

PHASE 1 & 2 ENGINEERING & ENVIRONMENTAL ASSESSMENT

FOR A PROPOSED RESIDENTIAL DEVELOPMENT SITE ADJACENT BUTT LANE, SNAITH

VOLUME 1

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1.0 INTRODUCTION

- 1.01 Following instructions from Midland Construction Services Ltd during August 2018, CoDa Structures have undertaken an appraisal of a potential residential development site adjacent Butt Lane, Snaith.
- 1.02 The site is undeveloped.
- 1.03 It is proposed to develop the site for housing.
- 1.04 Sections 2.0 – 7.0 of this report undertake a desk based assessment to determine the environmental quality of the land at the site and to identify the potential for any environmental risks as follows:-
- to establish the likely extent of any potential contamination at the site as a result of its current and previous use;
 - to establish the sensitivity of the site in relation to the site's geology, hydrogeology and hydrology;
 - to assess the significance of any potential contamination at the site with respect to possible harm to the surrounding environment and site end users;
 - to provide recommendations for further works as appropriate.
- 1.05 The interpretation provided in this report is based upon information gathered from public data sources.
- 1.06 A trial pit ground investigation was undertaken on the site on 20 September 2018.
- 1.07 A window sampling borehole investigation was undertaken on the site on 27 November 2018. In addition, 6 No. gas/groundwater monitoring wells were installed on the site.
- 1.08 Falling head permeability testing in trial pits was also undertaken on 27 November 2018.
- 1.09 The local authority is East Riding of Yorkshire Council (ERYC).

2.0 LOCATION, TOPOGRAPHY & CURRENT CONDITION

- 2.01 The site is located to the west of Butt Lane and lies approximately 275m to the south of the centre of Snaith. A site location plan (Fig. 1) is attached in Volume 2, Appendix B.
- 2.02 The Ordnance Survey co-ordinates for the centre of the site are 464370mE, 421730mN.

- 2.03 The site is approximately 2.00 hectares in area.
- 2.04 The boundaries of the site are defined as follows:-
- Northern boundary : Fencing and/or hedgerow to residential properties beyond (check).
 - Southern boundary : Undefined.
 - Eastern boundary : Hedgerow to back of verge to Butt Lane.
 - Western boundary : Fencing and/or hedgerow to residential properties beyond.
- 2.05 The site can be accessed from Butt Lane.
- 2.06 A site walk-over was undertaken on 14 September 2018 and the following noted:-
- The site is used for growing crops.
 - There are no obvious visual signs of contamination on the site.
- 2.07 The site is undeveloped farmland.
- 2.08 The general fall of the site is to the southeast. Site levels range from:-
- | Location | Level m (AOD) |
|-------------------|---------------|
| Northern boundary | 7.81 – 10.45 |
| Southern boundary | 6.61 – 7.85 |
| Eastern boundary | 6.61 – 7.81 |
| Western boundary | 7.61 – 1.10 |
- 2.09 A site topographical survey (Fig 2) is attached in Volume 2, Appendix C.
- 2.10 A site aerial photograph is attached in Volume 2, Appendix D.

3.0 HISTORIC SITE USAGE

3.01 Extracts from Ordnance Survey Sheets dating back to 1853 have been examined and the following constitutes a brief history of the entire site and the surrounding land:-

Map date & Scale	On-site Features	Features within 250m of site	Features within 1000m of site
1853 1:10,000	- the site is undeveloped.	- the surrounding area is predominantly undeveloped.	- the surrounding area is predominantly undeveloped; - River Aire to the north; - village of Snaith to the north; - railway lines to the north; - village of West Cowich to the east; - brickyard to the southeast.
1892 1:2,500	- no significant change noted.	- sand pit to the north.	- Not Applicable (N/A)
1891/92 sheets 1:10,000	- no significant change noted.	- no significant change noted.	- gas works to the north; - sand pit to the northeast.
1906 1:2,500	- no significant change noted.	- no significant change noted.	- N/A
1907/08 sheets 1:10,000	- no significant change noted.	- no significant change noted.	- no significant change noted.
1948/52 sheets 1:10,000	- no significant change noted.	- residential development to the north.	- no significant change noted.
1955/56 sheets 1:10,000	- no significant change noted.	- no significant change noted.	- no significant change noted.
1964 1:10,000	- no significant change noted.	- further residential development to the north.	- N/A
1973 1:10,000 map incomplete	- no significant change noted.	- further residential development to the north; - residential development to the southeast and west.	- sewage works to the northwest.
1975/81 sheets 1:2,500	- no significant change noted.	- residential development to the northwest.	- N/A
1978/81 sheets 1:2,500	- no significant change noted.	- residential development to the southeast and southwest.	- N/A
1982/84 sheets 1:10,000	- no significant change noted.	- residential development to the southwest.	- residential development to the northeast and west.
1991 1:2,500 map incomplete	- no significant change noted.	- no significant change noted.	- N/A
1994 1:2,500	- no significant change noted.	- no significant change noted.	- N/A
1999 1:10,000	- no significant change noted.	- further residential development to the north, west and northwest.	- further residential development to the northeast, west and northwest; - depot to the north.
2006 1:10,000	- no significant change noted.	- no significant change noted.	- further residential development to the southwest and west.
2018 1:10,000	- no significant change noted.	- residential development to the northeast.	- further residential development to the southwest and west.

3.02 Historic Ordnance Survey plans are attached in Volume 2, Appendix E.

4.0 GEOLOGY AND HYDROGEOLOGY

4.01 Geology:

BGS Geological Sheet 79 Goole indicates the following:-

- The site is underlain by the Sherwood Sandstone Group of the Guadalupian Age.
- The Brighton Sand Formation is likely to be present at the surface.
- No faults or abnormal features are recorded on or in the vicinity of the site.
- No coal seams are recording as outcropping on or in the near vicinity of the site.
- There are no areas of made or filled ground within 1000m of the site.

A borehole log (Ref: SE62SW197) viewed on the BGS website, undertaken approximately 250m to the southeast of the site, indicates the following sequence of strata:-

Borehole (SE62SW197)	
Strata	Thickness (m)
Made Ground	0.70
Clay	1.00
Sand	1.10
Clay	1.70
Sandstone	34.50

4.02 Mining and Minerals:

A mining report has been obtained from D. Bellis Consulting Surveyors and is summarised as follows:-

- There are no recorded mine workings below the site.
- There are no recorded mine entries on or within 20m of the site.
- The site is not within the boundary of former opencast coal mining site and is not within 800m of a current or planned opencast coal mining site.
- There is coal in reserve, but no workings are currently planned.
- There is no evidence of any coal mining related subsidence claims in relation to the site since 31 October 1994.

The mining report is attached in Volume 2, Appendix F.

There are 7 no. recorded BGS mineral sites within 1000m of the site. Of these 4 no. are within 500m of the site and details are summarised as follows:-

Location: Snaith 232m to the northeast
Type: Opencast
Status: Ceased
Commodity: Sand

Location: Snaith 241m to the northeast
Type: Opencast
Status: Ceased
Commodity: Sand

Location: West Colwick 330m to the east
Type: Opencast
Status: Ceased
Commodity: Sand

Location: Eastfield House 380m to the northeast
Type: Opencast
Status: Ceased
Commodity: Sand

4.03 **Hydrogeology:**

No watercourses are believed to lie on or in the immediate vicinity of the site.

From the inspection of OS maps and the OS Water Network Map, there are watercourses in the vicinity of the site as follows:-

- drainage ditch approximately 100m to the southeast.
- drainage ditch approximately 375m to the southeast.
- drainage ditch approximately 400m to the south.
- 2 no. drainage ditches approximately 450m to the north.
- 2 no. drainage ditches approximately 500m to the south.

The River Aire lies approximately 900m to the north of the site.

There is a small pond approximately 375m to the southeast of the site.

The site is not believed to be prone to flooding and is located in Flood Zone 1 on the Environment Agency (EA) Flood Map.

The site is underlain by a bedrock aquifer designated as a Principle Aquifer which is strata that has a high intergranular and/or fracture permeability and usually provides a high level of water storage that may support water supplies and/or river base flow on a strategic scale.

The superficial aquifer is designated as a Secondary Aquifer – A which is strata which contains permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flows to rivers.

The overlying soils are classified as having a high leaching potential.

Low permeability drift deposits may be present at the surface.

There are 15 no. discharge consents within 1000m of the site. Of these 1 no. is within 500m of the site and details are summarised as follows:-

- storm water overflow 420m to the east

There have been 5 no. pollution incidents within 1000m of the site. Of these 1 no. has been within 500m of the site and details are summarised as follows:-

1 no. Category 3 Minor Incident involving:-

- sewage 200m to the south

The pollution incident does not appear to be associated with any activities on the site.

There has been 1 no. substantiated pollution incident within 1000m of the site but it was not within 500m of the site.

There is 1 no. water abstraction license held within 1000m of the site and details are summarised as follows:-

- surface water abstraction for spray irrigation 766m to the west.

The site is within Zone III of a Source Protection Zone.

There have been no prosecutions relating to controlled waters within 1000m of the site.

