



Geotechnical and Geoenvironmental Report

Site: Crawford Street, Newport

Prepared For: MVR Solutions Limited

Issue Date: December 2024

Job No: 17245

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Proposed Apartment Development, Crawford
Street, Newport**

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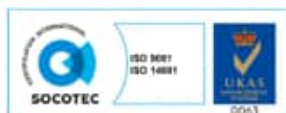
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04	02.12.2024	Update to ground gas risk assessment & geoenvironmental risk assessment

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Executive Summary

Site Location and Proposed Development	MVR Solutions Ltd (the Client) is proposing the residential development of a parcel of land located off Crawford Street, Newport, NP19 7AY. The development is to comprise 30No. apartments with parking, contained within a single three storey building.				
Site History	The site was first occupied by a brick works and associated excavation sometime between 1886 and 1902. The brickworks became disused and infilled by 1920. The site became unoccupied, but surrounding area developed by housing. The site became occupied by the current building at sometime between 1922 and 1937. The site has been occupied by depots, car maintenance and car sales until present day.				
Geology	Made ground over Tidal Flat Deposits over St Maughan's Formation. River Terrace Deposits may be present between the TFD and SMF.				
Radon	No radon protective measures are required for new developments on the investigation site.				
Ground Conditions	Depth (m)			Thickness (m)	Stratum
	0.0	-	1.05/5.2	1.05/5.2	MADE GROUND: Loose dark grey silty angular fine to coarse GRAVEL of slag, ceramics, wood, coal ash and glass.
	1.05/5.2	-	16.0/17.7	11.5/12.5	TIDAL FLAT DEPOSITS Various layers of superficial strata including soft light greyish blue silty CLAY , and/or soft dark brown fibrous PEAT with occasional plant fragments and very strong organic odour.
	9.3/15.0	-	>12.0/16.2	Absent/>2.7	POSSIBLE RIVER TERRACE DEPOSITS. Brownish red mottled grey clayey gravelly SAND/silty sandy GRAVEL . Gravel is angular siltstone and siltstone lithorelicts.
	16.0/17.7	-	>21.0/23.9	Unproven	ST. MAUGHAN'S FORMATION Various interbedded layers of extremely weak to strong reddish grey MUDSTONE , strong greyish brown mottled grey SILTSTONE , weak to medium strong reddish brown and grey SANDSTONE and extremely weak to medium strong reddish brown and grey CONGLOMERATE . Occasional bands of residual mudstone up to 1.25m in thickness.
Soil Contamination of Concern	Arsenic, lead, PAHs, TPH, volatile organic compounds have been identified above GAC/laboratory guidelines.				
	To protect future site users from the identified contamination the site will need to be capped. The capping should consist of the proposed buildings and hard standings. In garden and soft landscaped areas the capping should consist of 600mm of suitable inert topsoil, and subsoil. The capping soils should be underlain by a no dig barrier and a capillary break/drainage layer due to the high concentrations of contamination.				
Groundwater Risk Assessment	It is considered that the wider aquatic environment is at a very low risk from the site. It is therefore considered that a Level 3 Groundwater Assessment is not necessary. However, a Piling Risk Assessment should be carried out prior to the installation of piles to assess and manage the potential risks of contaminating controlled waters through the introduction of new migration pathways into the deeper groundwater body. This may lead to further rounds of groundwater monitoring, samples taken and assessment. Groundwater monitoring before and after the piling may also be required. The Piling Risk Assessment has already been commissioned by the client and will be carried out on completion of this report.				
Ground Gas Risk Assessment	'Gas Characteristic Situation 1' (GS1) is applied to the site in line with recommendations provided in CIRIA C665. Consequently, gas protection measures are not required.				
Foundation Solution	A piled foundation solution will be required for structures on site. Due to the proximity to a railway, it is recommended that continuous flight auger (CFA) piled foundations be utilised, to reduce vibrations occurring from traditional driven piles.				
	It is recommended a CFA piled foundation solution socketed into bedrock within the extremely weak to strong reddish grey MUDSTONE , strong greyish brown mottled grey SILTSTONE , weak to medium strong reddish brown and grey SANDSTONE and extremely weak to medium strong reddish brown and grey CONGLOMERATE , at depths ranging from 16.5m to 20.2m below existing ground level is used.				
	Significant allowances should be made for intermittent bands of residual bedrock such as that encountered at 18.3-19.55m in BH02. If such bands are encountered at termination depth, then the depth of pile should be increased until a competent layer is reached.				
	It is understood that a 1.3m high king post retaining wall will be used at the east of the site.				
Recommended Further Work	A Piling Risk Assessment is required prior to the installation of piles to assess and manage the potential risks of contaminating controlled waters through the introduction of new migration pathways into the deeper groundwater body. The assessment may lead to further rounds of groundwater monitoring. Groundwater monitoring before and after the piling may also be required.				

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Annex B Radon Report
Annex C Preliminary Unexploded Ordnance Risk Assessment
Annex D Risk Assessment Definitions
Annex E Exploratory Hole Logs
Annex F Soakaway Results
Annex G CBR Correlations
Annex H Laboratory Chemical Test Results
Annex I Geotechnical Test Results
Annex J Ground Gas Monitoring Results
Annex K Estimation of Passive Ventilation Performance

Drawings

Drawing 01 Exploratory Hole Locations

SECTION 1 Introduction and Proposed Development

1.1 Introduction

MVR Solutions Limited (the Client) is proposing the residential development of a parcel of land located off Crawford Street, Newport, NP19 7AY. The development is to comprise 35No. apartments with parking, contained within a single three storey building.

TFW Group Limited (hereafter referred to as Terra Firma) has been commissioned by the Client to undertake a geoenvironmental assessment and geotechnical investigation of the site.

The main objectives of the geoenvironmental assessment programme are:

- Investigate the potential human health and environmental liabilities at the site associated with any contamination
- Provide a summary of the human health and environmental conditions at the site, together with any necessary further intrusive works and / or remediation works to render the site fit for its intended use

The main objectives of the geotechnical site investigation are:

- Investigated the type, strength and bearing characteristics of the shallow superficial and underlying solid geology
- Provide engineering foundation and floor slab recommendations for the proposed development
- Provide infiltration rates and stormwater drainage viability.
- Provide recommendations regarding any other geotechnical aspects pertaining to the development

In order to achieve the above objectives, Terra Firma carried out an assessment programme including, a review of existing data, followed by a field investigation to collect geotechnical and geoenvironmental data from selected locations.

1.2 Limitations and Exceptions of Investigation

The Client has requested that a Geoenvironmental Site Assessment (GSA) and Geotechnical Investigation (GI) be performed to enable the outlined main objectives.

The GSA and GI were conducted, and this report has been prepared for the sole internal reliance of the Client and their design and construction team. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma. If an unauthorised third party comes into possession of this report, they rely on it at their peril and the authors owe them no duty of care and skill. The report represents the findings and opinions of experienced geoenvironmental and geotechnical consultants. Terra Firma does not provide legal advice and the advice of lawyers may be required.

The subsurface geological profiles, any contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

The southern portion of the building could not be accessed during the site work.

1.3 Quality Assurance

The quality and environmental aspects of the assessment comply with Terra Firma business management system which is UKAS Accredited to ISO 9001:2015 and ISO 14001:2015 standards.

SECTION 2 Review of Existing Data

2.1 Physical Setting and Current Site Use

The development site is rectangular in shape and locates off Crawford Street, Newport. The site centres on an approximate National Grid Reference of 331720, 188850, occupying a plan area of approximately 0.23 Hectares.

The site is currently occupied by several buildings, including a car sales lot with the centre of the site comprised of car parking spaces. No service entry pits, above ground tanks, or below ground tanks were identified during the site visit.

The site elevation is approximately 8m AOD.

The site location can be seen on **Figure 2.1** along with the exploratory hole locations on **Drawing 01**.



Figure 2.1 Site Location

2.2 Site History

Historical maps of the site have been obtained in an Envirocheck Report, provided by Landmark Information Group. The history plans are supplied in **Annex A** of this report, and the most relevant editions are summarised in **Table 2.1**. Distances are approximate, and any changes in-between map editions may not be recorded.

Table 2.1 Historical Development from Map Information

Map Edition & Scale	Key Features on Site	Key Features off Site
1883 1:2,500	The site is currently comprised of open, unoccupied land. A reën (drainage channel) appears to be situated on site, trending northwest to southeast, and draining directly into River Usk.	A railway line is situated 5m east from the site, trending north to south. Much of the area situated immediately south is comprised of a 'Brick Field' with various excavations and brick kilns. The River Usk is situated 160m west. Land to the north of the site is comprised of open unoccupied land. East of the site is residential land. A tramway passes the southeast corner of the site.
1886-87 1:10,560	No significant changes have been made to the site since 1883.	No significant changes have been made within the surrounding area since 1883.
1902 1:2,500	The site now seems to be part of the Newport Patent Brick Works, with a large majority of the site having been excavated. A building occupies the southeast corner of the site.	Much of the land situated west of the site has also been excavated. Further residential development has taken place within the surrounding areas.
1920 1:2,500	The building at the southeast of the site is no longer evident and the excavation appears to have been infilled. The site is no longer occupied by the brick works.	Crawford Street is under construction to the immediate west of the site. The Brick Works has now been redeveloped for residential housing. Allotment gardens are situated north of the site.
1937 1:2,500	Several buildings are now situated on the north and southwest of the site.	Rows of housing lie to the immediate north and northwest of the site.
1955-57 1:2,500	The site is recorded as being a parcels depot and the buildings at the southwest of the site are no longer evident. Additional buildings have been constructed at the southeast.	Allotment gardens are located to the immediate west of the site.
1966 1:2,500	The site is recorded as being a car distribution depot. Buildings at the southeast have been removed.	No significant changes.
1981-83 1:10,000	No significant changes.	No significant changes.
1993 1:1,250	The southeast portion of the building has been demolished.	The allotment garden to the west has become a playground.
2000 Aerial Photograph	The north of the site is occupied by a building and the south by a car park.	No significant changes.
2021 1:10,000	No significant changes.	No significant changes.

