



GROUND INVESTIGATION REPORT FOR BRYN LANE – OUTLINE PLANNING, WREXHAM

TE1749-TE-00-XX-RP-GE-001-V04

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FINAL

Prepared for:

Net World Sports

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EXECUTIVE SUMMARY

Introduction	Tier Environmental was commissioned by Net World Sports to undertake a Ground Investigation of Bryn Lane – Outline Planning. The purpose of the investigation was to determine the nature and extent of soil and groundwater beneath the Site for the purposes of environmental and geotechnical assessment.
Proposed land use	The proposals comprise a commercial development, including industrial and storage & distribution uses, and ancillary retail/hotel floorspace with associated roadways, pavements and parking areas. As part of the proposals there are areas of soft landscaping across the site.
Site location and surrounding land uses	The site is located at Land North of Bryn Lane, Wrexham, LL13 9UT. The Site is currently in use as agricultural fields, with surrounding land uses comprising both residential to the north, and industrial to the south of Bryn Lane. There are no nearby significant current land uses in the vicinity of the Site.
Previous investigations	Tier Environmental have previously conducted a Preliminary Risk Assessment for the Site: report reference: “TE1624-TE-00-XX-RP-GE-001-V03” dated June 2023. A full copy of this report is included within Appendix I. The PRA covers both the outline planning and detailed planning areas of the Site.
Fieldwork	Fieldwork was conducted between 5 th and 23 rd of June 2023, supervised by a suitably qualified Tier Environmental Engineer and comprised: • 17 No. machine excavated trial pits to depths between 1.90m bgl and 4.00m bgl. • 8 No. hand excavated trial pits to depths between 1.00m bgl and 1.20m bgl. • 12 No. window sample boreholes to depths of 5.45m bgl.
Laboratory testing	Samples of soil and groundwater were submitted for analysis of a range of metal, other inorganic and organic components including asbestos. Geotechnical testing was scheduled on selected samples. All testing was undertaken at accredited laboratories.
Ground conditions	The site is broadly underlain site wide by topsoil to depths of 0.20m to 0.55m bgl or Made Ground to typical depths of between 0.25m to 1.10m bgl. Made Ground was encountered principally in the central northeast of the site. These are underlain by natural soils comprised of Devensian Till, described as a firm becoming stiff and locally very stiff Clay. A more weathered horizon of brown clay was recorded in the order of 0.25m to 1.40m thick overlying the dark grey unweathered Till which was proven to the maximum drilled depth of 5.45m bgl. Sand lenses were also recorded near surface to 0.55m and 1.35m bgl. Localised areas of soft organic clays and Peat are described within the central northeast of the site within an infilled pond from depths of 0.59m to 1.10m bgl to depths of 1.75m to 2.60m bgl. A shallow perched groundwater level of between 0.30-0.85m bgl was encountered in some area of the site within Made ground soils, with a more consistent groundwater body of between 1.18-3.81m was recorded in the natural soils in monitoring wells.
Ground stability	Ground conditions were stable across the majority of Site, with areas of softer ground encountered in trial pits targeted in historic pond locations.
Foundations and floor slabs	Given the encountered ground conditions and the nature of the proposed development, the most likely foundation solution would be a pads or similar traditional shallow foundations. Based on the range of shear strengths derived from in-situ shear testing, an allowable bearing capacity of circa 150-170kN/m ² could be achieved at 1.20m bgl. Localised over excavation of organic rich Made Ground soils and Peat as recorded in TP117 and TP118 (which would not be considered suitable as a founding stratum and would arise to differential settlements beyond tolerable limits) may be required, with deepening of foundations or engineered replacement with suitable material. Piles could be considered where loadings cannot be transferred to shallow soils.
Sulphate class	The conclusion of the assessment is that a DS-2 and ACEC Class AC-2 is appropriate for buried concrete design purposes within Made Ground and natural soils based on results from groundwater testing, taking into account a conservative assumption of ‘mobile’ groundwater in accordance with BRE guidance despite the presence of anticipated low permeability clay soils.
Phosphorus	The Site is located within the River Dee and Bala Lake Designated Special Area of Conservation (SAC). The drainage strategy/design for the proposed development should therefore incorporate appropriate on-site and/or off-site mitigation measures which should be agreed with the regulatory authorities. The proposed development will involve the development of the majority of the site, with buildings and hardstanding proposed and demolishing the farm buildings at Little Acorns and Honey Suckle Cottage off Francis Lane. Not only will this act to inhibit infiltration into the ground, it will also largely remove the source of agricultural phosphate from the site. The site won topsoil will be reused within the development within screening bunds and soft landscaping, but agricultural fertilisers and manure will no longer be used on the site. Wastewater drainage from the proposed development will be either via the on-site combined sewer and the Five Fords WwTW or on-site wastewater treatment and discharge to the on-site surface water drainage system.



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	A Phosphates Assessment has been prepared separately by Tier and submitted as part of the hybrid planning application.
Contamination – Human Health	No measured soil concentrations of potential contaminants of concern have been reported in excess of Generic Assessment Criteria (GACs) protective of human health appropriate to the proposed land use. On this basis , it is not considered that the site represents a potential risk to end-users. Of the 14 No. of Made Ground samples submitted for asbestos screening, none were reported to contain asbestos.
Contamination – Controlled Waters	From a conceptual site model perspective, the Devensian Till is classified as a Secondary Undifferentiated Aquifer, and the bedrock geology is classified as a Principal Aquifer associated with Kinnerton Sandstone Formation in the western/northern parts of the Site and a Secondary A Aquifer associated with the Salop Formation comprising mudstone in the southern / southeastern part of the Site. There is an inferred fault located beneath the site orientated from southwest to northeast associated with these two bedrock formations. The site is within a Source Protection Zone Total Catchment 3 associated with the Principal Aquifer, and the nearest surface water receptor comprises an underground water course 110m west. There are no potable or non-potable water abstractions located within 1km of the Site. The cohesive Till deposits have been proven to depths of circa 15.00m bgl in this investigation and are recorded to depths of circa 26.0 to 38.0m bgl in nearby BGS records which is considered sufficient to provide protection of the underlying bedrock aquifers from any vertical migration of potential contaminants of concern. On this basis the controlled waters sensitivity is considered to be low. Measured groundwater concentrations of copper, nickel, zinc, fluoranthene, benzo(a)pyrene, total ammonia and electrical conductivity are not considered to present a risk to the controlled waters environment for the following reasons: • The potential for significant dilution between the Site and nearby water bodies; • The low sensitivity of the controlled waters environment; • The localised nature of those soil leachate concentrations in excess of the WQS and the absence of any reported widespread leachable concentrations; • The fact that the Site will incorporate buildings / hardstanding and a dedicated drainage system that shall reduce infiltration rates through the soils; • The absence of any nearby potable or non-potable groundwater abstractions; • The protection offered to the underlying principal aquifer by the presence of >10.0m of low permeability cohesive Till soils. • The absence of a nearby viable surface water body where a consumption of fish by humans exposure scenario would be realised for fluoranthene and benzo(a)pyrene.
Gas protection	A Gas Screening Value of 0.553 l/hr has been calculated, derived using the maximum peak recorded carbon dioxide concentration of 7.9%v/v and the maximum peak flow rate of 0.7 l/hr. Assessment of this gas screening value alone places the Site in a Characteristic Situation 1 – very low risk scenario in accordance with CIRIA C665 for which ground gas protection measures are not required.
Radon Requirements	The Site lies within an area where less than 1% of the properties are above the action level whereby no radon protection measures are required.
Other issues	A gas main runs through the Site in the East (oriented north to south) which meant excavations and boreholes could not be undertaken within this area; a recommended exclusion zone of 30m and compulsory 15m exclusion zone either side of the main was enforced by Wales and Western Utilities. Based on ecological sensitivity following an assessment on the Site; it was not possible to conduct intrusive investigations in the close proximity of existing trees, hedgerows and ponds.. Tier Environmental did not undertake any machine operated intrusive investigation within 10m of these features.
Further works	• Supplementary ground investigation for foundation design • Additional ground gas monitoring as required as part of a detailed investigation to supplement the existing 2 No. visits. • Confirmation of sewer and gas main location to be diverted
Waste Soils Classification	Basic waste characterisation has determined that all Made Ground soils are non-hazardous. WAC testing has not been completed as part of these works and final waste disposal routes should be confirmed prior to removal from site. It is anticipated that natural soils will be suitable for disposal to an inert waste landfill.
Materials re-use	Subject to volumetric cut and fill requirements the majority of Made Ground materials and all of natural soil materials may be considered chemically suitable for potential re-use subject to careful management and placement of materials and in line with an appropriate end-of-waste protocol such as WRAP Quality Protocol for Aggregates from Inert Waste, U1 Exemption or a Materials Management Plan in accordance with the CL:AIRE Definition of Waste Code of Practice (DoWCoP). Suitability for re-use would also be subject to confirmation of the geotechnical suitability



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depending on whether the materials are to be re-used in load bearing areas. This would need to be detailed in a supporting document.

Please note that any previously landfilled or mining waste materials may not be appropriately subject to consideration under DoWCoP and may not be re-used under DoWCoP unless sufficient lines of evidence and agreement with the local Natural Resources Wales Waste Team can be sought beforehand.

In addition, Section 12.3 of this report includes statements with respect to re-use of excavated and stockpiled clean naturally occurring soils within the site and re-use on other sites. These statements are designed to provide a clear intention to reuse any clean, naturally occurring soils derived from future excavations at this Site (which may also include temporary future stockpiling these materials).



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1. INTRODUCTION

Tier Environmental was commissioned by Net World Sports to undertake a Land Contamination Risk Management (LCRM) Ground Investigation for an area of land referred to as Bryn Lan – Outline Planning, located on the land north of Bryn Lane, Wrexham, LL13 9UT (the “Site”).

The title of this report is in accordance with that described in the Land Contamination Risk Management guidance (available at <https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm>) which has superseded CLR 11:

Stage 1:

- LCRM Tier 1 Preliminary Risk Assessment Report
- LCRM Tier 2 Generic Quantitative Risk Assessment Report

1.1. Proposed Development

This report relates to the outline planning application areas associated with hybrid planning application reference P/2023/0497. A separate report has been produced by Tier in relation to the detailed/full planning application areas of the hybrid application.

Under current proposals the development will comprise:

- Construction of new buildings collectively providing up to 72,635 sqm GEA of floorspace for B1c (light industry appropriate in a residential area), B2 (general industrial), and B8 (storage and distribution) uses, as well as potential ancillary retail/drive thru facilities, a hotel and a petrol filling station (A1, A3, C1, sui generis). The overall quantum of A1, A3, C1 and/or sui generis use floorspace would not exceed 16,150 sqm GEA;
- *Access and parking provision, internal roads, service yards and car and HGV parking. Up to 908 car parking spaces and up to 138 HGV trailer spaces and HGV lorry spaces are proposed across the application site;
- Retention and enhancements of some existing on-site green spaces and provision of landscaping around the application site; and
- Implementation of drainage/attenuation measures.

1.2. Previous Reports

Tier Environmental have previously conducted a Preliminary Risk Assessment for the Site: report reference: “TE1624-TE-00-XX-RP-GE-001-V03” dated June 2023. A full copy of this report is included within Appendix I. The PRA covers both the outline planning and detailed planning areas of the Site.

A Detailed Unexploded Ordnance Risk Assessment has also been completed by 1st Line Defence Ltd (Ref: DA18240-00, dated July 2023).

1.3. Objectives

Taking into account the proposed development of the Site, the objectives of this appraisal were:

- To determine current ground and groundwater conditions.
- To determine the potential risks to human health and the wider environment.
- To provide a preliminary waste soils classification.



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- To determine potential risks posed to the Site from hazardous ground gases and / or vapours.
- Provide preliminary outline remedial measures to manage any identified risks.
- To provide preliminary geotechnical parameters to inform floor slab and foundation recommendations.

1.4. Assumptions

The following assumptions are made in this report:

- It is assumed that ground levels will not change significantly from those described in this report or as shown on proposed development drawings. If this is not the case, then amendments to the recommendations made in this report may be required.
- The ground investigation has been designed with due consideration of known or suspected constraints (including underground services and access constraints).
- Any references to observations of suspected asbestos-containing materials are for information only and should be verified by a suitably qualified asbestos specialist and/or confirmed by laboratory analysis.
- The use of the term 'Topsoil' within this report is based on a visual identification only and that these materials have not been classified in accordance with BS3882:2015.
- The use of the terms 'shallow' and 'deep' within this report (from a geotechnical perspective) assume *typically* between ground level to circa 3.00m below ground level (bgl) for 'shallow' and greater than 3.00m bgl regarded as 'deep';
- The comments and opinions presented in this report are based on the findings of the desk study and ground conditions encountered during intrusive investigation works performed by Tier Environmental and the results of tests carried out within one or more laboratories. There may be other conditions prevailing on the Site which have not been revealed by this investigation and which have not been taken into account by this report.
- Responsibility cannot be accepted for any conditions not revealed by this investigation. Any diagram or opinion on the possible configuration of the findings is conjectural and given for guidance only. Confirmation of intermediate ground conditions should be undertaken if deemed necessary.

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2. SITE DETAILS AND DESCRIPTION

Table 2.1 Current Site Overview.

Site name	Bryn Lane – Outline Planning
Site address	Land north of Bryn Lane, Wrexham, LL13 9UT. A site location plan is included as Drawing No. TE1750-TE00-XX-DR-GE-001-V01 within Appendix A.
National Grid Reference (NGR)	338807, 350938
Approximate Site area	17.15ha
Site shape	The Site is irregular in shape
Current land use on the Site	The Site is predominantly agricultural with both grassed and cropped fields, with a residential / farm property (Little Acorns) located in the southern extent of the Site, and a residential property, Honeysuckle Cottage, located in the northern extent of the Site. The agricultural fields are delineated by trees and hedgerows. It should be noted that the aforementioned properties are only within the detailed/full application area.
Surrounding land uses	The Site is surrounded by agricultural land, residential properties to the northwest and industrial buildings associated with the industrial estate to the south of Bryn Lane.
General topography and ground levels	The land slopes from approximately 40m AOD in the west to between 27 and 31m AOD in the east and northeast which follows the general topographical trend in the surrounding area.

An aerial photograph (from publicly available online maps) of the Site is shown below with the wider site boundary including both the detailed and outline applications in **blue** and the outline application site boundary shown in **red**.

Figure 2.1 Recent Aerial Photograph from Groundsure





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3. PREVIOUS INVESTIGATION FINDINGS

Tier Environmental have previously conducted a Preliminary Risk Assessment for the Site (report reference: TE1624-TE-00-XX-RP-GE-001-V03, dated June 2023). A full copy of this report is included within Appendix I. The PRA covers both the outline planning and detailed planning areas of the Site.

A Detailed Unexploded Ordnance Risk Assessment has also been completed by 1st Line Defence Ltd (Ref: DA18240-00, dated July 2023).

