



Phase II Geo-Environmental Assessment

Pfizer
32 New Lane
Havant
PO9 2NG

Prepared for:

Havant Property Investment LLP
38 Seymour Street
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PFIZER, 32 NEW LANE, HAVANT

NON-TECHNICAL CLIENT SUMMARY

This report presents the findings of a Phase II Intrusive Investigation undertaken to determine ground conditions, establish if there are any environmental risks associated with the site and its development and provide a geotechnical appraisal. Pertinent findings and conclusions may be summarised as follows:

- The previous Phase I Desk Study identified the site to comprise a pharmaceutical distribution centre, formerly used as for manufacturing. On this basis, risks were identified associated with human interaction with shallow soils, intrusion of soil gases into buildings and risks to controlled waters from site-derived contamination.
- This intrusive investigation comprised the drilling of 22 boreholes and 12 trial pits across the site, with ground conditions found to comprise a moderate thickness of made ground overlying successive layers of cohesive and granular River Terrace Deposits. Below this lay London Clay, which comprised of a soft initial layer of silt overlying stiff, grey clay.
- Laboratory analysis of shallow and deeper soils from across the site has not currently identified contamination capable of posing a significant risk to future site users in a commercial setting. Moreover, laboratory testing of groundwater has not identified concentrations considered to pose a risk to the groundwater body, whilst soil vapour analysis has not identified a risk associated with intrusion of organic vapours into future buildings (or neighbouring properties).
- An initial programme of ground gas monitoring has found the site to fall into Characteristic Situation 1, for which no ground gas protection measures would be required.
- Although significant risks have not been identified by this work and the site as a whole does not appear to be heavily contaminated, further investigation of currently inaccessible areas of the site are planned subsequent to demolition of the existing buildings, some of which are key contaminant source areas. Once these works are carried out, a final Conceptual Site Model and if necessary, Remedial Strategy will be prepared to safely redevelop the site.

ENGINEERING SUMMARY

- The ground condition may be suitable for the use of conventional spread foundations with a bearing capacity of between 95 kN/ m² and 125 kN/ m² depending on depth and nature, although if structural loads exceed these capacities, then a deep foundation solution, such as piles may need to be considered.
- Suspended ground floor construction or an appropriately re-engineered fill beneath ground bearing floor slabs is recommended.
- Soakaway testing has identified the shallow ground conditions to be variable in permeability, although testing in the granular superficial deposits found high infiltration rates that may be suitable for infiltration drainage. However, due to the generally shallow groundwater found across the site, further targeted testing is recommended to identify an appropriate location and depth.
- A design sulphate class of DS-1 is considered suitable for concrete in direct contact with Made Ground and the superficial River Terrace Deposits at the site, with an aggressive chemical environment for concrete (ACEC) of AC-1. However, the underlying London Clay should be classified as DS3 (AC-3).

The above points represent a simplified summary of the findings of this assessment and must not form the basis for key decisions for the proposed development. A thorough review of the details is contained within the following report, or alternatively get in touch and we'll talk you through it.

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Where ground investigations have been conducted, these have been limited to the level of detail required for the site in order to achieve the objectives of the investigation.

The report has been written, reviewed and authorised by the persons listed above. It has also undergone EPS' quality management inspection. Should you require any further assistance regarding the information provided within the report, please do not hesitate to contact us.

The National Planning Policy Framework 2019 requires a competent person to prepare site investigation information, which is defined as a person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation. EPS considers that it fulfils these criteria and would welcome any request for staff CVs or case studies to demonstrate it.

As stated within DEFRA's Contaminated Land Statutory Guidance (2012), with any complex risk assessment it is possible that different suitably qualified people may reach slightly different conclusions when interpreting the same information. EPS recognises this and considers the conclusions presented within this report to be robust and appropriate but input from the Local Authority and their judgement in line with this guidance would still be welcomed.

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1 INTRODUCTION

In January 2021, Environmental Protection Strategies Ltd (EPS) was commissioned by Havant Property Investment LLP to complete a Phase II Geo-Environmental Assessment Report at Pfizer, 32 New Lane, Havant PO9 2NG ('the site'); see Figure 1. Selected site photographs are included as Appendix A and a Detailed Site Layout is included in Appendix B.

The work was commissioned in order to partially fulfil pre-commencement requirements relating to contaminated land for the demolition of the existing buildings and construction of a new commercial warehouse building (Havant Borough Council ref APP/21/00200). A proposed development plan is included as Appendix C.

An initial desk-based report, reference *Phase I Environmental Assessment – 32 New Lane, Havant (Issue 4)* – January 2021 (Reference: UK20.5052), was previously undertaken for the site by EPS in January 2021 (Issue 4), a summary of which is provided in Section 2. It is recommended that the previous report is reviewed before the reader examines the content of this document.

This current report presents the findings, conclusions, and recommendations of the Phase II Intrusive Investigation undertaken as instructed.

This report has been prepared and checked for quality under the National Quality Mark Scheme for Land Contamination Management (NQMS). This is a scheme developed by the National Brownfield Forum to provide visible identification of documents that have been checked for quality by a Suitably Qualified and experienced Person (SQP). The NQMS declaration is included as Appendix D.

1.1 Objectives

The objectives of this investigation were as follows:

- a) Investigate potential contaminant linkages identified in the Conceptual Site Model (CSM) by means of investigating shallow soils, groundwater and soil gases.
- b) Determine the potential risks posed by the site and make recommendations for further work that may be required, to ensure safe development in accordance with the Environment Agency's *Land Contamination: Risk Management* guidance (LC:RM, 2020) and the *National Planning Policy Framework*.
- c) Collect information on ground conditions and strength in order to make appropriate recommendations for geotechnical design.
- d) Undertake soakaway testing in order to assess the infiltration characteristics of the site and make recommendations for appropriate drainage design.
- e) Perform a preliminary Unexploded Ordnance (UXO) risk assessment.

1.2 Scope of Work

To perform an exploratory assessment of the site in accordance with the principles and requirements of DEFRA's 'Contaminated Land Statutory Guidance' (2012), BS10175 – 'Investigation of Potentially Contaminated Sites', BS5930:2015 'Code of practice for ground investigations' and BS EN 1997 'Geotechnical Design', the following tasks were undertaken:

Intrusive Investigation:

- Site walkover, inspection of any visual evidence of contamination at the site, obtaining photographic records.
- Health and safety briefing / site supervision.
- Drilling of 11 boreholes to depths of between 12.0m and 20.0m using a cable percussive drilling rig.
- Installation of groundwater monitoring wells within seven of the deep boreholes.
- Drilling of 11 window sample boreholes to a depth of 1.8m below ground level (bgl) using a track-mounted percussive rig.
- Installation of gas/vapour monitoring wells within all window sampler boreholes.
- Excavation of 12 trial pits using a mechanical excavator.
- Soakaway testing at three locations
- Continual logging of ground conditions including inspection of samples for visual and olfactory contamination, and laboratory analysis of selected representative soil samples.
- In-situ testing using a photo-ionisation detector (PID).
- One return groundwater monitoring visit and collection of groundwater samples for laboratory analysis.
- One return gas/vapour monitoring visit using summa canisters and three additional gas monitoring visits using a GFM Gas Analyser and PID.

Reporting:

- Data collection
- Interpretation of data including completion of a Generic and Detailed Quantitative Risk Assessment

The findings and conclusions of these investigations are presented in the following sections. It should be noted that further investigations are intended once the existing buildings have been vacated and demolished.

1.3 Limitations and Constraints

The purpose of this report is to present the findings of a soil sampling investigation conducted at the location(s) specified. When examining the data collected from the investigations made during the assessment, Environmental Protection Strategies Ltd (EPS) makes the following statements:

No investigation method is capable of completely identifying all ground conditions that might be present in the soil or groundwater under a site. Where outlined in our report, we have examined the ground beneath a site by constructing a number of boreholes and / or trial pits to recover soil and / or groundwater samples. The locations of these excavations and sampling points are considered to be representative of the condition of the whole site subsurface however, ground conditions are naturally variable and it may be possible that the conditions encountered may differ to those found during the investigation.

No visible evidence of Japanese Knotweed was identified during the site walkover. However, this plant can be difficult to identify in the early stages of growth and therefore it is not always possible to identify its presence at certain times of the year. For this reason, EPS cannot confirm that Japanese Knotweed rhizomes do not exist and it is recommended that if it is suspected that this species, or other similarly invasive plants are present at the site, a specialist contractor should be commissioned to make a detailed assessment.

The investigation was carried out to assess the significance of contamination resulting from the use of the site as identified in this report. Unless EPS has otherwise indicated, no assessment of potential impact of any other previous uses has been made.

2 SITE CHARACTERISATION

The following section provides a summary of the information collected for the previous Phase I Environmental Assessment completed by EPS in January 2021 in relation to the site location and geo-environmental context. The previous assessment was desk-based and has been supplemented by EPS as needed as part of the current phase of works. It should be noted that the previous report included a 'limb' of the site extending to the north, known as the 'North Site Distribution Warehouse'. This part of the site is no longer included in the redline boundary.

2.1 Site Location & Description

Detail	Description
Location	The site is located adjacent to the east of New Lane, in northeast Havant, Hampshire.
National Grid Reference	472540, 107180
Topography	The site area is flat, situated at around 15m Above Ordnance Datum (AOD).
Site Description	The property is an industrial facility covering around 66,000 square metres (6.6ha), of which around 28,000 square metres has been developed as buildings. A number of separate buildings lie within the site as detailed in Section 2.3. Currently the pharmaceutical operations undertaken on site involve repackaging injectables for onward supply, but manufacturing has taken place in the past. The site is predominantly surfaced with hardstanding, although a large, gravelled area is located towards the northwest. Vegetation is mostly limited to semi-mature to mature trees along the site boundaries.
Surrounding Land Use	The site lies in a predominantly urban area, with industrial facilities, centre and commercial outlets to the north and a site occupied by Sumika Polymers Ltd (a plastics extruding operation), and Kenwood UK south of the property, bound by a railway line to the east. Residential areas are located to the immediate west of the site along New Lane and to the east beyond the railway line.

A plan showing the site location is provided as Figure 1.

2.2 Geo-Environmental Setting

Detail	Description
Geology	Geological maps of the area suggest the natural ground conditions are likely to comprise superficial deposits covering the majority of the site, which are described as glacial / postglacial undifferentiated river terrace gravels. These comprise sands, silts and clays, with the exception of the western edge of the site where clay and gravels are present, referred to as Head (deposits). Bedrock below the superficial deposits is shown as the London Clay Formation.
Hydrogeology	Groundwater vulnerability maps for the area show that the superficial deposits are classified as a Secondary A Aquifer, whilst the underlying bedrock is classified as an Unproductive Strata. The site lies within an Inner Source Protection Zone (SPZ), designated as Zone 1c by the EA, covering sub-surface activity only (i.e. the groundwater is abstracted at depth from beneath the overlying confining low permeability London Clay). In previous work, Golder Associates inferred a groundwater flow direction from north to south and found that rest levels within 3m of the surface (around 12m AOD).
Hydrology	The nearest surface watercourse is the River Lavant, a watercourse which lies around 75m west of the site beyond New Lane. The watercourse flows in a roughly southerly direction, ultimately discharging into Langstone Harbour.
Landfill & Waste	No active or historic landfills are recorded within 1km.
Licensed Industrial Activities	The site formerly held an authorisation under the Integrated Pollution Control (IPC) regulations, licensed to Wyeth Research (UK) Ltd and to John Wyeth and Brother Ltd, for the manufacture and use of organic chemicals within the chemical industry. These authorisations have since been revoked. The site holds authorisations granted by the Environment Agency for various waste management activities on site, both as a Licensed Waste Management Facility and a Registered Waste Transfer site. These authorisations relate to the generation, storage and transfer of pharmaceutical-type wastes from primary site operations. EPS are not aware of any licensed radioactive sources that have been utilised at the site, and none are listed in the Envirocheck. Sumika Polymer Compounds UK Ltd, located just to the south hold a permit for the use of inorganic chemicals, including use of antimony.

Detail	Description
Summary of Site History	The site is located in the northern area of Havant and comprised undeveloped agricultural land from the mid to late nineteenth century until the post WW2 period. The main site was purchased in 1956 and was developed for pharmaceutical purposes in phases. In 1985 the northern distribution area (largely outside of current redline boundary) was purchased from Goodmans Loudspeakers. By the early 1950s, the central area was being used as allotment gardens with the remainder being undeveloped. In the following decade, the site underwent the first built development and by 1960, a factory building had been established in the north-western part, covering approximately 25% of the total site. Further expansion of the site was undertaken in the south-western and north-eastern areas of the site during the late 1960s and 1970s. By the early 1980s, the site comprised 5 large factory buildings and 6 smaller buildings throughout the property. Historical, 'tanks' are shown on the south west, centre north and the north east of the site around this time. By the early 1990s, further integration of the factory buildings had been carried out and much of the site was fully utilised. The configuration comprised rectangular buildings and a general absence of stand-alone structures such as tanks and storage vessels. Some demolition/ clearance of buildings has occurred in recent times as described in Section 2.3. The 2020 Ordnance Survey map shows the north-eastern and western areas to be site clear of buildings. In recent years, site activities have involved the repackaging of medical injectable products into dispensable units. Materials are imported into site in bulk quantities and no manufacturing of product is undertaken. Operations in the past did include primary and secondary manufacturing and of note in this respect, pharmaceutical operations began on site in around 1956/1957, a small fine chemicals manufacturing unit (FCMU) was established in 1961, and by 1992, a solvent recovery plan was installed at the site.

Detail	Description
Previous Site Assessment	Pfizer commissioned a report to reference their exit from the site from Golder Associates (UK) Ltd, entitled "<i>Divestiture Environmental Site Assessment</i>" dated 26th September 2019. The 2019 Golder report covers a review of previous environmental investigations and works conducted at the site by another consultant, ERM, in 1999 and 2008, though does not include these original reports. The Golder report, however, provides an overview of the basis and detail of these investigations, and the primary conclusions of this review are as follows: • An investigation was carried out in the late 1990s in relation to the loss of solvents and effluent containing solvents (including chlorinated solvents) in the north eastern area of the site and around the FCMU. Following investigation and analysis of sub-surface (soils and groundwater) by ERM, although parts of the site had become contaminated from materials sourced in this area, the overall impact of the solvents was considered to be limited. Phenol, acetone and isopropanol were also detected in groundwater around the FCMU. Around 30 cubic metres of impacted soils were excavated along with the solvent area drainage channel and sump from this part of the site in 1999. ERM indicated that a former solvent store may have also existed near to their BH1, in the north eastern corner of the main site. Publicly available aerial imagery from 1999 (Google Earth™, 2021) shows earthworks underway in this area of the site, possibly associated with the remedial works. • An investigation was carried out in 2008 in the area of the current Biotech Packaging Facility (BPF) prior to the demolition of the former tabletting and dispensary buildings. Although parts of the site had become contaminated from materials sourced in this area, ERM concluded that there was no significant impact of site-derived contamination on the underlying sub-surface conditions and no remedial works were warranted. • An investigation was carried out in 2009 close to the former wastewater sumps prior to the site's connection to the foul sewer network. Although parts of the site had become contaminated from materials sourced in this area possibly associated with damaged drainage, ERM concluded that there was no significant impact of site-derived contamination on the underlying sub-surface conditions and no remedial works were warranted.

Detail	Description
Golder Groundwater Investigation & DQRA (2020)	In addition to the 2019 Golder report, EPS have also been provided with a <i>Groundwater Investigation</i> (ref 20137712.600/A.0, February 2020) and <i>Detailed Quantitative Risk Assessment (DQRA) for Controlled Waters</i> (ref 20137712.602 / A.0, March 2020), with the key points summarised below: • Golder installed eight groundwater monitoring wells to sample groundwater through late 2019 into 2020. The well positions were based on previously recorded contamination down-gradient positions, as well as utilising pre-existing well. • The historical well (BH4-1996) initially reported the chlorinated solvents TCE and PCE above screening criteria in 2019, but concentrations were markedly lower in the subsequent 2020 samples. ERM's boreholes BH1, BH3 and BH4 also identified chlorinated solvents when sampled in the past (in 1996). BH4-1996 was located in the central northern area, near the solvent warehouse, with GA04 nearby. GA07 was located on the eastern boundary outside Building G. • Vinyl Chloride (a daughter product of TCE and PCE) was reported above the screening criteria in GA04, and TCE in GA07. No other CoCs were detected in Golder's wells and they concluded a significant decrease compared to historical results. They also stated that based on observations made during drilling, the water table aquifer consists of a generally clayey material and migration is not a significant concern. The concentrations were not found to be widespread and appeared to be confined within the property boundary. • Acetone, Isopropanol and Phenol previously detected on the site, were not picked up by Golder in 2019/2020. • The subsequent DQRA focussed on shallow chlorinated solvent concentrations and concluded that based on a 50m compliance point, the calculated contaminated concentrations would be significantly lower than comparison values protective of controlled waters. On that basis, no unacceptable risks were identified. EPS understands that there are other reports pertaining to the site in addition to those referenced above prepared by ERM. As with the ERM reports, these have not been seen or reviewed by EPS.

Detail	Description
Select Planning History	A review of Havant Borough Council's planning portal includes the following relevant records with regards to potential contamination at the site: 1) 91/ 52191/ 006 Extension to canopy on sheltered drum store in north east corner of site (May 1991). 2) 92/52191/011 Solvent emission control plant to include new chimney and solvent/water disposal tanks (2 of) (November 1992). 3) 98/ 52191/ 021 Construction of a Firemain Pumphouse, two water storage tanks and the installation of an underground firemain (June 1998). 4) 98/52191/023 Demolition of existing manufacturing buildings and construction of new warehouse within the western part of the site (July 1998). 5) 98/ 52191/ 022 Construction of a housing over the existing pump station, the re-construction of the Solvent Capture Control Building and associated pipebridges within the northern part of the site (July 1998). 6) 01/ 52191/ 027 Removal of 2 oil storage tanks and bund wall. New bund wall and extension of existing plant room to north elevation. Installation of 6 chiller units with service canopy and extension to existing pipe bridge (March 2001). 7) APP/ 10/ 00955 Construction of new cold storage warehouse facility (February 2011). 8) APP/ 13/ 00837 Erection of new metal-clad substation enclosure (October 2013).
Drainage & Utilities	Golder stated that other than contained storage and use of diesel for power generation purposes (four generators exist on site in central southern area), there are no other above-ground storage tanks (ASTs) or underground storage tanks (USTs) used for oil storage. The remediation undertaken in the north east of the site in 1999, described above, was associated with damaged drainage. A CCTV survey did reportedly identify damage in that area although the remediation stated that the drainage (along with the impacted soils) was also removed as part of the remediation. It is not known whether any historical soakaway drainage exists. There is reportedly no oil-interceptor system associated with the site's surface water drainage arrangements. Golder also stated that there are six electricity substations on site, although they are 'dry-type' and do not contain PCBs. It is not clear however what substations were used in the past. No process wastewater is currently generated by the facility.

