

PHASE 1 & 2 ENGINEERING AND ENVIRONMENTAL ASSESSMENT

FOR LAND ADJACENT LIDGETT LANE, PILLEY

VOLUME 1

CONTENTS

- 1.0 INTRODUCTION
- 2.0 LOCATION, TOPOGRAPHY & CURRENT CONDITION
- 3.0 HISTORIC SITE USAGE
- 4.0 GEOLOGY & HYDROGEOLOGY
- 5.0 POLLUTION CONTROLS & WASTE
- 6.0 IDENTIFIED POSSIBLE SOURCES OF CONTAMINATION
- 7.0 RISK ASSESSMENT
- 8.0 GROUND INVESTIGATION
- 9.0 CONTAMINATION – DESIGN OBJECTIVES & PHILOSOPHY
- 10.0 REDEVELOPMENT PROPOSALS - DISCUSSION
- 11.0 CONTAMINATION ASSESSMENT
- 12.0 RECLAMATION PROPOSALS
- 13.0 ADDITIONAL INVESTIGATION WORKS
- 14.0 SUMMARY

Volume 1 : revision ---

Volume 2 : revision –

VOLUME 2**APPENDICES**

APPENDIX A	-	LIST OF DOCUMENTS REFERRED TO
APPENDIX B	-	SITE LOCATION PLAN - FIG. 1
APPENDIX C	-	SITE TOPOGRAPHICAL SURVEY - FIG. 2
APPENDIX D	-	SITE PHOTOGRAPHS
APPENDIX E	-	HISTORIC ORDNANCE SURVEY PLANS
APPENDIX F	-	MINING SEARCH
APPENDIX G	-	TRIAL PIT AND TRIAL TRENCH LOGS
APPENDIX H	-	ROTARY BOREHOLE LOGS
APPENDIX I	-	CHEMICAL TEST RESULTS
APPENDIX J	-	GEOTECHNICAL TEST RESULTS
APPENDIX K	-	CONTAMINATION ASSESSMENT CRITERIA
APPENDIX L	-	SITE SECTIONS - FIG. 3

1.0 INTRODUCTION

- 1.01 Following instructions from Jaguar Estates Ltd and Wortley Construction Ltd on 08 September 2014, CoDA Structures have undertaken an appraisal of a proposed residential development site adjacent Lidgett Lane, Pilley. The appraisal assesses engineering and environmental issues.
- 1.02 The site is currently farmland.
- 1.03 It is proposed to develop the site with approximately 35 houses.
- 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 30 September 2014.
- 1.07 A rotary borehole ground investigation was also undertaken on the site on 6 October 2014.
- 1.08 A trial trench ground investigation was undertaken on the site on 03 March 2015.
- 1.09 The local authority is Barnsley Metropolitan District Council (BMDC).

2.0 LOCATION, TOPOGRAPHY & CURRENT CONDITION

- 2.01 The site is located to the south of Lidgett Lane and lies approximately 7.0 miles to the south of Barnsley Town Centre. A site location plan (Fig. 1) is attached in Appendix B.
- 2.02 The Ordnance Survey co-ordinates for the centre of the site are 433700mE, 400400mN.
- 2.03 The site is approximately 2.4 hectares in area.

2.04 The boundaries of the site are defined as follows:-

- Northern boundary : Hedgerow to edge of Lidgett Lane;
- Southern boundary : Timber period fence to residential properties beyond;
- Western boundary : Stone wall to the back of verge to Pilley Green
- Eastern boundary : Post and wire fence and hedgerow to adjacent land.

2.05 The site can be accessed from Lidgett Lane.

2.06 A site walk-over was undertaken in March 2012 and the following noted:-

- the site is farmland.
- there are hedgerows and trees to the perimeter of the site.
- there are no obvious visual signs of contamination on the site.