5.0 POLLUTION CONTROLS & WASTE

5.01 Pollution Controls:

There are no Integrated Pollution Control Permits held within 1000m of the site.

There are no Integrated Pollution Prevention and Control Permits held within 1000m of the site.

There are 3 no. Local Authority Pollution Prevention and Control Permits held within 1000m of the site.

There are no Local Authority Integrated Pollution Prevention and control Permits held within 1000m of the site.

There are no registered radio active substance licences held within 1000m of the site.

There are no COMAH (Control of Major Accident Hazards Sites) within 1000m of the site.

There have been no prosecutions relating to authorised processes within 1000m of the site.

5.02 **Waste:**

There is 1 no. registered landfill site within 1000m of the site. It is within 500m of the site and details are summarised as follows:-

Location: Snaith 243m to the northeast
Category: Landfill, no restrictions on source of waste
Status: License lapsed, surrendered, cancelled, defunct.
Authorised: Construction and demolition waste.
Waste

There is 1 no. British Geological Survey recorded landfill site within 1000m of the site. It is within 500m of the site and details are summarised as follows:-

Location: Colwich Road, Snaith 208m to the northeast.

There are no Local Authority recorded landfill sites within 1000m of the site.

There are 3 no. historic landfill sites within 1000m of the site. Of these 2 no. are within 500m of the site as follows:-

Location: Snaith 191m to the northeast
Last Input: 26.09.88
Types of: Included inert and household waste.
Waste

Location: Snaith 193m to the northeast
Last Input: 31.12.73
Types of: Not specified.
Waste

There are recorded areas of infilled ground indicated on the historic OS map within 500m of the site as follows:-

- potentially infilled ground (pit, quarry etc) 1984 map 281m to the northeast
- potentially infilled ground (pit, quarry etc) 1984 map 437m to the east

There are no integrated pollution control registered waste sites within 1000m of the site.

There are no registered waste treatment/disposal sites within 1000m of the site.

There is 1 no. licensed waste management facility within 1000m of the site.

There are no registered waste transfer sites within 1000m of the site.

6.0 IDENTIFIED POSSIBLE SOURCES OF CONTAMINATION

6.01 Soil Contamination:

The site does not appear to have been filled or artificially lifted in level. However, any fill that has been imported onto the site may have elevated levels of contamination, depending upon the source and nature of the materials.

The site has not been previously developed.

The site does not appear to be at risk from the uncontrolled tipping or spillages of waste products, residues or chemicals from past activities on the site.

Potentially contaminative activities in the near vicinity (within 250m) of the site have included the following:-

- sand pit

Potentially contaminative activities in the surrounding area (within 250 - 1000m) of the site have included the following:-

- | | | |
|-------------|-----------------|-------------|
| - brickyard | - railway lines | - gas works |
| - sand pit | - sewage works | - depot |

It does not appear that the site has been at risk from the uncontrolled tipping of waste products, residues or chemicals from past industrial activities in the vicinity of the site.

Contemporary Trade Directory entries in the vicinity (within 250m) of the site are as follows:-

Car Dealers

(Inactive) 41m to the northeast

Body Repairs
Petrol Filling Station

(Inactive) 78m to the north
(Active) 232m to the northwest

There is 1 no. fuel station entry in the vicinity (within 500m) of the site and details are summarised as follows:-

Location: Pontefract Road, Snaith 232m to the northwest
Status: Open

The site does not appear to be at risk from the migration of hydrocarbon contamination from the filling station, even if any fuel leaks have occurred, due to the distance of the filling station from the site.

It is recommended that a ground investigation is undertaken on the site with soil sampling for contamination testing.

6.02 Pollution of Controlled Waters:

The possibility of leachate contamination if any uncontrolled filling or contamination is present on the site may need to be investigated to assess the potential for pollution to controlled waters (underlying aquifer). However, this risk is considered to be very low.

6.03 Gas Contamination:

The development may be at risk from the migration of landfill gases on the site as there are known landfill sites within 250m of the site.

Database information indicates that the site is in an area where basic Radon protection measures are not required in the construction of new dwellings or extensions.

It is recommended that gas monitoring is undertaken on the site.

7.0 RISK ASSESSMENT

- 70.1 The following contaminated land risk assessment methodology is based on CIRIA C552 (2001) Contaminated Land Risk Assessment – ‘A Guide to Good Practice’, in order to quantify potential risk via risk estimation and risk evaluation, which can be adopted at the Phase 1 stage. This will then determine an overall risk category which can be used to identify likely actions. This methodology uses qualitative descriptors and is therefore a qualitative approach.

The methodology requires the classification of:-

- the magnitude of the consequence (severity of risk occurring), and
- the magnitude of the probability (likelihood) of a risk occurring.

- 7.02 The potential consequences of contamination risks occurring at this site are classified in accordance with table 7.1, which is adapted from the CIRIA guidance.

Table 7.1 - Classification of Consequences:

Classification:	Definition of Consequence:
Severe	Short term (acute risks to human health). Short term risk of pollution of sensitive water resource or ecosystem. Catastrophic damage crops/buildings/property/infrastructure, including off-site soils.
Medium	Medium/long term (chronic) risks to human health. Medium/long term risk of pollution of sensitive water resource or ecosystem. Significant damage to crops/buildings/property/infrastructure (on or off-site). Contamination of off-site soils.
Mild	Easily preventable, permanent health effects on humans. Pollution of non-sensitive water resources. Localised damage to crops/buildings/property/infrastructure (on or off site).
Minor	Easily preventable non-permanent health effects on humans, or no effects. Minor, low level and localised contamination of on-site soils. Easily repairable damage to crops, buildings/property/infrastructure.

- 7.03 The probability of contamination risks occurring at this site will be classified in accordance with Table 7.2, which is also adapted from the CIRIA guidance. Note that for each category it is assumed that a pollution linkage exists. Where a pollution linkage does not exist the likelihood is zero, as is the risk.

Table 7.2 – Classification of Probability:

Classification:	Definition of Probability:
High Likelihood	Circumstances are such that an event appears very likely in the short term, or almost inevitable in the longterm; or there is already evidence that such an event has occurred.
Likely	Circumstances are such that an event is not inevitable, but is possible in the short term, and is likely over the longterm.
Low Likelihood	Circumstances are such that it is by no means certain that an event will occur even over along period, and it is less likely in the short term.
Unlikely	Circumstances are such that it is improbable that an event would occur even in the longterm.

- 7.04 For each possible pollution linkage (source-pathway-receptor) identified the potential risk can be evaluated. Based upon this CIRIA C552 presents definitions of the risk categories, together with the investigatory and remedial actions that are likely to be necessary in each case, as indicated in Table 7.3. These risk categories apply to each pollutant linkage, not simply to each hazard or receptor.

Table 7.3 – Definition of Risk Categories and Likely Actions required:

Risk Category:	Definition of Likely Actions Required:
Very high	Severe harm to a defined receptor is very likely, or has already occurred. The risk is likely to result in a substantial liability. Urgent investigation (if not already undertaken) is likely to be required. Urgent remediation is likely to be required.
High	Harm to a defined receptor is likely. The risk, if realised, may result in a substantial liability. Urgent investigation (if not already undertaken) is likely to be required. Remediation is likely to be required in the long term, possibly sooner.
Moderate	Harm to a defined receptor is possible, but severe harm is unlikely. Investigation is likely to be required to clarify the level of potential liability and risk. Some remediation may be required in the long term.
Low	Harm to a defined receptor is possible, but is likely to be mild at worst. Liabilities could theoretically arise, but are unlikely. Further investigation is not required at this stage. Remediation is unlikely to be required.
Very low	Harm to a defined receptor is unlikely and would be minor at worst. No liabilities are likely to arise. Further investigation is not required at this stage. Remediation is unlikely to be required.

7.05 This relationship can also be represented as a matrix, as indicated in Table 7.4.

Table 7.4 – Probability / Consequence Matrix:

Probability	Consequence			
	Severe	Medium	Mild	Minor
High Likelihood	Very High Risk	High Risk	Moderate Risk	Low Risk
Likely	High Risk	Moderate Risk	Moderate Risk	Low Risk
Low Likelihood	Moderate Risk	Moderate Risk	Low Risk	Very Low Risk
Unlikely	Low Risk	Low Risk	Very Low Risk	Very Low Risk

7.06 The following potential contamination pathways have been identified on the site:-

Horizontal and vertical migration pathways of leachate through the potentially permeable soils and geological formations.

Human Uptake Pathways (derived from CLEA model and LQA for residential use with plant uptake):

- Ingestion of soil
- Ingestion of indoor dust
- Dermal contact with soil
- Contact with indoor dust
- Inhalation of vapours outside
- Inhalation of vapours inside
- Vertical and lateral migration of volatile vapours and ground gas
- Indirect ingestion

- Airborne hazardous fibres
- Plant root uptake.

7.07 The following environmental receptors have been identified on site:-

- Groundwater (Principle Aquifer)
- Drainage ditches
- Buildings / structures
- Flora / Fauna
- Underground services
- Third party land.

7.08 The following human receptors have been identified on the site:-

- Construction and maintenance workers
- End users.

