



Ground Gas Addendum Report
Bennett Street
Manchester

Reference: 15-425-R3-1
Date: March 2023



GROUND GAS ADDENDUM REPORT

Bennett Street
Manchester
M12 5NL

Prepared for:
Kellen Homes



Report Ref: 15-425-R3-1
Date Issued: March 2023

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QUALITY ASSURANCE

PROJECT NUMBER	15-425		
VERSION	Version 1		
REMARKS	Issue 1		
DATE	July 2022		
PREPARED BY	H Mason		
QUALIFICATIONS	MESci (Hons), FGS		
CHECKED BY	M Dee		
QUALIFICATIONS	BSc (Hons), FGS, AMIEEnvSc		
AUTHORISED BY	M. Dyer		
QUALIFICATIONS	BSc(Hons), FGS, AIEMA, MIEEnvSc, CEnv		

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1. INTRODUCTION

1.1. BACKGROUND

E3P has previously completed a ground investigation on the site located off Bennett Street in Manchester. The findings of the ground investigation are presented within the E3P report entitled Phase I & II Geoenvironmental Site Assessment (Report reference 15-425-R1-1, dated June 2022).

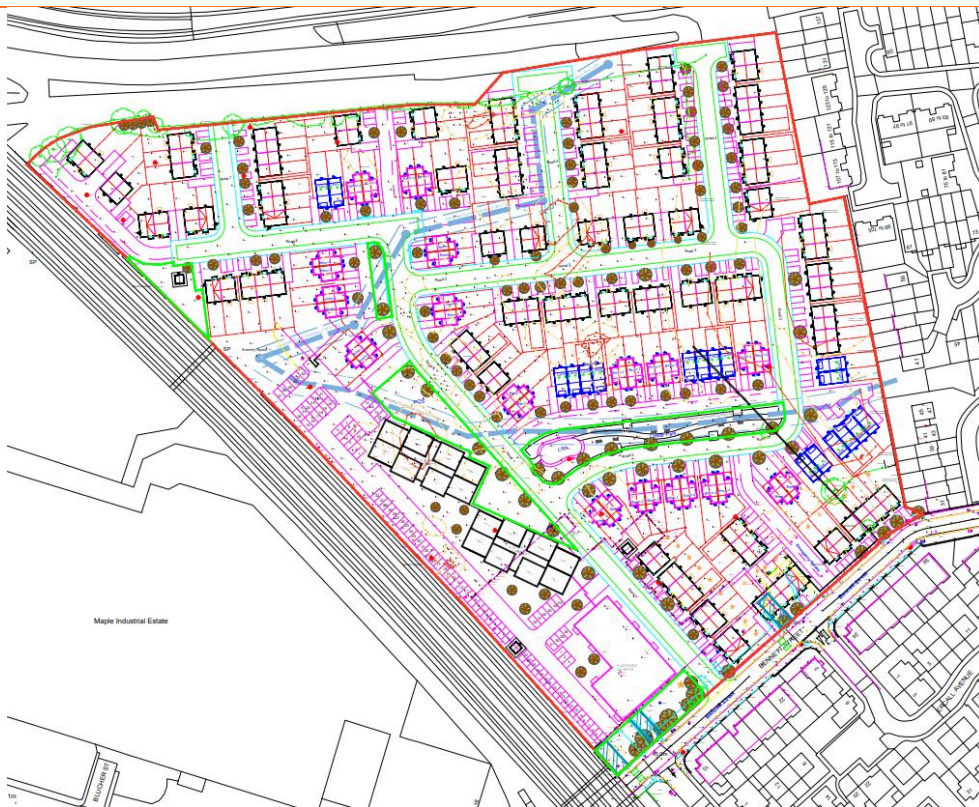
During the investigation E3P installed twenty-three ground gas monitoring wells, which were to be monitored over a period of six months after installation. The data collected from the gas monitoring wells are summarised in this report and this comprises the completed ground gas assessment.

1.2. PROPOSED DEVELOPMENT

E3P understands that Kellen Homes intends to construct a mixed-use development comprising low-rise housing, apartment blocks, and café and retail units with adapted estate roads and infrastructure. Drawing 15-425-002 (Appendix III) identifies the proposed development layout.

A snapshot of the proposed development layout is indicated in Figure 1.1.

FIGURE 1.1 SNAPSHOT OF THE 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 Made Ground deposits were identified within each exploratory hole location advanced on the site to a maximum proven depth of 5.45 m bgl (WS106). Although in general, Made Ground in the south of the site extends to circa 2.00 m bgl and 3.00 m in the north. Beneath the main building in the southeast, Made Ground was proven to a depth of 1.30 m bgl and comprised concrete over yellowish-brown, slightly clayey gravel over reworked gravelly clay. Made Ground could not be proven to its full extent at WS106, WS111, WS112, WS115, WS124, WS128 and WS136. This was due to obstructions in the east of the site, cobbles within Made Ground or dense Made Ground. In general, the majority of locations identified asphalt or concrete surface cover overlaying reworked gravelly clays containing gravel of mixed lithology, including brick clinker, ash, ceramic, sandstone and coal. Visual and olfactory evidence of contamination was noted within several exploratory hole locations. Hydrocarbon odours were identified in 16 out of the 36 locations within Made Ground (WS101, WS104, WS107, WS109, WS112b, WS113, WS115, WS116, WS117, WS118, WS121, WS128, WS132, WS133, WS135 and WS136). An oily sheen was observed in WS133 in Made Ground.
Drift Deposits Drift deposits were identified within the majority of exploratory hole locations to a maximum proven depth of 5.45 m bgl (WS116, WS117, WS118, WS119, WS120, WS123b, WS126, WS129, WS130 and WS133). In general, a brown stiff to very stiff CLAY was encountered. Drift geology was generally homogenous across the site. Soft clay was identified at WS114 from 1.00 to 2.00 m bgl, WS116 from 2.80 to 3.00 m bgl and WS126 from 2.00 to 3.70 m bgl. Granular deposits were found in limited areas of the site at WS126 between 3.70 and 3.90m interbedded with CLAY. Pockets of organic deposits were identified at 3.50 m bgl within WS113.



