

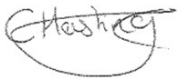
GROUNDTECH
CONSULTING

COSTA DRIVE THRU, WREXHAM

GEO-ENVIRONMENTAL APPRAISAL

BRIAN CLANCY HIGBY PARTNERSHIPS

FEBRUARY 2024

Document Control Form		
PROJECT	*COSTA DRIVE THROUGH, WREXHAM*	
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SUMMARY

Site Details		
Site Location		*The site is located east of Wrexham Town Centre approximately on national grid reference 333972, 350527.*
Site Area		*The site covers roughly 0.09 hectares and is generally level. The sit is currently utilised as a car park with some small areas of soft landscaping.*
Preliminary Risk Assessment		
History		The site remained undeveloped from 1872 to 1898 when a sand pit was dug on site. The sand pit remained until 1959 when it appeared to be infilled. The site was developed into a car park in 2003 and has remained unchanged since then. The surrounding area has ben an industrial and commercial area since before 1872. The current retail park was developed in 2003.
Geology/Hydrogeology		The superficial deposits underlying the site are Glaciofluvial sheet deposits characterised by sand and gravel. The superficial deposits are considered a Secondary A aquifer. The bedrock is indicated to be the Salop Formation comprising of mudstone, sandstone and conglomerate. The bedrock is considered a Secondary A Aquifer.
Mining		The site lies in area requiring a mining search. The property is not within an area affected by past recorded mine workings and there are no mine entries within 20m of the site boundary.
Environmental Setting		The nearest named water course is the River Gwenfro 665m south of the site. There are 5 current industrial land uses within 250m of the site.
Pollution Linkage (PL) Assessment	Human Health	*Deep Made Ground may be present within the infilled sand pit located on the site and may be contaminated with a range of contaminants. The site will be covered in hardstanding but some small areas of are proposed. The risk is considered Moderate to Low.*
	Controlled Waters	*The site is underlain by granular superficial deposits considered a Secondary A aquifer. The bedrock is considered a Secondary A aquifer. The closest surface water feature is the River Gwenfro c. 665m south of the site. No significant source of mobile contamination has been encountered by the desk based study and the risk is considered Low.*
	Permanent Ground Gas	*There is considered onsite and offsite sources of ground gas including the infilled sand pit on site. The risk from permanent ground gases is considered moderate.*
Ground Model		

Made Ground Soils	*Made ground was encountered to a maximum depth of 2.4m bgl and comprised four main populations including clayey sand gravel and occasionally clayey gravelly sand. Minor constituents within the Made Ground included concrete, brick, tarmac and sandstone.*
Natural Soils	*Natural soils were encountered to a maximum depth of 5.0m bgl and adhered to the geological records. Brown occasionally gravelly sand was encountered from 0.5m bgl to a maximum observed depth of 5.0mbgl.*
Bedrock	*Bedrock was not encountered during the investigation.*
Groundwater	*No groundwater strikes were observed during the investigation.*
Ground Engineering Assessment	
Foundations	*The most suitable foundation solution is considered to be Vibro Treatment/Vibro Stone Columns (VSCs). Piles are also considered feasible founding within the medium dense Sand at 5.0m bgl. An allowable bearing pressure of 200kN/m^2 can be achieved with a 350mm diameter driven pile.*
Highways	*CBR values of 5% are likely achievable within the natural strata. Made Ground should be assumed to have a CBR value of <2.5%.*
SuDS	*SuDS drainage is considered feasible due to the granular natural deposits. If SuDS are to be considered, soil percolation tests should be undertaken in accordance with BRE365.*
Constraints	*Concrete obstruction were encountered within WS03 and WS05 at depths of between 1.8m and 2.0m bgl and will require grubbing out prior to foundation installation.*
GQRA and Revised (PL) Assessment	
Human Health	*No elevated contaminants of concern have been encountered and the risk to Human Health is considered Low.*
Controlled Waters	*The nearest surface water feature is the River Gwenfro circa 665m from the site. The site is underlain by Superficial A aquifers in both the superficial and bedrock deposits. No mobile contamination has been encountered and the site will be covered by hardsurfacing with a new drainage system installed. The risk to controlled waters is considered Low.*
Permanent Ground Gas	*The site has been classified as CS1 and no gas protection measures are required within the proposed development. The site lies in an areas not requiring radon protection.*
Final Appraisal	
Required Further Work	• *Detailed foundation design* • *Further ground investigation to confirm geotechnical parameters for pile design, if required* • *Confirmation of recommendations made within this appraisal with regulators*

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Plans		
Plan Reference	*Revision*	*Title*
GRO-23255-P01	-	*Project Location Plan*
GRO-23255-P02	-	*Preliminary Findings and Constraints Plan*
GRO-23255-P03	-	*Illustrative Preliminary Conceptual Site Model (CSM)*
GRO-23255-P04	-	*Exploratory Hole Location Plan*
GRO-23255-P05	-	*Ground Engineering Model*
GRO-23255-P06	-	*Revised Development Constraints Plan*
GRO-23255-P07	-	*Revised Illustrative Conceptual Site Model (CSM)*

1.0 INTRODUCTION

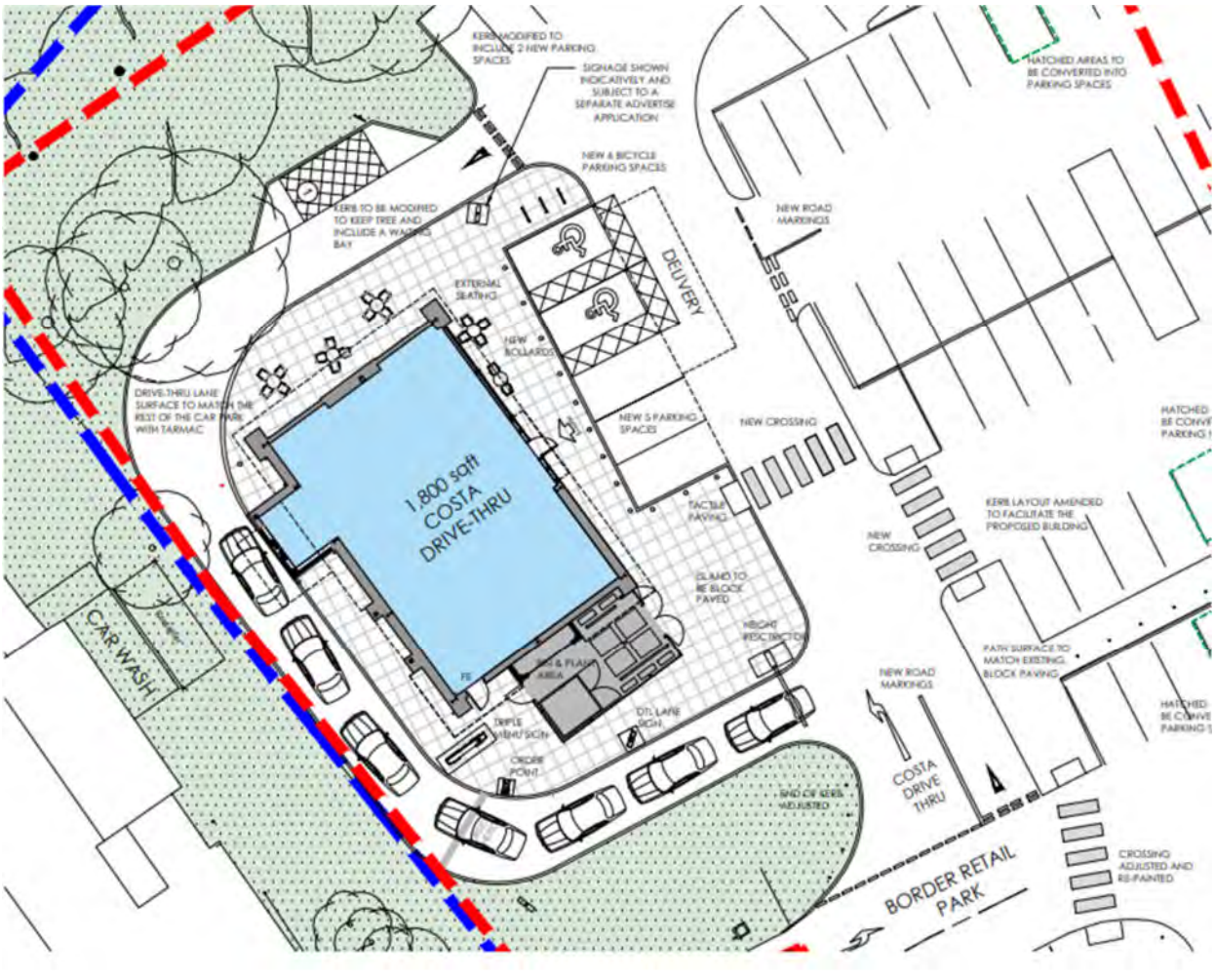
1.1 Project Objectives

Groundtech Consulting Limited have been instructed by Brian Clancy Higby Partnership to undertake a Geo-Environmental Appraisal for a site at Border Retail Park in Wrexham.

The appraisal includes a Preliminary Risk Assessment (PRA) in accordance with current LCRM risk assessment guidance and a main investigation in accordance with BS 5930:2020, BS 10175:2017, BS 8576:2013 and Eurocode 7 to revise the CSM and quantify the level of risk identified in the PRA. It has been prepared in accordance with current UK Legislation.

1.2 Proposed Development

The proposed development is commercial end use comprising the construction of a new Costa Coffee shop with drive-through facility and associated car parking.



Proposed Development

1.3 Limitations

This report contains information obtained from a number of sources, and the information is assumed to be correct.

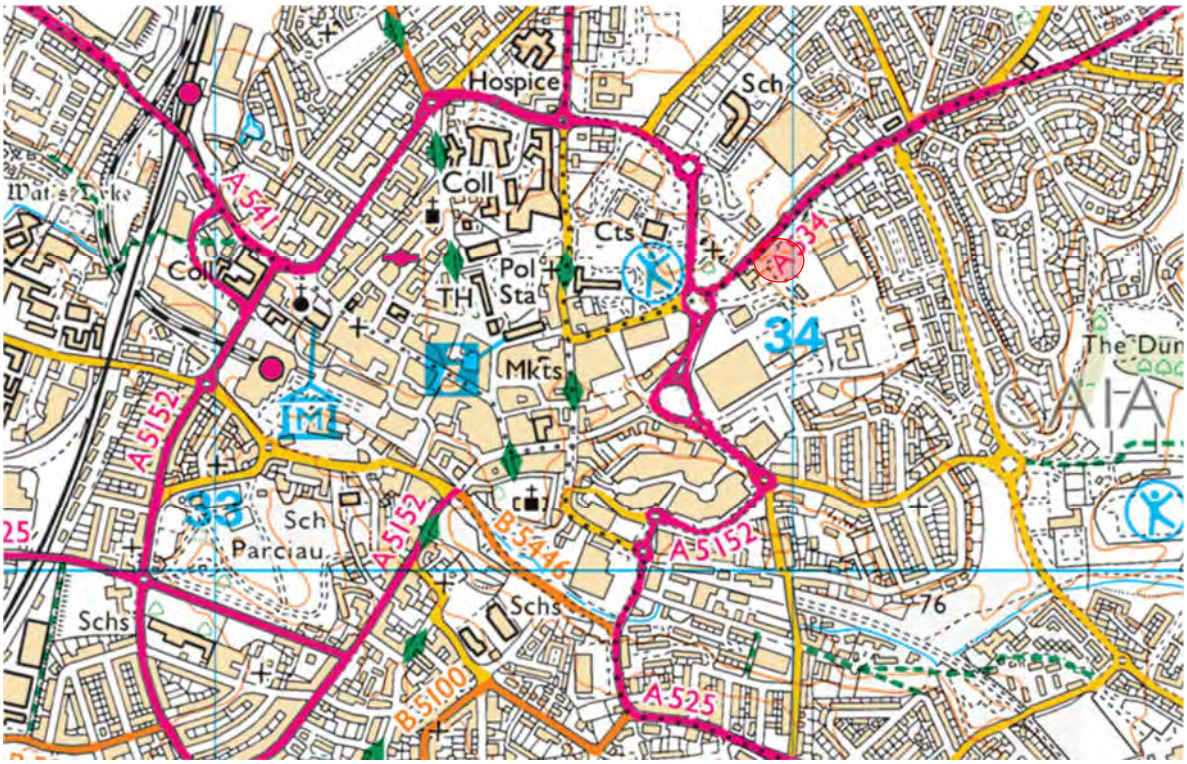
Other conditions may exist on the site that have not been taken into account in this assessment as they are outside the scope of works. Groundtech Consulting are not responsible for these circumstances that are not outlined in the report.

The assessment has been prepared for the exclusive use of the client. No third parties may rely on or reproduce the contents of the report without the written permission of Groundtech Consulting Limited. If any unauthorised third party comes into possession of the report they rely on it at their own risk and Groundtech Consulting Limited will not be obliged to provide a duty of care.

2.0 SITE SETTING

2.1 Location

The site is located in the eastern area of Wrexham Town Centre, as shown on the Project Location Plan *GRO-23255-P01*. The site is approximately centred on National Grid Reference 333972, 350527.



Project Location

Access to the site is gained off A5152 Holt Road to the west.

2.2 Site Description

The site is roughly rectangular in shape and covers an area of approximately 0.09 hectares. The topography of the site is level.

Site Features
The site is currently part of an active car park within Border Retail Park. The site is generally featureless and is surfaced by tarmac with spray painted car park spaces. There are minimal areas of vegetation in the north, west, and south.

Site Boundaries and Surrounding Land Uses
The site is bound by landscaped areas in the north, west, and south with bushes, shrubs, and semi mature to mature trees. The eastern boundary of the site consists of the wider car park outside the proposed development boundary.

The site is surrounded by the following features/land uses:

- *North - Vegetated areas, Holt Street, Starbucks, and Asda superstore.*
- *East - Car park and Wickes store.*
- *South - Burger King and car park.*
- *West - Tesco car wash, petrol station, and A5152 Holt Road.*

Site photographs are presented in *Appendix 2* and relevant features are recorded on the Preliminary Development and Constraints Plan *GRO-23255-P02*.

3.0 ENVIRONMENTAL SETTING

3.1 Site History

Available historical maps have been obtained, a list of dates and scale are listed in the table below:

Scale	Date
1:500	*1874*
1:1,250	*1958/59, 1966/68, 1975/78, 1984/89, 1990/94, 2003*
1:2,500	*1873, 1899, 1912, 1937, 1960*
1:10,000/10,560	*1872, 1898/1900, 1909/14, 1938, 1949, 1960/64, 1974/79, 1980/82, 1985, 1989/92, 2001, 2010, 2023*

The plans were examined, and potential issues have been identified and summarised in the table below:

Date	Site	Surrounding Area
1872/74	*Undeveloped field.*	***Foundry** c.82m south.* ***Tannery** c.124m south.* ***Tank** c.206m south west.* ***Depot** c.226m north east.*
1898/1900	***Sand pit** on site.*	***Flour Mills (Victoria Mills)** c.82m south west.* ***Sand Pit** c.156m east.* ***Carriage Works** c.250m south west.*
1909/14	*No significant change.*	***Sand Pit** c.50m south west.* ***Timber Yard** c.97m south west.* ***Depot** c.213m north east.* ***Slaughterhouses** c.237m east.*
1937/38	*No significant change.*	***Victoria Mills** disused.* ***Abattoir** c.72m south.* ***Carriage Works** turned into **warehouse**.*
1949	*No significant change.*	***Sand Pit** c.220m north east.*
1958/59	*Sand pit **infilled**.*	***Garage** c.84m south west.* ***Tank** c.110m south east.* ***Depot** c. 50m east and west*
1960/64	*No significant change.*	***Mills** turned into **warehouse**.* ***Works** c 230m south west*
1966/68	*No significant change.*	***Electricity Substations** c.160m north west and c.248m south.*
1990/92	*No significant change.*	***Abattoir** turned into **depot**.* *Depot c. 50m west now labelled **Gagare***
2001/03	*Site becomes car park.*	***Depots** and **warehouses** changed into **retail park**.* ***Petrol filling station** c. 10m west*
2023	*No significant change.*	*No significant change.*

The historical maps are presented in *Appendix 3*.

