

B PHASE I – DESK STUDY

A short summary of the Phase I Desk Study pertinent information is presented in this section and the reader is directed to our earlier report; LP2354 Phase I Desk Study for a full account.

6 Environmental Setting

6.1 Site Location and Description

Table 1 Site location and description details

	Classification / Information
Site Address	Woodfords, Shipley Road, Southwater RH13 9BQ
National Grid Reference	TQ156250
Site Size	c. 3.8 Ha
Elevation	c. 46 m AOD
Topography	Reasonably level and a slight $< 2^\circ$ slope down towards the south east
Description	The site comprises a central residential property with outbuildings, swimming pool and stable. The northern field contains a riding school, and the southern field is used as a paddock. Additionally, there is a static home, believed to be used in conjunction to the main residence. Overhead power cables are located in the south-east of site.
Structures	Building onsite of various ages and constructions. Diagonal cracking was noted along back wall of the garage building adjacent to the oil tank. A disused well was observed on site during the walkover. The well was covered at the time of the walkover and as such its depth is unknown. An ~1.5m deep swimming pool was present in the garden of the property near the centre of the site.
Surface Water Features	The site is bounded and traversed by several drainage ditches: A central drainage ditch with culverted sections, feeds a stream ~140m to the east of the site. Boundary drainage ditches were visibly dry. The western drainage ditch is culverted below the access road and sandbags were noted. Drainage ditches around stables were wet with c.10 cm water, no significant rainfall prior to visit.
Boundaries	The site is bounded by dry drainage ditches, barb wire fences and a mixture of hedgerow and trees, many of which exceed 5m in height.
Surrounding area	The site is located within the Shipley Parish on the suburban perimeter of Southwater, still designated a village in name but more in keeping with the character of a town. Envirocheck listed no contemporary trade directory entries (including Fuel Stations) within 250m of the site.

	The immediate surrounding areas are; residential, woodland (inc ancient), drainage and agricultural land
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6.1.1 Environmental Desk Study

Table 2 Summary of the environmental setting

	Classification / Information	Additional notes
Geology	Superficial: None Bedrock: Weald Clay- Mudstone	Unspecified crystals noted in local borehole records
Hydrogeology	Weald Clay- Unproductive Not within a Source Protection Zone No licence abstractions within 1km	Faults may act as conduits for groundwater Disused well noted onsite
Hydrology	Nearest Surface Water: Onsite central drainage ditch and culvert 3 discharge consents within 250m of the site, the nearest is 64m west of the site and is for the discharge of final treated effluent into the ditch to Lackenhurst Gill from a Domestic Property including farmhouse	The closest surface water feature for which the Environment Agency have surface water quality data is 800m to the east Blakes Gill Tributary
Flooding	Not within an EA flood zone 2 or 3 Low risk of groundwater flooding mapped 445m N off site	
Designated Environmentally Sensitive Sites	Ancient Woodland adjoins the North East corner of the site: Pollards Hill Wood	
Ground Workings, Mining/Extraction and natural cavities	None within 250m	Historic Brickyard c500m to the North

7 Site Usage

7.1 Current Land Use

The site is currently used as a residential property with 2 above ground oil tanks, swimming pool and stable with associated menage and paddock. Additionally, there is a static home, believed to be used in conjunction to the main residence with an above ground propane tank.

A sign was noted on the access gate for 'J Jones Designs and Construction Ltd' and mini digger and mini dumper were also noted on site. Construction materials and equipment were stored around the stables.

The fields themselves are separated into paddocks by electric fences and are used for grazing horses.

Discussions with the current resident indicate an outfall drain from a cesspit associated with the property crosses the southern field of the site in a roughly northwest to southeast alignment. Scaring in the grass was visible in the approximate location of the drain.

There is 1 active contemporary trade directory entry reported in the Envirocheck report database search within 500m. This relates to a dry cleaners, 445m to the north-east.

7.2 Evidence of Onsite Contamination

The walkover completed as part of the Desk Study Ref LP2354 identified the following features as possible sources of contamination:

- Northern Field soil bund: mixture of soils and wastes; glass- reinforced window glass, hexagonal bottle and wine bottles, bricks, concrete, ceramic, plastics, metal can, aerosol can 'mite spray' – insecticide, grey brown soil containing road subbase gravel, orange clay and the remains of burning.
- East side of menage soil bund; evidence of mixed waste burning including plastics. The mound may comprise soil removed to level and construct the menage.
- Central tree line hummocky ground;
- Above ground propane tank (c.750-1500 litres)
- Disconnected above ground single skinned unbunded oil tank [near stables] (c.900 litres)
- Above ground double skinned, banded 2500litre oil tank [rear of main residence]
- Construction materials [around stable area]

There are 3 above ground fuel storage tanks located on site. The site has a swimming pool, so whilst not seen on walkover it is assumed associated chemicals are stored on site. A sketch plan showing the location of the above features is presented in Figure 3, Appendix B.

7.3 Land Use Desk Study

Table 3 Summary of the site land use.

A summary of the land uses	Classification / Information
Neighbouring Land Use	No sources of contamination identified within 500m of the site
Site History	Site is a farmhouse and arable lands from 1875 – present times, an orchard was mapped onsite briefly in the 1990's. The surrounding area is farmlands, woodlands in 1875, with a brickpit c.800m north and a train station c.1km

	north. These became discussed around the 1980's and were repurposed into the Country Park and Downs Link Footpath respectively. There has been much residential development in Southwater Village and Woodfords now sits on the suburban margin of what is effectively now a small town.
Unexploded Ordnance	Low Risk
Waste Planning and Landfill Records	No Landfills or Waste Management, Treatment or Transfer sites identified within 500m
Other Regulatory Records	No Pollution incidents to controlled waters (major incidents within 250m) No Pollution prevention and controls (within 250m) No Registered radioactive substances No Hazardous Substances
Radon	The site is not within a radon affected area (less than 1% of homes are above the action level for radon).

7.4 Previous Investigations

The site has been the subject of 1 No. reports undertaken by LEAP, the findings of which are summarised above. LEAP has not been made aware of any other reports.

The preliminary geoenvironmental risk assessment completed as part of LEAP's previous investigation noted a limited number of potential contaminant linkage with the potential to impact future residents or controlled water receptors. These comprised heavy metals, PAH and asbestos around the existing structures and within the soil bunds present on site, and pesticides associated with historical agricultural activities. The risk of contamination associated with the tanks was considered to be very localised to the areas of the tanks due to the low permeability of the underlying soils. The bonfire areas were also noted to be a potential source of metals, PAH and VOC contamination.