2.3 Current & Former Building layout

The following key current and former buildings have been identified and reference should be made to Appendix B for the current layout.

Building *	Location on Site	Description
A	NE corner	Small building built in 1974 of unknown use, possibly waste or former solvent store.
B	SE corner	Pharmaceutical building built in 1978, replaced by Building H.
C	SE corner	Bulk liquid store and laboratory built in 1978, including sugar solution storage for cough syrups.
D	Central Northern area	Possibly part of manufacturing support warehouse, built in 1964 replaced by Building N.
E	Central Northern area	Very small building built adjacent to boiler house ('R') in 1970. Unknown use.
F	Central Western Area	Built in 1956, central site building, replaced by Building S.
G (Present in 2021)	NE corner	Biotech Packaging Facility (BPF) which incorporates the site's waste storage area. Built c.2009.
H (Present in 2021)	Central Eastern area	Pharma Offices & Packaging Facility. c.1992. Previously manufacturing of pharmaceuticals
I	Central Western Area	Built in 1956, central site building, replaced by Building S.
J	Central Northern Area	BPF Switch room.
K (Present in 2021)	SE corner	Offices & packaging facility for quality control. c.1981-1990.
L (Present in 2021)	SE	Offices & Packaging Facility. c.1981-1990.
M	Central Eastern area	Transfer area associated with Building H.
N (Present in 2021)	Central Northern area	Low Bay Warehouse, just south of Building Q. c.1964/ 66
O	No records identified	-
P (Present in 2021)	Central	High Bay Warehouse just south of Building N containing the European Distribution Centre c.2009.
Q (Present in 2021)	Central Northern area	Site workshop and solvent (toluene) and oils store, just north of Building N. Partially redundant c.2002.
R	Central North/ NW area	Former boilerhouse. Now electricity substation.
S	Central northwest area.	'Injectables' and Nutritional SMA Large building demolished c.2002.
T	NW corner	Engineering workshop demolished c.2002.
U	NW corner	Former administrative building, demolished c. 2002.
V	Western area	Staff Restaurant. Demolished with northern site area in 2015-17.
W	Western area	Reception/ Security
X	No records identified	-
Y	No records identified	-

Building *	Location on Site	Description
Z (Present in 2021)	Central Southern/ SW Area	Cold Stores 2 and 3, built in 2011. Diesel generator adjacent to these stores.
Fine Chemicals Manufacturing Unit (FCMU)	NE	Built in 1961. Adjacent to solvent storage. Demolished 1998.
Solvent Recovery	NE	Built in 1992.
SMA Building	SW area	Build in 1971, associated with smaller Buildings J and N. Demolished c.2001. SMA is infant milk formula.
Tablet/ Dispensary	NE area	Built in 1956 (tablet) and 1975 (dispensary) and are replaced by BPF (Building G). Former tabletting and dispensary buildings were in central area, near BPF
North Site Distribution Warehouse	NE 'limb' (Outside of current redline).	Building in 1985 (but not currently within redline site boundary).

*Note: Some of the earlier records do show that building references changed slightly as the site developed, for instance Building G was originally in the central northern area not the current BPF Packaging facility. EPS have attempted to use only the latest references for consistency.

2.4 Industry Profiles

Reference has been made to two Department of Environment Industry Profiles (published in 1995), which are available via CL:AIRE's Water and Land Library (WALL). The two profiles which have been reviewed are highlighted below:

DoE industry Profile— Chemical Works: Fine Chemicals Manufacturing Works

The profile describes fine chemicals as those which are manufactured to high and well-defined standards of purity. They include, amongst others, intermediates for pharmaceuticals, high purity laboratory reagents, vitamins, food additions and high purity solvents. The FCMU on this site appears to have been quite small scale. Some points which may be relevant to this site:

- Carrier solvents are used to transfer material mixes through the reaction steps, and may include toluene, methanol, dichloromethane and acetone.
- Solvent recovery plants are typical Potential Areas of Concern (PAOC) as are underground effluent drains (or soakaways)
- Contaminants of Concern (CoCs) include soluble organics such as alcohols, acetone, ethyl acetate and phenol, which can migrate considerable distances from the source and permeate water supply pipes. As well as less soluble solvents such as toluene and chlorinated solvents.

DoE Industry Profile - Chemical Works: Pharmaceutical Manufacturing Works

The profile describes primary and secondary processing (as was historically undertaken at this site). Primary processing is the extraction and production of the active ingredient from its sources using methods such as organic synthesis, biological processes, extraction of animal or vegetable substances or inorganic chemical preparation. Secondary processing is the conversion of the active ingredient into products suitable for administration.

- Organic solvents are mainly of concern in primary production, as solvents are used in far smaller volumes in secondary production.
- Acids and alkalis are used in both primary and secondary processes, occurring often in both bulk storage areas and associated pipework.

2.5 Key Potential Areas of Concern (PAOC)

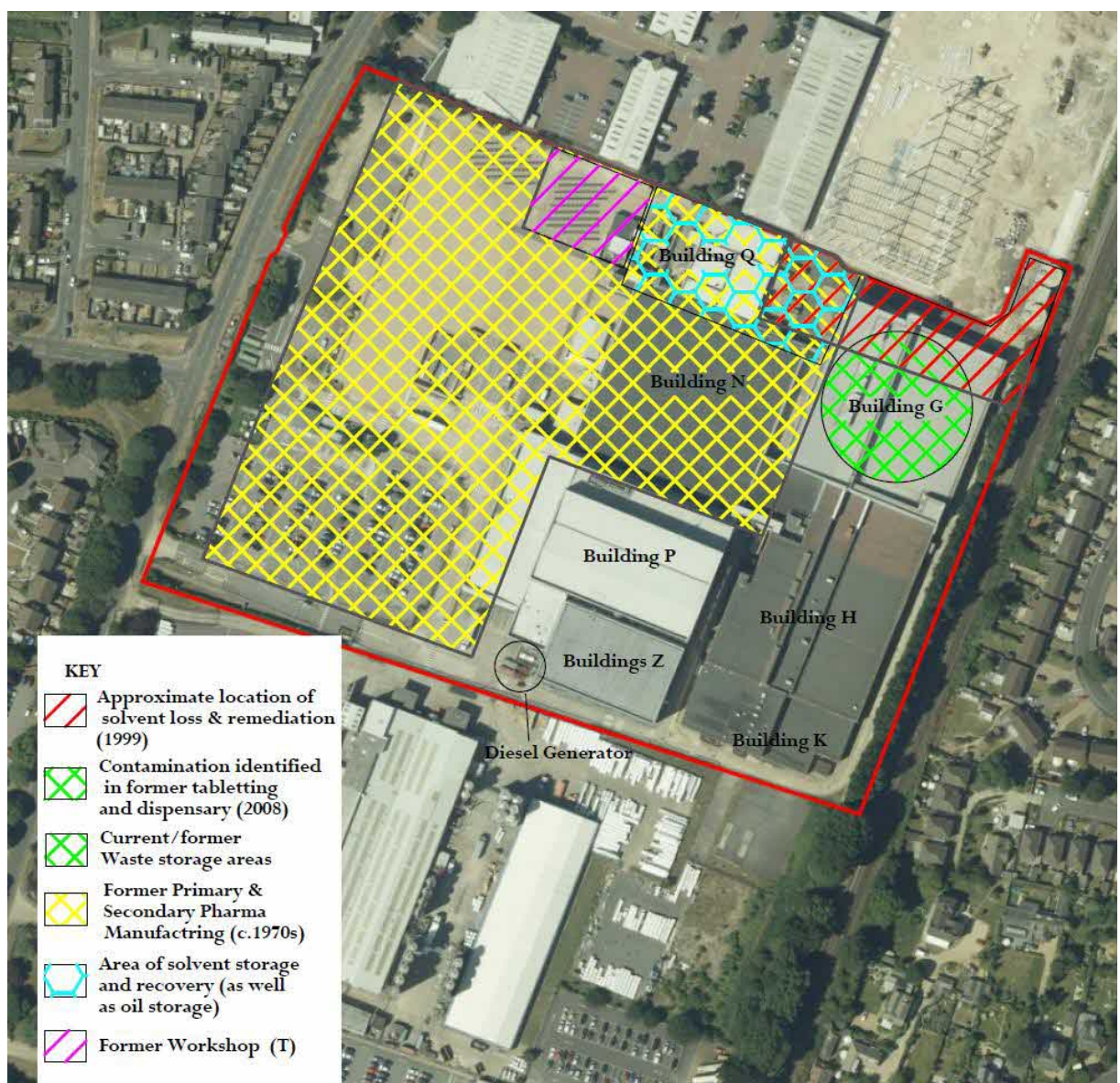
The Phase I report identified a need for further investigation in several areas, summarised as follows:

- Localised detailed delineation of the already identified and partially remediated areas of potential concern in the north-east of the site including the FCMU, Waste Storage Area, Boiler House and Solvent Storage).
- Assessment of ground gas conditions beneath the areas of the site under future building footprints.
- Shallow groundwater conditions with some additional monitoring wells to bolster the existing monitoring well network and provide a single unified snapshot of groundwater conditions at the site now. This being for both human health and controlled waters protection.

Based on the available site records, additional PAOC would include:

- Diesel generator/fuel storage in the central southern area, including former oil storage removed in around 2001.
- Former engineering workshop (Building T).
- Historical records in the Golder report shows that in 1995, Cyanamide products were transferred to the site. Cyanamide is a product associated with significant VOC, cyanide, PCB and metals contamination in America (specifically at Pfizer's Wyeth Holdings site in New Jersey in the 1990s). Reference – https://www.nj.gov/dep/srp/community/sites/pi/american_cyanamid_fs.pdf
- It also has to be acknowledged that the 'contaminating potential' of the site is likely lower now than it was in the past, as primary and secondary processing no longer takes place. Therefore, the site layout when those processes were undertaken is potentially more significant in terms of contamination. During those periods, buildings were present to the centre, west and northwest, many of which do not remain or have changed significantly.

- Drainage infrastructure, particularly drainage runs present when the site was used for manufacturing but prior to full mains connections and solvent recovery should be considered a PAOC at this stage. It is known, based on the 1999 remediation, that the drainage did cause some contamination in the past but it is not known as to whether the problem extended further across the site. All drainage runs from the 1950-70s would likely be made of ceramic sections and not entirely water-tight. Even if no formal soakaway or infiltration drainage was present, the gradual accumulation of contamination in and around the drainage runs, including within any pea shingle surrounding the pipes, is plausible and should not be discounted.



2.6 Information Gaps & Uncertainty

EPS are not aware of any site-wide investigation, and only the Golder reports have been made available as background, but there is still a high level of historical records in terms of the contamination status of the site.

The remediation undertaken in 1999 should be beneficial but it is not known if all of the impact was captured, or what specifically the source was beyond the operations generally undertaken in that area (i.e., it is not clear whether the source was ongoing after the remediation was completed). EM R referenced a possible additional former solvent store to the north east (possibly Building A or in that area), which would be separate to the main solvent warehouse (Building Q).

Prior to the development of the solvent recovery plant in 1992, it is not known whether the solvent that was not recovered was simply lost through fugitive emissions or whether there was liquid loss to the drainage/ground. The remediation undertaken in 1999 would suggest some solvent had been discharged through drainage. It is not known whether infiltration or soakaway drainage existed, but the shallow ground conditions may have been viable for it. The 2009 investigation referenced in the Golder report describes a connection to mains drainage in Section 2.2, suggesting the site was not fully connected to mains drainage in the past.

There is a record of 'fire chemicals' being stored on the site within the planning records. EPS are not aware of any perfluorinated chemicals (PFCs), i.e., perfluorooctane sulfonate (PFOS) or perfluorooctanoic acid (PFOA) which have been stored or used on site and have not therefore been considered CoCs in the CSM. The fire firefighting store is shown on Appendix B, in the central northern area. Equally, refrigerants used at the site, which are discussed in the Phase I assessment, are not considered capable of posing an ongoing risk from soil or water contamination and have also not been considered a CoC.

2.7 Regulatory Input

Within the Phase I report, an initial consultation was provided by Environmental Health team of Havant Borough Council for the redevelopment of the site for commercial purposes.

The officer, Mr Jonathan Driver, highlighted the following points:

- There are a number of potentially contaminating landuse features associated with the extant Pfizer site, and it is known that the underlying local geology (river terrace deposits) is capable of supporting contaminant migration over significant distances (well over a hundred metres) from the point of release.
- Whilst it is acknowledged that the proposals are for continued commercial use, it is nevertheless appropriate to address contamination associated with the prior (extant) landuse as a material planning matter to the redevelopment of the site.
- The risk driver for any remediation is likely to be off-site receptors (residential properties within 25-50 m of the site boundary) but risks also must also be acknowledged for the protection of employees, and the development itself. Assessment is expected to be proportionate, and to respond to the context of the site.

- There are multiple features of interest at the site, and so securing sufficient coverage prior to demolition might prove difficult, and a condition may still be proposed if a Phase 2 investigation is limited by restricted access to the site.

2.8 Conceptual Site Model & Recommendations

Through consideration of the site's history and environmental setting and taking account of the previous desk-based assessment produced by EPS in 2021, several plausible contaminant linkages within the site-specific Conceptual Site Model have been identified both currently and that could become active through the proposed development.

These linkages are associated with the historical and ongoing use of the site for primary and secondary pharmaceutical & fine chemicals manufacturing with processing and packaging in recent years, including use of solvents on site from the late 1950s. Waste materials have also been stored and treated on site.

Whilst the proposed commercial end use is not particularly sensitive to contamination, no more so than the current use, risks to neighbouring properties and receptors, including residential properties from site-derived contamination as well as controlled waters, still exist. No new contaminant linkages are likely to be introduced in terms of risks to these existing receptors but risks to new receptors such as groundworkers and future site users are plausible. The Phase I assessment considered it unlikely that any off-site land uses could be identified as a significant source of contamination migrating onto the site.

The nature of the local underlying geological and hydrogeological conditions, underlain by a thin superficial drift deposit designated as a Secondary A Aquifer by the Environment Agency, is such that impact on soils and groundwater at shallow depths below the site could represent a longer term risk if not managed during the development of the site. The impact of site-derived contamination on strategic groundwater and water supply resources is considered low/negligible however, given the presence of a thick unit of London Clay below the superficial deposits and the absence of water supply points in the vicinity of the site. If a piled foundation solution were to be used that penetrated the London Clay Formation (unlikely), then the CSM would need to be revisited as the deeper underlying chalk is a highly sensitive aquifer (within a SPZ I).

Taking account of the feedback from the local Environmental Health team, any groundwater within the superficial should also be considered as a pathway for contamination to migrate off-site. Any residual contamination from the previous allotment usage is also unlikely to remain capable of posing an ongoing risk to receptors.

On this basis, although it was recognised that ground investigation data was available stretching back over the last 20 years, it was recommended that targeted further investigation be undertaken including soil and groundwater testing and a ground gas and vapour monitoring programme.

The fabric of the site buildings will need to be considered in light of potential environmental exposure during site development; as such, materials including Asbestos Containing Materials (ACMs), containerised liquids, oils, cleaning materials, wastes and refrigerants will require management during site demolition and development activities. EPS have assumed that appropriate good practice and duty of care will be applied during this process, and not create any additional contaminant linkages or worsen any soil or groundwater contaminant concentrations.