7.09 Summary – Earthworks and Construction Phase:

A Risk Assessment of the site is summarised in the table below:-

Source	Receptor	Pathway	Consequence	Probability	Risk Category	Comments
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from former site uses and former industries in the vicinity of the site.	R1: Groundwater (aquifer). R2: Drainage ditches	P1: Horizontal and Vertical migration of leachate through potentially permeable soils and service trenches.	Medium/ Severe	Unlikely	Low	
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from former site uses and former industries in the vicinity of the site.	R3: Buildings and structures.	P1: Horizontal and Vertical migration of leachate through potentially permeable soils and service trenches.	Medium	Unlikely	Low	Made ground, if present on the site, may contain elevated sulphate levels which could result in corrosion of buried concrete structures. However, sulphate resisting cement can be used in concrete.
S3: Hydrocarbon contamination from nearby filling station.	R3: Buildings and structures.	P1: Horizontal and Vertical migration of leachate through potentially permeable soils and service trenches.	Minor	Low Likelihood	Very Low	
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from former site uses and former industries in the vicinity of the site.	R4: Construction Workers.	P2: Human uptake pathways (see 7.06).	Severe	Likely	High	The risk to construction workers who do not use the appropriate PPE is likely to be significant. Site remediation works and measures can reduce risk to Low.
S3: Hydrocarbon contamination from nearby filling station.	R4: Construction Workers.	P2: Human uptake pathways (see 7.06)	Severe	Low Likelihood	Moderate	The risk to construction workers who do not use the appropriate PPE is likely to be significant. Site remediation works and measures can reduce risk to Low.

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S4: Gas generation in known landfill sites within 250m of the site	R4: Construction Workers.	P3: Vertical migration of volatile vapours and ground gas	Severe	Low Likelihood	Moderate	The risk to construction workers who do not use the appropriate PPE is likely to be significant.
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from former site uses and former industries in the vicinity of the site.	R5: Neighbouring Sites.	P1: Horizontal and Vertical migration of leachate through potentially permeable soils and service trenches.	Medium	Unlikely	Low	Construction activities can lead to the discharge and mobilisation of contaminants within the site soils. Site remediation works and measures can reduce risk to Low.

7.10 Site Risk Assessment Summary Post Development:

Source	Receptor	Pathway	Consequence	Probability	Risk Category	Comments
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from former site uses and former industries in the vicinity of the site.	R6: Maintenance Workers.	P2: Human uptake pathways.	Severe	Unlikely	Low	The risk to maintenance workers who do not use the appropriate PPE is likely to be significant. Remediation works, if required, such as contamination hot spot removal will reduce risk to Low.
S3: Hydrocarbon contamination from nearby filling station.	R6: Maintenance Workers.	P2: Human uptake pathways.	Severe	Low Likelihood	Moderate	The risk to construction workers who do not use the appropriate PPE is likely to be significant. Site remediation works and measures can reduce risk to Low.
S4: Gas generation in known landfill sites within 250m of the site.	R6: Maintenance Workers.	P3: Vertical migration of volatile vapours and ground gas.	Severe	Low Likelihood	Moderate	The risk to construction workers who do not use the appropriate PPE is likely to be significant. Site remediation works and measures can reduce risk to Low.
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from former site uses and former industries in the vicinity of the site.	R7: Site end users.	P2: Human uptake pathways. P3: Vertical migration of volatile vapours	Severe	Likely	High	Hardcover areas will act as a barrier between contamination and end users. Remediation works, if required, such as contamination hot spot removal

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the vicinity of the site.			and ground gas.					and provision of an inert capping layer to garden areas will reduce risk to Low.
S3: Hydrocarbon contamination from nearby filling station.	R7: Site end users.		P2: Human uptake pathways. P3: Vertical migration of volatile vapours and ground gas.	Severe	Low Likelihood	Moderate		Hardcover areas will act as a barrier between contamination and end users. Remediation works, if required, such as contamination hot spot removal and provision of an inert capping layer to garden areas will reduce risk to Low.
S4: Gas generation in known landfill sites within 250m of the site.	R7: Site end users.		P3: Vertical migration of ground gas.	Severe	Low Likelihood	Moderate		Gas protection measures can be incorporated within building.
S6: Radon generation in underlying geology.	R7: Site end users.		P3: Vertical migration of ground gas.	Severe	Unlikely	Low		
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from former site uses and former industries in the vicinity of the site.	R8: Flora and Fauna.		P4: Plant root uptake.	Severe	Unlikely	Low		Remediation works, if required, such as contamination hot spot removal and provision of an inert capping layer to garden areas will reduce risk to Low.
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from former site uses and former industries in the vicinity of the site.	R9: Services		P1: Horizontal and Vertical migration of leachate through potentially permeable soils and service trenches.	Severe	Unlikely	Low		Site remediation works, such as hotspot removal will reduce risk to Low. Service trenches to be back filled with inert materials. 'Protector Line' water pipes can be used if necessary.
S3: Hydrocarbon contamination from nearby filling station.	R9: Services		P1: Horizontal and Vertical migration of leachate through potentially permeable soils	Severe	Low Likelihood	Moderate		Site remediation works, such as hotspot removal will reduce risk to Low. Service trenches to be back filled with inert materials.

		and service trenches.						'Protector Line' water pipes can be used if necessary.
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7.11 A site conceptual section is shown on Fig. 2 attached in Volume 2, Appendix C.

8.0 GROUND INVESTIGATION**8.01 Fieldwork:**

12 No. trial pits were excavated to depths of between 3.00 – 4.00m using a JCB 3CX excavator on 20 September 2018. The purpose of the trial pits was to allow an insitu visual inspection of the superficial soils, recover samples for laboratory testing and to undertake insitu testing. It should be noted that TP11 was not excavated.

6 No. window sampling boreholes were sunk to depths between 3.04 – 4.31m using a tracked rig on 27 November 2018. The purpose of the boreholes was to allow an insitu visual inspection of the superficial soils, to undertake insitu testing and to install 6 no. gas/groundwater monitoring wells.

4 No. trial pits were excavated to depths of between 3.00 – 3.50m using a JCB 3CX excavator on 27 September 2018. The purpose of the trial pits was to undertake falling head permeability tests.

The location of the trial pits and window sampling boreholes are indicated on Fig. 2 attached in Volume 2, Appendix F.

8.02 Laboratory Testing:

To provide an assessment of soil contamination with respect to the proposed residential development soil samples were screened for a range of potential general contaminants. The screening included the following:-

Arsenic	Mercury	Zinc	PAH (16EPA)
Cadmium	Selenium	Boron (ws)	
Chromium	Copper	Sulphate (ws)	
Lead	Nickel	pH	

In view of the ground conditions encountered the following geotechnical testing was undertaken:-

- Atterberg Limits 6 No.

8.03 Ground Conditions:

The following typical ground conditions were encountered in the trial pits excavated on the site:-

Strata	Location					
	TP01	TP02	TP03	TP04	TP05	TP06
Approx. Ground Level (m AOD)	9.81	8.50	9.40	9.45	8.40	7.45
Topsoil	0.00 – 0.35m	0.00 – 0.30m	0.00 – 0.30m	0.00 – 0.30m	0.00 – 0.35m	0.00 – 0.38m
Sands / Gravels	0.35 – 1.10m (sand &	0.30 – 0.90m (sand &	0.30 – 0.80m (sand &	-	0.35 – 1.40m (sand)	-

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	gravel) 1.10 – 1.60m (clayey sand)	gravel)	gravel)			
Clay	1.60 – 1.80m (soft, low strength)	0.90 – 1.40m (very stiff)	0.80 – 1.30m (very stiff)	0.30 – 1.10m (very desiccated)	1.40 – 2.00m (firm)	1.38 – 1.50m (stiff, desiccated)
	1.80 – 2.30m (with sand bands)			1.10 – 1.60m (soft, low strength)		1.50 – 1.80m (very soft, low strength)
						1.80 – 2.10m (very stiff, high strength)
Silt	-	-	1.30 – 1.80m (very soft, low strength)	-	-	-
Sands / Gravels	2.30 – 3.40m (sand)	1.40 – 2.60m (sand)	1.80 – 2.70m (sand)	1.60 – 3.00m (sand)	2.00 – 3.50m (sand)	2.10 – 3.60m (sand & gravel)
		2.60 – 3.80m (sand & gravel)				
Clay	3.40 – 3.70m (firm)	-	2.70 – 3.50m (soft, low strength)	3.00 – 3.70m (soft, low strength)	-	-
Sand	-	-	3.50 – 4.00m (sand & gravel)	3.70 – 4.00m (sand)	-	-
Stability	Major collapse of pit walls below 2.30m	Continued collapse of pit walls below 3.40m	Slight collapse of pit walls from 1.80 – 2.70m and below 3.50m	Slight collapse of pit walls below 3.70m	Slight collapse of pit walls below 2.90m	Slight collapse of pit walls below 2.10m

