



Ground Gas Addendum Report
Proposed Industrial Development,
Pacific Park, Wrexham

Reference:14-255-R3-1
Date: July 2021



GROUND GAS ADDENDUM REPORT

Land to the South of Bridge Road North
Pacific Park
Wrexham
LL13 9PN

Prepared for:
Multimaq Limited

Report Ref: 14-255-R3-1
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1. INTRODUCTION

1.1. BACKGROUND

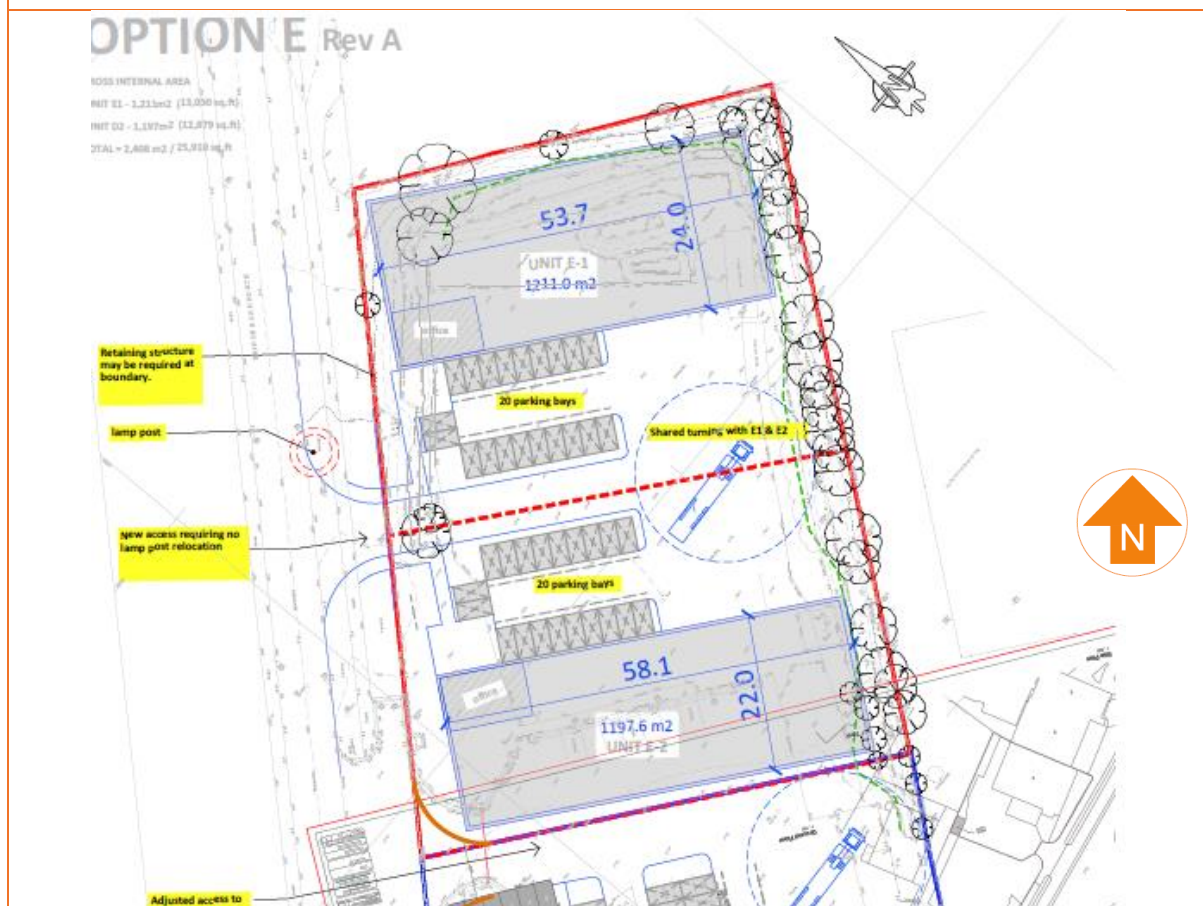
E3P has previously completed a ground investigation on the site known as Pacific Park, Wrexham. The findings of the ground investigation are presented within the E3P report entitled Phase II Geoenvironmental Site Assessment (report ref: 14-255-R2-1, dated May 2021).

During the investigation E3P installed ground gas monitoring wells, which were to be monitored over two months after installation. The data collected from the gas monitoring wells are summarised in this report and this comprises the completed ground gas assessment.

1.2. PROPOSED DEVELOPMENT

E3P understands that the proposed development will comprise of two industrial units with associated adopted estate roads and utility infrastructure. A snapshot of the proposed development layout is indicated in Figure 1.1.

FIGURE 1.1 SNAPSHOT OF PROPOSED DEVELOPMENT



1.3. OBJECTIVES

The objectives of the ground gas addendum report are to provide a detailed assessment of ground gas risk based on all available data from the E3P ground investigation works.

1.4. LIMITATIONS

The limitations of this report are presented in Appendix I.

1.5. CONFIDENTIALITY

E3P has prepared this report solely for the use of the client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from E3P; a charge may be levied against such approval.



2. INVESTIGATION RATIONALE

The ICSM has identified that the underlying Made Ground, infilled ponds and infilled land may represent a potential source of ground gas generation. Based on the identification of these sources, E3P has determined that the site represents a low ground gas source generation potential.

Within the context of the proposed industrial end use and ground gas generation potential, the gas assessment requires that six visits are required over three months, with at least two sets of readings at low or falling atmospheric pressure as set out within CIRIA 665 Tables 5.5a and 5.5b.