The Geotechnical Risk Assessment indicated the risk of high volume change potential soils on site potentially resulting in the need to deepen foundations near trees. The assessment also noted that the Weald Clay is known to locally contain pyrite which, when weathered, can result in ground conditions aggressive to concrete.

On the basis of the initial review and preliminary risk assessment, the site was given a Geotechnical Classification of **Geotechnical Category I** in accordance with EN1997-1 §2.1(14)-(21).

C PHASE II - INTRUSIVE INVESTIGATION

8 Investigation Rationale

The key objective of the intrusive investigation was to aid the design and construction of the proposed development (Figure 2).

To achieve the investigation rationale, the scope of works comprised a total of 20 investigation locations across the site: 14 No. machine excavated trial pits to a maximum depth of around 3.0m, 2 No. shallow samples from the soil bunds and 4 No. DCP CBR tests.

The scope of the investigation was non-targeted to give general coverage and, in accordance with BS10175, took into consideration the proposed development plans and the preliminary geoenvironmental and geotechnical risk assessments that were developed in the previous desk study. Investigation was not possible within the extent of the existing riding school, stables or residential properties at the time of the investigation.

The investigation locations were located to provide general coverage and preliminary information on the ground conditions on site. At this preliminary stage the location spacings may not meet the requirements of BS8004:2015+A1:2020⁶ Clause 4.2.1.1 for low rise buildings and further investigation may be required for the detailed design stage.

The spacing of the investigation locations was generally consistent with the recommended density of 25 to 50m for an exploratory investigation after BS10175 Section 7.7 although investigation in the area of the existing buildings and gardens was not possible at the time of the investigation.

The site investigation locations are provided in Figure 4, Appendix B and Table 4 provides a summary of the rationale, proposed scope and what was achieved in the field:

Table 4 Rationale and Scope for Investigation Locations

Trial Hole/Test Location	Rationale	Proposed Depth (m bgl)	Achieved Depth (m bgl)	Additional Comments
TPI-TPI4	To provide information on the ground conditions and enable sampling for geotechnical and environmental testing.	3.0	2.7 – 3.2	Located to assess potential pesticide and metal concentrations across the northern and southern fields.

⁶ BS 8004:2015+A1:2020 Code of Practice for foundations

Trial Hole/Test Location	Rationale	Proposed Depth (m bgl)	Achieved Depth (m bgl)	Additional Comments
Bund I-2	Enable sampling of the material making up the bund.	0.5	0.5	To provide preliminary information on make up of the soil bunds.
DCPI - DCP4	Assess the California Bearing Ratio of the shallow soils in the area of the proposed roads.	0.9	0.9	

Several of the potential contaminant sources were situated within the area of the site which was still in use or was only accessible via pedestrian gates. Therefore, investigation around the tanks, swimming pool, stable area and residential properties was not possible and should be undertaken once the site has been vacated. The currently inaccessible area is presented in Figure 4 Appendix B.

9 Site Work

9.1 Date and Weather Conditions

The intrusive investigations were undertaken in a single phase between 27th and 28th of January 2022. At the time of the investigations, the weather was dry and bright.

The Met Office Climate summaries indicate that the three months preceding the site works were particularly dry with November and December 2021 and January 2022 experiencing 20%, 90% and <30% of average seasonal rainfall respectively.

9.2 Site Work Methods

9.2.1 Trial Pitting

Trial pits were dug by a backhoe excavator. The trial pits had a target depth of 3m bgl and were typically 0.6m wide by 2.0m long. Trial pit dimensions are included as Appendix F. Spoil was replaced in reverse order. Trial pits were left mounded to allow for future settlement.

9.2.2 Hand Pitting

Hand pits were excavated using hand tools. Spoil was reinstated in reverse order.

9.2.3 Soil Logging and Sampling

Soil samples were recovered from the boreholes and trial pits for field screening, logging and sampling.

Boreholes were logged in general accordance with the requirements of BS 5930:⁷ and BS EN ISO 14688⁸. Borehole logs are presented in Appendix F.

Visual and olfactory evidence of contamination was noted if encountered. These observations were used to aid scheduling of samples for chemical laboratory analyses, and are included on the borehole logs in Appendix F and summarised in Section 10.1.2.

Samples were collected with a clean sampling trowel or by hand (using dedicated nitrile gloves for each sampling location). Samples were placed into laboratory supplied sampling containers, specific to the type of analyses required.

All sample containers were sealed and labelled with a unique location identity, depth and date of sampling.

9.3 Sampling and Field Tests

9.3.1 Soil Sampling

Geoenvironmental soil samples were selected to ensure that near-surface exposure of human health via direct contact was targeted, as well as to spatially and vertically delineate possible sources of contamination. Environmental samples were also taken from the bunds to assess whether they present a potential source of contamination and their classification for waste disposal purposes.

Geotechnical soil samples were targeted to characterise the geological sequence, and to obtain characteristic soils properties and specific geotechnical design parameters as per the proposed development.

9.3.2 Field Vane Test

In-situ field vane tests were undertaken in cohesive soils in the trial pits in accordance with BS EN ISO 22476-9 (Draft). The results are recorded on the trial pits logs in Appendix F.

9.3.3 In-situ California Bearing Ratio Test – Dynamic Cone Penetrometer

4 No. in-situ CBR tests have been undertaken across the site using the Dynamic Cone Penetrometer (DCP), recording blow counts over 900mm of penetration from test level. The

⁷ BS5930:2015+A1:2020 Code of Practice for Ground Investigation

⁸ BS EN ISO 14688 Parts 1-2 (2018) Geotechnical Investigation and Testing. Identification and classification of soil

test method and interpretation of the results have been undertaken in accordance with DMRB CS229⁹ using a modified DCP. The results are attached in Appendix G.

9.4 Laboratory Analysis

9.4.1 Geotechnical Laboratory Testing

Selected samples of the soils have been classified by laboratory analysis for geotechnical design purposes. The laboratory testing has been carried out by Geolabs Ltd at its laboratories in Watford, in accordance with BS1377¹⁰ and BS EN ISO17892¹¹. The sampling technique, type, storage and transport and the number of laboratory tests have been undertaken where possible in accordance with BS EN 1997-2:2007 and BS EN ISO 22475¹².

The following laboratory tests have been undertaken:-

Table 5 Geotechnical Laboratory Testing

Test	Number of tests	
	Weald Clay - Clay	Weald Clay – Mudstone
Moisture Content	11	-
Atterberg Limit Test	11	-
Sulphate Determination	3	1
pH	3	1

The geotechnical laboratory test results are provided in Appendix I.