Table 3.1 Preliminary Risk Assessment Report Summary

Introduction	Tier Environmental was commissioned by Net World Sports to undertake a desk study and Phase I Preliminary Risk Assessment for the proposed commercial development at Bryn Lane, Wrexham. The purpose of this investigation was to establish land use history and review the available information to determine the geoenvironmental setting of the Site and develop a preliminary conceptual site model with due consideration of potential soil and groundwater contamination, hazardous ground gases and mining.
Proposed land use	The proposals comprise a commercial development, including industrial and distribution, and ancillary retail/hotel floorspace.
Site location and surrounding land uses	The site is located at Bryn Lane, Wrexham, nearest post code LL13 9XW. To the north and east of the site the area is agricultural with a few residential houses and Wrexham Industrial Estate to the west and south of the site and the Clays Golf Driving Range and golf Course is west of the site. There are no nearby significant current land uses in the vicinity of the Site.
Site history	The Site was historically agricultural. Approximately 3 No. wells were identified in the south of the site within an area which will remain undeveloped under the current scheme. Pond locations and sizes are shown to vary over time indicating the potential for some of them to have been potentially infilled. Ridley View (shown in the present day location of Little Acorns) was developed in the south by 1992 (residential / farm). Pertinent surrounding land uses include farms, the Royal Ordnance Factory (Wrexham) to the south of the Site (as close as 20m south) and associated buildings and tanks etc, a clothing factory to the south (60m south), Wrexham Industrial Estate (25m south at its closest point). Given that the Site itself did not form part of the ROF Wrexham site it is not considered that there are any risks from explosives at the Site.
Geology, Hydrogeology and Hydrology	No previous ground investigation reports have been provided to Tier Environmental; however, available BGS information does not indicate the presence of any artificial ground on the Site (although land immediately south is shown to comprise 'Landscaped Ground'). Localised Made Ground within the Little Acorns farm/residential property and Honeysuckle Cottage area and potentially within historically infilled ponds may be anticipated. Superficial deposits comprise a Secondary Undifferentiated Aquifer associated with Devensian Till – Diamicton which has been proven in BGS logs to comprise cohesive materials locally to depths of Circa 26 to 38m bgl which is considered sufficient to provide protection of the underlying bedrock aquifers from any vertical migration of potential contaminants of concern. Bedrock comprises a Principal Aquifer associated with Kinnerton Sandstone Formation in the western/northern parts of the Site and a Secondary A Aquifer associated with the Salop Formation comprising mudstone in the southern / southeastern part of the Site. There is a inferred fault located beneath the site orientated from southwest to northeast associated with these two bedrock formations. There is a Source Protection Zone Total Catchment 3 located beneath the Site associated with the Principal Aquifer; however, the thickness of cohesive Till above this is considered to provide sufficient protection from any shallow contaminants of concern. The nearest surface water receptor comprises an underground water course 110m west. There are no potable or non-potable water abstractions located within 1km of the Site. On this basis the controlled waters sensitivity is considered to be low. The Site is located within the phosphate sensitive freshwater catchment of the River Dee and Bala Lake Special Area of Conservation (SAC).
Ground Gases	There are no landfills located within 250m of the Site. The only viable potential source of ground gases is therefore on-site localised Made Ground / potentially infilled ponds and off-site Made Ground.
Radon Requirements	The Site is not located within a high risk radon area and therefore basic radon protection measures are not currently required for the proposed development. Testing existing buildings and fitting radon prevention in new buildings might still be considered, particularly if there is a high risk location such as a routinely occupied basement.
Ecological Sensitivity	The Site does not lie within an ecologically sensitive area.



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Potential contaminative features	There are 4 No unspecified tanks south of the Site within 250m. A farm is located in the southern part of the Site and a residential property in the northern part of the site. Numerous potentially infilled ponds have been identified within the site.
Mining and quarrying	The Site Is not located within a mining area or an area subject to historic quarrying.
Previous investigations	Tier Environmental is not aware of any previous intrusion ground investigations within the site.
Phosphates	The Site is located within the River Dee and Bala Lake Designated Special Area of Conservation (SAC). The drainage strategy/design for the proposed development should therefore incorporate appropriate on-site and/or off-site mitigation measures which should be agreed with the regulatory authorities.
Unexploded Ordnance	The UXO risk is considered to be low based on publicly available maps; however, given the proximity of the former Royal Ordnance Factory, Wrexham immediately south of the Site it is recommended that a detailed UXO desk study is carried out for the Site.
Preliminary Conceptual Site Model Summary	Moderate / low to moderate risks have been identified for human health receptors and low risks have been identified for the controlled waters environment from inorganic, organic and asbestos impacts within any localised Made Ground associated with the former agricultural land use, farm in the south of the Site, , Honeysuckle Cottage, located in the northern extent of the Site, and any potentially infilled ponds. Moderate / low risks to human health have been identified from the off-site former ROF Wrexham located immediately south of the Site. Moderate to moderate / low risks have been identified associated with hazardous ground gases generated from on-site localised Made Ground / potentially infilled ponds and off-site Made Ground. Low risk has been identified with regard to phosphates within treated wastewater affecting the River Dee and Bala Lake SAC.
Waste Soils Classification	Based on the history of the Site and the anticipated potential contaminants of concern, it is unlikely that significant quantities of hazardous waste soil materials will be encountered; however, some may be locally present beneath some areas of the Site (potential infilled ponds and asbestos containing materials within demolition rubble at gate entrances). This will be subject to confirmatory investigation, sampling, laboratory analysis and waste classification in accordance with the Guidance on the Classification and Assessment of Waste (WM3).
Materials re-use	Subject to volumetric fill requirements and a future assessment of suitability of re-use (both chemically and geotechnically), some materials <i>may</i> be considered for potential re-use in line with an appropriate end-of-waste protocol such as WRAP Quality Protocol for Aggregates from Inert Waste, U1 Exemption or a Materials Management Plan in accordance with the CL:AIRE Definition of Waste Code of Practice (DoWCoP).
Further works	An intrusive ground investigation is currently underway that will further refine the preliminary conceptual site model and confirm the baseline phosphate concentrations across the site. It is recommended that a full UXO desk study is carried out for the Site.

Table 3.2 Detailed UXO Report Summary

German Ari Delivered UXO Risk	During WWII, the site was situated within Wrexham Rural District, which was subject to an overall very low density of bombing with an average of 3.8 items of recorded ordnance per 1,000 acres. Any bombing in the region that did occur appears to have been largely opportunistic and as a result of its position on the flight path to the important target of Liverpool. The only viable bombing target in the area was the nearby Royal Ordnance Factory (ROF) Wrexham. - Anecdotal sources attest that while the Luftwaffe may have been aware of the presence of ROF Wrexham, it was never struck by German bombing. This may have been due to its relatively isolated location. Despite the available source base being somewhat limited, no evidence of any bombing within the site footprint or the wider vicinity could be found. - Available high-resolution imagery of the site taken following the war indicates no evidence of ground disturbances or debris which could be indicative of on- site bomb damage. This is corroborated by pre- and post-war OS mapping which show no significant changes to the site and its immediate vicinity. - While the majority of the site did contain open agricultural ground, the area is considered likely to have been relatively frequently accessed and observed given both the presence of adjacent roadways and structures, as well as the nearby presence of ROF Wrexham. Ground conditions onsite are also anticipated to have been reasonably conducive to the detection of UXO, given the
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	relatively good condition of the open land and the presence of a structure within the north of the site. • In summary, given the very low bombing density of Wrexham Rural District, and the lack of evidence to suggest that any bombing occurred within ROF Wrexham or its wider vicinity, the site is not considered to be at an elevated risk of contamination from German aerial delivered UXO. As such, the site has been assessed to be at a Low Risk of German UXO.
UXO Risk Assessment	1st Line Defence has assessed that there is an overall Low Risk from German and anti-aircraft unexploded ordnance at the site of proposed works. There is also an assessed Low Risk from Allied unexploded ordnance.
Recommended Risk Mitigation Measures	The following risk mitigation measures are recommended to support the proposed works at the Bryn Lane, Wrexham site: • UXO Risk Management Plan (a free template to fill in which includes a set of guidelines, a suspect UXO action flowchart, and an example risk management plan) • Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.



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4. PRELIMINARY CONCEPTUAL SITE MODEL

Based on the information provided in the Preliminary Risk Assessment report a combined preliminary conceptual site model and conceptual exposure model was developed for the proposed future land use and has been reproduced below. This summarises the understanding of surface and sub-surface features, the potential contaminant sources, transport pathways and receptors. In assessing the likely contaminants of concern present at the Site, reference has also been made to Defra and Environment Agency supporting documentation. A preliminary qualitative risk assessment has also been made of the likelihood of the linkage operating and its potential significance in accordance with CIRIA C552.

The potential pollutant linkages identified and the qualitative risk assessment for these are presented in Table 4.1 below. The terms used in the preliminary qualitative risk assessment are defined in Appendix J.

4.1. Uncertainties

The following uncertainties exist in the preliminary conceptual model:

- The presence of any features unrecorded by the historic maps.
- Any unrecorded geological features.
- Any unrecorded pollution events during the Site's history.



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Table 4.1 Preliminary Assessment of Potential Pollutant Linkages (Continued on Next Page).

Justification / Comments
• Currently, the Site comprises predominantly agricultural use with a residential / farm property (Little Acorns) located in the southern extent of the Site, and Honeysuckle Cottage located in the northern extent of the Site. The agricultural fields are delineated by localised copses of trees and hedgerows. The majority of the Site is covered in grass with the exception of the area at the Little Acorns and Honeysuckle Cottage where some localised hardstanding is anticipated. Little Acorns appear to include barns and areas of equipment potentially associated with agricultural use (including a possibly horse walker). Ponds appear to be located in the western and southern parts of the Site. • The Site was historically agricultural with approximately 3 No. wells identified in the southern part of the Site. Pond locations and sizes are shown to vary over time indicating the potential for some of them to have been potentially infilled. Ridley View (shown in the present day location of Little Acorns) was developed in the south by 1992 (residential / farm). • Pertinent surrounding land uses include farms, the Royal Ordnance Factory (Wrexham) to the south of the Site (as close as 20m south) and associated buildings and tanks etc, a clothing factory to the south (60m south), Wrexham Industrial Estate (25m south at its closest point). Given that the Site itself did not form part of the ROF Wrexham site it is not considered that there are any risks from explosives at the Site. • No previous ground investigation reports have been provided to Tier Environmental; however, available BGS information does not indicate the presence of any artificial ground on the Site (although land immediately south is shown to comprise 'Landscaped Ground'). Localised Made Ground within the Little Acorns farm/residential property and Honeysuckle Cottage area and potentially within historically infilled ponds may be anticipated. • Superficial deposits comprise a Secondary Undifferentiated Aquifer associated with Devensian Till – Diamicton which has been proven in BGS logs to comprise cohesive materials locally to depths of Circa 26 to 38m bgl which is considered sufficient to provide protection of the underlying bedrock aquifers from any vertical migration of potential contaminants of concern. Bedrock comprises a Principal Aquifer associated with Kinnerton Sandstone Formation in the western/northern parts of the Site and a Secondary A Aquifer associated with the Salop Formation comprising mudstone in the southern / southeastern part of the Site. There is a inferred fault located beneath the site orientated from southwest to northeast associated with these two bedrock formations. • There is a Source Protection Zone Total Catchment 3 located beneath the Site associated with the Principal Aquifer; however, the thickness of cohesive Till above this is considered to provide sufficient protection from any shallow contaminants of concern. The nearest surface water receptor comprises an underground water course 110m west. There are no potable or non-potable water abstractions located within 1km of the Site. On this basis the controlled waters sensitivity is considered to be low. • There are no landfills located within 250m of the Site and the Site is not located within a high risk radon affected area. The only viable potential source of ground gases is therefore on-site localised Made Ground / potentially infilled ponds and off-site Made Ground. • The Site is located within the phosphate sensitive freshwater catchment of the River Dee and Bala Lake Special Area of Conservation (SAC). The proposed development will involve covering the site mostly in buildings and hardstanding and demolishing the farm buildings at Little Acorns. Not only will this act to inhibit infiltration into the ground, it will also largely remove the source of agricultural phosphate from the site. The site won topsoil will be reused within the development within screening bunds and soft landscaping, but agricultural fertilisers and manure will no longer be used on the site. Wastewater drainage from the proposed development will be either via the on-site combined sewer and the Five Fords WwTW or on-site wastewater treatment and discharge to the on-site surface water drainage system.



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Source	Potential Contaminants of Concern	Pathway	Receptor	Consequence	Probability	Qualitative Risk Assessment
Localised Made Ground associated with the former agricultural land use and farm in the south of the Site and any potentially infilled ponds.	Metals PAHs pH Hexavalent chromium	Direct contact, dust inhalation and ingestion	Future site users (commercial)	Medium	Likely	Moderate Risk
			Adjacent site users residential/commercial	Medium	Low Likelihood	Moderate / Low Risk
			Construction, site investigation, demolition and future maintenance workers	Medium	Likely	Moderate Risk
		Migration of mobile contaminants from Made Ground soils to adjacent sites along services and conduits	Adjacent site users residential/commercial	Medium	Low Likelihood	Moderate / Low Risk
		Migration via water pipes	Future site users (commercial)	Medium	Likely	Moderate Risk
		Lateral and/or vertical migration of mobile contaminants.	Aquifer 1 - Secondary (Undifferentiated) Aquifer associated with Devensian Till	Mild	Low Likelihood	Low Risk
			Aquifer 2 - Principal Aquifer associated with Kinnerton Sandstone Formation	Medium	Unlikely	Low Risk
			Aquifer 3 - Secondary A Aquifer associated with Salop Sandstone Formation	Medium	Unlikely	Low Risk
			Culverted watercourse located approximately 110m west.	Mild	Low Likelihood	Low Risk
	Naphthalene (a semi-volatile PAH) TPH / BTEX / MTBE Phenols	Vapour inhalation, direct contact, dust inhalation and ingestion	Future site users (commercial)	Medium	Likely	Moderate Risk
			Adjacent site users residential/commercial	Medium	Low Likelihood	Moderate / Low Risk
			Construction, site investigation, demolition and future maintenance workers	Medium	Likely	Moderate Risk
		Migration of mobile contaminants from Made Ground soils to adjacent sites along services and conduits	Adjacent site users residential/commercial	Medium	Low Likelihood	Moderate / Low Risk
		Migration via water pipes	Future site users (commercial)	Medium	Likely	Moderate Risk
		Lateral and/or vertical migration of mobile contaminants.	Aquifer 1 - Secondary (Undifferentiated) Aquifer associated with Devensian Till	Mild	Low Likelihood	Low Risk
			Aquifer 2 - Principal Aquifer associated with Kinnerton Sandstone Formation	Medium	Unlikely	Low Risk
			Aquifer 3 - Secondary A Aquifer associated with Salop Sandstone Formation	Medium	Unlikely	Low Risk
			Culverted watercourse located approximately 110m west.	Mild	Low Likelihood	Low Risk
	Asbestos	(Dust migration and) dust inhalation	Future site users (commercial)	Medium	Likely	Moderate Risk
			Adjacent site users residential/commercial	Medium	Low Likelihood	Moderate / Low Risk
			Construction, site investigation, demolition and future maintenance workers	Medium	Likely	Moderate Risk
Former ROF Wrexham and associated tanks located off-site	TPH / BTEX / MTBE VOCs / SVOCs Free phase product	Vapour inhalation, direct contact, dust inhalation and ingestion	Future site users (commercial)	Medium	Low Likelihood	Moderate / Low Risk
			Adjacent site users residential/commercial	Medium	Low Likelihood	Moderate / Low Risk
			Construction, site investigation, demolition and future maintenance workers	Medium	Low Likelihood	Moderate / Low Risk
		Migration of mobile contaminants from Made Ground soils to adjacent sites along services and conduits	Adjacent site users residential/commercial	Medium	Low Likelihood	Moderate / Low Risk
		Migration via water pipes	Future site users (commercial)	Medium	Low Likelihood	Moderate / Low Risk
		Lateral and/or vertical migration of mobile contaminants.	Aquifer 1 - Secondary (Undifferentiated) Aquifer associated with Devensian Till	Mild	Low Likelihood	Low Risk
			Aquifer 2 - Principal Aquifer associated with Kinnerton Sandstone Formation	Medium	Unlikely	Low Risk
			Aquifer 3 - Secondary A Aquifer associated with Salop Sandstone Formation	Medium	Unlikely	Low Risk



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Source	Potential Contaminants of Concern	Pathway	Receptor	Consequence	Probability	Qualitative Risk Assessment
			Culverted watercourse located approximately 110m west.	Mild	Low Likelihood	Low Risk
Phosphates from the proposed development from staff wastewater discharges containing human excreta and detergents.	Phosphates	Discharge of treated wastewater into the River Dee or tributaries	River Dee and Bala Lake SAC	Medium	Unlikely	Low Risk
On-site localised Made Ground / potentially infilled ponds and off-site Made Ground.	Hazardous ground gasses (methane, carbon dioxide, hydrogen sulphide, carbon monoxide and depleted oxygen)	Inhalation (indoor and outdoor)	Future site users (commercial)	Severe	Low Likelihood	Moderate Risk
			Adjacent site users residential/commercial	Severe	Unlikely	Moderate / Low Risk
			Construction, site investigation, demolition and future maintenance workers	Severe	Low Likelihood	Moderate Risk
		Migration of hazardous ground gases from beneath the Site to adjacent sites along services or other preferential conduits	Adjacent site users residential/commercial	Severe	Unlikely	Moderate / Low Risk
		Migration of ground gas / explosion	Buildings and services	Severe	Unlikely	Moderate / Low Risk

For definition of the terms used in the qualitative risk assessment, please see Appendix J.