2.3 Geological Setting

2.3.1 Geology

The 1:50,000 scale British Geological Map of the area (Sheet 249) was consulted for geology underlying the site. The site is shown to be underlain by St. Maughan's Formation. Detailed stratigraphical information is provided in **Table 2.2**.

Table 2.2 Detailed Stratigraphical Information

Period	Group	Formation
Devonian	St. Maughan's Formation	St. Maughan's Formation: Interbedded purple, brown and green sandstones and red mudstones with intraformational conglomerates containing calcrete clasts.

Strata are typically dipping 15° to the south in the local area.

Superficial deposits are recorded as tidal flat deposits. Tidal flat deposits including mud flat and sand flat deposits, are deposited on extensive nearly horizontal marshy land in the intertidal zone that is alternately covered and uncovered by the rise and fall of the tide. They consist of unconsolidated sediment, mainly mud and/or sand. They may form the top surface of a deltaic deposit. Normally a consolidated soft silty clay, with layers of sand, gravel and peat. Characteristically low relief.

Made ground is anticipated at the site, the depth of which is not known.

2.3.2 BGS Borehole Information

A BGS borehole record situated 160m west from the site details the ground conditions. This borehole record is summarised in **Table 2.3**.

Table 2.3 Summary of BGS borehole record ST38NW221

Depth (m)			Thickness (m)	Stratum
0.00	-	2.4	2.4	MADE GROUND
2.4	-	3.6	1.2	CLAY
3.6	-	6.0	2.4	BLUE CLAY
6.0	-	11.0	5.0	PEAT and CLAY
11.0	-	11.5	0.5	PEAT
11.5	-	12.4	0.9	RED CLAY
12.4	-	>15	-	GRAVEL

2.3.3 Radon

The Radon Report (**Annex B**) details that no radon protective measures are required for new developments on the investigation site.

2.3.4 Mining

The site sits outside the South Wales coal fields.

No relevant BGS mineral sites are recorded in the Envirocheck Report datasheets within 250m of the site.

2.3.5 Natural Hazards

The underlying geology is not prone to dissolution due to the significant mudstone component of the geological units and the risk of natural cavities in the bedrock is considered negligible.

2.4 Environmental Setting

The following sections have been compiled using the Landmark Information Group Envirocheck datasheet and maps which can be found in **Annex A**.

2.4.1 Hydrogeology

Superficial deposits beneath the site have an aquifer designation of unproductive strata.

The bedrock deposits beneath the site have an aquifer designation of secondary aquifer – A.

Deeper groundwater flow within the underlying bedrock will be controlled by the strata dip and any fractures or bedding planes within the rock units.

The hydraulic gradient will be at its steepest during periods of heavy rainfall and aquifer recharge.

It is anticipated that the groundwater is in hydraulic continuity with the River Usk.

The site does not locate within a groundwater source protection zone.

The nearest groundwater abstraction point is located 881m northwest, operated by Qds Environmental Ltd.

2.4.2 Hydrology

The nearest surface water feature locates on site/off site 13m to the east and comprises an inland river within the Usk and Llwyd catchment. River Usk lies approximately 160m west of the site.

2.4.3 Flooding

The site is at risk from extreme flooding from rivers or sea, as shown by fluvial models.

The site lies in an area benefiting from flood defence.

2.4.4 Waste

There are no recorded landfill sites within 250m of the site.

There are no licensed waste management facilities or waste transfer sites within 250m of the site.

There are no recorded discharge consents within 250m of the site

2.4.5 Pollution

2No. pollution incidents are recorded to have occurred within 250m radius of the site. These were situated 228m north and 236m northwest and were both Category 3 – Minor Incidents.

2.4.6 Sensitive Land Use

The site is not located within a sensitive land use area.

2.4.7 Measured Urban Soil Chemistry

The BGS have not published measured urban soil chemistry concentrations locally to the site.

2.4.8 Industrial Land Use

Relevant contemporary trade directory entries recorded within proximity of the site are summarised in **Table 2.4**.

Table 2.4 Relevant Contemporary Trade Summary

Company	Distance/Direction from site	Classification	Status
George Ford & Sons Ltd	34m, southwest	Exhaust & Shock Absorber Centres	Inactive
Dragon Building Supplies & Tool Hire	34m, southwest	Builders Merchants	Inactive
Crawford Tyres	47m, north	Tyre Dealers	Inactive
Michael Ashley Motors & Finance	47m, north	Car Dealers – Used	Inactive
Newport Vehicle Repair Centre	63m, north	Car Body Repairs	Inactive
Apex Joinery & Shopfitting Wales Ltd	73m, north	Shop Fittings Manufacturers	Active
Evans Halshaw Ltd	54m, southwest	Car Dealers	Inactive
A1 Blinds	65m, east	Blinds, Awnings and Canopies	Inactive
Beechwood Group	71m, southeast	Office Furniture and Equipment	Inactive
Dead Cars	72m, southeast	Car Dealers	Active
G W P Chemicals	72m, southeast	Hygiene and Cleansing Services	Inactive

Britannia Motor Co Limited (vehicle repair, testing and servicing) is positioned to the address. An internet search indicates that the company was previously registered to the site but has moved elsewhere in the Newport area. Another vehicle maintenance company called Intelligent Auto-Electrics was also previously located within the building at the north of the site.

2.4.9 Infilled Land

Potentially infilled land features within 250m of the site are summarised in **Table 2.5**.

Table 2.5 Potentially Infilled Land

Feature	Distance/Direction from site
Excavated land beneath site associated with Brick Works	On site
Infilled inland stream	50m, east
	56m, east
	92m, north

	110m, northwest
	120m, southeast
	152m, northeast
	198m, north

2.5 Unexploded Ordnance

MACC International Limited were commissioned to undertake a Preliminary Unexploded Ordnance Risk Assessment for the site.

The level of risk for hand dug excavations, limited mechanical excavations or trenching, and drilling or sampling is considered to be low.

The following recommendations for risk mitigation were made:

- Risk Communication & Safety Planning: Stakeholders should be made aware of the UXO risk levels within the project boundary and the possible impact an encounter may have on the project and third parties. Consequently, a UXO Safety Plan should be drawn up and included with the overall project safety planning.
- Safety Training: In keeping with CDM Regulations concerning all sub-surface hazards, UXO Safety Induction Training should be provided to everyone working or visiting the site. The training should be commensurate with the individual's responsibilities and duties on site. The training should be provided by a competent individual (preferably a trained EOD Engineer) and delivered as a separate module of the Site Safety Induction Course or as a Toolbox Talk.

Further detail is provided in the UXO risk assessment, presented in **Annex C**.

SECTION 3 Preliminary Human Health and Environmental Risk Assessment

3.1 General

The preliminary human health and environmental risk assessment is a qualitative evaluation of unacceptable risks to human health or the environment from potential 'contaminated land', based on reviewed information in preceding sections of this report.

For 'contaminated land' to exist as defined in Part 2A of the Environmental Protection Act (EPA) 1990, a Pollutant Linkage needs to be identified. Pollutant linkages are defined by having a valid 'source – pathway – receptor' as established in the preliminary conceptual site model.

For our definitions of pollution linkage and how we define risk please refer to **Annex D** which includes our classifications of consequence and probability, and risk assessment matrix.

3.2 Potential Sources of Contamination

Potential or known sources of contamination associated the sites current and historical land use are summarised in **Table 3.1**.

Table 3.1 Contamination Sources

ID	Source	Contaminant
S1	Made ground including infilled land associated with brick works.	Metals, PAH, TPH CWG, asbestos
		Ground Gas (methane, carbon dioxide)
S2	Past site use (depot, car sales, vehicle maintenance).	Metals, PAH, TPH CWG, asbestos, VOCs and SVOCs

No other significant potential on-site or off-site sources of contamination have been identified during the desk study.

3.3 Omitted Sources of Contamination

Other potential sources of contamination highlighted in preceding sections of this assessment have been reviewed and omitted from further risk assessment, for the reasoning listed in **Table 3.2**.

Table 3.2 Omitted Contamination Sources

Source & Contaminant	Reasoning
Peat and tidal flat deposits	Source - Peat and soils with high organic content are a source of methane and carbon dioxide, however there is no, or very little, current gas generation and the carbon dioxide has dissolved out of the gas trapped in the soil pores which causes a higher percentage of methane to be recorded from wells installed within organic-rich tidal flat deposits and peat. Pathway—TFD will prevent the migration of ground hgas from depth, due to it being cohesive and saturated. Additionally, due to their cohesive and low strength nature, and the pressure exerted by piles during installation, the unconsolidated TFD are likely to flow and remould around the pile, re-establishing the very low permeability of the TFD. Consequently, there is negligible pathway between ground gas from depth migrating upwards to the surface along the piles.

3.4 Potential Pollution Pathways

Potential contaminant pathways associated with a residential without home grown produce land use are as follows.

- P1 – Direct soil and dust ingestion
- ~~P2 – Consumption of home grown produce~~
- P3 – Dermal contact
- P4 – Inhalation of dust and vapours
- P5 – Vertical migration of leachates (unsaturated zone)
- P6 – Horizontal and vertical migration of contaminants (saturated zone)
- P7 – Artificial contaminant pathway (borehole, pile, excavation etc)
- P8 – Surface run-off
- P9 – Plant uptake
- P10 – Horizontal and vertical migration of ground gasses and vapours
- P11 – Direct contact with construction materials
- P12 – Inhalation of asbestos fibres

3.5 Potential Receptors

There are human and hydrological receptors to any contamination that may be present on site. Potential receptors include.

- R1 – Construction and maintenance workers
- R2 – Future site users (residents)
- R3 – Passers-by or neighbouring site users
- R4 – Groundwater (aquifer)
- R5 – Surface waters (river/lake)
- R6 – Area of public open space
- R7 – Construction materials (concrete/potable water pipes)

3.6 Preliminary Conceptual Site Model

The preliminary conceptual site model establishes potential pollutant linkages between contaminants (source), pathways and receptors, realised during the preparation of the desk study report. Where a potential pollutant linkage is identified an assessment of risk is subsequently undertaken. The preliminary conceptual site model is tabulated in **Table 3.3**.