9.4.2 Chemical Soil Analysis

Selected samples of soil were subjected to laboratory testing.

The suite of soil and groundwater contaminant analysis took into account the potential contaminants of concern identified in the CSM (heavy metals, PAHs, asbestos and pesticides). Soil samples were also analysed for pH and total organic carbon (TOC) to support the

⁹ CS 229 Data for Pavement Assessment. Design Manual for Roads and Bridges; Pavement; Inspection and Assessment

¹⁰ BS1377 Parts 1-9:1990 Methods of test for Soils for Civil Engineering Purposes

¹¹ BS EN ISO 17892 Parts 1-12 Geotechnical Investigation and Testing. Laboratory testing of soil

¹² BS EN ISO 22475 Parts 1-3 Geotechnical Investigation and Testing. Sampling methods and groundwater measurements

selection of assessment criteria in the subsequent quantitative risk assessment (QRA) for human health.

The laboratory testing also included selected samples for waste classification purposes to support the client with future materials management options.

Sampling techniques and storage have been undertaken as per BS 10175:2011+A1:2013 Code of Practice for Investigation of Potentially Contaminated Sites. The laboratory testing was carried out by The Environmental Laboratory Ltd at its laboratories in East Sussex. Where available, the tests for soils procedures were UKAS and MCERTS accredited.

The following analyses were completed on selected soil samples based on field observations and for general vertical and lateral coverage:

- 10 No. metals (As, Cd, Cr, CrVI, Cu, Pb, Hg, Ni, Se, Zn)
- 10 No. USEPA 16 PAHs
- 10 No. Asbestos identification
- 3 No. organochlorine and organophosphorus pesticide suites.
- 10 No. pH
- 10 No. TOC
- 3 No. Waste Acceptance Criteria tests

The laboratory test results are summarised in Section F and Appendix J, and the laboratory analytical certificates are provided in Appendix K.

9.5 Constraints to the Scope

Access was restricted to the central portion of the site, where the existing properties and gardens are positioned. Furthermore, due to field boundaries, gates and low trees some areas were inaccessible to the excavator. The investigation locations were therefore positioned in the paddock areas to the north and south of the property. No investigation was undertaken within the extent of the riding school.

10 Ground Conditions

The ground conditions are described in detail in the logs attached in Appendix D. In summary the soil conditions were as follows:

Table 6: Summary of soils encountered

Depth From (m)	Depth To (m)	Soil Type	Description

0.0	0.20 / 0.30	TOPSOIL	Greyish brown to dark brown silty clayey TOPSOIL with rootlets.
0.20 / 0.30	0.85 / 1.80	CLAY	Firm to stiff orangish brown to brown mottled grey to light grey occasionally laminated slightly silty CLAY.
0.85 / 1.8	1.5 / 2.2	CLAY	Firm to stiff light orangish brown and light grey occasionally finely laminated slightly gravelly slightly silty CLAY. Gravel is fine to coarse tabular laminated siltstone and mudstone.
1.80 / 2.70	2.7 / 3.2	MUDSTONE & SILTSTONE	Interbedded very weak to weak brown to orangish brown thinly laminated ironstained SILTSTONE and MUDSTONE & Extremely weak to very weak blue grey thinly laminated silty MUDSTONE.

The ground conditions encountered generally comprised topsoil over firm to stiff silty clays which became slightly gravelly with depth to between 1.8m and 2.7m bgl over interbedded very weak siltstones and extremely weak mudstones which were recovered as tabular gravel. The depth to rock head varied slightly across the site with slightly shallow depth to rock in the southern portion of the site. In the northern area the siltstone and mudstones were encountered between 1.8m and 2.7m bgl. In the southern field rock was encountered between 1.5m and 2.1m bgl. The rock at depth was generally very weak to weak siltstone although occasional bands of extremely weak bluish grey mudstone were encountered in several of the excavations. Fossil rich bands were observed within the mudstone in trial pits TP2, TP3 and TP9.

Relic shear surfaces were noted within the clays at between 0.5m and 1.4m bgl in trial pits TP1, TP2, TP5, TP8 and TP13. These surfaces represent layers where the soils have previously sheared and exhibit what is referred to as residual strength. Potentially desiccated soils were encountered in TP2 and TP13 adjacent to the tree line.

The topsoil encountered in trial pits TP9, TP10, TP11, TP12 and TP14 (all located in the south section of the site) appeared reworked and contained rare fine brick gravel. Furthermore, fine charcoal fragments were noted in the topsoil encountered in TP9.

10.1 Soil bunds

Two soil bunds were noted on site during the previous walkover. Bund 1 located on the north western boundary of the site was ~57m in length, ~1.5m high and between 3m and 4m in width. Bund 2 adjacent to the riding school was ~48m long by 4m to 5m wide and ~1.5m to 2m tall. Excavations were undertaken into the undisturbed sections of the soil bunds, one per bund to provide a preliminary assessment of their contents and enable sampling for preliminary classification. Bund 1 was found to comprise topsoil over reworked natural clays with occasional wood fragments noted in both the clay and the topsoil. Machine access was not available to Bund 2 and as such a shallow hand excavation was undertaken on top of the bund.

The hand pit encountered silty clayey topsoil over reworked natural clay soils. Following the removal of fences additional sampling of the bunds is recommended to confirm their contents.

10.1.1 Groundwater

No groundwater strikes or seepages were encountered in any of the trial pits during the investigation.

10.1.2 Visual and Olfactory Evidence of Contamination

With the exception of the fine brick and charcoal noted in trials pits 9, 10, 11, 12 and 14 no visual or olfactory evidence for contamination was observed within any of the excavations during the investigation.

D GEOTECHNICAL INFORMATION

11 Strata Encountered

11.1 Topsoil

The site is underlain by silty clayey topsoil with abundant rootlets which was noted to appear reworked in the south section of the site.

11.2 Clay – Weald Clay Formation

The topsoil was underlain by firm to stiff clays to 1.5-2.2m. The results of the geotechnical laboratory testing are summarised in Table 7 below.

Table 7: Summary of Geotechnical Test Results for Clay

Test	Range
Moisture Content (%)	18.4 – 36.9
Liquid Limit (%)	43 - 79
Plastic Limit (%)	23 – 29
Plasticity Index (%)	20 - 50
Undrained shear strength (kN/m ²)*	100 - 205
Water Soluble Sulphate Content (g/l)	<0.010 – 1.9
Acid Soluble Sulphate Content (%)	0.016 – 1.4
Total sulphur (%)	0.023 – 0.84
pH	6.0 – 8.4

*Measured using a hand shear vane apparatus

Hand shear vane testing undertaken within the trial pits at depths of between 1.4m and 1.7m bgl returned undrained shear strengths of between 100 and 205kPa indicating stiff to very stiff soils.