Based on the available information, EPS have therefore undertaken a Phase II Intrusive Investigation to investigate potential contamination based on the following Conceptual Site Model. The scheduled chemical analyses have been based upon the CSM with the relevant Contaminants of Concern (CoC) shown each for source:

Source	Pathway	Receptor
On-site: Contaminated Soil/Infilled Material <i>Site Wide— Made ground</i> CoCs - PAHs, Metals, ACM, Ground Gases (CH ₄ & CO ₂)	Direct contact and inadvertent ingestion by eating or smoking with dirty hands	Construction workers during redevelopment & site users
<i>Area around Building Q (Solvent Warehouse) /FCMU & Northern Distribution Area.</i> VOCs (Inc. BTEX & Chlorinated Solvents) SVOCs, Acetone, Isopropanol, Phenol, TPH, PAH	Inhalation of fugitive dusts	Site users
<i>Area around Building G (BPF) and former tableting/ dispensary used for waste storage and recorded contamination in 2008</i> VOCs (Inc BTEX & Chlorinated Solvents), TPH, PAH, Metals	Ingress / diffusion through permeable potable water supply pipes	
<i>Current/ Former Diesel/Oil fuel storage area (current generators adj. Building Z - Cold Stores)</i> TPH (Inc BTEX), TPH, PAH)	Generation & Migration of Ground Gases to Indoor Air	
<i>Former Workshop (Building T)</i> (TPH, PAH)	Direct uptake via root systems	Plants
Historical Primary and Secondary Pharmaceutical Manufacturing VOCs (Inc BTEX & Chlorinated Solvents) SVOCs, Acetone, Isopropanol, Phenol, TPH, PAH, Metals, Acids/Alkalis	Direct Contact	Buried Infrastructure
Cyanamide Product Management c.1995 VOC (Inc. Benzene), cyanide, PCBs Metals Drainage Infrastructure VOCs (Inc. BTEX & Chlorinated Solvents) SVOCs, Acetone, Isopropanol, Phenol, TPH	Leaching of contaminants vertically through unsaturated soils	Groundwater

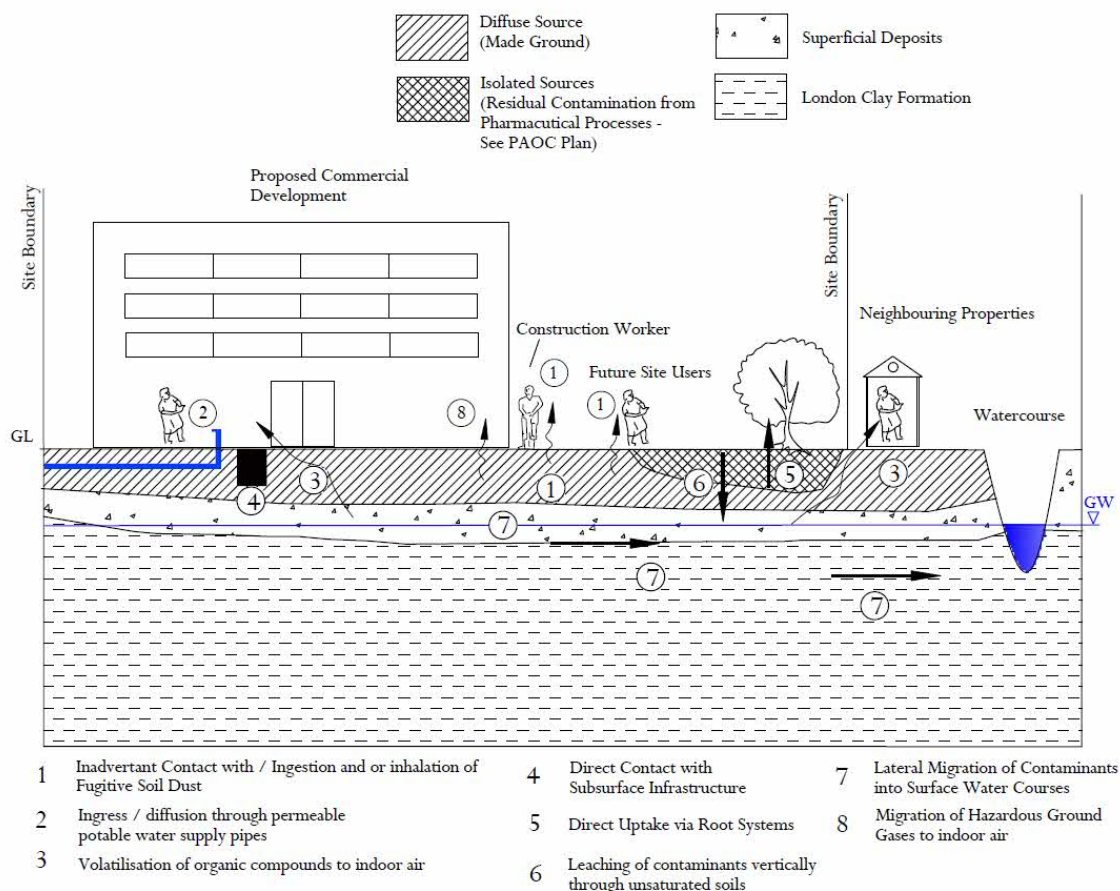
Source	Pathway	Receptor
Contaminated Soil/Groundwater	Lateral migration of contaminants in soil, through run-off, drainage or groundwater (& subsequent volatilisation of organic compounds to indoor air)	Surface waters
		Site users & Neighbouring Site Users

Notes:

PAH	Polycyclic Aromatic Hydrocarbons	ACM	Asbestos Containing Materials
VOCs	Volatile Organic Compounds	sVOCs	Semi-Volatile Organic Compounds
TPH	Total Petroleum Hydrocarbons	BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CH ₄	Methane	CO ₂	Carbon Dioxide
PCB	Poly-Chlorinated Biphenyls		

The following diagram provides an illustration of the plausible contaminant linkages that may be active at the site and which may need further investigation or control to ensure safe development:

Illustrative Conceptual Site Model – Pfizer, Havant



2.9 Unexploded Ordnance

A preliminary Unexploded Ordnance (UXO) Assessment was obtained for the site. This concluded that the potential for UXO to be present at the site is unlikely and that no further action was required to address the risk prior to breaking ground. A copy of this report is included as Appendix D.

3 SUMMARY OF INTRUSIVE INVESTIGATIONS

Intrusive ground investigations were undertaken between 20th January and 11th February 2021 in accordance with EPS standard operating procedures, copies of which will be made available on request. A summary of all site activities is presented in the following sections:

3.1 Exploratory Hole Locations

Exploratory hole locations were selected through consideration of the potential contaminant linkages identified through the Phase I Desk Study, the proposed development layout, the client's requirements, current access limitations and the location of below ground utilities, as well as operational and health & safety considerations associated with an active site.

Eleven window sample boreholes (WS01-WS02, WS07-WS15) were formed at the site to a depth of 1.8 m using a track-mounted percussive drilling rig.

Eleven cable percussive boreholes (BH01-BH04, BH08, BH10-BH13, BH16-BH17) were drilled to depths of between 12m and 20m.

Twelve trial pits (TP1-TP2, TP11-TP13, TP15-TP16, TP18-TP19, TP22, TP29-TP30) were excavated using vacuum excavation techniques and a mechanical excavator to a maximum depth of 2.7m. Soakaway testing was also undertaken in three trial pits.

The exploratory hole layout was not designed through a formal stratified systematic sampling pattern, with the constraints at the site (primarily the existing buildings in active use) restricting the positions available. Due to the absence of a formal sampling pattern, the use of a three dimensional dataset (i.e. samples at varying depths) and targeted nature of the investigation taking into account the PAOCs, it is unlikely that any statistical analysis can be applied to the soil dataset in accordance with CL:AIRE's 2020 guidance (*Comparing Soil Contamination Data with a Critical Concentration*). It is therefore likely that the most significant sampling result for each source or averaging zone will drive the risk assessment and design of remedial measures.

The overall objective in terms of exploratory hole locations was to provide an appropriate lateral and vertical coverage of the soils/ groundwater/soil gases underlying the site in order to offer information relating to their quality and nature as well as provide information for geotechnical design. The exact locations were agreed amongst the project team prior to the beginning of the works. Further rationale for each sampling location is provided within the table below:

Location	Rationale
BH1, BH3, BH8, BH12-BH13, BH16-BH17	Drilled across the site to provide vertical and lateral information on the geology underlying the site and to allow installation of groundwater monitoring wells.

Location	Rationale
BH4, BH10, BH11	Drilled across the site to provide information on the geology at depth below the proposed building area, in order to aid pile design.
WS01-WS02, WS07-WS15	Boreholes drilled to facilitate installation of gas and vapour monitoring wells below the proposed new building area.
TP1-TP2, TP11-TP13, TP15-TP16, TP18-TP19, TP22, TP29-TP30	Excavated across the accessible western half of the site to provide information on the nature and quality of the shallow geology underlying the site. This generally targeted the areas of gravel/shingle and car parking where historic buildings were present.
SK01, SK02, SK05	Undertaken across the site to complete soakaway testing to understand the infiltration characteristics.

Groundwater monitoring standpipes were installed within seven of the deep boreholes (BH1, BH3, BH8, BH12-BH13, BH16-BH17) to enable follow up groundwater sampling. Groundwater sampling pipes were installed using 50mm diameter uPVC well casing and fitted with a gas tap. Slotted casing (1mm slot) was installed at each location from the base of the borehole to approximately 1.0m below the surface. The installations were completed to ground surface using plain casing. All piping was sleeved with geo-sock. A filter pack of 2-3mm of washed gravel extended from the base of the boreholes to approximately 0.1m above the slotted section with a bentonite seal to surface. All installations were finished with flush-mounted, bolt-down headworks.

Soil vapour monitoring wells were installed in all window sampler locations. The positions were designed to target specific sampling horizons within the subsurface. Each sampling point was fitted with a stainless steel sparge point at the base of the borehole (1.8m). A filter pack of 2-3mm washed gravel extended from the base of the installation to approximately 0.1m above the sparge point, with a bentonite seal to the surface.

As part of the investigation EPS also identified a number of the boreholes drilled by Golder in 2019/20 (as well as one from an investigation in 1996), which were incorporated into EPS' investigation in the form of groundwater monitoring. The boreholes used comprised the following:

- BH GA 01
- BHGA 02
- BHGA 03
- BHGA 04
- BHGA 07
- BHGA 07A
- BHGA 08A
- BHGA 09A
- BH04 1996

A borehole and trial pit location plan is presented as Figure 4.

3.2 In-Situ Testing & Soil Sampling

Each borehole was logged for ground conditions encountered and inspected for any physical evidence of contamination, such as soil staining, odour and the presence of separate phase liquids on a precautionary basis. Borehole and trial pit logs are presented in Appendix E.

Standard or cone penetration tests (SPT / CPT) were carried out in all materials using an automatic trip hammer. The number of blows required to advance a standard split spoon, (or solid 60° nose cone for the CPT test) over the final 300mm of a 450mm total drive was recorded, and is shown on the borehole records at the penetration resistance ("N" value).

Where potentially volatile organic compounds are suspected, EPS carries a Photoionisation Detector (PID), which can be used to measure the relative concentrations of vapour associated with soil samples collected from different depths and locations at the site. In these circumstances, soil samples will be placed into plastic bags, sealed, shaken and then allowed to rest for a few minutes to allow time for volatile vapour to accumulate in the air trapped within the bag. The PID probe will then be used to pierce the bag and sample the air above the soil to measure the concentration of volatile compounds that have accumulated. PID readings are only used to provide EPS with a basic means to quantify areas of volatile organic compound in the field to help guide the investigation. As potentially volatile organic compounds were identified in the conceptual site model, PID readings were collected during this intrusive investigation. These readings are included within borehole logs presented as Appendix E and the results are discussed further in later sections.

3.3 Laboratory Testing

Samples obtained for analysis of identified contaminants of concern were submitted to Element Materials Technology of Flintshire, who hold appropriate UKAS / MCERT accreditation for the required testing. Samples were transported in laboratory supplied containers and delivered to the laboratory by approved courier. An environmental laboratory testing schedule is included as Table 1.

Geotechnical testing was undertaken by Soil Property Testing, Huntingdon, a UKAS accredited laboratory. A geotechnical laboratory testing schedule is included as Table 2.

Copies of chain of custody documentation are held by EPS and will be made available on request.

3.4 Groundwater Sampling

EPS returned to site on 18th February 2021 to collect groundwater samples from selected monitoring wells (including those from previous investigation at the site). Groundwater samples were collected using the 'low flow' sampling technique in accordance with EPS standard operating procedures. Each borehole was monitored for dissolved oxygen, redox, pH and temperature before sampling. The results of this monitoring are included in Table 3.

3.5 Ground Gas & Vapour Monitoring

One round of soil vapour monitoring was also undertaken on the 19th February 2021 to measure the presence and concentration of contaminants and ground gases within the soil vapour. Soil vapour samples were collected using Summa cannisters, which connect to the sampling point via a dedicated sampling train supplied by Element Materials Technology of Flintshire.

Subsequently samples obtained for analysis of identified contaminants of concern were submitted to Element Materials Technology of Flintshire, who hold appropriate UKAS / MCERT accreditation for the required testing. Samples were transported in laboratory supplied containers and delivered to the laboratory by approved courier.

During sampling of soil vapour within each of the monitoring points, leak test of the sampling train was undertaken. Limonene present within shaving foam was used as a potential leakage indicator. The joints within the sampling train were treated with shaving foam containing limonene, and subsequently all soil gas samples were tested for presence of limonene.

Three further rounds of ground gas monitoring were undertaken following completion of the intrusive works, on the 25th February, 5th March and 9th March 2021 to measure the presence and concentration of ground gas (including carbon dioxide, oxygen and methane) and organic vapour using a GFM 435 gas analyser, PID and flow meter respectively.

Recorded ground gas monitoring data is included as Table 4 with the results and implications of this data discussed in later sections of this report.

4 FINDINGS OF THE INVESTIGATION

This section of the report provides a summary of the findings of the various aspects of the ground investigation.

4.1 Ground Conditions

A total of 22 boreholes and 12 trial pits were formed at the site and the ground conditions encountered, from surface level, have been interpreted to comprise:

- Made Ground
- River Terrace Deposits
- London Clay Formation

Site specific borehole and trial pit logs are included as Appendix E and give descriptions and depths of strata encountered. A summary of the general strata encountered across the site is provided in the table below, with more detailed description given in the following sub sections.

Geological Strata	Maximum Depth to Base of Strata (m bgl)	Strata Thickness (m)
Made Ground	2.5	0.15 -2.5
River Terrace Deposits	7.8	2.8 -6.6
London Clay Formation	>20.0 (not proven)	>5.8 -> 14.7 (not proven)

4.1.1 *Made Ground*

Made Ground was encountered within the vast majority of boreholes below variable surfacing of concrete, tarmac and gravel. It predominantly comprised a brown, gravelly clay with brick and concrete fragments, although in places it was noted to comprise a more granular material. Some hardcore (likely representing subbase material) was found in places. Its thickness was variable but fairly regularly in the range of 1.0-1.5m and was proven to a depth of 2.5m in BH01.

A concrete slab was encountered within BH01 at a depth of 2.2-2.5m, whilst another was found in BH17 between 1.4m and 1.6m. These are considered remnants of historic foundations.

4.1.2 *River Terrace Deposits*

Below the made ground in all boreholes lay soils interpreted as River Terrace Deposits. These generally comprised an initial layer of brown, gravelly clay with variable gravel content and some gravel lenses. Gravel was brown, black, and white, angular to sub-rounded flint and chert. Although logged in the field as a clay, some of the geotechnical laboratory testing indicates it could be gravellier in places. Some significantly softer layers of more cohesive soils were also encountered in the River Terrace Deposits in a number of locations, such as BH13, BH16, BH17 TP11 and TP29, although there seemed to be no particular distribution to these soil layers.

Below this layer in the majority of borehole locations lay dense to very dense, black, brown and white, angular to sub-rounded, sandy gravel. This was noted to range quite substantially from a gravelly sand to a cobbly gravel with very little sand content. The depth of this layer ranged between 1.8m and 7.8m and was found to vary in thickness across the site. It was not encountered within BH3, BH4 and BH13.

It should be noted that the geotechnical laboratory testing recorded unnatural materials such as concrete, glass and brick in three samples ranging in depth from 2.0m to 4.0m. However, no physical evidence of made ground at these depths was identified and therefore this is considered to represent drag down during the drilling process, as opposed to being evidence of significant thicknesses of made ground.

4.1.3 London Clay Formation

Encountered directly below the River Terrace Deposits in all deep shell & auger boreholes lay soils interpreted as part of the London Clay Formation.

This generally comprised an initial layer of soft, grey, clayey silt / very silty clay, overlying generally stiff to very stiff, brownish grey clay, which extended to the base of all boreholes.

4.2 Groundwater

Groundwater was struck within all shell & auger boreholes during the investigation and follow up monitoring identified groundwater to rest at levels ranging between 2.13m (BH8) and 3.40m (BHGA01 – borehole from previous investigation) bgl.

Groundwater elevation ranges between 11.46m AOD (BH12) and 12.95m AOD (BH16) and appears to flow in a westerly / south-westerly direction towards the River Lavant. These findings are broadly comparable with Golder Associates previous work (2019, 2020), although they interpreted the flow direction to be from north to south, therefore slightly different to EPS

4.3 Physical Evidence of Contamination

Despite the presence of a limited thickness of made ground, there was no palpable evidence of contamination, waste or putrefiable material encountered across the majority of the site. The only physical evidence comprised a moderate fuel odour within shallow soils in TP15.

This was supported by headspace testing undertaken at regular intervals during the field works which did not identify any concentrations of organic vapours above 10ppmV.

4.4 Chemical Laboratory Analysis

4.4.1 Soil

A laboratory analysis testing schedule is presented as Table 1 and all environmental sample results obtained from the laboratory are included as Appendix F. The key results of laboratory testing on environmental soil samples are summarised below.

Contaminant	No. of Samples	No of Detections	Range of Detections (mg/ kg)		Highest Location & Depth (m bgl)
			Min	Max	
Arsenic	29	29	1.9	12.7	WS8 (0.9-1.0)
Cadmium	29	22	0.2	0.7	TP30 (1.8)
Chromium	29	29	25.0	204.3	WS7 (0.5-0.7)
Copper	29	29	3	34	BH12 (0.0-0.5)
Lead	29	23	6	98	BH17 (0.4-0.6)
Mercury	29	0	-	-	-
Nickel	29	29	4.9	39.6	BH8 (11.95-12)
Selenium	29	0	-	-	-
Zinc	29	29	9	96	BH17 (0.4-0.6)
Naphthalene	29	0	-	-	-
Benzo[a]pyrene	29	7	0.05	0.71	WS2 (0.3-0.5)
Dibenz(ah)anthracene	29	2	0.05	0.10	WS2 (0.3-0.5)
Cyanide	9	0	-	-	-
Benzene	29	0	-	-	-
Toluene	29	3	0.008	0.026	BH13 (1.0)
Ethylbenzene	29	1	-	0.006	BH13 (1.0)
m/p - xylene	29	2	0.009	0.036	BH13 (1.0)
o - xylene	29	1	-	0.006	BH13 (1.0)
TPH CWG	29	5	182	1674	TP15 (0.3-0.7)
PCB	15	0	-	-	-
VOC	28	4	0.006	0.082	BH13 (1.0)
SVOC	27	4	0.014	55.123	BH03 (0.0-0.8)
Ammoniacal Nitrogen	29	0	-	-	-
Asbestos (%)	35	0	-	-	-

Notes	-	Contaminant not found above laboratory detection limits
PAH		Polycyclic Aromatic Hydrocarbons
BTEX		Benzene, Toluene, Ethylbenzene, Xylenes
TPH CWG		Total Petroleum Hydrocarbons (Criteria Working Group)
VOC		Volatile Organic Compounds
SVOC		Semi-Volatile Organic Compounds
PCB		Polychlorinated Biphenyls

- Detectable concentrations of heavy metals were encountered across the site.
- Detectable concentrations of PAHs and TPH were encountered at selected locations above method detection limit.
- Low and isolated concentrations of VOC and SVOC were found at selected locations. The most notable concentration comprised 53.568mg/kg of the SVOC compound Butylbenzyl phthalate, which made up the bulk of the detected SVOC.

