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Our Ref: HLEI48353/001L

Date: 16th January 2017

Bianca Jackson
Taylor Wimpey North Thames
1st Floor
2 Imperial Place
Maxwell Road
Borehamwood
Hertfordshire
WD6 1JN

Dear Bianca,

Re: Additional Ground Gas Monitoring and Risk Assessment – Chequersfield, Welwyn Garden City, Hertfordshire AL7 4TX

1. Introduction

RPS Health, Safety and Environment was commissioned by *Taylor Wimpey North Thames* to undertake two additional rounds of ground gas monitoring at Chequersfield, Welwyn Garden City, Hertfordshire AL7 4TX.

A Ground Investigation Report was issued for the site by Soiltechnics Limited in January 2016 (ref: STM3370A-G01). At the time of the report there were no development proposals and it was assumed that the site would be developed for residential use. As part of the investigation, one round of ground gas monitoring was undertaken.

This report provides a summary of the previous ground gas monitoring that has been undertaken at the site and the results of the two additional rounds that have recently been completed by RPS.

2. Summary of Previous Report and Monitoring

Soiltechnics identified that the site historically formed part of a sand and gravel pit from the late 1930s. This site was subsequently backfilled around the 1960s. Information from the Environment Agency indicated that the site and an adjacent site to the north were recorded as historical landfill sites. The site itself was recorded as receiving inert waste from 1993.



Five window sample boreholes (DTS01 to DTS05) were advanced to a depth of 4.00m below ground level (bgl). Encountered ground conditions comprised Made Ground (ranging in thickness from 2.40m to an unproven thickness of 4.00m). This stratum was described as silty sandy gravelly clay or clayey gravelly sand. The Kesgrave Catchment Subgroup was encountered beneath the Made Ground in three of the boreholes. This stratum was described as comprising sand and gravel.

As part of the investigation groundwater/ground gas monitoring wells were installed in boreholes DTS01 and DTS04. Monitoring well DTS01 was screened across the Made Ground and monitoring well DTS04 was screened across the Made Ground and Kesgrave Catchment Subgroup.

An exploratory hole location plan is provided as Figure 1 and the borehole logs are provided in Appendix A.

As part of the assessment Soiltechnics undertook one monitoring round on 1st December 2015, to provide a preliminary assessment of the ground gas regime at the site.

The wells were monitored for concentrations of methane, carbon dioxide and oxygen. In addition, the flow rate was recorded. The results of the ground gas monitoring undertaken by Soiltechnics in 2015 are presented in Appendix B.

Methane was not recorded above the equipment limit of detection in either of the wells during the monitoring round. Carbon dioxide was recorded at a maximum concentration of 6.1% by volume (v/v) in monitoring well DTS04.

Ground gas flow rates were recorded at -0.6 litres per hour (l/hr) in monitoring well DTS01 and -0.5 l/hr in monitoring well DTS04. As a conservative measure, positive measurements for ground gas flow rates have been used in the ground gas assessment in Section 5 (e.g. a ground gas flow rate of 0.6 l/hr for monitoring well DTS01 has been utilised and 0.5 l/hr for well DTS04).

Low oxygen concentrations were recorded in both monitoring wells ranging from 5.1% v/v to 5.2% v/v. The atmospheric pressure was recorded at 1012mb during the monitoring round and was rising.

The results indicated that the site would be classified as Amber 1 under the NHBC guidelines or Characteristic Situation 2 (CS2) under CIRIA Report C665 Assessing risks posed by hazardous ground gases to buildings. Under these classifications, it was considered that basic ground gas protection measures would likely be required in the event that the site be developed.



3. Results of the RPS 2017 Ground Gas Monitoring

Two additional rounds of ground gas monitoring were undertaken by RPS at the site on 10th and 16th January 2017. At the time of the first visit, it was not possible to access monitoring well DTS04.

During the second visit, an additional monitoring well was observed adjacent to the west of well DTS04. This well was also monitored as part of the work (it has been given the ID BHA in the following sections). The base of monitoring well BHA was measured at 12.88m bgl and could therefore not have been undertaken as part of the 2016 Soiltechnics investigation (as all the boreholes were advanced to a maximum depth of 4.00m bgl). It is therefore considered likely that an additional phase of intrusive investigation may have been undertaken at the site.