3.2 Geology

The following British Geological Survey (BGS) records and other available information were inspected to accurately determine the geology underlying the site:

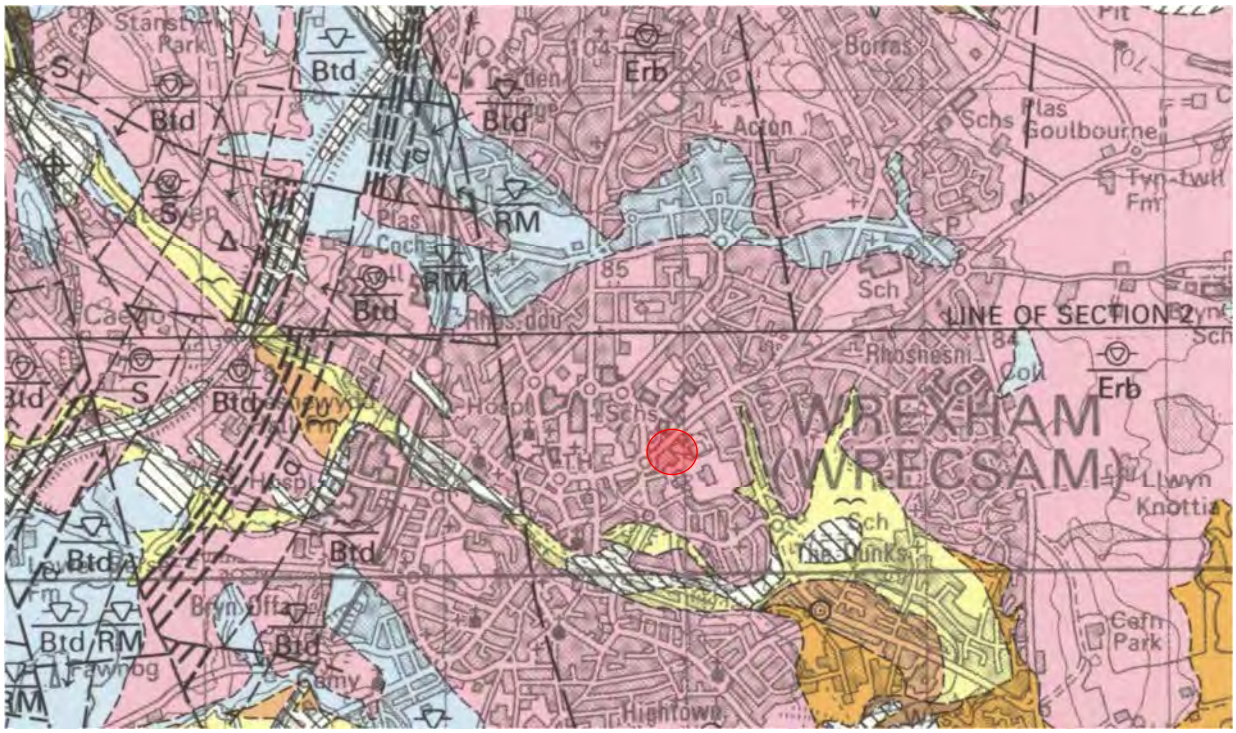
- *1:50,000 Scale Geological Sheet 121, Wrexham - Solid and Drift Edition*
- *Memoir*
- *BGS Records*

Made Ground

No Made Ground is indicated to underlie the site, however given the site's former use as a sand pit and the previous industrial surrounding land use it is anticipated.

Superficial Deposits

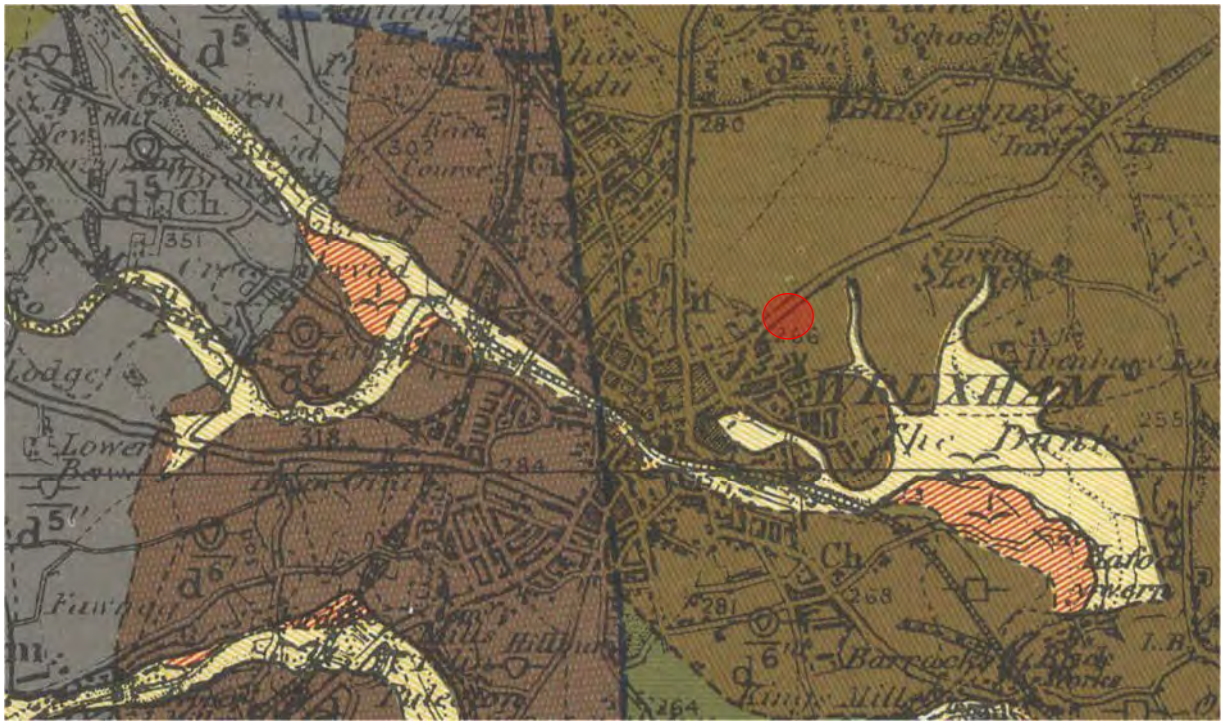
The site is indicated to be underlain by Devensian Glaciofluvial Sheet deposits, and this strata characteristically comprises sand and gravel.



Geological Map – Superficial Deposits

Solid Geology

The bedrock geology is indicated to be the Salop Formation, which consists of Mudstone, Sandstone and conglomerate.



Geological Map – Solid Geology

The nearest fault is circa 710m to the west of the site.

BGS Records

Four BGS borehole records approximately 200m north west of the site indicate Made Ground to a maximum depth of 0.9m bgl, underlain by dense Sand and Gravel to a maximum depth of 8.1m bgl.

The BGS records are presented in *Appendix 6.*

3.3 Hydrogeology

The superficial deposits in this area are classified by the Environment Agency as a Secondary A Aquifer (Permeable layers capable of supporting water supplies at a local rather than a strategic scale). This aquifer was formerly classified as a Minor Aquifer. The Aquifer is classified as having a high a high leaching potential (soils which have little ability to attenuate diffuse source pollutants and therefore have the potential to allow pollutants to move rapidly).

The bedrock is also classified as a Secondary A Aquifer.

The site is not indicated to lie within 1000m of a Source Protection Zone and is not indicated to lie within 500m of a groundwater abstraction.

3.4 Hydrology

The nearest named watercourse is the River Gwenfro located circa 665m south of the site.

Environment Agency information indicates that the site is outside a flood risk zone and is not at risk of flooding from rivers and coasts.

The risk from surface water and groundwater flooding on the site is negligible.

3.5 Environmental Consultations

A request has been submitted to the Contaminated Land Officer at Wrexham County Borough Council for information pertaining to the site, and this information is presented in *Appendix 3*. A summary of the relevant findings is presented below:

- *The Team is not aware of any known environmental problems or land reclamation schemes that would affect the site.*
- *The Team does not currently have a comprehensive database regarding historic land use or contamination, however the limited information available indicates that the above property has historical land use that has the potential to cause contamination, including road haulage, quarrying of sand, gravel and clay, and non-water fill. The council has not determined the site to be contaminated land.*
- *The site is not likely to be the subject of a Remediation Notice.*
- *The site is not considered to be a Special Site.*
- *The Team is not aware of any active or historical landfill sites within 250m, however it should be noted that the material used to backfill the sand pits on site may be classified as waste.*
- *The Team has received no complaints regarding contaminated land at the site.*

An environmental search has been conducted through Groundsure, which accesses British Geological Survey and Environment Agency databases. The complete EnviroInsight Report can be found in *Appendix 4*, a summary of the more relevant points is presented in the table below.

Record	<250m	250 – 500m	Description
Authorised Processes	*3*	*0*	*Unloading of petrol into storage c.41m south west.* *Storing and treating waste exemption c.93m south west.* *Unloading of petrol into storage c.138m north west.*
Pollution Incidents	*1*	*2*	*09/07/2001: Contaminated water c.194m south.* *24/11/2001: Oils and fuel c.288m north east.* *26/10/2002: Smoke c.454m west.*
Landfill and Waste Treatment	*1*	*2*	*Former recycling unit c.169m south.* *Former scrap metal works c.471m south west.* *Historical landfill c.482m south east.*
Discharge Consents	*0*	*5*	*Unspecified discharge (expired) c.313m south.* *Sewage discharges c.366m south.* *Sewage discharges c.457m south west.* *Unspecified discharge (expired) c.467m south west.* *Unspecified discharge (expired) c.482m south west.*
Petrol Filling Stations	*2*	*1*	*Tesco petrol station c.27m west.* *Asda petrol station c.139m north west.* *Asda petrol station c.449m south.*
Current Industrial Uses	*5*	*0*	*Tesco Extra c.9m west.* *Electricity substations c.79m north west and c.146m south.* *Masts c.156m west and c.238m north west.*

3.6 Radon

The latest radon map published by UKHSA indicate that the probability is between 5% and 10% and the site is in an area requiring radon precautions in foundations in accordance with BRE Report 211 'Radon – Guidance on protective measures for new dwellings' 2015 Edition.

The radon data in the Groundsure report is supplied by the BGS/Public Health England and is the definitive map of Radon Affected Areas in Great Britain and Northern Ireland and suggests the site is located within an area *where 1% to 3% of properties are affected by Radon and radon protection measures are not required*. The dataset was created using long-term radon measurements in over 479,000 homes across Great Britain and 23,000 homes across Northern Ireland, combined with geological data. The dataset is considered accurate to 50m to allow for the margin of error in geological lines, and the findings of this report supersede any answer given in the less accurate Indicative Atlas of Radon in Great Britain, which simplifies the data to give the highest risk within any given 1km grid square.

3.7 Coal Authority Consultation

The site lies in an area where the Law Society and Coal Authority recommends a mining search is undertaken due to past or current mining possible affecting the site.

A search was carried out with the Coal Authority, the report is presented in *Appendix 7*, the main findings are outlined below.

Past Mining
The property is not within a surface area that could be affected by any past recorded underground coal mining.

Present Mining
The site is not within the zone of influence of any present underground coal workings.

Future Mining
The property is not in an area where the Coal Authority are determining whether to grant a licence to remove coal by underground workings.

The property is not in an area likely to be affected at the surface by any planned underground workings.

However, reserves of coal exist in the local area that may be worked in the future.

No notice of the risk of land being affected by subsidence has been given under section 46 of the Coal Mining Subsidence Act 1991.

Mine Entries
There are no records of any mine entries on or within 20m of site boundary.

Coal Mining Geology
The Authority is not aware of any damage arising to geological faults or lines of weakness that have been affected by coal mining.

Opencast Coal Mining
The property is not in an area affected by past or present coal mining extracted by opencast methods. The property is also not in an area affected by a proposed opencast coal mine.

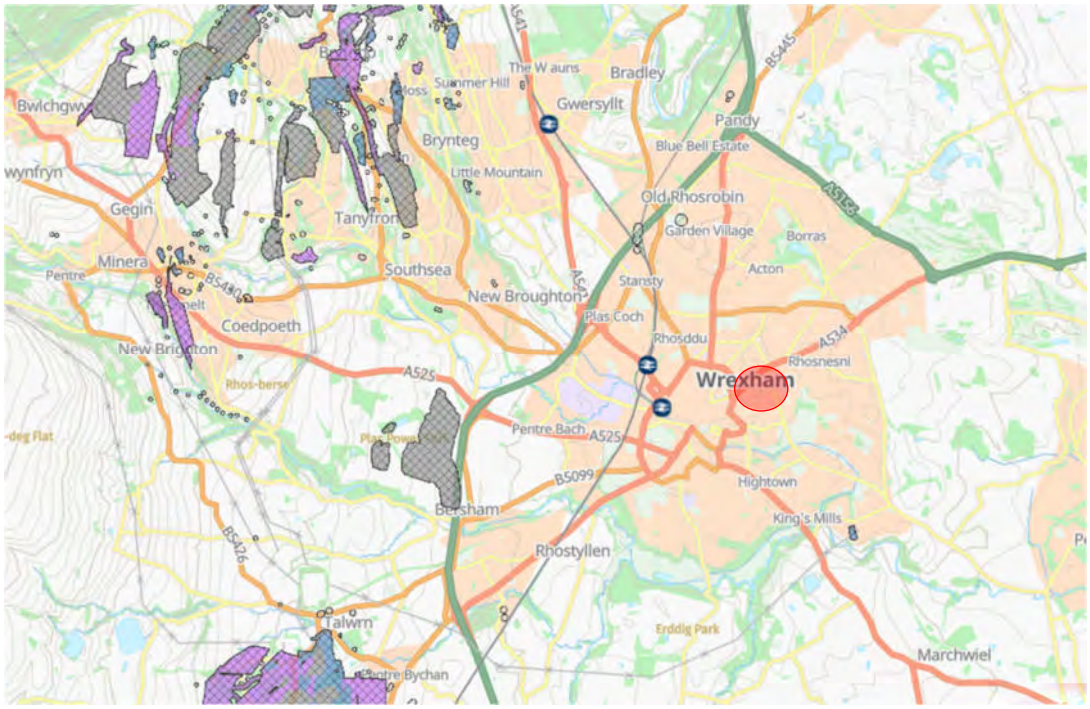
Subsidence
The Coal Authority has not received a damage notice or claim for the subject property or within 50m since 31 October 1994.

Mine Gas
There is no record of mine gas emission at the property.

Withdrawal of Support
The property is in an area which notice of entitlement to withdraw support was given in 1952.

Additional Mineral Workings/Extractions
A sand pit was formerly located on the site, and a number of other sand pits have been located within 250m of the site. These workings have since ceased.

Coal Authority Interactive Map
The online interactive Coal Authority map has been consulted and the following information has been gained from it.



Coal Authority Interactive Map.

- *The site is not in a Development High Risk area*
- *There are no coal outcrops beneath the site*
- *There are no past or probable shallow coal mine workings beneath the site*
- *There are no mine entries shown within 20m of the site*

4.0 LAND QUALITY CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

4.1 Introduction

The potential level of risk posed by contaminants in soil and/or groundwater will be influenced by the type and concentration of the contamination at source, the likelihood of exposure occurring, the potential pollution linkages and the likely chronic or acute effects on the receptors.

A contaminant is defined as a substance that has the potential to cause harm, a risk is considered to exist if such a substance is present at sufficient concentrations to cause harm and if a pathway is present a receptor could be exposed to the contaminant.

Section 4.0 compiles the information from the previous sections to assemble a Conceptual Site Model to inform the risk assessment process. The potential sources identified on the site and off the site that are within influencing distance are assessed to determine if pollution linkages exist and an unacceptable risk is posed to human health and controlled waters. The assessment has been carried out on a qualitative basis and aims to produce a complete and comprehensive Preliminary Conceptual Site Model, and the potential pollution linkages are displayed on *GRO-23255-P03* Illustrative Preliminary CSM.