- Asbestos was not encountered above minimum detection limits (MDL) of 0.001% in any sample.

4.4.2 Groundwater

The key results of laboratory testing on environmental groundwater samples are summarised below.

Contaminant	No. of Samples	No of Detections	Range of Detections (ug/ l)		Highest Location
			Min	Max	
Arsenic	16	1	-	6.6	BHGA07A
Calcium	16	1	-	5.0	BH04 1996
Calcium	16	16	34.8	132.5	BH12
Chromium	16	5	1.5	8.6	BH04 1996
Copper	16	0	-	-	-
Lead	16	0	-	-	-
Magnesium	16	16	1.1	8.6	BH12
Mercury	16	0	-	-	-
Nickel	16	6	2	33	BH12
Selenium	16	1	-	4	BHGA03
Zinc	16	10	3	16	BH17
Naphthalene	16	1	-	0.2	BH17
Benzo[a]pyrene	16	2	0.027	0.047	BH12
Dibenz(a,h)anthracene	16	0	-	-	-
Phenols	16	0	-	-	-
BTEX	15	0	-	1	-
TPH CWG	15	1	-	208	BH3
VOC	15	3	6	9.2	BH3
SVOC	16	0	-	-	-
PCB	3	0	-	-	-
Cyanide	16	0	-	-	-
Ammoniacal Nitrogen	16	16	0.05	1.42	BHGA07

Notes

-	Contaminant not found above laboratory detection limits
PAH	Polycyclic Aromatic Hydrocarbons
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
TPH CWG	Total Petroleum Hydrocarbons (Criteria Working Group)
PCB	Polychlorinated Biphenyls

- Minor and isolated concentrations of metals, PAH, TPH, VOC and SVOC were found at selected locations across the site however mostly within an order of magnitude of the method detection limits.
- At BH3, the identified VOCs were interpreted as TCE and cis-1-2-Dichloroethene, both chlorinated solvents.

4.4.3 Soil Vapour

The below table summarises the findings of the soil gas / vapour analysis undertaken by the laboratory analysis. For ease of use, only those VOCs / SVOCs identified above method detection have been summarised.

Contaminant	No. of Samples	No of Detections	Range of Detections ($\mu\text{g}/\text{m}^3$)		Highest Location & Depth
			Min	Max	
Carbon Dioxide (%)	11	2	0.05	0.07	WS14
Carbon Monoxide (%)	11	0	-	-	-
Hydrogen (%)	11	0	-	-	-
Methane (%)	11	0	-	-	-
Nitrogen (%)	11	11	79.1	79.4	WS07
Oxygen (%)	11	11	20.5	20.9	WS9, WS10, WS12, WS14, WS15
Hydrogen Sulphide (%)	11	0	-	-	-
Isobutene	11	3	5.3	25.2	WS12
Ethanol	11	2	209.1	299.6	WS01
Acetone & Propanal	11	8	14	114	WS14
Carbon Disulphide	11	1	-	5.6	WS01
2-butanone	11	4	38	91	WS13
Hexane	11	1	-	15.2	WS01
m/p - xylene	11	1	-	83.8	WS10
o - xylene	11	1	-	25.6	WS10
Styrene	11	1	-	13.2	WS10
1,2,3 - Trimethylbenzene	11	1	-	13.8	WS10
1,2,5 - Trimethylbenzene	11	1	-	8.4	WS10
Trichloroethene (TCE)	11	1	-	9.1	WS02
Tetrachloroethene (PCE)	11	7	11.5	37.3	WS02
1,1,1 - Trichloroethane	11	1	-	32.7	WS02
Sum of VOC TO15 Compounds	11	11	12.9	449.6	WS01
Aliphatic C4-C6	11	4	40	7431	WS10
Aliphatic C8-C10	11	4	80	122	WS01
Aliphatic C10-C12	11	7	72	190	WS07
Aromatic C5-EC7 (Benzene)	11	1	-	6.4	WS10
Aromatic EC7-EC8 (Toluene)	11	9	7.2	94.6	WS10
Aromatic EC8-EC10	11	1	-	201	WS10
Limonene	11	0	-	-	-

Notes: VOC Volatile Organic Compound

The laboratory testing has identified minor concentrations of a number of volatile organic compounds within various boreholes across the site.

4.5 Preliminary Waste Analysis

Waste classification (i.e. hazardous or non-hazardous) was undertaken on samples of both made ground and natural soils, which included total concentrations of metals and hydrocarbons, using computer software provided by HazWaste Online™. The results of the WAC analysis are included within Appendix F and the outputs from the software are included in a Waste Classification Report in Appendix G.

Waste Acceptance Criteria was subsequently undertaken on one sample each of the cohesive and granular layers of River Terrace Deposits respectively, and one of the underlying London Clay Formation. Although these results are preliminary given the limited sampling density, they are considered likely to represent the major waste streams produced through the development. These results, together with those of the waste classification above are summarised in the following table:

Strata	Typical Depth (m bgl) and Description	Is it Hazardous?	Waste Acceptance Criteria	Appropriate Landfill
Cohesive River Terrace Deposits	0.3->6.3 - Brown sandy CLAY	No	Passed criteria for Inert Landfill	INERT
Granular River Terrace Deposits	1.8-7.8 - Brown, black and white angular to rounded sandy slightly silty GRAVEL.	No	-	NON-HAZARDOUS*
London Clay Formation	>5.8-20.0 - Brownish grey SILT and dark grey CLAY	No	Passed criteria for Inert Landfill	INERT

Based on the above, both the shallow natural cohesive River Terrace Deposits and London Clay Formation can be classified as **INERT** for the purposes of off-site disposal, under the waste code **17 05 04**.

At present, the layer of granular River Terrace Deposits can only be classified as Non-Hazardous because not enough sample was provided to undertake the inert WAC test. However, this will be addressed during the following phases of investigation to confirm whether this layer can be classified as inert.

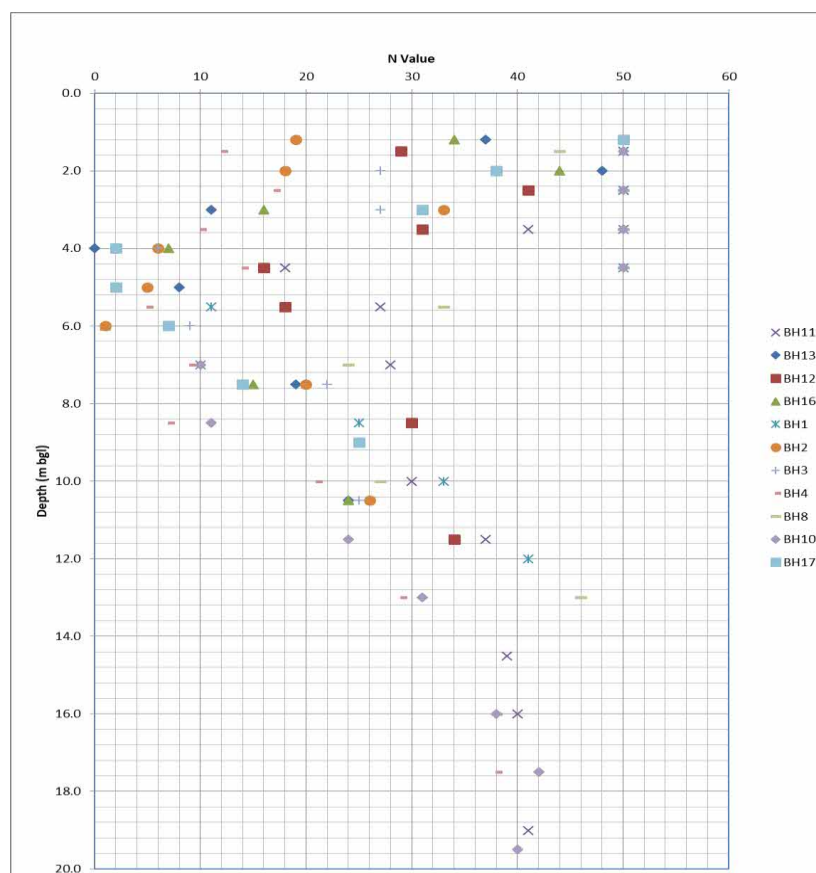
Due to the size of the site and the volume of variable made ground which will likely be disposed of, assessment of the waste characteristics of this material has not been made at this stage, particularly given that the most potentially contaminated area of the site is yet to be investigated in detail. It is therefore recommended that classification of this material be undertaken at a later date, possibly during construction works. However, based on the available testing already done, it is likely that the vast majority of it will be classified as non-hazardous.

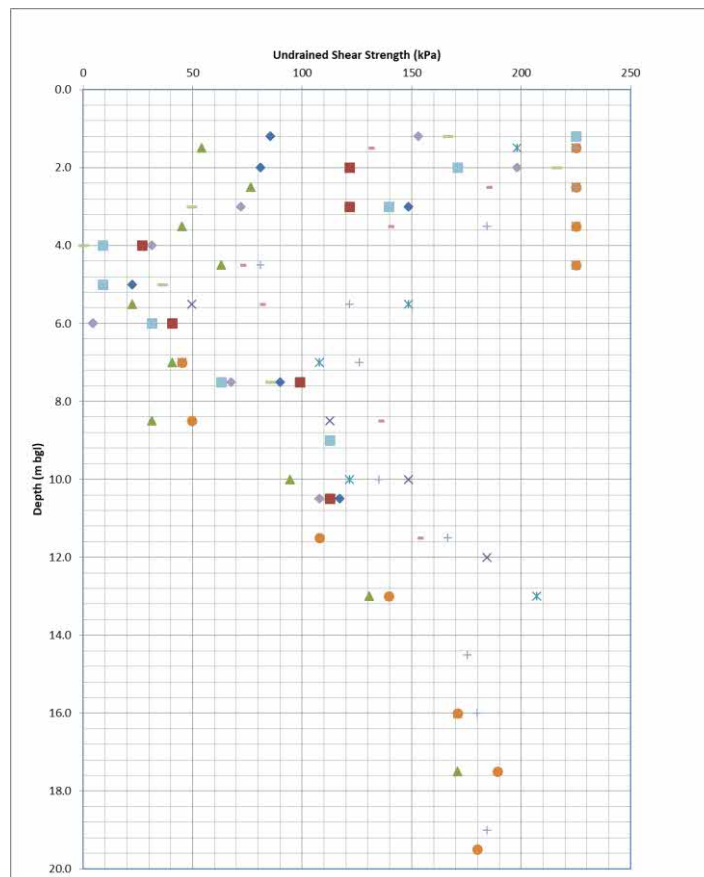
For made ground present on a brownfield site such as this, although the soil sampling process did not identify potentially hazardous concentrations of Asbestos Containing Material (ACM) within the soil, it must be acknowledged that the material may exist within areas which were not sampled or accessible during the investigation. Any visually identifiable fragments of ACM can invalidate any non-hazardous waste classification, as such, the above waste classifications are made on the proviso that any visually identifiable fragments of ACM are removed from the material prior to its disposal off-site. The subsequent ACM must then be disposed of in accordance with the Control of Asbestos Regulations 2012.

4.6 Geotechnical Testing

4.6.1 In-Situ Geotechnical Testing

The results of in-situ geotechnical testing are summarised in the graph below.





The above data indicates that the natural River Terrace Deposits to depths of around 4.0m are generally competent, although slightly variable in strength. However, between depths of around 4.0m and 7.0m, low strength soils were encountered associated with the silty upper layer of the London Clay Formation. Below this, the London Clay became generally stiff, typically increasing in strength with depth.

4.6.2 Laboratory Geotechnical Testing

The results of geotechnical laboratory testing are summarised in the table below and all geotechnical sample results obtained from the laboratory are included as Appendix H. The key results of laboratory testing on geotechnical soil samples are summarised below.

Strata	Range of Parameters										
	Moisture Content (%)		Plasticity Index (%)		Particle Size Distribution (%)			Undrained Shear Strength (kPa)		Coefficient of Volume Compressibility (m ² / MN)	
	Min	Max	Min	Max	Fines	Sand	Gravel	Max	Min	Max	Min
River Terrace Deposits	9.4	27.2	12 (4)	21 (12)	1-22	3-36	57-96	51		-	-
London Clay Formation	21.2	30.7	7	49	44-86	14-44	0-12	14	155	0.0	0.38

() adjusted for granular content

Moisture contents and Atterberg Limit was established for nine samples of cohesive soils in accordance with BS EN ISO: 17892-1: 2014 & BS1377: Part 2: 3.2, 4.4, 5.3, 5.4.

Particle Size Distribution was undertaken on 12 samples of granular soils in accordance with BS1377: Part 2: 1990: 9.2.

Undrained Triaxial Tests were done on 17 samples of cohesive soils in accordance with BS 1377: Part 2: 1990:3 Determination of Moisture Content, Part2: 1990:7 Determination of Density, Part 7: 1990: 8 Undrained Shear Strength, 9 Multistage Loading.

One Dimensional Consolidation Tests were undertaken on six samples of cohesive soils in accordance with BS 1377: Part 5: 1990: 3.5.

Sulphate contents and pH values determinations were carried out by the analytical laboratory, the results of which are included in Appendix F and summarised in section 6.4

A laboratory analysis testing schedule is presented as Table 1.

5 GEOTECHNICAL APPRAISAL

The ground conditions have been found to comprise a moderate thickness of made ground underlain by cohesive and granular River Terrace Deposits. Below this lay silt and clay of the London Clay Formation.

It should be appreciated that further intrusive investigations are proposed once the existing buildings have been vacated and demolished and this appraisal will be supplemented once findings from further investigations are available.

5.1 Geotechnical Category

Geotechnical Category (BS EN 1997-1:2004)	Definition
GC1	Geotechnical Category 1 (GC1) should only include small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations with negligible risk in terms of overall stability or ground movements and in ground conditions which are known.
GC2	Geotechnical Category 2 (GC2) should include conventional types of structure and foundation with no exceptional risk or difficult or loading conditions. Designs for structures in Geotechnical Category 2 should normally include quantitative geotechnical data and analysis.
GC3	Geotechnical Category 3 (GC3) should include structures or parts of structures, which fall outside the limits of Geotechnical Categories 1 and 2. This may include very large or unusual structures, structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions, or structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.

The proposed development comprises a limited number of a large commercial warehouse structure, and therefore the below assessment has been undertaken in accordance with Geotechnical Category 2 (GC2), including conventional types of structure and foundation with no exceptional risk or difficult ground or loading conditions, as defined by BS EN 1997-1:2004.

5.2 Structural Foundations

5.2.1 Spread Foundations

As detailed above, the development is understood to comprise the construction of a large commercial warehouse, with foundations being vertically loaded. The foundation assessment has been undertaken in accordance with BS EN 1997-1:2004 to take in to account;

- Bearing Pressure (Ultimate Limit State)
- Settlement (Serviceability Limit State)

The ground conditions are considered suitable for the use of conventional spread foundations, either strip footings or pad foundations bearing on the underlying River Terrace Deposits.

Allowable bearing capacities have been calculated for depths of up to 2.0m for the underlying natural soils and are provided in the table below:

Foundation Depth (m)	Allowable Bearing Capacity* (kN/ m ²)	
	Strip	Pad
1.0	95	110
1.5	100	120
2.0	105	125

* BS EN 1997 (EC7) Geo Load Combination 2

The allowable bearing capacity is the permissible increase in vertical stress at the level of the underside of the foundation, above existing overburden pressure, which may be calculated on the basis of a soil density of 18kN/ m³. The above allowable bearing capacities are provided on the basis that a minimum undrained shear strength of 60kPa can be achieved in any foundation excavation and if this isn't the case foundations would need to either be deepened or an alternative solution considered.

At the above bearing capacity, total settlements in soils are unlikely to exceed approximately 20mm to 25mm. Settlements in cohesive soils will comprise a relatively small proportion of immediate settlement and a larger portion of consolidation settlement which will take place over a long period of time. Settlements in granular soils will occur rapidly as loadings increase, with limited long-term consolidation being anticipated. Where foundations cross a change in strata, from cohesive to granular, it is recommended that nominal reinforcement is incorporated to control the effects of differential settlements.

A minimum foundation depth of 0.8m, below existing or proposed ground level is currently considered suitable for the site, subject to the following provisos: -

- Foundations should fully penetrate any made/ disturbed ground (currently recorded up to 2.50m deep) and should extend a minimum of 150mm in to undisturbed natural strata. It should be noted that foundations are to be removed from much of the site and this will likely disturb ground to greater depths than already encountered and will most likely result in foundations significantly deeper than the advised minimum.

- b) The cohesive soils will be subject to volume change (subsidence and / or heave) due to the presence of trees / vegetation. Foundations will therefore need to take into account the presence of trees, including those adjacent to the site boundaries. Laboratory analysis has established that the shallow cohesive River Terrace Deposits as having 'low volume change' potential in accordance with NHBC Standards Chapter 4.2 'Building Near Trees', whilst the deeper London Clay has a 'high volume change potential'.

It is recommended that all trees present locally, including those to be planted or recently removed, are given full consideration in the design process so that the impact of these may be taken in to account in foundation design.

Where foundations exceed 1.5m in depth due to the influence of trees / vegetation, full anti-heave precautions will need to be adopted.

5.2.2 Piles

Should structural loads exceed the allowable bearing capacities advised in Section 5.2.1 above then the use of a deep foundation solution, such as piles could also be considered.

Piles are considered likely to terminate in the underlying London Clay and will likely carry their loads in a combination of end bearing and skin friction. It would be unwise to assume any positive contribution to skin friction within any made or disturbed ground.