Strata	Location					
	TP07	TP08	TP09	TP10	TP12	TP13
Approx. Ground Level (m AOD)	8.75	7.60	7.75	8.20	7.60	7.30
Topsoil	0.00 – 0.35m	0.00 – 0.30m	0.00 – 0.30m	0.00 – 0.30m	0.00 – 0.35m	0.00 – 0.50m
Sands & Gravels	-	0.30 – 1.10m (sand)	-	-	-	-
Clay	0.35 – 1.40m (very stiff, desiccated)	1.10 – 1.50m (stiff, desiccated)	0.30 – 1.30m (very stiff, desiccated)	0.30 – 1.40m (very stiff, desiccated)	0.30 – 1.20m (desiccated)	0.50 – 1.35m (very stiff, high strength, desiccated)
	1.40 – 2.80m (very soft, low strength)		1.30 – 1.70m (firm, medium strength)	1.70 – 2.00m (soft, becoming firm, low strength)		
Silt	-	-	-	-	-	-
Sands & Gravels	2.80 – 3.80m (sand & gravel)	1.50 – 3.00m (sand & gravel)	1.70 – 3.50m (sand & gravel)	2.00 – 2.95m (sand & gravel)	1.20 – 2.00m (sand)	1.35 – 3.50m (sand & gravel)
		3.00 – 3.70m (sand)		2.95 – 3.50m (sand)	2.00 – 3.55m (sand & gravel)	3.50 – 3.95m (gravel)
Clay	-	-	-	-	-	-
Sand	-	-	-	-	-	-
Stability	Slight collapse of pit	Slight collapse of pit	Slight collapse of pit	Slight collapse of pit	Slight collapse of pit	Slight collapse of pit

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	walls below 3.10m	walls below 1.80m	walls below 3.20m	walls	walls	walls
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Strata	Location			
	S1	S2	S3	S4
Approx. Ground Level (m AOD)	8.10	8.85	7.60	9.70
Topsoil	0.00 – 0.35m	0.00 – 0.30m	0.00 – 0.35m	0.00 – 0.50m
Sands and/or Gravels	-	0.30 – 0.60m (sand & gravel)	-	-
Clay	0.35 – 1.90m	0.60 – 0.70m	1.35 – 1.75m	0.50 – 1.00m
Sands and/or Gravels	1.90 – 3.00m (sand & gravel)	0.70 – 1.00m (sand)	1.75 – 3.00m (sand & gravel)	1.00 – 3.50m (sand)
Silt	-	1.80 – 2.20m	-	-
Sand and/or Gravel	-	2.20 – 3.40m (gravel)	-	-
Stability	Pit wall stable whilst open	Pit wall stable whilst open	Pit wall stable whilst open	Pit wall stable whilst open

For the detailed description of the strata encountered see the trial pit logs attached in Volume 2, Appendix F.

The following typical ground conditions were encountered in the window sampling boreholes sunk on the site:-

Strata	Location					
	M1	M2	M3	M4	M5	M6
Approx. Ground Level (m AOD)	9.20	9.85	7.75	9.25	9.30	7.10
Topsoil	0.00 – 0.40m	0.00 – 0.25m	0.00 – 0.45m	0.00 – 0.40m	0.00 – 0.30m	0.00 – 0.40m
Clay	0.40 – 0.80m (firm)	0.25 – 1.00m (stiff)	0.45 – 0.55m (stiff)	0.40 – 1.00m (stiff)	0.30 – 1.80m (firm, medium strength)	0.40 – 0.80m (stiff)
		1.00 – 2.00m (firm, medium strength)	0.55 – 1.40m (stiff, high strength)			0.80 – 1.00m (firm)
Sand and/or Gravel	0.80 – 1.40m (medium dense, sand & gravel)	2.00 – 4.31m (medium dense, sand & gravel)	1.40 – 3.42m (medium dense, sand)	1.00 – 1.45m (medium dense, sand)	1.80 – 1.82m (sand)	1.00 – 1.50m (medium dense, sand & gravel)
Clay	1.40 – 2.40m (soft, low strength becoming stiff, high strength)	-	-	1.45 – 2.60m (soft, low strength)	1.82 – 2.00m (firm)	1.50 – 2.00m (firm)
Sand and/or Gravel	2.40 – 2.45m (sand)	-	-	2.60 – 2.70m (sand)	2.00 – 2.80m (medium dense, sand)	2.00 – 2.80m (medium dense, sand)
					2.80 – 4.38m (medium dense, sand & gravel)	2.80 – 3.04m (sand & gravel)
Clay	2.45 – 2.80m (firm)	-	-	2.70 – 2.80m (firm)	-	-
	2.80 – 3.45m					

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	(stiff, high strength)					
Sand	-	-	-	2.80 – 2.85m	-	-
Clay	-	-	-	2.85 – 3.00m (firm)	-	-
Sand	-	-	-	3.00 – 3.80m (medium dense)	-	-
Clay	-	-	-	3.80 – 4.40m (firm)	-	-

For the detailed description of the strata encountered see the window sampling borehole logs attached in Volume 2, Appendix E.

8.04 Groundwater:

Groundwater was encountered during the trial pit investigation as follows:-

Strata	Location					
	TP01	TP02	TP03	TP04	TP05	TP06
Approx. Ground Level (m AOD)	9.81	8.50	9.40	9.45	8.40	7.45
Groundwater	Soils damp at 2.80m Seepage at 3.20m	Soils wet at 3.40m	Soils damp at 1.80m Soils damp at 3.50m	Soils damp at 1.60m	Soils damp at 3.00m	Soils damp at 3.40m

Strata	Location					
	TP07	TP08	TP09	TP10	TP12	TP13
Approx. Ground Level (m AOD)	8.75	7.60	7.75	8.20	7.60	7.30
Groundwater	Soils damp at 3.20m	Not encountered	Soils damp at 2.60m	Soils damp at 3.40m	Soils damp at 2.80m	Soils damp at 3.50m

Strata	Location			
	S1	S2	S3	S4
Approx. Ground Level (m AOD)	8.10	8.85	7.60	9.70
Groundwater	Not encountered	Not encountered	Not encountered	Not encountered

Groundwater was encountered during the window sampling borehole investigation as follows:-

Strata	Location					
	M1	M2	M3	M4	M5	M6
Approx. Ground Level (m AOD)	9.20	9.85	7.75	9.25	9.30	7.10
Groundwater	Seepage at 1.35m	Seepage at 2.10m	Not encountered	Soils wet at 1.90m	Not encountered	Not encountered

8.05 Excavations:

The sides of the trial pits were generally unstable whilst open. Partial collapse of the trial pit walls were recorded in TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10 and TP11. Major or continual collapse of the trial pit walls were recorded in TP1 and TP2.

8.06 Laboratory Testing:**Soils:**

The results of the chemical analyses on the soil samples are summarised below.

Chemical Test result certificates are attached in Volume 2, Appendix I.

Samples taken from the topsoil (TP1, TP6, TP10 and TP13):-

Contaminant	Concentration in soils mg/kg*	No. of samples tested
Arsenic	5.0 – 10.0	4
Cadmium	<1.0	4
Chromium	11.0 – 17.0	4
Lead	25.0 – 110	4
Mercury	<1.0 – 4.0	4
Selenium	<3.0	4
Copper	15.0 – 26.0	4
Nickel	11.0 – 14.0	4
Zinc	39.0 – 64.0	4
Boron (Water Soluble)	<1.0	4
Sulphate (Water Soluble)	<0.1 g/l	4
pH	6.9 – 8.0	4
PAH	<0.1 – 2.5	4

* unless stated otherwise

The results of sulphate and pH determinants indicate sulphate content expressed as 2:1 aqueous extract of <0.1 g/l SO₄ with pH values between 6.9 – 8.0.

The results of Atterberg Limits tests are summarised in the following table:-

Trial Pit	Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity
TP3	1.00	26	16	10	Low
TP6	1.10	25			
TP6	1.60	27	18	9	Low
TP10	1.10	18	19	22	Intermediate
TP10	1.80	36	23	31	Intermediate
TP12	0.80	16	18	22	Intermediate

Geotechnical test result certificates are attached in Volume 2, Appendix J.

8.07 Insitu Testing:

The results of hand shear vane testing are summarised in the following table:-

Strata	Cohesion (kPa)
Low strength clay	34, 34, 36, 30, 32
Medium strength clay	44, 44
High strength clay	100, 130, 110
Very low strength silt or clay	12, 10, 18

The results of SPT testing are summarised in the following table:-

Strata	N Value
Low strength clay	5
Medium strength clay	16, 50/250, 10
High strength clay	26, 60, 22
Medium dense sand	26, 13, 28, 20, 36
Medium dense sand & gravel	30, 14, 15, 29, 35
Dense sand & gravel	46/155, 50/265, 50/225, 43/130

The results of falling head permeability testing in accordance with BRE: 365 Soakaways are summarised in the following table:-

Location	Soil Infiltration Rate m/s		
	Test 1	Test 2	Test 3
S1	5.82×10^{-6}	-	-
S2	4.40×10^{-6}	-	-
S3	No result	-	-
S4	No result	-	-

Geotechnical test result certificates are attached in Volume 2, Appendix J.

