



Ground Gas Addendum Report
Sulby Street, Manchester

Reference: 15-395-R4
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GROUND GAS ADDENDUM REPORT

Land off Sulby Street
Manchester
M40 5HY

Prepared for:
Challenger Homes (Moston) Limited

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1. INTRODUCTION

1.1. BACKGROUND

E3P has previously completed a ground investigation on the site known as Sulby Street, Manchester. The findings of the ground investigation are presented within the E3P report titled Phase II Geoenvironmental Site Assessment (Ref: 15-395-R2-1) dated February 2023.

During the investigation E3P installed six ground gas monitoring wells, which were to be monitored over a period of three 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

Challenger Homes Ltd intends to construct eight townhouses and twelve apartments with associated adopted estate roads, landscaping/private gardens, and utility infrastructure. Drawing 15-395-002 (Appendix III) identifies the Proposed Development Layout and snapshot is presented in Figure 1.1 below.

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. RATIONALE

Hazardous ground gas qualitative risk assessment is based on a conceptual site model (CSM) similar to that used for soil and groundwater contamination sources (i.e., source pathway receptor pollutant linkages).

The risk can be assessed based on knowledge of the ground conditions and CSM and a measure of hazardous gas concentrations and gas flow at the site within monitoring standpipes.

2.1. SOURCES AND PATHWAYS OF GROUND GAS

Table 2.1 summarises the potential sources and pathways of ground gas within the context of the recorded site setting and proposed development.

TABLE 2.1 IDENTIFIED POTENTIAL SOURCES OF GROUND GAS

SOURCE
Made Ground The site has undergone limited historical development activities (construction and demolition of former buildings and possible cut/fill earthworks) and the only notable change is a pond that was mapped on the western boundary of the site, circa 1848 – 1915 that was infilled. The pond may have been infilled with significant amounts of Made Ground that could contain contaminants such as inorganic heavy metals and polycyclic aromatic hydrocarbons (PAHs). Made Ground has been identified across the majority of the site. Made Ground deposits were encountered within all exploratory hole locations from ground level to a proven depth of 2.50m bgl (WS101), although, in general, Made Ground was encountered to a depth of less than 1.00 m bgl. Asphalt hand standing in the east of the site between 0.07 to 0.09 m bgl has been encountered within WS101, WS102 and WS105. Below this brown to black very gravelly sand with frequent cobbles. Gravel is fine to coarse angular to subrounded of brick and ash. Cobbles are angular bricks. Reworked slightly sandy, gravelly clay is present within WS101 between 0.09-1.50 m bgl. Across the remainder of the site, no hard standing is present, and the Made Ground deposits comprise a reworked topsoil of dark grey gravelly sand with frequent rootlets. Gravel is fine to coarse angular to subrounded of brick and ash.
Drift Strata Drift deposits were encountered within all exploratory locations between 0.28 m bgl (WS106) to a maximum proven depth of 5.45 m bgl. The drift deposits across the site comprise of firm to very stiff brown CLAY. Firm to stiff brown slightly sandy CLAY was encountered in WS104 between 0.70 m bgl and 5.45 m bgl. Soft deposits have been identified within this deposit between 2.00 m and 3.00 m bgl.
Solid Strata The solid bedrock geology was not encountered within any exploratory holes.
Landfill Sites & Infilled Land There are no current landfill sites within an influencing distance of the site. However, several waste exceptions have been identified, 144 m southwest of the site has a using waste exception. 193 m west of the site six waste exceptions for storing and treating waste. These waste exceptions relate to waste storage and treatment facilities, which are unlikely to involve the burial of waste and therefore not considered a source of hazardous ground gases.



The pond that is mapped on the western boundary of the site extends offsite. No evidence of this feature has been found, however due to the presence of low-permeability drift deposits identified across the site it is considered that the lateral migration of the potential ground gases is inhibited. As such, the former pond is not considered to pose an unacceptable degree of risk associated with hazardous ground gases to the proposed development.

Other Gases

The BGS reports indicates that 1-3% of houses are above the 'Action Level'.

Elevated SVOCs have been encountered within Made Ground deposits associated with WS101 (1.70 m bgl) and WS105 (0.20 m bgl) in the form of 2-Methylnaphthalene and Dibenzofuran.

As part of the E3P Phase II Geoenvironmental Site Assessment (Ref:15-395-R2, dated February 2023) an SVOC assessment has been undertaken in Section 4.2.1 to assess the risk posed by the potentially volatile contamination. Within the context of the developed site CSM and the lines of evidence approach, it can be determined that the residual compound in this instance is highly unlikely to pose any risk in terms of vapour migration and ingress to the dwelling. There is not considered to be a risk to the future end user

The CIRIA C665 guidance on gas risk assessment includes recommendations for periods and frequencies for monitoring visits. These recommendations take into account the nature of the proposed development and the likely generation potential of the source.

The proposed development comprises private residential properties, which would be classified as a Type A development (high sensitivity) in accordance with BS8485:2015+A1:2019. However, it is considered that the likely generation potential of the identified gas sources (taking into account the likelihood of future increases in gas generation) would be best classified as low.

Therefore within the context of the proposed residential end-use and ground gas generation potential, the gas assessment requires nine visits over six months, with at least two sets of readings at low or falling atmospheric pressure.



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)*
-  BS8485:2015+A1:2019 – *Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*

BS8485 provides guidance on the level of gas protection requirements based upon the characteristic situation (CS) and the proposed development based on building type.

Therefore, in accordance with BS8485, based on the measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) shall be derived for each monitoring point, from which the site characteristic hazardous gas flow rate (Q_{hgs}), and then the Characteristic Situation (CS) can be determined.

The following equation should be utilised:

$$Q_{hg} = q \left(\frac{C_{hg}}{100} \right)$$

Where:

q is the measured flow rate (in litres per hour) of combined gases from the monitoring standpipe
 C_{hg} is the measured hazardous gas concentration (in percentage volume/volume).

The subsequent derived gas screening value (GSV) should be the maximum Q_{hg} (flow rate x concentration as a percentage volume) for all the monitoring events.

A 'worst case check' may be carried out using the maximum recorded flow in any hole with the maximum concentration in any hole to present the plausible worst case conditions. Adoption of the worst case Q_{hg} requires thorough justification and reference to the CSM.

The final derived GSV can then be used to characterise the site as summarised in Table 3.1.



TABLE 3.1 SITE CHARACTERISATION BY GSV (BS8485:2015)

CS	HAZARD POTENTIAL	GSV (l/hr) FOR METHANE AND CARBON DIOXIDE	ADDITIONAL FACTORS
CS1	Very Low	< 0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	< 0.70	Typical measured flow rate <70 l/h (otherwise consider an increase to CS3)
CS3	Moderate	< 3.5	N/A
CS4	Moderate to High	< 15	N/A
CS5	High	< 70	N/A
CS6	Very High	> 70	N/A

Notes

- 1) The CS is equivalent to the characteristic GSV in CIRIA C665.
- 2) The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter should be considered.
- 3) Gas Screening Value is the Borehole Gas Volume Flow Rate, in litres per hour, multiplied by the concentration in the air stream of the particular gas being considered.
- 4) The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

NHBC guidance (Report No 10627R01) can also be considered, if appropriate, which is based on standard residential houses with precast concrete floors (block and beam) / suspended cast in situ concrete floor slabs.

The thresholds for GSVs based upon NHBC guidance are provided within Table 3.2.