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5. FIELDWORK

The information contained in this report is limited to areas of land accessible during the ground investigation within the Site boundary, as indicated on the Site plan, presented in Appendix A as Drawing No TE1749-TE-00-XX-DR-GE-001-V01.

Tier Environmental scoped the intrusive ground investigation using guidance presented in:

- BS 10175:2011+A2:2017;
- Land Contamination Risk Management (LCRM) - <https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm>;
- BS 5930:2015+A1:2020;
- BS EN 1997:2004 and 2007.

Tier Environmental's standard strata description criteria are compliant with the above guidance.

5.1. Scope of Ground Investigation

The ground investigation was conducted between 5th and 23rd June 2023 and was supervised by a suitably qualified Tier Environmental engineer. Table 5.1 below provides a summary of the exploratory holes completed and rationale. Exploratory hole locations are presented on Drawing No. TE1749-TE-00-XX-DR-GE-002-V01.

Table 5.1 Scope of Ground Investigation and Rationale

Exploratory Hole Type	Exploratory Hole Reference	Exploratory Hole Depths (m bgl)	Rationale
Trial pits	TP01 to TP12, TP15, TP17	1.90 to 4.00m	To confirm the shallow ground conditions across the Site, relatively shallow groundwater presence and rate of inflow, stability of excavations, and to enable shallow soil sampling for geotechnical and geoenvironmental parameters.
	TP13, TP14, TP16	3.20m to 4.20m	Completed within the vicinity of a historic pond to determine the shallow ground conditions and presence of any infill material
Window sample boreholes	WS01, WS03, WS05 to WS12	5.45m	To confirm the shallow and deep ground conditions across the Site, conduct <i>in situ</i> geotechnical tests, facilitate soil sampling for geotechnical and geoenvironmental parameters and installation of combined ground gas and groundwater monitoring wells.
	WS02, WS04	5.45m bgl	Completed within the vicinity of a historic pond to determine the shallow ground conditions and presence of any infill material, and installation of combined ground gas and groundwater monitoring well.
Hand dug pits	HDP01 to HDP08	1.00m bgl to 1.20m bgl	To confirm the shallow ground conditions across the Site, relatively shallow groundwater presence and rate of inflow, and to enable shallow soil sampling for geoenvironmental parameters.

The following constraints were identified during the ground investigation works:

- An intermediate pressure gas main runs through the east of the Site (oriented north to south). Wales and Western utilities marked out the gas main and set up a recommended 30m exclusion zone and compulsory 15m exclusion zone either side of the gas main, meaning no intrusive investigation could be conducted within this area.



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- Following a third party ecological investigation on Site, the existing trees, hedgerows and ponds were detailed to be ecologically sensitive; therefore Tier Environmental did not undertake any machine operated intrusive investigation within 10m of these areas.
- 2 No. existing occupied houses are located within the site boundary; however, it was not possible to complete works within these areas.
- A combined sewer is present in the west of the site (oriented north to south) an exclusion zone was also set up around this service

Table 5.2 Scope of Monitoring Installations

Exploratory Hole Location	Strata Targeted	Slotted Response Zone (m bgl)	Rationale
WS02	Made Ground and Till	1.00 to 4.00	Targeting shallow ground gas Made Ground source and perched groundwater body.
WS03	Till	1.00 to 5.00	Targeting shallow groundwater monitoring body.
WS04	Made Ground and Till	1.00 to 3.00	Targeting shallow ground gas Made Ground source and perched groundwater body.
WS05	Till	1.00 to 4.00	Targeting shallow groundwater monitoring body.
WS06	Till	1.00 to 5.00	Targeting shallow groundwater monitoring body.
WS07	Till	1.00 to 5.00	Targeting shallow groundwater monitoring body.

Depths and accurate descriptions of strata and groundwater observations made during investigation works, together with details of the samples recovered, are presented on the Engineer's exploratory hole records in Appendix B.

5.2. Geoenvironmental Testing

Sampling and QA/QC protocols are presented in Appendix N. Tier Environmental's schedule of chemical laboratory testing is presented in Table 5.3. and Table 5.4. The testing was carried out by Element Materials Technology, a UKAS and MCerts (where appropriate for soils analysis) accredited laboratory.

Human Health and Preliminary Waste Classification Laboratory Testing

Based upon the conclusions of the preliminary risk assessment, Tier Environmental scheduled chemical laboratory testing on selected soil samples. The purpose of the testing was to:

- Determine the concentration and spatial distribution of potential contaminants of concern in the Made Ground;
- Determine the chemical composition and properties of the shallow natural soils;
- Undertake a *preliminary* soils waste classification and waste disposal route determination

Table 5.3 Schedule of Chemical Testing for Human Health Risk Assessment and Preliminary Waste Soils Assessment.

Laboratory analysis	Made Ground 1 (Topsoil)	Made Ground 2 (Clay)	Made Ground 3 (Sand)	Made Ground 4 (Pond Infill)	Natural Soils (Till)
Tier Environmental soil suite*	5	2	2	2	4



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Laboratory analysis	Made Ground 1 (Topsoil)	Made Ground 2 (Clay)	Made Ground 3 (Sand)	Made Ground 4 (Pond Infill)	Natural Soils (Till)
Asbestos screen	10	1	2	1	NA
Speciated TPH / BTEX / MTBE	6	2	2	2	2
Organophosphorus pesticides	7	1	1	1	2
Organophosphate at PO ₄	5	1	1	1	2
Organophosphate at PO ₄ (low)	5	1	1	1	4
BRE SD1	0	0	0	0	10
Standard Explosives Suite	0		1	0	0
Calorific Value	0	0	0	1	0

*For definition of Tier Environmental analytical suites, please see Appendix N. NA - not applicable.

Controlled Waters Laboratory Testing

Based upon the conclusions of the preliminary risk assessment, Tier Environmental scheduled chemical laboratory testing on selected groundwater samples. The purpose of the testing was to:

- Determine the dissolved phase concentrations of potential contaminants of concern within groundwater beneath the Site;

Table 5.4 Schedule of Chemical Testing for Controlled Waters Risk Assessment.

Laboratory analysis	Groundwater
Tier Environmental groundwater suite*	6
Speciated TPH / BTEX / MTBE	6
VOCs / SVOCs	6

*For definition of Tier Environmental analytical suites, please see Appendix N. NA - not applicable.

5.3. Geotechnical Testing

Geotechnical laboratory testing was scheduled by Tier Environmental on selected samples as presented in Table 5.5. The testing was performed by Murray Rix Northern Ltd, a UKAS and MCerts (where appropriate for soils analysis) accredited laboratory. Test certificates including details of appropriate testing standards are presented in Appendix E and discussed in Section 7, below.

Table 5.5 Geotechnical Laboratory Testing Schedule.

Test	Stratum type	Number of tests	Rationale
1. General			
Moisture content	Made Ground	1	a) Assist with the determination of consistency of soil with depth. b) Assess desiccation of soils. c) Suitability of materials for reuse within earthworks.
	Till	5	
2. Classification			
Atterberg limit	Made Ground	1	a) Volume change potential.



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Test	Stratum type	Number of tests	Rationale
	Till	5	b) Plasticity assessment (comply with Eurocode 7 description) c) Consistency Index. d) Determine soil type (e.g., clay/silt). e) Use as an empirical guide to soil shear strength
Particle size distribution (wet/dry sieve)	Till	6	a) Classify soils for earthworks purposes. b) Establish type of soil (comply with Eurocode 7 description).
4. Compaction			
2.5 kg rammer dry density/moisture content relationship test	Till	6	Establish maximum dry density and optimum moisture content of materials to assess suitability for reuse within earthworks



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6. GROUND CONDITIONS

The following section provides a summary of the ground conditions encountered during the ground investigation including strata profile, obstructions and visual / olfactory evidence of contamination. Exploratory hole logs are provided in Appendix B.

Photographs of ground investigation works are provided in Appendix G.

6.1. Strata Profile

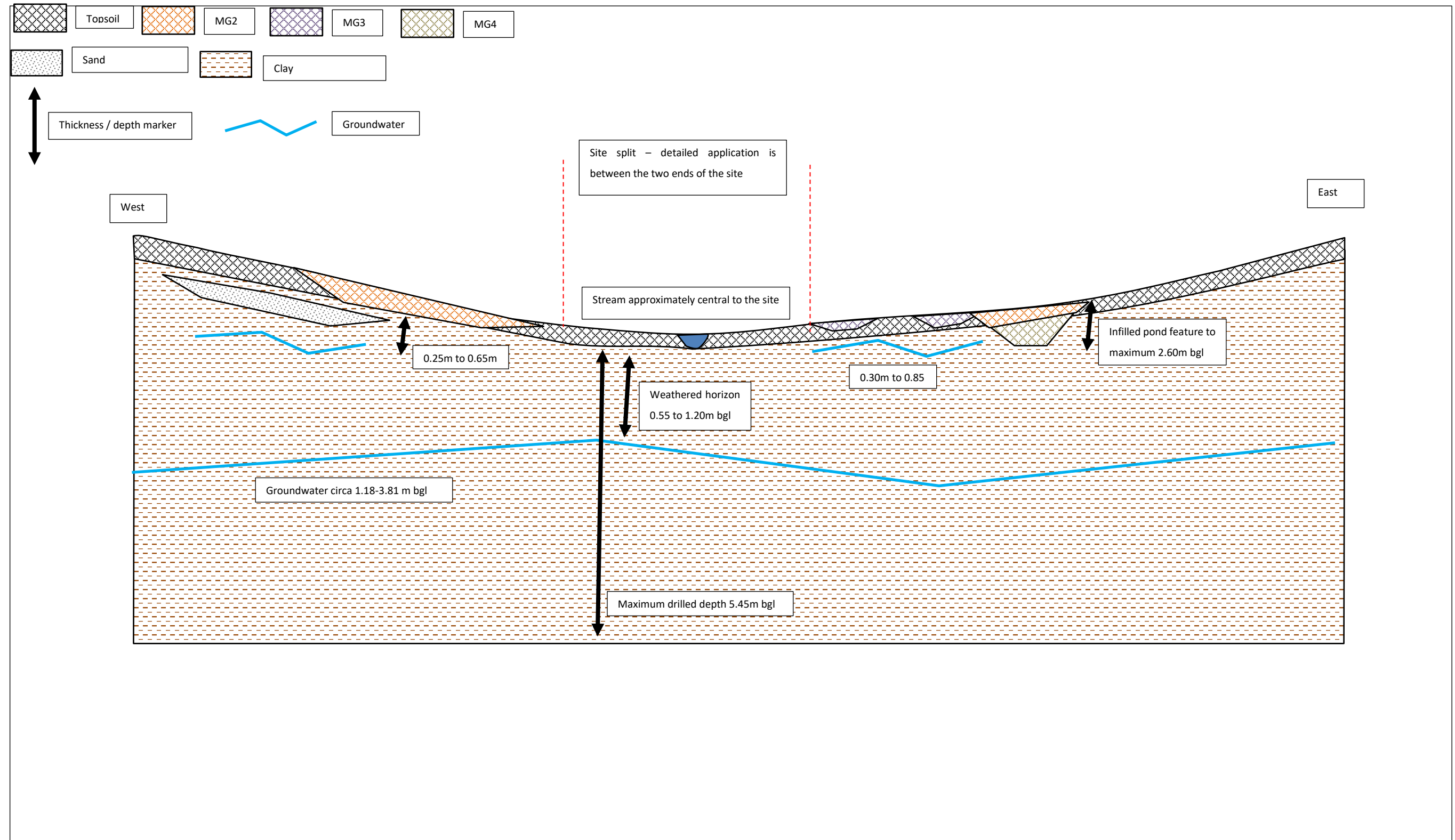
Figure 6-1 presented below provide a schematic summary of the ground conditions beneath the Site. The distinct populations of strata identified have been numbered and correspond with the more detailed descriptions below.



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Figure 6-1 Schematic Drawing of Ground Conditions





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6.2. Strata Descriptions

Made Ground – MG1 (Topsoil)

Locations encountered	HDP02, HDP05, HDP06. TP01 to TP13, TP15, TP17, WS01, WS03, WS05 to WS12
Depths encountered from top of stratum (range)	Ground Level
Depths encountered to base of stratum (range)	0.20m to 0.55m bgl
Thickness (range)	0.20m to 0.55m
Spatial location on site	Widespread across site
General description	A Topsoil described as a dark brown, slightly gravelly, clayey, fine to coarse Sand or firm to stiff, orangish brown, sandy, gravelly CLAY. The gravel is fine to medium, angular to subrounded of mudstone and limestone. Frequent rootlets throughout

Made Ground – MG2

Locations encountered	HDP01, HDP03. TP13, TP16, WS02, WS04.
Depths encountered from top of stratum (range)	Ground Level to 0.60m bgl
Depths encountered to base of stratum (range)	0.25m to 1.10m bgl
Thickness (range)	0.25m to 0.60m
Spatial location on site	Located in the central north of the site typically associated with infilled pond features
General description	Soft, dark brown, slightly sandy, gravelly Clay. Gravel is fine to coarse, angular gravel of concrete, brick, limestone and mudstone.

Made Ground – MG3

Locations encountered	HDP04, HDP07, HDP08, TP14, WS02, WS04
Depths encountered from top of stratum (range)	Ground Level
Depths encountered to base of stratum (range)	0.30m to 0.60m bgl
Thickness (range)	0.30m to 0.60m
Spatial location on site	Record in the east of the site in infilled ponds and ditches between fields in the west of the site
General description	Light brown, sandy, fine to coarse, angular Gravel of concrete, brick, limestone, asphalt and sandstone. Sand is fine to medium

Made Ground – MG4

Locations encountered	TP13, TP14, TP16, WS02, WS04
Depths encountered from top of stratum (range)	0.59m to 1.10m bgl
Depths encountered to base of stratum (range)	1.75m to 2.60m bgl



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Thickness (range)	1.16m to 1.50m
Spatial location on site	Located in the central north of the site associated with infilled pond features
General description	Black clayey gravelly spongy pseudo-fibrous to fibrous Peat with gravel of concrete and brick

Drift Deposits – DD1

Firm brown Clay (Till)	
Locations encountered	HDP01 to HDP08, TP02 to TP04, TP06, TP10.TP15
Depths encountered from top of stratum (range)	0.20m to 0.40m bgl
Depths encountered to base of stratum (range)	0.55m to 1.80m bgl
Thickness (range)	0.25m to 1.40m
Spatial location on site	Widespread across the site
General description	Typically a firm, light orangish brown, slightly gravelly, sandy, silty Clay where the gravel is fine to medium, angular to rounded of mudstone and quartz. Considered a more weathered form of the Till.

Drift Deposits – DD2

Stiff to Very Stiff Grey Clay (Till)	
Locations encountered	TP01 to TP17, WS01 to WS12
Depths encountered from top of stratum (range)	0.22m to 2.60m bgl
Depths encountered to base of stratum (range)	1.90m to 5.45m bgl
Thickness (range)	>0.15m to >5.10m (thickness not proven)
Spatial location on site	Located site wide
General description	Generally a stiff to very stiff, dark brown to dark grey, slightly sandy, slightly gravelly CLAY. Sand is fine to medium, gravel is fine to coarse, angular to subrounded of mudstone, sandstone, coal and quartz.