8.08 Gas Monitoring:

Gas monitoring results will be added to the following tables:-

Date: 10 December 2018			Atmospheric Pressure 1029 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate 1/h
M1	1.60	0.00	0.5	20.1	0.0
M2	0.95	0.00	0.2	20.7	0.0
M3	Dry	0.00	0.0	20.9	0.0
M4	0.90	0.00	0.3	20.0	0.0
M5	3.80	0.00	0.5	20.2	0.0
M6	Dry	0.00	0.6	19.9	0.6
Date: 04 January 2019			Atmospheric Pressure 1038 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate 1/h
M1	1.50	0.0	0.5	19.9	0.0
M2	0.90	0.0	0.5	20.2	0.0
M3	Dry	0.0	0.7	19.4	0.0

CoDa Structures

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M4	0.90	0.0	0.6	17.0	0.7
M5	3.50	0.0	0.6	20.4	0.0
M6	Dry	0.0	1.3	19.2	0.9

Date: 23 January 2019			Atmospheric Pressure 996 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
M1	2.50	0.0	0.5	20.4	0.0
M2	Dry	0.0	0.6	20.2	0.0
M3	1.22	0.0	0.5	20.4	0.0
M4	Dry	0.0	0.3	20.5	0.0
M5	1.90	0.0	0.6	20.0	0.0
M6	1.20	0.0	0.6	20.0	0.0

Date: 06 February 2019			Atmospheric Pressure 995 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
M1	2.52	0.0	0.5	20.4	0.0
M2	Dry	0.0	0.6	20.3	1.8
M3	1.22	0.0	0.6	17.8	2.2
M4	Dry	0.0	0.0	20.9	0.0
M5	1.80	0.0	0.6	19.8	0.8
M6	1.26	0.0	0.4	20.4	0.8

Date: 19 February 2019			Atmospheric Pressure 992 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
M1	2.50	0.0	1.2	19.2	0.0
M2	Dry	0.0	0.4	20.3	0.3
M3	1.35	0.0	0.7	18.5	0.2
M4	Dry	0.0	0.9	20.2	0.0
M5	2.60	0.0	0.8	19.6	0.2
M6	1.40	0.0	0.0	20.6	0.3

Date: 01 March 2019			Atmospheric Pressure 1013 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
M1	2.80	0.0	0.7	19.8	0.0
M2	Dry	0.0	0.5	20.3	0.0
M3	Dry	0.0	0.6	19.3	0.0
M4	Dry	0.0	0.7	20.3	0.0

M5	2.50	0.0	0.6	20.0	0.0
M6	1.80	0.0	0.4	20.4	0.0

Groundwater levels measured during the gas monitoring period are indicated in the following table:-

Borehole	Date					
	10.12.18	04.01.19	23.01.19	06.02.19	19.02.19	01.03.19
M1	1.60	1.50	2.50	2.52	2.50	2.80
M2	0.95	0.90	Dry	Dry	Dry	Dry
M3	Dry	Dry	1.22	1.22	1.35	Dry
M4	0.90	0.90	Dry	Dry	Dry	Dry
M5	3.80	3.50	1.90	1.80	2.60	2.50
M6	Dry	Dry	1.20	1.26	1.40	1.80

9.0 CONTAMINATION - DESIGN OBJECTIVES & PHILOSOPHY

9.01 Identification of Potential Hazards:

In January 2015 Land Quality Management Ltd (LQM) published Safe for Use Levels (S4UL's) for Human Health Risk Assessment introducing updated guidance for the assessment of risk to human health from land contamination. The S4UL's are based on assumptions on soil conditions, the existence of exposure pathways behaviour and type of contaminants. The apparent exceedence of the quoted S4UL's is taken as indicating that further detailed assessment is required or that remedial actions should be taken.

9.02 Sensitivity of Development:

The presence of elevated concentrations of particular analytes may present hazards in terms of personal health, damage to plant life and other environmental issues. The S4UL's are classified particular end uses as follows:-

Residential with home grown produce
Residential without home grown produce
Residential public open space
Allotments
Commercial/Industrial

9.03 Design Life:

It is important to recognise when considering a particular problem that the solution has finite life, a concept with which those in the construction industry are familiar. The design life is influenced by the materials used in construction, the environment and the degree of maintenance carried out to extend the design life.

Monitoring is required to determine whether a design is functioning correctly, commensurate with the prevailing environmental conditions. It is essential that future

users are aware of today's solutions since historically most buildings and infrastructure works continue in service. The effect of an increased design life should not be allowed to prejudice the original design principles.

9.04 **Legislation:**

The principle legislation relating to a potential pollution and contamination problems addressed in the Environmental Protection Act 1990 and Environmental Act 1995.

For 'contaminated' land to exist a significant 'pollution linkage' must be present, that is, there should be a source of contamination, a pathway by which the contamination can migrate, to an identified 'receptor' where it could cause 'significant harm'.

Should any link within this chain be severed then the land may not strictly be regarded as 'contaminated land' under the Environmental Protection Act 1990.

Based on the historic site usage and activities on and in the vicinity of the site it was anticipated that there may be contamination present on site use.

A ground investigation was commissioned to investigate soils and the chemical constituents of these soils, especially any made ground. The site was not expected to be severally contaminated and therefore a comprehensive testing regime based on the current industry standard BS 10175 : 2001 was not considered necessary. However, a contamination survey was undertaken with a provision that return visits would have to be made if contamination was exposed at a sufficient concentration to justify more extensive investigations.

9.05 **Design Objectives:**

- i) The objective of reclamation works is to improve any marginal land into ground suitable for its use for residential use with home grown produce. The standards would be in accordance with the LQM/ CIEH S4UL's for Human Health Risk Assessment and SP1010: Development of Category 4 Screening Levels (C4SL's) for Assessment of Land Affected by Contamination as attached in Volume 2, Appendix K. The Assessment Criteria values are based upon an SOM of 1.0%. If considered appropriate a further quantitative risk assessment will be undertaken using calculated site specific target values or S4UL's for SOM values obtained for the site by laboratory testing.
- ii) Risk Assessment
A qualitative risk assessment of any contaminants identified on the site will be undertaken. This will consider the significance of the contaminants identified in terms of source, pathway, receptor (ie. pollution linkage).

10.0 **DISCUSSION**

10.01 **Soils:**

The investigation has only revealed the presence of topsoil on the site. The results have

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been assessed using the proposed Assessment Criteria for residential use with home grown produce attached in Volume 2, Appendix K.

The test results from samples taken from the topsoil on the site are compared in the following tables:-

Contaminant	Concentration in soils mg/kg*	No. of samples tested	Assessment Criteria mg/kg	No. of samples exceeding Assessment Criteria
Arsenic	5.0 – 10.0	4	37	0
Cadmium	<1.0	4	26	0
Chromium	11.0 – 17.0	4	910	0
Lead	25.0 – 110	4	200	0
Mercury	<1.0 – 4.0	4	40	0
Selenium	<3.0	4	250	0
Copper	15.0 – 26.0	4	2400	0
Nickel	11.0 – 14.0	4	180	0
Zinc	39.0 – 64.0	4	3700	0
Boron (Water Soluble)	<1.0	4	290	0
Sulphate (Water Soluble)	<0.1 g/l	4	-	-
pH	6.9 – 8.0	4	<5	0
PAH	<0.1 – 2.5	4	#	#

* unless stated otherwise

see following table

Speciated PAH analysis of samples from the topsoil on the site are summarised in the following table:-

PAH 16 EPA	Concentrations in soils mg/kg	No. of Samples tested	Assessment Criteria mg/kg	No. of Samples exceeding Assessment Criteria
Acenaphthene	<0.1	4	210	0
Acenaphthylene	<0.1	4	170	0
Anthracene	<0.1	4	2400	0
Benzo (a) Anthracene	<0.1 – 0.2	4	7.2	0
Benzo (a) Pyrene	<0.1 – 0.2	4	5.0	0
Benzo (b) Fluoranthene	<0.1 – 0.2	4	2.6	0
Benzo (k) Fluoranthene	<0.1 – 0.3	4	77.0	0
Benzo (g,h,i) Perylene	<0.1 – 0.2	4	320	0
Chrysene	<0.1 – 0.3	4	15.0	0
Di-benzo (a,h) Anthracene	<0.1	4	0.24	0
Indeno (1, 2, 3-cd) Pyrene	<0.1 – 0.1	4	27.0	0

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Fluoranthene	<0.1 – 0.4	4	280	0
Fluorene	<0.1	4	170	0
Napthalene	<0.1	4	2.3	0
Phenanthrene	<0.1 – 0.2	4	95.0	0
Pyrene	<0.1 – 0.4	4	620	0
Total	<0.1 – 2.5	4	-	-

When compared with the proposed Assessment Criteria in relation to residential use with home grown produce no determinants with levels in excess of Assessment Criteria were encountered in the topsoil on the site.

Based on the assessment of the test results no remediation measures are required on the site. However, it is recommended that service trenches are backfilled with clean inert materials.

10.02 Controlled Waters:

The levels of contamination encountered on the site are not considered to pose a significant risk to controlled waters.

10.03 Mining:

The site is not affected by shallow coal seams or mine entries.