TABLE 3.2 THRESHOLDS FOR GAS SCREENING VALUES (GSV) IN ACCORDANCE WITH NHBC REPORT NO 10627R01 – RESIDENTIAL END USE

NHBC – SUBFLOOR VOID				
CLASSIFICATION	Methane ¹		Carbon Dioxide ¹	
	TYPICAL MAXIMUM CONCENTRATION ³ (%V/V)	GAS SCREENING VALUE ^{2,4} (l/hr)	TYPICAL MAXIMUM CONCENTRATION ³ (%V/V)	Gas Screening Value ^{2,4} (l/hr)
Green	< 1	< 0.16	< 5	< 0.78
Amber 1	< 5	< 0.63	< 10	< 1.56
Amber 2	< 5	< 1.56	< 30	< 3.10
Red	> 20	> 1.56	> 30	> 3.10

Notes

- 1) The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;
- 2) Gas Screening Value is the Borehole Gas Volume Flow Rate, in litres per hour, as defined in Wilson and Card (1999), which is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
- 3) The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
- 4) The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.



It should be noted that in the first instance, this assessment has been carried out in accordance with BS8485:2015+A1(2019) and the thresholds given in Table 3.1.

3.2. MONITORING METHODOLOGY

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

Gas measurements were recorded for a minimum of 300 seconds (5 minutes) at each location, increasing to 600 seconds if elevated concentrations identified, 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 3.3.

In addition to the raw data, the results for each individual standpipe have been assessed with reference to guidance provided in BS8485:2015. Based on the initial peak measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) have been derived for each monitoring point, from which an individual Characteristic Situation (CS) can ultimately be determined.



TABLE 3.3 SUMMARY OF GROUND GAS MONITORING RESULTS

WELL	STRATA	DATE	CH ₄ PEAK (%V/V)	CH ₄ STEADY (%V/V)	CH ₄ Q _{hg} (l/hr)	CO ₂ PEAK (%V/V)	CO ₂ STEADY (%V/V)	CO ₂ Q _{hg} (l/hr)	O ₂ (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	PEAK FLOW (l/hr)	STEADY FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
WS101	Made Ground	06/01/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19	996	Rising	0.1	0.1	0.50 – 2.50	2.44	Dry
		12/01/2023	0.1	0.1	0.0001	0.3	0.3	0.0003	19.2	984	Falling	0.1	0.1		2.44	2.40
		23/01/2023	0.1	0.1	0.0001	4.8	4.8	0.0048	0.6	1025	Falling	0.1	0.1		2.44	2.41
		14/02/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.9	1018	Falling	0.1	0.1		2.43	2.40
		14/03/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	994	Steady	0.1	0.1		2.44	2.41
		12/04/2023	0.1	0.1	0.0001	6.0	6.0	0.0060	0.1	978	Steady	0.1	0.1		2.43	2.39
		12/05/2023	0.1	0.1	0.0001	4.7	4.7	0.0047	2.2	1016	Rising	0.1	0.1		2.41	Dry
		Well damaged during fire													N/A	
WS102	Natural CLAY Drift	06/01/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.5	998	Rising	0.1	0.1	1.00-4.00	4.07	1.08
		12/01/2023	0.1	0.1	0.0001	0.3	0.3	0.0003	19.2	985	Falling	0.1	0.1		4.06	1.01
		23/01/2023	0.1	0.1	0.0001	1.8	1.8	0.0018	17.7	1023	Falling	0.1	0.1		4.08	1.99
		14/02/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.9	1017	Falling	0.1	0.1		4.06	1.71
		14/03/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	993	Steady	0.1	0.1		4.06	0.93
		12/04/2023	0.1	0.1	0.0001	5.5	5.5	0.0055	3.6	977	Steady	0.1	0.1		3.71	1.06
		12/05/2023	0.1	0.1	0.0001	4.5	1.7	0.0045	12	1016	Rising	0.1	0.1		3.80	1.00
		Well inaccessible as site cabin placed on top													N/A	
12/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.1	997	Steady	0.1	0.1	3.66	1.58			
WS103	Made Ground	06/01/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	997	Rising	0.1	0.1	0.50-1.00	0.99	0.93
		12/01/2023	0.1	0.1	0.0001	0.3	0.3	0.0003	19.2	984	Falling	0.1	0.1		0.99	0.80
		23/01/2023	0.1	0.1	0.0001	2.1	2.1	0.0021	18.2	1024	Falling	0.1	0.1		0.99	0.97
		14/02/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.9	1017	Falling	0.1	0.1		0.99	Dry
		14/03/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	994	Steady	0.1	0.1		0.99	0.88



WELL	STRATA	DATE	CH ₄ PEAK (%V/V)	CH ₄ STEADY (%V/V)	CH ₄ Q _{hg} (l/hr)	CO ₂ PEAK (%V/V)	CO ₂ STEADY (%V/V)	CO ₂ Q _{hg} (l/hr)	O ₂ (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	PEAK FLOW (l/hr)	STEADY FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
WS103 (Continued)	Made Ground	12/04/2023	0.1	0.1	0.0001	2	2	0.002	18.6	978	Steady	0.1	0.1	0.50-1.00	0.98	0.95
		12/05/2023	0.1	0.1	0.0001	3.2	3.2	0.0032	14.5	1015	Rising	0.1	0.1		0.85	0.68
		14/06/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.2	1009	Rising	0.1	0.1		0.98	Dry
		12/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.2	997	Steady	0.1	0.1		0.98	Dry
WS104	Natural CLAY Drift	06/01/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.1	996	Rising	0.1	0.1	1.00 - 4.00	3.6	0.65
		12/01/2023	0.1	0.1	0.0001	0.3	0.3	0.0003	19.2	982	Falling	0.1	0.1		3.57	0.47
		23/01/2023	0.1	0.1	0.0001	0.9	0.9	0.0009	17.7	1023	Falling	0.1	0.1		3.54	1.03
		14/02/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.9	1016	Falling	0.1	0.1		3.52	1.35
		14/03/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	993	Steady	0.1	0.1		3.52	0.50
		12/04/2023	0.1	0.1	0.0001	0.5	0.5	0.0005	19.6	977	Steady	0.1	0.1		3.50	0.79
		12/05/2023	0.1	0.1	0.0001	0.8	0.7	0.0008	20.1	1017	Rising	0.1	0.1		4.00	1.20
		14/06/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20	1011	Rising	0.1	0.1		3.50	1.62
		12/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.1	997	Steady	0.1	0.1		3.49	1.19

Notes

CIRIA Characteristic Situation		Q _{hg}			
	CS1	<0.07	Typical Max CO2 <5 % Typical Max CH4 <1 %	Values in BOLD exceed CS1 Thresholds	
	CS2	<0.7	Flow rate not to exceed 70 l/hr otherwise consider increase to CS3	Values in BLUE denote water above level of response zone (flooded)	
	CS3	<3.5			
	CS4	<15	Quantitative Risk Assessment required to evaluate scope of protective measures		



3.3. SUMMARY OF MONITORING RESULTS

3.3.1. GROUNDWATER

The water levels within several of the monitoring wells were recorded to be above the top of the response zone (flooded) on a number of occasions, as summarised in Table 3.4, thus rendering some of the monitoring data unreliable. Therefore, each time a flooded well was encountered, the well was bailed and left to re-equilibrate. Wells were re-monitored after a period of 20–30 minutes.

Table 3.4 FLOODED MONITORING WELL DATA

WELL	VISIT 1 06/01/2023	VISIT 2 12/01/2023	VISIT 3 23/01/2023	VISIT 4 14/02/2023	VISIT 5 14/03/2023	VISIT 6 12/04/2023	VISIT 7 12/05/2023	VISIT 8 14/06/2023	VISIT 9 12/07/2023
WS101	-	-	-	-	-	-	-	N/A	-
WS102	-	-	-	-	Y	-	Y	N/A	-
WS103	-	-	-	-	-	-	-	-	-
WS104	Y	Y	-	-	Y	Y	-	-	-

Within remaining monitoring wells, groundwater levels were observed to rise over the monitoring period, however, due to the predominantly low permeability cohesive drift stratum, it is likely that water levels are representative of surface water collecting within the standpipes and not a true representation of groundwater.