Drift Deposits – DD3

Sand (Till)	
Locations encountered	TP04, TP05, WS05, WS07
Depths encountered from top of stratum (range)	0.25m to 0.70m bgl
Depths encountered to base of stratum (range)	0.55m to 1.35m bgl
Thickness (range)	0.25m to 0.65m
Spatial location on site	Localised lenses, no spatial correlation
General description	A light yellowish brown, clayey, silty, gravelly, fine to coarse Sand where the gravel is mudstone, sandstone, coal and occasional igneous lithologies.



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6.3. Obstructions

No buried obstruction or services were encountered during the ground investigation works.

6.4. Visual and Olfactory Evidence of Contamination

No visual or olfactory evidence of contamination was observed during the works; however, a summary of other important observations noted during Tier Environmental investigations is summarised in Table 6.1 below:

Table 6.1 Visual and/or Olfactory Evidence of Contamination Summary

Exploratory Hole Location	Depth Range (m bgl) Encountered From	Depth Range (m bgl) Encountered To	Location on Site	Description
TP13	0.85	2.10	North east within vicinity of historic infilled ponds	Strong natural organic odour and Peat
TP14	0.59	1.75		Very soft grey clay, peat and tree roots
TP16	0.60	1.90		Very soft grey clay, peat and tree roots
WS02	1.10	2.60		Strong natural organic odour and Peat
WS04	0.96	2.00		Strong natural organic odour and Peat

6.5. Groundwater Observations During Fieldwork

Table 6.2 below provides a summary of the groundwater observations during the fieldworks. Further information of groundwater observed is presented in the exploratory hole logs in Appendix B.

Table 6.2 Field Observations of Groundwater.

Exploratory hole	Strike (m bgl)	Rise in groundwater after 20 mins. (m bgl)	Formation	Observations
TP04	0.70	No rise	Till	Seepage
TP13	0.85	No rise	Made Ground	Rapid inflow
TP14	0.70	No rise	Made Ground	Slight inflow
TP16	0.70	No rise	Made Ground	Slight inflow from west wall of pit
WS02	1.10	No rise	Made Ground	None
WS04	1.00	No rise	Made Ground	None

6.6. Groundwater Monitoring

Table 6.3 below provides a summary of the groundwater monitoring results conducted to date. In total, 2 No, visits have been carried out between 12th and 17th July 2023.



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Table 6.3 Groundwater Monitoring Results Summary

Exploratory hole	Response Zone	Depth range (m bgl)	Formation	Observations
WS02	1.00 to 4.00	0.47-0.85	Made Ground and Till	None
WS03	1.00 to 5.00	3.40-3.63	Till	None
WS04	1.00 to 3.00	0.30-0.68	Made Ground and Till	None
WS05	1.00 to 4.00	3.28-3.81	Till	None
WS06	1.00 to 5.00	1.18-3.38	Till	None
WS07	1.00 to 5.00	0.75-1.77	Till	None



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7. PRELIMINARY GEOTECHNICAL ASSESSMENT

7.1. Determination of pH and Water-Soluble Sulphate

Representative samples of the soil and groundwater encountered during the Tier Environmental ground investigations, were tested to determine their pH and concentrations of water-soluble sulphate (SO_4^{2-}). The results are presented in Appendix C and summarised in the Table 7.1 below. It is assumed that the Site is a 'natural ground' site, and the groundwater is 'mobile in accordance with BRE SD1 due to the recorded groundwater levels across site.

The conclusion of the assessment is that a DS-2 and ACEC Class AC-2 is appropriate for buried concrete design purposes within Made Ground and natural soils based on results from groundwater testing. Whilst no evidence of gross hydrocarbon contamination has been observed at the Site, a concrete specialist should review the TPH results and ground conditions summary within this report to ensure appropriate concrete design against retardation / degradation due to hydrocarbons.

Table 7.1 Results of Soil pH Testing and Water-Soluble Sulphate Determination.

Exploratory Hole Location	Depth (m bgl)	pH	Water-soluble sulphate	Design sulphate class	ACEC sulphate class
MADE GROUND					
TP13	0.70	8.63	467.8	<10 No. samples, the mean of the highest 2 No. results (rounded to 100 mg/l) is taken as the characteristic value: 300mg/l DS-1	Mean of the lowest 20% of values is used as the characteristic value: 7.35 AC-1
TP13	1.45	7.86	56.3		
TP14	0.40	8.22	66.5		
TP14	1.10	7.26	17.4		
TP16	0.35	7.96	37.1		
HDP07	0.10	7.45	8.7		
Topsoil					
TP01	0.40	7.26	3	<10 No. samples, the mean of the highest 2 No. results, (rounded to 100 mg/l) is taken as the characteristic value: 200mg/l DS-1	Mean of the lowest 20% of values is used as the characteristic value: 7.11 AC-1
TP06	0.20	7.52	13.5		
TP08	0.20	7.73	15.4		
TP10	0.25	7.11	4.7		
TP12	0.25	7.69	341.4		
Till					
TP03	1.40	8.51	199.1	>10 No. samples, the mean of the highest 20% of results (rounded to 100 mg/l) is taken as the characteristic value: 300mg/l DS-1	Mean of the lowest 20% of values is used as the characteristic value: 8.26 AC-1
TP17	1.00	8.84	121.1		
WS01	1.20	8.57	311.1		
WS02	3.00	8.76	147		
WS03	2.00	8.45	334.9		
WS05	1.20 SPT	8.36	124.4		
WS07	4.00	8.6	210.9		
WS08	2.00 SPT	8.26	255.9		
WS10	1.50	8.78	93.5		
WS10	2.00	-	98		
WS11	1.20	8.54	82.1		
WS12	0.80	8.17	158.4		



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Exploratory Hole Location	Depth (m bgl)	pH	Water-soluble sulphate	Design sulphate class	ACEC sulphate class
WS12	3.00 SPT	8.38	273.4		
GROUNDWATER					
WS04	NA	7.33	461.8	Highest determined concentration (rounded to 100 mg/l) is taken as the characteristic value: 1000mg/l DS-2	Mean of the lowest 20% of values is used as the characteristic value: 7.28 AC-2
WS02	NA	7.23	396.0		
WS06	NA	7.75	1000.8		
WS05	NA	7.72	703.7		
WS07	NA	7.79	443.9		

ACEC - Aggressive Chemical Environment for Concrete (see BRE, 2005).

7.2. Geotechnical Parameters

The data obtained during the Ground Investigation has been assessed for the recorded soil types in order to provide characteristic values in order to aid the final foundation design.

Cohesive Soils

Moisture content and Atterberg Limit testing was undertaken on samples from cohesive superficial material at the site. A summary of the results is shown in Table 7.2 below.

Table 7.2 Soil Classification Test Results for cohesive soils

Exploratory hole	Depth (m bgl)	Stratum	MC (%)	LL (%)	PL (%)	PI (%) (Modified)	Class	Volume Change Potential	Consistency Index
TP12	2.25	Till	18.1	43	17	23.88	Medium	Medium	0.93
TP14	0.80	Peat	44	50	21	28.42	Medium to High	Medium	0.20
TP01	1.50	Till	22.8	43	18	24.5	Medium	Medium	0.80
TP10	2.3	Till	18.0	41	17	23.04	Medium	Medium	0.95
TP09	0.70	Till	17.2	41	16	22.5	Medium	Medium	0.95
TP15	3.0	Till	19.8	40	15	23.25	Medium	Medium	0.80

ND - Not determined; MC - Moisture content, LL - Liquid limit, PL - Plastic limit, PI - Plasticity index.

Consistency index (CI) is obtained from Atterberg limits and is allowed by Eurocode 7 as a scientific means of determining consistency of clays over and above an engineer merely sticking a thumb in ($CI = (LL - mc) / PI$ using unmodified PI).

6 No. Atterberg Limit Tests were performed on samples of identified cohesive soils. Results indicate the material is of medium plasticity Clay.

Granular Soils

6 No. samples of cohesive natural soils, were submitted for determination of their Particle Size Distribution. Table 7.3 below summarises the soil classification in accordance with Table 6/1 of the Specification for Highway Works Series 600.



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Table 7.3 Particle Size Classification

Location	Depth (m bgl)	Description	Series 600 Class*	Series 600 Typical Use
TP04	0.80	Clayey slightly gravelly SAND	2A, 2B, 7A	Cohesive General Fill, Fill to Structures
TP05	0.40	Clayey slightly gravelly SAND	2A, 2B, 7A	Cohesive General Fill, Fill to Structures
TP16	1.50	Made Ground: Very soft CLAY	2A, 2B, 7A	Cohesive General Fill, Fill to Structures
TP07	2.70	Stiff slightly gravelly CLAY	2A, 2B, 7A	Cohesive General Fill, Fill to Structures
TP17	2.00	Firm slightly gravelly CLAY	2A, 2B, 7A	Cohesive General Fill, Fill to Structures
TP02	0.50-0.70	Firm slightly gravelly CLAY	2A, 2B, 7A	Cohesive General Fill, Fill to Structures

Shear Strength Parameters

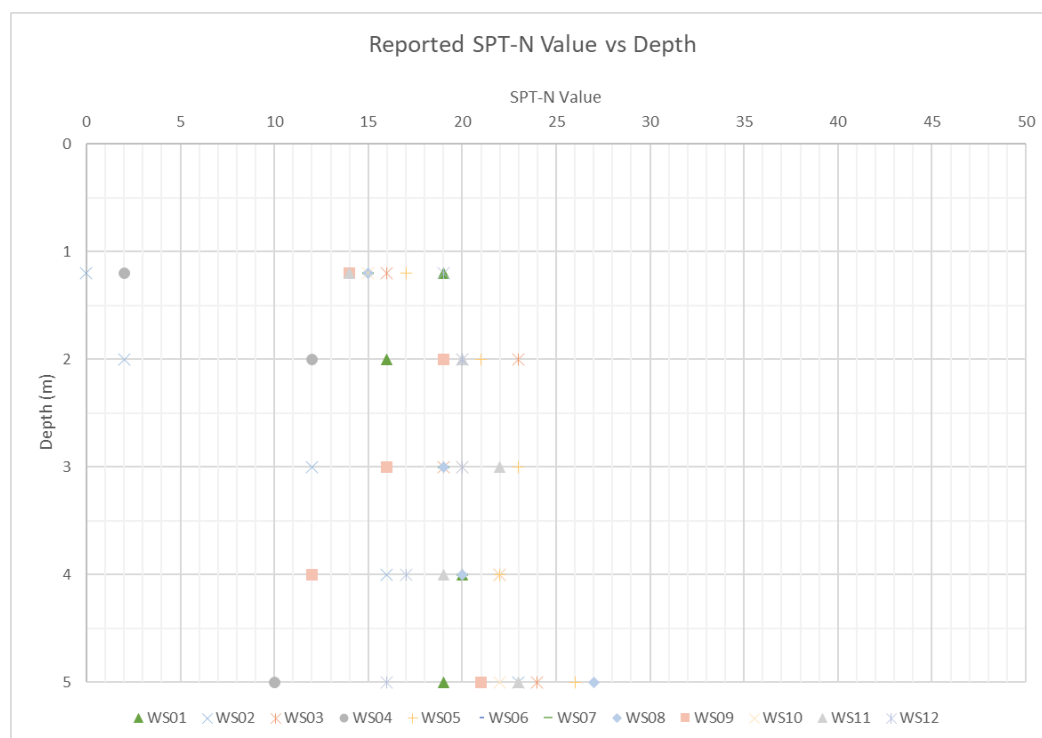
A total of 113 No. hand shear vane tests were completed within the cohesive soils on site.

Standard Penetration Tests (SPT) were carried out in all of the boreholes. The undrained shear strength of the natural clay strata tested can be estimated using the relationship developed by Stroud, where:

$$C_u = f_1 \times \text{SPT N60 value}$$

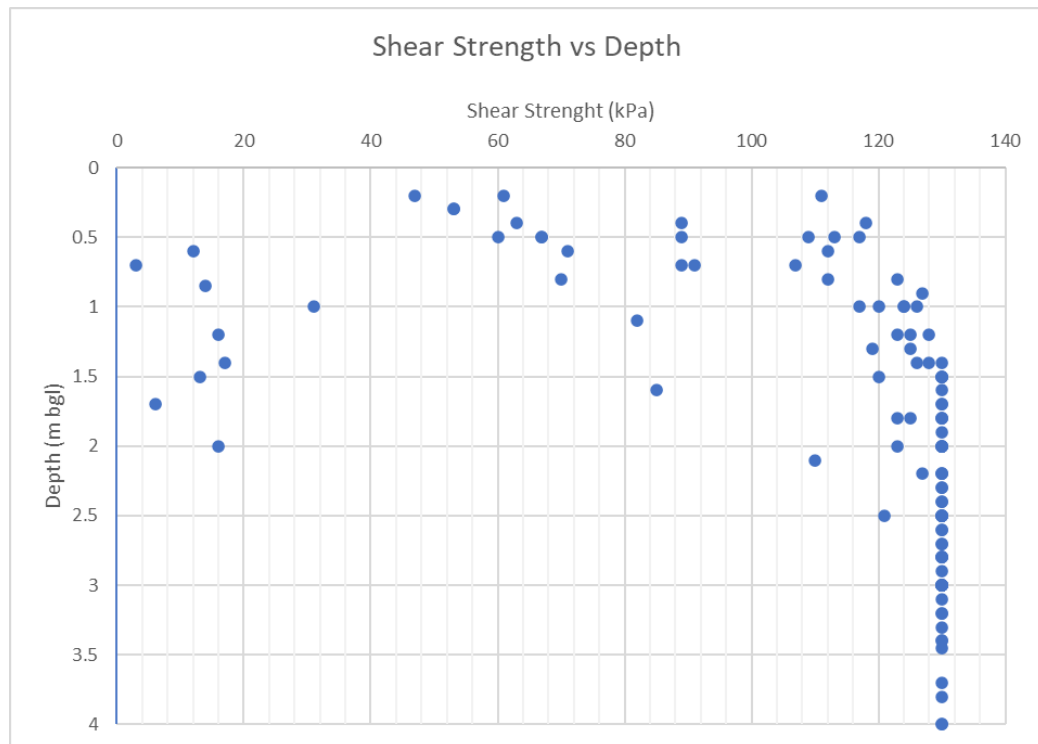
The value of f_1 is dependent on the Plasticity Index (I_p). A further review of derived shear strengths will be completed following receipt of the geotechnical testing results. In the meantime, Figure 7-1 below shows the recorded SPT-N value against depth.

Figure 7-1 Reported SPT-N Value with Depth



Results indicate a general range of between N=3-19 at 1.20m bgl suggesting soft to firm and locally stiff soils, with the above visual representation showing a general increasing SPT-N value with depth. In general results do not tend to exceed circa N= 22, which would be within the stiff cohesive soil category. No shallow refusal was also met within the window samples. Laboratory data will be reviewed upon receipt; however, shear strengths have been derived from in-situ hand shear vane tests taken within trial pits, and presented within Figure 7.2 below.

Figure 7.2 Shear strength from In-Situ Shear Vane Results



Results indicate generally high strength (>75kPa) cohesive soils which would equate to stiff soils. Generally soils improve with depth and reach the shear vane limit of 130kPa from 1.10m bgl. Localised low-end values of 5-18 kPa have been recorded within an area of a historic pond with soft organic rich soils. Removing these low results would give a range of between 75-130kPa for soils at circa 1.20m bgl.

Foundation Recommendations

The site is broadly underlain site wide by topsoil to depths of 0.20m to 0.55m bgl or Made Ground to typical depths of between 0.25m to 1.10m bgl, principally in the central northeast of the site. These are underlain by natural soils comprised of Devensian Till, described as a firm becoming stiff and locally very stiff Clay. A more weathered horizon of brown clay was recorded in the order of 0.25m to 1.40m thick overlying the dark grey unweathered Till which was proven to the maximum drilled depth of 5.45m bgl. Sand lenses were also recorded near surface to 0.55m and 1.35m bgl. Localised areas of soft organic clays and Peat are described within the central northeast of the site within an infilled pond from depths of 0.59m to 1.10m bgl to depths of 1.75m to 2.60m bgl.. These soft soils would not be considered suitable as a founding stratum and would arise to differential settlements beyond tolerable limits.