10.04 Gas:

Sources of Gas:

Radon protection measures are not required on the development.

Potential sources of methane and carbon dioxide gas are identified in Section 6.03 and are summarised in the following table. The table also gives an indication of the likely gas generation potential and the risk of gas generation increasing in the future.

Source Area	Generation potential of source	Risk of gas generation increasing in future
Known landfill sites or backfilled quarries etc within 250m	Low	Very Low

Gas Pathways:

The typical ground conditions encountered during the investigation indicated made ground over sandstone. Consequently, a direct gas migration pathway through the made ground to the surface exists.

Gas Monitoring:

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The most recent guidance on gas risk assessment (CIRIA C665) 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, which are shown in the table below:

		Generation potential of source				
		Very Low	Low	Moderate	High	Very High
Sensitivity of development	High (residential with gardens)	6/3	9/6	12/6	24/12	24/24
	Moderate (flats)	6/2	6/3	9/6	12/12	24/24
	Low (commercial)	4/1	6/2	6/3	12/6	12/12
6/3 indicates 6 readings over 3 months. At least 2 readings should be taken during periods of low and falling atmospheric pressure						

The proposed development comprises housing. It is considered that the generation potential of the gas source (taking into account the likelihood of future increases in gas generation) is low. However, initially 6 readings over a period of 3 months will be taken.

Gas monitoring at the site has been carried out on six occasions. Three of the monitoring visits were carried out when atmospheric pressure was below 1000mb.

A summary of the monitoring results is shown in the table below.

Monitoring Point	Gas concentrations recorded (% v/v)		Flow rates recorded (litre/hour)
	Methane	Carbon Dioxide	
M1	0.0	0.5 – 1.2	0.0
M2	0.0	0.2 – 0.6	0.0
M3	0.0	0.0 – 0.7	0.0
M4	0.0	0.0 – 0.9	0.0
M5	0.0	0.5 – 0.8	0.0
M6	0.0	0.0 – 1.3	0.0

ND: None detected

Site Gas Regime:

Where Flow rates are shown as 'none detected' a default value of 0.1 litres/hour has been used, representing the limit of detection of the measuring equipment.

The gas monitoring data has been appraised in order to assess the potential gas emission rate from the soils beneath the site.

Borehole gas screening values (GSV) for both methane and carbon dioxide have been calculated for each borehole and are shown in the table below.

Borehole No.:	Gas Screening Value – Methane (litre/hour)	Gas Screening Value – Carbon Dioxide (litre/hour)
M1	0.0	0.0012

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M2	0.0	0.0108
M3	0.0	0.0154
M4	0.0	0.0063
M5	0.0	0.0064
M6	0.0	0.0144

Based on the maximum recorded concentrations of methane the site is categorised in accordance with the NHBC 'traffic light system' as Green.

Based on the GSVs obtained for methane the site is categorised in accordance with the NHBC 'traffic light system' as Green.

Based on the maximum recorded concentrations of carbon dioxide the site is categorised in accordance with the NHBC 'traffic light system' as Green.

Based on the GSVs obtained for carbon dioxide the site is categorised in accordance with the NHBC 'traffic light system' as Green.

Based on the gas readings taken to date the following gas protection measures are recommended on the development:-

- Robust concrete ground floor construction.
- Well ventilated underfloor void (i.e. passive venting).
- Low permeability carbon dioxide resistant membrane with tapped and lapped joints. The membrane is to be taken across cavities and sealed on to service entries.

The desk study data indicates the site is in an area where Radon protection measures are not required.

10.05 Foundations:

Ground conditions on the site are very variable with bands of sands, sands and gravels, soft clays, firm clays, stiff clays, very stiff clays and very soft silt.

The very soft clays and silt on the site are not considered to be a suitable foundation strata as potentially damaging settlements could occur.

Strip footings can be utilised on the development founded on the firm clays below the site. The underside of foundations should be a minimum of 0.90m below finished ground level. Trench footings will be required where very soft silts and clays are present or where foundations are in cohesive strata in the influence zone of trees.

A safe working bearing pressure of 50 kN/m² can be adopted in the low strength clays, 100 kN/m² can be adopted in the medium strength clays and sands of 150 kN/m² can be adopted in the high strength clays.

However, whilst shallow spread foundations can be considered care needs to be taken to avoid over-stressing of the underlying bands of soft strata causing potentially damaging settlements. Therefore, recommended that semi rigid rafts on a 'cushion' of well compacted granular material are utilised on the site. The bearing pressure under the raft thickening should be limited to 50 KN/m².

A safe working bearing pressure of 50 KN/m² can be adopted in the low strength clays, 100 KN/m² can be adopted in the medium strength clays and sands of 150 KN/m² can be adopted in the high strength clays.

It is also recommended that footings are mesh reinforced to resist potential small differential settlements that may occur.

10.06 Ground Floor Construction:

Due to the presence of very soft clays and silts, and where cohesive soils are present in the influence of trees, it is recommended a suspended ground floor with a 300 mm minimum under floor void is utilised for plots where strip and trench footing are utilised.

Where firm or stiff clays, sands and gravels are present, provided the sub base thickness does not exceed 600mm, ground bearing slabs on well compacted hardcore could be utilised for plots where strip and trench footing are utilised.

10.07 Sulphate attack on Buried Concrete:

The results of the sulphate analysis compared to BRE Special Digest 1, 'Concrete in Aggressive Ground' indicate Class DS-1 conditions and ACEC site classification AC-1s.

10.08 Excavations:

Excavations on the site are likely to be unstable in the short term, whereas excavations in natural strata are stable in the short term and trench support should be provided in accordance with current Health & Safety Guidance.

Groundwater is unlikely to be encountered in foundation or drainage excavations but it should be noted that soils were recorded as damp in a number of the trial pits. It should also be noted that the groundwater table is likely to be subject to seasonal variations.

10.09 Pavements:

CBR values in the firm clays and sands are likely to be reasonable (circa 2-5%). However, soft spots may be present in cohesive strata which would need to be excavated and replaced with well compacted granular material. Loose areas may be present in granular strata which would require excavation and re-compaction.

CBR values in the soft clays are likely to be low (< 2%). Therefore, a well compacted 6F2 capping layer may be required under the proposed adopted highways.

Under drives, if soft clays are encountered, oversized granular material should be rolled into the soft clays to stiffen the formation. However, localised very soft areas may be present that would require excavated and replacement with compacted granular material.

10.10 **Drainage:**

The results of falling head permeability testing indicate the use of soakaway is not feasible in the north western and south eastern sectors of the site. The results obtained in the south western and north eastern sectors indicate relatively low soil infiltration rates. Therefore, in view of the results and the variable nature of the rear surface strata below the site, it is considered that the use of soakaways on the development is not appropriate.

A conventional granular bed and surround can be adopted to drainage.

11.0 **CONTAMINATION RISK ASSESSMENT**

Due to the levels of contamination encountered on the site, no further risk assessment is required.

12.0 **REMEDIAL PROPOSALS**

The proposed works shall include the following, although this does not necessarily indicate the order or full extent of the works.

- Disconnect and/or divert any live services on the site.
- Grub out all vegetation and remove from site. Any vegetation to be retained, should be adequately protected from the works.
- Inspect the site for hazardous materials visible on the surface, remove from site together with any fly tipping and rubbish to a suitably licensed tip, using approved methods and a suitably licensed contractor.
- After the initial site strip the formation is to be inspected. Any areas of deleterious material or contamination not identified in the ground investigation identified by visual or olfactory evidence and subsequent chemical testing is to be remediated if necessary, in accordance with a risk assessment.

- Topsoil can be stockpiled on the site for re-use.
- Any imported engineering fill material should be compacted in accordance with the Dpt. Highways Specification.
- Arisings from the made ground on the site is likely to be classified as inert so guidance should therefore be sought from the local Waste Management Regulation Office regarding the disposal of soils from the site.