2.07 The general fall of the site is to the south. Site varies as follows:-

- north western corner 158.69m AOD
- north eastern corner 150.50m AOD
- south western corner 147.87m AOD
- south eastern corner 139.88m AOD

2.08 A site topographical survey (Fig. 2) is attached in Volume 2, Appendix C.

2.09 Site photographs are attached in Volume 2, Appendix D.

3.0 HISTORIC SITE USAGE

3.01 Extracts from Ordnance Survey Sheets dating back to 1855 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
1855 1:10,000	- the site appears to be farmland;	- the surrounding area appears to be predominantly undeveloped; - Village of Pilley to the northwest; - Village of Pilley Green to the south;	- the surrounding area is predominantly undeveloped; - Village of Birdwell to the northeast; - old coal pit to the north; - old quarries to the northeast and west; - Birdwell Dike to the northeast; - Pilley Hills Colliery to the northwest; - Wharnccliffe Silkstone Colliery to the southeast; - blacksmiths to the south; - quarry to the south; - ironstone pit to the northwest; - quarry to the east; - railway lines to the south; - clay pit to the southeast;
1893 1:2,500	- no significant change noted;	- edge of a spoil heap to the south;	- not applicable (N/A);
1893/94 sheet 1:10,000	- no significant change noted;	- no significant change made;	- reservoir to the west; - quarry to the northeast; - significant expansion of Wharnccliffe Silkstone Colliery to the south; - residential development to the northeast; - gas works to the east; - Silkstone Colliery No. 2 pit to the southwest;
1905 1:2,500	- no significant change noted;	- residential development to the west and south; - railway branch line to the north and sidings to the east;	- N/A
1906/07 sheets 1:10,000	- no significant change noted;	- no significant change noted;	- sewage works to the northeast. - expansion of Birdwell to the northeast; - brickworks to the south; - air shaft to the southwest;
1931 1:2,500	- no significant change noted;	- no significant change noted;	- N/A
1932 1:10,000	- no significant change noted;	- no significant change noted;	- further expansion of Birdwell to the northeast; - further expansion of Wharnccliffe Colliery to the south; - sludge and filter beds to the

CoDa Structures Consulting Civil & Structural Engineers 14 Springfield Court Guiseley Leeds LS20 8FD	PHASE 1 & 2 ENGINEERING & ENVIRONMENTAL ASSESSMENT FOR LAND ADJACENT LIDGETT LANE, PILLEY
---	--

			southeast;
1938 1:10,000	- no significant change noted;	- no significant change noted;	- no significant change noted;
1948 1:10,000	- no significant change noted;	- no significant change noted;	- no significant change noted;
1956 1:10,000	- no significant change noted;	- residential development to the north;	- residential development to the south; - opencast coal workings to the southwest;
1957 1:2,500	- no significant change noted;	- railway branch line to the north and sidings to the east no longer present; - small ponds to the south;	- N/A
1963 1:2,500	- no significant change noted;	- further residential development to the north	- N/A
1965/66 sheet 1:10,000	- no significant change noted;	- slag heap to the south;	- commercial development to the east; - further residential development to the east; - Wharnccliffe Silkstone Colliery no longer shown to the south except for spoil heaps to the south;
1978/80/82 1:10,000 map incomplete	- no significant change noted;	- no significant change noted;	- commercial development to the south;
1982 1:2,500	- no significant change noted;	- no significant change noted;	- N/A
1993 1:2,500	- no significant change noted;	- no significant change noted;	- no significant change noted;
2006 1:10,000	- no significant change noted;	- no significant change noted;	- further expansion of Birdwell to the northeast; - further residential development to the southwest; - industrial park development to the south; - depot and works to the east;
2012 1:10,000	- no significant change noted;	- no significant change noted;	- no significant change noted;

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

4.0 GEOLOGY AND HYDROGEOLOGY**4.01 Geology:**

1:50,000 British Geological Survey (BGS) Geological Sheet 87 Barnsley indicates the following:-

- The site is underlain by Pennine Middle Coal Measures and sandstone may be present in the north eastern sector of the site.
- Drift deposits are unlikely to be present at the surface.
- The Tankersley fault appears to traverse the site in a northwest to southeast direction. The Birdwell fault lies adjacent the northwest corner of the site.
- Two coal seams may outcrop on the site.
- The approximate position of the faults and the coal outcrops are indicated on Fig 2.