Outcomes of the preliminary conceptual site model are used as a basis for the design and implementation of the site investigation, whereby areas of potential contamination can be targeted as well as investigating the wider site.

Findings of the site investigation can in turn be used to develop and refine the conceptual site model.

Table 3.3 Preliminary Conceptual Site Model

Source	Pathway	Receptor	Preliminary Risk Assessment		
			Consequence	Probability	Risk & Justification
Human Health					
Soils S1	Direct soil and dust ingestion P1 Dermal contact P3 Inhalation of dust and vapours P4 Inhalation of asbestos fibres P11	Construction and maintenance workers R1	Medium	Low Likelihood	Medium Risk - COSHH assessment and good level of PPE/ hygiene by site workers/ staff; dust suppression measures if required. Suitably designed site investigation recommended
		Passers-by or neighbouring site users R3	Medium	Unlikely	Low Risk - Dust suppression measures if required.
		Future site users (residents) R2	Medium	High Likelihood	High Risk - Suitably designed site investigation recommended
Ground Gas S2	Horizontal and vertical migration of ground gasses and vapours P9	Future site users (residents) R2, Construction and maintenance workers R1	Severe	Unlikely	Medium Risk – Made ground is a potential source of ground gas.
Vapours S1			Severe	Unlikely	Medium Risk: The site's former use as a garage is a potential source of hydrocarbon vapours
Impacted Groundwaters S1	Horizontal and vertical migration of contaminants (saturated zone) P6 Dermal contact P3	Construction and maintenance workers R1	Medium	Unlikely	Low Risk: Although there is a potential for groundwater to be impacted by the made ground or past site uses, a realistic pathway between the source and receptor is unlikely to exist.
Soils S1	Direct Contact P10	Construction materials (water pipes) R7	Mild	Low Likelihood	Low Risk: An appropriate water supply pipe material should be chosen after the potable water supplier has completed an assessment in accordance with UK Water Industry Research guidance; Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites, UKWIR Report Ref: 10/WM/03/21.
Aggressive ground conditions – Sulphates S1		Construction materials (concrete) R7	Mild	Low Likelihood	Low Risk: Chemical analysis of the soils should be undertaken and the appropriate classification of concrete should be specified as per BRE Special Digest 1: Concrete in Aggressive Ground.
Aquatic Environment					
Soils (leachate) S1	Surface run-off P8	Surface waters (river/lake) R5	Mild	Low Likelihood	Low Risk: The risk of contaminated leachate from made ground soils migrating off site is

					considered low due to the distance required for the surface water to travel, and the current and proposed development, which is covered almost entirely by hardstanding.
Soil (leachate) Free Product (S2)	Vertical migration of leachates/liquid contaminants (unsaturated zone) P5	Groundwater (aquifer) R4	Mild	Likely	Medium Risk: Contaminated soils from made ground could leach into the perched groundwater, however the current and proposed development, which is covered almost entirely by hardstanding will reduce the chance of this occurring. Free product from the site's past use may migrate into the unsaturated zone
Soils (leachate) S1 Free Product S2	Horizontal and vertical migration of contaminants (saturated zone) P6	Surface waters (river/lake) R5	Mild	Likely	Medium Risk: Free product from the site's past use may migrate from the perched groundwater/near surface into nearby surface water bodies
		Groundwater (aquifer) R4	Mild	Likely	Medium Risk: Free product from the site's past use may migrate into the saturated zone from the site.

SECTION 4 Field Investigation

4.1 Site Works

A geotechnical and geoenvironmental site investigation comprising nine windowless sampler boreholes, one soakaway test trial pit and two rotary percussive boreholes was undertaken between the 10th and 24th May 2022.

A further 6No. rotary percussive boreholes were drilled between the 10th to 12th of September 2024.

The fieldwork was supervised by Terra Firma, who logged the exploratory holes to the requirements of BS 5930:2015+A1:2020. The proposed locations of the exploratory holes were determined by Terra Firma in general accordance with BS 10175:2011+A2:2017 in order to assess the findings of the preliminary conceptual site model.

The exploratory hole logs are presented in **Annex E**.

Trial pits referenced were formed using a JCB 3CX excavator with a 0.60m wide bucket.

Breaking out of the hardstanding was required at trial pit SA1 prior to excavation.

Representative disturbed samples were taken and retained in airtight containers for environmental and geotechnical testing.

On completion the trial pit was backfilled with materials arisings compacted in layers using the excavator bucket. The ground surface was left proud to accommodate future settlement of backfilled materials.

Soakaway tests were carried out in SA1 in general accordance with BRE DG 365:2016. The excavation sides were squared using the excavator bucket and dimensions recorded within the test section. The trial pit was partially filled with clean water using a dedicated bowser with a 75mm diameter outlet and the fall in level recorded against time. The results are presented in **Annex F**.

The windowless sampler boreholes referenced WS01 to WS09 were formed using a Terrier 2000 rig. Dynamic sampling techniques were employed from surface to produce a continuous disturbed sample.

Standard penetration tests (SPT) were carried out at regular intervals in general accordance with BS1377: Part 9:1990:3.3. SPT results summarised as N values are presented on the borehole log.

Representative disturbed samples were taken and retained in airtight containers for environmental and geotechnical testing.

Boreholes reference BH01 to BH08 were formed using a track mounted rotary drilling rig. Dynamic sampling techniques were employed from surface to produce a continuous disturbed sample. On refusal to dynamic sample the boreholes were continued by rotary core drilling methods utilising a water/air mist flush.

All core samples were retained in sequence in labelled coreboxes.

Standard penetration tests (SPT) were carried out at regular intervals in general accordance with BS1377: Part 9:1990:3.3. SPT results summarised as N values are presented on the borehole log.

Boreholes were monitored for groundwater ingress as drilling proceeded.

On completion, boreholes referenced WS01, WS03, WS04, WS05, and BH03 to BH08 were installed with slotted standpipes consisting of a 50mm ID HDPE slotted tube set in a granular filler zone and sealed above with a bentonite plug. Installations were protected at surface with a flush cover. Full installation details are recorded on the relevant logs.

Dynamic Cone Penetrometer tests were carried out at WS01, WS03, WS04, and WS05 using a CNS Farnell A2465 dynamic cone penetrometer. Probe depths were measured with respect to ground level and the number of blows for the penetration of the probe was recorded. Equivalent CBR values have been calculated and presented with the results in **Annex G**.

The remaining boreholes were backfilled with a mix of materials arising and cement and the surface reinstated.

Exploratory hole locations are shown on **Drawing 01**.

4.2 Ground Conditions

The ground conditions encountered by the exploratory holes can in general be summarised as shown in **Table 4.1**.

Table 4.1 Summary of Typical Ground Conditions

Depth (m)			Thickness (m)	Stratum
0.0	-	1.05/5.2	1.05/5.2	MADE GROUND: Loose dark grey silty angular fine to coarse GRAVEL of slag, ceramics, wood, coal ash and glass.
1.05/5.2	-	9.3/15.0	6.0/11.5	TIDAL FLAT DEPOSITS Various layers of superficial strata including soft light greyish blue silty CLAY , and/or soft dark brown fibrous PEAT with occasional plant fragments and very strong organic odour.
9.3/15.0	-	>12.0/16.2	Absent/>2.7	POSSIBLE RIVER TERRACE DEPOSITS. Brownish red mottled grey clayey gravelly SAND /silty sandy GRAVEL . Gravel is angular siltstone and siltstone lithorelicts.
16.0/17.7	-	>21.0/23.9	Unproven	ST. MAUGHAN'S FORMATION Various interbedded layers of extremely weak to strong reddish grey MUDSTONE , strong greyish brown mottled grey SILTSTONE , weak to medium strong reddish brown and grey SANDSTONE and extremely weak to medium strong reddish brown and grey CONGLOMERATE . Occasional bands of residual mudstone up to 1.25m in thickness.

4.3 Groundwater

Groundwater information recorded during the site investigation is summarised in **Table 4.2**.

Table 4.2 Groundwater Summary

Location	Depth (m)	Depth after 20 minutes (m)	Details
WS02	3.0	-	Suspected perched groundwater
WS03	3.0	-	
WS06	3.0	-	

BH02	3.0	-	
BH02	9.0	-	Suspected groundwater
BH03	3.0	1.0	Fast inflow
BH04	3.0	1.1	Fast inflow
BH04	9.5	2.2	Fast inflow
BH05	3.0	1.1	Fast inflow
BH06	3.0	1.1	Fast inflow
BH06	9.5	2.2	Fast inflow
BH07	3.0	1.1	Fast inflow
BH07	9.5	2.2	Fast inflow
BH08	3.0	1.1	Fast inflow

4.4 Stability and Obstructions

Trial pit SA1 was stable during excavation however some instability was recorded in the windowless sampler boreholes leading to termination of the boreholes and poor recovery.

4.5 Installation Well Construction

Gas well locations were selected on a non-targeted basis to characterise the gas contamination status of the site. A square grid pattern was adopted.

Gas installation well construction details are summarised in **Table 4.3**.

Table 4.3 Installation Well Summary

Location	Response Zone		Stratum
	From (m)	To (m)	
WS01	1.0	3.0	Made ground and Tidal Flat Deposits
WS03	1.0	3.0	Made ground
WS04	1.0	3.0	Made ground
WS05	1.0	3.0	Made ground and Tidal Flat Deposits
BH03	3.0	6.0	Tidal Flat Deposits
BH04	8.0	12.0	Tidal Flat Deposits and Possible River Terrace Deposits
BH05	3.0	6.0	Tidal Flat Deposits
BH06	8.0	12.0	Tidal Flat Deposits and Possible River Terrace Deposits
BH07	8.0	12.0	Tidal Flat Deposits and Possible River Terrace Deposits
BH08	3.0	6.0	Tidal Flat Deposits

4.6 Laboratory Chemical Testing

4.6.1 Sampling Strategy

Soil sampling locations were selected on a non-targeted basis to characterise the contamination status of a defined area of the site.

Sample locations, depths and suspected/known contamination source targets are summarised in **Table 4.4**.