Given the encountered ground conditions and the nature of the proposed development, the most likely foundation solution would be a pads or similar traditional shallow foundations. Based on the range of shear strengths derived from in-situ shear testing, an allowable bearing capacity of circa 150kN/m² could be achieved at 1.20m bgl. Localised over excavation of organic rich Made Ground soils and Peat as recorded in TP13 and TP14 in the



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north east may be required, with deepening of foundations or engineered replacement with suitable material. Other areas of soft organic soils may be present elsewhere on site.

Piles could be considered where loadings cannot be transferred to shallow soils, potentially the multi storey hotel in the west of the site. These would be adopted for the entire structure, dependent upon the design requirements and economic feasibility. Piles are likely to be the most appropriate solution due to the absence of a suitable founding stratum at shallow depth and the overall increase in levels. It is considered that a bored, CFA or Rotary piled solution would be suitable for the site. More detailed investigation would be required to confirm foundation design and pile parameters.

Table 7.4 Possible Foundation Solutions

Location	Unit	Foundation Solution	Considerations
North East	1	Pad Foundations	• Soft organic clays and peat associated with Infilled Pond. • Gas main diversion • Localised shallow groundwater
West	Filling station	Pad Foundations	• Combined sewer main diversion • Localised shallow groundwater
Central	6-10, Hotel	Pad/Piles if required	• Combined sewer main diversion • Localised shallow groundwater
South	11-13, Drive Thru	Pad Foundations	• Possible softer soils along field boundaries/ditches

The following softer spots were encountered during investigation works which may require localised excavation and replacement:

- Infilled pond in the east of the site with organic clays and peat soils;
- Potentially infilled or diverted section of ditch in the north of the site in TP222;
- Deeper alluvial soils are anticipated in the vicinity of the existing streams/brooks which may require spanning.

7.3. Floors

With regard to the design and construction of normal ground bearing floor slabs, these may be suitable for the majority of the developments however it must be noted at the outset, that due to the potential variability of strata across the footprint of the buildings, the proposed regrading works and low shear strengths in organic rich clays, a ground bearing slab may not be appropriate for all units without some form of ground improvement. Consideration is also required for any proposed watercourse diversions.

If soft spots are to be removed, then consideration can be given to re-engineering the firm/stiff clays on site.

7.4. Earthworks

The compaction data has been assessed by comparing the results against criteria commonly used in earthworks to achieve an adequate density for engineered fills. The criteria indicate whether the samples could achieve in excess of 95% of Maximum Dry Density (MDD – a requirement often included in highways specifications) and whether they could be compacted to less than 5% air voids ratio (a requirement applied where raft foundations are to be adopted). Results of compaction testing are summaries in Table 7.5



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Table 7.5 Compaction Results Summary

Sample	Depth (m bgl)	Soil	Natural Moisture Content (%)	Optimum Moisture Content (%)	Moisture Content at 95% Maximum Dry Density (%)	Conditioning Required?
TP04	0.80	Clayey slightly gravelly SAND	16.9	21	24	Yes – too dry
TP05	0.40	Clayey slightly gravelly SAND	17.6	16	19.8	Yes - too dry
TP16	1.50	Made Ground: Very soft CLAY	38.9	19	22	Yes - too dry
TP07	2.70	Stiff slightly gravelly CLAY	19.9	17	21	Yes - too dry
TP17	2.00	Firm slightly gravelly CLAY	19.1	17	20	Yes - too dry
TP102	0.50-0.70	Firm slightly gravelly CLAY	24.8	18	21.5	Yes - too wet

The results of compaction testing undertaken on samples indicate that it could be recompacted to achieve >95% of MDD and <5% air voids. Based upon the results obtained, the natural could be used as an engineered fill, subject to other suitability considerations. It should be noted that suitability for compaction is highly dependent on the initial moisture content of the material to be compacted. Some processing of the material (including screening and crushing of unsuitable elements) may be required during the enabling works phase to remove over-sized or unsuitable material. Where Made Ground is to be reused as an engineered fill, it would be sensible to select granular fills only and subject them to a confirmatory testing regime where they were required to achieve a compaction specification as a structural fill.

Construction plant should be provided with an adequate working platform in line with the requirements of BRE report, “BR 470: Working Platforms for Tracked Plant”. Again, further advice should be sought from the temporary works designer. However, the following factors should be considered. It is understood that the existing Made Ground at the Site is to be excavated and re-engineered to remove buried obstructions. Excavated materials will be processed and re-engineered as an Engineered Fill. During construction, the in situ CBR value must be checked against the Design CBR value, to confirm design requirements are being met.

7.5. Groundworks, Excavation Stability and Groundwater Dewatering

In our opinion, there should be no particular difficulties in excavating the strata indicated in the boreholes utilising an appropriate and suitably sized mechanical excavator. Excavations into existing Made Ground and the underlying natural soils should be assumed to be unstable. No man entry into unsupported excavations should be allowed without an appropriate risk assessment. Reference to CIRIA report 097 (1983) should be made to establish suitable means of support or battering of excavation sides.

It is recommended that all excavations to greater than 1.20 metres depth, or for shallower excavations where groundwater is encountered above this level are closely supported, especially where man entry is required. Alternatively, where space permits, the excavations might be battered back to an appropriate angle. A shallow perched groundwater level of between 0.30-0.85m bgl was encountered in some area of the site within Made ground soils, with a more consistent groundwater body of between 1.18-3.81m was recorded in the natural soils in monitoring wells. Should groundwater seepages occur, and water accumulate in shallow excavations it should be able to be removed by pumping from a filtered sump. However, groundwater control by more robust means, such as well pointing, may be required locally.

It should be noted that should deep {circa 3.0m} basements be constructed as part of the development then we would recommend that the standpipes are monitored for groundwater levels for an extended period of time and take into consideration seasonal variations and periods of very wet weather to measure the fluctuation of the standing water levels. It should be noted that groundwater inflows and levels are likely to be subject to seasonal and climatic variations.



8. HUMAN HEALTH RISK ASSESSMENT

Results of chemical analysis are presented in full in Appendix C.

8.1. Data Interpretation Approach

The analytical data obtained were reviewed for completeness and consistency. The data for each sample type was then compiled, screened against the Generic Assessment Criteria (GACs) for a commercial/industrial land use and those potential contaminants of concern which were found to exceed the GACs were then subjected to detailed analysis as described below.

Previously, it was possible for results from soil (and leachate) samples to be subject to statistical assessment in accordance with a 2008 guidance document (CL:AIRE / CIEH Guidance on Comparing Soil Contamination Data with a Critical Concentration). This guidance has now been withdrawn and replaced with the following document:

- Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration (CL:AIRE 2020)

The purpose behind statistical assessment is ultimately to determine whether concentrations of contaminants are at levels that present potential risk to the future site users (and the wider environment if the statistical assessment is conducted on leachate test results).

The new guidance places even greater emphasis and reliance on the desk study being carried out first, appropriately detailed sampling strategies, collection and testing of samples for contamination and use of appropriate screening criteria.

The guidance requires an increased number of criteria to be met before a robust statistical assessment can be conducted and introduces the principle of the Central Limit Theorem (CLT); a key tool of statistics that is used in the comparison of confidence intervals with the critical concentration. A common 'rule of thumb' is that the CLT will apply provided your sample size is between 20 and 50.

On this basis, Tier Environmental considers that statistical assessment in accordance with the CL:AIRE 2020 guidance may not be applied in this instance given that the number of samples obtained is below 20 No. for any given identified soil population.

Due consideration of the ground conditions, distinct identifiable populations of soil and proposed development layout has been undertaken and, where appropriate, laboratory results associated with discrete populations or 'hotspots' have been assessed separately.

8.2. Selection of Generic Assessment Criteria (GAC)

In short, for the majority of the contaminants of concern, LQM/CIEH Suitable 4 Use Levels (S4ULs) published in 2015 have been adopted as GACs for a commercial/industrial land use; however, further details on the hierarchical approach for the selection of the GACs used as screening criteria for this assessment is provided in Appendix K.

These values are considered as appropriate screening criteria as they incorporate updated assumption exposures derived for the production of C4SLs but within the context of deriving screening criteria above which assessment of the risks or remedial action may be needed (i.e. within the context of the planning regime rather than Part 2A context for which C4SLs were derived).

For those potential contaminants of concern where the selected GAC is dependent on Soil Organic Matter content (SOM), an assumed SOM of 1% has been selected based on the reported Total Organic Carbon (TOC) concentrations (which have been converted to SOM by dividing by a conversion



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factor of 0.58). It should be noted; however, that for any soil samples where the TOC may be artificially driven by the presence of petroleum hydrocarbons, that these TOC results have been removed from the data set when determining an appropriate characteristic SOM. For this purpose, Tier Environmental have notionally considered that any TOC results from soil samples where the measured total TPH concentration exceeds 500mg/kg should be removed.

8.3. Human Health Risk Assessment

No measured concentrations of potential contaminants of concern have been reported in excess of the respective GACs protective of human health for a commercial/industrial land use.

Measured Potential Contaminant of Concern Concentrations without Publicly Available GACs

No measured concentrations of potential contaminants of concern have been reported in excess of the laboratory method detection limit for which there are no current publicly available GACs.

Asbestos

Asbestos can be present in soil as fragments of bulk Asbestos Containing Materials (ACMs) (e.g. asbestos cement sheeting) and also as discrete asbestos fibres within the soil matrix. This investigation has carried out assessments to determine whether both bulk fragments and / or fibres are present in the soil at the site. The asbestos assessment commenced on site with inspection of the Made Ground by our suitably qualified supervising engineer for the presence of bulk ACMs.

During the fieldwork no suspected ACMs were identified.

Of the 14No. of Made Ground samples submitted for asbestos screening, none were reported to contain asbestos.

8.4. Utilities

It is recommended that the results of the chemical testing and details of the proposed remedial works are provided to the appropriate utility companies to determine the necessity for service protection.

8.5. Construction and Maintenance Workers

Contamination may pose a short-term (acute) or long-term (chronic) risk to workers during construction and maintenance. The potential risks must be specifically assessed as part of the health and safety evaluation for the works to be performed in accordance with prevailing legislation. Site practices must conform to the specific legislative requirements and follow appropriate guidance (e.g., HSE, 1991; CIRIA, 1996).

On the basis of the results obtained, no potential exposure risks to construction and maintenance workers have been highlighted.

Asbestos **has not** been reported during the ground investigation works; however, in the event that previously unidentified asbestos is identified during future earthworks / construction works at concentrations above 0.001% w/w (i.e. above 'trace' levels), the Control of Asbestos Regulations 2012 should be adhered to. A summary of complying with CAR: risk assessments, licensing and training is provided in Appendix O is provided for reference.



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9. CONTROLLED WATERS RISK ASSESSMENT

9.1. Introduction

In order to assess whether there is a potentially unacceptable risk of pollution of controlled waters, samples of groundwater have been submitted for laboratory chemical analysis as per the summary presented in Table 5.4 within this report. Analytical data from groundwater sample testing undertaken by Tier Environmental have been evaluated against Water Quality Standard (WQS) values appropriate to the Conceptual Site Model.

In accordance with Part 2A of the Environmental Protection Act 1990, Tier Environmental has made regard to all of the WQS values that are relevant to the Site and a judgment has been made against the most stringent of those relevant standards. Further details are provided, along with the approach for selection of TPH / BTEX WQS values, in Appendix L.

In some instances, the laboratory method detection limit is greater than the appropriate WQS value. In these instances, only measured concentrations in excess of the laboratory method detection limit have been considered likely to potentially represent a possible significant risk to controlled waters.

For those potential contaminants of concern for which the WQS values are dependent on hardness (e.g. cadmium EQS values), an appropriate hardness in mg CaCO₃/l will be selected based on the reported values in the groundwater beneath the Site.

9.2. Controlled Waters Environment Conceptual Site Model Summary

From a conceptual site model perspective, the Devensian Till is classified as a Secondary Undifferentiated Aquifer, and the bedrock geology is classified as a Principal Aquifer associated with Kinnerton Sandstone Formation in the western/northern parts of the Site and a Secondary A Aquifer associated with the Salop Formation comprising mudstone in the southern / southeastern part of the Site. There is an inferred fault located beneath the site orientated from southwest to northeast associated with these two bedrock formations. The site is within a Source Protection Zone Total Catchment 3 associated with the Principal Aquifer, and the nearest surface water receptor comprises an underground water course 110m west. There are no potable or non-potable water abstractions located within 1km of the Site. The cohesive Till deposits have been proven to depths of circa 15.00m bgl in this investigation and are recorded to depths of circa 26.0 to 38.0m bgl in nearby BGS records which is considered sufficient to provide protection of the underlying bedrock aquifers from any vertical migration of potential contaminants of concern. On this basis the controlled waters sensitivity is considered to be low.

The proposed development will involve the development of the majority of the site, with buildings and hardstanding proposed and demolishing the farm buildings at Little Acorns and Honeysuckle Cottage off Francis Lane. Not only will this act to inhibit infiltration into the ground, it will also largely remove the source of agricultural phosphate from the site. The site won topsoil will be reused within the development within screening bunds and soft landscaping, but agricultural fertilisers and manure will no longer be used on the site. Wastewater drainage from the proposed development will be either via the on-site combined sewer and the Five Fords WwTW or on-site wastewater treatment and discharge to the on-site surface water drainage system.

9.3. Groundwater Testing

Table 9.1 below summarises the measured concentrations of contaminants of concern from groundwater samples at the Site that have been reported in excess of the respective WQS values.



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Table 9.1 Summary of Measured Concentrations of Dissolved Phase Groundwater Potential Contaminants of Concern in Excess of WQS Values

Potential Contaminant of Concern	Units	LoD*	WQS	Maximum Concentration	No. samples >WQS	Monitoring Well Location
Copper	µg/l	3	1	9	6 of 6	WS03
Nickel	µg/l	0.2	4	8.7	2 of 6	WS03
Zinc	µg/l	1.5	10.9	22	2 of 6	WS04
Fluoranthene	µg/l	0.005	0.0063	0.305	1 of 6	WS03
Benzo(a)pyrene	µg/l	0.005	0.00017	0.13	3 of 6	WS03
Total Ammonia	mg/l	0.03	0.6	2.69	3 of 5	WS02
Electrical Conductivity	uS/cm	2	2500	2506	1 of 6	WS05

* LOD= Laboratory Method Limit of Detection

Measured groundwater concentrations of copper, nickel, zinc, total ammonia and electrical conductivity have been reported in excess of the WQS protective of the controlled waters environment by either the same order of magnitude or one order of magnitude. Given the marginal nature of these exceedances, the potential for significant dilution between the Site and nearby significant water bodies, the low sensitivity of the controlled waters environment as described in Section 9.2 above, the localised nature of those soil leachate concentrations in excess of the WQS and the absence of any reported widespread leachable concentrations, the fact that the Site will incorporate buildings / hardstanding and a dedicated drainage system that shall reduce infiltration rates through the soils, the absence of any nearby potable or non-potable groundwater abstractions, the protection offered to the underlying principal aquifer by the presence of >10.0m of low permeability cohesive Till soils, it is not considered that these measured concentrations pose a risk to the controlled waters environment.

Measured concentrations of fluoranthene and benzo(a)pyrene have been reported in excess of the respective WQS protective of the controlled waters environment by between 2 No. orders of magnitude and 3 No. orders of magnitude. Further specific consideration of the reported soil leachate concentrations of fluoranthene and benzo(a)pyrene concentrations have been made. The EQS values for fluoranthene and benzo(a)pyrene are derived assuming bioaccumulation in fish and ultimately consumption of the fish by humans which is an exposure scenario that is not viable for this Site given the absence of a nearby viable surface water body where this will scenario be realised.