3.3.2. BAROMETRIC PRESSURE

Visits 7 and 8 were undertaken during a periods of relatively high/rising pressure, with pressures recorded between 1009 mbar to be 1017 mbar.

Visits 3 and 4 were undertaken during periods of relatively high/falling pressure, with pressures recorded between 1016 mbar and 1025 mbar.

Visit 6 was undertaken during a period of low pressure/steady pressure, with the pressure being recorded at 977 mbar.

During the remaining visits the atmospheric pressure has been relatively low, generally between 982 mbar and 998 mbar.

It is therefore considered that the visits have been undertaken over representative conditions.

3.3.3. GAS FLOW

Throughout the monitoring period, flow rates were recorded to be 0.1 l/hr (limit of detection of the analyser).



3.3.4. GAS CONCENTRATIONS

The maximum methane value recorded within the monitoring wells was 0.1% v/v (limit of detection of the analyser).

Carbon dioxide concentrations were recorded at concentrations ranging from 0.1% v/v to 6.0% v/v (WS101). Elevated carbon dioxide readings above the 5% CS₂ threshold have been encountered during Visit 6 in WS101 (6% CO₂) and WS102 (5.5% CO₂). As the 5% CS₂ threshold has only been exceeded slightly on the one occasion the average carbon dioxide reading for the site is <5%.

Elevated CO₂ readings coincide with depleted O₂ readings. During visit 6 O₂ levels were recorded as 0.1% in WS101 and 3.6% in WS102. During this monitoring visit the ambient atmospheric pressure was recorded as 977 mbar (lowest recorded pressure), as such higher pressure will be present within the well, the differential in pressure effectively causes a suction action. Depleted O₂ levels were also recorded during visit 3 and 7 in WS101 and WS102, again linked with marginally elevated CO₂ readings, however these visits were undertaken during higher pressure events 1016 mbar to 1025 mbar.

For the avoidance of doubt E3P have carried out further analysis on the data and plotted the gas concentrations on the Land Quality Management (LQM) gas composition tool (Figure 3.1a and 3.1b). As all of the data points plot within either the zone indicative of ambient air or the area indicative of air / CO₂ mixing there no further validation sampling is required and the marginally elevated CO₂ and the depleted O₂ are not seen to be risk to the future development.

FIGURE 3.1a LQM GAS COMPOSITION TOOL – WS101

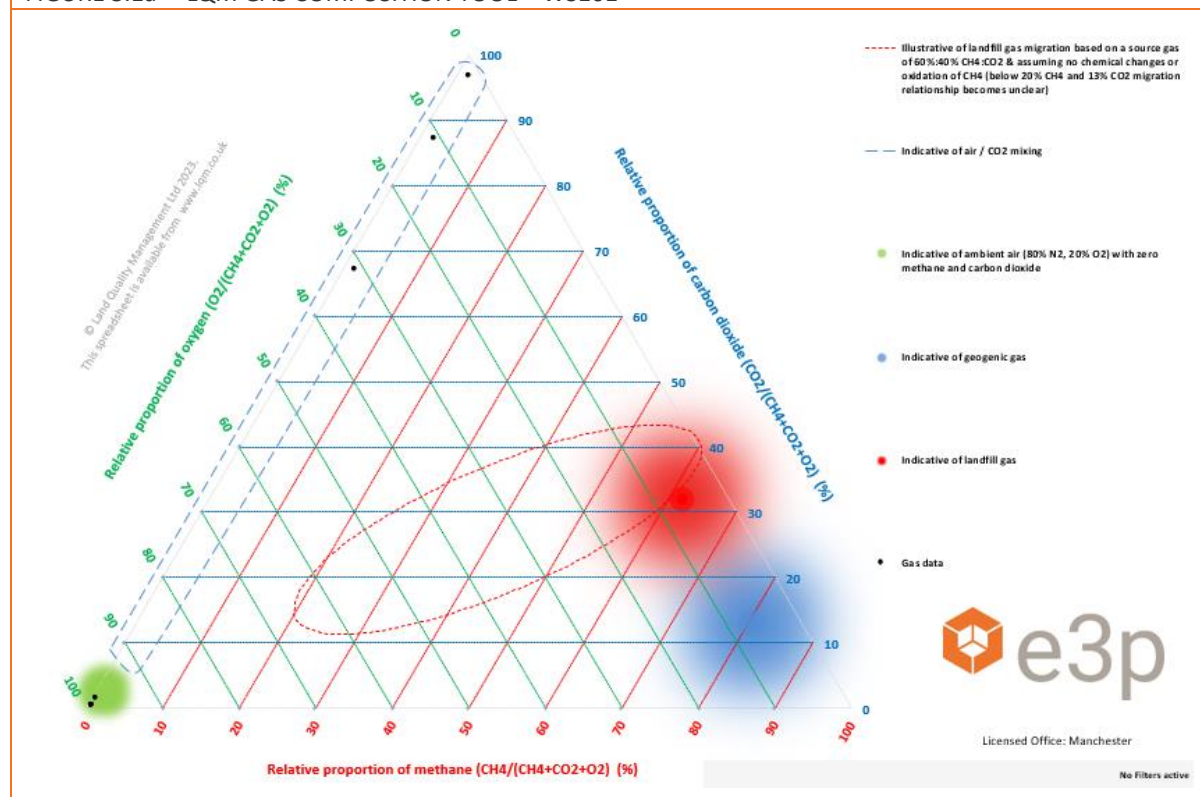
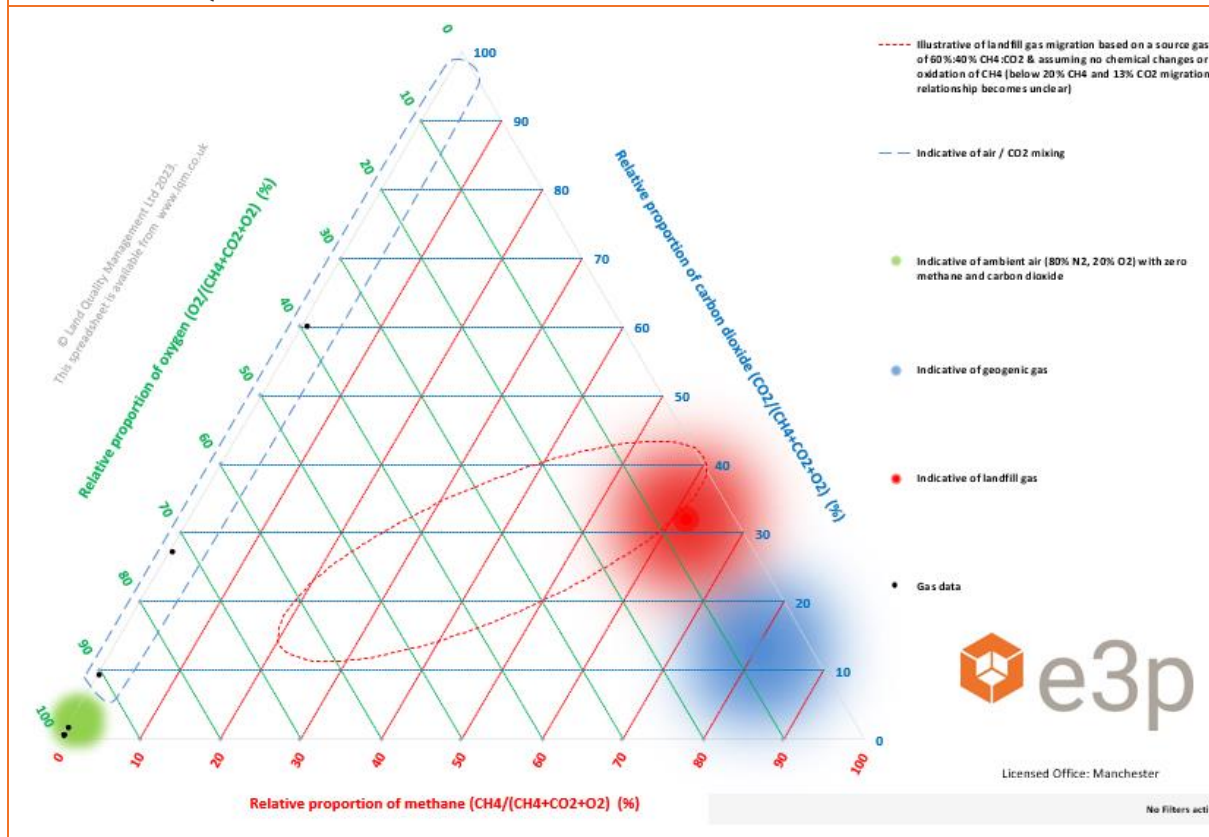