TABLE 2.1 GROUND GAS MONITORING LOCATION RATIONALE

LOCATION	GROUND GAS SOURCE	DEPTH OF MONITORING WELL (m)
WS101	Deeper Groundwater Well / Natural Strata	1.00–3.00
WS103	Made Ground	0.50–1.20
WS105	Deeper Groundwater Well / Natural Strata	1.00–4.00
WS106	Made Ground	0.50–1.00
CP101	Deeper Groundwater Well / Natural Strata	15.00–16.00
CP102	Deeper Groundwater Well / Natural Strata	21.00–22.00

2.1. MONITORING METHODOLOGY

Concentrations of methane (CH₄), carbon dioxide (CO₂) and oxygen (O₂) were measured using a calibrated infra-red gas analyser (GFM435) with gas flow rates were measured using an integrated flow meter.

Gas measurements were recorded for a minimum of 60 seconds at each location, at which point the maximum concentration of CH₄ and CO₂, together with the lowest concentration of O₂ were recorded. The results of the ground gas monitoring are presented in Table 2.2.



TABLE 2.2 SUMMARY OF GROUND GAS MONITORING RESULTS

WELL	DATE	CH ₄ INITIAL (%V/V)	CH ₄ STEADY (%V/V)	CH ₄ GSV (l/hr)	CO ₂ INITIAL (%V/V)	CO ₂ STEADY (%V/V)	CO ₂ GSV (l/hr)	O ₂ (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
WS101	25/02/21	0.10	0.10	-0.00601	0.10	0.10	-0.00601	20.20	1021	Rising	-6.01	1.00-3.00	2.86	G.L.
	10/03/21	0.10	0.10	0.00013	0.10	0.10	0.00013	20.30	1009	Falling	0.13		2.85	G.L.
	23/03/21	0.10	0.10	0.00026	0.10	0.10	0.00026	20.30	1012	Falling	0.26		2.67	0.22
	09/04/21	0.10	0.10	0.00052	0.30	0.30	0.00156	19.90	1019	Steady	0.52		2.68	0.25
	23/04/21	0.10	0.10	0.00026	0.20	0.20	0.00052	20.00	1029	Falling	0.26		2.67	0.54
	21/05/21	0.10	0.10	0.00013	0.20	0.20	0.00026	19.90	1017	Rising	0.13		2.67	0.62
WS103	Monitoring Well Destroyed											0.50-1.20	-	-
WS105	25/02/21	0.10	0.10	0.00448	0.10	0.10	0.00448	20.10	1021	Rising	4.48	1.00-4.00	3.63	0.30
	10/03/21	0.10	0.10	0.00396	0.20	0.20	0.00792	20.00	1009	Falling	3.96		3.62	0.44
	23/03/21	0.10	0.10	0.01116	0.40	0.40	0.04464	19.30	1012	Falling	11.16		3.62	0.36
	09/04/21	0.10	0.10	0.00874	0.30	0.30	0.02622	19.50	1019	Steady	8.74		3.61	0.41
	23/04/21	0.10	0.10	0.00734	0.40	0.40	0.02936	19.20	1029	Falling	7.34		3.60	0.68
	21/05/21	0.10	0.10	0.0067	0.30	0.30	0.0201	19.70	1017	Rising	6.70		3.60	0.74
WS106	25/02/21	0.10	0.10	-0.00144	1.30	1.30	-0.01872	19.20	1021	Rising	-1.44	0.50-1.00	0.77	Dry
	10/03/21	0.10	0.10	-0.00088	0.90	0.90	-0.00792	19.40	1009	Falling	-0.88		0.76	Dry
	23/03/21	0.10	0.10	0.00052	1.10	1.10	0.00572	19.30	1012	Falling	0.52		0.76	Dry
	09/04/21	0.10	0.10	0.00088	0.90	0.90	0.00792	19.50	1019	Steady	0.88		0.75	Dry
	23/04/21	0.10	0.10	0.0012	1.20	1.20	0.0144	19.20	1029	Falling	1.20		0.75	Dry
	21/05/21	0.10	0.10	0.00094	0.80	0.80	0.00752	19.20	1017	Rising	0.94		0.75	Dry



WELL	DATE	CH ₄ INITIAL (%V/V)	CH ₄ STEADY (%V/V)	CH ₄ GSV (l/hr)	CO ₂ INITIAL (%V/V)	CO ₂ STEADY (%V/V)	CO ₂ GSV (l/hr)	O ₂ (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)	
CP101	25/02/21	0.10	0.10	-0.00026	1.10	1.10	-0.00286	18.70	1021	Rising	-0.26	15.00– 16.00	14.74	1.07	
	10/03/21	0.10	0.10	0.00026	1.40	1.40	0.00364	18.20	1009	Falling	26.00		14.75	1.24	
	23/03/21	Unable to Access Monitoring Well.											-	-	
	09/04/21	0.10	0.10	0.00052	1.30	1.30	0.00676	18.50	1019	Steady	0.52		14.75	1.25	
	23/04/21	0.10	0.10	0.00013	1.10	1.10	0.00143	18.90	1029	Falling	0.13		14.75	2.54	
	21/05/21	0.10	0.10	0.00026	0.90	0.90	0.00234	19.20	1017	Rising	0.26		14.72	3.50	
CP102	25/02/21	0.10	0.10	-0.00159	0.10	0.10	-0.00159	19.90	1021	Rising	-1.59	21.00– 22.00	20.15	2.28	
	10/03/21	0.10	0.10	-0.00234	0.30	0.30	-0.00702	19.60	1009	Falling	-2.34		20.20	2.49	
	23/03/21	0.10	0.10	-0.01007	0.10	0.10	-0.01007	20.00	1012	Falling	-10.07		19.83	1.29	
	09/04/21	0.10	0.10	-0.0097	0.20	0.20	-0.0194	19.90	1019	Steady	-9.70		19.85	1.54	
	23/04/21	0.10	0.10	-0.0113	0.40	0.40	-0.0452	19.50	1029	Falling	-11.30		19.90	2.98	
	21/05/21	0.10	0.10	-0.01021	0.30	0.30	-0.03063	19.60	1017	Rising	-10.21		19.82	4.20	