Table 4.4 Sample Locations, Depths and Targets

Location	Depth (m)	Contamination Targets
SA1	0.9	S1, S2

WS01	0.5	S1, S2
WS02	0.6	S1, S2
WS03	0.6	S1, S2
WS04	0.6	S1, S2
WS05	0.4	S1, S2
WS06	0.7	S1, S2
WS07	0.4	S1, S2
WS08	1.5	S1, S2
WS09	0.5	S1, S2
BH03	-	S1, S2
BH04	-	S1, S2
BH05	-	S1, S2
BH06	-	S1, S2
BH07	-	S1, S2
BH08	-	S1, S2

4.6.2 Soil Laboratory Analysis

During the site investigation works soil samples were taken and despatched to the accredited laboratories of Eurofins Chemtest for laboratory chemical testing. Soil samples were tested for the determinands listed in **Table 4.5**.

Table 4.5 Soil Laboratory Analysis

Metals & Metalloids	In-Organics	Organics	Others
Arsenic	Cyanide	Phenols	pH (acidity)
Cadmium	Sulphate	PAH	Asbestos
Chromium III		Petroleum Hydrocarbons	
Chromium VI		VOCs	
Copper		SVOCs	
Lead		BTEX	
Mercury		MTBE	
Nickel			
Selenium			
Zinc			

The results are discussed in detail in **SECTION 5** and the laboratory test results certificates may be found in **Annex H**. Waste Acceptance Criteria Testing was also tested for; the results of which will be contained within a re-issued report.

4.6.3 Groundwater Laboratory Analysis

Groundwater samples were collected from installation wells and submitted to the laboratories of Eurofins Chemtest. Samples were tested for the determinands listed in **Table 4.6**.

Table 4.6 Groundwater Laboratory Analysis

Metals & Metalloids	In-Organics	Organics	Others
Arsenic	Cyanide	Phenols	pH (acidity)
Cadmium	Sulphate	Petroleum Hydrocarbons	Hardness
Chromium III	Sulphide	PAH	Electrical Conductivity
Chromium VI		VOCs	Oxygen Demands
Chromium		SVOCs	
Copper		BTEX	
Lead		MTBE	
Mercury			
Nickel			

Selenium

The results are discussed in detail in **SECTION 5** and the laboratory test results certificates may be found in **Annex H**.

4.7 Groundwater Sampling

A groundwater-hydrocarbon interface meter was used to record the depth to groundwater, and to check for any hydrocarbon free product on each groundwater monitoring visit. No free product was recorded on any of the monitoring visits. The depth to groundwater is presented in **Table 4.7**.

Table 4.7 Groundwater Levels Prior to Groundwater Monitoring

Location	Groundwater Body	Well head AOD (m)	Water Depth Below Ground Level (m)	Water Depth Above Ordnance Datum (m)
BH03	Shallow	7.91	2.50	5.41
BH04	Deep	7.98	2.40	5.58
BH05	Shallow	8.01	1.70	6.31
BH06	Deep	8.01	1.80	6.21
BH07	Deep	7.86	1.90	5.96
BH08	Shallow	7.80	2.60	5.20

The groundwater level data indicates shallow groundwater and the deeper groundwater both fall to the southwest. Therefore, rather than flowing directly towards River Usk, it appears to be taking a slightly longer path towards the meander to the south.

The groundwater does not appear to be influenced by the small stream that lies 13m to the east.

4.8 Soil Property Testing

4.8.1 In-situ Permeability Testing

During the site investigation one trial pit soakaway test was undertaken in SA1 and carried out in general accordance with BRE DG 365:2016.

Soakaway test results are summarised in **Table 4.8**.

Table 4.8 Summary of Soakaway Results

Trial Pit	Depth Range of Test (m)	Infiltration Rate (ms ⁻¹)
SA1	0.9-1.5	Insufficient infiltration recorded

The test results are discussed in **SECTION 8.6** and the calculation sheets may be found in **Annex F**.

4.9 Waste Acceptance Criteria Testing

During the site investigation two samples were tested for Waste Acceptance Criteria (WAC). The results are presented in **Annex H**.

4.9.1 Laboratory Geotechnical Testing

A schedule of laboratory tests was prepared by Terra Firma and samples were despatched to the accredited laboratories of Apex Testing Solutions. A summary of the testing carried out is presented in **Table 4.9**.

Table 4.9 Summary of Geotechnical Testing

Geotechnical Test	Standard	No. Tested
Point Load Test	ISRM 1985	7
Uniaxial Compressive Strength of Rock	ISRM 2007	2

The test results are presented in **Annex I** and discussed in **SECTION 7** of this report.

4.10 Photo-Ionisation Testing

Monitoring of all 10No. wells was carried out using an ION Science Tiger XT Handheld VOC Detector on 28th November 2024. The results of the testing are discussed in Section 8.

SECTION 5 Evaluation of Geoenvironmental Analytical Results

5.1 Assessment Methodology

Comparison of the analytical results has been made with the 2015 Suitable 4 Use Levels (S4UL) provided by Land Quality Management (LQM) Limited and the Chartered Institute of Environmental Health (CIEH) or provisional Category 4 Screening Levels (pC4SL).

5.2 Soil Test Results

A summary of the chemical test results which include the regulatory soil guideline values used in a residential setting without plant uptake are given in the following tables. The complete results can be found in **Annex H**.

5.2.1 Inorganics & Miscellaneous

Ten samples were tested for a standard suite of inorganics, pH and organic matter. The summarised results are in **Table 5.1**.

Table 5.1 Summary of Soil Chemical Test Results – Inorganics & Miscellaneous

Substance	Threshold Value (mg/kg)	Source	Measured Concentrations (mg/kg)		Number of Exceedances
			Minimum	Maximum	
Arsenic	40	LQM/CIEH	7.4	210	1 of 10
Cadmium	85	LQM/CIEH	<0.10	0.45	0 of 10
Chromium III	910	LQM/CIEH	4.9	13	0 of 10
Chromium VI	6	LQM/CIEH	<0.5	<0.5	0 of 10
Copper	7100	LQM/CIEH	24	98	0 of 10
Lead	310	pC4SL	52	1200	2 of 10
Mercury (inorganic)	56	LQM/CIEH	0.15	0.80	0 of 10
Nickel	180	LQM/CIEH	7.1	16	0 of 10
Selenium	430	LQM/CIEH	<0.25	0.96	0 of 10
Zinc	40000	LQM/CIEH	40	200	0 of 10
Cyanide	8*	-	<0.50	2.4	-
Boron	11000	LQM/CIEH	0.85	7.6	0 of 10
Sulphate (%)	0.24	BRE	0.045	0.20	0 of 10
Organic Matter (%)	-	-	2.1	4.7	-
pH	-	-	8.3	9.8	-
Phenols	120	LQM/CIEH	<0.10	4.4	0 of 10
Notes:					
- No available guideline					
* CLEA guideline withdrawn but used as guide only to show maximum recorded concentration is very low.					

5.2.2 Organics

Ten samples were tested for speciated polycyclic aromatic hydrocarbons. The summarised results are in **Table 5.2**.

Table 5.2 Summary of Soil Chemical Test Results – Speciated Polycyclic Aromatic Hydrocarbons

Substance	Threshold Value	Source	Measured Concentrations (mg/kg)	Number of Exceedances
-----------	-----------------	--------	---------------------------------	-----------------------

	(mg/kg)		Minimum	Maximum	
Naphthalene	2.3	LQM/CIEH	<0.10	370	9 of 10
Acenaphthylene	2900	LQM/CIEH	<0.10	22	0 of 10
Acenaphthene	3000	LQM/CIEH	<0.10	42	0 of 10
Fluorene	2800	LQM/CIEH	<0.10	200	0 of 10
Phenanthrene	1300	LQM/CIEH	<0.10	790	0 of 10
Anthracene	31000	LQM/CIEH	<0.10	490	0 of 10
Fluoranthene	1500	LQM/CIEH	22	1300	0 of 10
Pyrene	3700	LQM/CIEH	22	1300	0 of 10
Benzo(a)anthracene	11	LQM/CIEH	11	590	9 of 10
Chrysene	30	LQM/CIEH	12	660	7 of 10
Benzo(b)fluoranthene	3.9	LQM/CIEH	13	610	10 of 10
Benzo(k)fluoranthene	110	LQM/CIEH	5.9	270	2 of 10
Benzo(a)pyrene	3.2	LQM/CIEH	11	600	10 of 10
Indeno(123cd)pyrene	45	LQM/CIEH	6.6	370	4 of 10
Dibenzo(ah)anthracene	0.31	LQM/CIEH	2.5	80	10 of 10
Benzo(ghi)perylene	360	LQM/CIEH	6.2	550	1 of 10
Total PAH	-	-	110	7700	-
Notes:					
Thresholds based on 1.0% soil organic matter					
- No available guidelines					

Ten samples were tested for petroleum hydrocarbon. The summarised results are shown in **Table 5.3**.

Table 5.3 Summary of Soil Chemical Test Results – Petroleum Hydrocarbons

Substance	Threshold Value (mg/kg)	Source	Measured Concentrations (mg/kg)		Number of Exceedances
			Minimum	Maximum	
Aliphatic					
PH C5 – C6 Ali	42	LQM/CIEH	<1.0	<1.0	0 of 10
PH C6 – C8 Ali	100	LQM/CIEH	<1.0	11	0 of 10
PH C8 – C10 Ali	27	LQM/CIEH	<1.0	680	1 of 10
PH C10 – C12 Ali	130	LQM/CIEH	<1.0	1000	1 of 10
PH C12 – C16 Ali	1100	LQM/CIEH	<1.0	4500	1 of 10
PH C16 – C21 Ali	65000*	LQM/CIEH	<1.0	6900	0 of 10
PH C21 – C35 Ali	65000*	LQM/CIEH	140	2600	0 of 10
PH C35 – C44 Ali	65000	LQM/CIEH	<1.0	470	0 of 10
Aromatic					
PH C5 – C7 Arom	370	LQM/CIEH	<1.0	<1.0	0 of 10
PH C7 – C8 Arom	860	LQM/CIEH	<1.0	<1.0	0 of 10
PH C8 – C10 Arom	47	LQM/CIEH	<1.0	12	0 of 10
PH C10 – C12 Arom	250	LQM/CIEH	<1.0	670	1 of 10
PH C12 – C16 Arom	1800	LQM/CIEH	<1.0	4700	1 of 10
PH C16 – C21 Arom	1900	LQM/CIEH	6.3	6300	3 of 10
PH C21 – C35 Arom	1900	LQM/CIEH	98	16000	4 of 10
PH C35 – C44 Arom	1900	LQM/CIEH	<1.0	1600	0 of 10
Notes: PH – Petroleum Hydrocarbon					

Ali – Aliphatic
 Arom – Aromatic
 Thresholds based on 1.0% soil organic matter
 * – Ali C16-21 and C21-C35 based on criteria for Ali EC >16-35

Five samples were tested for a full suite of volatile and semi-volatile organic compounds. Noteworthy compounds exceeding laboratory limits of detection are summarised in **Table 5.4**.