FIGURE 3.1b LQM GAS COMPOSITION TOOL – WS102



3.4. CONCLUSION

The determined Characteristic Situation for each standpipe for each visit is presented in Table 3.5.

This indicates that based on the peak flow rates the majority of the monitoring visits classify as Characteristic Situation (CS)1 – Very Low Gas Risk.

TABLE 3.5 GAS RISK PROFILE AND LOCATION

WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH_4 (%V/V)	MAX CH_4 Q_{hg} (l/hr)	MAX CO_2 (%V/V)	MAX CO_2 Q_{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
WS101	06/01/2023	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/01/2023	2.40	0.1	0.1	0.0001	0.3	0.0003	CS1	Green
	23/01/2023	2.41	0.1	0.1	0.0001	4.8	0.0048	CS1	Green
	14/02/2023	2.40	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	14/03/2023	2.41	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/04/2023	2.39	0.1	0.1	0.0001	6	0.0060	CS2	Amber 1
	12/05/2023	Dry	0.1	0.1	0.0001	4.7	0.0047	CS1	Green
	14/06/2023	Well damaged during fire							
	12/07/2023								

WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH ₄ (%V/V)	MAX CH ₄ Q _{hg} (l/hr)	MAX CO ₂ (%V/V)	MAX CO ₂ Q _{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
WS102	06/01/2023	1.08	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/01/2023	1.01	0.1	0.1	0.0001	0.3	0.0003	CS1	Green
	23/01/2023	1.99	0.1	0.1	0.0001	1.8	0.0018	CS1	Green
	14/02/2023	1.71	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	14/03/2023	0.93	Monitoring well flooded						
	12/04/2023	1.06	0.1	0.1	0.0001	5.5	0.0055	CS2	Amber 1
	12/05/2023	1.00	Monitoring well flooded						
	14/06/2023	Well inaccessible as site cabin placed on top							
	12/07/2023	1.58	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS103	06/01/2023	0.93	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/01/2023	0.80	0.1	0.1	0.0001	0.3	0.0003	CS1	Green
	23/01/2023	0.97	0.1	0.1	0.0001	2.1	0.0021	CS1	Green
	14/02/2023	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	14/03/2023	0.88	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/04/2023	0.95	0.1	0.1	0.0001	2	0.0020	CS1	Green
	12/05/2023	0.68	0.1	0.1	0.0001	3.2	0.0032	CS1	Green
	14/06/2023	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/07/2023	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS104	06/01/2023	0.65	Monitoring well flooded						
	12/01/2023	0.47							
	23/01/2023	1.03	0.1	0.1	0.0001	0.9	0.0009	CS1	Green
	14/02/2023	1.35	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	14/03/2023	0.50	Monitoring well flooded						
	12/04/2023	0.79							
	12/05/2023	1.20	0.1	0.1	0.0001	0.8	0.0008	CS1	Green
	14/06/2023	1.62	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/07/2023	1.19	0.1	0.1	0.0001	0.1	0.0001	CS1	Green



E3P have assessed the previous variables and come to the following conclusions:

- ✿ Ground gas monitoring suggests that the site can be classified as CS1, and in it is considered that gas protection measures will not be required.
 - Marginally elevated CO2 readings have been identified during visit 6 in a period of low pressure, no further elevated readings have been noted. Further analysis carried out indicates that there is no risk posed as the data plots within either the zone indicative of ambient air or the area indicative of air / CO2 mixing.
- ✿ Made Ground has been encountered in localised areas at a maximum depth of 2.50m bgl but more generally was encountered at a depth less than 1.00m bgl.
- ✿ The site is predominantly CLAY at depths of 0.28m bgl to 5.45 m bgl.
- ✿ As outlined in RB17 Table A1 – Scenario 3, if the site is underlain by Made Ground deposits averaging less than 1.00 m, overlying natural soils with a low organic content (Glacial Till), as is the case with the site in question, ground gas protection measures are not required.
- ✿ No evidence of the infilled pond at the western boundary has been identified. It is likely that the historical mapping incorrectly maps this feature within the site boundary, or the area simply retained water and was what would be considered a true 'pond' of any significant depth. The pond may have existed off site, however due to the presence of low-permeability drift deposits across the site, the potential for lateral migration is negligible and the pond is not considered a potentially significant source with respect to hazardous ground gases.
- ✿ With due consideration to the Conceptual Site Model and the absence of any persistent gas source and gas generation potential, it is considered by E3P that the site can be classified as CS1, and therefore no gas protection measures are required.

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 reinterpretation 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	Aboveground 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 nonaqueous 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	Vibronaceae column
ICSM	Initial conceptual site model	VOC	Volatile organic compound
LEL	Lower explosive limit	VRSC	Vibroreplacement stone columns
LMRL	Lower method reporting limit	VSC	Vibrostone columns
LNAPL	Light nonaqueous phase liquid (petrol, diesel, kerosene)	WHO	World Health Organisation
MCV	Moisture condition value	WRAP	Waste and Resources Action Programme