4.02 Mining & Minerals:

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

- The following seams have been worked below the site:-

Seam	Depth (m)	Section (cm)	Date	Remarks
Flockton Thick	52	50	Pre 1967	Subjacent
Top Fenton	104	83	Pre 1977	Subjacent
Low Fenton	107	120	Pre 1980	Adjacent
Parkgate	126	137	Pre 1930	Subjacent
Thorncliffe	155	120	Pre 1968	Subjacent
Silkstone	208	114	Pre 1922	Subjacent
Whinmoor	267	94	Pre 1968	Subjacent

- There is coal in reserve below the site but no workings are currently planned.
- The site is situated on or adjacent an area of a former opencast coal mine.
- There are 2 no. recorded mine entries to the east of the site.
- The site is situated adjacent an area of made ground that was a former colliery site.
- There are some indications that gas emissions have occurred at or adjacent to the site.

- The area in close proximity to adits to the east of the site which have been subject to remedial works under emergency surface hazard procedures.
- The site is in an area where there may be unrecorded shallow workings.
- The property or property adjacent the site has been subject to a claim for past coal mining subsidence.

The mining report is attached in Volume 2, Appendix F

It is recommended that a rotary borehole investigation should be undertaken to investigate the possible presence of shallow coals workings below the site. In addition 4 No. gas monitoring wells should be installed to investigate the possible emission of mine gases at the site. A minimum of six gas readings should be taken.

There are 2 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: Pilley 400m to the east
Type: Opencast
Status: Ceased
Commodity: Sandstone

Location: Potter Holes Plantation, Tankersley 375m to the southeast
Type: Opencast
Status: Ceased
Commodity: Clay and Shale

Location: Tankersley 437m to the south
Type: Deep mine
Status: Ceased
Commodity: Coal

Location: Tankersley 500m to the south
Type: Opencast
Status: Ceased
Commodity: Clay and Shale

4.03 **Hydrogeology:**

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

From the inspection of OS maps watercourses lie in the vicinity of the site (within 500m to the west.

- drainage ditches 250m to the south
- un-named watercourse 250m to the west

- Birdwell Dike 360m to the west

There are other water features in the vicinity of the site (within 500m) as follows:-

- small pond 200m to the south
- groundwater issues 350m to the southeast
- groundwater sinks 400m to the southwest

The site is not believed to be prone to flooding and the Environment Agency flood map indicates that the site is in Flood Zone 1. Potential flooding issues are assessed further in CoDA Structures Flooding and Drainage Assessment report for the site.

The site is underlain by a bedrock aquifer designated as a Secondary Aquifer A which is strata with permeable layers capable of supporting water supplies at a local rather than strategic level and in some cases can form an important source of base flow to rivers.

There is no superficial aquifer designation for the site.

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

There are 10 No. discharge consents within 1000m of the site. Of these 1 No. is within 500m of the site and details are summarised as follows:-

- trade effluent 450m to the southeast

There have been 6 No. pollution incidents within 1000m of the site but none have been within 500m of the site.

There are no water abstraction licenses held within 1000m of the site.

The site does not lie within 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 3 No. Integrated Pollution Prevention and Control Permits held within 1000m of the site.

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

There are 2 No. Control of Major Accidents Hazards Site (COMAH) within 1000m of the site and details are summarised as follows:-

Location: Wentworth Industrial Estate, Tankersley 602m to the south
Type: Lower tier
Status: Record ceased to be supplied under COMAH Regulations

Location: Wentworth Way, Tankersley 621m to the south
Type: Lower tier
Status: Record ceased to be supplied under COMAH Regulations

5.02 Waste:

There is 1 No. registered landfill sites within 1000m of the site but it is not within 500m of the site.

There are no British Geological Survey recorded landfill sites within 1000m of the site.

There are 2 No. Local Authority recorded landfill sites within 1000m of the site but neither are within 500m of the site.

There are 2 No. historic landfill sites within 1000m of the site but neither are within 500m of the site.

There is 1 No. waste treatment/disposal sites within 1000m of the site but it is not within 500m of the site.

There are 3 No. waste management facilities within 1000m of the site.

There is 1 No. waste transfer sites within 1000m of the site.