The results of Atterberg limited testing indicate the cohesive soils beneath the site comprise intermediate to very high plasticity clays. An A line plot summarising the plasticity testing results is present in Figure 5 Appendix B.

11.3 Siltstone & Mudstone – Weald Clay Formation

The clays were underlain by interbedded grey and brown siltstones and occasional blue grey mudstones to the full depth of investigation. Laboratory testing of the siltstone and mudstone was beyond the scope of works, however, based on the field tests the siltstone and mudstone

are classified as extremely weak to weak. The brown and grey mudstones and siltstones were generally very weak to weak whilst the blue mudstones were extremely weak.

E GEOTECHNICAL APPRAISAL

12 Geotechnical Design

The foregoing geotechnical appraisal does not constitute a Geotechnical Design Report in accordance with BSEN1997. The following recommendations are for preliminary design purposes only.

For the detailed design, the short-term and long-term design situations must be considered. Where relevant, the following limit states should be considered:-

- Loss of equilibrium of the structure or the ground, considered as a rigid body, in which the strengths of structural material and the ground are significant in providing resistance (EQU)
- Internal failure or excessive deformation of the structure or structural elements in which the strength of structural materials is significant in providing resistance (STR)
- Failure or excessive deformation of the ground, in which the strength of soil or rock is significant in providing resistance (GEO)
- Loss of equilibrium of the structure or the ground due to uplift by water pressure or other vertical actions (UPL)
- Hydraulic heave, internal erosion and piping in the ground caused by hydraulic gradients (HYD)

The following factors should also be considered.

- Overall stability and ground movements
- Nature and size of the proposed construction including the design life
- Conditions with regards to the surroundings (e.g. neighbouring structures, traffic, utilities, vegetation, contamination etc.)
- Ground and groundwater conditions
- Influence of the environment.

13 Geotechnical Appraisal

13.1 Swelling and Shrinkage

Based on the laboratory test results in Section D, an overall classification of NHBC **HIGH** Volume Change Potential (VCP) is recommended for the clay soils.

Foundations will therefore require deepening in accordance with NHBC Chapter 4.2 where clay soils are encountered near trees. Foundation depths should be calculated based on the

mature height of the tree, however, the existing height is relevant for trees which are to be removed. Deepening may be terminated where the rock is encountered at depth.

13.2 Sulphates

The potential for high levels of sulphates within the natural soils on site has been identified due to the underlying geology. In particular, construction activities that may substantially disturb previously unweathered strata and expose sulfur minerals such as pyrite to air, water and bacteria can result in the relatively rapid oxidation of such minerals producing high levels of sulphates. In accordance with the BRE¹³ methodology, four samples, three of the clay and one of the mudstone were therefore tested for water and acid soluble sulphate, total potential sulphate (TPS) and pH.

Based on the results of the testing, oxidisable sulphides (OS) are locally >0.3%, indicating pyrite is present. Using highest sulphate class calculated from both the water soluble sulphate and TPS, the soils are classified as Design Sulphate Class DS-5 and assuming static groundwater, the ACEC class is AC-4s. It should be noted that the DS-5 classification is based on the one sample of the mudstone tested with all other samples tested exhibiting significantly lower sulphate concentrations, It may be possible to reduce the sulphate classification with further testing.

13.3 Groundwater

No groundwater strikes or seepages were encountered in any of the excavations completed on site. However, it should be noted that the investigation was undertaken towards the end of a particularly dry winter and as such shallower groundwater may be anticipated during wet winter months. Slight groundwater seepages along the interface between the clays and the underlying mudstone are often encountered onsite underlain by the Weald Clay.

Long term groundwater monitoring was beyond the scope of works and would be required to fully assess the groundwater regime.

13.4 Bearing Capacity and Foundations

13.4.1 Shallow Foundations

Allowable Bearing Capacity or Pressure is a conservative estimate of the ultimate bearing resistance of the ground, selected on the basis of the soil/rock description, and taking a presumed degree of settlement into account. It has traditionally been used to check simple

¹³ Building Research Establishment Special Digest I: 2005. Concrete in aggressive ground. Part I: Assessing the aggressive chemical environment.

foundation designs. The use of this method is acceptable under BS EN 1997-1¹⁴ as a “prescriptive method”, with the allowable bearing pressures now termed “presumed bearing resistance”.

The presumed bearing resistance is highly dependent on proposed depth of foundation, width of foundation and the structure’s tolerance for settlement. The following section provides a preliminary presumed bearing resistance assuming a stated depth and width of foundation and assumes that settlements of up to 25mm can be tolerated by the structure. Should alternative foundation depths and dimensions be required, or the proposed structure have different long term movement requirements then the following assessment should be re-evaluated.

All loads should be transferred beneath any topsoil, made ground, loose, soft, low strength, desiccated or disturbed soils and transferred onto the stiff clays below about 1.0m depth. On the basis of the findings of the intrusive investigation to date, a preliminary presumed bearing resistance of 125kPa may be assumed for a 600mm wide foundation on the stiff clays below about 1.0m and this capacity could be increased further should foundations extend to the mudstone at depth. Foundations will require deepening in the clay soils near trees to NHBC HIGH VCP precautions.

It is noted that one proposed structure, Plot 73, is in close proximity to the existing swimming pool. Care should be taken to ensure foundations do not load the infilled pool. At this stage foundations in this area should extend below the depth of infill into the natural soils at depth.

Further information may be required for the detailed design stage, including the foundation design details and further investigation to meet the requirements of BS EN 1997 and BS 8004¹⁵ particularly in the area of the site currently occupied by properties.

Where foundations are stepped or span different soil types, allowance should be made for nominal reinforcement.

13.5 Floor Slabs

With reference to NHBC Standard 5.2, suspended floor slabs are recommended:-

- Where the depth of fill exceeds 600mm
- Where foundations are deepened below 1.5m in accordance with NHBC Standards Chapter 4.2
- Where desiccated soils are encountered
- Where vibratory ground improvement techniques have been used

¹⁴ BS EN 1997-1(2004)+A1:2013 Eurocode 7:Geotechnical Design: General Rules

¹⁵ BS 8004:2015+A1:2020 Code of Practice for foundations

- On sloping sites
- Where foundations have been piled.

Given the high VCP of the clay soils suspended floor slabs are recommended on site.