Monitoring wells DTS01 and DTS04 were monitored for concentrations of methane, carbon dioxide and oxygen. In addition, the flow rate and barometric pressure were recorded. The results of the ground gas monitoring carried out by RPS in 2017 are presented in Appendix C.

Methane was not recorded above the equipment limit of detection (0.1 % v/v) within any of the monitoring wells. Carbon dioxide was recorded at a maximum concentration of 7.1% v/v within monitoring well DTS01 on 16th January 2017. Ground gas flow rates were not recorded above the equipment limit of detection (<0.1 l/hr).

The lowest recorded oxygen concentration was 10.0% v/v within monitoring well DTS01 on 16th January 2017. iVOCs were recorded at a maximum concentration of 0.4ppm within monitoring well BHA. The atmospheric pressure ranged from 1017mb to 1000mb during the monitoring rounds. During both monitoring rounds the atmospheric pressure was steady.

4. Ground Gas Assessment

The results of all three rounds of ground gas monitoring have been utilised in the ground gas assessment.

The CIRIA Report C665 *Assessing risks posed by hazardous ground gases to buildings* outlines indicative guideline concentrations for carbon dioxide and methane in association with gas flow rates for which gas protection measures may be required in new residential or commercial developments. The methodology is based on the Modified Wilson and Card approach that characterises the gas regime into a series of Characteristic Situations (1 to 5), with corresponding indicative gas protection measures. The Characteristic Situations are defined using gas screening



values. This is calculated by multiplying the maximum gas concentration by the maximum measured borehole flow rate.

Using this methodology, the ground gas regime at this site corresponds to Characteristic Situation 2 (CS2). Under CS2, basic ground gas protection measures are required for new developments.

5. Conclusions

The three rounds of ground gas monitoring undertaken at the site indicate that CS2 is applicable. Under CS2, basic ground gas protection measures are required as part of any new development. The requirement for ground gas protection measures should be confirmed and approved by the Local Authority prior to the finalisation of the building design.

I trust that this meets your requirements. Should you have any questions, comments or wish to discuss any of the above further please do not hesitate to contact me.