A preliminary assessment of potential pile capacities, for single isolated continuous flight auger (CFA) piles has been provided in the table below, although in view of the wide variety of piles sizes available, and the range of installation plant and techniques, the design of the piles should be carried out by, and should remain the responsibility of the specialist piling contractor, who will reflect their own methods, experience and design procedures within their proposals.

Depth of pile below ground level (m bgl)	Approximate Allowable Working Load (kN)		
	300mm Diameter Pile	450mm Diameter Pile	600mm Diameter Pile
15	195	325	475
18	255	415	600

5.3 Ground Floor Construction

Given the depth of made ground encountered and the underlying cohesive soils, the use of suspended ground floor slabs would typically be the most appropriate.

However, it is recognised that this may not prove an economic solution for a development of this nature and if required, consideration could be given to the use of ground-bearing floor slab construction, provided any shallow made ground or natural cohesive material is removed and replaced with an imported granular fill that is compacted in layers to a suitable specification to ensure that the slab is constructed within allowable tolerances.

5.4 Groundworks

Whilst excavations in the natural cohesive soils may remain stable for short periods (although they were very gravelly in places) during construction the long-term stability of these and any excavations in granular soils or made / disturbed ground should not be relied upon in unsupported excavations.

Heavy plant and stockpiles of materials should not be permitted close to the edges of unsupported excavations. Further reference may be made to CIRIA Report No. 97 'Trenching Practice' 1992.

Groundwater has been found to rest at depths as shallow as 2.13m and therefore, it is possible that significant quantities of groundwater could be present in excavations. On this basis, shoring and groundwater control techniques may be required.

5.5 Drainage

Infiltration testing was undertaken in three trial pit locations (SK01, SK02, SK05) in general accordance with *BRE Digest 365*. The results of the testing are detailed in the table below:

Trial Pit Location	Test Depth (m bgl)	Infiltration Rate (m/s)	Comments
SK01 (test 1)	1.35	2.117×10^{-5}	Complete test
SK02 (test 1)	1.5	4.261×10^{-5}	
SK02 (test 2)	1.5	2.459×10^{-5}	
SK05 (test 1)	1.5	-	Readings could not be taken in this test due to rapid infiltration. The entirety of a 2000L water tanker drained almost instantaneously into the ground, with the rate at no time slow enough to take readings. It took approximately 12 minutes to drain the tanker on each occasion.
SK05 (test 2)	1.5	-	
SK05 (test 3)	1.5	-	

The results of the infiltration testing in SK01 and SK02 are generally indicative of 'medium to low permeability' conditions.

The testing in SK03 indicates good permeability conditions and is likely to be associated with it being undertaken in the granular layer of River Terrace Deposits.

Based on the results, it is possible that an infiltration drainage solution will be suitable at the site, particularly if the water drains directly into the granular layer and provided the water table is not too high. Further testing targeting this layer is recommended to be undertaken to confirm this.

It is further recommended that soakaways aren't placed within 5m of existing or proposed structures.

5.6 Concrete Grade

Sulphate contents and pH values determinations were carried out for the natural material by the analytical laboratory, the results of which are also included within Appendix F. Results for concrete grade are summarised within the following table:

Strata	Water Soluble Sulphate (mg/l SO ₄)		Total Potential Sulphate		pH	
	Min	Max	Min	Max	Min	Max
Made Ground	6.6	412.7	-	-	8.67	11.16
River Terrace Deposits	3.2	182.2	-	-	7.97	9.44
London Clay Formation	12.2	275.8	0.84	3.00	7.92	9.02

In accordance with Part 1 of the BRE Special Digest 1 'Concrete in Aggressive Ground' 2005, a Design Sulphate Class (DS) of DS-1 with an aggressive chemical environment for concrete (ACEC) of AC-1 is considered appropriate for the Made Ground and River Terrace Deposits on site. However, for the underlying London Clay, a Design Sulphate Class (DS) of DS-3 is considered appropriate, with an aggressive chemical environment for concrete (ACEC) of AC-3 due to concentrations of total potential sulphate.

5.7 Re-Use of Materials

Depending on final site levels, there may well be the opportunity to re-use site-won materials on site as part of either structural or indeed general filling operations. This would require the materials to be proven 'suitable' in both an environmental and geotechnical sense and any potential wastes would need a suitable framework such as a Materials Management Plan (see Section 6.8) to justify their re-use.

Initially, it would seem that shallow natural cohesive soils are likely to comply with the requirements of Class 2, General Cohesive Fill, of the 'Manual of Contract Documents for Highways Works, Volume 1, Specification for Highways Works', whilst the natural granular soils are likely to comply with the requirements of Class 1, General Granular Fill. Some of the granular may well be suitable as Class 6, Selected Granular Materials, although the fines content does appear slightly high in some locations. Testing detailed below should be undertaken as part of the further works to confirm appropriate materials classification.

5.7.1 General Fill Specification

In general, all fill should comply with the 'Manual of Contract Documents for Highways Works, Volume 1, Specification for Highways Works'. Compaction of any fill materials shall be in accordance with Table 6/4 of the Specification for Highways Works.

Immediately prior to placing the first layer of any fill, all surfaces upon which fill is to be placed shall be cleaned of all objectionable materials in an approved manner. Such surfaces shall have all water removed from depressions and shall be properly monitored to obtain a suitable bond with the fill.

No vegetable matter, other perishable material shall be placed in the fill.

The fill shall be prepared by levelling, moistening (if required) and rolling so that the surface materials will be compacted and will provide a satisfactory bonding surface.

Materials to be used for fill, which for whatever reason become, or when placed are too wet for immediate compaction shall be placed in temporary stockpiles or removed until the moisture content is reduced sufficiently to permit adequate compaction. Conversely, excavated material with a moisture content lower than that required, to ensure adequate compaction shall be wetted before placement.

Prior to placement, the fill shall be tested for the following:

- Particle Size Distribution
- Plasticity Index
- Optimum Dry Density (2.5kg compaction)
- Natural Moisture Content

The in-situ competency of the fill shall be checked at regular intervals to ensure that they are placed to the required effort. This should include either, plate load testing, sand replacement density testing or nuclear density meter testing. In addition, the fill may also be checked using a hand shear vane or perth penetrometer, depending on material properties.

The fill should be placed to ensure that at least 95% of the optimum dry density is being achieved. If this is not achieved, then the fill may need to be removed and re-compacted.

6 ENVIRONMENTAL APPRAISAL

The following section outlines the approach applied to assessing the risks posed to human health and controlled waters, then identifies any sample results found by this investigation which warrant further consideration. In accordance with the Environment Agency's Land Contamination: Risk Management, this section represents the second tier of Stage 1, the Generic Quantitative Risk Assessment.

6.1 Human Health

6.1.1 *Land Use Setting & Generic Screening*

In order to screen laboratory data for concentrations of contaminant in soil with potential to cause harm to human health in a commercial land-use setting, relevant generic screening values for contaminants in soil have been used. The technical framework used to derive the assessment criteria and the documents in which they are published are summarised as follows:

- *EA Science Reports* (SC 050021/SR2, SC050021/SR3, and SC050021/SR7)
- *EA Soil Guideline Value Science Reports*
- *Suitable for Use Levels (S4ULs) for Human Health Risk Assessment* – LQM and CIEH (2015)
- *Soil Generic Assessment Criteria for Human Health Risk Assessment* - ECI AGS/CL: AIRE (2010)
- *Development of Category 4 Screening Levels for assessment of land affected by contamination* - SP1010 – DEFRA (2013)

A summary of the screening criteria and the methodology used to derive them is included in Appendix I.

6.1.2 ~~Assessment of Results~~ *Human Health*

The results of the screening process for on-site human receptors showed that generic screening criteria, where available, protective of future site users were not exceeded for any contaminant at any location.

Some relatively low concentrations of VOCs and SVOCs have been identified at selected locations, with one more notable concentration (53.568mg/kg) of Benzylbutyl Phthalate identified within a shallow soil sample in BH3. This borehole is located in the north-eastern part of the site where contamination has been historically identified. However, a groundwater sample from the same borehole did not identify concentrations of this compound above method detection limit, suggestive that vertical migration has been limited. It is therefore unlikely to represent contamination capable of posing a significant risk to future site users as any human interaction will be prevented by capping of the site, however further testing in this area should be undertaken during the second phase of works to confirm this low level of risk. Once a comprehensive dataset is available, the risk can be reviewed with the development of site-specific assessment criteria if necessary.

6.2 Controlled Waters

6.2.1 Generic Screening

In addition to screening the recorded concentrations of contaminants in soils capable of posing a risk to human health, EPS has also screened the results of groundwater analysis for potential to cause harm to water resources.

The criteria used for this process were derived by EPS using the following technical guidance:

- *Environment Agency Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination.*

Resource Sensitivity of Area	Basis of Tier 1 Criteria
High Groundwater Resource Potential (HGWRP) - Principal Aquifers	UK Drinking Water Standards (UKDWS)
Low Groundwater Resource Potential (LGWRP) - Secondary Aquifers not being abstracted and Unproductive groundwater strata	UK Environmental Quality Standards (EQS)

Screening criteria for Low Groundwater Resource Potential (LGWRP) have been adopted for this site due to the underlying geology being classified as a Secondary A Aquifer and taking account of the nearby watercourse (where EQS would typically apply).

6.2.2 Assessment of Results- Controlled Waters

The screening process has shown that screening criteria, where available, protective of controlled waters have not been exceeded by any groundwater samples

Although very minor detections of the chlorinated solvents TCE, DCE and Vinyl Chloride were identified within the groundwater sample obtained from BH3, the concentrations of these detections (5ug/ l, 4ug/ l and 0.2ug/ l) are very low and only very slightly above method detection limit, and all within their respective Water Quality Standards. Even if the most-sensitive UK Drinking Water Standards are referenced, the concentrations recorded on site for these chlorinated solvents are still very low (UK DWS of 10ug/ l, 10ug/ l and 0.5ug/l would apply respectively for these compounds).

On this basis, the identified contamination is considered unlikely to be capable of posing a significant risk to controlled waters in the context of the sensitivity of the site. This is a preliminary finding, which will need to be confirmed once further investigation data becomes available for key areas of the site (particularly across the north, and northeast).

6.3 Assessment of Risks from Soil Vapour – Inhalation

To assess the risks to future site users from vapour intrusion, a series of 11 soil gas monitoring points were fitted with a stainless steel sparge point towards the base of the borehole. The screened section was installed between 1.65m and 1.8m within each borehole.

This risk assessment has been undertaken using site-specific information, where available, to derive risk-based assessment criteria.

6.3.1 Methodology

Following collection of soil vapour analytical data, it is possible to further assess the vapour migration and inhalation pathways. The focus of this assessment is on vapour intrusion to indoor air as this is the critical exposure pathway for the vapour inhalation pathways.

Use of soil vapour data removes some of the uncertainty when assessing risks from vapour intrusion, as the partitioning and volatilisation from soil/groundwater to soil gas does not need to be modelled as it is measured directly.

6.3.2 Model Selection

There are a number of human health modelling software packages capable of modelling risks from CoC concentrations measured in soil gas. One of these is CLEA 1.07 and as such it has been adopted as a suitable modelling tool to assess the potential risks to human health receptors from CoC in soil gas.

6.3.3 Chemical and Toxicological Parameters

The toxicological parameters were selected following the guidance presented within SR2 using the pre-loaded data within the CLEA model.

6.3.4 Model Input Parameters

In order to accurately reflect the risk to the offsite receptors, the following basic model input parameters were used.

Land Use	Commercial
Receptor	Female (com) 16-65 yrs
Building	Office (post-1970)
Soil Type	Sandy Loam

It should be noted that the model set up is considered to represent a conservative scenario as for the purpose of risk assessment.

6.3.5 Selection of Contaminants of Concern

A number of contaminants were measured at concentrations above laboratory MDL. In the absence of detailed modelling information available for some of these contaminants, the following have been used to represent the potential risks associated with inhalation of volatile contaminants by neighbouring residents.

- Carbon Disulphide
- Xylenes
- Styrene
- Trichloroethene
- Tetrachloroethene
- 1,1,1 – trichloroethane
- Aliphatic C5-C6
- Aliphatic C8-C10
- Aliphatic C10-C12
- Aromatic EC5-EC7 (Benzene)
- Aromatic EC7-EC8 (Toluene)
- Aromatic EC8-EC10
- 2 Propanone (Acetone)

6.3.6 Assessment of Risks from Vapour Inhalation

Maximum concentrations of the selected contaminants measured within the soil vapour sampled were input into the model to assess the risks to current and future on-site receptors. The CLEA Output is presented as Appendix J.

The results of the soil gas assessment indicate that the maximum measured concentrations of all contaminants in soil vapour do not present an unacceptable level of risk to current or future site users, with the calculated hazard indices for all contaminants being 0.00, which falls significantly below the trigger value of 1.0.

As such the risks to future site users from volatile contamination originating at the site is considered to be acceptable. This assessment also demonstrates that off-site risks from site-derived contaminant sources generating organic vapours to neighbouring residential properties are unlikely to be significant.

In addition, concentrations of volatile organic compounds were not identified above 0.5ppmV during any soil gas monitoring visit (see Table 4), which corroborated the low-risk findings of the quantitative assessment.

6.4 Preliminary Ground Gas Risk Assessment

The results of the soil gas monitoring are presented in Table 4 and have been assessed in accordance with CIRIA guidance '*Assessing Risks Posed by Hazardous Ground Gases to Buildings*' (C665). It is acknowledged that the current dataset (three monitoring visits but none at falling barometric pressure) is too limited to generate Gas Screening Values in accordance with this guidance. As such these preliminary values have been calculated, with the final values to be confirmed once further monitoring data becomes available for the whole site.

Results of the monitoring visits show that no discernible flow was recorded at any of the borehole locations and that no methane was measured above minimum instrument detection limits of 0.1% v/v. Carbon dioxide was only encountered at a maximum of 0.1% within three boreholes.

As proposed development plans are understood to include the construction of a commercial warehouse building, the '*Modified Wilson and Card Classification System*' has been used to assess the risks from ground gases, (in accordance with CIRIA C665).

The maximum individual Gas Screening Value (GSV) is calculated by multiplying the maximum borehole flow rate (l/hr) by the maximum gas concentration (%). This gives a gas screening value for both methane and carbon dioxide of <0.0001 l/hr, which falls into the 'very low risk' category and Characteristic Situation 1 (CS1) conditions.

These results are also confirmed by the findings of the laboratory gas analysis from the summa canisters obtained on site, which did not identify any concentrations of methane above method detection limit of 0.05%, whilst carbon dioxide was measured at a maximum concentration of 0.07%.

6.5 Refined Conceptual Site Model

The contaminant linkages presented in the Conceptual Site Model all require the dataset for the whole site prior to re-evaluation. As this is not yet available, a refined CSM cannot yet be presented. However, based on the available findings there is no reason to suggest that additional linkages should be included in the CSM and the majority, if not all, of the current linkages may well not be active. That would remove the need for any formal below-ground remediation, with the exception of measures typically required to protect buried infrastructure. Barrier drinking water pipes are likely to be required regardless of the findings of the supplementary investigation.

6.6 Summary of Findings

The previous Phase I Desk Study identified the site to comprise a pharmaceutical distribution centre, formerly used as a pharmaceutical manufacturer. On this basis, a number of plausible contaminant linkages were identified associated with human interaction with shallow soils, intrusion of organic vapour to buildings and risks to controlled waters.

The intrusive investigation comprised the drilling of 22 boreholes and 12 trial pits across the site, with ground conditions found to comprise a moderate thickness of made ground overlying successive layers of cohesive and granular River Terrace Deposits. Below this lay London Clay Formation which comprised of a soft initial layer of silt overlying stiff, grey clay.

Whilst this investigation involved detailed investigation of the western half of the site, only sporadic investigation was possible in the eastern and north eastern areas due to the presence of operational buildings. These latter areas include the majority of the Potential Areas of Concern, so further investigation will be needed to finalise the Conceptual Site Model and, if necessary, the Remedial Strategy for the whole site to ensure safe redevelopment. These initial findings should therefore be considered preliminary. However, the sporadic investigation and monitoring that was possible in these areas, coupled with findings of the available previous investigation (by Golder Associates and ERM in the past), suggests that significant risks from site-derived contamination do not exist and there is no obvious barrier to redeveloping the site (in terms of contamination). In addition, even without the remaining data the available dataset almost certainly confirms that the site does not pose a significant possibility of significant harm to existing receptors and would not warrant determination as 'contaminated land' under Part 2A of the Environmental Protection Act 1990 (although that decision would remain the value judgement of the LPA).

Laboratory analysis of shallow and deeper soils from across the site has not identified concentrations of contaminants to exceed the adopted screening criteria protective of future site users in a commercial setting. An initial assessment of the risks posed has not identified a significant risk to either human health or controlled waters, although further testing during the supplementary phase of works is necessary confirm the risk assessment and final Conceptual Site Model. As part of this process, it may be necessary to develop site-specific assessment criteria for certain compounds which currently lack readily available published screening criteria, such as the semi-volatile organic compounds encountered in BH3.

In addition to this, laboratory testing of groundwater has not identified concentrations which are considered to pose a risk to the groundwater body, whilst detailed quantitative soil vapour analysis has not identified a risk associated with intrusion of volatile organic compounds into future buildings. An initial programme of ground gas monitoring has found the site to fall into Characteristic Situation 1, for which no ground gas protection measures would be required.

Once the Conceptual Site Model is finalised, remedial requirements (if needed) can be appraised and presented in a strategy for review by regulators and the client. Even if no risks are identified through the next phase of investigation, there will still be a need for an outline remedial approach for dealing with any unforeseen contamination, through a Discovery Strategy.

In the context of potentially unacceptable or acceptable risks as outlined within the Environment Agency's *Land Contamination: Risk Management* guidance, risks have not been identified by this work that require mitigation, however it should be noted that further investigation is planned in currently inaccessible areas of the site, subsequent to demolition of the current buildings.

6.7 Recommendations

Although significant risks have not been identified as part of this investigation, additional investigation is currently planned subsequent to the demolition of the onsite buildings. It is recommended that as part of these works, additional soil, ground gas and groundwater monitoring be undertaken, particularly in the east and north / north-eastern sections of the site in order to further assess the risks from remaining Potential Areas of Concern, as of contamination identified in historic investigations, as well as the concentration of Benzylbutyl Phthalate found in BH3 during this investigation.