6.0 IDENTIFIED POSSIBLE SOURCES OF CONTAMINATION

The past history of the site would indicate no obvious sources of contamination.

6.01 Soil Contamination:

It does not appear that the site has been filled or artificially raised in level. However, the area adjacent the eastern boundary of the site is recorded as being an area of made ground and has been part of a colliery site. In addition open cast mining has taken place to the south of the site and the site is recorded as being on or adjacent to an area of open cast mining. Therefore any fill that may have been imported onto the site may have elevated levels of contamination, depending upon the source and nature of the material used.

Historic OS plans indicate the site has not been developed and appears to be have only been used as farmland.

The farmland use is considered to be a very low risk contaminative activity.

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

- railway lines, sidings
- spoil heaps

Potentially contaminative activities in the surrounding area have included the following:-

- coal pits
- blacksmiths
- 'works'
- open cast coal mine
- quarries
- ironstone pits
- gas works
- brickworks
- clay pit
- colliery
- depots
- sludge & filter beds
- sewage works
- industrial park

In view of past activities adjacent the site it is possible the site has been at risk from the uncontrolled tipping of waste materials, residues or chemicals from surrounding past industries/activities particularly if made ground is present on the site.

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

- Air Conditioning Equipment (inactive) 215m to the northwest of the site

There are no fuel station entries in the vicinity of the site (within 500m).

It is recommended that a ground investigation is undertaken on the site and if made ground is encountered or suspected contamination is encountered soil sampling should be undertaken for contamination testing.

6.02 Pollution of Controlled Waters:

The possibility of leachate contamination from any uncontrolled filling that has taken place on the site may need to be investigated to assess the potential for pollution to controlled waters (the underlying secondary aquifer - A and Birdwell Dike).

6.03 Gas Contamination:

The development does not appear to be at risk from the migration of landfill gas onto the site from known landfill sites in the surrounding area as none are within 250m of the development.

The development does not appear to be at risk from landfill gases from a backfilled clay pit and/or quarry and/or sludge and filter beds in the surrounding area to the site as these features are in excess of 250m from the site.

The development may be at risk from mines gases if shallow coal seams/workings are present below the site. In addition there are particular records that gas emissions from mine workings have occurred at the site.

Therefore it is recommended that gas monitoring should be undertaken on the site.

Database information indicates that the site is in an area where Radon protection measures are not required.

7.0 RISK ASSESSMENT

- 7.0.1 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.

- 7.0.2 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 residing in the underlying secondary aquifer – A
- Birdwell Dike
- Buildings / structures
- Flora / Fauna
- Underground services
- Third party land.

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

- Construction.
- Maintenance Workers.
- End users.

**PHASE 1 & 2 ENGINEERING & ENVIRONMENTAL ASSESSMENT
FOR LAND ADJACENT LIDGETT LANE, PILLEY**

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 adjacent industries/activities.	R1: Groundwater (secondary aquifer – A). R2: Birdwell Dike	P1: Horizontal and Vertical migration of leachate through potentially permeable soils and service trenches.	Medium	Likely	Moderate	Low permeability soils if present below the site, will prevent the migration of contaminants. Some types of contamination is likely to be localised. Site remediation works and measures can reduce risk.
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from adjacent industries/activities.	R3: Buildings and structures.	P1: Horizontal and Vertical migration of leachate through potentially permeable soils and service trenches.	Medium	Likely	Moderate	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.
S1: Contamination in made ground used to fill the site. S2: Uncontrolled tipping of waste products and residues from adjacent industries/activities.	R4: Construction workers.	P2: Human uptake pathways (see 7.06). P3: Vertical migration of volatile vapours and ground gas.	Severe	Likely	High	Some types of contamination is likely to be localised. Site remediation works and measures can reduce risk. The risk to workers who do not use the appropriate PPE is likely to be significant.
S3 Gas Generation in landfill sites S4 Backfilled quarries, sludge/filter beds and/or clay pit within 250m of the site.	R4: Construction workers.	P2: Human uptake pathways (see 7.06). P3: Vertical migration of volatile vapours and ground gas.	Severe	Unlikely	Low	No known such features within 250m of the site.