Table 5.4 Summary of Soil Chemical Test Results – Noteworthy VOC & SVOC

Substance	Measured Concentrations (mg/kg)	
	Minimum	Maximum
4-Methylphenol	<0.0005	0.00075
2-Methylnaphthalene	<0.0005	0.0056
Dibenzofuran	<0.0005	0.0091
Azobenzene	<0.0005	0.00069
Carbazole	<0.0005	0.041

5.2.3 Asbestos Testing

Ten soil samples were scheduled for asbestos screening. Asbestos was not detected.

5.3 Groundwater Test Results

Twelve groundwater samples were collected from boreholes BH03 to BH08 over two rounds of groundwater monitoring. The samples were tested for a suite of inorganic and organic determinands. The results are summarised in **Table 5.5** to **Table 5.7**.

Table 5.5 Summary of Groundwater Chemical Test Results – Inorganics

Determinand	Threshold Value (µg/l)	Source	Measured Concentrations (µg/l)		Number of Exceedances
			Minimum	Maximum	
Arsenic	50	WFD2	1.5	120	1
Cadmium	0.08	WFD1	<0.08	<0.11	BLDL
Chromium III	4.7	WFD2	<0.5	2.2	0
Chromium VI	3.4	WFD2	<0.5	2.2	0
Copper	1.0	WFD2	0.66	1.8	7
Lead	1.2	WFD1	<0.5	<0.5	0
Mercury	0.07	WFD3	<0.01	<0.05	0
Nickel	4	WFD1	<0.5	2.7	0
Selenium	10	DWD	<0.5	0.69	0
Zinc	10.9	WFD2	5.8	20	5
Cyanide, Total	1.0	WFD2	<5	<50	BLDL
Sulphide	-	-	<5	<5	BLDL
Sulphate (mg/l)	400	BRE	12	160	0
pH	-	-	7.1	8.1	-
BOD (mg/l)	-	-	4.6	8.0	-
COD (mg/l)	-	-	12	90	-
Electrical Conductivity (uS/cm)	-	-	920	9200	-
Hardness (mg/l)	-	-	250	1400	-

Notes:

WFD1 - Water Framework Directive – Inland Surface Waters (AA)
 WFD2 - Water Framework Directive – Freshwater (Long Term Mean)
 WFD3 - Water Framework Directive – Inland Surface Waters (MAC)
 DWD – Drinking Water Directive
 BRE – British Research Establishment
 - No available guideline
 * Conservative threshold for Chromium VI used
 BLDL - Below laboratory detection limit
 ALDL - Above laboratory detection limit

Table 5.6 Summary of Groundwater Chemical Test Results – Organics

Determinand	Threshold Value (µg/l)	Source	Measured Concentrations (µg/l)		Number of Exceedances
			Minimum	Maximum	
Naphthalene	2	WFD1	<0.01	4.3	2
Acenaphthylene	-	-	<0.01	<0.01	BLDL
Acenaphthene	-	-	<0.01	4.5	5
Fluorene	-	-	<0.01	2.7	5
Phenanthrene	-	-	<0.01	5.6	5
Anthracene	0.1	WFD1	<0.01	1.4	4
Fluoranthene	0.0063	WFD1	<0.01	8.2	5
Pyrene	-	-	<0.01	6.2	5
Benzo(a)anthracene	-	-	<0.01	<0.01	BLDL
Chrysene	-	-	<0.01	<0.01	BLDL
Benzo(b)fluoranthene	0.017	WFD3	<0.01	<0.01	0
Benzo(k)fluoranthene	0.017	WFD3	<0.01	<0.01	0
Benzo(a)pyrene	0.00017	WFD1	<0.01	<0.01	BLDL
Indeno(123cd)pyrene	-	-	<0.01	<0.01	BLDL
Dibenzo(ah)anthracene	-	-	<0.01	<0.01	BLDL
Benzo(ghi)perylene	0.0082	WFD3	<0.01	<0.01	BLDL
Phenols	7.7	WFD2	<3	<3	0

Notes:

WFD1 - Water Framework Directive – Inland Surface Waters (AA)
 WFD2 - Water Framework Directive – Freshwater (Long Term Mean)
 WFD3 - Water Framework Directive – Inland Surface Waters (MAC)
 - No available guideline
 ALDL - Above laboratory detection limit
 BLDL - Below laboratory detection limit

Table 5.7 Summary of Groundwater Chemical Test Results – Petroleum Hydrocarbons

Substance	Threshold Value (ug/l)	Source	Measured Concentrations (ug/l)		Number of Exceedances
			Minimum	Maximum	
Aliphatic					
TPH >C5 – C6 Ali	15000	WFD1	<1.0	<1.0	0
TPH C6 – C8 Ali	15000	WFD1	<1.0	<1.0	0
TPH C8 – C10 Ali	300	WFD1	<1.0	<1.0	0
TPH C10 – C12 Ali	300	WFD1	<1.0	<1.0	0
TPH C12 – C16 Ali	300	WFD1	<1.0	64	0
TPH C16 – C21 Ali	-	-	<1.0	980	4
TPH C21 – C35 Ali	-	-	<1.0	41000	4

TPH C35 – C44 Ali	-	-	<1.0	5000	3
Aromatic					
TPH C5 – C7 Arom	10		<1.0	<1.0	0
TPH C7 – C8 Arom	700		<1.0	<1.0	0
TPH C8 – C10 Arom	300		<1.0	<1.0	0
TPH C10 – C12 Arom	90		<1.0	2.0	0
TPH C12 – C16 Arom	90		<1.0	43	0
TPH C16 – C21 Arom	90		<1.0	97	1
TPH C21 – C35 Arom	90		<1.0	20	0
TPH C35 – C44 Arom	-	-	<1.0	<1.0	-
Notes: PH – Petroleum Hydrocarbon Ali – Aliphatic Arom – Aromatic					

Twelve samples were tested for a full suite of volatile, semi-volatile organic compounds, BTEX, and MTBE. Noteworthy compounds exceeding laboratory limits of detection are summarised in **Table 5.8**.

Table 5.8 Summary of Groundwater Chemical Test Results – Noteworthy VOC & SVOC

Substance	Measured Concentrations (mg/kg)	
	Minimum	Maximum
2-Methylnaphthalene	<0.0005	0.00081
Dibenzofuran	<0.0005	0.001
Dimethylphthalate	<0.0005	0.0012
Carbazole	<0.0005	0.0019
Di-N-Butyl Phthalate	<0.0005	0.058

SECTION 6 Geotechnical Testing Results

Geotechnical testing results are summarised in the following sections and presented in their entirety in **Annex I**.

6.1 Point Load Index Testing

Selected sections of rock cores were submitted to Apex Testing Services and scheduled for Point-Load Index testing and Uniaxial Compressive Strength testing.

The Uniaxial Compressive Strength (UCS) is related to the Point Load Index (IS_{50}) by a conversion factor, K , as follows;

$$UCS = (K) IS_{50}$$

Published K values for sedimentary rock typically range from 16 to 24 (Rusnak, J., Mark, C. *Using the Point Load Test to Determine the Uniaxial Compressive Strength of Coal Measure Rock*. 2000). TFW Group Ltd have typically found the K value to sit in the region of $K=20$ locally. This value has subsequently been employed to estimate UCS values where point load testing was undertaken. UCS values derived from point load testing results are summarised in **Table 6.1**.

Table 6.1 Summary of Point Load Index Test Results

Borehole	Depth (m)	Test Type (see results certificates)	Geological Formation	Point Load Index (Is ₅₀)	Uniaxial Compressive Strength (MPa)	UCS corrected for a Factor of Safety of 3 (MPa)
	Point Load Index Tests (UCS derived from Is ₅₀ and K=20)					
BH01	19.0	A	Mudstone	0.06	1.2	0.4
BH01	21.0	D	Mudstone	2.27	45.4	15.13
BH01	15.5	I	Mudstone	2.13	42.6	14.2
BH01	17.3	D	Sandstone	2.50	50.0	16.67
BH01	17.3	A	Sandstone	4.70	94.0	31.3
BH01	18.1	D	Mudstone	3.24	64.8	21.6
BH01	18.1	A	Mudstone	3.30	66.0	22.0
	UCS Test Results					
Borehole	Depth (m)			UCS (MPa)		
BH02	17.7-17.9		Sandstone	90.4		
BH02	19.55-19.71			28.0		

Table Notes:

- D - Diametral loading
- A - Axial loading
- I - Irregular lump

SECTION 7 Ground Gas Risk Assessment

7.1 Gas Risk Characterisation

Due to the presence of made ground and peat beneath the site, gas monitoring wells were installed within selected boreholes.

7.1.1 Gas Source

Made ground deposits with a significant organic content have the potential to produce methane and carbon dioxide gasses.

7.1.2 Gas Migration Pathways

Gas migration can take place through the superficial deposits, up alongside foundations and into buildings through service entries, drains and cracks.

The migration of ground gas from peat at depth is reduced significantly by overlying clay deposits of very low permeability and low organic content.

7.1.3 Potential Receptors

Future occupants are considered potential receptors of ground gas.

7.1.4 Driving Forces

The installation of piled foundations, which will be required for the proposed development, can disturb the clays of low permeability to provide a driving force upwards from the organic soils at depth, alongside the pile and the newly created pathways.