Yours sincerely

Environment



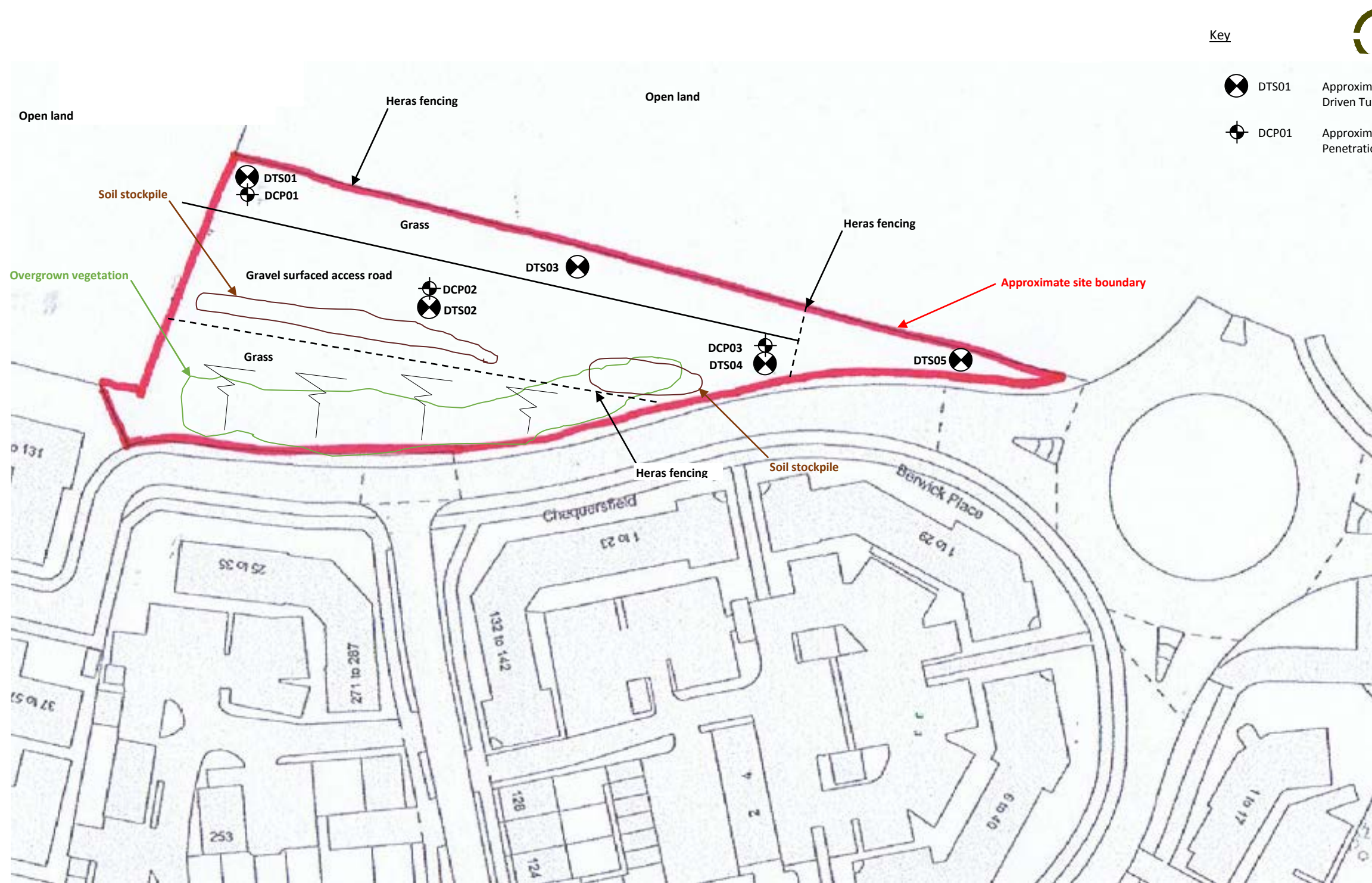
Liz Holland
Senior Consultant

Enc: Figure 1 . Exploratory Hole Location Plan

- Appendix A . Exploratory Hole Logs
- Appendix B . Soiltechnics 2015 Ground Gas Monitoring Data
- Appendix C . RPS 2017 Ground Gas Monitoring Data
- Appendix D . General Notes





FIGURES



Key



-  DTS01 Approximate location of borehole formed by Driven Tube Sampling techniques
-  DCP01 Approximate location of Dynamic Cone Penetration testing

Title

Plan showing existing site features and location of exploratory positions

Scale

Not to scale

Drawing number

02



APPENDIX A

Exploratory Hole Logs

WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS		SAMPLING		
					TYPE/DEPTH (m)	RESULT	FROM (m)	TO (m)	TYPE
	Soft low strength brown slightly gravelly sandy CLAY. Gravel consists of flint and railway ballast. MADE GROUND						0.10		ES
	Medium dense orange brown occasionally grey clayey silty gravelly SAND. Gravel consists of flint. MADE GROUND		0.35				0.40		ES
	Soft low strength orange brown slightly gravelly silty sandy CLAY. Gravel consists of flint and concrete. MADE GROUND		0.70						
					PP 0.90	25	0.90		D
					PP 1.10	50			
	Loose to medium dense brown, dark grey and orange brown slightly clayey gravelly SAND. Gravel consists of flint and concrete. MADE GROUND		1.20						
							1.50		D
	Soft low strength brown to dark brown slightly gravelly sandy CLAY. Gravel consists of flint and occasional coal. MADE GROUND		1.80		PP 1.90	25			
					PP 2.10	25			
				PP 2.30	50				
				PP 2.50	50				
				PP 2.70	50				
Soft low strength orange brown slightly gravelly very sandy CLAY. Gravel consists of flint. MADE GROUND		2.60		PP 2.90	50	2.80		D	
				PP 3.10	50				
				PP 3.30	25				
				PP 3.50	25				
				PP 3.70	25				
Loose to medium dense orange brown slightly clayey silty SAND and GRAVEL. Gravel consists of flint. MADE GROUND		3.80				3.90		D	
			4.00						
BOREHOLE TERMINATED AT 4.00m									

Notes: Standpipe installed to 4m depth. For Dynamic Cone Penetration testing, refer to DCP01.