Three potential types of impacts exist for a site and all three need to be considered in the qualitative preliminary risk assessment:

- *Impacts from sources on the subject site.*
- *Impacts to the surrounding area from the subject site.*
- *Impacts to the subject site from the surrounding area.*

4.2 Potential Contamination Sources

Onsite Sources and Associated Contaminants of Concern (CoC)
From the information obtained during the preliminary risk assessment a number of potential sources of contamination have been identified which may affect the redevelopment of the site for commercial end use.

A sand pit was previously located on site which may have been infilled and associated depot was located adjacent to the site boundary. Made Ground is therefore anticipated to be present beneath the site which could be a potential source of metals, speciated Polycyclic Aromatic Hydrocarbons (PAHs), asbestos, and permanent ground gases.

Offsite Sources and Associated Contaminants of Concern (CoC)
A number of potential sources of offsite contamination have been identified from information obtained during the preliminary risk assessment, which may affect the redevelopment of the site for commercial end use and include the following:

- *Garages 4m south, 39m south west and 84m south west*
- *Petrol stations 27m west, 139m north west, and 449m south*
- *Former sand pits 50m south west, 156m east, and 220m north east*
- *Former abattoir 72m south*
- *Former flour mill 82m south west*
- *Former foundry 82m south*
- *Former timber yard 97m south west*
- *Former tanks 110m south east and 206m south west*

- *Former tannery 124m south*
- *Electricity substations c.160m north west and c.248m south*
- *Former depots 213m and 226m north east*
- *Former slaughterhouses 237m east*
- *Former carriage works 250m south west*

Potential offsite sources of permanent ground gases include the potentially infilled sand pits.

Fuel derived hydrocarbons, lubricating oils, creosote, herbicides, PAHs, PCBs, asbestos and ash may be associated with the garages, petrol stations, foundry, depots, tanks and carriage works.

Contaminants of Concern associated with the flour mill and tannery may include heavy metals and PAHs.

The electricity substations may be a source of PolyChlorinated Biphenyls (PCBs) used as cooling agents in transformers.

The timber yard could be a potential source of metals, acids/alkalis, organic solvents, preservatives, and creosotes.

The abattoir and slaughterhouses could be potential sources of metals, pathogens, acids/alkalis, organic solvents, and preservatives.

4.3 Pollution Linkages

The definition of a pollution linkage is a medium which allows a contaminant to impact a receptor. Potential pollution linkages have been recognized for the commercial development from the identified contamination sources that exist.

At this stage the contaminants identified above are considered to potentially pose an unacceptable risk human health and controlled waters through the following pollution linkages:

- *Direct soil and dust ingestion*
- *Dermal contact with soil both indoors and outdoors*
- *Indoor air inhalation from soil and vapour*
- *Outdoor inhalation of soil and vapour*
- *Migration and accumulation of ground gas into internal spaces*
- *Impaction of groundwater from soil contamination (diffuse and point)*
- *Impaction of groundwater from groundwater plume*
- *Migration of soil and groundwater contamination impacting surface waters*

4.4 Receptors

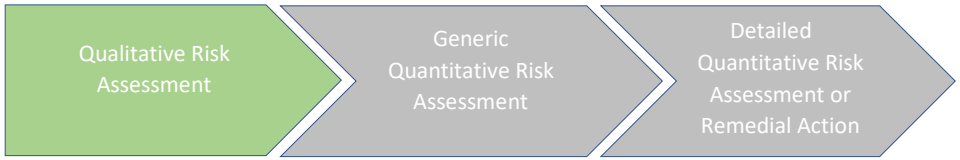
Receptors generally fall into the categories of human health or controlled waters within the river basin system. The recognized receptors are listed below:

- *Site end users (commercial)*
- *River Gwenfro c.665m south*
- *Secondary A Aquifer in the bedrock*
- *Clean potable water supply pipe*

4.5 Preliminary Conceptual Site Model (CSM)

The factual information obtained from the searches and summarised in Section 2.0 and 3.0 has been used to compile a Preliminary CSM. Using Source-Pathway-Receptor assessment criteria that is applicable in the UK, a risk assessment has been completed to determine if a plausible pollution linkage exists between the identified contaminants and receptors. The risk classification has been estimated in accordance with the CIRIA C552 assessment criteria outlined in *Appendix 8*.

Human Health Pollution Linkage Assessment



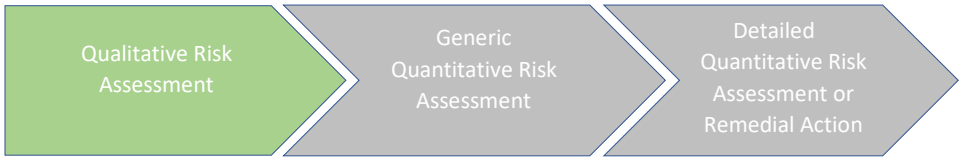
- The table below represents the first stage in the land quality risk assessment process - **the Qualitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					*Qualitative Risk Assessment*	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL1	Contaminated Soils	Ingestion of soil and dust. Dermal contact with soil.	Low Likelihood	Medium	Moderate to Low	*Pollution Linkage 1 refers to proposed site users coming into contact with contaminated soils on the site.* *Historically, the site has contained a sand pit before being infilled and turned into a car park. Made Ground is likely to be present beneath the site and potential Contaminants of Concern may include heavy metals, PAHs, and asbestos.* *The potential sources are considered to be at a distance far enough away that they will not have impacted the site.* *The proposed development is for commercial end use mainly comprising hardsurfacing. Where hardsurfacing exists, the pathway to potential contaminants will be broken. Some areas of soft landscaping are proposed creating a pathway to site end users. Therefore, a minor pollution linkage is considered to exist within areas of soft landscaping at this stage.*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL2	Contaminated Soils	Inhalation of vapour.	Unlikely	Medium to Severe	Low	*This pollution linkage refers to volatile vapours migrating into confined spaces within the proposed development. No sources of volatiles have been identified onsite, therefore a realistic pollution linkage is not considered to exist.* *A petrol filling station is located adjacent to site. The PFS is down gradient, however a watching brief should be undertaken during the ground investigation.*
PL3	Contaminated Soils	Inhalation of soil dust by adjacent site users.	Unlikely	Medium	Low	*Pollution Linkage 3 relates to contamination on the subject site affecting adjacent site users. It is anticipated that mobile contamination is not present beneath the site and the surrounding land has a similar or worse land use.* *A realistic pollution linkage is not considered to exist.*
PL4	Contaminated Soils	Attacking potable water supply pipe.	Unlikely	Medium	Low	*This pollution linkage refers to the possible contaminants permeating potable water pipes and consumption by the future site end users. Made Ground is likely to be present at installation depth, however significant organic contamination is not anticipated.* *At this stage, it is recommended that a local water company risk assessment is carried out to ensure the correct water supply pipe material is selected.*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL5	Ground Gas	Migration and accumulation of ground gas in internal spaces.	Low Likelihood to Likely	Medium to Severe	Moderate	*Made Ground is likely to be present beneath the site and could be a potential source of ground gases.* *Possible offsite sources include the petrol station, infilled sand pits, electricity substations, and tanks. Depending on the nature of the sand pit backfill, this could be a potential source of permanent ground gas. Granular superficial deposits may have allowed the lateral migration of ground gas onto the site.* *An intrusive investigation with the installation of standpipes and ground gas monitoring is recommended depending on the nature of the backfill.* *The site is not within an area requiring radon precautions within foundations.*

Controlled Waters Pollution Linkage Assessment



- The table below represents the first stage in the land quality risk assessment process – **Qualitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					*Qualitative Risk Assessment*	
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL6	Contaminated Soils	Impaction of groundwater from soil contamination (diffuse and point). Impaction of groundwater from groundwater plume.	Unlikely	Medium	Low to Moderate	*The site has historically been used as a sand pit before being developed as a car park.* *Geological maps indicate that the superficial deposits underlying the site are Devensian Glaciofluvial Sheet deposits. The superficial deposits are granular and there is the potential for downward migration of potential contaminants from the infilled sand pit to the underlying Secondary A Aquifer. The bedrock is the Salop Formation, which is classed as a Secondary A Aquifer.* *The site is not within 500m of a SPZ and the groundwater is not considered to be a sensitive resource. There are no potable water abstractions within 1000m.* *A new drainage system will be installed as part of the proposed commercial development which will considerably reduce infiltration and leaching of potential contaminants. The proposed development will be almost entirely covered in hardstanding.* *Therefore, a minor pollution linkage is considered to exist.*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL7	Contaminated Soils	Migration of soil and groundwater contamination impacting surface waters.	Unlikely	Medium	Low	*Pollution Linkage 7 refers to the impaction of the River Gwenfro located circa 665m south of the site from contaminated soils and groundwater.* *No significant sources of mobile contamination have been identified by the desk-based consultations, and there are significant attenuation distances to the nearest surface water feature.* *Therefore, a potential pollution linkage is not considered to exist.*

5.0 SCOPE OF INVESTIGATION AND RATIONALE

5.1 Project Objectives

The aim of the fieldwork was to:

Determine the stratification beneath the site
Maintain watching brief for visual and olfactory evidence of contamination
Obtain samples using methodology in current guidance for contamination testing
Identify realistic pollution linkages to groundwater
Obtain relevant geotechnical parameters for preliminary foundation design to address both ULS and SLS conditions
Install monitoring standpipes for gas and groundwater monitoring
Assess the identified pollution linkages in the CSM

5.2 Scope of Works

The following scope of works was completed on Tuesday 28th November:

- *8 No. Windowless sample boreholes were advanced to a maximum depth of 5.00m bgl using a Dando Terrier Windowless Sample Rig*

The exploratory hole locations are presented on Groundtech Plan *GRO-23255-P04* and the exploratory hole logs are in *Appendix 9*.

The exploratory holes were positioned to establish the stratification beneath the site and target any areas of concern as summarised in the table below:

Location	Target Rationale
WS01 – WS08	*General coverage*
WS01, WS03-WS06	*Former sand/gravel pit*
WS03-WS05, WS07	*Proposed building footprint*

The exploratory holes were logged by a suitably experienced geo-environmental engineer in general accordance with the following current guidance:

- *BS 5930 'Code of Practice for Site Investigations' 2020*
- *BS EN 14688-1:2002 'Geotechnical Investigation and Testing – Identification and classification of soil'*

5.3 Soil Sampling

During the intrusive investigation, representative samples were taken at regular intervals, changes of strata and where evidence of contamination existed. Laboratory analysis was scheduled on the samples obtained.

The samples obtained are summarised in the table below:

Soil Sample	Number
Environmental Sample	*25*
Disturbed Sample	*30*

The samples have been obtained in accordance with current environmental and geotechnical guidance. The sampling plan has been designed obtain samples from all required strata using the correct methodology.

Disturbed samples of soil for geo-environmental testing were placed in the correct sampling containers as required by the laboratory in accordance with their MCERTS and UKAS Accreditation. Transportation was arranged in a timely manner and the samples were at the correct temperature.

The sample locations and depths are recorded on the exploratory logs.

5.4 Geo-Environmental Testing

To inform the Generic Quantitative Risk Assessment, the following geo-environmental testing was scheduled to assess the risk from contamination on the site. The testing is based on the potential sources identified in the PRA and observations during the Ground Investigation.

Contaminant of Concern (CoC)	Matrix	Number
Arsenic, cadmium, chromium (total and hexavalent), copper, lead, mercury, nickel, selenium, zinc, speciated polycyclic hydrocarbons, organic matter, sulphate and pH.	*Soil*	*3*
Asbestos	*Soil*	*3*

The Geo-Environmental Laboratory Testing Results are presented in *Appendix 10*.

Representative disturbed samples were obtained for all soil types encountered. Selected samples were scheduled for testing at an approved laboratory in accordance with BS 1377 'Method of Test for Soils for Civil Engineering Purposes' 1990. The following tests were scheduled:

British Standard	Test Method	Number
Part 3	*pH Value*	*3*
Part 3	*Water Soluble Sulphate Content*	*3*

The Geotechnical Laboratory Testing Results are presented in *Appendix 10*.

5.5 Gas and Groundwater Monitoring/Sampling

Gas and groundwater monitoring installations were constructed in the boreholes. The standpipes consisted of high-density polyethylene (HDPE) pipe - a bentonite seal was placed around the plain pipe and a clean gravel pack was placed around the slotted pipe. A summary of the installation construction is presented in the table below:

Location	Depth	Response Zone (m bgl)	Targeted Strata	Reason
WS01	*4.50*	*1.00 – 3.50*	*Granular Natural Strata*	*Ground Gas*
WS04	*2.50*	*1.00 – 2.50*	*Granular Made Ground*	*Ground Gas*
WS06	*2.00*	*1.00 – 2.00*	*Granular Natural Strata*	*Ground Gas*

WS07	*3.00*	*1.00 – 3.00*	*Granular Natural Strata*	*Ground Gas*

Permanent gas and flow rate monitoring was carried out using GFM 436 infrared gas monitor with integral electronic flow analyser. The measurements taken are listed below:

- *Oxygen (O_2), carbon dioxide (CO_2) and methane (CH_4) as the percentage volume in air (%v/v).*
- *Hydrogen sulphide (H_2S) and carbon monoxide (CO) as the percentage volume in air (%v/v).*
- *Lower Explosive Limit (%LEL) of methane.*
- *Atmospheric and borehole pressure, including pressure trend.*
- *Flow measurements (l/hr).*
- *Weather and ground surface conditions.*

Both peak and steady state conditions were monitored to understand the behaviour of the permanent ground gas, the steady state conditions were recorded by allowing the gas monitor to run for a minimum of 3 minutes or steady state conditions were reached.

Permanent gas monitoring results are presented in *Appendix 11*.

6.0 GROUND MODEL

6.1 Made Ground

The site was mostly covered by tarmac. There were some small areas of soft landscaping to the north, south and west

Made Ground was encountered across the site to depths between Ground Level and 2.4m bgl. Four main Made Ground populations were encountered during the investigation and are described below:

1. *Red brown slightly clayey sandy angular to subangular fine to coarse gravel with minor constituents of concrete, brick, tarmac and sandstone was encountered within all exploratory holes from 0.15m bgl to a maximum depth of 0.5m bgl.*

2. *Yellow brown gravelly fine to coarse sand, gravel is angular to subangular fine to coarse with minor constituents of concrete, brick and sandstone was encountered within WS01, WS04, WS07, WS08 from 0.40m bgl to a maximum depth of 1.2m bgl.*

3. *Brown clayey sandy angular to subangular fine to coarse gravel with minor constituents of concrete, wood, sandstone and brick was encountered within WS05 from 0.5m bgl to a maximum depth of 2.0m bgl.*

4. *Brown clayey gravelly fine to coarse sand with minor constituents of brick, coal, sandstone and wood was encountered within WS02, WS04, WS07 and WS08 from 0.3m bgl to a maximum depth of 2.4m bgl.*



Exploratory Hole Locations

6.2 Natural Ground

The natural strata encountered generally confirmed the published geological records. Three main natural stratification encountered during the investigation and are described below:

1. *Brown gravelly fine to coarse sand with minor constituents of sandstone was encountered within WS01, WS02, WS04 from 0.50m bgl to a maximum depth of 4.0m bgl.*

2. *Brown fine to coarse sand was encountered within WS01, WS06, WS07, WS08 from 1.2m bgl to a maximum depth of 4.0m bgl.*

6.3 Bedrock

Bedrock was not encountered in this investigation.

6.4 Groundwater

Groundwater strikes were not observed in any of the exploratory boreholes.

6.5 Watching Brief

A watching brief was maintained during the Ground Investigation for visual and olfactory evidence of contamination.

No evidence of contamination was identified during the excavation of the boreholes.

6.6 Excavation Stability

Collapse was noted in the natural sand deposits during excavation of the boreholes.

6.7 Excavation Progress

Advancement of the boreholes became difficult below 3.0m bgl due to collapse of the natural sand.