Site clearance and the demolition of the existing commercial buildings and their slabs has been approved by Prior approval APP/21/00783, albeit the majority of pre-commencement conditions attached to the pending permission (approved subject to S106 agreement) APP/21/00200 enable site clearance.

The agreement of the final Conceptual Site Model and Remedial Strategy is not possible to complete without undertaking the site clearance for the reasons stated above (these areas are not accessible at present).

6.8 Waste Management

Depending on the requirements of the final scheme and any associated earthworks balance, it is possible that the site will be subject to a materials management exercise to ensure all potential waste soils are handled and re-used in a legally correct sustainable fashion.

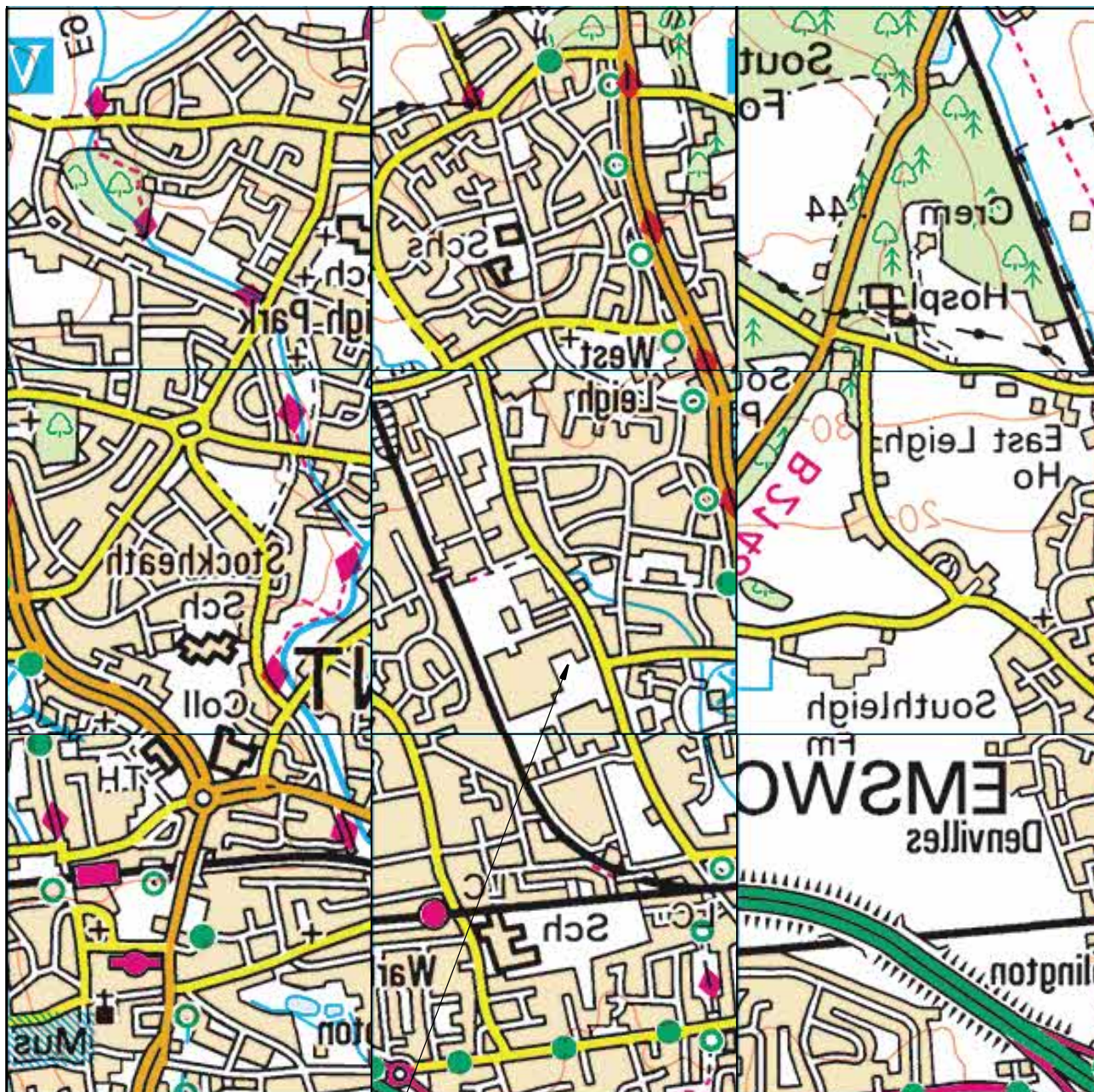
In those circumstances, through a risk assessment process and in accordance with CL:AIRE's *Definition of Waste: Development Industry Code of Practice*, re-use criteria can be defined for site-won soils which are suitable for use being both protective of relevant receptors and geotechnically appropriate (with input from the structural engineers as necessary). EPS will can prepare a Materials Management Plan and have it formally declared by a Qualified Person prior to commencement of groundworks. EPS will also assist with similar mechanisms for re-using waste materials exempt of an environmental permit, such as a U1.

Where viable, EPS would always encourage the employment of an MMP to sustainably manage the re-use of site won soils and minimise the highly unsustainable practise of landfilling. In this instance, EPS have been instructed to prepare and declare an MMP under the CL:AIRE DoWCoP framework.

7 GLOSSARY

BPF	Biotech Packaging Facility
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes
CoC	Contaminant of Concern
CSM	Conceptual Site Model
DCE	1,1 Dichloroethene
EA	Environment Agency
EDC	European Distributing Centre
FCMU	Fine Chemicals Manufacturing Works
HBC	Havant Borough Council
MTBE	Methyl Tert Butyl Ether
PAOC	Potential Areas of Concern
PCE	Tetrachloroethene
PFC	Perfluorinated Chemicals
PFOA	Perfluorooctanic Acid
PFOS	Perfluorooctane Sulfonate
UST	Underground Storage Tank
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
VC	Vinyl Chloride
WALL	CL:AIRE Water and Land Library

FIGURES



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Date: March 2021



— Approximate Site Boundary

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Title: Current Site Layout

Project: 32 New Lane, Havant

Fig No : 2

Scale: NTS

Drawn By: MJ **Approved By:** SB

Job No : UK20.5052c

Dwg No : 32NewLane/ 0321/ 02

Date: March 2021



— Approximate Site Boundary

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Title: Aerial Photograph

Project: 32 New Lane, Havant

Fig No : 3

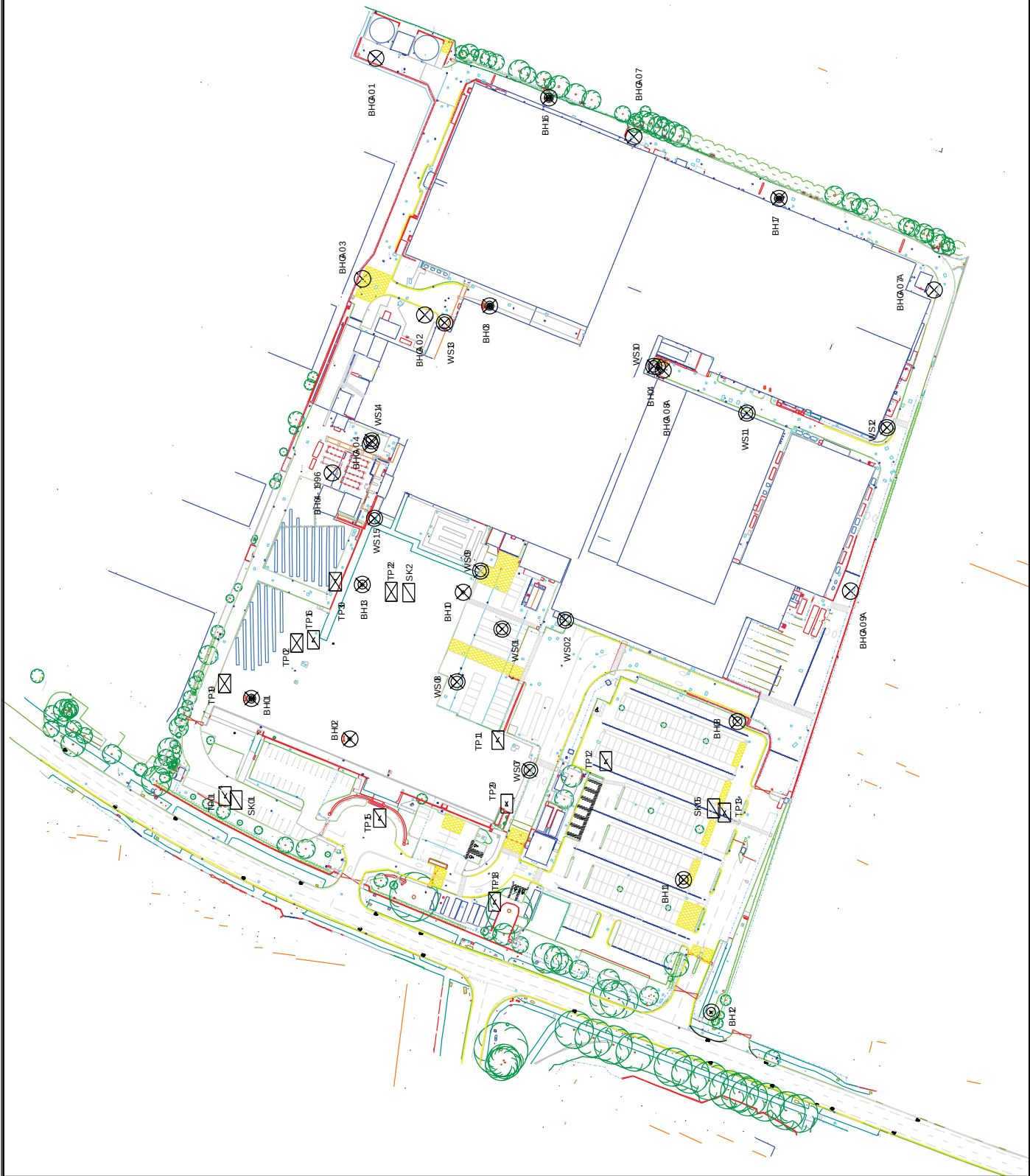
Scale: NTS

Drawn By: MJ **Approved By:** SB

Job No : UK20.5052c

Dwg No : 32NewLane/0321/03

Date: March 2021



○

NOTATION

Date: March 2021

TABLES



Table 1a –Laboratory Testing Schedule (Environmental - Soil)

Sample ID	Sample Depth (m bgl)	EPS Mini Suite	EPS TPH Suite	EPS Waste Suite	VOC & SVOC	PCB	Ammonical Nitrogen	pH and Water Soluble Sulphate	Asbestos Screen
BH1	2.5	-	-	-	-	-	-	1	-
BH1	2.5-3.0	1	1	-	1	-	-	-	-
BH1	10.0-10.45	-	-	-	-	-	-	1	-
BH02	3.5-4.0	1	1	1	1	1	1	-	-
BH03	0.0-0.8	1	1	-	1	1	1	-	-
BH3	2.95-3.0	-	-	-	-	-	-	1	-
BH03	3.0-4.0	1	1	-	1	-	1	-	-
BH3	12.45-12.5	-	-	-	-	-	-	1	-
BH04	0.5	1	1	-	1	1	1	-	-
BH4	5.5-5.95	-	-	-	-	-	-	1	-
BH4	14.95-15	-	-	-	-	-	-	1	-
BH4	17.5-17.95	-	-	-	-	-	-	1	-
BH6	1.15-1.2	-	-	-	-	-	-	1	-
BH6	3.95-4.0	-	-	-	-	-	-	1	-
BH6	9.45-9.5	-	-	-	-	-	-	1	-
BH8	0.8	1	1	-	1	-	-	-	-
BH8	2.5-3.0	1	1	-	1	-	-	-	-
BH8	11.95-12	-	-	-	-	-	-	1	-
BH10	2.5-3.0	-	-	-	-	-	-	1	-
BH10	7.0-9.0	1	1	-	1	-	1	-	-
BH10	10.45-10.5	-	-	-	-	-	-	1	-
BH11	0.0-0.5	1	1	-	1	1	1	-	-
BH11	3.6-4.0	-	-	-	-	-	-	1	-
BH11	11.5-11.95	-	-	1	-	-	-	1	-
BH12	0.0-0.5	1	1	-	1	1	1	-	-
BH12	2.5-3.0	1	1	-	1	-	-	1	-
BH12	7.45-7.5	-	-	-	-	-	-	1	-
BH13	1	1	1	-	1	1	1	-	-
BH13	4.95-5.0	-	-	-	-	-	-	1	-
BH13	6.0-6.5	1	1	-	1	1	1	-	-
BH13	8.95-9.0	-	-	-	-	-	-	1	-
BH16	2.95-3.0	-	-	-	-	-	-	1	-
BH16	4.9-5.0	-	-	-	-	-	-	1	-
BH16	6.5	1	1	-	1	-	1	-	-
BH16	11.95-12.0	-	-	-	-	-	-	1	-



BH17	0.4-0.8	-	-	-	-	-	-	-	-
BH17	3.95-4.0	-	-	-	-	-	-	1	-
BH17	5.95-6.0	-	-	-	-	-	-	1	-
BH17	8.95-9.0	-	-	-	-	-	-	1	-
WS2	0.3-0.5	1	1	1	1	1	1	-	-
WS7	0.5-0.7	1	1	-	1	1	1	-	-
WS8	0.9-1.0	-	-	1	-	-	-	-	-
WS9	0.6-0.8	1	1	-	1	1	1	-	-
TP01	0.5	-	-	-	-	-	-	-	1
TP02	0.5	-	-	-	-	-	-	-	1
TP11	0.5	-	-	-	-	-	-	-	1
TP11	1.5	1	1	-	1	1	1	-	-
TP12	0.2-0.4	-	-	-	-	-	-	-	1
TP12	2.1	1	1	-	1	1	1	-	-
TP13	0.2-0.25	1	1	-	1	-	1	-	-
TP15	0.3-0.7	1	1	-	1	1	1	-	-
TP15	1	1	1	-	1	-	1	-	-
TP16	1.6	1	1	-	1	-	1	-	-
TP18	1.2-1.3	-	-	-	-	-	-	-	-
TP19	0.5	-	-	-	-	-	-	-	1
TP22	0.5	-	-	-	-	-	-	-	1
TP22	1.2	1	1	-	1	-	1	-	-
TP29	0.5	-	-	-	-	-	-	-	1
TP30	1.8	1	1	-	1	1	1	-	-

Notes:

mbgl

1

-

EPS Mini Suite

EPS TPH Suite

EPS Waste Suite

VOC

SVO C

PCB

meters below ground level

Sample Taken

Sample Not Analysed

Organic Matter, Cyanide, Metals, PAH's, Phenols, Asbestos, pH, sulphates

TPH CWG, BTEX, MTBE

Waste Characterisation Suite

Volatile Organic Compounds

Semi-Volatile Organic Compound

Polychlorinated Biphenyls

Table 1b –Laboratory Testing Schedule (Environmental - Groundwater)

Sample ID	EPS Mini Suite	EPS TPH Suite	Ammoniacal Nitrogen	VOC & SVOC	PCB	Ferrous Iron
BH1	1	1	1	1	1	1
BH3	1	1	1	1	1	1
BH8	1	1	1	1	1	1
BH12	1	1	1	1	1	1
BH16	1	1	1	1	1	1
BH17	1	1	1	1	1	1
BH04 1996	1	1	1	1	1	1
BHGA01	1	1	1	1	1	1
BHGA02	1	1	1	1	1	1
BHGA03	1	1	1	1	1	1
BHGA04	1	1	1	1	1	1
BHGA07	1	1	1	1	1	1
BHGA07A	1	1	1	1	1	1
BHGA08A	1	1	1	1	1	1
BHGA09A	1	1	1	1	1	1

Notes:

mbgl

1

-

EPS Mini Suite

EPS TPH Suite

VOC

SVOC

meters below ground level

Sample Taken

Sample Not Analysed

Organic Matter, Cyanide, Metals, PAH's, Phenols, Asbestos

TPH CWG, BTEX, MTBE

Volatile Organic Compounds

Semi-Volatile Organic Compound

Table 1c –Laboratory Testing Schedule (Environmental –Soil Gas)

Sample ID	TO15 List + TICs	Ground Gases	Hydrogen Sulphide	THP	Limonene
WS01	1	1	1	1	
WS02	1	1	1	1	
WS07	1	1	1	1	
WS08	1	1	1	1	
WS09	1	1	1	1	
WS10	1	1	1	1	
WS11	1	1	1	1	
WS12	1	1	1	1	
WS13	1	1	1	1	
WS14	1	1	1	1	
WS15	1	1	1	1	

Notes:

mbgl

1

-

Ground Gases

meters below ground level

Sample Taken

Sample Not Analysed

Carbon Dioxide, Methane, Oxygen, Nitrogen, Carbon Monoxide

Table 2 –Laboratory Testing Schedule (Geotechnical)

Sample ID	Sample Depth (m bgl)	Moisture Content	Liquid / Plastic Limits	Particle Size Distribution	Undrained Triaxial	Oedometer Consolidation
BH1	4.5-5.0	-	-	1	-	-
BH1	12.0-12.5	1	1	-	-	-
BH3	2.0-2.5	-	-	1	-	-
BH3	5.0-5.45	-	-	-	1	-
BH3	12.0-12.45	-	-	-	1	-
BH4	3.5-4.0	1	1	-	-	-
BH4	11.5-11.95	-	-	-	1	1
BH4	19.0-19.45	-	-	-	1	1
BH6	1.2-1.65	-	-	1	-	-
BH6	9.0-9.45	-	-	-	1	-
BH8	2.5-3.0	-	-	1	-	-
BH8	8.5-8.95	-	-	-	1	-
BH8	10.0-10.45	1	1	-	-	-
BH8	14.5-14.95	-	-	-	1	-
BH10	1.5-2.0	1	1	-	-	-
BH10	3.5-4.0	-	-	1	-	-
BH10	5.5-5.95	-	-	-	1	1
BH10	5.95-6.0	1	1	-	-	-
BH10	14.5-14.95	-	-	-	1	1
BH11	2.5-3.0	-	-	1	-	-
BH11	13.0-13.45	-	-	-	1	1
BH11	13.45-13.5	1	1	-	-	-
BH11	17.5-17.95	-	-	-	1	1
BH12	1.1-2.0	-	-	1	-	-
BH12	6.20	-	-	1	-	-
BH12	7.0	-	-	-	1	-
BH12	10.0	-	-	-	1	-
BH13	2.0-2.45	-	-	1	-	-
BH13	5.95-6.0	1	1	-	-	-
BH13	12.0-12.45	-	-	-	1	-
BH16	3.9-4.0	1	1	-	-	-
BH16	5.0-5.45	-	-	-	1	-
BH16	6.95-7.0	-	-	1	-	-
BH16	9.95-10.0	1	1	-	-	-
BH16	12.0-12.45	-	-	-	1	-