13.6 Roads

13.6.1 Test Results

A series of 4 No. dynamic cone CBR tests were carried out along the line of the proposed access road. The results were in the range 2.9 – 7.6%

Based on the results of plasticity testing the shallow soils are assessed as marginally frost susceptible.

13.6.2 Recommendations

TRRL 1132 Structural Design of Bituminous Roads indicates that for soils with plasticity ranging from 20% to 50% a CBR of 2% to 4% should be anticipated. A preliminary design CBR value of 2.5% is recommended for a silty clay subgrade.

Further confirmatory testing may be required if the proposed roads are to be adopted.

High plasticity clays such as the Weald Clay soften rapidly when exposed to moisture. As such excavation to formation level during the wet winter months should be avoided and where possible prolonged exposure of the formation level to the elements should be avoided. Where significant softening does occur over excavation and replacement with suitably compacted granular fill is recommended.

13.7 Excavations

Excavations in the silty clays should be stable in the short term. However, the site is gently sloping, and relic shear surfaces were noted in some excavation to a maximum depth of 1.4m bgl. As such excavations may be unstable where these surfaces intersect the excavation face. Therefore, excavations perpendicular to the slope should be avoided and should be kept short (say around 5m) and be backfilled as soon as possible.

Furthermore, although no groundwater seepages were encountered during this investigation the works were undertaken during a period of particularly dry weather. As such the potential for minor groundwater seepages particularly at the boundary between the clay soils and the underlying mudstone should be anticipated. Excavations will therefore be unstable in the long term and should be backfilled as soon as possible. Allowance should be made for light pumping.

Appropriate Health and Safety precautions must be adhered to where man entry into excavations is required. Even stiff clay soils at shallow depth can collapse, particularly following wet weather. Alternative foundation methods may need to be adopted where trench footings cannot be safely or satisfactorily constructed.

13.8 Filling

The preliminary recommendations contained within this report assume that ground levels are to remain at a similar level across the site for the proposed development, and that no significant changes in level are proposed.

An existing swimming pool is located within the garden of the Woodfords property at the centre of the site. Prior to redevelopment the pool will have to be excavated and backfilled with suitable compacted granular fill.

13.9 Slope Stability

The site is gently sloping at an angle of $\sim 2^\circ$ to the southeast. Provided no significant level changes are proposed, no slope stability issues are anticipated. However, if significant levels changes are proposed, then global stability checks are recommended.

13.10 Retaining Walls

LEAP is not aware that any retaining walls are proposed on site.

13.11 Settlement

Based on the presumed bearing resistance given in Section 13.4, settlements should be within typical tolerable limits for the low rise development proposed.

If soft clays are encountered at formation level or below, significant settlement should be anticipated and serviceable limit state analyses will be required.

At this stage it is assumed that ground levels will remain at the current level for the proposed development. If significant level raises are proposed, this may induce significant settlement in the natural soils and detailed settlement analyses will be required.

Where foundations are stepped or span different soil types, differential settlement should be anticipated and allowance should be made for nominal reinforcement.

13.12 Heave and Uplift

In accordance with NHBC Standards Chapter 4.2, precautions against heave should be used where foundations are within the influence of trees and the resulting foundation depth is greater than 1.5m. Compressible material must be provided against the inside faces of all external wall foundations greater than 1.5m in depth. For pier and beam foundations, additional voids are required below ring beams.

14 Geotechnical Recommendations

Further assessment including a geotechnical design report will be required once the details of the proposed construction are known.

Further intrusive investigation is recommended within the previously inaccessible areas, and additional sulphate testing may enable a reduction in the Design Sulphate Classification.

F GEO-ENVIRONMENTAL QUANTITATIVE RISK ASSESSMENT

15 Revised Conceptual Site Model

15.1 Introduction

The preliminary conceptual site model completed as part of the desk study identified a number of plausible contaminant linkages. The revised CSM provides an updated understanding of the site based on the findings of the site investigation and analytical results and was used to inform the quantitative risk assessment (QRA) undertaken in Sections 16 onwards in the context of the proposed residential land use.

No evidence for visual or olfactory evidence for hydrocarbon contamination was encountered within any of the excavations on site. However, it should be noted that investigation was limited to the area of the site not currently occupied by residential buildings and private gardens, and it was not possible to undertake trial holes in the vicinity of the fuel tanks.

15.2 Distribution of Contamination

The exploratory logs are provided in Appendix F and a summary of the laboratory analytical results in Appendix J.

The ground conditions encountered on site comprised topsoil over firm to stiff clays of the Weald Clay Formation. No made ground was encountered on site with the exception of two soil bunds situated in the northern portion of the site. Based on one excavation into the undisturbed portion each of the two bunds they appeared to comprise reworked natural soils with rare wood fragments.

The topsoil in the southern portion of the site appeared reworked with fine brick gravel noted in several excavations (Trial pits 9, 10, 11, 12, and 14). Fine charcoal fragments were also noted within the topsoil in TP9. No other visual evidence for contamination was observed within the soils.

16 Human Health Risk Assessment

16.1 Rationale and Approach

The generic quantitative risk assessment (GQRA) for human health was conducted in line with the CLEA methodology by comparing the soil analytical results from the ground investigation with Generic Assessment Criteria (GAC). The GACs were selected using the rationale and assumptions provided in Appendix L.

Sets of soil GACs are available for SOMs of 1%, 2.5% and 6%. In this case, TOC in the Made Ground samples that were analysed ranged from 0.48 to 2.7%. Using the conversion of $SOM = TOC \times 1.72$, this equates to a SOM range of 0.83 to 4.6%. 1% SOM was considered to be appropriate to maintain conservatism.

For some contaminants of concern, direct contact will be the dominant pathway for exposure. In order to support with development options, human exposure to all unsaturated soils, irrespective of depth, has been considered for the purpose of this assessment. This will maximise the information available to the design team on the suitability of all unsaturated material and can support with their materials management options.

The risk assessment did not include statistical analysis. CL:AIRE 2020¹⁶ provides guidance on the appropriate sample sizes for particular statistical distributions of data and non-targeted soil sampling approaches. The number of soil samples collected in the site investigation indicates that statistics are not appropriate to use in this case.

The potential risks to human health from the inhalation of vapours derived from groundwater were discounted in the CSM.

The focus of the GQRA was chronic risks to human health because these often occur at lower doses than acute responses to exposure. Groundworkers during construction and future maintenance may be exposed to unacceptable levels of contamination. The CLEA assessment approach is designed to evaluate long term chronic exposure to contaminants and therefore, this approach is not appropriate for groundworkers who will be exposed for short durations on a site. As such, a GQRA was not undertaken to evaluate the potential for unacceptable exposure to groundworkers and future maintenance workers. A qualitative evaluation is however, provided in Section 16.2.