7.2 Gas Screening Value

Four ground gas monitoring wells were installed in WS01, WS03, WS04 and WS05. Installation details are shown on the relevant log.

Six rounds of gas monitoring have been carried out. The installations were tested for carbon dioxide, methane, oxygen, carbon monoxide and hydrogen sulphide using a Gas Analyser GA5000.

Recorded gas concentrations are summarised in **Table 7.1**.

Table 7.1 Measured Gas Concentration Summary

Gas	Minimum (% V/V)	Maximum (% V/V)
Methane	0.1	32.8
Carbon Dioxide	0.1	10.1
Oxygen	0.2	20.7

Methane levels peaked at 32.8% V/V. Carbon dioxide levels varied between 0.1% and 10.1% V/V. Oxygen concentrations varied between 0.2% and 20.7% V/V.

The gas flow rate from the boreholes was also assessed, a maximum flow rate of 0.3l/hr was recorded.

Based on a flow rate of 0.3 l/hr and the highest recorded carbon dioxide concentration of 10.1%, a gas screening value of 0.0282 l/hr is calculated, as follows:

$$(10.1/100) \times 0.3 = 0.0303 \text{ l/hr}$$

The results to date are presented in **Annex J**.

When this monitoring result is compared with Table 8.5 of CIRIA report C665, the site is classified as 'Gas Characteristic Situation 1' (CS1). However, as the peak methane has risen significantly above 1%, and carbon dioxide above 5% consideration should be given to raising the classification to 'Gas Characteristic Situation 2' (CS2) in line with recommendations provided in CIRIA C665. This is discussed further below.

7.4 Quantitative Risk Assessment

It is common in natural soils and low generation made ground for concentrations of carbon dioxide above 5% to be present, but for the Gas Screening to indicate Characteristic Situation CS1. Ternary plots can be used to identify when concentrations above 5% caused by microbial respiration of carbon dioxide or similar low risk processes do not require an increase from Characteristic Situation CS1 to CS2.

The gas monitoring results were inputted into the LQM Ternary Gas Composition Tools.

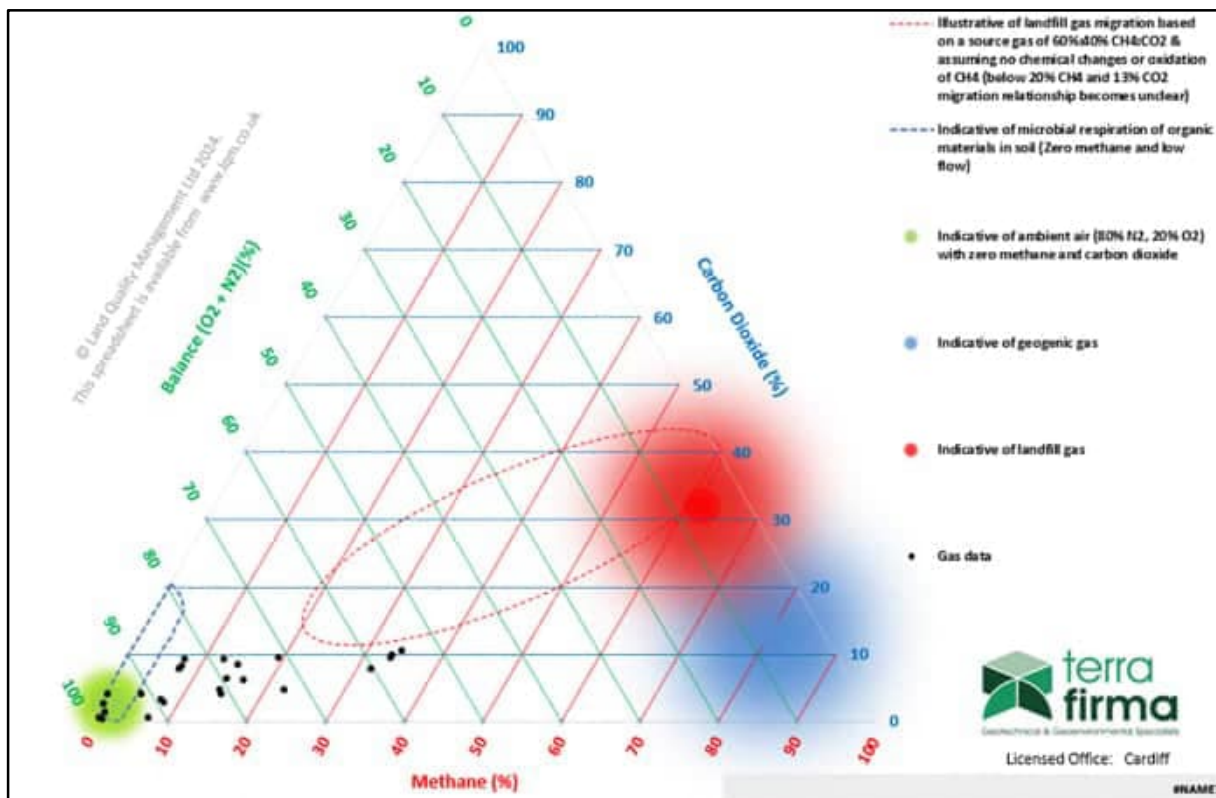


Figure 9.1 Methane, Carbon Dioxide and Balance Gas Ternary Plot

The Ternary Plot shown on **Figure 9.1** uses oxygen and nitrogen ($O_2 + N_2\%$) versus methane ($CH_4\%$) and carbon dioxide ($CO_2\%$). The plot indicates that the results are not indicative of landfill gas or geogenic gas. The plot is also not indicative of landfill gas migration, however as no landfills have been identified at or within proximity of the site, this would not be expected anyway.

Many of the results are centred around concentrations of ambient air, and microbial respiration of organic materials in soil. However, where the concentrations of methane increase, the source of the ground gas becomes less obvious. Figure 9.2 is a Ternary Plot from SoBRA's Hazardous Ground Gas Top Tips document. It indicates that the concentrations of ground gas that fall outside ambient air and microbial respiration of organic materials in soil are sourced

from made ground, which has a low rate of gas generation, and therefore a low risk of emissions.

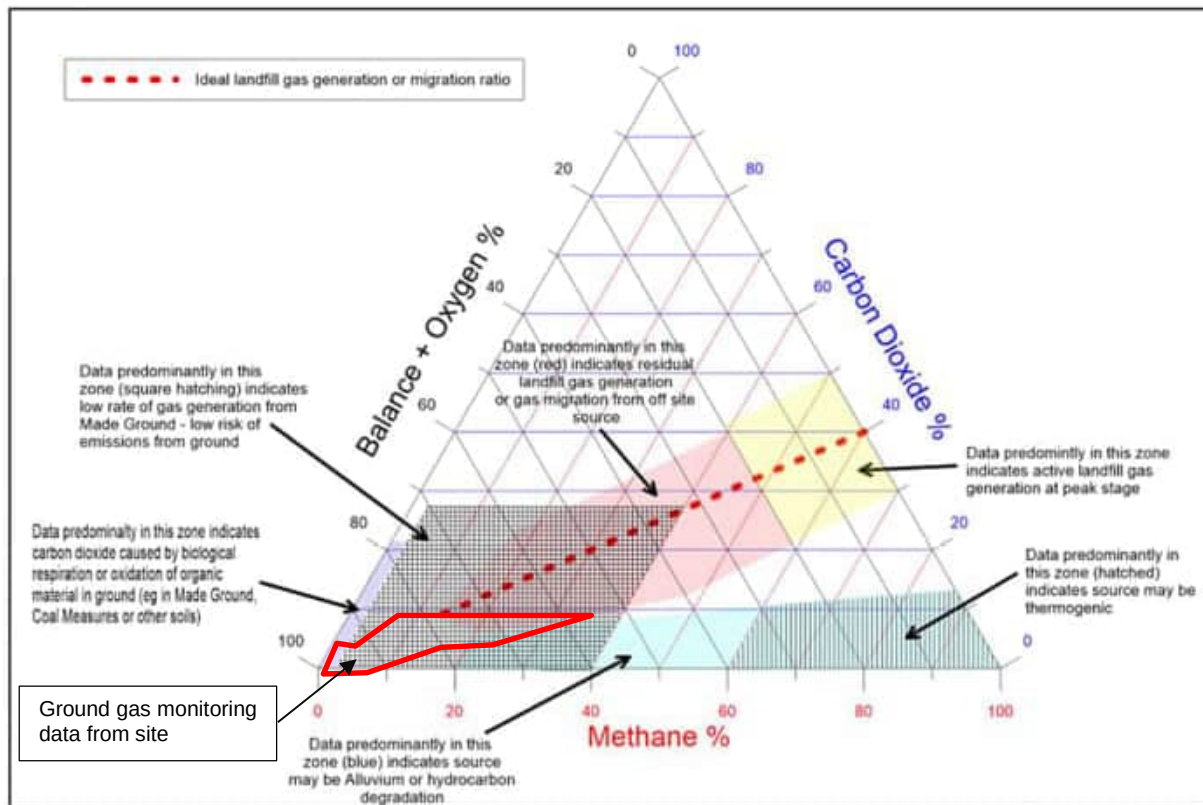


Figure 9.2 SoBRA Ternary Plot Guide

The made ground, identified as a potential source of ground gas at the site typically comprises of non-biodegradable material such as natural soil and rock fragments, ash, and brick. None of this material will decompose to create significant concentrations of methane or carbon dioxide. Further to this, the made ground beneath the site was used to infill a former brick works, between 1902 and 1920. The made ground was subsequently built upon by buildings. Biodegradable material is highly unlikely to have been deposited during this period, and unlikely to have been used for the purpose of a development plateau. Any small quantities of biodegradable material would either have broken down by now or will be broken down so slowly that the concentrations of ground gas being created will be negligible.

Alluvial soils and buried peat can quite often give high concentrations of methane and carbon dioxide in monitoring wells, often methane concentrations can reach up to 90%. This is because the gas has been generated historically and is trapped in the pores due to limited transport (at low diffusion rates). The methane accumulates at increasing depth in peat columns, but this does not indicate high rates of production (Clymo and Bryant, 2008; Fritz et al., 2011). There is no, or very little, current gas generation and the carbon dioxide has dissolved out of the gas trapped in the soil pores which causes a higher percentage of methane to be recorded. It is considered that this is the source of the high methane and carbon dioxide concentrations. The consistently low flow rates also suggest that there is negligible gas generation.