Concrete obstructions were encountered within WS03 and WS05 at depths of between 1.8m and 2.0m bgl.

7.0 GROUND ENGINEERING

7.1 Assessment Background

The ground engineering investigation has been undertaken to formulate an accurate ground model in order to undertake preliminary foundation design. The ground model has been constructed with a moderate level of confidence, the ground model has evolved from the information obtained by the PRA.

The site currently forms part of a car park with small areas of soft landscaping. Granular Made Ground underlies the site to a maximum depth of 2.4m bgl. The natural strata comprised granular Glaciofluvial deposits encountered to a maximum observed depth of 5.0m bgl.

The proposed development is for a new Costa Coffee shop with drive through and parking.

The main limitation is the loose sand located between 2.0m and 4.0m bgl. This strata rules out the use of shallow foundations for this development.

Concrete obstructions were encountered within WS03 and WS05 at depths of between 1.8m and 2.0m bgl. Deeper Made Ground was observed within the eastern portion of the site associated with the former sand and gravel pit seen on the historical maps between 1909 and 1949. These obstructions will require grubbing up prior to foundation installation.

7.2 Geotechnical Parameters

The geotechnical test results have been evaluated to derive geotechnical parameters for the soils underlying the site. A depth to SPT N value graph is presented in *Appendix 1* as *GRO-23255-P05* to provide a generalised ground model for the site.

Characterization of the geotechnical parameters above has been undertaken to select a characteristic value, which is a cautious estimate of the value affecting the occurrence of the limit state.

The characteristic values of the granular strata have been selected based on correlation with SPT N values. The characteristic values for the Ultimate Limit State (ULS) selected are presented below:

Stratum	Parameter	Selected Characteristic Value
Loose Sand	*Angle of shearing resistance (ϕ')*	*30°*
Medium Dense Sand	*Angle of shearing resistance (ϕ')*	*31°*

7.3 Preliminary Foundation Design

Due to the poor SPTs between 1.2m and 4.0m bgl within the natural Sand and the deep Made Ground to 2.4m bgl, the most suitable foundations for the proposed development are considered to be Vibro Ground Improvement/Vibro Stone Columns (VSCs) or piles transferring load to the medium dense Sand from 4.0m bgl. A shallow foundation solution is not considered to be a viable option for the proposed development.

Vibro Stone Columns

The most suitable foundation solution for the proposed development are considered to be shallow reinforced strip foundations constructed in vibro treated ground.

A preliminary design resistance for ultimate limit state and serviceability limit state conditions will be provided by the specialist vibro contractor in their detailed design however, it is likely that the foundations could be designed to provide an allowable bearing capacity of around 150kN/m^2. The specialist vibro contractor should provide fitness for purpose cover for the treated zones and depth of treatment.

The depth of foundations is to be a minimum of 0.35m below the surface of the vibro treated ground as the integrity of the columns is not validated to this depth. The reinforced concrete foundation should be designed to span between the centres of adjacent stone columns.

Piled Foundations

Piled foundation designs will need to satisfy Ultimate Limit State (ULS) and Serviceability Limit State (SLS) conditions. This is due to the poor ground conditions and Made Ground within the upper circa 2.4m of the ground beneath the site due to the infilled sandpit. The length of the piles will vary depending on the final load requirements. Detailed loadings are not available at this stage.

Preliminary foundation design by calculation has been carried out using due skill and care using the global factor of safety method.

The site should be grubbed up to a minimum depth of 2.0m bgl to remove obstructions for the proposed piling works. This should be discussed and confirmed with a specialist piling Contractor.

Design by Calculation

A piled foundation solution is considered the most appropriate for the proposed development end bearing in medium dense sand.

The preliminary design by calculation has been based on the following ground model:

- *Made Ground* - *2.4m bgl*
- *Loose Sand* - *4.0m bgl*
- *Medium dense Sand* - *5.0m bgl*

Driven piles are likely to be suitable due to the loose sand, for a single 225mm diameter driven pile 5m in length end bearing in the medium dense Sand, an allowable load of 90kN has been calculated.

The piles should be driven to sett using a pile driving formulae, this will validate the detailed design which is to be undertaken by calculation.

It is recommended that a deeper investigation is undertaken to confirm the strata beneath the toe of the pile in accordance with EC7.

An appropriate working platform should be constructed in accordance with BR470 guidance.

Construction Recommendations

The recommendations in this appraisal are preliminary and the detailed design should be developed in advance and during the construction phase. If the ground conditions or groundwater regime encountered during the construction phase differ significantly to the conditions encountered during the Ground Investigation, work should cease and Groundtech Consulting contacted for further advice.

During the construction phase, supervision by a suitably qualified geotechnical engineer should be on a continuous basis to check the design assumptions are correct and construction conforms to design in accordance with EC7. Supervision should include inspections, Control Ground Investigations and monitoring by a suitably qualified geotechnical engineer.

7.4 Building Near Trees

The site is underlain by granular deposits and there is no possibility of heave occurring. Should cohesive strata be encountered during the construction phase, Groundtech Consulting should be contacted for advice.

7.5 Floor Slabs

Greater than 600mm of Made Ground is generally present beneath the site and therefore suspended floor slabs are recommended.

7.6 Construction

The boreholes indicate that instability of excavations is anticipated within the natural granular deposits. Instability of the Made Ground is a possibility and should be considered in the groundworks method statements.

Tracked high specification plant is recommended to maintain the build programme. Breaking equipment may also be required locally to penetrate obstructions identified by them to Ground Investigation. Concrete obstructions were encountered within WS03 and WS05 from 1.8m to 2.0m bgl.

Groundwater was not encountered during this investigation.

7.7 Concrete Classification

Made Ground
Water soluble sulphate testing was undertaken on three samples of the Made Ground. The range of soluble sulphate (SO_4) recorded is <1.50mgl/l to 218.6mg/l. Associated pH values ranged between 6.64 and 11.19 indicating alkaline conditions.

In a small dataset, the highest of the results of sulphate test results should be taken as the characteristic value and the lowest of the pH values. For the natural soils, a characteristic soluble sulphate concentration of 218.6mg/l has been selected together with a characteristic pH of 6.64.

Natural Strata
Water soluble sulphate testing was undertaken on three samples of the natural granular deposits. The range of soluble sulphate (SO_4) recorded is 8.8mgl/l to 33.6mg/l. Associated pH values ranged between 7.55 and 9.82 indicating slightly alkaline conditions.

In a small dataset, the highest of the results of sulphate test results should be taken as the characteristic value and the lowest of the pH values. For the natural soils, a characteristic soluble sulphate concentration of 33.6mg/l has been selected together with a characteristic pH of 7.55.

Granular deposits are present beneath the site therefore the groundwater is considered to be mobile.

The results of laboratory pH and sulphate content indicate that ACEC Class AC-1 and sulphate class DS-1 conditions prevail in accordance with BRE Special Digest 1 “Concrete in aggressive ground” 2005. The specific

concrete mixes (the Design Concrete Class) to be used on site will be determined by the site specific concrete requirements in terms of the durability and structural performance. These are assessed in terms of the Structural Performance Level (SPL) and any need for Additional Protective Measures (APM) detailed in Part D of BRE Special Digest 1 with further guidance in Pt E and F.

7.8 Highway Design

CBR values of 5% are likely to be achieved in undisturbed natural soils for pavement design purposes, unless proven otherwise by in-situ testing at sub-base level by a specialist geotechnical engineer. As a minimum the subgrade should be proof rolled prior to construction. Some reengineering of the subgrade is required prior to highway construction to achieve the required design CBR value.

Untreated made ground should be assumed to have a CBR value of <2.5%, unless proven otherwise. Highways Agency document HD25 'Interim Advice Note 73/06 Revision 1' (2009) states that where a subgrade has a CBR value lower than 2.5%, it is considered unsuitable support for a pavement foundation since it would tend to deform under construction traffic, and must be improved.

Where highways are proposed in areas underlain by Made Ground, it is recommended that made ground to a depth of 1.0m below subgrade level is excavated, sorted and classified in accordance with Series 600 (Earthworks) of the Highways Agency "Specification for Highways Works". Following the above, any suitable material which can be used as part of highway construction shall be compacted in accordance with the earthworks specification.

7.9 Sustainable Urban Drainage System (SuDS)

Soil percolation testing was outside of the scope of works of this Ground Investigation but could be a feasible option for the proposed development due to the presence of natural granular strata encountered beneath the site.

8.0 LAND QUALITY

8.1 Geo-Environmental Testing Results - Soils

Samples of Made Ground and natural strata have been tested for a range of relevant Contaminants of Concern. In accordance with LCRM, a Generic Quantitative Risk Assessment (GQRA) has been undertaken to determine the significance of the concentrations as derived through Geo-Environmental testing.

The GQRA process comprises the comparison of the actual concentrations measured on site with Generic Assessment Criteria (GACs) for the protection of human health.

The GACs used for the assessment of soil concentrations have been derived using the CLEA model. The GACs used are listed below:

- *Soil Guideline Values (SGVs) which demonstrate minimal risk.*
- *LQM/CIEH S4ULs which use the same toxicological data as the SGVs but different exposure criteria.*
- *C4SLs which demonstrate low risk.*

In deriving the GACs for use on Brownfield sites we have assumed a 1% Soil Organic Matter, unless the results indicate otherwise.

The proposed end-use for the site is a commercial development comprising the construction of a new Costa Coffee shop and drive through with associated car parking. We have therefore undertaken the GQRA on the basis that the proposed development site falls under the commercial land-use scenario as defined in SR3 (EA, 2009b).

The strata or sources of contamination targeted by the laboratory testing scheduled is summarised in the table below:

Strata	Number of Samples Tested	Locations
Made Ground: Clayey sandy gravel	*2*	*WS02, WS08*
Made Ground: Clayey gravelly sand	*1*	*WS04*

A summary of the Geo-Environmental Testing results is presented below and the GQRA screening values are presented in *Appendix 12*:

Metals				
Contaminant	Range (mg/kg)	Screening value (mg/kg)	Exceedances	Locations
Arsenic	*6.40 – 9.80*	*640*	-	-
Cadmium	*<0.1*	*230*	-	-
Chromium	*11.0 – 26.4*	*8600*	-	-
Hexavalent Chromium	*<0.3*	*49*	-	-
Copper	*15 – 43*	*68000*	-	-
Lead	*7 – 46*	*2300*	-	-
Mercury	*<0.1*	*26*	-	-
Nickel	*10.30 – 13.60*	*980*	-	-
Selenium	*<1*	*13000*	-	-
Zinc	*11 – 44*	*730000*	-	-

Polycyclic Aromatic Hydrocarbons (PAHs)				
Contaminant	Range (mg/kg)	Screening value (mg/kg)	Exceedances	Locations
Naphthalene	*<0.04*	*190*	-	-
Acenaphthylene	*<0.03*	*83000*	-	-
Acenaphthene	*<0.05*	*84000*	-	-
Fluorene	*<0.04*	*63000*	-	-
Phenanthrene	*<0.03 – 0.10*	*22000*	-	-
Anthracene	*<0.04*	*520000*	-	-
Fluoranthene	*<0.03 – 0.09*	*23000*	-	-
Pyrene	*<0.03 – 0.08*	*54000*	-	-
Benzo(a)anthracene	*<0.06*	*170*	-	-
Chrysene	*<0.02 – 0.06*	*350*	-	-
Benzo(b)fluoranthene	*<0.05 – 0.06*	*44*	-	-
Benzo(k)fluoranthene	*<0.02 – 0.03*	*1200*	-	-
Benzo(a)pyrene	*<0.04*	*35*	-	-
Indeno(123cd)pyrene	*<0.04*	*500*	-	-
Dibenzo(ah)anthracene	*<0.04*	*3.5*	-	-
Benzo(ghi)perylene	*<0.04*	*3900*	-	-
Others				
Organic Matter	*0.6 – 4.7%*			
Asbestos Screen				
Position	Depth (m bgl)	Result	Quantification	
WS03	*1.30*	*Fibre Bundles*	*<0.001mass%*	
WS04	*1.50*	*None Detected*	*n/a*	
WS08	*0.30*	*None Detected*	*n/a*	

8.2 Generic Quantitative Risk Assessment - Soils

The Made Ground underlying the site generally consists of occasionally clayey sandy gravel and gravelly sand. Made Ground was encountered to a maximum depth of 2.4m bgl. The proposed development is for a new Costa Store and drive thru. The entire site will be covered in hard standing.

Metals

No elevated concentrations of metals were recorded within any of the Made Ground samples that were screened based on the site having a commercial end use. There were no sources on site of heavy metals. The surrounding land use has not impacted the site.

Speciated Polycyclic Hydrocarbons (PAHs)

No elevated concentrations of speciated PAHs were recorded in any of the samples tested based on the commercial end use of the site. There were no sources on site of heavy metals. The surrounding land use has not impacted the site.

Asbestos

One sample returned a positive asbestos result. Chrysotile fibres were detected within WS03 at <0.001mass%. This is likely from the material used to backfill the sand pit. The asbestos was detected in a location underneath the proposed building footprint.

8.3 Permanent Ground Gases

During the monitoring period, methane (CH_4) has not been recorded within the standpipes.

Detectable levels of carbon dioxide (CO_2) were recorded within the standpipes, the concentrations ranged between 0.0% v/v and 2.4% v/v.

Oxygen (O_2) concentrations ranged between 17.3% v/v and 20.0% v/v.

No positive gas flow rates were recorded during the gas monitoring programme.

Groundwater was recorded within the WS06 at 0.52m bgl during one monitoring visit. The groundwater is likely mobile and present at a greater depth than the standpipes.

The atmospheric pressure ranged between 969mb and 1004mb during the monitoring period and was carried out during periods of steady and falling barometric pressure.

8.4 Characterisation of the Gas Screening Value (GSV)

In accordance with BS 8485:2019 and CIRIA Report C665, November 2007 - an adequate risk assessment can be undertaken based on the following limiting factors:

- *The proposed development has been considered as* ***Medium sensitivity*** *based on the site being developed with Commercial Buildings (Table 5.5 – Typical/Idealised frequency and period of monitoring, after Wilson et al, 2005).*
- *The risk associated with the generation potential of a source is considered as* ***very low****, (assessment based on the environmental setting) as well as observations noted during the fieldworks.*
- *Negligible flow rates have been recorded (Table 8.5 – Modified Wilson & Card classification). For this site, three of the monitoring visits were targeted to correlate with a falling atmospheric pressure trend. As a comparison, monitoring has also been undertaken during steady atmospheric pressure trends.*

Based upon the results recorded, in accordance with BS 8485:2019 and CIRIA Report C665 - the risk to the site from ground gases has been assessed by converting the results to gas screening values (GSVs), calculated by multiplying the typical maximum gas concentrations with the recorded maximum positive flow rates. In addition, individual "hazardous gas flow rates" (Qhg) have been derived for each monitoring event.

GSV (l/hr) = max borehole flow rate (l/hr) x max gas concentration (%)

For this assessment, the maximum recorded concentration of carbon dioxide of 2.4%v/v has been used. As no flow rates have been detected, the limit of detection of the gas analyser of 0.1l/hr has been used to calculate the GSV.

Carbon Dioxide GSV = 0.024 (2.4%) x 0.01 = 0.00024 l/hr

Methane GSV = 0.0 l/hr

8.5 Assessment

Ground gas monitoring was carried out as multiple potential ground gas sources were identified within influencing distance of the site. The material used to backfill the sandpit on site could be a source of ground gas.

There are several offsite sources of ground gas including petrol filling stations and garages located close to the site.

Methane has not been detected and a maximum concentration of carbon dioxide of 2.4%v/v has been recorded over the monitoring period.

Groundwater was encountered within WS06 at 0.52m bgl from one monitoring visit.

In order to assess the ground gas regime beneath the site and the need to incorporate ground gas precautions, guidance was taken from BS 8485:2019. Based on the site being developed with commercial end use, the Wilson and Card method has been used to carry out the assessment.