Sulby Street

Ground Gas Addendum

July 2023

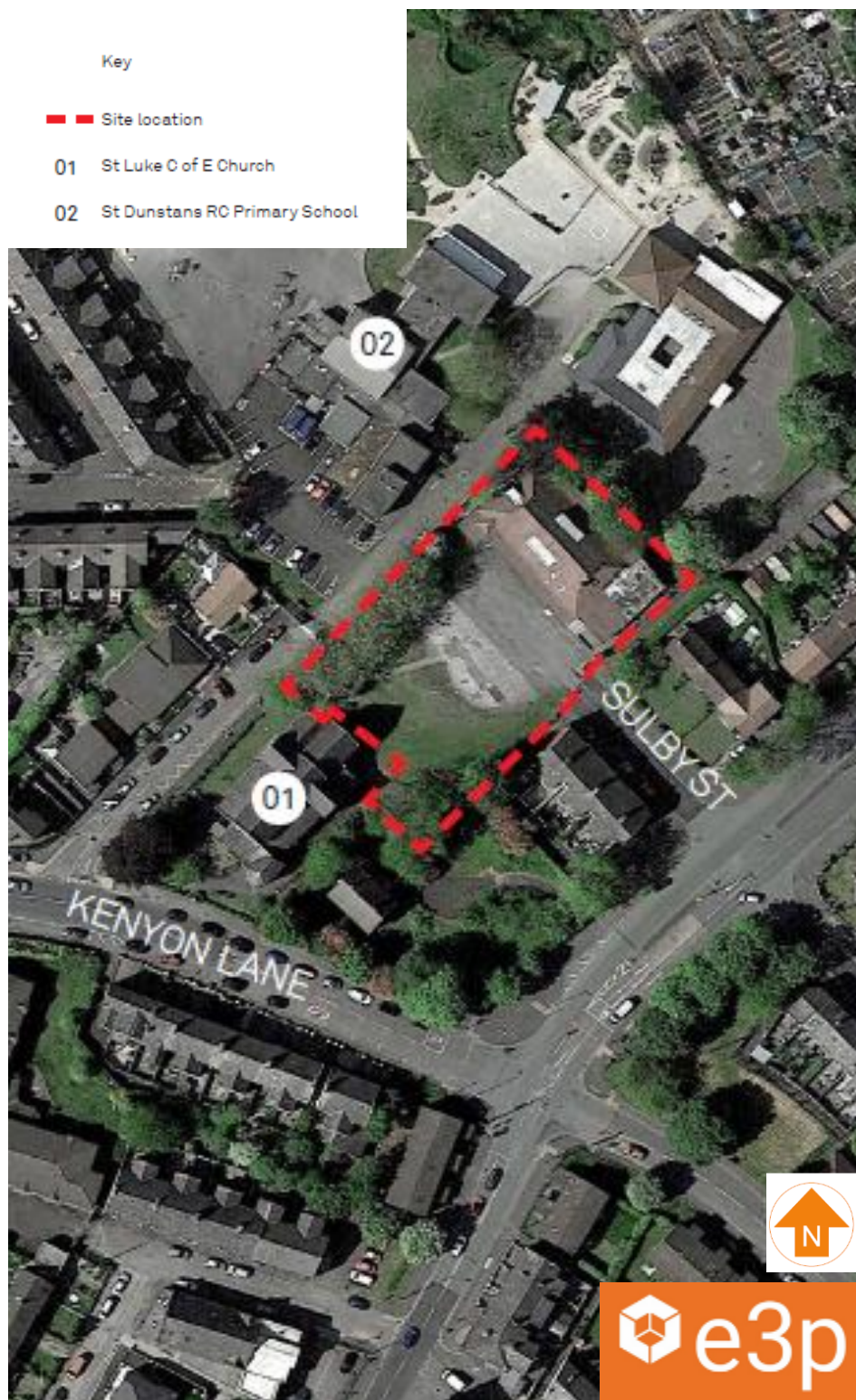
MIBK	Methyl isobutyl ketone	WTE	Water table elevation
m	Metres	ppm	Parts per million
km	Kilometres	mg/m³	Milligram per metre cubed
% v/v	Percent volume in air	m bgl	Metres below ground level
mb	Millibars (atmospheric pressure)	m bcl	Metre below cover level
l/hr	Litres per hour	mAOD	Metres above ordnance 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