16.2 Evaluation of Potential Risks to Future Residents

The samples analysed comprised six samples of the topsoil, two of the underlying natural clay soils and two from the soil bunds. The laboratory analytical results were assessed to determine the potential risks to future site users under a generic residential land use scenario assuming that homegrown produce are consumed (resi HGP). The quantitative risk assessment is provided in Appendix J and the laboratory certificates are provided in Appendix K. Summary tables are provided below.

¹⁶ CL:AIRE, 2020 'Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration.' CL:AIRE, Buckinghamshire. ISBN 978-1-905046-35-5.

Table 8: Summary of Soil Contamination Test Results for the shallow soils

Determinand	Number of samples	Number >LOD	Maximum Conc. (mg/kg unless otherwise stated)	Generic Assessment Criteria (mg/kg)	Number of Exceedances
METALS					
Arsenic	8	8	19.7	37	0
Cadmium	8	0	<0.5	22	0
Chromium	8	8	32.3	910	0
Hexavalent Chromium	8	0	<0.8	21	0
Copper	8	8	22.9	2,400	0
Lead	8	8	39.8	200	0
Mercury ¹	8	0	<0.5	40	0
Nickel	8	0	16.1	130	0
Selenium	8	0	<1.0	250	0
Zinc	8	8	68	3,700	0
ASBESTOS					
Asbestos	8	0	None detected	Presence	0
HYDROCARBONS					
Benzo(a)pyrene ²	8	0	<0.1	5.0	0
Naphthalene	8	0	<0.1	2.3	0
Total PAHs	8	1	0.5	n.v.	-

Notes to table

1. Assessment criterion based on inorganic mercury
 2. As a surrogate marker for genotoxic PAH
 3. As a marker compound for threshold PAH
- n.v. – no appropriate value

None of the metals or PAH compounds tested for were recorded at concentrations in excess of the Generic Assessment Criteria (GAC) values for a residential development with private gardens. Furthermore, all pesticides tested for were recorded below the laboratory limit of detection. No asbestos was detected within any of the samples tested.

It is noted that no investigation was possible around the existing properties, gardens and fuel tanks. As such there remains the potential for as yet unidentified contamination and further sampling in these areas is recommended once the current occupants have vacated.

Table 9: Summary of Soil Contamination Test Results for the soils bunds

Determinand	Number of samples	Number >LOD	Maximum Conc. (mg/kg unless otherwise stated)	Generic Assessment Criteria (mg/kg)	Number of Exceedances
METALS					
Arsenic	2	2	20	37	0
Cadmium	2	0	<0.5	22	0
Chromium	2	2	33.1	910	0
Hexavalent Chromium	2	0	<0.8	21	0
Copper	2	2	33.4	2,400	0
Lead	2	2	33.3	200	0
Mercury ¹	2	0	<0.5	40	0
Nickel	2	2	33.1	130	0
Selenium	2	0	<1.0	250	0
Zinc	2	2	107	3,700	0
ASBESTOS					
Asbestos	2	0	None detected	Presence	0
HYDROCARBONS					
Benzo(a)pyrene ²	2	1	1.2	5.0	0
Naphthalene	2	0	<0.1	2.3	0
Total PAHs	2	1	12.6	n.v.	-

Notes to table

1. Assessment criterion based on inorganic mercury
 2. As a surrogate marker for genotoxic PAH
 3. As a marker compound for threshold PAH
- n.v. – no appropriate value

Preliminary laboratory testing of the samples taken from the two soil bunds recorded none of the contaminants tested for at concentrations considered to pose a risk to future residents. Additional confirmatory testing is recommended to fully assess the contents of the bunds prior to redevelopment.

16.3 Evaluation of Potential Risks to Groundworkers

There is a legal duty for employers to ensure that suitable health and safety controls should be in place to protect groundworkers and they should evaluate the potential for exposure including using data provided in this report which should be included in any future Health and Safety file for the site under The Construction (Design and Management) Regulations 2015.

The investigation works completed to date have not encountered any contaminants at concentrations that would pose a risk to construction or groundworkers. Assuming that appropriate PPE is utilised and site hygiene is maintained the risk to construction workers is considered negligible.

17 Controlled Waters Risk Assessment

17.1 Evaluation of Potential Risks to Controlled Waters

The site is underlain by the Weald Clay Formation which is designated as a non-aquifer. Furthermore, no groundwater was encountered during the investigation undertaken on site. Given the very low contaminant concentrations recorded on site the risk to groundwater is considered very low.

A drainage ditch crosses the centre of the site on a roughly northwest to southeast alignment. No in situ fuel tanks were located in the vicinity of the drainage ditch. One decommissioned tank had been placed ~8 – 10m from the central ditch for disposal. During the investigation no staining or odours were noted associated with this tank. Given the very low contaminant concentrations encountered the risk to surface water receptors posed by the site is considered negligible. This assessment would require revision should contamination associated with tank be encountered during the further investigation works. Care should be taken to ensure that excess sediment does not enter the surface water system during the construction phase.

18 Waste Disposal

It is anticipated that the proposed development will generate waste soils and materials will need to be removed from site as part of the construction process.

Where soils are to be disposed off-site, it is the duty of the waste producer, in this case Reside Developments, 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. There are various forms of pre-treatment that are acceptable. In this case it could include “reduction in volume”, which could be achieved by segregating the Made Ground and re-using part of it on site.

Where made ground soil is to be re-used on site then it is recommended that this is carried out under the CL:AIRE Definition of Waste Industry Code of Practice (DoWCoP) for re-use of soils¹⁷.

All of the samples tested have been screened using the HazWasteOnline© tool for a waste classification purposes. Based on the results of this screening it is considered that the soils would be classified as non-hazardous for waste disposal purposes.

As a preliminary classification three samples, one of the natural clay soils and one each from the two soils bunds were tested for waste acceptance criteria to indicate whether it will be accepted at landfill. The results indicate that both the natural soils and the soil bund waste would be accepted as inert waste however it is recommended that this is confirmed with a haulier/receiving site.

It is strongly advised that detailed discussions be held with remediation/groundworks contractors and that receiving landfill sites are identified in advance of commencing any waste removal.

19 Geo-Environmental Conclusions

The investigation to date was limited to the paddocks to the north and south of the developed area and encountered topsoil over firm to stiff clays over mudstones and siltstones at depth. No groundwater was encountered during the investigation. No made ground was encountered on site although the topsoil appeared reworked over much of the southern half of the site.