When considering the results, in accordance with BS 8485:2019 (Modified Wilson and Card Classification), it can be seen that the GSV values for methane and carbon dioxide correspond with CS1 criteria (GSV of less than 0.07l/hr) and gas protection measures are not required.

Characteristic Situation 1

An extract of the Modified Wilson and Card table is presented below:

Characteristic Situation (Wilson and Card)	Methane		Carbon Dioxide	
	Wilson and Card		Wilson and Card	
	Gas Screening Value (l/hr)	Typical Maximum Concentration (%v/v)	Gas Screening Value (l/hr)	Typical Maximum Concentration (%v/v)
1	<0.07	<1	<0.07	<5
2	<0.7	Borehole flow rate not greater than 70l/hr	<0.7	Borehole flow rate not greater than 70l/hr
3	<3.5		<3.5	
4	<15	Quantitative Risk Assessment Required	<15	Quantitative Risk Assessment Required
5	<70		<70	
6	>70		>70	

The proposed commercial development is classified as a Building Type C in accordance with BS 8485:2019 and the site is designated as CS1 therefore, 0 points of protection are required for the proposed development.

8.6 Radon Gas

The site lies in an area where radon protective measures are not required within new structures.

8.7 Conclusions

No gas protection measures are required within the proposed commercial development at the site

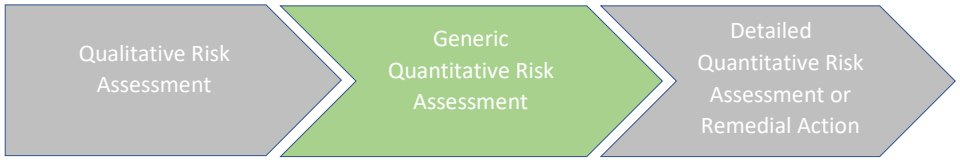
No radon precautions are necessary

It is recommended that confirmation of these findings is made with the Local Authority prior to any irrevocable action being taken.

8.8 Revised Pollution Linkage Assessment

The CSM has been revised based on the Ground Investigation and testing using Source-Pathway-Receptor assessment criteria that is applicable in the UK, a risk assessment has been completed to determine if a plausible pollution linkage exists between the identified contaminants and receptors.

Human Health Pollution Linkage Assessment



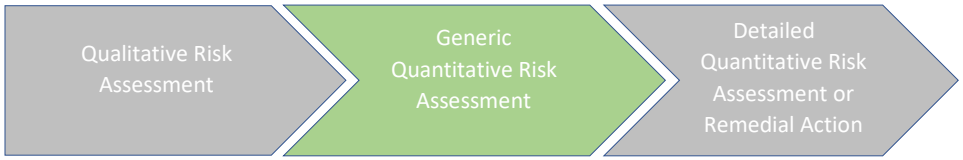
- The table below represents the second stage in the land quality risk assessment process - **the Generic Quantitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					*Generic Quantitative Risk Assessment*	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL1	Contaminated Soils	Ingestion of soil and dust. Dermal contact with soil.	Low Likelihood	Medium	Low	*Pollution Linkage 1 refers to proposed site users coming into contact with contaminated soils on the site.* *Historically, the site has contained a sand pit before being infilled and turned into a car park. Made Ground is present beneath the site to a maximum depth of 2.4m bgl. No elevated Contaminants of Concern were encountered within the Made Ground tested. One sample returned a positive result for Chrysotile fibres at a concentration of 0.001mass%. The JIWG tool has indicated that CAR does not apply and the receptor ranking is very low.* *The proposed development is for commercial end use including areas of hardsurfacing. Where hardsurfacing exists, the pathway to potential contaminants will be broken. There is no significant contamination at the site. Therefore, a plausible pollution linkage is not considered to exist.*

Conceptual Site Model						*Generic Quantitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL2	Contaminated Soils	Inhalation of vapour.	Unlikely	Medium to Severe	Low	*This pollution linkage refers to volatile vapours migrating into confined spaces within the proposed development. No sources of volatiles have been identified during the Ground Investigation, therefore a realistic pollution linkage is not considered to exist.*
PL3	Contaminated Soils	Inhalation of soil dust by adjacent site users.	Unlikely	Medium	Low	*Pollution Linkage 3 relates to contamination on the subject site affecting adjacent site users. No mobile contamination has been detected and the surrounding land uses are similar or worse than the site historical uses.* *A realistic pollution linkage is not considered to exist.*
PL4	Contaminated Soils	Attacking potable water supply pipe.	Unlikely	Medium	Low	*This pollution linkage refers to potential contaminants permeating potable water pipes and consumption by the future site end users. Made Ground is likely to be present at installation depth. It is recommended that a local water company risk assessment is carried out to ensure the correct water supply pipe material is selected.*
PL5	Ground Gas	Migration and accumulation of ground gas in internal spaces.	Low Likelihood	Medium to Severe	Low	*Made Ground is present beneath the site to a maximum depth of 2.4m bgl.* *Four monitoring visits have been conducted. No methane has been encountered in any of the visits. Maximum concentrations of carbon dioxide of 2.4%v/v has been*

Conceptual Site Model						*Generic Quantitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
						encountered along with no flow rate. The site has been classified as CS1 and no gas protection measures are required within the proposed development. *The site is not within an area requiring radon precautions within foundations.*

Controlled Waters Pollution Linkage Assessment



- The table below represents the second stage in the land quality risk assessment process – **Generic Quantitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL6	Contaminated Soils	Impaction of groundwater from soil contamination (diffuse and point). Impaction of groundwater from groundwater plume.	Unlikely	Medium	Low	*The site has historically been used as a sand pit was that has likely being infilled.* *Geological maps indicate that the superficial deposits underlying the site are Devensian Glaciofluvial Sheet deposits. The superficial deposits are granular and will there is possible downward migration of potential contaminants from the infilled sand pit to the underlying Secondary A Aquifer. The bedrock is the Salop Formation, which is classed as a Secondary A Aquifer.* *The site is not within 500m of a SPZ and the groundwater is not considered to be a sensitive resource. There are no potable water abstractions within 1000m.* *Geo-environmental testing of the soils below site has returned low concentrations and no evidence of contamination based on commercial end use.* *A new drainage system will be installed as part of the proposed commercial development which will considerably reduce infiltration and leaching of potential contaminants. The hardsurfacing will reduce infiltration.*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
						Therefore, a realistic pollution linkage is not considered to exist.
PL7	Contaminated Soils	Migration of soil and groundwater contamination impacting surface waters.	Unlikely	Medium	Low	*Pollution Linkage 7 refers to the impaction of the River Gwenfro located circa 66m5 south of the site from contaminated soils and groundwater.* *No significant sources of mobile contamination have been identified by the Ground Investigation.* *No pollution linkage is considered to exist.*

8.9 Outline Remedial Strategy

Soils
Geo-environmental testing indicates that the Made Ground has no significant contamination. Asbestos was detected in one of the Made Ground samples at a maximum concentration of <0.001mass%. The majority of the site will be covered by buildings and hardsurfacing breaking the pollution linkage to site end users. The asbestos encountered is underneath the proposed building location.

Where soft landscaping is to be included suitable landscaping topsoil should be imported. The cover system should be made up of a minimum of 300mm of topsoil to act as a growing medium at the surface.

Controlled Waters
Significant mobile contamination has not been detected within the Made Ground soils. Remediation with respect to controlled waters is not considered necessary at this stage.

Ground Gas
Gas monitoring has indicated that the site falls into CS1 conditions and gas protection measures are not required.

The site is not within an area requiring Radon precaution measures.

8.10 Asbestos in Soils

Asbestos in the form of Chrysotile fibre bundles has been recorded in one of the three samples screened from across the site within a sample gathered from WS03 at 1.3m bgl at a concentration of <0.001% mass.

If soils will are to be disturbed as part of the ground works, in accordance with the Joint Industry Working Group (JIWG) decision support tool for CAR2012 work categories, the combined hazard and exposure ranking is very Low where very low concentrations of asbestos have been detected in the Made Ground soils below the site.

The work is classified as non-licenced, and CAR does not apply.

The JIWG tables are presented in Appendix 13. This should be used as an aid to classify risk and recommend the level of protection required, the final decision on how asbestos within the soils should be managed should be made by the contractor.

The Made Ground soils encountered at the site should be left in-situ where possible to prevent disturbance and dispersion of any asbestos fibres.

The contractor should be implement measures to their satisfaction. Should intrusive work take place at the site, it should be assumed that asbestos fibres are present within all of the granular Made Ground soils encountered which have been encountered at the site as a precautionary approach. Due to the localised nature of the Made Ground soils at the site a limited number of samples could be screened and the extent of the asbestos contamination could not be determined.

All such works will need to be agreed with the regulatory bodies (HSE, LA).

8.11 Health and Safety - Construction and Ground Workers

During the reclamation and construction phases of the site development it will be necessary to protect the health and safety of site personnel. The risk to construction and ground workers is assessed in the table below:

PL Ref	Potential Source	Pollution Linkage	Likelihood	Severity	Level of Risk
PL8	*Made Ground*	*Ingestion, direct contact, inhalation of dusts.*	*Likely*	*Medium*	***Low***
PL8	*Asbestos*	*Ingestion, direct contact, inhalation of dusts.*	*Likely*	*Medium*	***Low***

The risk should be communicated to ground workers through a site induction and information made available on noticeboards.

General guidance on these matters is given in the Health and Safety Executive (HSE) document "Protection of Workers and the General Public during the Redevelopment of Contaminated Land". In summary, the following measures are suggested to provide a minimum level of protection:

- *All ground workers should be issued with the relevant protective clothing, footwear and gloves. These protective items should not be removed from the site and personnel should be instructed as to why and how they are to be used.*
- *Hand-washing and boot-washing facilities should be provided.*
- *Care should be taken to minimise the potential for off-site migration of contamination by the provision of dust suppression control and wheel cleaning equipment during the construction works.*
- *Good practices relating to personal hygiene should be adopted on the site.*
- *The contractor shall satisfy the Health and Safety Executive with regard to any other matters concerning the health, safety and welfare of persons on the site.*

8.12 Waste Classification by Assessment

We have reviewed the testing results and inputted them into the HazWasteOnline model which allows users to code and classify waste as defined in the EWC (European Waste Catalogue 2002) based on EC Regulation 1272/2008 on the Classification, labelling and packaging of substances and mixtures (CLP) and latest Environment Agency guidance (WM3 "Guidance on the classification and assessment of waste (1st edition 2015)-Technical Guidance").

This is a useful tool as waste producers have the legal responsibility to classify any waste they produce.

Three samples were tested to assess whether they contained any contaminants in the hazardous range when screened against assessment criteria within WM3. The results are in the Waste Classification Report presented in *Appendix 14*.

Reference	Depth (m bgl)	Strata	Contaminant	Hazardous
WS03	*1.3*	*MG: Clayey sandy gravel*	-	*Non-hazardous*
WS04	*1.5*	*MG: Gravelly clayey Sand*	-	*Non-hazardous*
WS08	*0.3*	*MG: Clayey sandy gravel*	-	*Non-hazardous*

Based on the assessment tool the Made Ground has been classified as *Non-Hazardous*. Total testing was not undertaken on the natural soils and are assumed to also be *Non-Hazardous*.

Asbestos was detected within one sample of the screened Made Ground at concentrations of <0.001mass%. This does not affect the classification of the soils.

8.12 Waste Acceptance Criteria (WAC) Results

The Landfill Directive (Directive 1999/31/EC on the landfilling of waste) led to the establishment of a methodology for classifying wastes. Wastes can only be accepted at a landfill if they meet the relevant Waste Acceptance Criteria (WAC) for that type of landfill. There are three different WAC, these are for:

- *Inert waste*
- *Non-Hazardous waste*
- *Hazardous waste*

Wastes should first be classified based on their total concentrations as detailed in the previous section. WAC testing is then required if the end disposal route is a landfill.

Waste Acceptance Criteria (WAC) testing was outside the scope of this investigation and the guidance given below is general.

The possibility of automatic inert classification of the natural soils should be explored in accordance with Section 4.3 of the EA guidance document. The Council Decision includes a list of wastes in Section 2.1.1 of the document that are assumed to be inert and therefore acceptable at a landfill for inert waste without testing, this is the case if:

- *They are single stream waste of a single waste type (although different waste types from the list may be accepted together if they are from a single source)*
  and
- *There is no suspicion of material or substances such as metals, asbestos, plastics, chemicals, etc to an extent which increases the risk associated with the waste sufficiently to justify contamination and they do not contain other their disposal in other classes of landfill.*

If any organic contaminated material is encountered during the construction phase, it is possible that this may be classified as hazardous and testing should be undertaken at that time.

Materials should segregated and where necessary sufficient time is allowed to further classify the material properly, including discussion with landfill sites and waste transfer stations to find the best disposal route. It is recommended that where possible that the soils could be recycled at a suitable local waste treatment plant or transfer station rather than a landfill disposal route.

The reuse of soils on the site this should be done in accordance with the CL:AIRE "Development Industry Code of Practice for the Definition of Waste" (CL:AIRE CoP). Any re-use scheme should be designed to minimise disposal costs.

After a cut and fill balance plan/volume calculation has been carried out, a U1 and T5 exemption could be registered. This will allow the use of the following soils without a waste permit or under Dow CoP MMP:

- *1,000 tonnes (c. 600m^3) of non-hazardous soil*
- *5,000 tonnes (c. 3,000m^3) of natural sand and gravels.*
- *50,000 tonnes (c. 25,000m^3) of bituminous material to be used in roadways.*
- *5,000 tonnes (c. 3,000m^3) of crushed concrete/stone.*

9.0 FINAL APPRAISAL

9.1 Land Quality

The site has previously been used as a sand pit and is currently utilised as a car park. Made Ground has been encountered to maximum depths of 2.4m bgl consisting of granular strata. No olfactory or visual evidence of contamination was noted during the Ground Investigation.

Testing was undertaken on three samples of the Made Ground. No elevated concentrations of contaminants were detected within the screened samples based on commercial end use. One sample detected chrysotile fibres at a concentration of <0.001mass%.

Landscaped areas should have a minimum of 300mm clean topsoil placed to act as a growing medium. In areas of proposed hardsurfacing, it will effectively act as a cover system.

Significant mobile contamination has not been identified and the risk to controlled waters is *Low*.

The risk to potable water supply pipes is considered *Low* at this stage. A water supply pipe risk assessment should be undertaken.

Gas monitoring undertaken at the site has placed the area in CS1 conditions and gas protection measures are not required.

The Made Ground encountered below the site has been classified as *Non-Hazardous*.

9.2 Ground Engineering

The most suitable foundation solution is considered to be Vibro Treatment/Vibro Stone Columns. Piles founding on the medium dense sand at least 4.0m begl is also considered feasible.

Made Ground in excess of 600mm has been encountered across the site therefore suspended floor slabs will be required for the proposed construction.

It is likely that Made Ground will be present at highway/pavement formation level. Untreated Made Ground should be assumed to have a CBR value of less than 2.5%, unless proven otherwise.

Soakaways are likely to be feasible within the granular natural ground deposits. Testing should be undertaken in accordance with BRE365 should SuDS drainage be considered for the development.

9.3 Required Further Work

The following further work is considered necessary to progress the site to construction phase:

Detailed Foundation design
Confirmation of recommendations made in this appraisal with regulators
Further Ground Investigation to confirm geotechnical parameters for pile design

10.0 RELEVANT INDUSTRY REFERENCES

British Standards Institution. *Investigation of Potentially Contaminated sites - code of practice*. BS 10175:2017.

British Standards Institution '*Code of Practice for Site Investigations*' BS 5930:2020

British Standards Institution "*Geotechnical investigation and testing – Identification and classification of soil*" BS EN ISO 14688:2002.

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UK Drinking Water Standards: Water Supply (Water Quality) Regulations 1989 (SI 1989/1147) and Water Supply (Water Quality) Regulations

UKWIR Report 10/WM/03/21 2010 "Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites"

Health & Safety Executive, 1991. 'Protection of Workers & the General Public during the Development of Contaminated Land'.