NOTES

CIRIA Characteristic Situation		GSV	
	CS1	<0.07	Typical Max CO ₂ <5 % Typical Max CH ₄ <1 %
	CS2	<0.7	Flow rate not to exceed 70 l/hr otherwise consider increase to CS3
	CS3	<3.5	
	CS4	<15	Quantitative Risk Assessment required to evaluate scope of protective measures

Values in BLUE denote water above monitoring well



3. GROUND GAS RISK ASSESSMENT

3.1. GROUND GAS RISK ASSESSMENT METHODOLOGY

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIRIA Report 665 – *Assessing risks posed by hazardous ground gases to buildings* (2007). However, it is recommended that the full ground gas assessment and recommended protection measures are agreed with the local authority prior to their adoption on site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

CIRIA C665 and NHBC Report No 10627-R01 provide assessments for carbon dioxide and methane based upon gas screening values (GSVs) utilising flow rates and concentrations. The site-based GSVs for steady state methane and carbon dioxide are based upon the following equation:

$$GSV = \frac{\text{concentration (by vol)}}{100} \times \text{flowrate (1 / hr)}$$

The GSVs within CIRIA C665 are based upon all buildings other than standard residential houses. The NHBC GSVs are based upon standard residential houses with precast concrete floors (block and beam). The CIRIA 665 report author (Steve Wilson) since provided further clarification regarding which guidance should be adopted for residential houses that have suspended cast in-situ concrete floor slab: for the avoidance of doubt, it was confirmed that the GSVs within the CIRIA 665 guidance should be adopted.

The GSVs within CIRIA C665 are based upon all buildings other than standard residential houses. The thresholds for GSVs based upon CIRIA guidance are provided within Table 3.1.

TABLE 3.1 THRESHOLDS FOR GAS SCREENING VALUES (GSV) IN ACCORDANCE WITH CIRIA C665 COMMERCIAL END USE.

CLASSIFICATION	GSV (METHANE AND CARBON DIOXIDE)
CS1	< 0.07
CS2	< 0.70
CS3	< 3.5
CS4	< 15
CS5	< 70
CS6	> 70



3.1.1. SOURCES OF GROUND GAS

The Phase I report and subsequent ground investigation has identified the following potential sources of ground gas:

-  Made Ground deposits.
-  Infilled Pond.
-  Infilled land in close proximity to the site.

3.1.2. GROUND CONDITIONS

MADE GROUND

Made Ground deposits were encountered within all exploratory hole locations to depths of between 0.21m and 2.10m bgl (TP106), however, generally Made Ground was encountered to a depth of less than 1.60m bgl. Made Ground

Within TP101 a layer of black reworked clay (0.09-0.20m bgl) was observed overlying a layer of limestone gravel. The trial pit was terminated due to the likely presence of underlying services.

Made Ground deposits comprise a grey sandy gravel of concrete, limestone and asphalt overlying the majority of the site with the exception of TP103 where the location was overlain with a grey slightly silty, sandy gravel of limestone (MOT).

Underlying the above strata varying Made Ground deposits were encountered. Within WS101 a black sandy gravel of concrete and brick was encountered to depths of 0.61-0.70m bgl.

In locations (WS104, WS105, TP102, TP103, TP106, TP107, TP109, CP101) a reddish brown sandy gravel with gravel of brick, metal wire and plastic with large boulders of concrete and sections of brick wall encountered at depths of between 0.14-1.21m bgl.

In locations TP106 and TP108 a stiff blackish brown gravelly clay was observed overlying the reddish brown gravel at depth of between 0.60-1.00 mbgl and 0.50-1.20mbgl respectively.

In locations (WS102, WS103, TP104) a brownish black sandy gravel with pockets of clay were encountered where the gravel consisted of ash, clinker and mudstone at depths of between 0.33-1.88m bgl. In the case of TP104 a clay layer was observed overlying this layer. This strata is likely to be associated with the former railway tracks.

A layer of firm brownish black sandy gravelly clay was observed in (WS101, WS104, TP102, TP103, TP107, TP108, TP109 and CP101) at depths of between 0.48-1.60m bgl. This was observed as a layer of reworked natural stratum.

Within TP102 a layer of asphalt (0.04-0.07m bgl) was observed to be overlying a layer of concrete (0.07-0.19m bgl) which was underlain with a layer of reddish brown sandy gravel (0.19-0.72m bgl), which was in turn underlain with a layer of reworked clay (0.72-1.42m bgl).

DRIFT DEPOSITS

Drift deposits were encountered within the majority of exploratory location with the exception of TP101 where the full depth of Made Ground could not be proven due to potential underlying services.