Chemical testing of the shallow soils and earth bunds have encountered no contaminants at concentrations considered to pose a risk to future residents or construction workers. However, investigation to date has been limited to the paddocks with no investigation around the existing properties. As such there remains the potential for as yet unidentified contamination in these areas of the site.

20 Geoenvironmental Recommendations

Access to the central portion of the site around the stables and existing properties was limited as these areas were still in use at the time of the investigation. Further sampling beneath the footprint of these structures and around the fuel tanks is recommended following their demolition. At this stage remedial measures to mitigate the risk to future residents is not considered necessary however this assessment may require revision following the additional

¹⁷ The Definition of Waste: Development Industry Code of Practice. Version 2 2011. CL:AIRE

investigation. For preliminary costing purposes it may be prudent to allow for removal of some contaminated soils around the three fuel tanks.

It is unknown whether importation of natural soils will be required as part of the development. Importing of uncontaminated natural materials will require a Materials Management Plan (MMP) to be produced and a declaration made to CL:AIRE under DoWCoP.

APPENDIX A – Limitations

Limitations

LIMITATIONS

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. Unless explicitly agreed otherwise in writing, this report has been prepared under LEAP's standard terms and conditions, as included in the quotation for this works.

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.

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. LEAP cannot be held responsible for any disclosures or changes in regulation that are provided post production of this report, and will not automatically update the report.

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.

The extent of the exploratory holes, laboratory testing and monitoring undertaken may have been restricted due to a number of factors including accessibility, the presence of buried or overhead services, current development and site usage, timescales or clients specification. The exploratory holes only assess a small proportion of the site area with respect to the site as a whole, and as such may only provide an overall assessment of ground conditions on site. The presence of hotspots of undisclosed contamination or exceptional and unforeseen ground conditions cannot be discounted.

Eurocode 7 gives guidance on the type of sampling, sample quality, number and spacing of intrusive investigations, and number of laboratory tests required. It is intended that the Geotechnical Information section of this report will fulfil the general requirements of the Ground Investigation Report as set out in section 6 of Eurocode7¹⁸, although this is subject to the restrictions imposed on the investigation as listed above. For geotechnical design, Eurocode 7 requires the Geotechnical Design Report to address both the geotechnical and

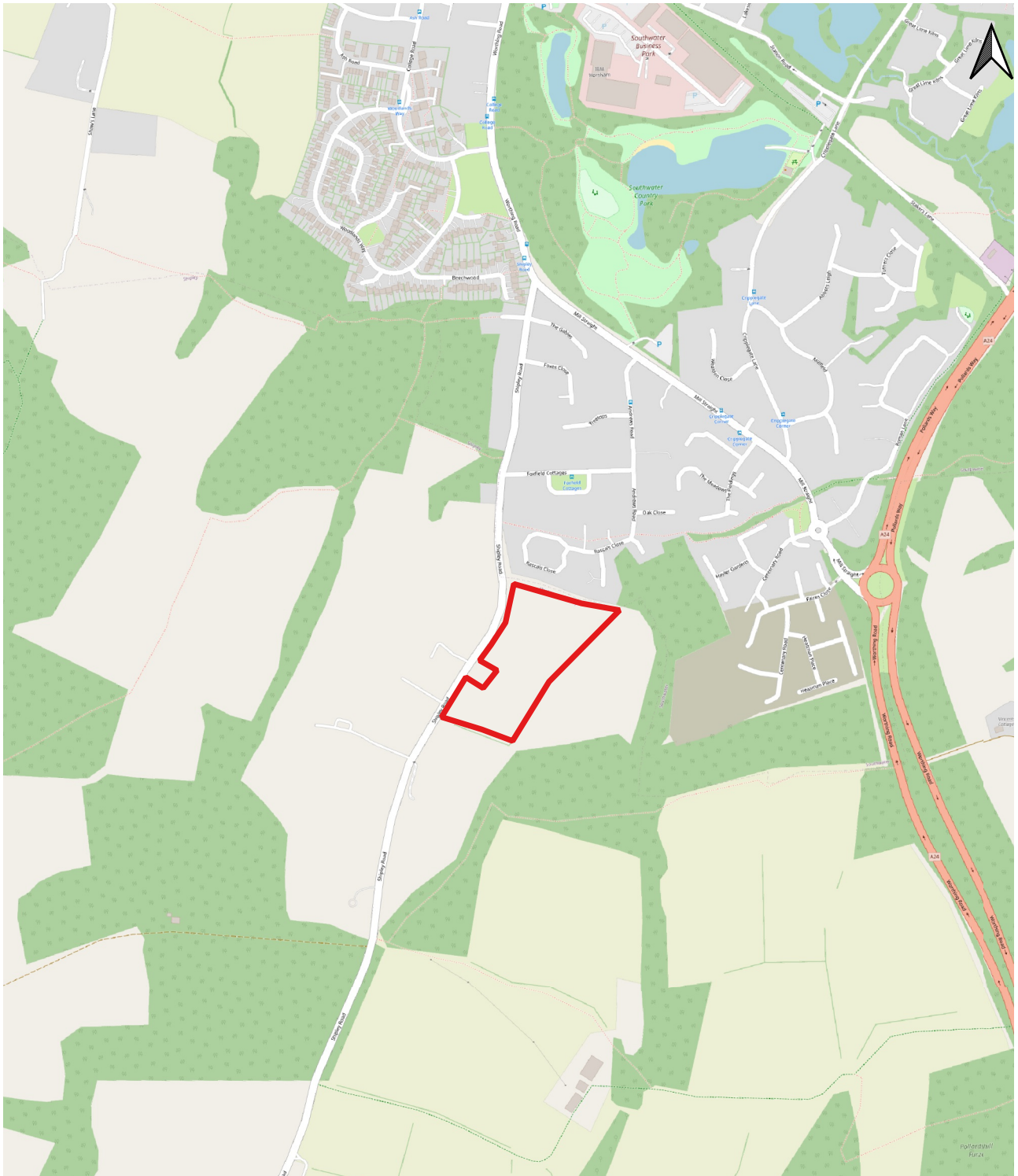
¹⁸ BS EN 1997 Eurocode 7- Geotechnical Design - Part 1: General Rules (2004) and Part 2: Ground Investigation and Testing (2007)

structural aspects of the geotechnical design for both the limit and serviceability states. The Geotechnical Appraisal section of this report will not meet the requirements of a Geotechnical Design Report (GDR), and should therefore be used for preliminary guidance only.