BH17	3.5-4.0	-	-	1	-	-
BH17	6.95-7.0	-	-	1	-	-
BH17	12.0-12.45	-	-	-	1	-

Notes:

mbgl

1

-

meters below ground level

Sample Taken

Sample Not Analysed

Table 3 - Groundwater Monitoring Parameters (18/02/2021)

Location	Depth to water (m bgl)	pH	Dissolved Oxygen (ppm)	Temperature (°C)	Redox	Electrical Conductivity (uS/ cm)	Product Thickness
BH1	3.03	7.21	2.10	11.3	36.2	688.0	n/a
BH3	2.55	7.48	1.80	11.6	111.7	561.0	n/a
BH8	2.13	7.43	2.98	10.7	141.8	520.4	n/a
BH12	2.20	7.12	0.83	11.5	6.86	1088	n/a
BH13	3.05	7.40	2.64	11.2	141.8	622.7	n/a
BH16	2.27	7.72	4.0	11.1	127.7	669.7	n/a
BH17	2.80	7.11	0.41	12.2	1.5	744.0	n/a
BHGA01	3.40	7.37	3.32	11.7	94.1	879.0	n/a
BHGA02	2.61	7.87	6.10	9.5	122.6	577.5	n/a
BHGA03	2.85	7.33	4.74	12.3	143.6	584.0	n/a
BHGA04	2.16	7.65	6.47	11.5	148.9	569.0	n/a
BHGA07	2.78	7.33	0.56	12.3	-69.0	654.4	n/a
BHGA07A	2.83	7.19	4.0	11.3	104.5	1128	n/a
BHGA09A	2.50	6.96	0.27	11.7	-64.3	1140	n/a
BH08A	2.47	7.08	3.38	10.6	93.7	620.0	n/a
BH-04-1996	2.30	7.58	7.63	10.6	171.5	538.9	n/a

Notes

n/a –not any
m bgl –metres below ground level
ppm –parts per million

Table 4 - Ground Gas Monitoring Data

(25/02/2021)

Sample ID	WS01	WS02	WS07	WS08	WS09	WS10	WS11	WS12	WS13	WS14	WS15
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
O ₂ (%)	20.7	20.4	20.8	20.7	20.6	20.6	20.4	20.6	20.5	20.6	20.5
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Readings collected on 25th February 2021 at an atmospheric pressure of 1025-1026 (rising).

(05/03/2021)

Sample ID	WS01	WS02	WS07	WS08	WS09	WS10	WS11	WS12	WS13	WS14	WS15
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
O ₂ (%)	20.7	20.5	20.5	20.4	20.4	20.4	20.1	19.9	20.3	20.2	20.2
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Readings collected on 5th March 2021 at an atmospheric pressure of 1029-1030 (rising).

(09/03/2021)

Sample ID	WS01	WS02	WS07	WS08	WS09	WS10	WS11	WS12	WS13	WS14	WS15
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
O ₂ (%)	20.8	20.7	20.7	20.5	20.6	20.5	20.4	20.5	20.5	20.5	20.7
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC	<.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Readings collected on 9th March 2021 at an atmospheric pressure of 1020-1020 (steady).

APPENDICES

APPENDIX A

Selected Site Photographs



— Approximate Site Boundary

① Approximate Photo Location

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Title: Photograph Location Plan

Project: 32 New Lane, Havant

Appendix A

Scale: NTS

Drawn By: MJ Approved By: SB

Job No: UK20.5052c

Dwg No: 32NewLane/0321/A

Date: March 2021

Photo 1: View looking west at the northwest corner of the site.



Photo 2: View looking southeast across the site.



Photo 3: View looking north along the eastern edge of the site, with BH17 under the yellow cover.



Photo 4: View looking northeast, from the southwest corner of the site.



Photo 5: View looking west at the southwest corner of the site, with BH12 underway.



Photo 6: View looking south across the gravelled area in the west of the site.



Photo 7: TP12

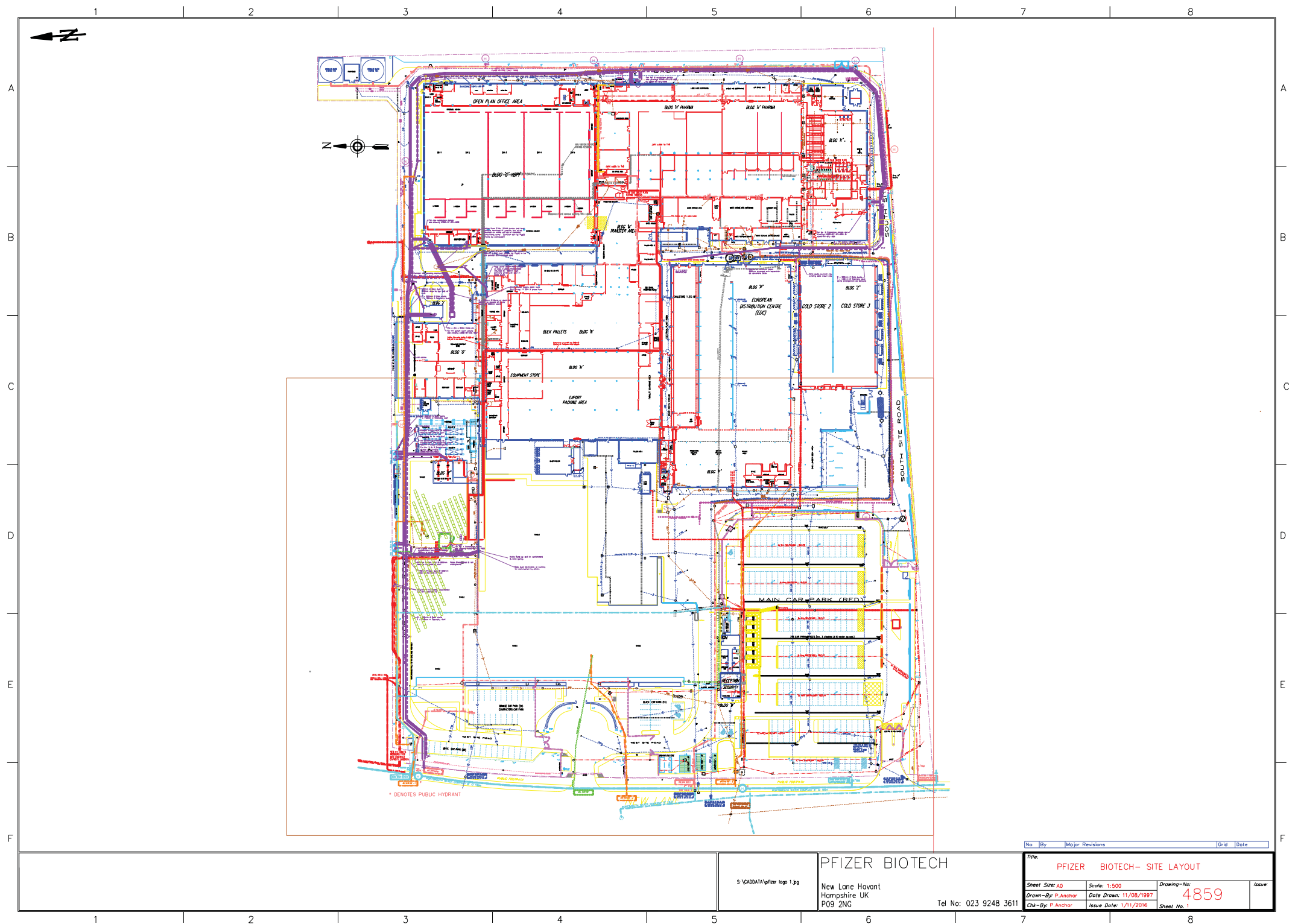


Photo 8: TP1



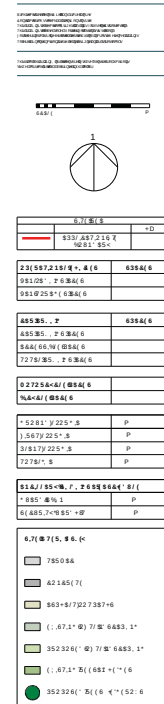
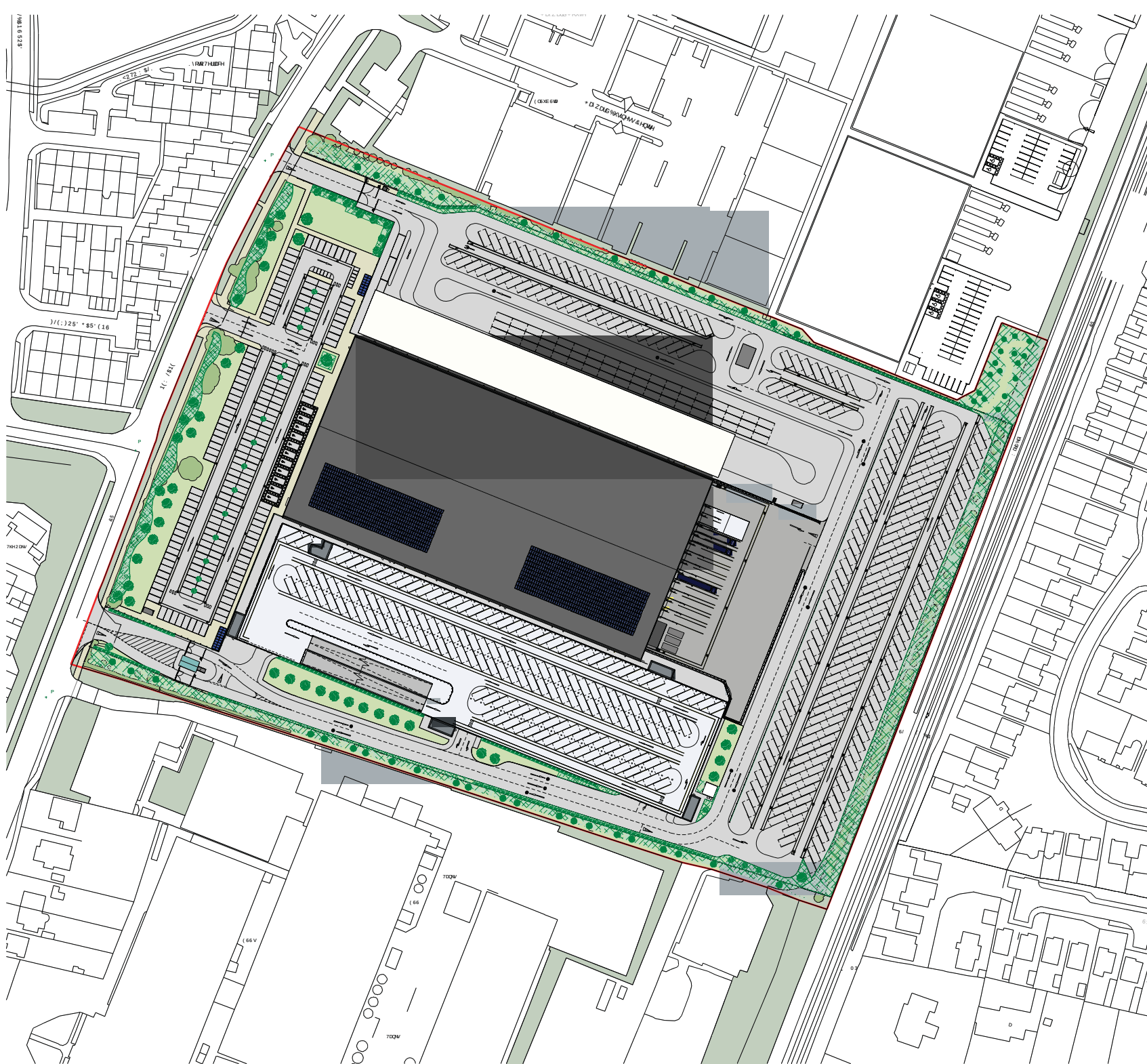
APPENDIX B

Detailed Site Layout



APPENDIX C

Proposed Development Plan



APPENDIX D

National Quality Mark Scheme Declaration



NQMS SQP Declaration of Document Adequacy

Project

Project Name	UK20.5052C
Project Address	New Lane, Havant (Phase II)
NQMS Declaration Reference	0321-D3093

Summary Description of Project / Proposed development

Phase II Geo-Environmental Assessment/Commercial Redevelopment

Document

Document Title	Phase II Geo-Environmental Assessment
Document Type	Phase II
Document Reference	UK20.5052C
Document Date	March 2021
Document Author / Publishing Organisation	EPS
Named Client	N/A



Regulator's Contact Details

Local Authority Details

Local Authority Name	N/A
Contact Name	N/A
Contact Telephone	N/A
Contact Email	N/A
Contact Role	N/A

Regulator Details

Regulator	N/A
Contact Name	N/A
Contact Telephone	N/A
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Chartered or Professional Institution Membership Reference	Assessment 0014938



Declaration

I, Marcus Bell, confirm that I am the person described in the SQP Details section and hold current valid registration as a Suitably Qualified and Experienced Person Registration No. SQP0117 with the NQMS.

I have reviewed the document described in the Document Details section, in relation to the project and site described in the Site Details section, and I am satisfied that:

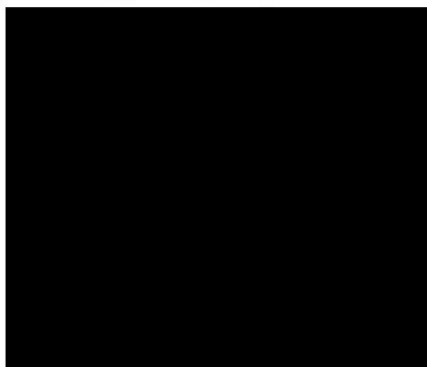
1. The work has been carried out by appropriately capable people with reference to the Brownfield Skills Framework. ✓
2. That the work carried out is, to the best of my knowledge, undertaken with reasonable skill and care, and the information and data reported:
 - i. describe an appropriate scope and objectives and ✓
 - ii. accord with relevant good practice guidance and standards and ✓
 - iii. are based upon appropriately robust science and ✓
 - iv. are factually correct and ✓
 - v. have been appropriately reviewed. ✓
3. That all specialist aspects have been reviewed by an appropriately qualified/competent person with relevant skills and experience in that specialist area. ✓
4. That the interpretation and conclusions are reasonable. ✓
5. That proposals to mitigate actual potential or residual risks are appropriate. ✓
6. I am competent to sign this Declaration and that
 - a. I am fully aware and comply with the Code of Conduct of Institute of Environmental Management Assessment through which I hold Chartership 0014938. ✓
 - b. The work of this review and Declaration are within the limits of my knowledge, competence and professional capacity. ✓

Note: The document that has been reviewed was prepared by the organisation named for the benefit of the named Client who has reliance upon it. Any professional liability arising from any proven negligent act or omission by the Company carrying out the work and publishing the document rests with that Company and not with the SQP or the NQMS.

Signed:

Date:

Name:
[Block capitals]



0321-D3093

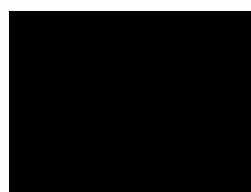


APPENDIX 1 – TECHNICAL AUDITING OF REPORTS

In order to have confidence in the conclusions that are presented within any report it is necessary for clients, regulators and stakeholders to know that the data has been audited in a way that ensures that it is fit for purpose. To this end the SQP is directed to apply the following list of critical questions and challenges in using their experience to assess the suitability of any product and before signing off the declaration which accompanies any report.

The lists below have been compiled by regulators and practitioners experienced in the peer review of land contamination management data. They are not meant to be exhaustive in their coverage, but they do focus attention on those aspects of submissions that tend to have the most influence on decisions made and regulatory acceptability. The lists are not meant to duplicate or replace other standard checklists or quality management and control measures that are also used to ensure the factual (as opposed to interpretative) content, accuracy or style of reports.