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**PHASE 1 & 2 ENGINEERING & ENVIRONMENTAL
ASSESSMENT
FOR A PROPOSED RESIDENTIAL DEVELOPMENT
SITE ADJACENT BUTT LANE, SNAITH**

10.0 SUMMARY

Site Name & Location	Butt Lane, Snaith																																																																																		
Proposal	Housing																																																																																		
Local Authority	East Riding of Yorkshire Council.																																																																																		
Site History	The site has not been previously developed. Potentially contaminative activities in the near vicinity (within 250m) of the site have included a sand pit. Potentially contaminative activities in the surrounding area (250 – 1000m) have included a brickyard, railway lines, a gas works, a sand pit, a sewage works and a depot.																																																																																		
Geology	<p>BGS Geological Sheet 79 Goole indicates the following:-</p> <ul style="list-style-type: none">- The site is underlain by the Sherwood Sandstone Group of the Guadalupian Age.- The Brighton Sand Formation is likely to be present at the surface.- No faults or abnormal features are recorded on or in the vicinity of the site.- No coal seams are recording as outcropping on or in the near vicinity of the site.- There are no areas of made or filled ground within 1000m of the site. <p>A borehole log (Ref: SE62SW197) viewed on the BGS website, undertaken approximately 250m to the southeast of the site, indicates the following sequence of strata:-</p> <table><tr><th colspan="2">Borehole (SE62SW197)</th></tr><tr><th>Strata</th><th>Thickness (m)</th></tr><tr><td>Made Ground</td><td>0.70</td></tr><tr><td>Clay</td><td>1.00</td></tr><tr><td>Sand</td><td>1.10</td></tr><tr><td>Clay</td><td>1.70</td></tr><tr><td>Sandstone</td><td>34.50</td></tr></table>						Borehole (SE62SW197)		Strata	Thickness (m)	Made Ground	0.70	Clay	1.00	Sand	1.10	Clay	1.70	Sandstone	34.50																																																															
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Sandstone	34.50																																																																																		
Hydrogeology	The site is in a high sensitivity hydrogeological area as it is underlain by a Principle Aquifer and lies within a Source Protection Zone. However, there are no groundwater abstractions within 1000m of the site.																																																																																		
Flooding	The Environment Agency flood map indicates that the site is in Flood Zone 1.																																																																																		
Mining	The site is not affected by shallow coal workings or mine entries.																																																																																		
Ground Conditions	The following typical ground conditions were encountered on the site:-																																																																																		
	<table><tr><th rowspan="2">Strata</th><th colspan="6">Location</th></tr><tr><th>TP01</th><th>TP02</th><th>TP03</th><th>TP04</th><th>TP05</th><th>TP06</th></tr><tr><td>Approx. Ground Level (m AOD)</td><td>9.81</td><td>8.50</td><td>9.40</td><td>9.45</td><td>8.40</td><td>7.45</td></tr><tr><td>Topsoil</td><td>0.00 – 0.35m</td><td>0.00 – 0.30m</td><td>0.00 – 0.30m</td><td>0.00 – 0.30m</td><td>0.00 – 0.35m</td><td>0.00 – 0.38m</td></tr><tr><td rowspan="2">Sands / Gravels</td><td>0.35 – 1.10m (sand & gravel)</td><td rowspan="2">0.30 – 0.90m (sand & gravel)</td><td rowspan="2">0.30 – 0.80m (sand & gravel)</td><td rowspan="2">-</td><td rowspan="2">0.35 – 1.40m (sand)</td><td rowspan="2">-</td></tr><tr><td>1.10 – 1.60m (clayey sand)</td></tr><tr><td rowspan="3">Clay</td><td>1.60 – 1.80m (soft, low strength)</td><td rowspan="3">0.90 – 1.40m (very stiff)</td><td rowspan="3">0.80 – 1.30m (very stiff)</td><td>0.30 – 1.10m (very desiccated)</td><td rowspan="3">1.40 – 2.00m (firm)</td><td>1.38 – 1.50m (stiff, desiccated)</td></tr><tr><td rowspan="2">1.80 – 2.30m (with sand bands)</td><td>1.10 – 1.60m (soft, low strength)</td><td>1.50 – 1.80m (very soft, low strength)</td></tr><tr><td></td><td></td><td>1.80 – 2.10m (very stiff, high strength)</td></tr><tr><td>Silt</td><td>-</td><td>-</td><td>1.30 – 1.80m (very soft, low strength)</td><td>-</td><td>-</td><td>-</td></tr><tr><td rowspan="2">Sands / Gravels</td><td rowspan="2">2.30 – 3.40m (sand)</td><td>1.40 – 2.60m (sand)</td><td rowspan="2">1.80 – 2.70m (sand)</td><td rowspan="2">1.60 – 3.00m (sand)</td><td rowspan="2">2.00 – 3.50m (sand)</td><td rowspan="2">2.10 – 3.60m (sand & gravel)</td></tr><tr><td>2.60 – 3.80m (sand & gravel)</td></tr><tr><td>Clay</td><td>3.40 – 3.70m (firm)</td><td>-</td><td>2.70 – 3.50m (soft, low strength)</td><td>3.00 – 3.70m (soft, low strength)</td><td>-</td><td>-</td></tr><tr><td>Sand</td><td>-</td><td>-</td><td>3.50 – 4.00m</td><td>3.70 – 4.00m</td><td>-</td><td>-</td></tr></table>						Strata	Location						TP01	TP02	TP03	TP04	TP05	TP06	Approx. Ground Level (m AOD)	9.81	8.50	9.40	9.45	8.40	7.45	Topsoil	0.00 – 0.35m	0.00 – 0.30m	0.00 – 0.30m	0.00 – 0.30m	0.00 – 0.35m	0.00 – 0.38m	Sands / Gravels	0.35 – 1.10m (sand & gravel)	0.30 – 0.90m (sand & gravel)	0.30 – 0.80m (sand & gravel)	-	0.35 – 1.40m (sand)	-	1.10 – 1.60m (clayey sand)	Clay	1.60 – 1.80m (soft, low strength)	0.90 – 1.40m (very stiff)	0.80 – 1.30m (very stiff)	0.30 – 1.10m (very desiccated)	1.40 – 2.00m (firm)	1.38 – 1.50m (stiff, desiccated)	1.80 – 2.30m (with sand bands)	1.10 – 1.60m (soft, low strength)	1.50 – 1.80m (very soft, low strength)			1.80 – 2.10m (very stiff, high strength)	Silt	-	-	1.30 – 1.80m (very soft, low strength)	-	-	-	Sands / Gravels	2.30 – 3.40m (sand)	1.40 – 2.60m (sand)	1.80 – 2.70m (sand)	1.60 – 3.00m (sand)	2.00 – 3.50m (sand)	2.10 – 3.60m (sand & gravel)	2.60 – 3.80m (sand & gravel)	Clay	3.40 – 3.70m (firm)	-	2.70 – 3.50m (soft, low strength)	3.00 – 3.70m (soft, low strength)	-	-	Sand	-	-	3.50 – 4.00m	3.70 – 4.00m	-	-
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Clay	3.40 – 3.70m (firm)	-	2.70 – 3.50m (soft, low strength)	3.00 – 3.70m (soft, low strength)	-	-																																																																													
Sand	-	-	3.50 – 4.00m	3.70 – 4.00m	-	-																																																																													

Client: MIDLANDS CONSTRUCTION SERVICES LTD

Project No: 7849

Date: 18 March 2019 – revision A

**PHASE 1 & 2 ENGINEERING & ENVIRONMENTAL
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			(sand & gravel)	(sand)		
Stability	Major collapse of pit walls below 2.30m	Continued collapse of pit walls below 3.40m	Slight collapse of pit walls from 1.80 – 2.70m and below 3.50m	Slight collapse of pit walls below 3.70m	Slight collapse of pit walls below 2.90m	Slight collapse of pit walls below 2.10m

Strata	Location					
	TP07	TP08	TP09	TP10	TP12	TP13
Approx. Ground Level (m AOD)	8.75	7.60	7.75	8.20	7.60	7.30
Topsoil	0.00 – 0.35m	0.00 – 0.30m	0.00 – 0.30m	0.00 – 0.30m	0.00 – 0.35m	0.00 – 0.50m
Sands & Gravels	-	0.30 – 1.10m (sand)	-	-	-	-
Clay	0.35 – 1.40m (very stiff, desiccated)	1.10 – 1.50m (stiff, desiccated)	0.30 – 1.30m (very stiff, desiccated)	0.30 – 1.40m (very stiff, desiccated)	0.30 – 1.20m (desiccated)	0.50 – 1.35m (very stiff, high strength, desiccated)
	1.40 – 2.80m (very soft, low strength)		1.30 – 1.70m (firm, medium strength)	1.70 – 2.00m (soft, becoming firm, low strength)		
Silt	-	-	-	-	-	-
Sands & Gravels	2.80 – 3.80m (sand & gravel)	1.50 – 3.00m (sand & gravel)	1.70 – 3.50m (sand & gravel)	2.00 – 2.95m (sand & gravel)	1.20 – 2.00m (sand)	1.35 – 3.50m (sand & gravel)
		3.00 – 3.70m (sand)		2.95 – 3.50m (sand)	2.00 – 3.55m (sand & gravel)	3.50 – 3.95m (gravel)
Clay	-	-	-	-	-	-
Sand	-	-	-	-	-	-
Stability	Slight collapse of pit walls below 3.10m	Slight collapse of pit walls below 1.80m	Slight collapse of pit walls below 3.20m	Slight collapse of pit walls	Slight collapse of pit walls	Slight collapse of pit walls

Strata	Location			
	S1	S2	S3	S4
Approx. Ground Level (m AOD)	-	-	-	-
Topsoil	0.00 – 0.35m	0.00 – 0.30m	0.00 – 0.35m	0.00 – 0.50m
Sands and/or Gravels	-	0.30 – 0.60m (sand & gravel)	-	-
Clay	0.35 – 1.90m	0.60 – 0.70m	1.35 – 1.75m	0.50 – 1.00m
Sands and/or Gravels	1.90 – 3.00m (sand & gravel)	0.70 – 1.00m (sand)	1.75 – 3.00m (sand & gravel)	1.00 – 3.50m (sand)
Silt	-	1.80 – 2.20m	-	-
Sand and/or Gravel	-	2.20 – 3.40m (gravel)	-	-
Stability	Pit wall stable whilst open	Pit wall stable whilst open	Pit wall stable whilst open	Pit wall stable whilst open