Ground level (mAOD)

Co-ordinates
523575, 211330

Title

Driven tube sampler borehole record

Surface breaking

No

Groundwater observations

No groundwater encountered.

Date of excavation (range if applicable)

24/11/2015

Appendix

B

Location plan on drawing number

01

DTS01

WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS		SAMPLING		
					TYPE/DEPTH (m)	RESULT	FROM (m)	TO (m)	TYPE
	Soft low strength brown slightly gravelly sandy CLAY. Gravel consists of flint. MADE GROUND						0.10		ES
	Soft low strength orange brown and brown slightly gravelly sandy CLAY. Gravel consists of flint and brick. MADE GROUND		0.30				0.40		ES
	Medium dense orange brown slightly clayey slightly gravelly silty SAND. Gravel consists of flint and coal. MADE GROUND		0.60					0.90	D
	Soft medium strength grey and dark brown slightly gravelly silty sandy CLAY. Gravel consists of flint. MADE GROUND		1.30		PP 1.40	50		1.50	D
					PP 1.60	50			
					PP 1.90	50			
	Medium dense orange brown and dark brown slightly gravelly silty SAND. Gravel consists of flint. MADE GROUND		2.10					2.50	D
	Soft low strength grey and dark brown slightly gravelly silty sandy CLAY. Gravel consists of flint. MADE GROUND		2.70		PP 2.90	50			
					PP 3.10	25			
				PP 3.30	25				
	Soft low strength light brown and grey slightly sandy slightly gravelly silty CLAY. Gravel consists of flint. MADE GROUND	3.40		PP 3.50	25		3.50	D	
				PP 3.70	50				
				PP 3.90	50				
	----- BOREHOLE TERMINATED AT 4.00m		4.00						

Notes: For Dynamic Cone Penetration testing, refer to DCP02.

Ground level (mAOD)

Co-ordinates
523593, 211309

Title

Driven tube sampler borehole record

Surface breaking

No

Groundwater observations

No groundwater encountered.

Date of excavation (range if applicable)

24/11/2015

Appendix

B

Location plan on drawing number

01

DTS02

WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS		SAMPLING		
					TYPE/DEPTH (m)	RESULT	FROM (m)	TO (m)	TYPE
	Grey gravel onto brown to light brown clayey sandy GRAVEL. Gravel consists of flint, brick and concrete. MADE GROUND								
			0.40		PP 0.30	50	0.20		ES
	Soft low strength orange brown and light brown slightly sandy gravelly CLAY. Gravel consists of flint and chalk. MADE GROUND						0.50		ES
			0.80						
	[Loose to medium] dense orange brown slightly clayey silty SAND and GRAVEL. Gravel consists of flint. MADE GROUND						0.90		D
			1.50						
	Soft low strength dark grey occasionally orange silty clayey gravelly SAND. Gravel consists of coal and flint. MADE GROUND						1.50		D
			2.00		PP 2.10	25			
	Soft low strength orange brown slightly sandy gravelly CLAY. Gravel consists of flint and coal. MADE GROUND				PP 2.30	25			
			2.50						
	Soft [low strength] dark grey occasionally orange silty clayey gravelly SAND. Gravel consists of coal and flint. MADE GROUND						2.50		D
			2.70						
	[Loose to medium dense] orange brown clayey gravelly SAND. Gravel consist of flint. MADE GROUND								
			3.10						
	[Medium dense] orange brown silty SAND and GRAVEL. Gravel consists of flint. KESGRAVE CATCHMENT SUBGROUP								
			3.50						D
			4.00						
	BOREHOLE TERMINATED AT 4.00m								

Notes:

Ground level (mAOD)

Co-ordinates
523631, 211314

Title

Driven tube sampler borehole record

Surface breaking

No

Groundwater observations

No groundwater encountered.