Solid Strata

Bedrock was encountered within the advanced rotary boreholes only between 12.10 m bgl (RB104) and 29.10 m bgl (RBH101) to a maximum proven depth of 50.00 m bgl. Red SANDSTONE was identified beneath the drift overlying a reddish grey MUDSTONE with SANDSTONE bands.

The site is located within a Coal Mining Reporting Area. The coal authority interactive map shows underground workings are present beneath the site to the east. The intrusive ground investigations comprising five, deep, rotary boreholes did not identify any shallow coal seams or evidence of historic mine workings to the base of the boreholes. Reasonably deep drift at the site may suggest historic shallow mining would not be viable. No evidence of surface disturbances or record of the same in the Coal Authority report. During the E3P works completed to date, no evidence has been noted to support the presence of a viable shallow coal seam beneath the site. No evidence is encountered of historical shallow workings.

Landfill Sites

There are no active or historical landfills within 250 m of the site.

The site has undergone some historical development and Ground working; the Made Ground associated with the historical development and infilling of historic ponds may produce hazardous ground gases such as methane and carbon dioxide.

Other Gases

The BGS reports that full radon protective measures are not necessary in the construction of new dwellings or extensions.

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 are 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 500 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 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	CLAY	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1024	Rising	0.1	0.1	2.00 – 3.00	3.31	1.34
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1000	Rising	0.1	0.1		3.30	2.25
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.5	1008	Falling	0.1	0.1		3.25	2.10
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.3	1023	Falling	0.1	0.1		3.25	2.53
		05/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.1	1004	Falling	0.1	0.1		3.25	2.60
		25/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.6	1010	Steady	0.1	0.1		3.22	2.51
		16/05/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1005	Steady	0.1	0.1		3.22	2.61
		10/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.0	1006	Falling	0.1	0.1		3.22	2.76
		20/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.0	1013	Falling	0.1	0.1		3.22	2.87
WS103	CLAY	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.5	1024	Rising	0.1	0.1	1.00 – 2.00	1.80	1.13
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1000	Rising	0.1	0.1		1.80	1.20
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.3	1009	Falling	0.1	0.1		1.89	1.10
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.3	1025	Falling	0.1	0.1		1.89	1.04
		05/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.1	1003	Falling	0.1	0.1		1.90	1.25
		25/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.6	1010	Steady	0.1	0.1		1.88	1.07
		16/05/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1005	Steady	0.1	0.1		1.89	1.23
		10/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1009	Falling	0.1	0.1		1.88	1.40
		20/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.9	1013	Falling	0.1	0.1		1.88	1.52



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)
WS104	CLAY	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1026	Rising	0.1	0.1	1.50 – 3.00	Bung Jammed	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1000	Rising	0.1	0.1			
		08/03/2022	Area Flooded													
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1025	Falling	0.1	0.1		Bung Jammed	
		05/04/2022	Monitoring Well Destroyed													
		25/04/2022														
		16/05/2022														
		10/06/2022														
		20/06/2022														
WS105	MG	11/01/2022	Monitoring Well Destroyed											0.50 – 1.00		
		04/02/2022														
		08/03/2022														
		22/03/2022														
		05/04/2022														
		25/04/2022														
		16/05/2022														
		10/06/2022														
		20/06/2022														



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)	
WS107	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1024	Rising	0.1	0.1	1.00 – 2.00	1.93	Dry	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1001	Rising	0.1	0.1		1.95	1.90	
		08/03/2022	No Access														
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1025	Falling	0.1	0.1		1.45	Dry	
		05/04/2022	Monitoring Well Destroyed														
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															
WS108	MG	11/01/2022	Monitoring Well Destroyed												0.50 – 2.00		
		04/02/2022															
		08/03/2022															
		22/03/2022															
		05/04/2022															
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															



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)	
WS109	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1025	Rising	0.1	0.1	0.50 – 2.50	2.47	1.77	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1001	Rising	0.1	0.1		2.50	2.00	
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.4	1008	Falling	0.1	0.1		2.50	2.20	
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.9	1025	Falling	0.1	0.1		2.50	2.34	
		05/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.9	1025	Falling	0.1	0.1		2.50	2.10	
		25/04/2022	Monitoring Well Destroyed														
		16/05/2022															
		10/06/2022															
		20/06/2022															
WS110	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1025	Rising	0.1	0.1	0.50 – 2.00	1.87	1.64	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1001	Rising	0.1	0.1		1.90	1.85	
		08/03/2022	Monitoring Well Destroyed														
		22/03/2022															
		05/04/2022															
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															