The following typical ground conditions were encountered in the window sampling boreholes sunk on the site:-

Strata	Location					
	M1	M2	M3	M4	M5	M6
Approx. Ground Level (m AOD)	-	-	-	-	-	-
Topsoil	0.00 – 0.40m	0.00 – 0.25m	0.00 – 0.45m	0.00 – 0.40m	0.00 – 0.30m	0.00 – 0.40m
Clay	0.40 – 0.80m (firm)	0.25 – 1.00m (stiff)	0.45 – 0.55m (stiff)	0.40 – 1.00m (stiff)	0.30 – 1.80m (firm, medium strength)	0.40 – 0.80m (stiff)
		1.00 – 2.00m (firm,	0.55 – 1.40m (stiff, high			0.80 – 1.00m (firm)

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		medium strength)	strength)			
Sand and/or Gravel	0.80 – 1.40m (medium dense, sand & gravel)	2.00 – 4.31m (medium dense, sand & gravel)	1.40 – 3.42m (medium dense, sand)	1.00 – 1.45m (medium dense, sand)	1.80 – 1.82m (sand)	1.00 – 1.50m (medium dense, sand & gravel)
Clay	1.40 – 2.40m (soft, low strength becoming stiff, high strength)	-	-	1.45 – 2.60m (soft, low strength)	1.82 – 2.00m (firm)	1.50 – 2.00m (firm)
Sand and/or Gravel	2.40 – 2.45m (sand)	-	-	2.60 – 2.70m (sand)	2.00 – 2.80m (medium dense, sand)	2.00 – 2.80m (medium dense, sand)
					2.80 – 4.38m (medium dense, sand & gravel)	2.80 – 3.04m (sand & gravel)
Clay	2.45 – 2.80m (firm)	-	-	2.70 – 2.80m (firm)	-	-
	2.80 – 3.45m (stiff, high strength)					
Sand	-	-	-	2.80 – 2.85m	-	-
Clay	-	-	-	2.85 – 3.00m (firm)	-	-
Sand	-	-	-	3.00 – 3.80m (medium dense)	-	-
Clay	-	-	-	3.80 – 4.40m (firm)	-	-

Groundwater:

Groundwater was encountered during the trial pit investigation as follows:-

Strata	Location					
	TP01	TP02	TP03	TP04	TP05	TP06
Approx. Ground Level (m AOD)	9.81	8.50	9.40	9.45	8.40	7.45
Groundwater	Soils damp at 2.80m Seepage at 3.20m	Soils wet at 3.40m	Soils damp at 1.80m Soils damp at 3.50m	Soils damp at 1.60m	Soils damp at 3.00m	Soils damp at 3.40m

Strata	Location					
	TP07	TP08	TP09	TP10	TP12	TP13
Approx. Ground Level (m AOD)	8.75	7.60	7.75	8.20	7.60	7.30
Groundwater	Soils damp at 3.20m	Not encountered	Soils damp at 2.60m	Soils damp at 3.40m	Soils damp at 2.80m	Soils damp at 3.50m

Strata	Location			
	S1	S2	S3	S4
Approx. Ground Level (m AOD)	8.10	8.85	7.60	9.70
Groundwater	Not encountered	Not encountered	Not encountered	Not encountered

Groundwater was encountered during the window sampling borehole investigation as follows:-

Strata	Location					
	M1	M2	M3	M4	M5	M6
Approx. Ground Level (m AOD)	9.20	9.85	7.75	9.25	9.30	7.10
Groundwater	Seepage at 1.35m	Seepage at 2.10m	Not encountered	Soils wet at 1.90m	Not encountered	Not encountered

Foundations

Ground conditions on the site are very variable with bands of sands, sands and gravels, soft clays, firm clays, stiff clays, very stiff clays and very soft silt.

The very soft clays and silt on the site are not considered to be a suitable foundation strata as potentially damaging settlements could occur.

Strip footings can be utilised on the development founded on the firm clays below the site. The

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	<p>underside of foundations should be a minimum of 0.90m below finished ground level. Trench footings will be required where very soft silts and clays are present or where foundations are in cohesive strata in the influence zone of trees.</p> <p>A safe working bearing pressure of 50 KN/m² can be adopted in the low strength clays, 100 KN/m² can be adopted in the medium strength clays and sands of 150 KN/m² can be adopted in the high strength clays.</p> <p>However, whilst shallow spread foundations can be considered care needs to be taken to avoid over-stressing of the underlying bands of soft strata causing potentially damaging settlements. Therefore, recommended that semi rigid rafts on a 'cushion' of well compacted granular material are utilised on the site. The bearing pressure under the raft thickening should be limited to 50 KN/m².</p> <p>A safe working bearing pressure of 50 KN/m² can be adopted in the low strength clays, 100 KN/m² can be adopted in the medium strength clays and sands of 150 KN/m² can be adopted in the high strength clays.</p> <p>It is also recommended that footings are mesh reinforced to resist potential small differential settlements that may occur.</p>
Ground Floor Construction	<p>Due to the presence of very soft clays and silts, and where cohesive soils are present in the influence of trees, it is recommended a suspended ground floor with a 300 mm minimum under floor void is utilised for plots where strip and trench footing are utilised.</p> <p>Where firm or stiff clays, sands and gravels are present, provided the sub base thickness does not exceed 600mm, ground bearing slabs on well compacted hardcore could be utilised for plots where strip and trench footing are utilised.</p>
Building Near Trees	Applicable as clay soils are present on the site.
Pavements	<p>CBR values in the firm clays and sands are likely to be reasonable (circa 2-5%). However, soft spots may be present in cohesive strata which would need to be excavated and replaced with well compacted granular material. Loose areas may be present in granular strata which would require excavation and re-compaction.</p> <p>CBR values in the soft clays are likely to be low (< 2%). Therefore, a well compacted 6F2 capping layer may be required under the proposed adopted highways.</p> <p>Under drives, if soft clays are encountered, oversized granular material should be rolled into the soft clays to stiffen the formation. However, localised very soft areas may be present that would require excavated and replacement with compacted granular material.</p>
Dewatering	Groundwater is unlikely to be encountered in foundation or drainage excavations but it should be noted that soils were recorded as damp in a number of the trial pits. It should also be noted that the groundwater table is likely to be subject to seasonal variations.
Excavations	Excavations on the site are likely to be unstable in the short term and trench support should be provided in accordance with current Health & Safety Guidance.
Sulphate Classification	The results of the sulphate analysis compared to BRE Special Digest 1, 'Concrete in Aggressive Ground' indicate Class DS-1 conditions and ACEC site classification AC-1s.
Drainage	<p>The results of falling head permeability testing indicate the use of soakaway is not feasible in the north western and south eastern sectors of the site. The results obtained in the south western and north eastern sectors indicate relatively low soil infiltration rates. Therefore, in view of the results and the variable nature of the rear surface strata below the site, it is considered that the use of soakaways on the development is not appropriate.</p> <p>A conventional granular bed and surround can be adopted to drainage.</p>
Contamination Assessment	When compared with the proposed Assessment Criteria in relation to residential use with home grown produce no determinants with levels in excess of Assessment Criteria were encountered in the topsoil on the site.
Controlled Waters	The levels of contamination encountered on the site are not considered to pose a significant risk to controlled waters.
Remediation Proposals	None required.
Remediation Statemen	Not required.
Gas Protection	No protection measures required on the development.
Radon	No protection measures required on the development.
Unforeseen	Should any areas of previously unidentified potentially contaminated soil be encountered during site

CoDa Structures

Consulting Civil & Structural Engineers
14 Springfield Court
GUISELEY
LS20 8FD

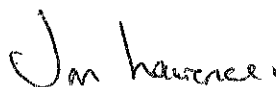
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Circumstances	construction works we would recommend consultation with CoDA Structures to ensure that the recommendations continue to apply.
Construction Works	It is recommended that construction personnel with direct contact with the soils at the site use appropriate PPE equipment (i.e. gloves and overalls) together with welfare facilities in accordance with general health and safety guidelines.
Utilities	We would recommend that a copy of the ground investigation report when available, is supplied to Utility Companies, and that their recommendations relating to appropriate supply pipes are adhered to.
Statutory Consultation	We would recommend that a copy of the ground investigation report once prepared is issued to the Local Authority for comment and approval prior to the development of the site.

11.0 CAVEATS

- 11.01 The comments given in this report and recommendations made are based on the information that could be obtained from reasonably accessible sources. Discussions have not yet been held with statutory bodies and the local authority.
- 11.02 The comments and recommendations made in this report are based on the ground conditions encountered during the site work, and on the results of laboratory testing on a selected number of samples taken in the field. There may be conditions prevailing at the site with respect to ground conditions and contamination that have not been encountered during the investigations, and which have therefore not been taken into account in this report.
- 11.02 This report has been prepared for the sole use of Midlands Construction Services Ltd and their development funder, unless agreed otherwise in writing by CoDA Structures.

Signed:



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J Lawrence B Eng C Eng M I Struct E