Date of excavation (range if applicable)

24/11/2015

Appendix

B

Location plan on drawing number

01

DTS03

WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS		SAMPLING		
					TYPE/DEPTH (m)	RESULT	FROM (m)	TO (m)	TYPE
	Vegetation onto soft low strength brown sandy gravelly CLAY. Gravel consist of brick, concrete, flint and ash. MADE GROUND						0.20		ES
	Firm medium strength light brown slightly gravelly sandy CLAY. Gravel consists of chalk and flint. MADE GROUND		0.45		PP 0.50	50	0.50		ES
	Medium dense to very dense brown slightly clayey gravelly SAND. Gravel consists of flint, clinker and brick. MADE GROUND		0.70				0.90		D
	Very dense becoming medium dense orange brown slightly clayey gravelly SAND. Gravel consists of flint. MADE GROUND		1.20				1.50		D
	Medium dense dark grey silty clayey gravelly SAND. Gravel consists of flint. MADE GROUND		1.80				2.30		D
	Medium dense orange brown silty SAND and GRAVEL. Gravel consists of rounded to angular medium to coarse flint. KESGRAVE CATCHMENT SUBGROUP		2.40				3.50		D
	BOREHOLE TERMINATED AT 4.00m		4.00						

Notes: Standpipe installed to 4m depth. For Dynamic Cone Penetration testing, refer to DCP03.

Ground level (mAOD)

Co-ordinates
523636, 211296

Title

Driven tube sampler borehole record

Surface breaking

No

Groundwater observations

No groundwater encountered.

Date of excavation (range if applicable)

24/11/2015

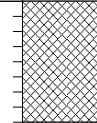
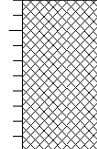
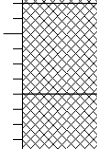
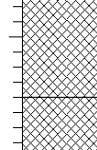
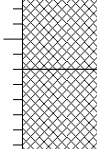
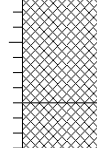
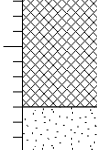
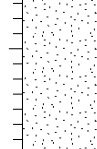
Appendix

B

Location plan on drawing number

01

DTS04

WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS		SAMPLING		
					TYPE/DEPTH (m)	RESULT	FROM (m)	TO (m)	TYPE
	Grass onto soft brown slightly gravelly sandy CLAY. Gravel consists of flint and occasional ash. MADE GROUND						0.20		ES
	Firm medium strength orange brown and light brown sandy gravelly CLAY. Gravel consists of flint and chalk. MADE GROUND		0.40		PP 0.50	50	0.50		ES
	[Loose] brown slightly gravelly clayey SAND. Gravel consists of flint. MADE GROUND		0.90		PP 0.70	75	0.90		D
	[Loose] brown slightly gravelly very clayey SAND. Gravel consists of flint. MADE GROUND		1.20				1.50		D
	[Loose] brown slightly gravelly clayey SAND. Gravel consists of flint. MADE GROUND		1.70						
	[Medium dense] orange brown silty SAND and GRAVEL. Gravel consists of flint. MADE GROUND		2.10				2.50		D
	[Loose] dark brown slightly clayey gravelly SAND. Gravel consists of flint. MADE GROUND		2.70						
	[Medium dense] orange brown slightly clayey gravelly SAND. Gravel consists of flint. KESGRAVE CATCHMENT SUBGROUP		3.20				3.50		D
	----- BOREHOLE TERMINATED AT 4.00m		4.00						

Notes:

Ground level (mAOD)

Co-ordinates
523683, 211300

Title

Driven tube sampler borehole record

Surface breaking

No

Groundwater observations

No groundwater encountered.

Date of excavation (range if applicable)

24/11/2015

Appendix

B

Location plan on drawing number

01

DTS05



APPENDIX B

Soiltechnics 2015 Ground Gas Monitoring Data



Soiltechnics 2015 Ground Gas Monitoring Results

Ground gas concentrations 1st December 2015

Monitoring Well ID	Flow Rate (l/hr)	Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)	iVOCs (ppm)
		Peak	Steady	Peak	Steady	Steady	Peak
DTS01	-0.6	<0.1	<0.1	5.2	5.1	5.2	-
DTS04	-0.5	<0.1	<0.1	6.1	6.1	5.1	-

- Readings not provided

Atmospheric Pressure: 1012mb . Trend: Rising

Soiltechnics 2015 Groundwater Monitoring Results

Monitoring Well ID	Well Screen Depth (m bgl)	Strata	Depth to Groundwater (m bgl)
			01/12/15
DTS01	1.00 to 4.00	Made Ground	3.86
DTS04	1.00 to 4.00	Made Ground and Kesgrave Catchment Subgroup	3.87

The above results were provided as part of the Soiltechnics Limited Ground Investigation Report, ref: STM3370A-G01, dated January 2016.