Subsequent sensitivity analysis has demonstrated that measured groundwater concentrations of fluoranthene and benzo(a)pyrene have been reported only *marginally* in excess of the respective Maximum Allowable Concentrations (MAC) EQS values for Inland Surface Waters by up to one order of magnitude in WS03 only. As such, and in the absence of viable 'bioaccumulation in fish and consumption of fish by humans' scenario given the other evidence listed above, it is therefore considered that the reported soil leachate concentrations of fluoranthene and / or benzo(a)pyrene are unlikely to present a potential risk to the controlled waters environment.



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10. GROUND GAS RISK ASSESSMENT

10.1. Introduction

The ground gas risk assessment has been undertaken in accordance with the following guidance:

- BS 8485:2015+A1:2019;
- CIRIA C665, 2007;
- Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide Are Present, NHBC, 2007;
- A Pragmatic Approach to Ground Gas Risk Assessment RB17. CL:AIRE, 2012; and,
- Ground Gas Monitoring and 'Worst-Case' Conditions TB17, CL:AIRE, 2018

The ground gas risk assessment has been conducted with full consideration of the viable sources, pathways and receptors included within the Preliminary Conceptual Site Model presented in Section 4.

Ground gas monitoring was conducted in conjunction with groundwater monitoring (and sampling); however, it should be noted the gas monitoring was conducted first, prior to any groundwater monitoring / sampling works. The monitoring well locations and construction were designed with due consideration of the proposed development layout and preliminary conceptual site model. Further information pertaining to monitoring wells is provided in Table 5.2.

10.2. Ground Gas Monitoring Results

The full ground gas monitoring results from the installations are presented in Appendix F and summarised below:



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Table 10.1 Ground Gas Monitoring Results Summary 1 No. Visits of Proposed Monitoring Programme of 2 No. Visits

Strata Targetted by Response Zone	Monitoring Well Reference	Maximum peak gas flow rate (l/h)	Maximum steady state gas flow (l/h)	Maximum peak CH4 (%v/v)	Maximum steady state CH4 (%v/v)	Maximum peak CO2 (%v/v)	Maximum steady state CO2 (%v/v)	Lowest O2 recorded (%v/v)
Till	WS02	5.2	4.0	0.1	0.1	7.9	7.3	16.0
Till	WS03	0.1	0.1	0.1	0.1	2.5	2.5	16.5
Till	WS04	5.8	0.3	0.1	0.1	3.0	3.0	17.5
Till	WS05	0.3	0.3	0.1	0.1	2.9	2.8	17.5
Till	WS06	0.3	0.3	0.1	0.1	2.7	2.6	16.6
Till	WS07	0.2	0.2	0.1	0.1	2.5	1.5	16.8

Bold = maximum value reported across all visits.



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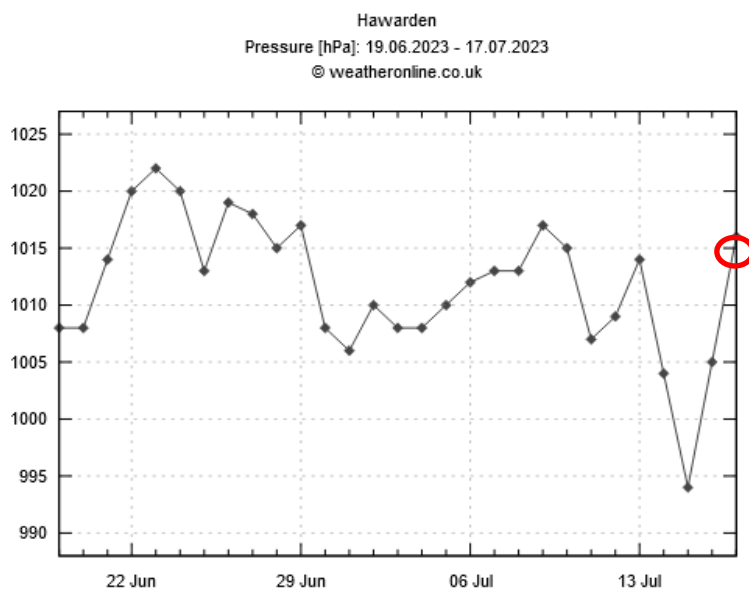
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10.3. Ground Gas Risk Assessment

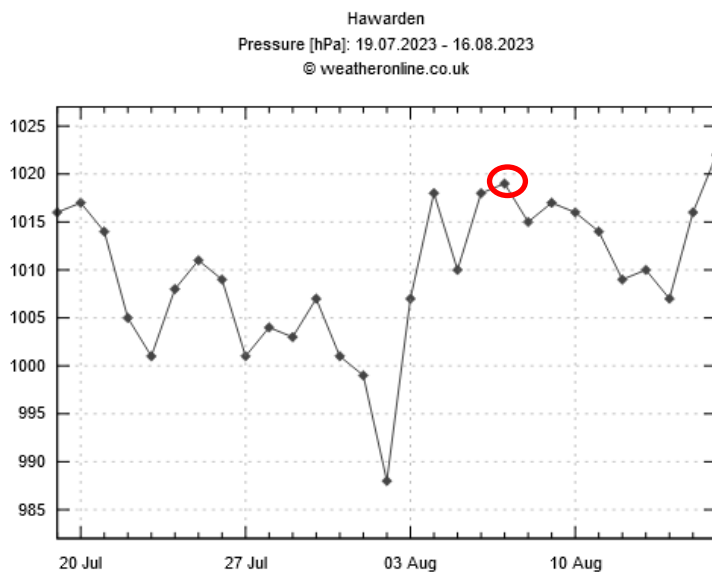
A preliminary monitoring period of 2 No. visits has been selected for this investigation.

The total atmospheric pressure range of the ground gas monitoring data included in this report was between 1014 mbar and 1016 mbar. This range covers moderate (1000 mbar to 1015mbar) and high (>1015 mbar) atmospheric pressures. Monitoring events included periods of rising pressure trends.

Visit 1 – 17/07/2023



Visit 2 – 07/08/2023





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Consideration of Groundwater Effects

An assessment has been made to determine whether groundwater levels beneath the Site lie at a shallow depth at, or above, the plain section of the monitoring well or within cohesive strata. In those instances where shallow groundwater is located within the plain section of the monitoring well pipe or within cohesive strata this can result in 'groundwater pumping' or a 'piston effect' where the measured peak (and in some cases steady) flow rates reported at these monitoring well locations are significantly (and artificially) influenced by the pressures formed in the void above the groundwater in the plain section of the pipe or within the pipework installed within cohesive strata, as opposed to being truly representative of the ground gas flow rates. In such instances, this scenario can create 'artificial' negative and/or relatively high peak positive readings depending on whether the groundwater levels have increased or decreased in between monitoring events or since installation of the monitoring wells.

The results of the ground gas monitoring within this report have indicates that there have been the following instances of artificial groundwater pumping i.e where the groundwater level is within the plain section of pipe:

- WS02 with a peak flow rate of 5.2l/hr and steady flow rate of 4.0l/hr where the groundwater level is recorded at 0.44m bgl.
- WS04 with a peak flow rate at 5.8l/hr where the groundwater level is recorded at 0.10m bgl.

It is therefore considered that these elevated flow rates can be reasonably removed from GSV calculations.

The results of the ground gas monitoring have been assessed in accordance with the criteria specified for this Site, which were derived as described in Appendix M.

Initial 'Worst-Case' GSV Calculation – Carbon Dioxide and Methane

An initial conservative assessment has been made by calculating a 'worst-case' Gas Screening Value (GSV) for the Site by using:

- the maximum reported methane or carbon dioxide concentration (whichever is highest) from any monitoring well and during any ground gas monitoring visit; and,
- the remaining maximum peak positive flow rate (after any negative flow rates or 'artificially' high flow rates have been discounted as described above) from any monitoring well and during any ground gas monitoring visit

Table 10.2 Initial Worst-Case GSV Calculation

Ground Gas	Maximum Reported Peak Concentration (% v/v)				Selected Concentration used in GSV Calculation (% v/v)	Maximum Appropriately Selected Gas Flow Rate (l/hr)	'Worst case' GSV (l/hr)
Methane (CH ₄)	0.1	}	→	X	7.9	0.7	= 0.0553
Carbon dioxide (CO ₂)	7.9						

CIRIA C665 provides two separate methods to 'characterise' a site that firstly requires the assessor to distinguish between two fundamental development 'situations':



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- **Situation A** - Any development other than Situation B (e.g. factories, shops, commercial, warehouses, schools, cinemas, sports centres, stadiums, high rise housing, housing with basements, etc) for which the **Modified Wilson and Card 'Characteristic Situation' classification system** is applied; and,
- **Situation B** - Low rise building with minimum ventilated under floor void (min 150 mm) for which the **NHBC Traffic light classification system** is applied
- In this instance, as the Site is due to be developed as commercial units, it shall be regarded as a 'Situation A' scenario for the purposes of the ground gas risk assessment.

Table 10.2 demonstrates that the Site is placed in a Characteristic Situation 1– very low risk scenario on the basis of the 'worst case' GSV alone.

CIRIA C665 indicates that in the event that the reported methane concentrations are '*typically*' >1% v/v and/or the reported carbon dioxide concentrations are '*typically*' >5% then consideration should be made to increase the determination of the Site to a Characteristic Situation 2 – Low Risk scenario.

As the maximum reported carbon dioxide concentrations exceed these thresholds, Tier Environmental has conducted further consideration of whether the Site should be classified as a Characteristic Situation 2 – Low Risk scenario below:

Carbon dioxide has been recorded in excess of 5% v/v in WS02 only at 7.9% v/v during the first visit. This location targeted a historic infilled pond and logs described soils of organic clays and peat. This is considered then primary source for this elevated carbon dioxide and therefore it is not considered representative of site wide values. Dependent on the requirement of the cut and fill for the site, this localised area of peat, which would be unsuitable as a founding strata, may be removed as part of earthworks and by doing so remove the source of the elevated carbon dioxide.

Further ground gas monitoring may be required as part of a detailed investigation.

Carbon Monoxide and Hydrogen Sulphide

There is no current UK risk assessment guidance available for carbon monoxide and hydrogen sulphide derived from ground gases.

A maximum peak carbon monoxide concentration of 3 ppm has been reported which is below the workplace long term exposure limit (30ppm) and the workplace short term exposure limit (200ppm) published by the Health and Safety Executive (EH40/2005 Workplace Exposure Limits) and below the WHO long term (24 hours) indoor exposure guideline value (5.68 ppm).

A maximum peak hydrogen sulphide concentration of 1 ppm has been reported which is below the workplace long term exposure limit (5ppm) and the workplace short term exposure limit (10ppm) published by the Health and Safety Executive (EH40/2005 Workplace Exposure Limits).

Considerations for Construction and Maintenance Workers

During engineering and construction activities, the ground gas data indicate that the following aspects are to be considered during the preparation of relevant site H&S plans, method statements and related documents, and appropriate working methods adopted:

- **Carbon dioxide concentrations in ground gas** : The measured CO₂ concentrations in ground gas reported are elevated relative to background levels and could present an asphyxiation risk in excavations and other confined spaces. The Health & Safety Executive has published information defining safe occupational exposure levels for CO₂ and the latest guidance must be consulted to determine whether the ground gas regime necessitates specific precautions during site works.



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10.4. Radon Gas

The majority of the Site lies within an area where less than 1% of the properties are above the action level whereby no radon protection measures are required. The south of the site is within an area where 1-3% of properties are above the action levels and therefore confirmation that no basic radon protection measures are required should be confirmed with the Local Building Control Office. UK Radon indicates testing/protection may be required for high-risk locations i.e. basement.



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11. REVISED CONCEPTUAL SITE MODEL AND GENERIC QUANTITATIVE RISK ASSESSMENT OF POLLUTANT LINKAGES

The preliminary combined conceptual site model and conceptual exposure model, developed from the desk study information and presented in Section 4, has been revised in light of the ground investigation and the chemical analysis results presented above in Table 11.1, below.

A revised qualitative risk assessment has also been made of the likelihood of the linkage operating and its potential significance in accordance with CIRIA C552.



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Table 11.1 Revised Assessment of Potential Pollutant Linkages (Continued on Next Page).

Justification / Comments
- The site is broadly underlain site wide by topsoil to depths of 0.20m to 0.55m bgl or Made Ground to typical depths of between 0.25m to 1.10m bgl, principally in the central northeast of the site. These are underlain by natural soils comprised of Devensian Till, described as a firm becoming stiff and locally very stiff Clay. A more weathered horizon of brown clay was recorded in the order of 0.25m to 1.40m thick overlying the dark grey unweathered Till which was proven to the maximum drilled depth of 5.45m bgl. Sand lenses were also recorded near surface to 0.55m and 1.35m bgl. Localised areas of soft organic clays and Peat are described within the central northeast of the site within an infilled pond from depths of 0.59m to 1.10m bgl to depths of 1.75m to 2.60m bgl. - No measured soil concentrations of potential contaminants of concern have been reported in excess of Generic Assessment Criteria (GACs) protective of human health appropriate to the proposed land use. On this basis, it is not considered that the site represents a potential risk to end-users. - Of the 14 No. of Made Ground samples submitted for asbestos screening, none were reported to contain asbestos. - From a conceptual site model perspective, the Devensian Till is classified as a Secondary Undifferentiated Aquifer, and the bedrock geology is classified as a Principal Aquifer associated with Kinnerton Sandstone Formation in the western/northern parts of the Site and a Secondary A Aquifer associated with the Salop Formation comprising mudstone in the southern / southeastern part of the Site. There is an inferred fault located beneath the site orientated from southwest to northeast associated with these two bedrock formations. The site is within a Source Protection Zone Total Catchment 3 associated with the Principal Aquifer, and the nearest surface water receptor comprises an underground water course 110m west. There are no potable or non-potable water abstractions located within 1km of the Site. The cohesive Till deposits have been proven to depths of circa 15.00m bgl in this investigation and are recorded to depths of circa 26.0 to 38.0m bgl in nearby BGS records which is considered sufficient to provide protection of the underlying bedrock aquifers from any vertical migration of potential contaminants of concern. On this basis the controlled waters sensitivity is considered to be low. - The Site is located within the phosphate sensitive freshwater catchment of the River Dee and Bala Lake Special Area of Conservation (SAC). The proposed development will involve the development of the majority of the site, with buildings and hardstanding proposed and demolishing the farm buildings at Little Acorns and Honey Suckle Cottage off Francis Lane. Not only will this act to inhibit infiltration into the ground, it will also largely remove the source of agricultural phosphate from the site. The site won topsoil will be reused within the development within screening bunds and soft landscaping, but agricultural fertilisers and manure will no longer be used on the site. Wastewater drainage from the proposed development will be either via the on-site combined sewer and the Five Fords WwTW or on-site wastewater treatment and discharge to the on-site surface water drainage system. - Measured groundwater concentrations of copper, nickel, zinc, total ammonia and electrical conductivity, fluoranthene and benzo(a)pyrene are not considered to pose a risk to the controlled waters environment for the following reasons: - The potential for significant dilution between the Site and nearby significant water bodies; - The low sensitivity of the controlled waters environment; - The localised nature of those soil leachate concentrations in excess of the WQS and the absence of any reported widespread leachable concentrations; - The fact that the Site will incorporate buildings / hardstanding and a dedicated drainage system that shall reduce infiltration rates through the soils; - The absence of any nearby potable or non-potable groundwater abstractions; - The protection offered to the underlying principal aquifer by the presence of >10.0m of low permeability cohesive Till soils. - The absence of a nearby viable surface water body where a consumption of fish by humans exposure scenario would be realised for fluoranthene and benzo(a)pyrene. - A Gas Screening Value of 0.553 l/hr has been calculated, derived using the maximum peak recorded carbon dioxide concentration of 7.9%v/v and the maximum peak flow rate of 0.7 l/hr. Assessment of this gas screening value alone places the Site in a Characteristic Situation 1 – very low risk scenario in accordance with CIRIA C665 for which ground gas protection measures are not required. It should be noted this has been derived from a preliminary regime of 2 No. visits and further ground gas monitoring will be required as part of a detailed investigation.