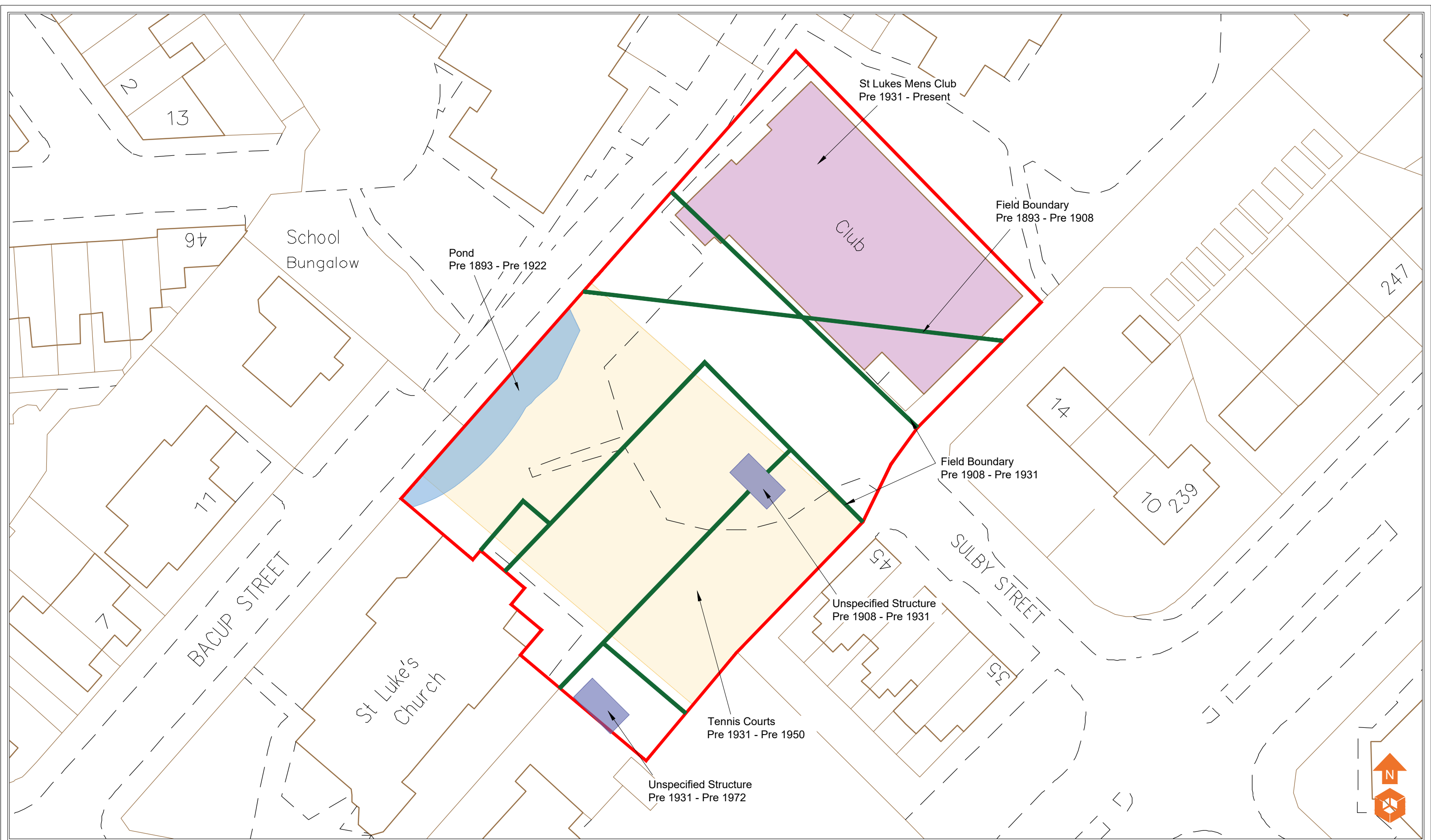
DRAWINGS

DRAWING 15-395-001 – SITE LOCATION PLAN

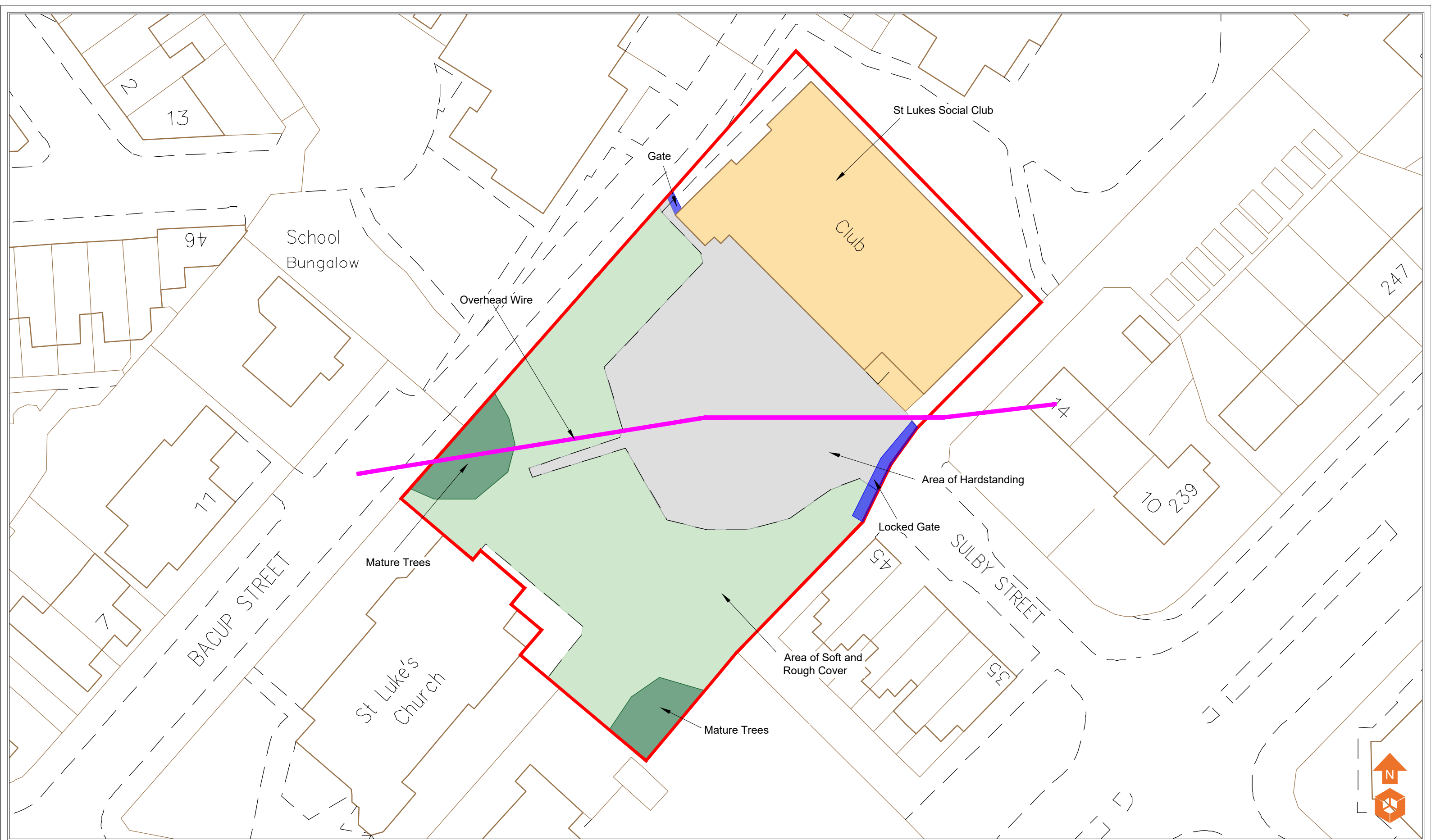




	Notes:					Client: Challenger Homes	Job No: 15-395	Date: 18.02.2022	 Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk
							Drawing No: 002	Scale: NTS @ A3	
	P1	REVB	18.02.2022	EB	BH	Job Title: Sulby Street, Moston	Drawing Title: Proposed Development Plan	The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.	
	P1	REVA	20.01.2022	CB	BH				
	Phase	Issue	Date	Drawn	Checked				



Historical Features Former Pond Former Field Boundary Former Unspecified Structures Former Tennis Courts St Lukes Mens Club					Notes:					Client: Challenger Homes		Job No: 15-395		Date: 20.01.2022		e3p Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk	
P1 REVA 20.01.2022 CB BH					Phase Issue Date Drawn Checked					Job Title: Sulby Street, Moston		Drawing No: 003		Scale: NTS @ A3		Drawing Title: Historical Features Plan The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.	



Site Features

- St Lukes Social Club
- Overhead Wire
- Area of Hardstanding
- Area of Soft and Rough Cover
- Mature Trees
- Gate

Notes:

P1	REVA	20.01.2022	CB	BH
Phase	Issue	Date	Drawn	Checked

Client:

Challenger Homes

Job Title:

Sulby Street, Moston

Job No:

15-395

Drawing No:

004

Date:

20.01.2022

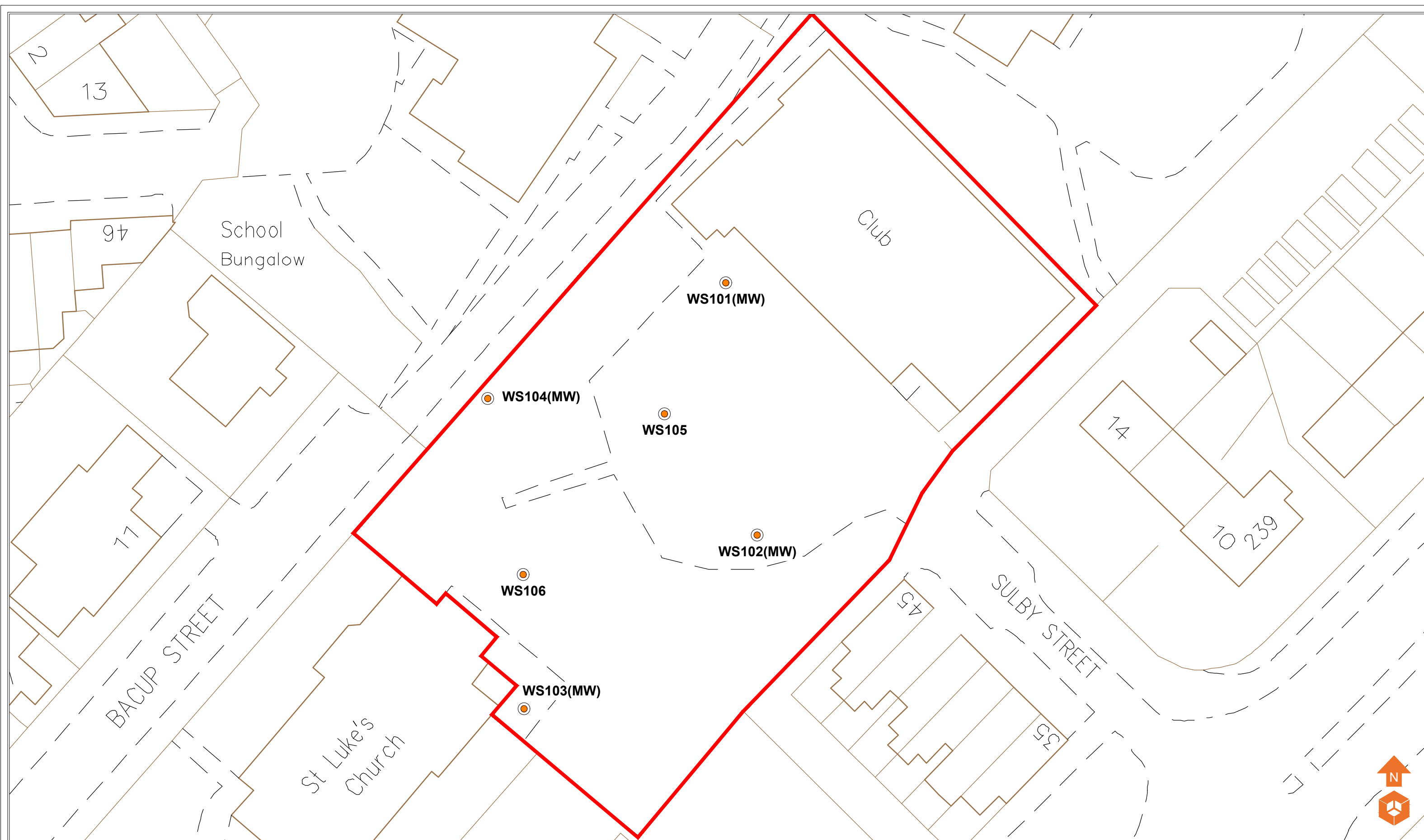
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NTS @ A3