The drift deposits generally comprised a stiff to very stiff, high to very high strength brown slightly gravelly CLAY with gravel of sandstone and quartz.

CLAY deposits were interbedded with a brown slightly clayey medium SAND within CP101 at a depth of 15.70-15.90m bgl and in CP102 at depths of between 21.20-21.40m bgl.

SOLID GEOLOGY

Solid geology was not encountered during the ground investigation. A review of BGS borehole records in the vicinity of the site have not encountered the underlying bedrock geology, and it is assumed to be in excess of 30.00mbg

3.1.3. GROUNDWATER

WS101, WS105, CP101 and CP102 were flooded during the monitoring period and therefore cannot be included within the gas assessment.

Within WS106 no groundwater was observed during the monitoring period with the installation being noted as dry throughout.

3.1.4. GAS FLOW

During the monitoring a positive flow was noted within WS106 in four occasions, while on two occasions a negative flow was observed.

Negative flows are indicative of back pressure from wind being greater than the active flow from the wells. The positive flow may be due to the presence of ground gas however the concentrations are considered to be very low.

Within the remaining monitoring wells, both positive and negative flows were recorded however as they were flooded they will not be utilised within the assessment.

3.1.5. GAS CONCENTRATIONS

Methane has only been recorded at concentrations of 0.1 % v/v, the limit of detection (LOD).

Carbon dioxide concentrations have been recorded between 0.1 % v/v (LOD) and 1.40 % v/v. The maximum concentration within WS106 was recorded at 1.30 % v/v.

3.1.6. GAS ASSESSMENT

In accordance with the methodology outlined with the CIRIA publication C665, E3P have utilised the results of the ground gas monitoring surveys to calculate a tentative gas screening value (GSV). The GSVs for the monitoring positions are summarised in Table 3.2.

TABLE 3.2 GAS RISK PROFILE AND LOCATION

LOCATION	MAX CO ₂ (% v/v)	GSV (l/hr)	MAX CH ₄ (% v/v)	GSV (l/hr)	CLASSIFICATION
WS106	1.30	-0.01872	0.10	-0.00144	CS1

Note: WS101, WS105, CP101 and CP102 were flooded on all monitoring visits and therefore haven't been included within the assessment.



The GSV has been compared to the criteria outlined with CIRIA C665 to determine the level of risk to the proposed development and to ensure the appropriate remedial options are incorporated into any future building design in this area.

Ground gas monitoring suggests that the site can be classified as CS1, however, given there are a number of potential gas sources on site or in close proximity (Made Ground, infilled pond and off-site landfill cell), and the assessment has only been completed off one borehole as the remaining boreholes were flooded, an allowance of CS2 should be considered with further assessment required to confirm the ground gas regime.

As such, E3P have completed an RB17 assessment using TOC (Total Organic Carbon) results taken from chemical analysis of soil samples during the ground investigation to further refine the ground gas assessment.

4. RB17 APPROACH

In addition to the above ground gas monitoring, the potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIEH Research Bulletin 17 *A Pragmatic Approach to Ground Gas Risk Assessment* (RB17).

This approach is considered to provide additional lines of evidence in the consideration of the ground gas protection measures required at the subject site due to flooded monitoring wells. It is considered appropriate given the age and limited thickness of Made Ground identified.

The desk based analysis and subsequent ground investigation has identified the following potential sources of ground gas:

-  Made Ground deposits.
-  Infilled Pond.
-  Infilled land in close proximity to the site.

Given the low sensitivity of the site with respect to hazardous ground gas, it was considered that a ground gas assessment undertaken in accordance with the latest guidance provided by CL:AIRE in their research bulletin RB17 would be suitable as an addition to the above ground gas monitoring results.

CL:AIRE Research Bulletin RB17 provides an alternative framework for the investigation and assessment of ground gas that takes into account other factors such as site history and the nature of the ground conditions beneath a site. It has been prepared to allow gas well installation and monitoring to be avoided where appropriate and may also be used in conjunction with gas monitoring to reduce the monitoring period or to avoid extra gas monitoring where anomalous results are recorded. The assessment is summarised in Table 4.2.



4.1. RB 17 ASSESSMENT

Table 4.1 details the TOC results obtained from the soil analysis completed as part of the E3P site investigation.

TABLE 4.1 TOC RESULTS

LOCATION	MATERIAL	TOC (%)
TP104 1.90m	Made Ground: Blackish brown gravelly clay. Gravel is fine to coarse angular to sub-angular of brick and concrete.	1.9%
TP108 1.25m	Made Ground: Reddish brown sandy gravel. Gravel angular to subangular, fine to coarse of brick fragments.	1.7%
TP108 0.40m	Made Ground: Reddish brown sandy gravel. Gravel is fine to coarse angular to sub-angular of brick.	1.2%

TABLE 4.2 RB17 GROUND GAS RISK ASSESSMENT

ITEM	OUTCOME	ACTION	RISK SCORE
Have any credible OFF SITE ground gas sources been identified within the Desk Study & ICSM that would include: <i>Registered landfill within 250m; Historical landfill; Infilled pond within 50m; Infilled ground 100m.</i>	Yes	Infilled ground within 50m of the subject site and on-site.	3
Is the site located within close proximity to a variable groundwater regime (river or tidal) that could potentially influence the ground gas regime.	No	None identified however shallow groundwater has been identified which is considered to be variable from data obtained to date.	1
Has a credible pathway for the migration of gas from historical mine workings been identified.	No	None Identified	0
Average depth of Made Ground >5.0m	No	None Identified	0
Average depth Made Ground >3.0m	No	None Identified	0
Average Depth Made Ground >1.0m	Yes	Made Ground deposits encountered at an average depth of 1.60m bgl. Maximum depth of Made Ground proven at 2.10mbgl.	3
TOC <1	No	None Identified	0
TOC 1-3	Yes	TOC was observed between 1.2–1.9% within Made Ground deposits.	3
TOC >3	No	None Identified	0