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)
WS113	CLAY	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1025	Rising	0.1	0.1	1.00 – 3.00	2.26	1.42
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1001	Rising	0.1	0.1		2.30	1.65
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1008	Falling	0.1	0.1		2.25	1.43
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.0	1024	Falling	0.1	0.1		2.26	1.55
		05/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.0	1002	Falling	0.1	0.1		2.25	1.30
		25/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1010	Steady	0.1	0.1		2.26	1.69
		16/05/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1003	Steady	0.1	0.1		2.26	1.71
		10/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.0	1007	Falling	0.1	0.1		2.28	1.76
		20/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1013	Falling	0.1	0.1		2.28	1.76
WS114	CLAY	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1025	Rising	0.1	0.1	1.00 – 2.00	1.82	0.61
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1001	Rising	0.1	0.1		1.85	1.10
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.5	1007	Falling	0.1	0.1		1.85	1.15
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.0	1024	Falling	0.1	0.1		1.8	1.04
		05/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.0	1002	Falling	0.1	0.1		1.8	1.55
		25/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1010	Steady	0.1	0.1		1.8	1.03
		16/05/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1003	Steady	0.1	0.1		1.8	1.05
		10/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.0	1006	Falling	0.1	0.1		1.8	1.09
		20/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1012	Falling	0.1	0.1		1.8	1.20



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)	
WS116	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1025	Rising	0.1	0.1	1.50 – 2.00	1.92	1.70	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1002	Rising	0.1	0.1		1.95	1.90	
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1008	Falling	0.1	0.1		1.95	Dry	
		22/03/2022	Monitoring Well Destroyed														
		05/04/2022															
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															
WS119	CLAY	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1025	Rising	0.1	0.1	2.00 – 5.00	3.50	1.38	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1002	Rising	0.1	0.1		3.50	2.30	
		08/03/2022	Monitoring Well Destroyed														
		22/03/2022															
		05/04/2022															
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															



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)	
WS120	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1025	Rising	0.1	0.1	0.50 – 2.00	1.98	1.82	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1002	Rising	0.1	0.1		2.00	Dry	
		08/03/2022	Monitoring Well Destroyed														
		22/03/2022															
		05/04/2022															
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															
WS122	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1025	Rising	0.1	0.1	0.50 – 1.00	1.03	0.83	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1002	Rising	0.1	0.1		1.05	1.00	
		08/03/2022	Monitoring Well Destroyed														
		22/03/2022															
		05/04/2022															
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															



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)
WS123	MG	11/01/2022	Monitoring Well Destroyed											0.50 – 2.00		
		04/02/2022														
		08/03/2022														
		22/03/2022														
		05/04/2022														
		25/04/2022														
		16/05/2022														
		10/06/2022														
		20/06/2022														
WS126	CLAY	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1026	Rising	0.1	0.1	2.00 – 4.00	3.89	3.05
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1003	Rising	0.1	0.1		4.00	3.40
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1006	Falling	0.1	0.1		3.90	2.99
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.3	1024	Falling	0.1	0.1		3.90	3.11
		05/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.1	1003	Falling	0.1	0.1		3.90	2.85
		25/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1010	Steady	0.1	0.1		3.90	3.27
		16/05/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1003	Steady	0.1	0.1		3.90	3.27
		10/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.0	1007	Falling	0.1	0.1		3.90	3.32
		20/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.9	1014	Falling	0.1	0.1		3.90	3.32



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)	
WS127	CLAY	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1025	Rising	0.1	0.1	1.00 – 4.00	3.92	1.05	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1022	Rising	0.1	0.1		3.95	1.80	
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1007	Falling	0.1	0.1		3.9	1.25	
		22/03/2022	Monitoring Well Destroyed														
		05/04/2022															
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															
WS129	CLAY	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1025	Rising	0.1	0.1	2.00 – 4.00	3.94	1.26	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1023	Rising	0.1	0.1		3.95	2.10	
		08/03/2022	Monitoring Well Destroyed														
		22/03/2022															
		05/04/2022															
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															



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)	
WS130	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1025	Rising	0.1	0.1	1.00 – 2.00	1.93	1.68	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1023	Rising	0.1	0.1		1.95	1.85	
		08/03/2022	Monitoring Well Destroyed														
		22/03/2022															
		05/04/2022															
		25/04/2022															
		16/05/2022															
		10/06/2022															
		20/06/2022															
WS131	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1025	Rising	0.1	0.1	0.50 – 1.00	1.00	Dry	
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1000	Rising	0.1	0.1		1.00	Dry	
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1008	Falling	0.1	0.1		1.00	Dry	
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.9	1024	Falling	0.1	0.1		1.00	Dry	
		05/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.0	1002	Falling	0.1	0.1		1.00	Dry	
		25/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.7	1009	Steady	0.1	0.1		1.00	Dry	
		16/05/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1003	Steady	0.1	0.1		1.00	Dry	
		10/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.0	1008	Falling	0.1	0.1		1.00	Dry	
		20/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.7	1015	Falling	0.1	0.1		1.00	Dry	