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Source	Potential Contaminants of Concern	Pathway	Receptor	Consequence	Probability	Qualitative Risk Assessment
On-site localised Made Ground / potentially infilled ponds and off-site Made Ground.	Hazardous ground gasses (methane, carbon dioxide, hydrogen sulphide, carbon monoxide and depleted oxygen)	Inhalation (indoor and outdoor)	Future site users (commercial)	Severe	Low Likelihood	Moderate Risk
			Adjacent site users residential/commercial	Severe	Unlikely	Moderate / Low Risk
			Construction, site investigation, demolition and future maintenance workers	Severe	Low Likelihood	Moderate Risk
		Migration of hazardous ground gases from beneath the Site to adjacent sites along services or other preferential conduits	Adjacent site users residential/commercial	Severe	Unlikely	Moderate / Low Risk
		Migration of ground gas / explosion	Buildings and services	Severe	Unlikely	Moderate / Low Risk

For definition of the terms used in the qualitative risk assessment, please see Appendix J.



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12. PRELIMINARY WASTE MATERIALS CLASSIFICATION

12.1. Introduction

If the Site is to be redeveloped and materials are disposed off Site, the material exported from the Site to Landfill should be hauled by a registered waste carrier in accordance with Duty of Care Regulations 1991 and the Hazardous Waste Regulations 2005.

There will be requirement for the waste producer to provide appropriate Waste Acceptance Criteria (WAC) testing of the Soils for disposal to ensure that the soils are appropriately classified and that the landfill is licensed to receive such soils. Mixing of hazardous and non-hazardous waste is not permitted. For any hazardous wastes, a consignment note shall be completed, signed, and retained by all parties involved. The consignment note shall state the volume of waste, a physical description of the material and statement of its chemical composition. The waste consignment notes shall be kept by the contractor for a period of at least two years. For non-hazardous wastes, a Waste Transfer Note (WTN) shall be completed. The WTN should be signed and a copies should be kept by the contractor for a period of at least two years. Finally, consignment notes and WTNs shall be shown to an enforcement officer from the local council or Natural Resources Wales, if asked.

Approach to Assessing Hazard Properties

Flammability and Oxidisability

For any samples flagged as possessing hazardous properties flammability and oxidisability, for which there are no thresholds, Tier Environmental has used professional judgment and on-site observations to decide whether the waste soil, as a whole, is likely to be flammable or oxidising. It should be noted that flammability/oxidisability alone are unlikely to result in a hazardous classification for waste soil.

Worst Case Metal Compounds

The choice of an appropriate worst case metal compound in soil has been made on the basis of the available lines of evidence. For example, if laboratory chemical analysis has demonstrated that no measured concentrations of hexavalent chromium have been reported in excess of the laboratory method detection limit, there it would be regarded as evidence of an absence of a soil source of hexavalent chromium. In such an instance, the worst case metal chromates may be replaced in favour of the next worst case metal compound.

pH

For samples that have been determined as hazardous based on pH alone and cement/concrete has been identified in the sample, Tier Environmental may assume that the high pH was due to the crushing process in the laboratory and is not representative of the waste as a whole. If further detailed determination of this is required then Tier Environmental recommend that such assessment is carried out on these results in a manner described in the AGS Waste Classification for Soils – A Practitioners' Guide (dated 2019):

- Consideration of the acid/alkali reserve to be conducted (as described in WM3 Appendix C4 and C8).
- If large enough, the cement/concrete fraction may be separated manually before testing. Waste concrete from construction and demolition which doesn't contain hazardous substances is non-hazardous (LoW code 17-01-01).
- If cement/concrete has been identified in the sample, a second analysis may be conducted on an 'as received' sample, avoiding the need for crushing before testing. The high pH is typically associated with the finer fractions of cement. If the 'as received' sample has an acceptable pH, this provides additional confidence that the high pH was due to the crushing process and is not representative of the waste as a whole.



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Asbestos

With respect to asbestos, If the waste contains fibres that are free and dispersed then the waste will be hazardous if the waste as a whole contains 0.1% w/w or more asbestos in accordance with WM3. If the waste contains any identifiable pieces of suspected asbestos containing material (i.e. any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye), then these pieces must be assessed separately. The waste is hazardous if the concentration of asbestos in the piece of asbestos containing material is 0.1% w/w or more. The waste shall then be regarded as a mixed waste and classified accordingly.

The following codes will then be assigned to the asbestos waste as appropriate:

- 17 06 05* Construction material containing asbestos
- 17 06 01* Insulation material containing asbestos

17 06 05* would normally be used in preference to 17 06 01* for the asbestos in asbestos contaminated soil and stones in accordance with WM3.

Tier Environmental Geoenvironmental engineers hold up to date UKATA Asbestos Awareness training certificates in order to demonstrate 'competence' that is required as described in WM3.

Flammable Liquid Waste

Tier Environmental consider that such a hazard property would apply if free phase product has been reported in the sample. As such, in those instances where materials are classified as hazardous based on this alone and no free phase product is encountered, it is considered that the materials may be regarded as being non-hazardous. Please note that the table below includes a column to show whether free phase product has been encountered within the sample location.

12.2. Preliminary Waste Materials Classification

Tier Environmental have assessed the chemical results in terms of basic waste characterisation of materials on site. This provides a preliminary assessment of whether a material is potentially non-hazardous or hazardous waste.

The results of this preliminary assessment are summarised in the following table.

Natural Soils / Bedrock

Representative samples of natural soils have been obtained during the investigation.

The results of basic waste characterisation are summarised in the table below. It is likely that any natural soils (that are not impacted by any known contamination from shallow Made Ground, or unexpected contamination) would be suitable for disposal to an inert waste landfill. It is recommended that the landfill is approached to confirm this position prior to off-site disposal. Otherwise, additional testing will be required to confirm the waste disposal route for natural soils beneath the Site.



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Table 12.1 Preliminary Materials Waste Classification

Exploratory Hole Location	Sample Depth (m bgl)	Simplified Description of the Sample	Basic Waste Characterisation Result	If 'Potentially Hazardous': Is it Possible to Demonstrate the Material is Non-Hazardous?
TP01	0.40	Topsoil: Dark brown sandy gravelly Clay	Non-Hazardous	N/A
TP03	1.40	Natural: Brown gravelly Clay (Till)	Non-Hazardous	N/A
TP04	0.20	Topsoil: Dark brown sandy gravelly Clay	Non-Hazardous	N/A
TP06	0.20	Topsoil: Dark brown clayey Sand	Non-Hazardous	N/A
TP08	0.20	Topsoil: Dark brown clayey Sand	Non-Hazardous	N/A
TP10	0.25	Topsoil: Dark brown clayey Sand	Non-Hazardous	N/A
TP12	0.25	Topsoil: Dark brown sandy gravelly Clay	Non-Hazardous	N/A
TP13	0.70	Made Ground: Gravelly Clay	Non-Hazardous	N/A
TP13	1.45	Made Ground: Black clayey gravelly Peat	Non-Hazardous	N/A
TP14	0.40	Made Ground: Gravel of limestone, sandstone and brick	Non-Hazardous	N/A
TP14	1.10	Made Ground: Black clayey gravelly Peat	Non-Hazardous	N/A
TP16	0.35	Made Ground: Gravelly Clay	Non-Hazardous	N/A
TP17	1.00	Natural: Brown gravelly Clay (Till)	Non-Hazardous	N/A
HDP07	0.10	Made Ground: Clayey gravelly Sand	'Potentially hazardous' but can be downgraded to non-hazardous (see next column for details).	Yes. Driven by 'HP 3(i): Flammable "flammable liquid waste"' (hazard statement: Flam. Liq. 3; H226 "Flammable liquid and vapour. "). However, Tier Environmental consider that such a hazard property would apply if free phase product has been reported in the sample. As no free phase product was encountered, it is considered that the materials above may be regarded as being non-hazardous.
WS10	1.50	Natural: Brown gravelly Clay (Till)	Non-Hazardous	N/A
WS12	0.80	Natural: Brown gravelly Clay (Till)	Non-Hazardous	N/A



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12.3. Materials Re-Use

Subject to volumetric fill requirements and a future assessment of suitability of re-use (both chemically and geotechnically), some materials may be considered for potential re-use in line with an appropriate end-of-waste protocol such as WRAP Quality Protocol for Aggregates from Inert Waste, U1 Exemption or a Materials Management Plan in accordance with the CL:AIRE Definition of Waste Code of Practice (DoWCoP). Please note that any previously landfilled or mining waste materials may not be appropriately subject to consideration under DoWCoP and may not be re-used under DoWCoP unless sufficient lines of evidence and agreement with the local Natural Resources Wales Waste Team can be sought beforehand.

Re-Use of Excavated and Stockpiled Clean Naturally Occurring Soils on Other Sites

In addition, Tier Environmental are aware that CL:AIRE is classing stockpiled clean, naturally occurring soils as waste, unless their final destination is identified in a Materials Management Plan, before they are excavated. However, Tier Environmental consider that any clean naturally occurring soils arising from enabling works, earthworks or construction activities would be regarded as an asset and the default assumption for this Site (prior to excavation and stockpiling) is not the intention to discard these materials where they may be reasonably re-used on this, or another, development site. Stockpiling is a recognised, recommended means of safely storing soils. Whilst there may be advantages to leaving soils in-situ, stripping topsoil and subsoil prior to earthworks is a routine construction activity. Tier Environmental consider that it is not unreasonable to state that in the event that the developer owns another site where the construction phase is ongoing, soils can be transferred between their sites as an owned product and never become waste.

The above paragraph above is therefore considered a clear intention to reuse any clean, naturally occurring soils derived from excavations at this Site (which may also include temporary stockpiling these materials). It is considered; however, that in addition to this the following must be adhered to:

- Reuse does need to occur within a 'reasonable' timeframe (12 No. months); and,
- If soils are transferred to a third party (another developer), there needs to be some contractual agreement in place, as in this situation it is important to have something in place confirming that surplus soils are required by the third party.

Re-Use of Excavated and Stockpiled Clean Naturally Occurring Soils Within The Site They Are Excavated From

Further to the above, where soils are naturally occurring, uncontaminated and re-used on the site they are excavated from, they fall outside of the Waste Framework Directive (WFD) i.e. they will not be classified as a waste. Currently the CL:AIRE Definition of Waste Code of Practice states the following which appears to support this position: *"If the material is waste an Environmental Permit will be required to lawfully deposit or re-use it unless the material is "uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated", which is excluded from waste regulation by the Waste Framework Directive (2008)."*



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13.CONCLUSIONS AND RECOMMENDATIONS

13.1. Conclusions

- The site is broadly underlain site wide by topsoil to depths of 0.20m to 0.55m bgl or Made Ground to typical depths of between 0.25m to 1.10m bgl, principally in the central northeast of the site. These are underlain by natural soils comprised of Devensian Till, described as a firm becoming stiff and locally very stiff Clay. A more weathered horizon of brown clay was recorded in the order of 0.25m to 1.40m thick overlying the dark grey unweathered Till which was proven to the maximum drilled depth of 5.45m bgl. Sand lenses were also recorded near surface to 0.55m and 1.35m bgl. Localised areas of soft organic clays and Peat are described within the central northeast of the site within an infilled pond from depths of 0.59m to 1.10m bgl to depths of 1.75m to 2.60m bgl.
- A shallow perched groundwater level of between 0.30-0.85m bgl was encountered in some area of the site within Made Ground soils, with a more consistent groundwater body of between 1.18-3.81m was recorded in the natural soils in monitoring wells
- No measured soil concentrations of potential contaminants of concern have been reported in excess of Generic Assessment Criteria (GACs) protective of human health appropriate to the proposed land use. On this basis , it is not considered that the site represents a potential risk to end-users.
- Of the 14 No. of Made Ground samples submitted for asbestos screening, none were reported to contain asbestos.
- From a conceptual site model perspective, the Devensian Till is classified as a Secondary Undifferentiated Aquifer, and the bedrock geology is classified as a Principal Aquifer associated with Kinnerton Sandstone Formation in the western/northern parts of the Site and a Secondary A Aquifer associated with the Salop Formation comprising mudstone in the southern / southeastern part of the Site. There is an inferred fault located beneath the site orientated from southwest to northeast associated with these two bedrock formations. The site is within a Source Protection Zone Total Catchment 3 associated with the Principal Aquifer, and the nearest surface water receptor comprises an underground water course 110m west. There are no potable or non-potable water abstractions located within 1km of the Site. The cohesive Till deposits have been proven to depths of circa 15.00m bgl in this investigation and are recorded to depths of circa 26.0 to 38.0m bgl in nearby BGS records which is considered sufficient to provide protection of the underlying bedrock aquifers from any vertical migration of potential contaminants of concern. On this basis the controlled waters sensitivity is considered to be low.
- The proposed development will involve the development of the majority of the site, with buildings and hardstanding proposed and demolishing the farm buildings at Little Acorns and Honey Suckle Cottage off Francis Lane. Not only will this act to inhibit infiltration into the ground, it will also largely remove the source of agricultural phosphate from the site. The site won topsoil will be reused within the development within screening bunds and soft landscaping, but agricultural fertilisers and manure will no longer be used on the site. Wastewater drainage from the proposed development will be either via the on-site combined sewer and the Five Fords WwTW or on-site wastewater treatment and discharge to the on-site surface water drainage system.
- Measured groundwater concentrations of copper, nickel, zinc, total ammonia and electrical conductivity, fluoranthene and benzo(a)pyrene are not considered to pose a risk to the controlled waters environment for the following reasons:
 - The potential for significant dilution between the Site and nearby significant water bodies;
 - The low sensitivity of the controlled waters environment;
 - The localised nature of those soil leachate concentrations in excess of the WQS and the absence of any reported widespread leachable concentrations;
 - The fact that the Site will incorporate buildings / hardstanding and a dedicated drainage system that shall reduce infiltration rates through the soils;
 - The absence of any nearby potable or non-potable groundwater abstractions;
 - The protection offered to the underlying principal aquifer by the presence of >10.0m of low permeability cohesive Till soils.



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- The absence of a nearby viable surface water body where a consumption of fish by humans exposure scenario would be realised for fluoranthene and benzo(a)pyrene.
- A Gas Screening Value of 0.553 l/hr has been calculated, derived using the maximum peak recorded carbon dioxide concentration of 7.9%v/v and the maximum peak flow rate of 0.7 l/hr. Assessment of this gas screening value alone places the Site in a Characteristic Situation 1 – very low risk scenario in accordance with CIRIA C665 for which ground gas protection measures are not required.
- Basic waste characterisation has determined that all Made Ground soils are non-hazardous. WAC testing has not been completed as part of these works and final waste disposal routes should be confirmed prior to removal from site. It is anticipated that natural soils will be suitable for disposal to an inert waste landfill.

13.2. Recommendations

- Further detailed investigation as required to inform foundation design;
- Further ground gas monitoring to refine the ground gas regime;
- Confirmation of sewer and gas main location to be diverted



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14.REGULATORY APPROVALS

The conclusions and recommendations presented above are considered reasonable based on the findings of the site investigation. However, these cannot be guaranteed to gain regulatory approval and, therefore, the report should be passed to the appropriate regulatory authorities and/or other organisations for their comment and approval prior to undertaking any works on site.

It is recommended that conditions placed on any planning permission are discharged prior to commencement of site works.