The presence of asbestos may be noted during the site walkover survey, intrusive investigations and/or from the results of contamination testing. However, this report does not constitute an asbestos survey. On this basis, the presence of asbestos on site cannot be discounted and a full asbestos survey should be undertaken.

APPENDIX B – Figures and Drawings

Figures and Drawings



Basemap: © OpenStreetMapcontributors
Note 1: Elevations not shown



Client: Reside

Title: Site Location

Project ID: LP2826

Project: Woodfords, Shipley Road, Southwater

Date: 23/02/22

Figure No. 1



Indicative Accommodation Schedule

Master	
210m	2-Bedroom Flats
114m	2-Bedroom Houses
75m	2-Bedroom Bungalows
75m	3-Bedroom Houses
114m	3-Bedroom Bungalows
114m	4-Bedroom Houses
Acheule	
210m	2-Bedroom Flats
114m	2-Bedroom Houses
75m	2-Bedroom Flats
75m	2-Bedroom Houses
114m	3-Bedroom Houses
114m	4-Bedroom Houses
Total: 72 Dwellings	

Core Parking 1 space per Flat
 2 spaces per 2.5/3-bed House, 4.4-bed attached
 4 spaces per detached 4-bed house
 20 additional on-street spaces
 Spaces marked with asterisk **Sparked** can be removed

Cycle Parking 1 space per Flat, 2 spaces per house with all
 bathrooms, garden access or shared access



leap
environmental

Date: 23/02/22

Project ID: LP2826

Title:	Proposed Layout
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Fig. No.	2
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Basemap: Supplied by the client



Client: Reside Developments

Title: Site restraints

Project ID: LP2826

Project: Shipley Lane, South Water

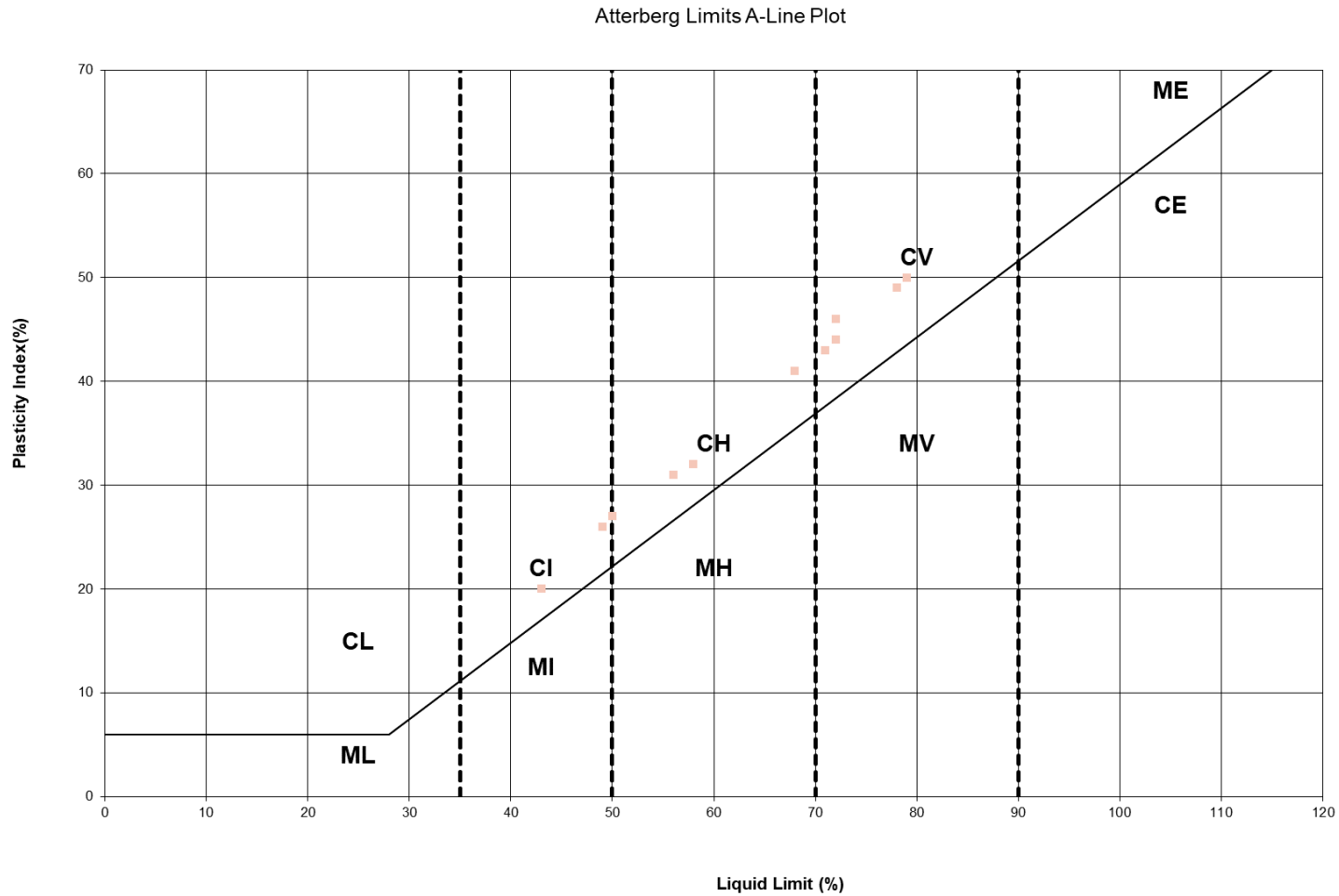
Date: 08/03/22

Figure No. 3

[illegible]

Note 1: Exploratory holes have been positioned by 3rd party surveyors and should therefore only be taken as approximate
Note 2: Exploratory holes shown are not to scale
Note 3: Elevations not shown

	Client:	Reside Developments	Title:	Site Investigation Locations	Project ID:	LP2826
	Project:	Woodfords, Shipley Road, Southwater	Date:	23/02/22	Figure No.	4



Client supplied image, ©ECE Architecture



Client:	Reside Developments	Date:	23/02/22	Project ID:	LP2826
	Woodfords, Shipley Road, Southwater				
Project:	Woodfords, Shipley Road, Southwater	Title:	A line plot	Fig. No.	5

APPENDIX C – Photographic Record

Photographic Record



Plate 1 – View from the TP1 location across the area of the hors riding school.



Plate 2 – View from TP2 looking south east.



Plate 3 -Arisings from TP9 with overhead lines visible beyond.



Plate 4 – Ground conditions encountered in TP1