The response zone installed within the Tidal Flat Deposits has created an artificial mechanism by which gas can enter the headspace of the well. The saturated cohesive deposits would naturally act as a barrier to this gas. Due to the depth at which these layers are located, there is no realistic pathway for the ground gas to migrate to the surface.

These results are broadly consistent with previous monitoring undertaken in the made ground for the broader site area in 2021. The only results that were elevated from the previous phase December 2024

of gas monitoring were in wells with response zones located with the tidal flat deposits with lenses of peat. The response zones were installed primarily for groundwater monitoring rather than for ground gas.

Natural soils that are known to contain methane, e.g. Alluvium, Peat, etc, providing pockets of trapped gas cannot be released quickly following changes in groundwater level (which is rare and not likely on most sites).

7.3 Conclusion

The gas monitoring results are consistent those expected for a site underlain by natural soils with high peat/organic content and “typical” made ground. However, given the negligible rate at which the ground gas is generated, it is considered that the risk from ground gas at the site is very low and that ground gas protection measures are not necessary. The site should therefore be classified as ‘**Gas Characteristic Situation 1**’ (**CS1**).

SECTION 8 Quantitative Risk Assessment

8.1 Contaminants of Concern

Contaminants identified as part of the investigation are summarised in **Table 8.1** and **Table 8.2**, along with an interpretation of the likely contamination source. Where applicable, the contaminant, source relationship is based on the inferences made in the preliminary conceptual site model.

Table 8.1 Contaminants of Concern in Soils

Location	Depth	Contaminant	Source
SA1	0.9	Naphthalene, Fluorene, Phenanthrene, Fluoranthene, Pyrene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	S2 -Past site use (depot, car sales, vehicle maintenance).
WS01	0.5	Arsenic, Naphthalene, Phenanthrene, Fluoranthene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS02	0.6	Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS03	0.6	Naphthalene, Fluorene, Phenanthrene, Fluoranthene, Pyrene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene, Benzo[g,h,i]perylene	
WS04	0.6	Naphthalene, Phenanthrene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS05	0.4	Lead, Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Dibenz(a,h)Anthracene	
WS06	0.7	Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS07	0.4	Lead, Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS08	1.5	Benzo[a]anthracene, Benzo[b]fluoranthene, Benzo[a]pyrene, Dibenz(a,h)Anthracene	
WS09	0.5	Lead, Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Dibenz(a,h)Anthracene	

The compounds 4-Methylphenol, 2-Methylnaphthalene, Dibenzofuran, Azobenzene and Carbazole were also found above laboratory detection limits.

Table 8.2 Contaminants of Concern in Groundwater

Location	Depth	Contaminant	Source
BH03 (Shallow)	3.0-6.0m	Copper, Zinc, Aliphatic TPH >C16-C21, Aliphatic TPH >C21-C35, Aliphatic TPH >C35-C44, Dimethylphthalate, Carbazole, Di-N-Butyl Phthalate, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene	S2 -Past site use (depot, car sales, vehicle maintenance).
BH04 (Deep)	8.0-12.0m	Copper, Zinc, Carbazole, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene	S2 -Past site use (depot, car sales, vehicle maintenance).
BH05 (Shallow)	3.0-6.0m	Copper, Zinc, Naphthalene	S2 -Past site use (depot, car sales, vehicle maintenance).
BH06 (Deep)	8.0-12.0m	Copper, Zinc	S2 -Past site use (depot, car sales, vehicle maintenance).
BH07 (Deep)	8.0-12.0m	Copper, Zinc, Di-N-Butyl Phthalate	S2 -Past site use (depot, car sales, vehicle maintenance).
BH08 (Shallow)	3.0-6.0m	Copper, Aliphatic TPH >C16-C21, Aliphatic TPH >C21-C35, Aliphatic TPH >C35-C44, Aromatic TPH >C16-C21, 2-Methylnaphthalene, Dibenzofuran, Carbazole, Di-N-Butyl Phthalate, Naphthalene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene	S2 -Past site use (depot, car sales, vehicle maintenance).

The contaminants identified in the groundwater and soil are generally indicative of petrol, diesel and lubricating oils. PAHs, Dibenzofuran, 2-Methylnaphthalene, and Carbazole are frequently released into the environment via the combustion of fossil fuels such as vehicle exhaust, which would explain their presence at the site given its former use as a car sales and maintenance garage. Many of these contaminants were also found at elevated concentrations in the soil.

Di-N-Butyl Phthalate and Dimethylphthalate are plasticisers and are released fairly easily from plastic products by leaching if not disposed of properly. They are often found in car parts.

Most of the contaminants, and highest concentrations are recorded from the shallower response zones, however minor concentrations of Carbazole and Di-N-Butyl Phthalate were also detected in the deeper response zones. Elevated concentrations of naphthalene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, and Pyrene were also recorded in one of the deeper wells, at a similarly elevated concentration to one of the shallow wells. This indicates that either there is a possible pathway between the shallower groundwater and the deeper groundwater, despite the presence of the low permeability of the tidal flat deposits between the two, or the contamination has migrated from off-site.

Although no official UK target concentrations exist for Di-N-Butyl Phthalate or 2-Methylnaphthalene, both fall well below the USEPA tap water thresholds of 900µg/litre and 36µg/litre respectively. This suggests the risk to the aquatic environment from these compounds is insignificant. The compounds' overall relative mobility in groundwater are low to moderate and moderate respectively.

Although the maximum concentrations of naphthalene (4.3µg/litre) exceeded the threshold of 2.0µg/litre, the exceedances are relatively minor. It should also be noted that the threshold is based on protection of freshwater or saltwater organisms. Given that the site is located 160m from the Usk, the impact from the naphthalene beneath the site will reduce significantly following the effects of dilution and natural attenuation by the time it reaches the river. Anthracene and Fluoranthene were also elevated when compared to their threshold for the WFD threshold for inland surface water. However, given that they both have low overall relative

mobility in groundwater, their impact is also considered to be significantly reduced by the time it reaches the river.

There are no UK thresholds for Acenaphthene, Fluorene, Phenanthrene, and Pyrene. However, USEPA tap water thresholds for Acenaphthene, Fluorene, and Pyrene (530µg/litre, 290µg/litre, and 120µg/litre suggest they do not pose a significant risk to the aquatic environment. All four compounds have low overall relative mobility in groundwater.

There are no relevant target concentrations for Aliphatic TPH bands C16-C21, C21-C35, and C35-C44. However, given their expected very low mobility in groundwater, and the effects of biodegradation, dilution and natural attenuation, these heavy TPHs are not expected to pose a significant risk to the surrounding groundwater through horizontal and vertical migration (as indicated by the isolation of the high concentrations identified), or the River Usk located 160m away.

Arsenic, copper and zinc were also recorded within both the shallow and the deeper response zones. However, given the relatively minor exceedances recorded and the urban, post-industrial location of the site and the infilled land in proximity of the site, these contaminants are highly unlikely to deteriorate the surrounding groundwater body, and are not considered to pose a significant risk to the aquatic environment.

The Electrical Conductivity results are indicative of brackish groundwater, as expected near to the Usk estuary. The moderate COD concentrations in both the shallow response zone and deeper response zone are indicative of some organic or inorganic contaminants, as expected in an urban area.

8.2 PID Monitoring

A photo-ionisation detector was used to monitor for volatile organic compounds (VOCs) in each of the 9No. wells installed across the site.

Table 8.3 Measured Gas Concentration Summary

Location	Peak Concentration (ppm)
WS01	0.3
WS03	0.0
WS04	0.0
WS05	1.2
BH03	0.9
BH04	0.0
BH05	2.9
BH06	0.0
BH07	0.0
BH08	0.0

Most of the monitoring wells recorded no concentrations above 0.0ppm.

Where total VOC concentrations were recorded, they varied between 0.3ppm and 2.9ppm. The maximum concentration when converted to mg/kg is 9.4mg/m³, which lies well above the current Building Regulations Part F indoor air performance guideline of 0.3mg/m³. It also lies above the Work Exposure Limits (WELs) for benzene of 1ppm over an 8-hour time-weighted average).

The concentration of the total VOC is likely to fall dramatically by the time it migrates into the proposed building. This is confirmed by the Estimation of Passive Ventilation Performance presented in **Annex K**.

The calculation uses the maximum recorded concentration recorded by the PID, and assumes the following typical building construction, compared to a benzene guideline of 1ppm:

1. 150mm height void.
2. Full connectivity of void space across the width of structure.
3. 1No. 6000m² free air space air brick per 3m along the full length of the structure on both sides, 20No. air bricks in total per side.
4. Air bricks to be at least 150mm above finished ground level.

It is therefore considered that the underfloor void and ventilation would achieve a 'very good performance' by diluting hazardous vapours within the subfloor void space to concentrations below that which are considered hazardous to health.

The assessment should be reviewed following receipt of the final construction design drawings.

8.3 Pollutant Linkages

Based on the findings of the intrusive site investigation and identified contaminants, the preliminary conceptual site model has been revised. Significant pollutant linkages are tabulated in the refined conceptual site model **Table 8.3**. Identified pollutant linkages will require detailed risk assessment, appropriate mitigation or remedial measures.

Table 8.4 Refined Conceptual Site Model

Source	Pathway	Receptor
S1 – Made ground S2 – Past site uses	P1 - Direct soil and dust ingestion P2 - Consumption of home grown produce P3 - Dermal contact P4 - Inhalation of dust and vapours P9 - Plant uptake P10 – Horizontal and vertical migration of ground gasses and vapours	R1 - Construction and maintenance workers R2 - Future site users (residents) R3 – Passers-by or neighbouring site users R4 – Groundwater R5 – Surface Waters

8.4 Mitigation and Remedial Measures

The following sections summarise the likely mitigation and remedial measures suitable for the identified contamination and proposed development. Detailed methodology to achieve the measures should be prescribed in a Remediation Strategy Report and the results presented in a Validation Report upon completion of the development.