For all Land Contamination Management Reports	
• Are the aims and objectives of the project and the purpose of the report clearly set out? ✓ • Has all information been presented and summarised in a clear and understandable way? ✓ • Have relevant uncertainties been highlighted together with their implications for any conclusions drawn? ✓ • Are the overall conclusions and recommendations robust and justified by the supporting data being presented? ✓ • Are the next steps appropriate and clearly justified? ✓ • Has the approach adopted for the site followed best practice and up-to-date guidance? ✓	
For Reports dealing with RISK ASSESSMENT (Stage 1)	
Preliminary Risk Assessment (PRA) • Given the nature and size of the development, has a reasonable desk and site based study been presented to establish the land use history and environmental setting of the site and identified relevant contaminants, pathways and receptors? <i>- See Phase I</i> • Has a representative conceptual site model (CSM) been presented which identifies and assesses all relevant pollutant linkages having regard to the current and/or future site use (as appropriate)? ✓ • Have the limitations/uncertainties in the PRA and their effects on conclusions/recommendations been considered? ✓ • Has the basis of the decisions for the proposed next steps (e.g. no action, remediation or further risk assessment) been clearly presented and justified? ✓	



For Reports dealing with RISK ASSESSMENT (Stages 2 & 3)

Generic Quantitative Risk Assessment (GQRA)

- Is the site investigation design robust enough to gather the necessary site data, having regard to the aims and objectives of the project, the site setting and the CSM? In particular,
 - Have appropriate generic assessment criteria and tools been identified to enable risk estimation and evaluation and have their data requirements been incorporated into the design? ✓
 - Are the choices of investigatory techniques appropriate? ✓
 - Are the number, nature and locations of samples, testing and monitoring regimes sufficient? ✓
- Has the collected site data been analysed and risks estimated appropriately using the right tools, techniques or methods. In particular,
 - Have the right substances been quantified with appropriate limits of detection? ✓
- Have the pollutant linkages and risks to human health/controlled waters/other receptors been evaluated using appropriate generic assessment criteria and assumptions in line with the latest technical or regulatory guidance on compliance? ✓
- Have the limitations/uncertainties in the GQRA and their effects on conclusions been considered? ✓
- Has the basis of the decisions for the proposed next steps (e.g. further action, no action, remediation or further risk assessment) been clearly presented and justified? ✓

Detailed Quantitative Risk Assessment (DQRA) *N/A (only applied to vapour)*

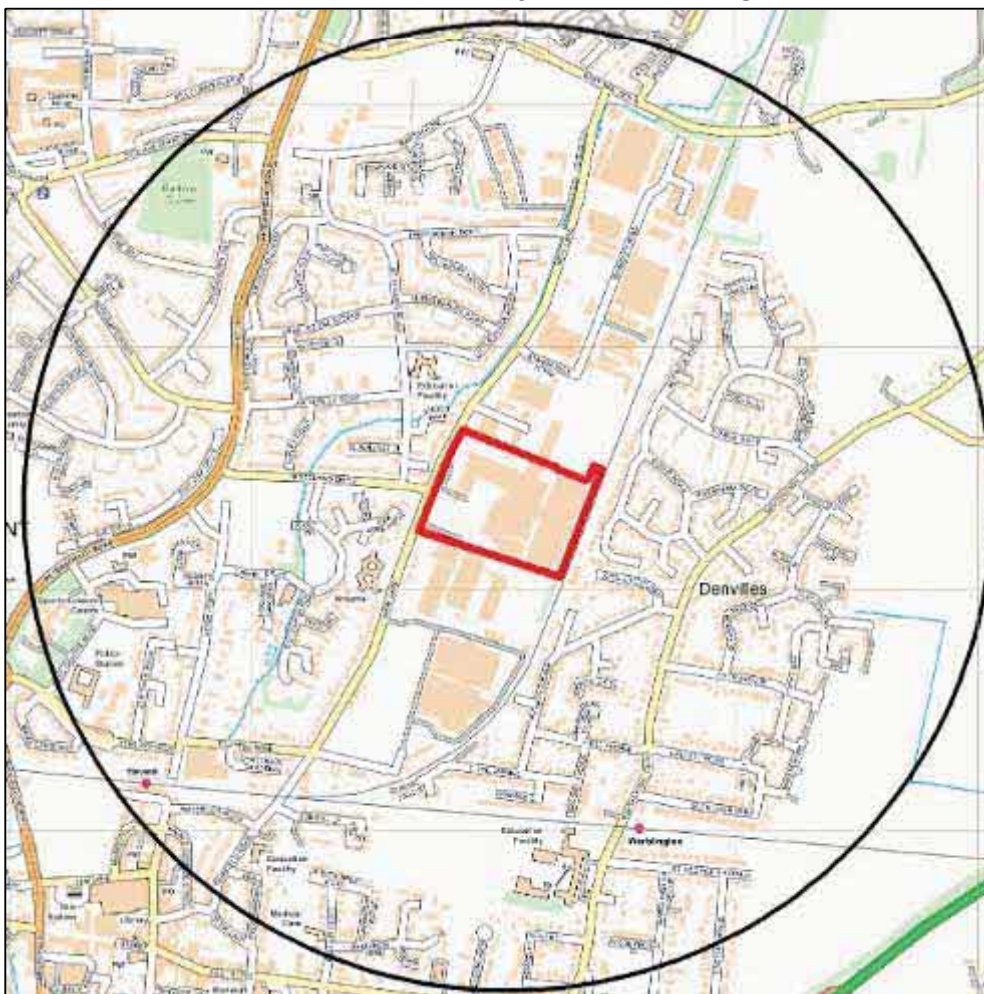
- Is the site investigation design robust enough to be able to gather the necessary data, having regard to the aims and objectives of the project, the site setting, the CSM and other parameters to develop site specific risk estimation models and site specific assessment criteria? (as per GQRA list above)
- Has the collected site data been analysed and risks estimated appropriately using the right tools, techniques models or methods. In particular,
 - Have the right substances been quantified with appropriate limits of detection?
 - Do the data/parameters used in any model adequately reflect actual site conditions?
 - Has any modelling been subject to sensitivity analysis and are the consequences of adopting more/less conservative data adequately expressed?
- Have the pollutant linkages and risks to human health/controlled waters/other receptors been evaluated using appropriate site specific assessment criteria and assumptions in line with the latest technical or regulatory guidance on compliance?
- Have the limitations/uncertainties in the DQRA and their effects on conclusions considered?
- Has the basis of the decisions for the proposed next steps (e.g. further action, no action, remediation or further risk assessment) been clearly presented and justified?

APPENDIX E

Preliminary UXO Assessment

PRELIMINARY UNEXPLODED ORDNANCE (UXO) THREAT ASSESSMENT

Meeting the requirements of CIRIA C681 'Unexploded Ordnance (UXO) – A guide for the Construction Industry' Risk Management Framework



6 ALPHA PROJECT NUMBER	8657	ORIGINATOR	D. Barrett
LANDMARK ORDER NUMBER	271735793_1	REVIEWED BY	L. Hayes (18 th January 2021)
CLIENT REFERENCE	UK20.5052C	RELEASED BY	L. Gregory (19 th January 2021)
STUDY SITE	Site at 472460, 107260		
RECOMMENDATION	No further action is required to address the UXO risk at this Study Site		

STUDY SITE

The Study Site is described as "Site at 472460, 107260", and it is centred on National Grid Reference 472530, 107170.

THREAT POTENTIAL AND RECOMMENDATIONS

The potential for a UXO hazard to occur, and more specifically, the potential for unexploded WWI and WWII ordnance to exist at this site is assessed as being **UNLIKELY** (Figure 2).

In accordance with CIRIA C681 Chapter 5 on managing UXO risks, 6 Alpha concludes that **NO FURTHER ACTION** is required to address the UXO risk at this Study Site. Should you have any queries, please contact Envirocheck.

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REPORT SUMMARY

During WWII, the Study Site was situated within Havant & Waterloo Urban District, which recorded eight High Explosive (HE) bomb strikes per 100 hectares; a very low level of bombing.

Luftwaffe aerial reconnaissance photography associated with the Study Site did not identify any primary bombing targets on-site, or within 1,000m of the Study Site boundary.

Air Raid Precaution (ARP) records were not available. Nonetheless, further research noted five bomb strikes within 660m; the closest impacting on Fourth Avenue, approximately 160m south.

Official bomb damage mapping was not available. An analysis of post-war mapping also did not identify any bomb damage, however, further research noted bomb damage to Fourth Avenue (160m south) and Hallet Road (550m south-east).

Whilst bombing was recorded in the wider area, as there was no bombing or bomb damage recorded in the Study Site's immediate vicinity during WWII, there is no evidence to suggest that further investigation into UXO is warranted.

USING THIS REPORT

This Preliminary Assessment is designed to inform environmental and construction professionals of the potential threat of military related explosives and/or ordnance on, or in, the vicinity of the Study Site.

This assessment is designed to be employed as a site-screening tool to meet with the requirement of Phase One of the CIRIA UXO Risk Management Framework; there are two broad prospective outcomes; either the threat level requires a detailed threat & risk assessment; or no further action is required. In the former instance we can provide a report within 10 working days (or more quickly upon application).

Two figures accompany the report, the Second World War (WWII) High Explosive (HE) Bomb Density and the final Probability of UXO Encounter. The purpose of this approach is to demonstrate that whilst bomb density statistics give an indication for WWII bombing, they should not be relied upon exclusively to generate a holistic assessment.

For further information, please contact Envirocheck:

Telephone: +44 (0)844 844 9952

Website: <http://www.envirocheck.co.uk>

Email: customerservice@envirocheck.co.uk

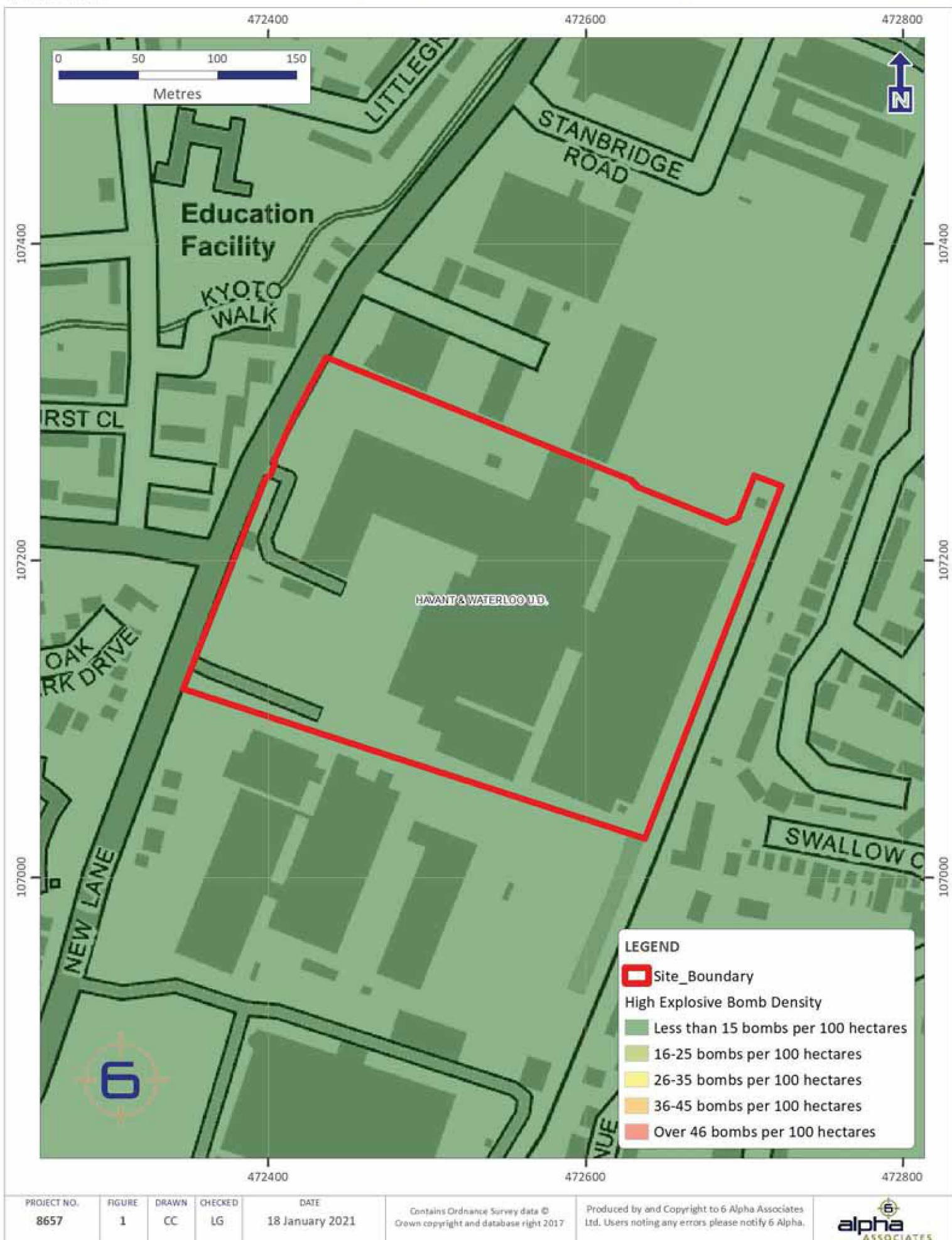
DATA FINDINGS

Threat Source (within 1,000m)	Detail	
	Identified	Comments
 Airfields/Military Facilities	D	West Leigh Camp was identified approximately 300m north-west and was occupied by the Royal Navy during WWII.
 Ordnance Manufacture/Storage	U	None recorded within 1,000m.
 WWII Decoy Bombing Sites	U	None recorded within 1,000m.
 WWII Defensive Features	U	None recorded within 1,000m.
 WWII Luftwaffe Designated Bombing Targets	U	Luftwaffe aerial photography did not identify any primary bombing targets on-site, or within 1,000m of the Study Site boundary.
 WWII Bomb Strikes (Study Site Boundary)	U	ARP records were not available.
 WWII Bomb Strikes (Wider Area)	D	Further research identified bomb strikes; 160m south, 330m north-east, 525m south-east, 620m south-east and 660m east-north-east.
 WWII Bomb Damage	D	Further research identified bomb damage 160m south and 550m south-east.
 Abandoned Bomb Register	U	The official abandoned bomb list did not identify any abandoned bombs on-site, or within 1,000m of the Study Site boundary.
 Potential Threat Sources	U	Further research has not uncovered any potential UXO threat sources associated with the Study Site.
 WWII Bombing Density Per 100 Hectares	D	The Study Site was located within Havant & Waterloo Urban District, which recorded eight HE bomb strikes per 100 hectares.

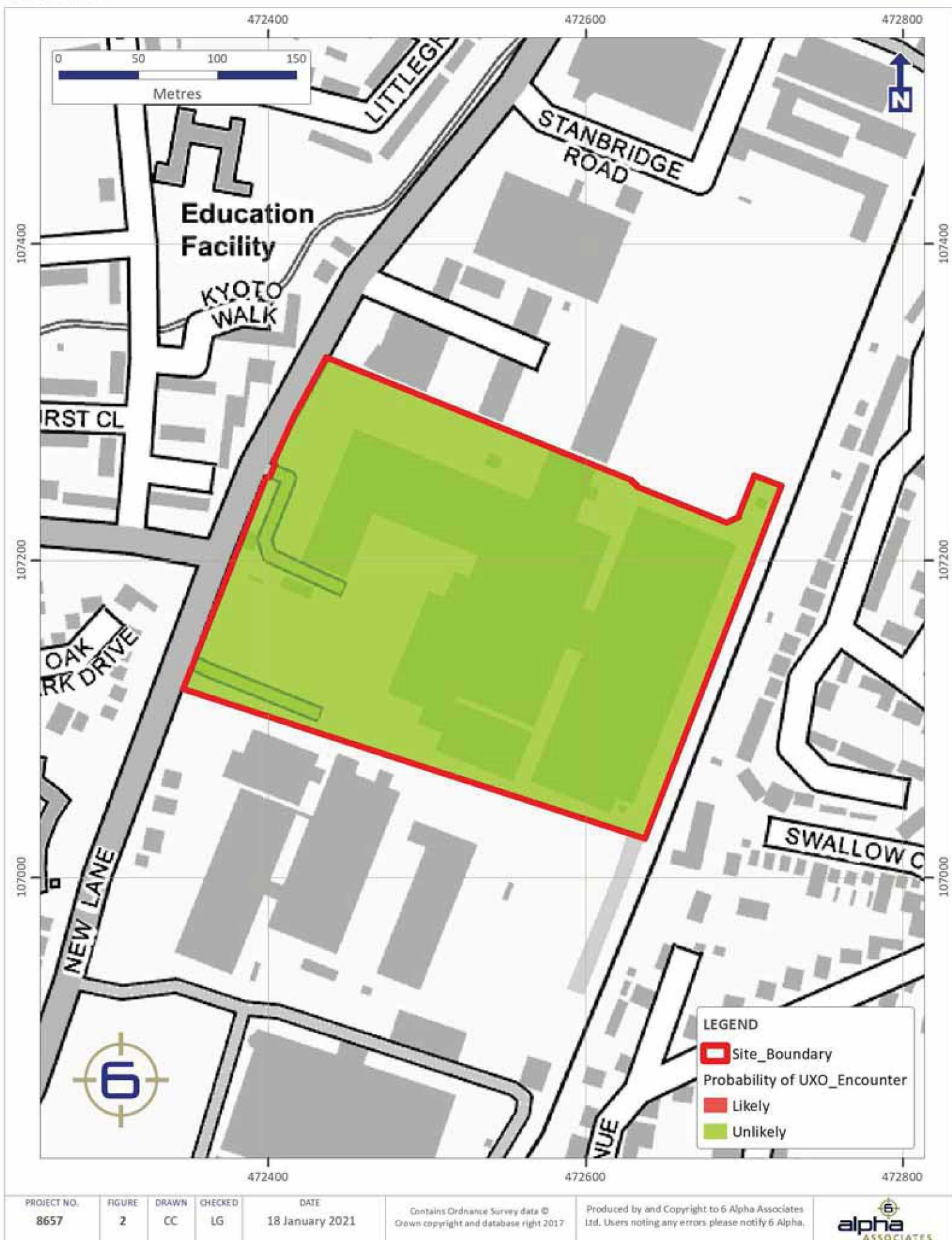
IMPORTANT NOTES

1. The term 'Preliminary UXO Threat Assessment' has been used to describe this report, to fall in line with the CIRIA C681 guidelines. Whilst the term 'Risk' can be justifiably used at this stage, the reader should note that the 'Consequence' function of 'Risk' is not considered. Should it be required, this would be addressed in the 'Detailed UXO Threat & Risk Assessment' (Stages 2 and 3).
2. This report is accurate and up to date at the time of writing.
3. The assessment levels have been generated from historical data and third-party sources. Where possible 6 Alpha have sought to verify the accuracy of such data, but cannot be held accountable for inherent errors that may be in third party data sets (e.g. National Archives or library sources).
4. 6 Alpha have exercised all reasonable care, skill and due diligence in producing this service.
5. Whilst every effort has been used to identify all potential UXO/explosive threats, there were a number of private facilities, which may not have released privately recorded information concerning UXO/explosive threats into the public domain. It is therefore possible that some of the aforementioned sites may not be included within the database.

WWII High Explosive Bomb Density



Probability of UXO Encounter





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