S5: Mine gases	R4: Construction workers.	P3: Vertical migration of volatile vapours and ground gas.	Severe	Likely	High	Due to the potential for exposure to gases, the risk to 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 adjacent industries/activities.	R5: Neighbouring Sites.	P1: Horizontal and Vertical migration of leachate through potentially permeable soils and service trenches.	Medium	Likely	Moderate	Low permeability soils if present below the site, will prevent the migration of contaminants. Some types of contamination is likely to be localised. Site remediation works and measures can reduce risk.

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 adjacent industries/activities.	R6: Maintenance Workers.	P2: Human uptake pathways. P3: Vertical migration of volatile vapours and ground gas.	Severe	Likely	High	Site remediation works such as hot spot removal will reduce risk to low. The risk to maintenance workers who do not use the appropriate PPE is likely to be significant.
S3: Gas generation in landfill sites. S4 Backfilled quarries, sludge/filter beds and/or clay pit within 250m S5: Mine gases from shallow coal seam.	R6: Maintenance Workers.	P2: Human uptake pathways. P3: Vertical migration of volatile vapours and ground gas.	Severe	Unlikely	Low	No known such features within 250m of the site.
	R6: Maintenance Workers	P3: Vertical migration of volatile vapours and ground gas.	Severe	Likely	High	Due to the potential for exposure to gases, the risk to 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	R7: Site end users.	P2: Human uptake pathways. P3: Vertical migration of volatile vapours and	Severe	Likely	Moderate	Hardcover areas will act as a barrier between contamination and end users. Remediation works such as contamination hot spot removal and

from adjacent industries/activities.		ground gas.				provision of an inert capping layer to garden areas will reduce risk to Low.
S3: Gas generation in landfill sites. S4 Backfilled quarries, sludge/filter beds and/or clay pit within 250m. S6: Radon generation in underlying geology.	R7: Site end users.	P2: Human uptake pathways. P3: Vertical migration of volatile vapours and ground gas.	Severe	Unlikely	Low	
S5: Mine gases from shallow coal seam.	R6: Site end users	P3: Vertical migration of volatile vapours and ground gas.	Severe	Likely	High	Gas protection measures can be incorporated into buildings to reduce the risk to Low.
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from adjacent industries/activities.	R7: Flora and Fauna.	P4: Plant root uptake.	Medium	Likely	Moderate	Remediation works such as contamination hot spot removal and provision of an inert capping layer will reduce risk to Low.
S1: Contamination in made ground if present on the site. S2: Uncontrolled tipping of waste products and residues from adjacent industries/activities.	R8: Services	P1: Horizontal and Vertical migration of leachate through potentially permeable soils and service trenches.	Severe	Likely	High	Site remediation works such as hot spot removal will reduce risk to Low. Service trenches to be back filled with inert material. 'Protector line' water pipes can be used if necessary.

8.0 GROUND INVESTIGATION**8.01 Fieldwork:**

12 No. trial pits and a trial trench were excavated to depths of between 2.40m and 4.0m using a JCB 3CX on 30 September 2014. The purpose of the trial pits was to allow an insitu visual inspection of the superficial soils, recover samples for laboratory testing and undertake insitu testing.

3 No. rotary boreholes were drilled on the site to depths of between 27.0 and 30.0m on 6 October 2014. The purpose of the boreholes was to investigate the possible presence of shallow coal seams/working below the site and to install 3 no. gas/groundwater monitoring wells. It should be noted that due to time constraints borehole R1 was not drilled.

5 No. trial trenches were excavated to depths between 3.00m and 3.60m using a JCB 3CX on 03 March 2015. The purpose of the trial trenches was to try and locate the position of the Tankersley Fault on the site.

The location of the trial pits, trial trenches and rotary boreholes are indicated on Fig. 2 attached in Volume 2, Appendix C.

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 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 soil profile was encountered in the trial pit investigation:-

Topsoil	0.20 – 0.40m
Clay	0.20 – 1.75m
Sandstones/Mudstones/Siltstones	

Topsoil was encountered in all the trial pits and varied in depth between 0.20 – 0.40m.

No made ground was encountered on the site.