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)
WS132	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1025	Rising	0.1	0.1	0.50 – 1.00	1.02	0.65
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1000	Rising	0.1	0.1		1.05	0.90
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.5	1008	Falling	0.1	0.1		1.02	0.88
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.9	1025	Falling	0.1	0.1		1.02	0.92
		05/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.0	1002	Falling	0.1	0.1		1.00	0.80
		25/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.6	1010	Steady	0.1	0.1		1.02	0.96
		16/05/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.8	1003	Steady	0.1	0.1		1.02	0.65
		10/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.0	1008	Falling	0.1	0.1		1.02	0.84
		20/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.7	1015	Falling	0.1	0.1		1.02	0.94
WS133	MG	11/01/2022	Monitoring Well Destroyed											0.50 – 3.00		
		04/02/2022														
		08/03/2022														
		22/03/2022														
		05/04/2022														
		25/04/2022														
		16/05/2022														
		10/06/2022														
		20/06/2022														



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)
WS135	MG	11/01/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1024	Rising	0.1	0.1	0.50 – 1.00	1.03	Dry
		04/02/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1000	Rising	0.1	0.1		1.05	1.00
		08/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.5	1008	Falling	0.1	0.1		1.04	Dry
		22/03/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1025	Falling	0.1	0.1		1.03	Dry
		05/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	20.0	1003	Falling	0.1	0.1		1.00	Dry
		25/04/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.7	1010	Steady	0.1	0.1		1.00	Dry
		16/05/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.7	1004	Steady	0.1	0.1		1.00	Dry
		10/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.9	1008	Falling	0.1	0.1		0.95	Dry
		20/06/2022	0.1	0.1	0.0001	0.1	0.1	0.0001	18.9	1012	Falling	0.1	0.1		0.95	Dry

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 level within several of the monitoring wells was 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	VISIT 2	VISIT 3	VISIT 4	VISIT 5	VISIT 6	VISIT 7	VISIT 8	VISIT 9
WS101	Y	-	Y	Y	-	Y	Y	Y	Y
WS103	Y	-	-	-	-	-	Y	Y	Y
WS104	-	-	-	-	-	-	-	-	-
WS105	-	-	-	-	-	-	-	-	-
WS107	-	-	-	-	-	-	-	-	-
WS108	-	-	-	-	-	-	-	-	-
WS109	-	-	-	-	-	-	-	-	-
WS110	-	-	-	-	-	-	-	-	-
WS113	-	-	-	-	-	-	-	-	-
WS114	Y	-	-	-	-	-	-	-	-
WS116	-	-	-	-	-	-	-	-	-
WS119	Y	-	-	-	-	-	-	-	-
WS120	-	-	-	-	-	-	-	-	-
WS122	-	-	-	-	-	-	-	-	-
WS123	-	-	-	-	-	-	-	-	-
WS126	-	-	-	-	-	-	-	-	-
WS127	-	-	-	-	-	-	-	-	-
WS129	Y	-	-	-	-	-	-	-	-
WS130	-	-	-	-	-	-	-	-	-
WS131	-	-	-	-	-	-	-	-	-
WS132	-	-	-	-	-	-	-	-	-
WS133	-	-	-	-	-	-	-	-	-
WS135	-	-	-	-	-	-	-	-	-

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 a true representation of groundwater.

3.3.2. BAROMETRIC PRESSURE

Visits 1 and 2 were undertaken during rising pressure. Visits 3, 4, 5, 8 and 9 were undertaken during falling pressure. Visits 6 and 7 were undertaken during steady pressure events.

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).

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

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	11/01/2022	1.34	Flooded						
	04/02/2022	2.25	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	2.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	2.53	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	2.60	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	2.51	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	2.61	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	2.76	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	2.87	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS103	11/01/2022	1.13	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.20	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	1.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	1.04	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	1.25	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	1.07	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	1.23	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	1.40	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	1.52	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS104	11/01/2022	-	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	-	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	-	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS107	11/01/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.9	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green



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
WS109	11/01/2022	1.77	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	2.00	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	2.20	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	2.34	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	2.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS110	11/01/2022	1.64	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.85	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS113	11/01/2022	1.42	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.65	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	1.43	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	1.55	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	1.30	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	1.69	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	1.71	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	1.76	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	1.76	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS114	11/01/2022	0.61	Flooded						
	04/02/2022	1.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	1.15	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	1.04	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	1.55	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	1.03	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	1.05	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	1.09	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	1.20	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS116	11/01/2022	1.70	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.90	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS119	11/01/2022	1.38	Flooded						
	04/02/2022	2.30	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS120	11/01/2022	1.82	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS122	11/01/2022	0.83	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.00	0.1	0.1	0.0001	0.1	0.0001	CS1	Green



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
WS126	11/01/2022	3.05	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	3.40	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	2.99	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	3.11	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	2.85	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	3.27	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	3.27	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	3.32	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	3.32	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS127	11/01/2022	1.05	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.80	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	1.25	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS129	11/01/2022	1.26	Flooded						
	04/02/2022	2.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS130	11/01/2022	1.68	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.85	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS131	11/01/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS132	11/01/2022	0.65	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	0.90	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	0.88	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	0.92	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	0.80	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	0.96	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	0.65	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	0.84	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	0.94	0.1	0.1	0.0001	0.1	0.0001	CS1	Green



