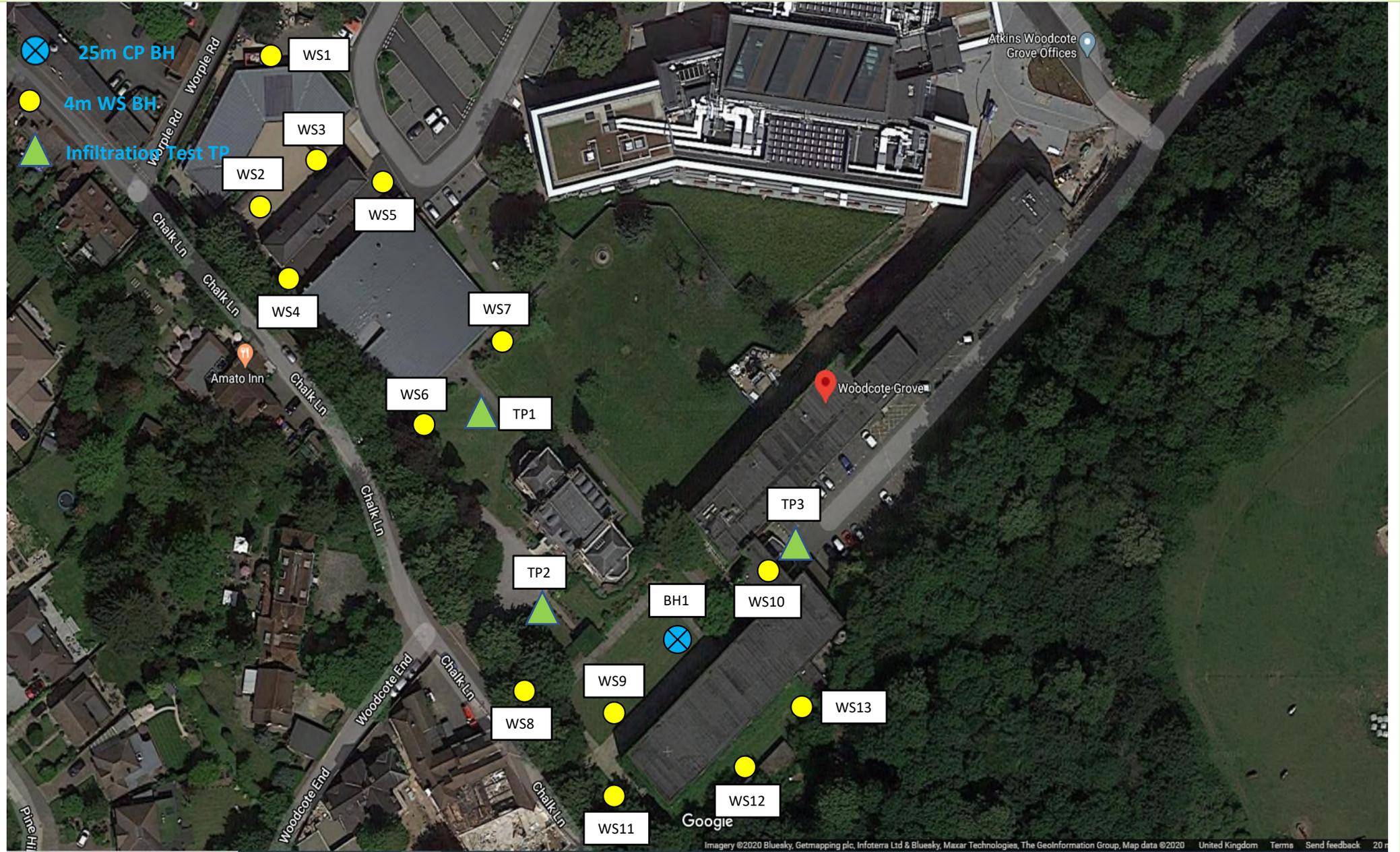
Drawn	Checked	Date
NK	NF	16.05.19

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Status  
**APPROVAL**

Figure 2

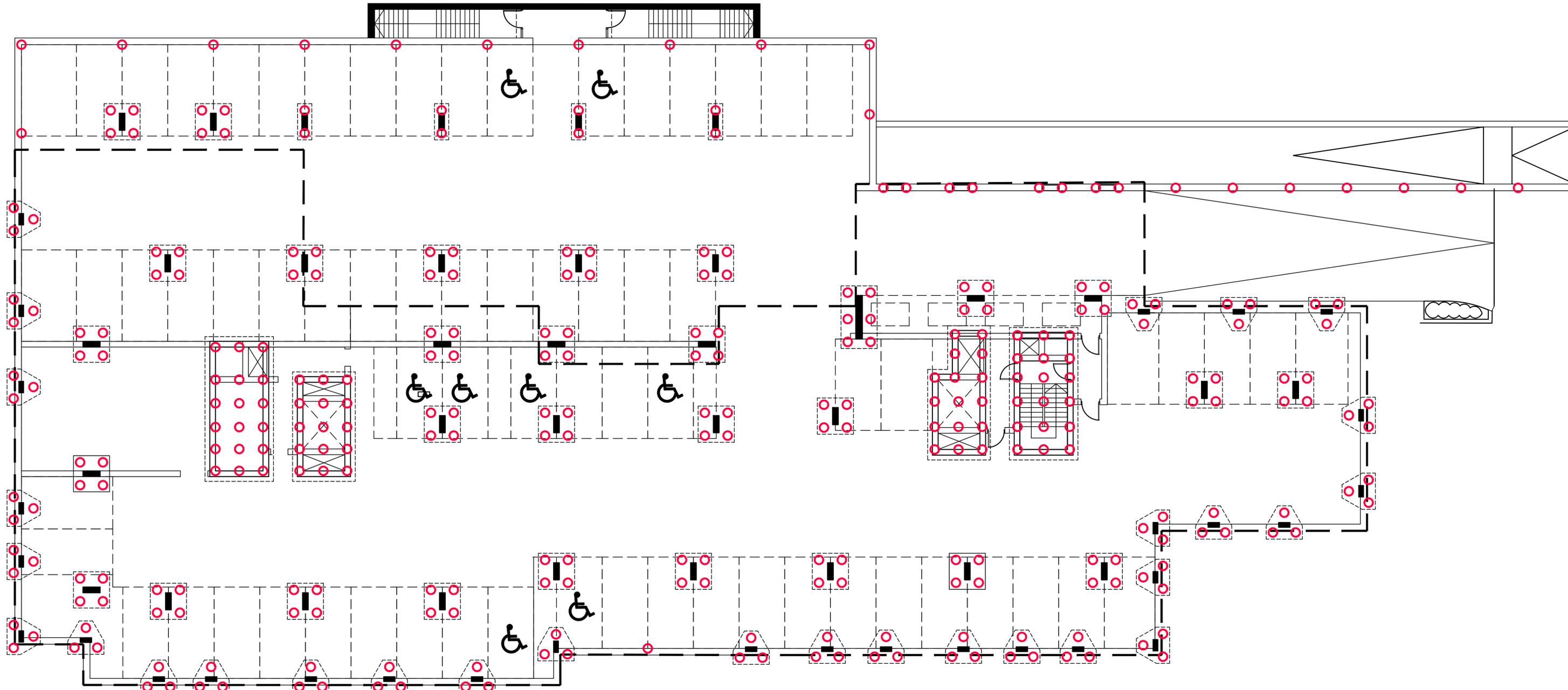
© ECE Architecture Limited. No dimensions to be scaled from drawing except for the purposes of Planning Applications. The contractor should check all dimensions on site. It is the contractor's responsibility to ensure compliance with Building Regulations.



Basemap: © Bluesky, Getmapping plc  
 Note 1: Exploratory holes shown are not to scale  
 Note 2: Elevations not shown



Client:	Canbury Construction Ltd	Date:	29/10/2020	Project ID:	LP2353
Project:	Woodcote Grove, Epsom	Title:	Exploratory Hole Locations	Fig. No.	3



*Basement Floor Plan - SSL = ???*

1:100 @ A1 1:200 @ A3

Figure 4: Provisional Pile Layout

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## APPENDIX B

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Screening Table:  
Soil Test Results