Environment Agency & NHBC, 2000. R&D Publication 66. Guidance for the Safe Development of Housing on Land Affected by Contamination.

Environment Agency "Guidance on the classification and assessment of waste (1st edition 2015) Technical Guidance WM3"

NHBC Standards 2023

CL:AIRE "*The Definition of Waste: Development Industry Code of Practice*" Version 2 March 2011.

CIRIA "*Asbestos in soil and made ground: a guide to understanding and managing risks*" C733 2014

Control of Asbestos Regulations (CAR) 2012

Harris, M R, Herbert, S. M, Smith, M A 'Remedial Treatment for Contaminated Land' (twelve volumes), special publications 101-112, CIRIA 1996.

Department of the Environment. 1995. Industry Profiles - 48 separate publications available from The Stationery Office, London

BRE Report 465 "Cover Systems for Land Regeneration" 2004.

Privett, K D, Matthews, S C, & Hodges, R, A, 'Barriers, liners and cover systems for containment and control of land contamination' 1996. CIRIA Special Publication 124.

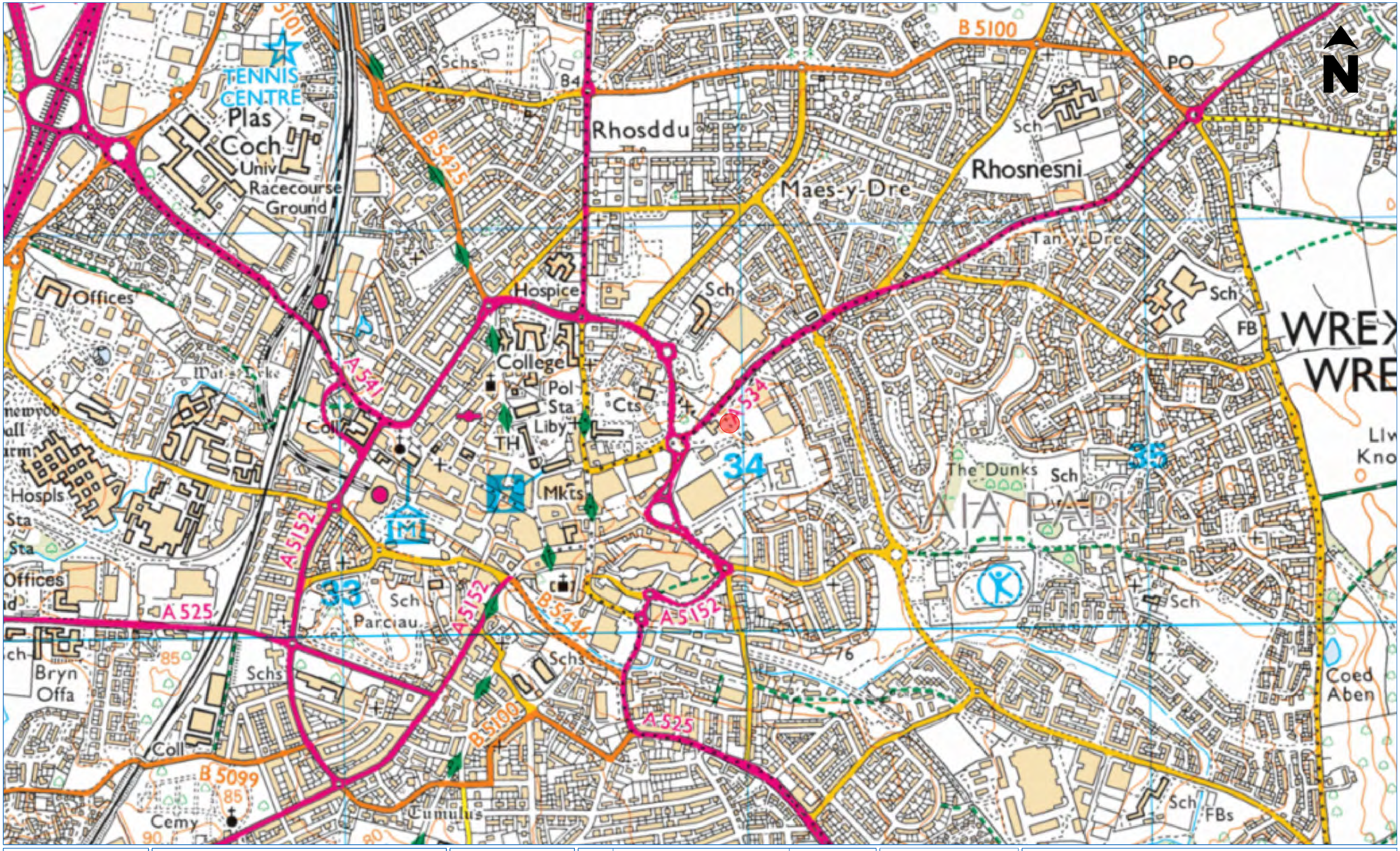
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APPENDIX 1 - Plans



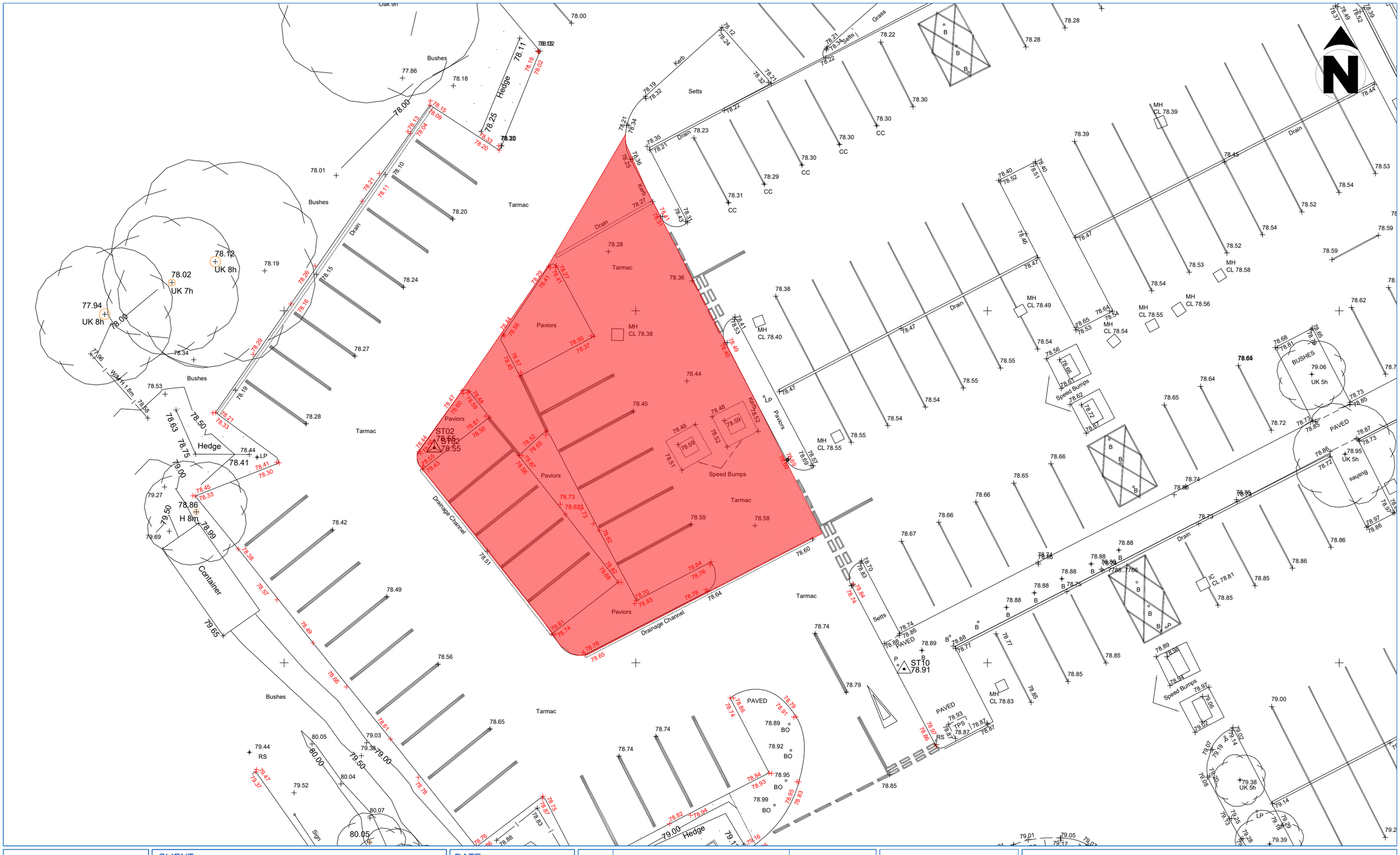
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	PROJECT TITLE: COSTA DRIVE THRU, WREXHAM	SCALE: NTS
	PLAN TITLE: SITE LOCATION PLAN	PLAN NUMBER: GRO-23255-P01

Rev.	Details	Date

Status	
Preliminary	
Draft	
Issued	●
For Comment	
Approved	

Notes

● Site Location



GROUNDTECH CONSULTING	CLIENT: BRIAN CLANCY HIGBY PARTNERSHIP	DATE: JANUARY 2024	
	PROJECT TITLE: COSTA DRIVE THRU, WREXHAM	SCALE: NTS	
	PLAN TITLE: PRELIMINARY DEVELOPMENT CONSTRAINTS PLAN	PLAN NUMBER: GRO-23255-P02	

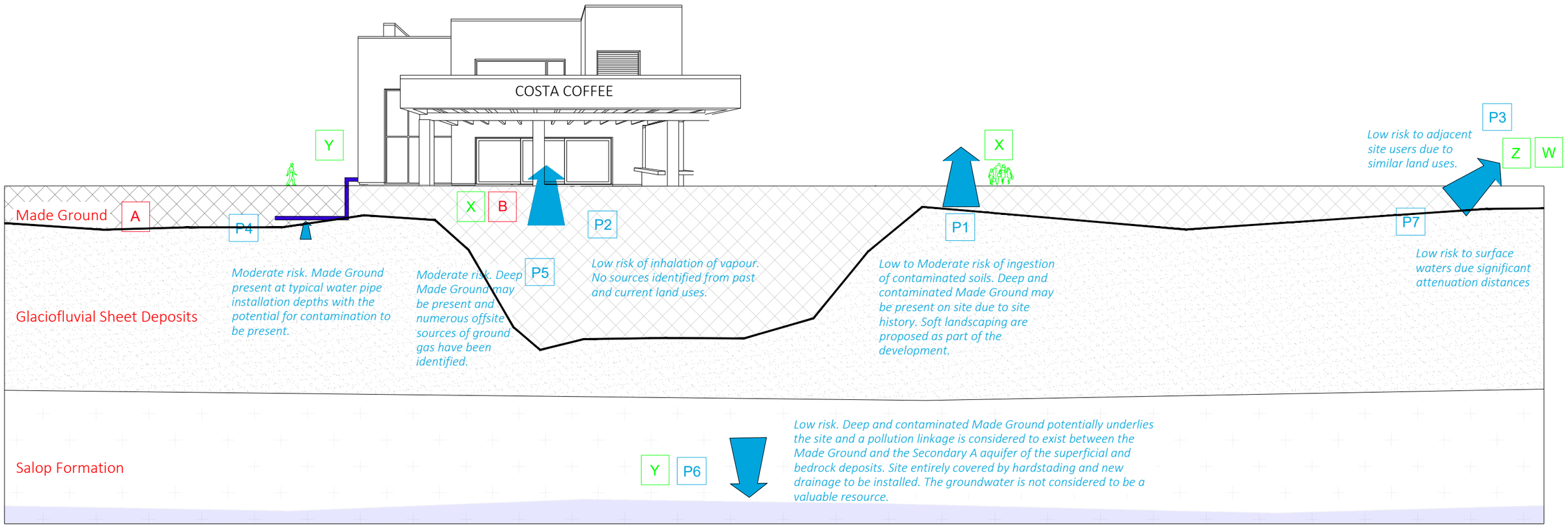
Rev.	Details	Date

Status	
Preliminary	
Draft	
Issued	●
For Comment	
Approved	

Notes

● Sand Pit Location

SOURCES	POLLUTION LINKAGES	RECEPTORS
A. Contaminated soils / Made Ground. B. Ground gas.	P1. Ingestion of soil and dust. P2. Inhalation of vapour. P3. Inhalation of soil dust by adjacent site users. P4. Attacking of potable water supply pipe. P5. Migration and accumulation of ground gas in internal places. P6. Impaction of groundwater from soil contamination. P7. Migration of soil and groundwater contamination impacting surface waters.	W. River Gwnfro located c. 665m south. X. Site end users. Y. Groundwater within the underlying Secondary A Aquifers. Z. Adjacent site users.



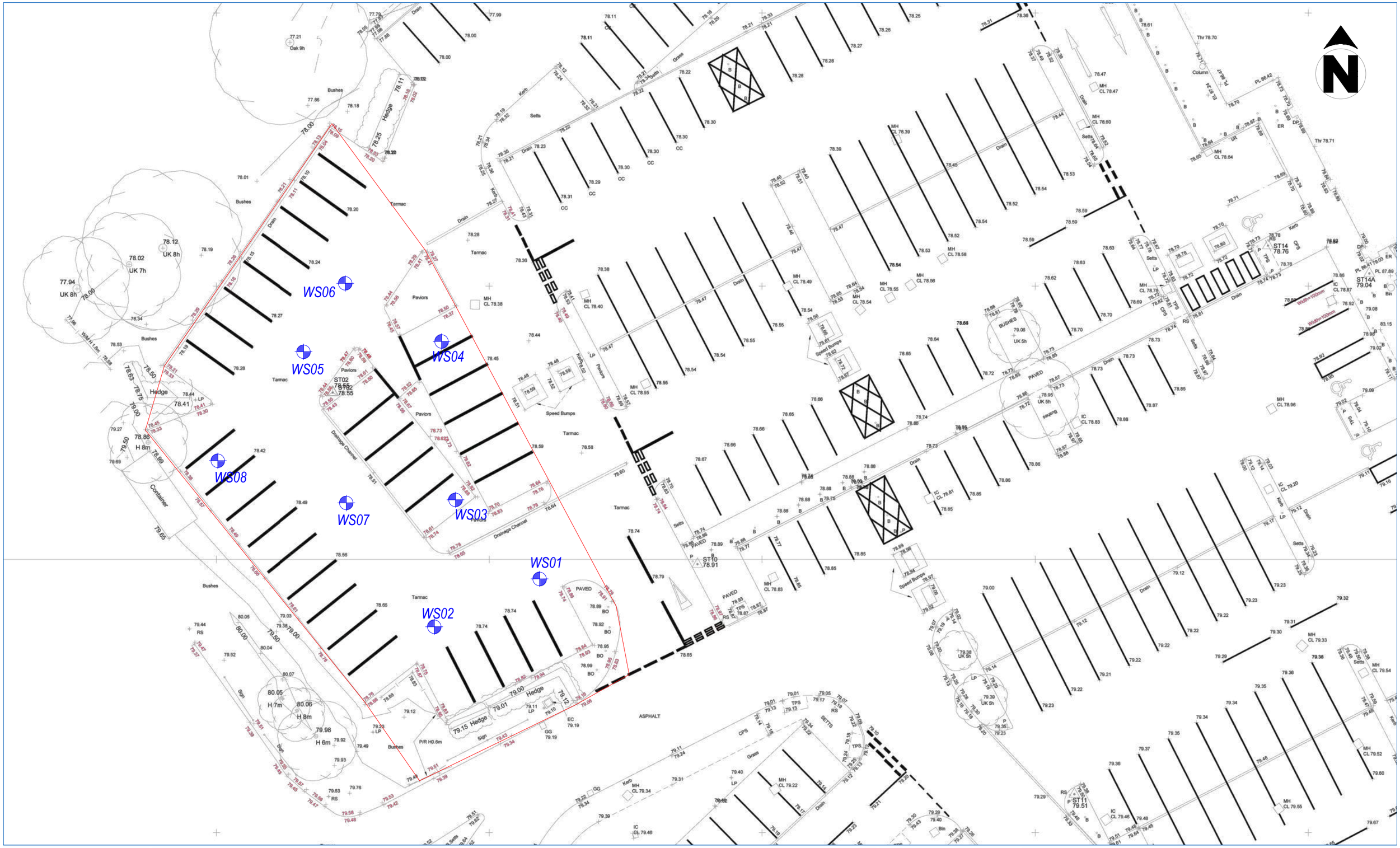
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CLIENT	BRIAN CLANCY HIGBY PARTNERSHIPS
PROJECT TITLE	COSTA DRIVE THRU, WREXHAM
PLAN TITLE	PRELIMINARY ILLUSTRATIVE CSM
DATE	JANUARY 2024
SCALE	NTS
PLAN NUMBER	GRO-23255-P03