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
WS135	11/01/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.00	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	Dry	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 could be classified as CS1/Green, and it is considered that gas protection measures would not be required if the site was considered within the context of the potential risk from CO₂ and CH₄.
- ✿ Made Ground deposits were identified within each exploratory hole location advanced on the site to a maximum proven depth of 5.45 m bgl (WS106). Although in general, Made Ground in the south of the site extends to circa 2.00 m bgl and 3.00 m in the north.
- ✿ Drift deposits were identified as brown stiff to very stiff CLAY.
- ✿ Monitoring wells set within Made Ground deposits did not record any elevated readings of CH₄ and CO₂.
- ✿ Organic deposits in WS113 did not produce any elevated readings.
- ✿ PID readings within the monitoring wells recorded results ranging from XXX – to XXX.
- ✿ The Site Conceptual Site Model (CSM) identified a site-wide risk associated with volatile and semi-volatile aromatic (polycyclic) hydrocarbons related to coal tar residues used as a sealing material to sandstone cobble sets. Removing / remediation of the residual PAH impact within the near-surface anthropogenic materials is not practicable or sustainable. The developed site CSM, therefore, requires that mitigation measures, including a vapour resistant (aromatic hydrocarbons), be installed within all new dwellings.
- ✿ All dwellings will be constructed and installed with mitigation measures that will inhibit the ingress of vapours in accordance with CIRIA 748.
- ✿ While the site is classified as CS1, the requirement for vapour mitigation measures will be virtue of their design and installation requirements also ensure all dwellings have ground gas mitigation protection that would be compliant with a minimum CS2.
- ✿ All vapour mitigation measures will be validated in accordance with the requirements of CIRIA 735.

It is recommended that the full ground gas assessment and recommended protection measures (if applicable) are agreed upon with the local authority before their adoption on-site. Furthermore, a suitably qualified engineer should validate all protection measures adopted.



3.5. VOC-RESISTANT MEMBRANE DESIGN, INSTALLATION & VALIDATION

Where VOC-resistant membranes are deemed necessary in plots and garages, they must be constructed in accordance with CIRIA 748, which includes installation by a qualified and experienced installer.

Membranes will be installed by a qualified person who will be vetted and approved by the supervising environmental consultant, with their details to be provided to the LPA within the verification report. The installer will prepare the pre-construction documentation and qualifications as detailed overleaf prior to the commencement of any works.

All verification works will be completed by either a chartered environmental specialist with suitable experience or a person who has completed formal training by CL:AIRE for installing membranes to protect gas and vapour ingress in new dwellings.

The verification process will be completed in accordance with the guidelines as set out within CIRIA 735 and 748.

Specifically for vapour membranes, the verification process will ensure: compliance with the specific requirement in CIRIA 748:

FIGURE 3.1 – CIRIA 748 VERIFICATION REQUIREMENT

Verifier (consultant⁴ or third party qualified and experienced installer¹) to conduct thorough verification (visual) inspection of all plots, and after placement of reinforcement if no protection provided. All joints, pipe penetrations etc air lanced to ASTM D4437. Consideration given to need for/scope of integrity testing (eg initially on 30 to 50 per cent of plots then falling to 0 to 10 per cent of plots if acceptable results obtained and no concerns raised by visual inspections)³.

Details of both the installer and verifier for each dwelling will be recorded on a plot-specific verification letter report to be provided to the LPA for approval.

A qualified specialist will complete integrity testing on a ratio of one in three plots to be tested across the complete development area where vapour membranes are deemed necessary.

3.6. VALIDATION PROCESS

3.6.1. STRUCTURAL ELEMENTS

The structural elements of the gas and vapour ingress protection system should be verified as follows:

- Confirmation on the final design for the floor slab;
- Confirmation of the joints in construction, gaps between the floor and walls and the number of openings within the floor (service penetrations) are restricted;
- Confirmation that the wall cavity is free of debris; and,
- Confirmation that the floor system has been utilised as specified.



For specific guidance regarding the correct gas membrane installation, reference should be made to the membrane manufacturer's specification, CIRIA C735 and BS8485:2015+A1:2019.

However, in summary, the following should be considered:

- ✳ Obtain confirmation from the relevant parties that the person(s) installing the membrane are suitably experienced and competent;
- ✳ Confirmation that the correct membrane is being used (vapour compliant);
- ✳ Undertake an inspection of the base/surface onto which the membrane is to be placed to ensure it is suitable and free of debris etc;
- ✳ Where the base is considered to be in acceptable condition for placement, instruction to proceed can be given; and,
- ✳ Once the membrane has been installed, it would then be inspected by a competent, experienced and suitably trained professional.

The installation and verification process for vapour membranes will include the following key attributes.

1. Membrane to be installed by NVQ Level 2 installer;
2. Prior to the commencement of any works, the specialist contractor will produce a detailed installation plan and method statement. CQA Procedures and qualifications for all parties involved in the construction process. This CQA and Verification plan will be subject to approval by the supervising consultant and will be included within the validation statement to be issued to the LPA;
3. Verification consultant will be deemed suitably competent, this will be either chartered status with suitable experience or formal training in CIRIA 735;
4. The first five and every third plot thereafter will be subject to air lancing integrity testing in accordance with an internationally recognised standard. The installer and integrity tester will provide the methodology for their works. The independent verifier will be in attendance during the integrity test works;
5. A detailed verification report will be prepared for each and every plot to be installed with a vapour membrane.