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15. REFERENCES

- BRE BR211 (2015). Radon: Guidance on Protective Measures for New Dwellings. IHS BRE Press, Bracknell.
- BRE SD1 (2005). Concrete in Aggressive Ground. Special Digest 1 (revised edition). IHS BRE Press, Bracknell.
- BRE 414 (2001) Protective measures for housing on gas-contaminated land. BRE.
- BS 10175:2011+A2:2017 Investigation of Potentially Contaminated Sites - Code of Practice. British Standards Institution, London.
- BS EN 1997-1:2004 Eurocode 7. Geotechnical Design. General Rules. British Standards Institution, London.
- BS EN 1997-2:2007 Eurocode 7. Geotechnical Design. Ground Investigation and Testing. British Standards Institution, London.
- BS5930:2015+A12020 Code of practice for ground investigations BSI
- BS EN ISO 17892-1-12:2018 Geotechnical investigation and testing BSI
- BS EN ISO 14688-1:2018 Geotechnical Investigation and Testing. Identification and Classification of Soil. Identification and Description. British Standards Institution, London.
- BS EN ISO 14688-2:2018 Geotechnical Investigation and Testing. Identification and Classification of Soil. Principles for a Classification. British Standards Institution, London.
- BS EN ISO 14689-1:2018 Geotechnical Investigation and Testing. Identification and Classification of Rock. Identification and Description. British Standards Institution, London.
- BS8485 2015 Code of Practice for the design of protective measures for methane and carbon dioxide ground gases in new buildings. British Standards
- BS85762013 Guidance on investigations for ground gas – permanent gases and volatile organic compounds (VOCs). BSI,
- CIRIA Rep R 97 (2001) Trenching Practice. Report 097, 2nd edition, CIRIA, London.
- CIRIA Rep R 149 (1995a) Protecting Development from Methane. Report 149, CIRIA, London.
- CIRIA Rep R 150 (1995b) Methane Investigation Strategies. Report 150, CIRIA, London.
- CIRIA Rep R 151 (1995c) Interpreting Measurement of Gas in the Ground Report 151, CIRIA, London.
- CIRIA Rep R 152 (1995d) Risk Assessment for Methane and Other Gases from the Ground. Report 152, CIRIA, London.
- CIRIA Rep R 132 (1996) A Guide for Safe Working on Contaminated Sites. Report 132, CIRIA, London.
- CIRIA C552 (2001) Contaminated land risk assessment. A guide to good practice (report no. C552).
- CIRIA C665 (2007) Assessing the risks posed by hazardous gases to buildings CIRIA, London



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CIRIA C748 (2014) Guidance on the use of plastic membranes as VOC barriers, CIRIA, London

CIRIA C735 (2014) Good practice on the testing and verification of protection systems for buildings against hazardous ground gases. CIRIA.

CIRIA C681 (2009) Unexploded ordnance (UXO) A guide for the construction industry (C681)

CIRIA C785 (2019) Unexploded ordnance (UXO) risk management guide for land-based projects (C785)

CIRIA C758D (2019) Abandoned mine workings manual (C758D)

Contaminated Land: Applications in Real Environments (CL:AIRE) (2011) Definition of Waste Code of Practice (version 2).

Department of Environment Food and Rural Affairs (DEFRA) (2012) Environmental Protection Act 1990:Part 2A Contaminated Land Statutory Guidance (report no. PB13735).

Environment Agency (2000) Technical Aspects of Site Investigation. Report P5-065/TR, Environment Agency, Bristol.

Environment Agency (2002) Guidance on Monitoring Landfill Leachate, Groundwater and Surface Water. Report LFTGN02, Environment Agency, Bristol.

Environment Agency (2007) Evaluation of Models for Predicting Plant Uptake of Chemicals from Soil. Report SC050021/SR, Environment Agency, Bristol.

Environment Agency (2006) Remedial Targets Methodology - Hydrogeological Risk Assessment for Land Contamination (report no.ea/br/e/std/vr10thanni).

Environment Agency (2008) Science Report SC050021/SR7 Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values.

Environment agency, 2007. Inter-laboratory comparison of in vitro bioaccessibility measurements for arsenic lead and nickel in soil, Science Report SC040060/SR2.

Environment Agency, 2009 Human health toxicological assessment of contaminants in soil (Science Report Final SC050021/SR2)

Environment Agency (2015) Guidance on the Classification and Assessment of Waste Technical Guidance WM3 (1st edition).European Union (1998) Drinking Water Directive (Council Directive 98/83/EC).

Gibbons, R. (1994) Statistical Methods for Groundwater Monitoring. Wiley, New York.

Groundsure Report 2021 GSIP-2021-10752-4061

Highways Agency (2006) Design of Pavement Foundations. Document HD 25/IAN 73/06.

HSE (1991) Protection of Workers and the General Public During the Development of Contaminated Land. HMSO, London.

HSE (2005) Occupational Exposure Limits. HSE report EH40/2005, HMSO, London.



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ICRCL (1986) Notes on the Fire Hazards of Contaminated Land. Guidance Note 61/84, 2nd Edition, Interdepartmental Committee on the Redevelopment of Contaminated Land, London.

Jeffries, J.(2009). A review of body weight and height data used within the Contaminated Land Exposure Assessment model (CLEA). Project SC050021/ Technical Review 1. Bristol: Environment Agency

Land Contamination Risk Management (LCRM) Environment Agency October 2020 <https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm> .

LQM/CIEH Ltd (2015) S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham.

NHBC (2007) Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present (report no .04).

NRA (1994) Protocol for a Leaching Test to Assess the Leaching Potential for Soils from Contaminated Sites. R&D Note 181.

SoBRA (2017) Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater – Version 1.0.

The Water Framework Directive, (Standards and Classification) Directions (England and Wales).

UK Water Industry Research (2010) Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites (report no. 10/WM/03/21)

WHO (2000) Air Quality Guidelines for Europe. 2nd edition, WHO Regional Office for Europe, Copenhagen.

World Health Organisation (2017) Guidelines for Drinking Water Quality (4th edition).

Britain From Above - <https://britainfromabove.org.uk/en/image/WPW060399>

<http://www.warstateandsociety.com/Bombing-Britain>

<https://www.epa.gov/pfas/basic-information-pfas>

UK Maps of Radon, <http://www.ukradon.org/information/ukmaps>

Health and Safety Executive (2015) Construction (Design and Management) Regulations.

Coal Authority Interactive Map Viewer, <http://mapapps2.bgs.ac.uk/coalauthority/home.html>

BGS Geology of Britain Viewer <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>



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16.GLOSSARY OF TERMS

ACEC	Aggressive Chemical Environment for Concrete (classification)
aOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
Designated location	Site (and the ecosystem on that site) protected under national or international legislation. A potential ecological receptor to be considered as part of the assessment of land contamination. Example designated locations include SSSIs (q.v.), SACs (q.v.), national nature reserves, Ramsar sites and bird special protection areas.
DQA	Data Quality Assessment
DQO	Data Quality Objective
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
K _{ow}	Octanol-water partition coefficient
LEL	Lower Explosive Limit
LL	Liquid Limit
LoD	Limit of Detection (analytical)
LoQ	Limit of Quantification (analytical)
Mean Value Test	Statistical test (described in the CIEH Guidance) to estimate the mean value of a normally distributed population of data at a given level of confidence. Normally for contaminated land assessment, the 95th percentile (referred to as the 95%UCL or US95) is applied as a reasonable but conservative estimate of the mean concentration for comparison with the relevant assessment criteria.
Maximum Value Test	Statistical test (described in the CIEH Guidance) to identify whether an elevated concentration within a normally distributed data set forms part of the underlying population from which it has been sampled or whether it is an outlier (such as a localised area of contamination) that merits further consideration.
MC	Moisture Content
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
PI	Plasticity Index
PID	Photoionisation Detector
PL	Plastic Limit
ppm	Parts per million
ppmv	Parts per million by volume
QA	Quality Assurance
QC	Quality Control
SAC	Special Area of Conservation
SOM	Soil Organic Matter



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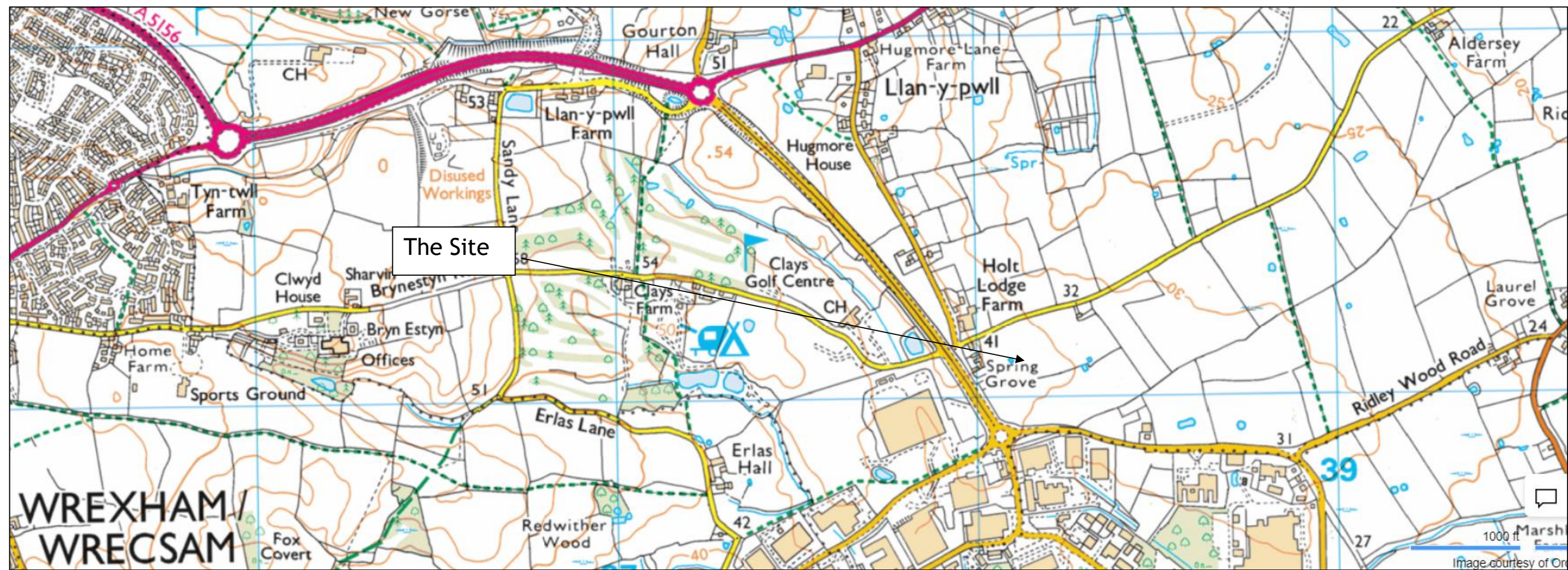
Date: 20/10/2023

SPT	Standard Penetration Test
SPZ	Source Protection Zone (see Appendix L)
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest
SVOC	Semi-Volatile Organic Compound
TEF	Toxicity Equivalent Factor
TPH	Total Petroleum Hydrocarbons
TWA	Time Weighted Average
US95	95 th percentile estimate of the true mean value of a data population (also known as 95%UCL).
VOC	Volatile Organic Compound

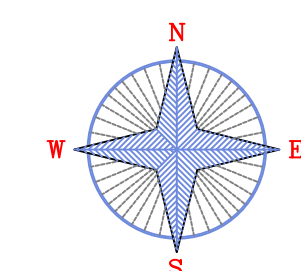
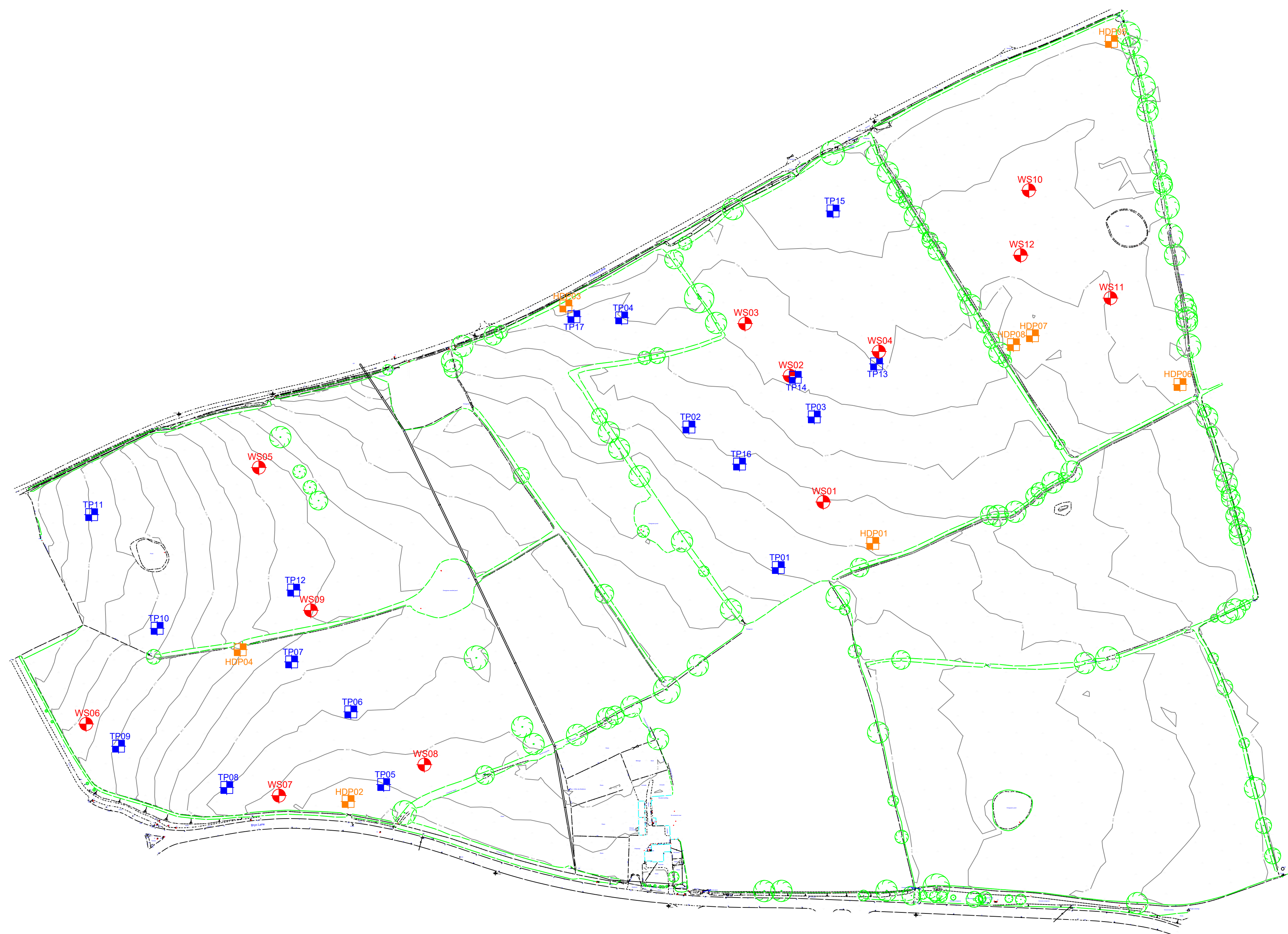
APPENDIX A - DRAWINGS



Site Location Plan



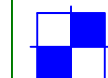
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Drawn by:	ER
Approved by:	SL
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DO NOT SCALE



NOTES

-  Outline Planning Trial Pit Location
-  Outline Planning Hand Dug pit Location
-  Outline Planning Window Sample Location

P1	26/06/2023	CS	ISSUED FOR INFORMATION		ER	ER
REV	DATE	BY	DESCRIPTION		CHK	APD

DRAWING STATUS: PRELIMINARY



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CLIENT: NET WORLD SPORTS

PROJECT: BRYN LANE WREXHAM
OUTLINE PLANNING

TITLE: EXPLORATORY HOLE LOCATION PLAN

SCALE: 1:200 @ A1	CHECKED: ER	APPROVED: ER
CAD FILE: -	DESIGN/DRAWN: CS	DATE: 26/06/2023
PROJECT No: TE1749	DRAWING No: TE1749-TE-00-XX-DR-GE-002-V01	REV: P1