Rev.	Details	Date

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Draft	
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For Comment	
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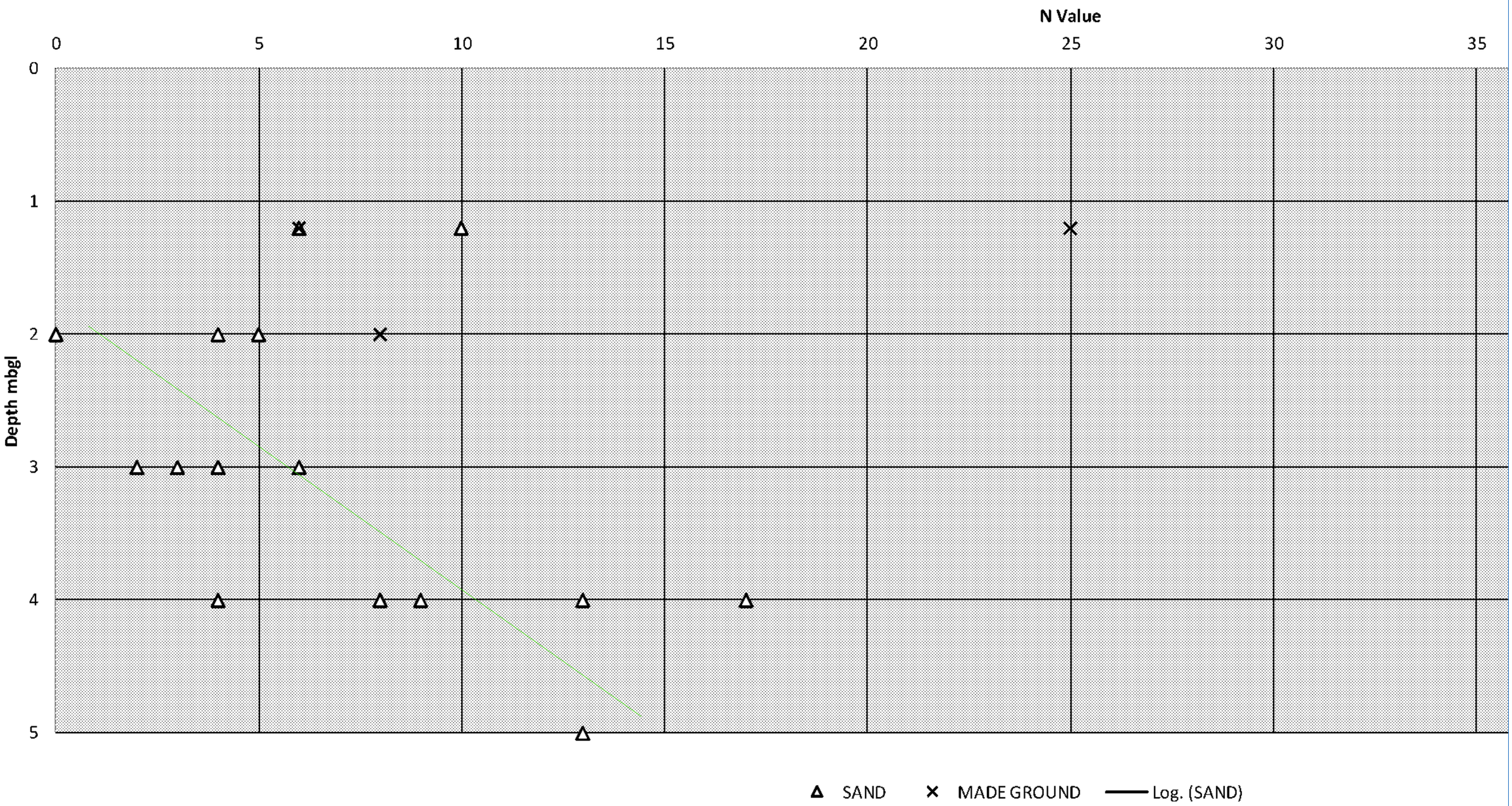
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GROUNDTECH CONSULTING	CLIENT BRIAN CLANCY HIGBY PARTNERSHIP	DATE JANUARY 2024			Status
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	PLAN TITLE EXPLORATORY HOLE LOCATION PLAN	PLAN NUMBER GRO-23255-P04	Rev.	Details / Date	

Notes
- Window sample location
- Site Boundary

DEPTH vs SPT 'N' VALUE



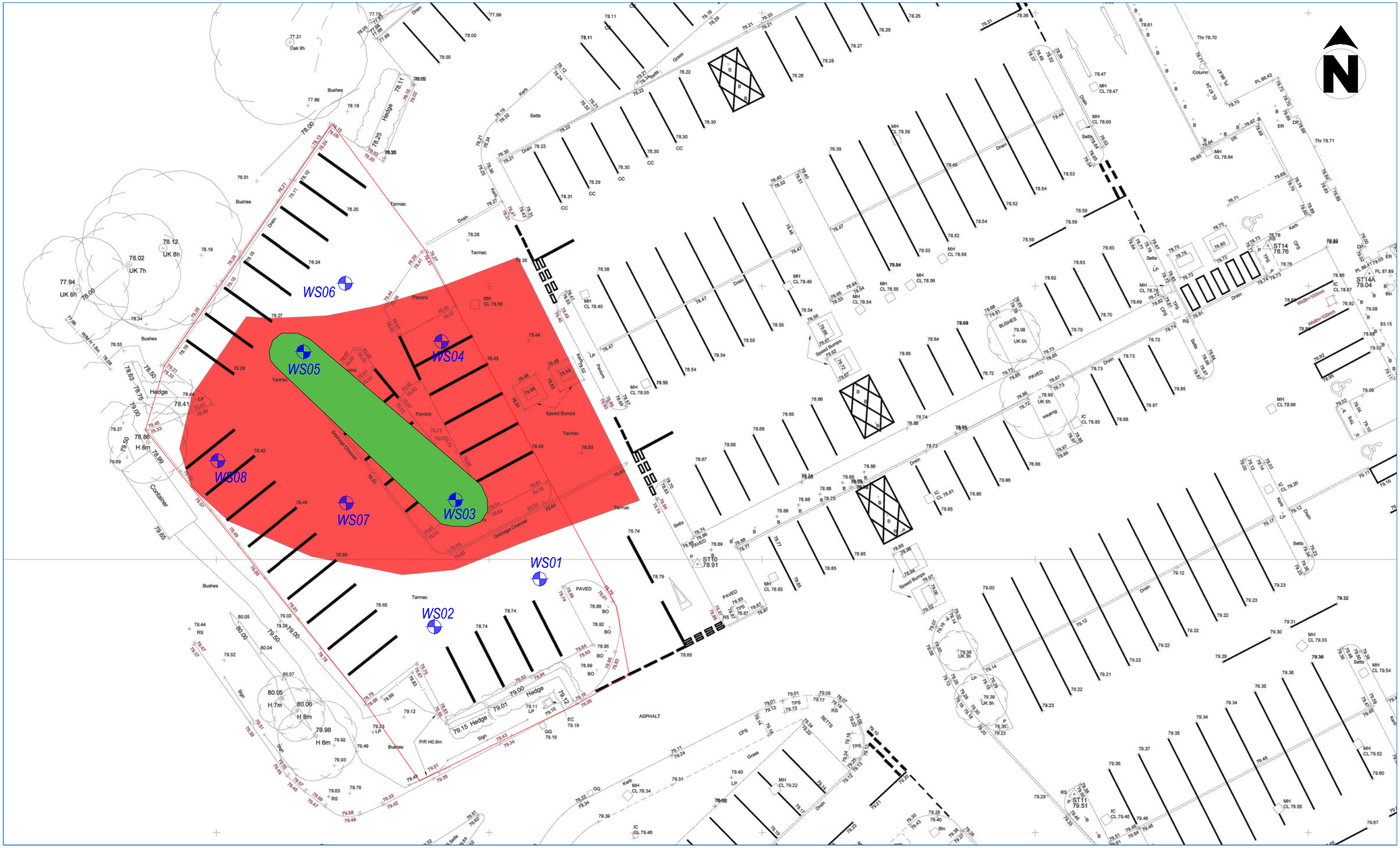
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CLIENT	BRIAN CLANCY HIGBY PARTNERSHIP
PROJECT TITLE	COSTA DRIVE THRU, WREXHAM
PLAN TITLE	GENERALISED GROUND MODEL
DATE	JANUARY 2024
SCALE	NTS
PLAN NUMBER	GRO-23255-P05

Rev.	Details	Date

Status	
Preliminary	
Draft	
Issued	●
For Comment	
Approved	

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GROUNDTECH CONSULTING	CLIENT: BRIAN CLANCY HIGBY PARTNERSHIP	DATE: JANUARY 2024	
	PROJECT TITLE: COSTA DRIVE THRU, WREXHAM	SCALE: NTS	
	PLAN TITLE: REVISED DEVELOPMENT CONSTRAINTS PLAN	PLAN NUMBER: GRO-23255-P06	

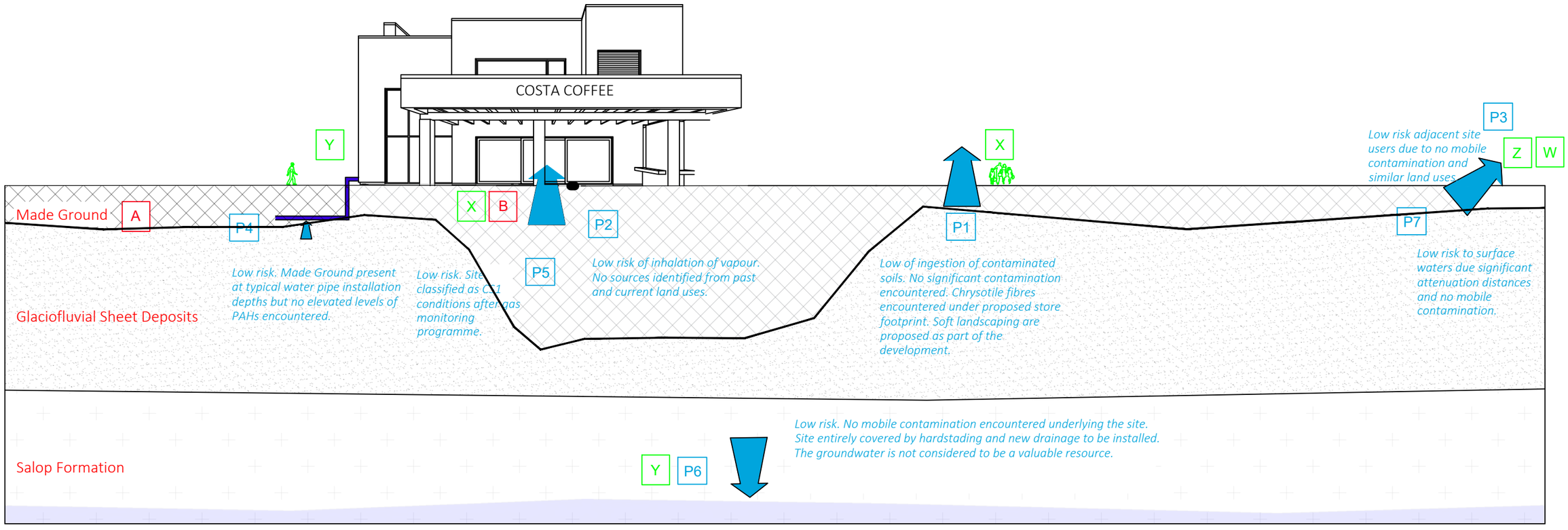
Rev.	Details	Date

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Preliminary	
Draft	
Issued	●
For Comment	
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- Window sample location
- Sand Pit Location
- Concrete Obstruction

SOURCES	POLLUTION LINKAGES	RECEPTORS
A. Contaminated soils / Made Ground. B. Ground gas.	P1. Ingestion of soil and dust. P2. Inhalation of vapour. P3. Inhalation of soil dust by adjacent site users. P4. Attacking of potable water supply pipe. P5. Migration and accumulation of ground gas in internal places. P6. Impaction of groundwater from soil contamination. P7. Migration of soil and groundwater contamination impacting surface waters.	W. River Gwnfro located c. 665m south. X. Site end users. Y. Groundwater within the underlying Principal bedrock Aquifers. Z. Adjacent site users.



GROUNDTECH CONSULTING

CLIENT	BRIAN CLANCY HIGBY PARTNERSHIPS
PROJECT TITLE	COSTA DRIVE THRU, WREXHAM
PLAN TITLE	PRELIMINARY ILLUSTRATIVE CSM
DATE	JANUARY 2024
SCALE	NTS
PLAN NUMBER	GRO-23255-P07

Rev.	Details	Date

Status	
Preliminary	
Draft	
Issued	●
For Comment	
Approved	

Notes

APPENDIX 2 - Site Photographs



Photograph 1 – western corner of site



Photograph 2 – General site photo looking west



Photograph 3 – natural arisings from WS07.



Photograph 4 - Soft landscaping west of site entrance

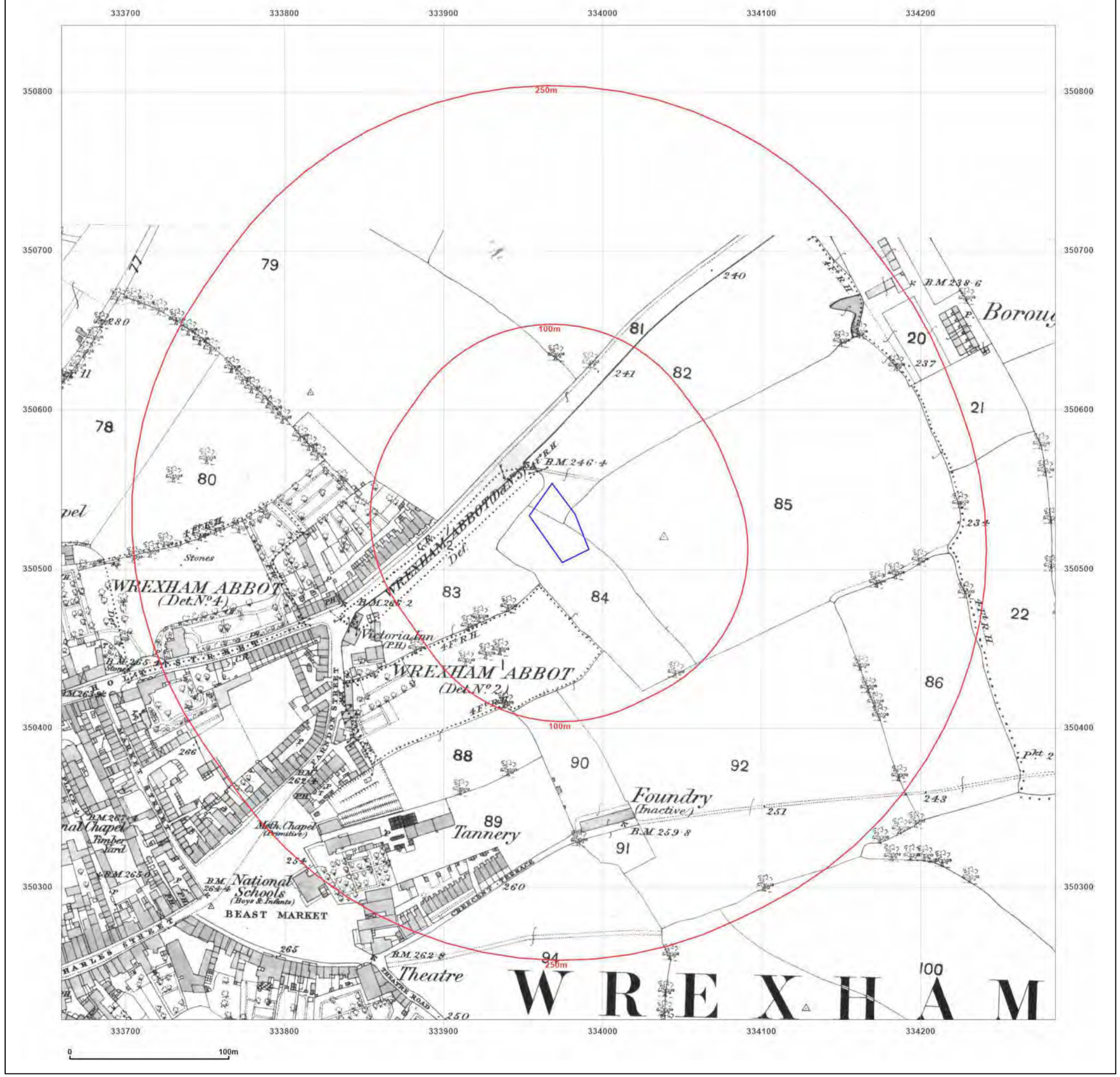


Photograph 5 – Soft landscaping in the northern area of site



Photograph 6 – Centre of the site.