The validation inspection is to include the items that are detailed in Table 3.6.

TABLE 3.6 GROUND GAS MITIGATION MEASURES VALIDATION ITEMS

INSPECTION	METHOD
Product Verification	Confirmation that suitable products have been installed to consist of photographs of product types, labels on packaging and delivery tickets.
Wall Cavity Inspection	Confirmation that gas membrane spans the external wall cavity above the periscopic vents.
General Condition	The membrane is to be inspected to ensure there are no tears, punctures or rips.
Jointing	The engineer is to check the overlaps between membranes are correctly sealed with sufficient overlaps.
Service Entry Points	Verification of the presence of preformed tophats sealed to the pipe and membrane as per the construction detail.



INSPECTION	METHOD
Passive Venting Systems	The engineer should verify the presence of vents at 2m centres on at least 3 of the external walls. Verification of the stone venting layer and presence of pipes to be supplied by photographic records from site.
Integrity testing	All joints, pipe penetrations etc air lanced to ATSM D4437- (initially for 30-50% of plots then falling to 10-25% of plots should acceptable results be obtained, and no concerns raised by visual inspection)

Examples of gas membrane verification photographs are provided in Plate 1.

It should be noted that these are for illustrative purposes only, as each site will have a site-specific gas membrane specification.



PLATE 1 EXAMPLE GAS MEMBRANE VERIFICATION

Plot – 236

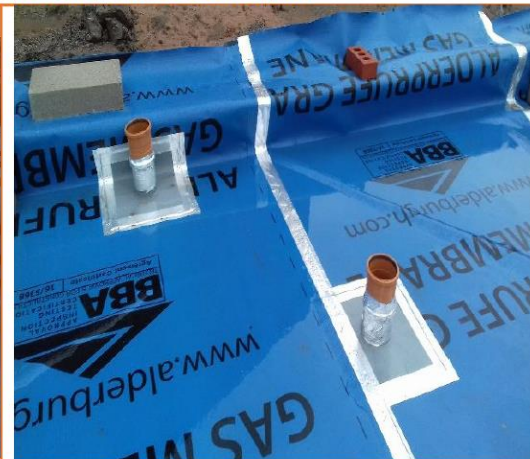
General Condition of Membrane-Good Condition



Verification of Joints and Seals-Good Condition



Verification of Service Penetrations-Good Condition



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



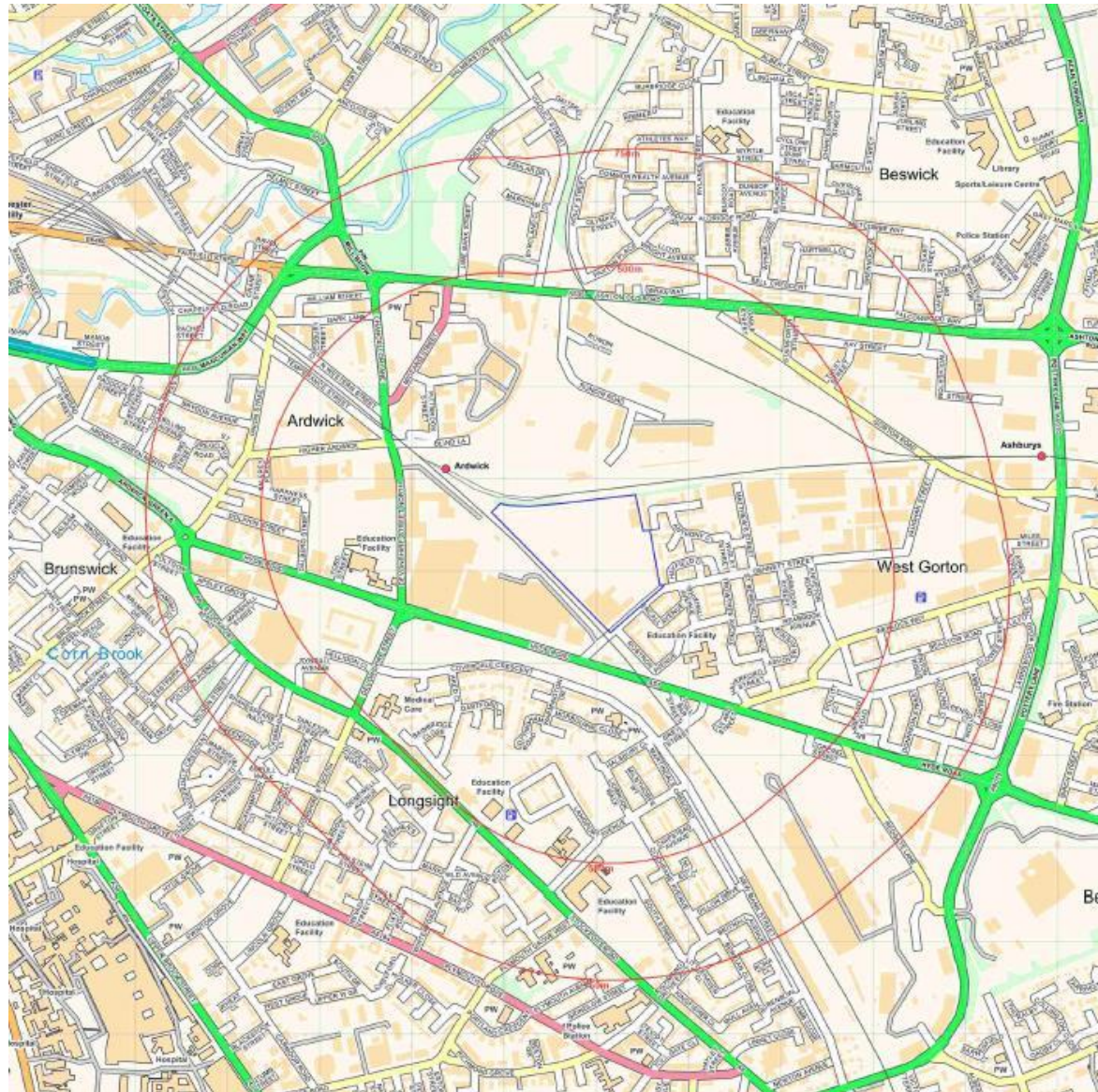
MIBK	Methyl isobutyl ketone	WTE	Water table elevation
m	Metres	ppm	Parts per million
km	Kilometres	mg/m³	Milligram per metre cubed
% v/v	Percent volume in air	m bgl	Metres below ground level
mb	Millibars (atmospheric pressure)	m bcl	Metre below cover level
l/hr	Litres per hour	mAOD	Metres above ordnance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