ITEM	OUTCOME	ACTION	RISK SCORE
Made Ground In-situ >20 Years	Yes	It is anticipated the Made Ground has been in place in excess of 20 years based on when the adjacent building was constructed, and former pond was infilled.	2
Made Ground In-situ <20 Years	No	None Identified	0
Only natural soils with no potential to generate CH ₄	No	Made Ground deposits located on the subject site have the potential to generate methane.	3
Recorded coal gas emission	No	None Identified	0
Radon Protection Measures Required	No	None Identified	0
Risk Score			15

Notes for E3P RB17 Gas Risk Assessment

This risk assessment is an internal tool kit developed by E3P in due consideration of the guidance published within CL:AIRE RB17. The minimum score attributed is 0 with the assessment to be completed by a suitably qualified person deemed capable of making a reasoned and informed assessment.

4.1.1. RISK SCORE

-  0 = Not Applicable or Present
-  1 = Low
-  2 = Moderate
-  3 = High

4.1.2. RISK PROFILE

-  Cumulative risk score is ≤ 14 the site is deemed to be very low risk and thus conforms to Characteristic Situation 1
-  Cumulative risk score is ≥ 15 but ≤ 20 the site is deemed to be very low risk and thus conforms to Characteristic Situation 2
-  Cumulative risk score is > 20 the site is deemed to be very low risk and thus conforms to Characteristic Situation 3

4.2. RB17 CONCLUSION

The RB17 assessment indicates a cumulative score of 15 and suggests the site should be characterised as Characteristic Situation 2.



5. OVERALL CONCLUSIONS

Following the completion of the ground gas monitoring and subsequent RB17 assessment it is determined that the site should be classified as Characteristic Situation 2 and ground gas protection measures are required in the construction of the proposed development.

Given the site is underlain with Made Ground in excess of 1.00m, and on and off-site infilled features there is considered to be significant sources which have the potential to produce hazardous ground gases. Therefore, the proposed developments will likely require specialist protection measures as detailed below.

5.1. COMMERCIAL BUILDING GAS RISK MITIGATION

5.1.1. BRITISH STANDARD BS8485 (2015)+A1 (2019)

British Standard BS8485 (2015)+A1(2019) provides two types of residential property that require assessment. These building types are:

- ✳ **Type C Building** – Commercial building with central building management control of any alterations to the building or its uses and central building management control of the maintenance of the building, including the gas protection measures. Single occupancy of ground floor and basement areas. Small to large-size rooms with active ventilation or good passive ventilation of all rooms and other internal spaces throughout ground floor and basement areas. Probably civil engineering construction. Examples include offices, some retail premises, and parts of some public buildings (such as schools, hospitals, leisure centres and parts of hotels).
- ✳ **Type D Building** – Industrial-style building having large-volume internal space(s) that are well ventilated. Corporate ownership with building management controls on alterations to the ground floor and basement areas of the building and on maintenance of ground gas protective measures. Probably civil engineering construction. Examples are retail park sales buildings, factory shop floor areas, warehouses. (Small rooms within these style buildings should be separately categorised as Type B or Type C.)

Based on the ground gas risk assessment and the proposed Type D Building, it is envisaged that a point score of 1.5 will be required for affected properties, as summarised in Table 5.1.

TABLE 5.1 BS8485 (2015)+A1(2019) POINTS REQUIRED FOR TYPE A, B, C AND D BUILDINGS

CHARACTERISTIC SITUATION	MINIMUM GAS PROTECTION SCORE (POINTS)			
	HIGH RISK		MEDIUM RISK	LOW RISK
	TYPE A BUILDING	TYPE B BUILDING	TYPE C BUILDING	TYPE D BUILDING
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 ^{A)}	5.5 ^{A)}	4.5	3.5
5	— ^{B)}	6	5.5	4.5
6	— ^{B)}	— ^{B)}	— ^{B)}	6



TABLE 5.2 SUMMARY OF GROUND GAS MITIGATION MEASURES – BS8485 (2015)+A1(2019)