A band of firm silty clay between 0.35 and 1.20m thick was encountered directly below the topsoil in TP1, TP3, TP6A, TP8, TP9, TP10 and TP11. The upper 0.25m of the clay band in TP9, the upper 0.40m of the clay band in TP10, and the upper 0.25m of the clay band in TP11 was friable.

A band of stiff silty clay 0.60m thick was encountered directly below the topsoil in TP4.

A band of sandy clay 0.30m thick was encountered directly below the topsoil in TP5.

A band of friable clay 0.20 and 0.35m thick was encountered directly below the topsoil in TP6 and TP7 respectively.

A band of firm silty clay in TP6A was underlain by a band of stiff silty clay 0.70m thick.

A band of sand, gravel and cobbles 0.65m thick was encountered in TP2 directly below the topsoil. This strata was recorded as possible made ground.

Bedrock was encountered in the trial pit investigation as follows:-

- TP1: weak, highly weathered siltstone/sandstone at 0.60m begl; strong, slightly weathered sandstone at 1.50m begl.
- TP2: weak, slightly weathered mudstone and siltstone at 1.03m begl.
- TP3: weak, moderately weathered mudstone at 1.40m begl; weak, moderately weathered mudstone at 2.60m begl; moderately weak, slightly weathered shaley mudstone at 3.00m begl.
- TP4: very weak, completely to highly weathered mudstone at 0.80m begl; strong, slightly weathered mudstone at 2.00m begl.
- TP5: very weak, completely to highly weathered mudstone at 0.50m begl; weak, moderately weathered mudstone at 1.65m begl; moderately weak, slightly weathered mudstone at 2.50m begl.
- TP6: very weak, completely to highly weathered mudstone at 0.60m begl; weak, moderately weathered mudstone at 1.60m begl; moderately weak, slightly weathered mudstone at 2.30m begl.
- TP6A: weak, slightly weathered mudstone at 2.10m begl; moderately weak mudstone at 3.20m begl.
- TP7: very weak, highly to moderately weathered mudstone at 0.60m begl; very weak, moderately weathered mudstone at 0.90m begl; weak, slightly weathered mudstone at 1.50m begl; weak, moderately weathered mudstone at 2.60m begl; weak mudstone at 3.10m begl.
- TP8: very weak, moderately weathered mudstone at 1.60m begl; weak, slightly weathered mudstone at 2.20m begl; weak, moderately to slightly weathered mudstone at 2.30m begl; strong, slightly weathered siltstone at 3.10m begl.

- TP9: very weak, moderately weathered mudstone at 1.40m begl; very weak, moderately weathered mudstone at 1.55m begl; weak, moderately weathered mudstone at 2.30m begl; weak, slightly weathered mudstone at 2.80m begl; strong, slightly weathered mudstone at 3.80m begl.
- TP10: very weak, highly weathered mudstone at 1.20m begl; very weak, moderately weathered mudstone at 1.35m begl; weak, slightly weathered mudstone at 1.60m begl.
- TP11: weak, moderately weathered shaley mudstone at 1.40m begl; weak, slightly weathered mudstone at 1.65m begl.

In TP7 a 0.90m thick coal seam was encountered at 1.70m begl over a 0.20m thick band of weak moderately weathered mudstone over a 0.30m thick coal seam at 2.80m begl over a 0.50m band of weak silty mudstone over a 0.30m thick coal seam. However, the base of the lower coal seam was not proved.

In TP9 a 0.60m thick coal seam was encountered at 1.70m begl over a 0.15m thick band of weak moderately weathered mudstone over a 0.35m thick coal seam at 2.45m begl over a 0.60m band of weak silty mudstone over a 0.40m thick band of coal.

The trial pit logs are attached in Volume 2, Appendix G.