8.4.1 Human Health

8.4.1.1 Contaminated Soils

To protect future site users from the identified contamination the site will need to be capped. The capping should consist of the proposed buildings and hard standings. In garden and soft landscaped areas the capping should consist of 600mm of suitable inert topsoil, and subsoil. The capping soils should be underlain by a no dig barrier and a capillary break/drainage layer due to the high concentrations of contamination.

As good practice, construction workers should adhere to good site management, COSHH, good standards of hygiene and appropriate health & safety on site, with personal protection equipment (PPE) and dust suppression where appropriate.

All imported soils should be validated as clean and suitable for use in accordance with 'Requirements for the Chemical Testing of Imported Soils for Various End Uses and Validation Cover Systems'.

For proposed new supply water pipes, the UK Water Industry Research publication 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites (Report 10/WM/03/21)' should be consulted.

In accordance with EC Regulation 1272/2008 and Environment Agency Guidance WM3 soils destined for off-site disposal should be classified on the basis of their hazard phrases prior to disposal. Soils are classified as a mirror entry waste and should be classified on the basis of their specific chemical properties.

If during earthworks ground conditions are encountered that are markedly different to those found during the investigation then the ground should be subject to additional sampling and testing and any necessary remedial measures designed and implemented before continuing with the works.

8.4.2 Aquatic Environment

Elevated concentrations of PAHs, TPHs and volatile organic compounds have been recorded within both the made ground, and shallow groundwater. Elevated concentrations of PAHs and minor exceedances of copper, zinc, carbazole and di-n-butyl phthalate were also recorded in the deeper groundwater. These contaminants are characteristic of the known historic uses at the site. The sources of contamination are likely to be accidental release of contaminants from the cars that previously occupied the site over many years rather than a leak from a buried tank for example.

No above or below ground fuel tanks have been identified at the site, either during the desk-based research, or during the exploratory investigation. It is considered that an ongoing source of contamination is therefore unlikely to be present at the site following its demolition and redevelopment. To ensure this is the case, during the building's demolition and removal of floor slab/hardstanding, it is recommended that a geoenvironmental engineer is present to confirm that no buried tanks, or contamination hotspots are present. A letter can then be provided to Newport City Council's contaminated land officer to confirm this. If any unexpected contamination or tanks are encountered during the demolition and groundworks, the geoenvironmental engineer should be informed and it should be dealt with accordingly.

Most of the organic contaminants recorded in the soil and groundwater have a very low to medium potential mobility ranking. The tidal flat deposits located directly beneath the made ground is recorded as unproductive strata. However, beneath the tidal flat deposits are possible river terrace deposits and sandstones of the St Maughan's Group; both of which are Secondary A aquifers. When comparing the contamination in the shallow wells with the deeper wells, there does appear to be some similarities indicating that a pathway may exist between the shallow groundwater and the more productive aquifer at greater depth. However, the concentrations of the organic contaminants in the deeper response zone tend to be far lower than those identified in the shallow, indicating degradation, natural attenuation, and dilution within the more productive aquifer. The tidal flat deposits are also likely to reduce the effectiveness of the pathway from the shallow groundwater body to the deeper groundwater.

Given the above, it is considered that the wider aquatic environment is at a very low risk from the site. It is therefore considered that a Level 3 Groundwater Assessment is not necessary. However, a Piling Risk Assessment should be carried out prior to the installation of piles to assess and manage the potential risks of contaminating controlled waters through the introduction of new migration pathways into the deeper groundwater body. This may lead to

further rounds of groundwater monitoring, samples taken and assessment. Groundwater monitoring before and after the piling may also be required.

The Piling Risk Assessment has already been commissioned by the client and will be carried out on completion of this report.

During the construction period, there is a risk to the environment/adjacent sites from de-watering, digging foundations, moving contaminated soil, drainage misconnections, discharges to local surface waters or the ground, runoff from construction materials and/or exposed ground, wheel washings and oil or chemical spills.

The risk is considered to be negligible as any adverse effects will be easily preventable by due diligence to good construction practise and housekeeping in preventing surface runoff and the spillage of materials.

The basic measures that should be taken are as follows:

- Prepare a drainage plan and mark the manholes to prevent pollutants accidentally reaching the surface water sewers;
- Carry out any activities that could cause pollution in a designated, bunded area, away from rivers or boreholes. Where possible it should drain to the foul sewer;
- Use settlement ponds to remove silty water;
- Store all oils and chemicals in a fully bunded area to prevent leaks or spills;
- Get advice on whether you need an environmental permit and apply in good time

SECTION 9 Engineering Recommendations

9.1 Preparation of Site

Prior to the demolition of the existing building, a full asbestos survey should be carried out. All deleterious materials should then be removed by licensed contractors to a suitable landfill facility.

All hard standing, floor slabs and foundations should be removed from beneath the proposed building extensions and areas of hard standing. Any buried obstructions should also be excavated and removed.

Allowances should be made for any temporary/permanent support works to any existing adjacent structure necessary as a result of the proposed works.

Contingencies should be made for the protection/diversion of any underground/overhead services present beneath/above the site brought about as a result of the proposed works.

Any reduced levels should be brought up to the required levels with suitable inert mainly granular materials. Department of Transport (DTP) type 2 sub-base or similar should be used and compacted in layers to the requirements of the Specification for Highway Works.

Allowances should also be made for the excavation of any soft spots/areas and their replacement with well compacted imported granular materials.

In accordance with EC Regulation 1272/2008 and Environment Agency Guidance WM3 soils and other materials destined for off-site disposal should be classified on the basis of their hazard phrases prior to disposal. Soils are classified as a mirror entry waste and should be classified on the basis of their specific chemical properties. Terra Firma offer this service if required.

9.2 Foundation and Floor Slab Solution

Given the low strength and variable consistency of the made ground soils and tidal flat deposits (soft clay and silts with peat) below the site, the use of traditional shallow foundations is prohibited. As such, a piled foundation solution will be required for structures on site.

Due to the proximity to a railway, it is recommended that continuous flight auger (CFA) piled foundations be utilised, to reduce vibrations occurring from traditional driven piles.

It is recommended a CFA piled foundation solution socketed into bedrock within the extremely weak to strong reddish grey MUDSTONE, strong greyish brown mottled grey SILTSTONE, weak to medium strong reddish brown and grey SANDSTONE and extremely weak to medium strong reddish brown and grey CONGLOMERATE, at depths ranging from 16.5m to 20.2m below existing ground level is used.

Significant allowances should be made for intermittent bands of residual bedrock such as that encountered at 18.3-19.55m in BH02. If such bands are encountered at termination depth, then the depth of pile should be increased until a competent layer is reached.

For a 300mm bored pile with a typical length of 19.2m an allowable working load of 400kN should be achieved. Variations in the above quoted length should also be expected.

Measurements should be put in place to monitor vibrations during pile installation. If vibrations exceed guideline levels, then measures should also be taken to dampen such vibrations. If, however, vibrations exceed permissible values then consideration should be given to an alternative solution.

The estimated working pile loads, pile type and lengths are for guidance only and should be confirmed by a specialist piling contractor and it may be prudent to install test piles at selected locations.

For the quoted pile sizes, founded within the competent in-situ materials, total settlements should not exceed 10mm with differential movements between adjacent piles being less than half this value.

Floor slabs should be designed as suspended.

It is understood that a 1.3m high king post retaining wall will be used at the east of the site.

Allowances should be made for the removal of any 'soft spots' and their replacement with well-compacted granular materials. Department of Transport (DoT) Type 2 materials or similar could be used and should be compacted in layers to the specification for Highway Works.

All foundation formations should be inspected by a suitably qualified Engineer before being concreted.

9.3 Excavations and Formations

Most of the shallow excavations will be possible with normal soil excavating machinery. Hydraulic breakers may be required if excavating floor slabs and foundations. Allowances should also be made for excavating unknown buried structures.

Shallow perched water and groundwater flows were not encountered during the investigation. Any water inflows together with rainwater infiltration should be dealt with by conventional pumping techniques. However, it should be noted that during times of heavy rainfall a higher water table will be encountered.

The sides of any excavations deeper than 1.20m, or shallower if unstable, should be supported by planking and strutting or other proprietary means.

The sub-formations/formations are likely to be susceptible to loosening, softening and deterioration by exposure to weather (rain, frost and drying conditions), the action of water (flood water or removal of groundwater) and site traffic.

Formations should never be left unprotected and continuously exposed to rain causing degradation, or left exposed/uncovered overnight, unless permitted by a qualified engineer.

Construction plant and other vehicular traffic should not be operated on unprotected formations.

As a minimum the formation/excavation surfaces must be protected by blinding concrete immediately after exposure.

Allowances should be made for the removal of soft spots/areas and their replacement with well compacted granular materials.

Allowances should also be made for special precautions to prevent formation deterioration in addition to the above.

9.4 Protection of Buried Concrete

When the results are compared with Table C2 of BRE Digest 1:2005, it indicates that buried concrete should generally conform to Class DS-1 AC-1s.

9.5 Access Roads and Car Parking Areas

For car parking and road areas, formations within the in-situ natural soils a CBR value of 5% may be used for design purposes.

Allowances should be made for the removal of any 'soft spots/areas' and their replacement with well-compacted granular materials as previously described.

Please note that the Local Council / Highways Authority may require in-situ CBR testing to be undertaken before a road is adopted. In-situ CBR Testing should be performed following earthworks to verify the performance of the engineered fill.

9.6 Storm Water Drainage

During the site investigation one soakaway test was undertaken in general accordance with BRE DG 365:2016. The soakaway test was carried out in trial pit SA1 within made ground.

The soakaway test recorded insufficient infiltration and was subsequently terminated early.

It is considered that soakaway storm water draining is unsuitable at the site.

SECTION 10 Recommended Further Work

A Piling Risk Assessment is required prior to the installation of piles to assess and manage the potential risks of contaminating controlled waters through the introduction of new migration pathways into the deeper groundwater body. The assessment may lead to further rounds of groundwater monitoring. Groundwater monitoring before and after the piling may also be required.