GAS PROTECTION SCORES FOR THE STRUCTURAL BARRIER		SCORE ^A	
Floor and Substructure Design			
Precast Suspended Segmental Subfloor (Beam and Block)		0	
Cast In-Situ Ground-Bearing Floor Slab (With Only Nominal Mesh Reinforcement)		0.5	
Cast In-Situ Monolithic Reinforced Ground-Bearing Raft or Reinforced Cast In-Situ Suspended Floor Slab With Minimal Penetrations		1 or 1.5 ^B	
Basement Floor and Walls Conforming to BS 8102:2009, Grade 2 Waterproofing ^{C D}		2	
Basement Floor and Walls Conforming to BS 8102:2009, Grade 3 Waterproofing ^{C D}		2.5	
Notes			
A) The scores are conditional on breaches of floor slabs, etc., being effectively sealed.			
B) To achieve a score of 1.5 the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations cast in (see A.2.2.2).			
C) The score is conditional on the waterproofing being provided by a suitable structural barrier with the design and detailing of the walls and floor meeting the requirements for Type B protection. The score cannot be assigned for Type A (waterproof membrane) or Type C (drained cavity wall).			
D) If a membrane is installed beneath and around the basement to provide Type A waterproofing (BS 8102:2009), it can be assigned a gas protection score in accordance with Table 7, if it meets all the criteria for a gas-resistant membrane in that table.			
When practical, utilities should enter the building above floor level with any conduit or meter housing being properly vented outside of the building.			
PROTECTION ELEMENT SYSTEM		SCORE	COMMENTS
Gas protection scores for ventilation protection measures			
(a) Pressure Relief Pathway – Usually formed of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building.		0.5	Whenever possible a pressure relief pathway (as a minimum) should be installed in all gas protection measures systems. If the layer has a low permeability and/or is not terminated in a venting trench (or similar), then the score is 0.
(b) Passive Subfloor Dispersal Layer – Media used to provide the dispersal layer are:  Clear void;  Polystyrene void former blanket;  Geocomposite void former blanket;  No-fines gravel layer with gas drains; and  No-fines gravel layer.	Very good performance	2.5	The ventilation effectiveness of different media depends on a number of different factors including the transmissivity of the medium, the width of the building, the side ventilation spacing and type and the thickness of the layer. The selected score should be assigned taking into account the recommendations in Annex B of BS 8485 (2015). Passive ventilation should be designed to meet at least “good performance”.
	Good performance	1.5	



PROTECTION ELEMENT SYSTEM	SCORE	COMMENTS
(c) Active Dispersal Layer – Usually comprising fans with active abstraction (suction) from a subfloor dilution layer with roof-level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers.	1.5 to 2.5	This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. There should be robust management systems in place to ensure the continued maintenance of the system, including pumps and vents. Active ventilation should always be designed to meet at least “good performance”.
(d) Active Positive Pressurisation – Provided by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket.	1.5 to 2.5	This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. The score assigned should be based on the efficient “coverage” of the building footprint and the redundancy of the system. Active ventilation should always be designed to meet at least “good performance”.
(e) Ventilated Car Park – Floor slab of occupied part of the building under consideration is underlain by a basement or undercroft car park.	4	Assumes that the car park is vented to deal with car exhaust fumes, designed to Buildings Regulations 2000, Approved Document F [9].



Gas Protection Score for the Gas-Resistant Membrane

Gas-resistant membrane meeting all of the following criteria:

- ✳ Sufficiently impervious to the gases with a methane gas transmission rate < 40 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method);
- ✳ Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- ✳ Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab);
- ✳ Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre-reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools);
- ✳ Capable, after installation, of providing a complete barrier to the entry of the relevant gas; and
- ✳ Verified in accordance with CIRIA C735.

2

The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints.

If a membrane is installed that does not meet all the criteria opposite then the score is zero.

A) Membrane with a methane gas transmission rate < 40.0 ml/day/m²/atm (average) for sheets and joints (tested in accordance with BS ISO 15105-1:2007 manometric method) is regarded as sufficiently impervious.

B) For example, reinforced LDPE (virgin polymer) membranes having a minimum mass per unit area of 370 g/m² and not significantly less than 0.4 mm thickness between the reinforcement scrim (tested in accordance with Procedure D (2 mm diameter tip) of BS EN ISO 9863-1:2016) installed above floor slabs are considered sufficiently strong to meet the performance criteria (see also C.3). Thicker and more robust membranes or an additional membrane protection layer should be installed directly beneath cast-in-situ floor slabs.

END OF REPORT



APPENDIX I

LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between E3P and the client as indicated in Section 1.3.
2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.
3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
4. During the site walkover, reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover, no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and do not constitute or replace full and proper surveys.
8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
9. E3P cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by E3P is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by E3P in this connection without their explicit written agreement there to by E3P.
10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.



APPENDIX II

GLOSSARY

TERMS

ACM	Asbestos-containing material	MMP	Materials management plan
ADS	Acoustic design statement	ND	Not detected
AST	Above-ground storage tank	NDP	Nuclear density probe
BGS	British Geological Survey	NMP	Noise management plan
BSI	British Standards Institute	NPSE	Noise policy statement for England
BTEX	Benzene, toluene, ethylbenzene, xylenes	NR	Not recorded
CA	Coal Authority	PAH	Polycyclic aromatic hydrocarbon
CBR	California bearing ratio	PCB	Polychlorinated biphenyl
CIEH	Chartered Institute of Environmental Health	PI	Plasticity index
CIRIA	Construction Industry Research Association	PID	Photo ionisation detector
CLEA	Contaminated land exposure assessment	POS	Public open space
CML	Council of Mortgage Lenders	PPE	Personnel protective equipment
CoC	Contaminants of concern	ProPG	Professional practice guidance
CSM	Conceptual site model	QA	Quality assurance
DNAPL	Dense non-aqueous phase liquid (chlorinated solvents, PCB)	SGV	Soil guideline value
DWS	Drinking water standard	SPH	Separate-phase hydrocarbon
EA	Environment Agency	SPT	Standard penetration test
EQS	Environmental quality standard	SVOC	Semi-volatile organic compound
FFL	Finished floor level	TPH	Total and speciated petroleum hydrocarbon
GAC	General assessment criteria	TPH CWG	Total Petroleum Hydrocarbon (Criteria Working Group)
GL	Ground level	UKWIR	United Kingdom Water Infrastructure Risk
GSV	Gas screening value	UST	Underground storage tank
HCV	Health criteria value	VCC	Vibro-concrete column
ICSM	Initial conceptual site model	VOC	Volatile organic compound
LEL	Lower explosive limit	VRSC	Vibro-replacement stone columns
LMRL	Lower method reporting limit	VSC	Vibro-stone columns
LNAPL	Light non-aqueous phase liquid (petrol, diesel, kerosene)	WHO	World Health Organisation
MCV	Moisture condition value	WRAP	Waste and Resources Action Programme