APPENDIX C

RPS 2017 Ground Gas Monitoring Data



RPS 2017 Ground Gas Monitoring Results

Ground gas concentrations 10th January 2016

Monitoring Well ID	Flow Rate (l/hr)		Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)	iVOCs (ppm)
	Peak	Steady	Peak	Steady	Peak	Steady	Steady	Peak
DTS01	<0.1	<0.1	<0.1	<0.1	0.2	0.2	20.6	<0.1
DTS04	-	-	-	-	-	-	-	-

- Monitoring well not accessible at the time of monitoring

Atmospheric Pressure: 1000mb . Trend: Steady

Ground gas concentrations 16th January 2016

Monitoring Well ID	Flow Rate (l/hr)		Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)	iVOCs (ppm)
	Peak	Steady	Peak	Steady	Peak	Steady	Steady	Peak
DTS01	<0.1	<0.1	<0.1	<0.1	7.1	7.1	10.0	<0.1
DTS04	<0.1	<0.1	<0.1	<0.1	0.8	0.8	19.5	<0.1
BHA	<0.1	<0.1	<0.1	<0.1	1.4	1.1	19.8	0.4

Atmospheric Pressure: 1017mb to 1016mb . Trend: Steady

RPS 2017 Groundwater Monitoring Results

Monitoring Well ID	Well Screen Depth (m bgl)	Strata	Depth to Groundwater (m bgl)	
			10/01/17	16/01/17
DTS01	1.00 to 4.00	Made Ground	3.911	Dry
DTS04	1.00 to 4.00	Made Ground and Kesgrave Catchment Subgroup	-	Dry
BHA	Base of well at 12.88m bgl	Unknown	-	9.920



APPENDIX D

General Notes

RPS HEALTH, SAFETY & ENVIRONMENT

Phase 2 – Site Investigations

General Notes

1. The assessments made in this report are based on the ground conditions as revealed by intrusive investigations, together with the results of any field or laboratory testing or chemical analysis undertaken and other relevant data which may have been obtained including previous site investigations. In any event, ground contamination often exists as small discrete areas of contamination ("hot spots") and there can be no certainty that any or all such areas have been located and/or sampled.
2. There may be special conditions appertaining to the site which have not been taken into account in the report. The assessment may be subject to amendment in the light of additional information becoming available.
3. Where any data supplied by the Client or from other sources, including that from previous site investigations, have been used it has been assumed that the information is correct. No responsibility can be accepted by RPS Companies for inaccuracies within the data supplied by other parties.
4. Whilst the report may express an opinion on possible ground conditions between or beyond trial pit or borehole locations, or on the possible presence of features based on either visual, verbal or published evidence this is for guidance only and no liability can be accepted for the accuracy thereof.
5. Comments on groundwater conditions are based on observations made at the time of the investigation unless otherwise stated. Groundwater conditions may vary due to seasonal or other effects.
6. This report is prepared and written in the context of the agreed scope of work and should not be used in a different context. Furthermore, new information, improved practices and changes in legislation may necessitate a re-interpretation of the report in whole or part after its original submission.
7. The copyright in the written materials shall remain the property of the RPS Company but with a royalty-free perpetual licence to the client deemed to be granted on payment in full to the RPS Company by the client of the outstanding amounts.
8. The report is provided for sole use by the Client and is confidential to them and their professional advisors. No responsibility whatsoever for the contents of the report will be accepted to any person other than the Client.
9. These terms apply in addition to the RPS Group "Standard Terms of Business" (or in addition to another written contract which may be in place instead thereof) unless specifically agreed in writing. (In the event of a conflict between these terms and the said Standard Terms of Business the said Standard Terms of Business shall prevail). In the absence of such a written contract the Standard Terms of Business will apply.