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Site Features Plan



Location Symbols

Approximate Window Sample Probehole Location

Approximate Window Sample Probehole Location with Install

Notes:

P1	REVA	06.01.2023	OW	NG
Phase	Issue	Date	Drawn	Checked

Client:

Challenger Homes

Job Title:

Sulby Street, Moston

Job No:

15-395

Drawing No:

005

Date:

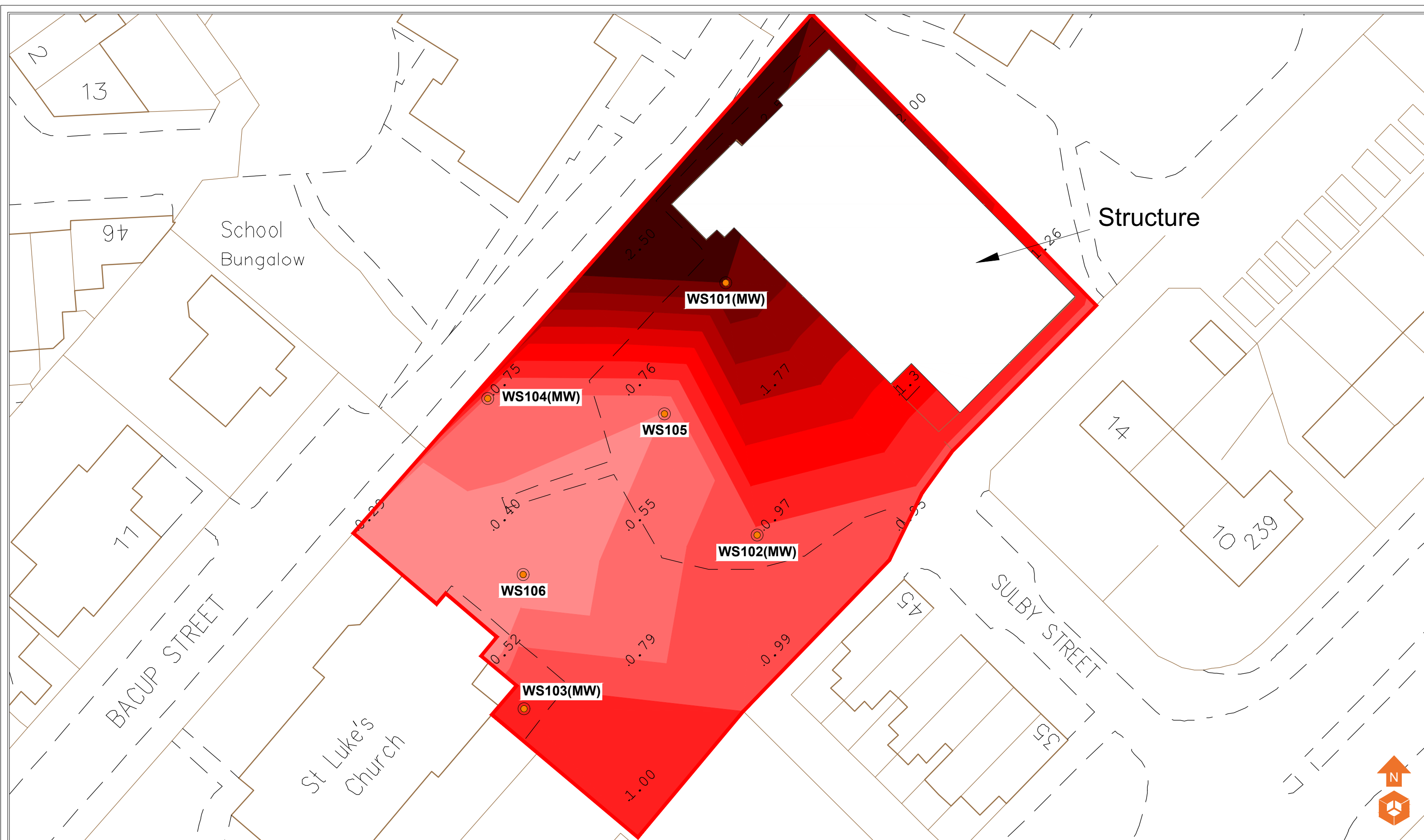
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Scale:

NTS @ A3

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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install

Made Ground Depth (m)

- Depth of Made Ground 0.00 - 0.24m
- Depth of Made Ground 0.25 - 0.49m
- Depth of Made Ground 0.50 - 0.74m
- Depth of Made Ground 0.75 - 0.99m
- Depth of Made Ground 1.00 - 1.24m
- Depth of Made Ground 1.25 - 1.49m
- Depth of Made Ground 1.50 - 1.74m
- Depth of Made Ground 1.75 - 1.99m
- Depth of Made Ground >2.00m

Notes:

P1	REVA	19.01.2023	OW	NG
Phase	Issue	Date	Drawn	Checked

Client:

Challenger Homes

Job Title:

Sulby Street, Moston

Job No:

15-395

Drawing No:

006

Date:

19.01.2023

Scale:

NTS @ A3



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APPENDIX IV

E3P EXPLORATORY HOLE

LOGS

Borehole Log

Borehole No.

WS101

Sheet 1 of 1

Project Name: Sulby Street

Project No.
15395

Co-ords: 387411.70 - 401576.83

Hole Type
WS

Location: Moston

Level: 87.41

Scale
1:50

Client: Challenger Group

Dates: 06/12/2022 - 06/12/2022

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.09			0.09	87.32		MADE GROUND: Asphalt.	
		0.50	ES					MADE GROUND: Brown slightly sandy gravelly clay. Gravel is fine to coarse angular to subrounded of brick and ash.	1
		1.00	D	N=7 (1,1/1,2,2,2)					
		1.00							
		1.50	ES		1.50	85.90		MADE GROUND: Black sandy gravel is angular to subrounded of brick, clinker and ash.	2
		1.70							
		2.00		N=1 (1,1/1,0,0,0)					
		2.50			2.50	84.90		Very stiff high strength brown CLAY. Circa 4.00m bgl becomes stiff medium strength. Circa 5.00m bgl becomes very stiff high strength.	3
		3.00	D	N=18 (3,3/4,4,5,5)					
		3.00							
		4.00		N=17 (3,3/4,3,4,6)					4
		5.00	D	N=30 (3,4/4,6,10,10)					5
		5.00							
		5.45			5.45	81.96		End of borehole at 5.45 m	6
									7
									8
									9
									10

Remarks

1. Completed. 2. Monitoring well installed response zone between 0.50m and 2.50m bgl.

Borehole Log

Borehole No.