Pacific Park, Wrexham

Ground Gas Addendum

July 2021

MIBK	Methyl isobutyl ketone	WTE	Water table elevation
m	Metres	ppm	Parts per million
km	Kilometres	mg/m³	Milligram per metre cubed
% v/v	Percent volume in air	m bgl bgl	Metres below ground level
mb	Millibars (atmospheric pressure)	m bcl	Metre below cover level
l/hr	Litres per hour	mAOD	Metres above ordnance datum (sea level)
µg/l	Micrograms per litre (parts per billion)	kN/m²	Kilonewtons per metre squared
ppb	Parts per billion	µm	Micrometre
mg/kg	Milligrams per kilogram (parts per million)	SSRT	Site Specific Remediation Target
PSD	Particle Size Distribution	DD	Dry Density
CL:AIRE	Contaminated Land: Applications in Real Environments	Mc	Moisture Content
ρ	Bulk Density	GPR	Ground Penetrating Radar
NDP	Nuclear Density Probe	FFL	Finished Floor Level
LEL	Lower Explosive Limit	UKWIR	UK Water Industry Research
CIRIA	Construction Industry Research and Information Association	LOD	Limit of Detection

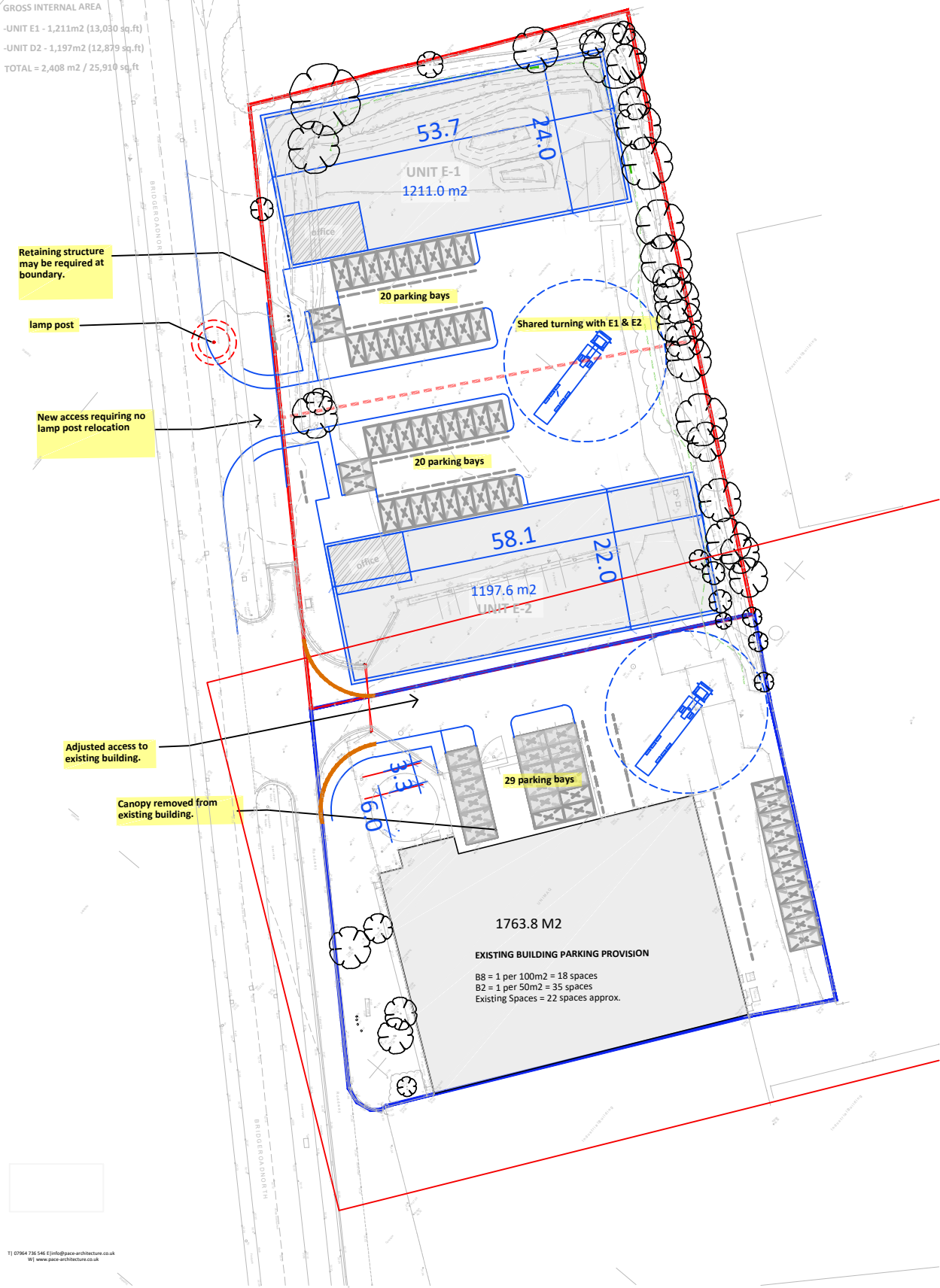


APPENDIX III

DRAWINGS

OPTION E Rev A

GROSS INTERNAL AREA
-UNIT E1 - 1,211m2 (13,030 sq.ft)
-UNIT D2 - 1,197m2 (12,879 sq.ft)
TOTAL = 2,408 m2 / 25,910 sq.ft