APPENDIX 3 - Historical Maps



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Site Details:

Costa Drive Thru, Border Retail Park, Wrexham, LL13 8NG

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Report Ref: EMS-882948_1128841
Grid Ref: 333972, 350529

Map Name: County Series

Map date: **1873**

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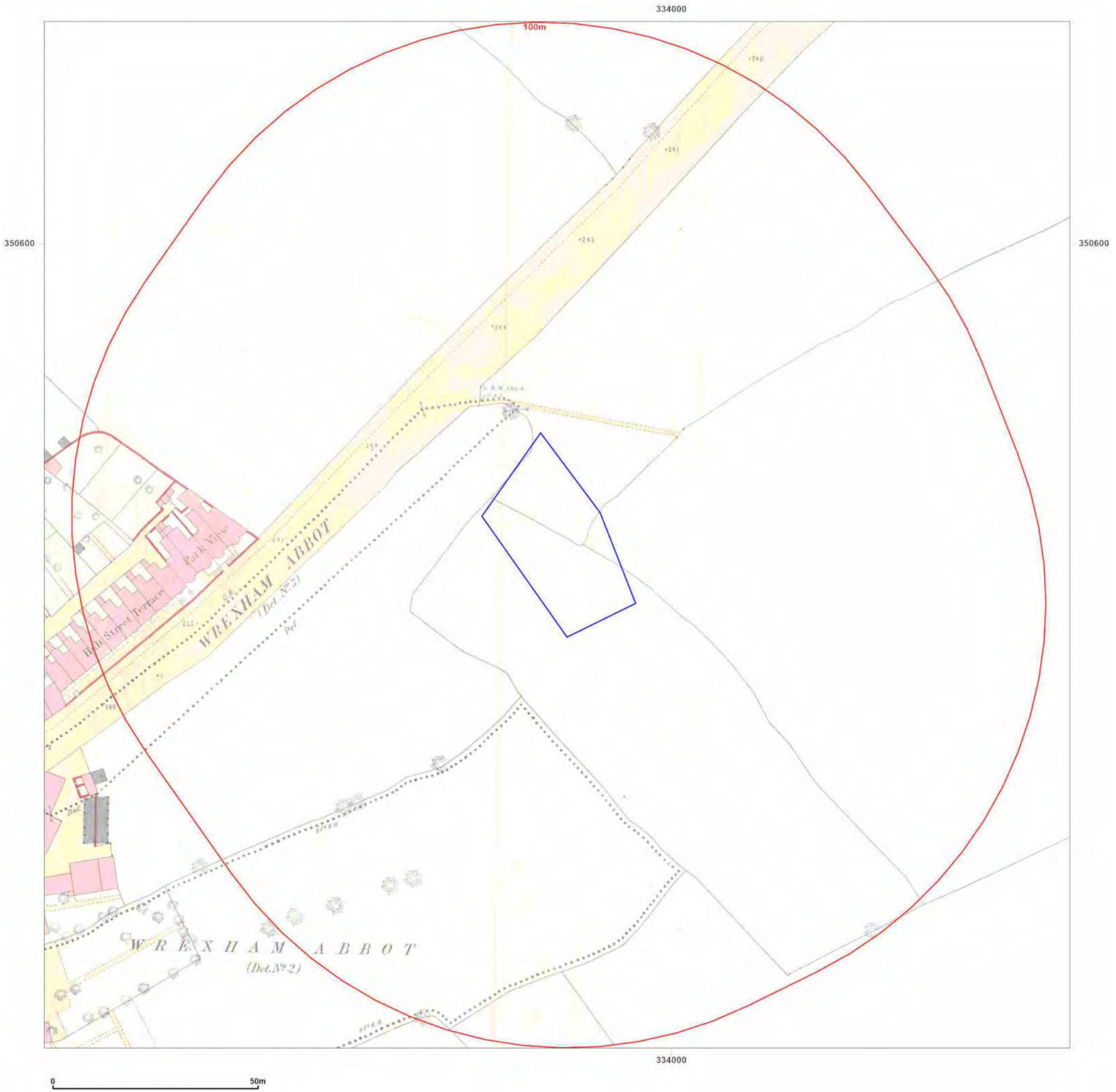
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Site Details:

Costa Drive Thru, Border Retail Park, Wrexham, LL13 8NG

Client Ref: EMS_882948_1092594
Report Ref: EMS-882948_1128841
Grid Ref: 333972, 350529

Map Name: County Series Town Plan

Map date: **1874**

Scale: 1:500

Printed at: 1:1,000

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Surveyed 1874
Revised N/A
Edition N/A
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Site Details:

Costa Drive Thru, Border Retail Park, Wrexham, LL13 8NG

Client Ref: EMS_882948_1092594
Report Ref: EMS-882948_1128841
Grid Ref: 333972, 350529

Map Name: County Series

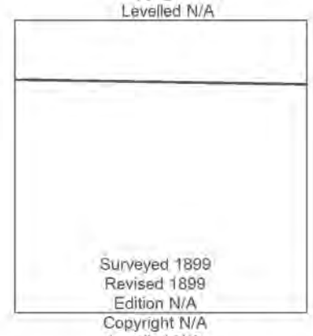
Map date: **1899**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1899
Revised 1899
Edition N/A
Copyright N/A
Levelled N/A



Surveyed 1899
Revised 1899
Edition N/A
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Map legend available at:
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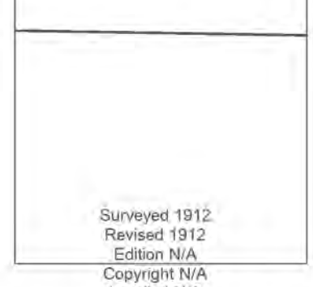
Map date: **1912**

Scale: 1:2,500

Printed at: 1:2,500

N
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Surveyed 1912
Revised 1912
Edition N/A
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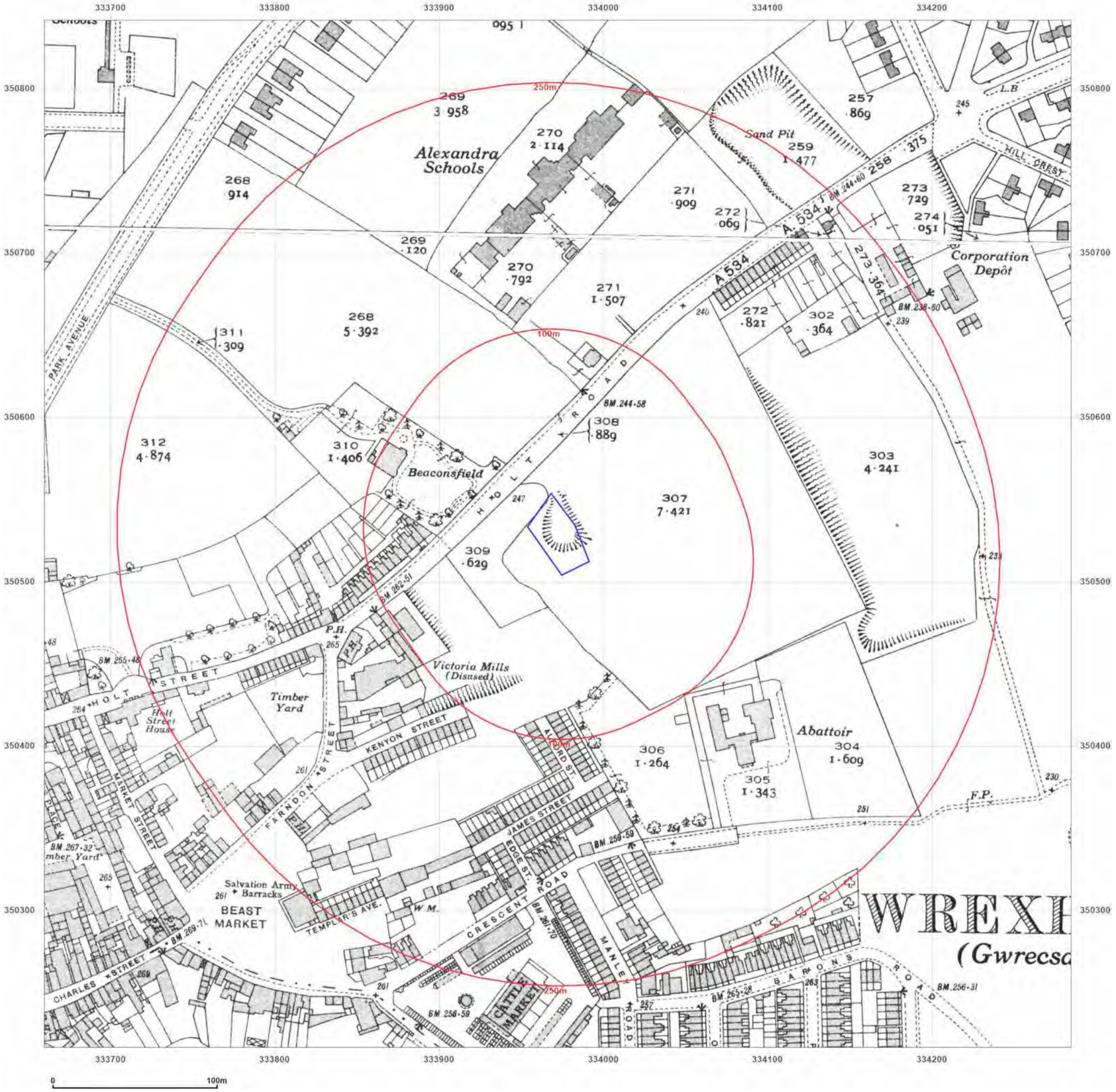
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Client Ref: EMS_882948_1092594
Report Ref: EMS-882948_1128841
Grid Ref: 333972, 350529

Map Name: County Series

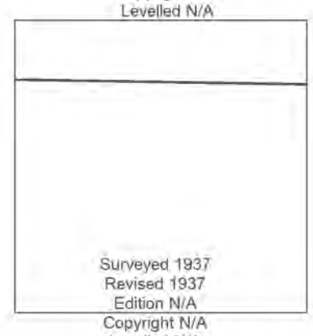
Map date: **1937**

Scale: 1:2,500

Printed at: 1:2,500

N
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Surveyed 1937
Revised 1937
Edition N/A
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Revised 1937
Edition N/A
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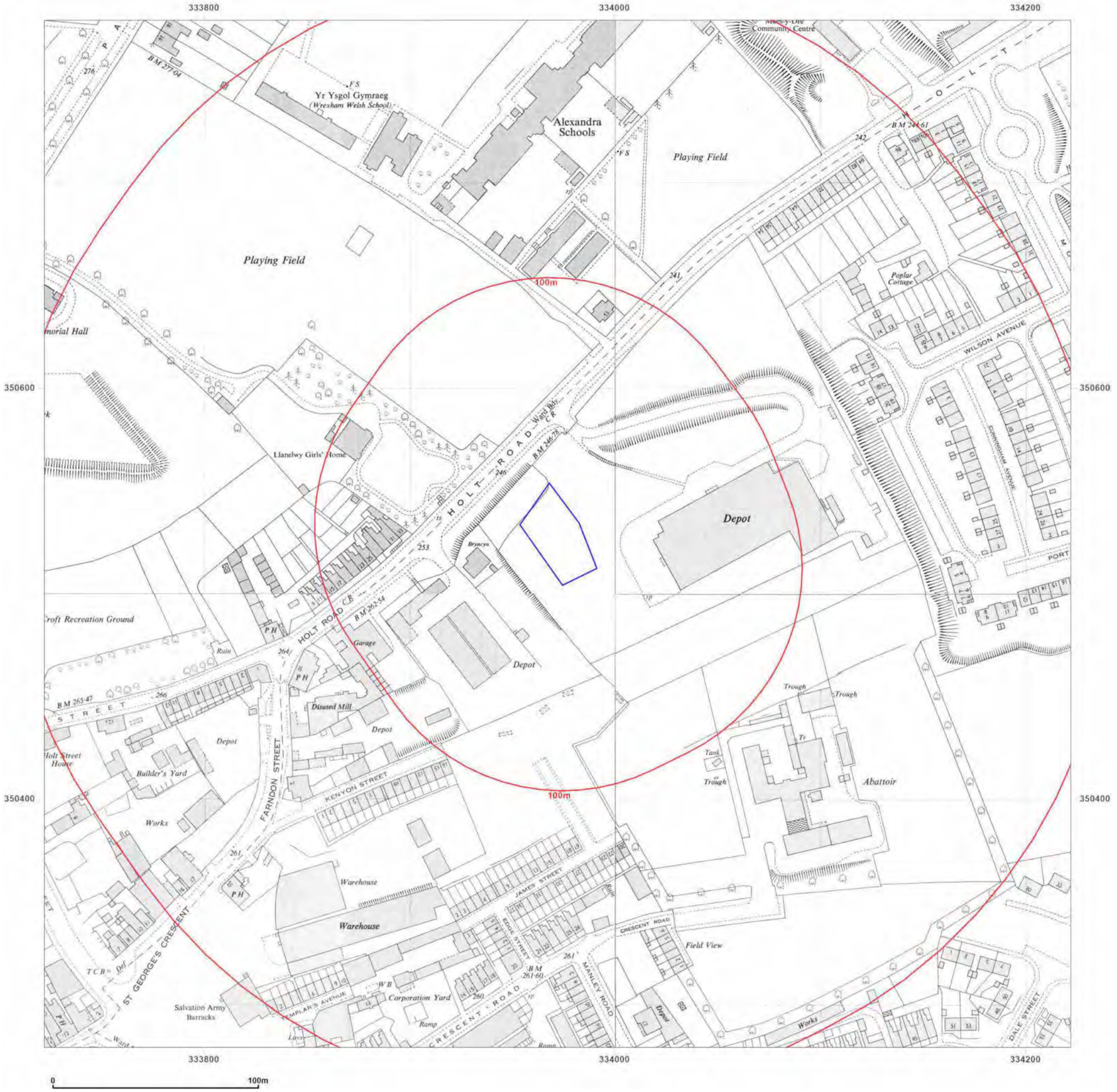
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Client Ref: EMS_882948_1092594
Report Ref: EMS-882948_1128841
Grid Ref: 333972, 350529

Map Name: National Grid

Map date: **1958-1959**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1958
Revised 1958
Edition N/A
Copyright N/A
Levelled 1950

Surveyed 1958
Revised 1958
Edition N/A
Copyright 1959
Levelled 1950

Surveyed 1958
Revised 1958
Edition N/A
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