WS102

Sheet 1 of 1

Project Name: Sulby Street

Project No.
15395

Co-ords: 387416.90 - 401555.95

Hole Type
WS

Location: Moston

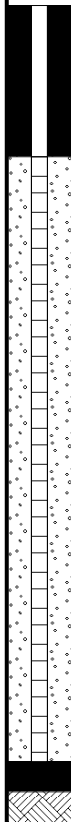
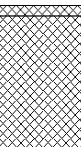
Level: 87.66

Scale
1:50

Client: Challenger Group

Dates: 06/12/2022 - 06/12/2022

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.07			0.07	87.59		MADE GROUND: Asphalt.	
		0.50	ES					MADE GROUND: Brown to black very gravelly sand with frequent cobbles. Gravel is fine to coarse angular to subrounded of brick and ash. Cobbles are angular of brick.	
		1.00	D	N=9 (5,3/2,2,3,2)	0.95	86.71		Stiff medium strength brown CLAY. Circa 2.00m bgl becomes firm low strength. Circa 5.00m bgl becomes stiff medium strength.	1
		1.00							
		1.50	ES						
		2.00	D	N=8 (1,1/1,3,2,2)					2
		2.00							
		2.50	U						
		3.00	D	N=9 (1,2/2,2,2,3)					3
		3.00							
		4.00	D	N=9 (1,1/1,2,3,3)					4
		4.00							
		5.00	D	N=14 (2,3/3,3,4,4)					5
		5.00							
					5.45	82.21		End of borehole at 5.45 m	6
									7
									8
									9
									10

Remarks

1. Completed. 2. Monitoring well installed response zone between 1.00m and 5.00m bgl. 3. Water strike encountered at 2.60m bgl.

Borehole Log

Borehole No.

WS103

Sheet 1 of 1

Project Name: Sulby Street

Project No.
15395

Co-ords: 387393.81 - 401535.93

Hole Type
WS

Location: Moston

Level: 87.65

Scale
1:50

Client: Challenger Group

Dates: 06/12/2022 - 06/12/2022

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.08			0.08	87.57		MADE GROUND: Dark grey gravelly sand with frequent rootlets. Gravel is fine to coarse angular to subrounded of brick and ash.	
		0.50	ES					MADE GROUND: Black very gravelly sand with frequent rootlets. Gravel is fine to coarse angular to subrounded of clinker and ash.	
		1.00	D	N=12 (1,2/2,3,3,4)	1.00	86.65		Stiff medium strength brown CLAY. Circa 3.00m bgl becomes very stiff high strength.	1
		1.00							
		1.20	ES						
		2.00	D	N=14 (2,3/3,4,3,4)					2
		2.00							
		2.50	U						
		3.00	D	N=23 (3,4/5,6,6,6)					3
		3.00							
		4.00	D	N=21 (2,3/3,6,6,6)					4
		4.00							
		5.00	D	N=25 (2,2/4,5,7,9)					5
		5.00							
		5.45			5.45	82.20		End of borehole at 5.45 m	6
									7
									8
									9
									10

Remarks

1. Completed. 2. Monitoring well installed response zone between 0.50m and 1.00m bgl.

Borehole Log

Borehole No.

WS104

Sheet 1 of 1

Project Name: Sulby Street

Project No.
15395

Co-ords: 387390.35 - 401566.55

Hole Type
WS

Location: Moston

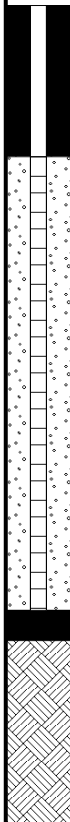
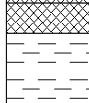
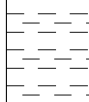
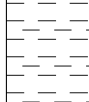
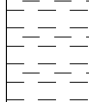
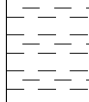
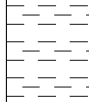
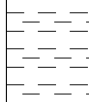
Level: 87.47

Scale
1:50

Client: Challenger Group

Dates: 06/12/2022 - 06/12/2022

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.40	ES		0.50 0.70	86.97 86.77		MADE GROUND: Dark grey clayey gravelly sand with frequent rootlets. Gravel is fine to coarse angular to subrounded of brick, clinker and ash.	1
		1.00 1.00	D	N=6 (1,2/1,1,2,2)				MADE GROUND: Dark grey very gravelly sand with occasional cobbles. Gravel is fine to coarse angular to subrounded of brick and ash. Cobbles are angular of brick.	
		1.50	ES					Firm low strength brown slightly sandy CLAY. Circa 2.00m bgl becomes soft very low strength. Circa 3.00m bgl becomes stiff medium strength.	2
		2.00		N=4 (1,1/1,1,1,1)					
		3.00 3.00	D	N=17 (3,4/3,4,5,5)					3
		4.00 4.00	D	N=17 (3,4/3,4,5,5)					4
		5.00		N=14 (1,2/3,3,3,5)					5
					5.45	82.02			6
								End of borehole at 5.45 m	7
									8
									9
									10

Remarks

1. Completed. 2. Monitoring well installed response zone between 1.00m and 4.00m bgl.



Borehole Log

Borehole No.

WS105

Sheet 1 of 1

Project Name: Sulby Street

Project No.
15395

Co-ords: 387404.95 - 401565.71

Hole Type
WS

Location: Moston

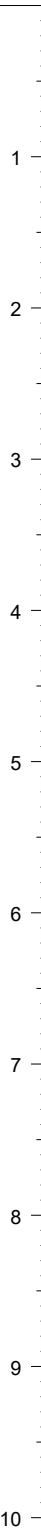
Level: 87.55

Scale
1:50

Client: Challenger Group

Dates: 06/12/2022 - 06/12/2022

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES	N=8 (1,1/1,2,2,3)	0.08	87.47		MADE GROUND: Asphalt.	
					0.50	87.05		MADE GROUND: Black gravelly clayey sand. Gravel is fine to coarse angular to subrounded of brick and concrete.	
		1.00	D					Stiff medium strength brown CLAY. Circa 3.00m bgl becomes very stiff high strength.	
		1.00	ES						
		1.00							
		1.50	U						
		2.00	D	N=14 (2,3/3,3,4,4)					
		2.00							
		3.00	D	N=20 (3,3/3,5,6,6)					
		3.00							
		4.00	D	N=22 (4,3/4,6,6,6)					
		4.00							
		5.00	D	N=21 (4,4/4,5,6,6)					
		5.00							
					5.45	82.10		End of borehole at 5.45 m	

Remarks

1. Completed.



Borehole Log

Borehole No.

WS106

Sheet 1 of 1

Project Name: Sulby Street

Project No.
15395

Co-ords: 387391.17 - 401551.22

Hole Type
WS

Location: Moston

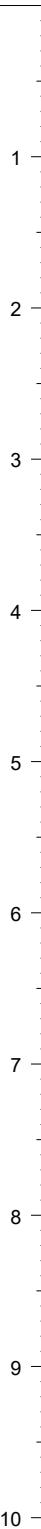
Level: 87.59

Scale
1:50

Client: Challenger Group

Dates: 06/12/2022 -

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.28	87.31		MADE GROUND: Black very gravelly sand with frequent rootlets. Gravel is fine to coarse angular to subrounded of brick, clinker and ash. Stiff medium strength brown CLAY.	
		0.80	ES						
		1.00	D						
		1.00		N=10 (1,2/2,2,3,3)					
		1.50	U						
		2.00	D						
		2.00		N=15 (2,3/3,4,4,4)					
		3.00	D						
		3.00		N=14 (2,3/3,3,3,5)					
		4.00	D						
		4.00		N=17 (2,3/3,4,4,6)					
		5.00	D						
		5.00		N=18 (2,3/4,4,5,5)					
					5.45	82.14		End of borehole at 5.45 m	

Remarks

1. Completed. 2. Water strike encountered at 2.50m bgl.