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Notes:				
P1	REVA	06.07.2020	LM	BH
Phase	Issue	Date	Drawn	Checked

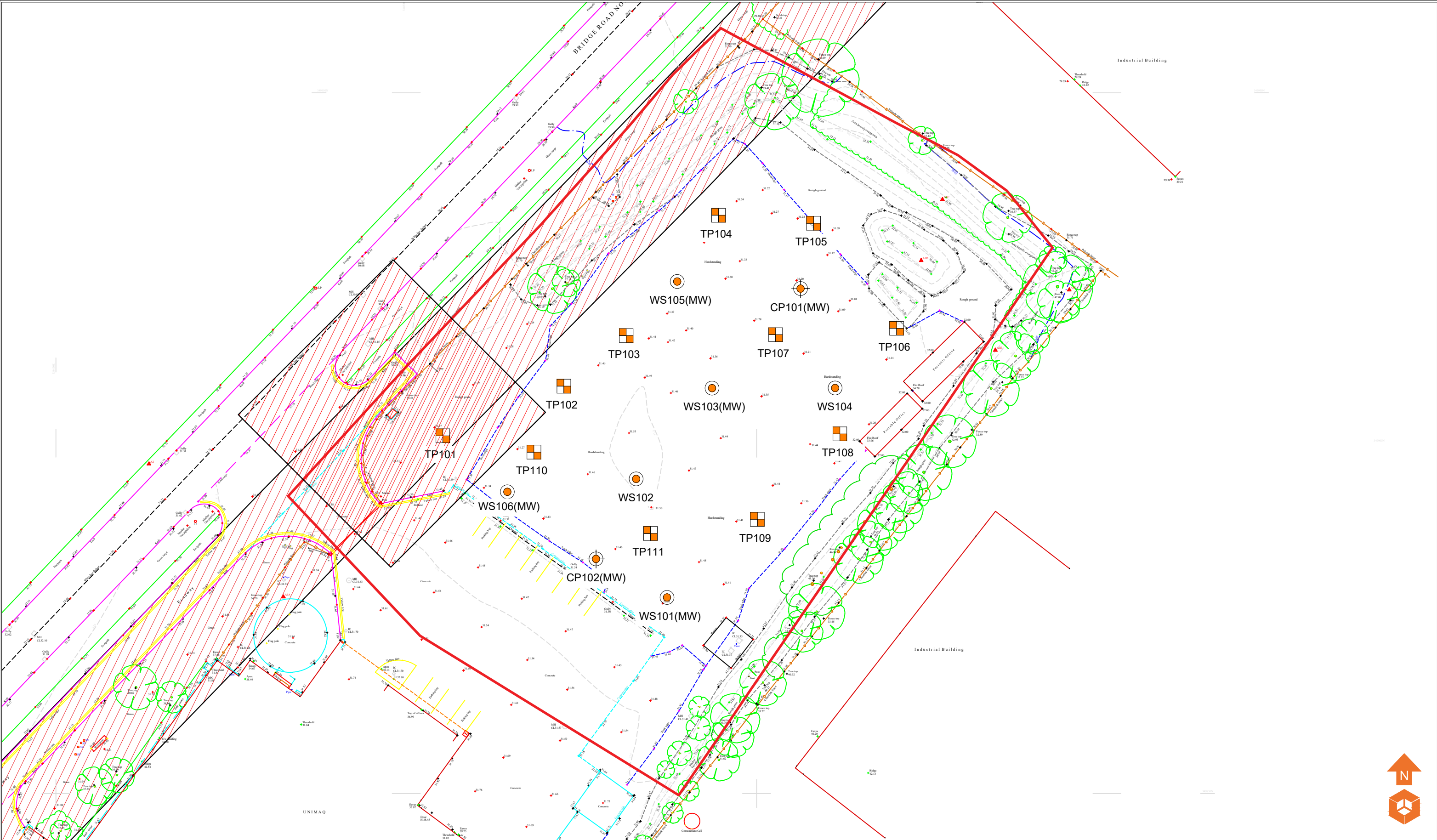
Client:	
Multimaq Ltd	
Job Title:	
Pacific Park, Wrexham	

Job No:	14-255	Date:	06.07.2020
Drawing No:	002	Scale:	NTS@ A3
Drawing Title:		Proposed Development Plan	



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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Trial Pit Location
- Approximate Cable Percussive Borehole Location
- Approximate Cable Percussive Borehole Location with Install
- Gas Main Easement / Gas Governor Box

Notes:

P1	REVB	12.05.2021	EB	BH
P1	REVA	26.02.2021	EB	MJ
Phase	Issue	Date	Drawn	Checked

Client:

Multimaq Ltd

Job Title:

Pacific Park,
Wrexham

Job No:

14-255

Drawing No:

005

Date:

12.05.2021

Scale:

NTS

Drawing Title:

Exploratory Hole
Location Plan



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