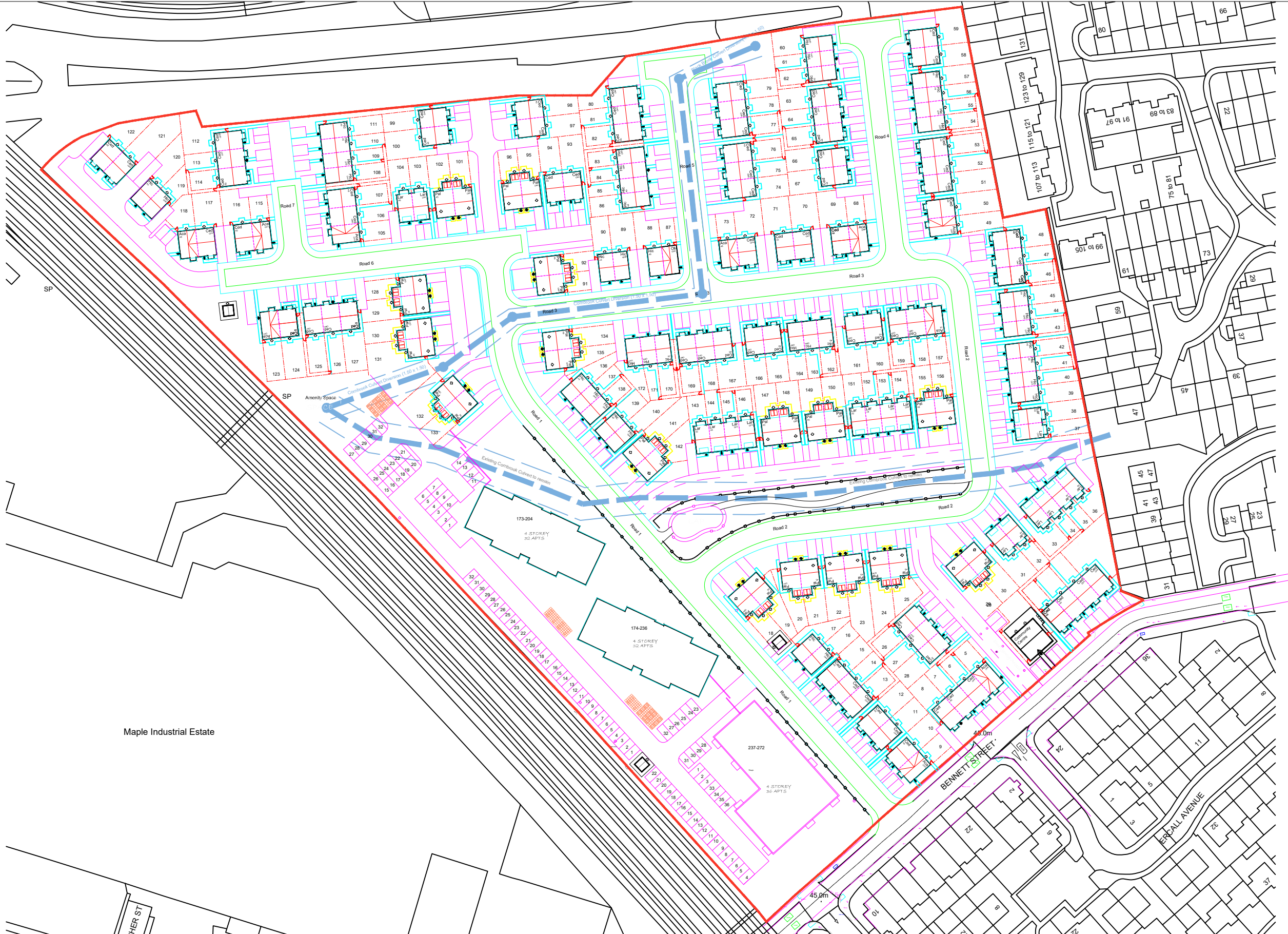


APPENDIX III

DRAWINGS

DRAWING 15-974-001 – SITE LOCATION PLAN





Maple Industrial Estate

CHER ST



Notes:

P1	REVA	21.07.2022	EB	MD
Phase	Issue	Date	Drawn	Checked

Client:

Kellen Homes

Job Title:

Bennett Street,
Manchester

Job No:

15-974

Drawing No:

002

Date:

21.07.2022

Scale:

1:1000 @ A3

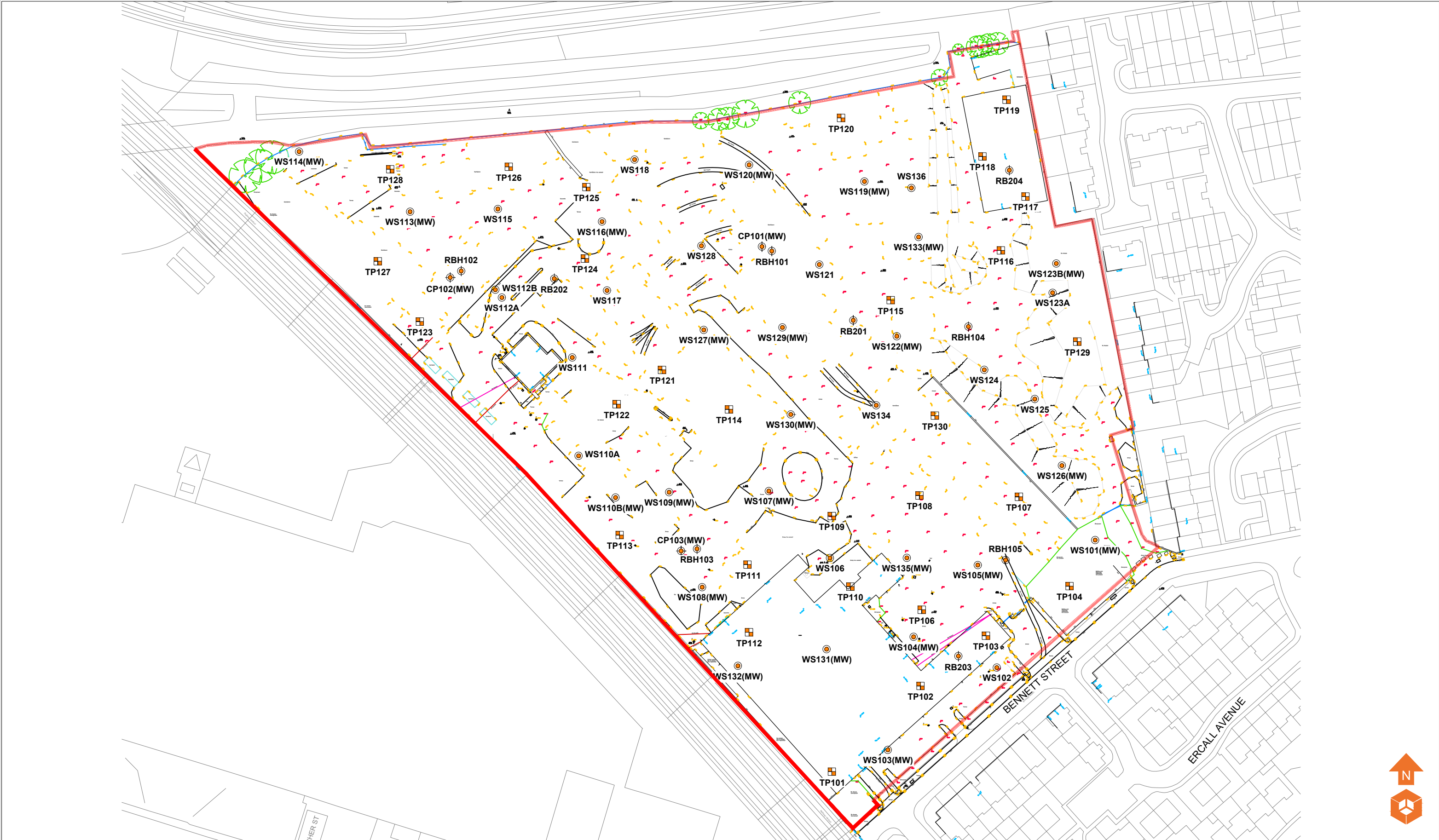
Drawing Title:

Proposed
Development
Plan



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

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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Cable Percussive Borehole Location
- Approximate Rotary Borehole Location
- Approximate Trial Pit Location

Notes:

P1	REVI	31.10.2022	EB	NS
P1	REVI	21.10.2022	EB	SE
P1	REVG	14.03.2022	HM	OJ
P1	REVF	26.01.2022	LM	OJ
P1	REVE	13.01.2022	LM	EC
P1	REVD	10.01.2022	LM	EC
P1	REVC	04.01.2022	CB	EC
P1	REVB	21.12.2021	EB	EC
P1	REVA	02.12.2021	LM	MD
Phase	Issue	Date	Drawn	Checked

Client:

Kellen Homes

Job Title:

Bennett Street,
Manchester

Job No:

15-974

Drawing No:

005

Date:

31.10.2022

Scale:

NTS@ A3

Drawing Title:

Exploratory
Hole Location
Plan



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