The following soil profiles were encountered in the rotary boreholes:-

R1	
Strata	Thickness (m)
Topsoil	0.40
Soft Brown Soil and Clay (possibly fill)	2.10
Weak Orange Brown Sandstone	0.30
Weak Grey to Dark Grey Sandstone	1.60
Moderately Strong Orange Brown Sandstone	0.70
Strong Grey/Brown Mudstone	1.80
Moderately Strong Light Brown Mudstone	0.50
Strong Light Grey Mudstone/Siltstone	4.10
Strong Dark Grey to Grey Mudstone	2.50
Strong Light Grey Mudstone	1.00
Very Strong Light Grey Mudstone/Siltstone	15.00

R2	
Strata	Thickness (m)
Topsoil over Brown Clay	1.80
Weak Brown Mudstone/Sandstone	0.70
Moderately Strong Brown/Grey Sandstone	0.30
Weak Orange Sandstone	0.90
Coal	0.70
Moderately Strong Grey Mudstone	0.80
Coal	0.60
Moderately Strong Light Grey Mudstone	12.60
Strong Light Grey Brown Mudstone	1.40
Strong Light Grey Mudstone/Siltstone	10.20

R3	
Strata	Thickness (m)
Topsoil	0.40
Weak Yellow Brown Clay	0.20
Weak Brown Sandstone	0.80
Moderately Strong Dark Brown Mudstone	2.00
Weak Dark Orange and Brown Mudstone	0.80
Weak to Moderately Strong Grey Mudstone	5.20
Weak Grey to Light Grey Mudstone	1.50
Very Weak Grey Mudstone	0.30
Strong Grey to Dark Grey Mudstone	1.30
Strong to Very Strong Light Grey Mudstone	6.00
Very Strong Light Grey Siltstone	8.50

The rotary borehole logs are attached in Volume 2, Appendix H.

8.04 Groundwater:

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

TP7: ground damp at 2.80m begl.

TP10: ground damp at 3.30m begl

TP11: groundwater seepage at 3.00m begl.

Groundwater was encountered in the rotary borehole investigation.

R1: slow groundwater inflow at 11.50m begl.

R2: slow groundwater inflow at 18.40m begl.

Groundwater was encountered in the trial trench investigation as follows:-

TT1a: localised slow groundwater entry at 1.10m begl.

TT2: localised slow groundwater entry at 1.20m begl.

TT3: localised groundwater seepage at 1.70m begl.

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

Borehole	Date					
	28.10.14	18.11.14	10.12.14	06.01.15	11.02.15	03.03.15
R1	Dry	Dry	Dry	Dry	Dry	Dry
R2	2.40	2.45	2.55	3.90	2.20	2.60
R3	Dry	Dry	Dry	1.93	Dry	Dry

8.05 Excavations:

Excavation progress was generally reasonable until competent bedrock was encountered. The excavations were stable whilst open.

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, TP3, TP6 and TP10):-

Contaminant	Concentration in soils mg/kg*	Number of samples tested
Arsenic	12.0 – 16.0	4
Cadmium	<1.0	4
Chromium	19.0 – 23.0	4
Lead	38.0 – 72.0	4
Mercury	<1.0	4
Selenium	<3.0	4
Copper	28.0 – 37.0	4
Nickel	20.0 – 29.0	4
Zinc	83.0 – 100	4
Boron (water soluble)	<1.0	4
Sulphate (water soluble)	<0.1 g/l	4
pH	5.1 – 7.4	4
PAH	0.3 – 6.6	4

* unless noted otherwise.

The results of sulphate and pH determinations indicate sulphate content expressed as 2:1 aqueous extract of <0.10 g/l SO₄ with pH values of between 5.1 – 7.4.

Samples taken from the made ground (TP2):-

Contaminant	Concentration in soils mg/kg*	Number of samples tested
Arsenic	7.0	1
Cadmium	<1.0	1
Chromium	18.0	1
Lead	12.0	1
Mercury	<1.0	1
Selenium	<3.0	1
Copper	20.0	1
Nickel	26.0	1
Zinc	55.0	1
Boron (water soluble)	<1.0	1
Sulphate (water soluble)	<0.1 g/l	1
pH	5.2 – 8.4	1
PAH	<0.1	1

* unless noted otherwise

The result of a sulphate and pH determination indicates a sulphate content expressed as 2:1 aqueous extract of <0.10 g/l SO₄ with a pH value of 8.4.

Samples taken from the natural ground (TP1, TP6, TP9 and TP10):-

The results of sulphate and pH determinations indicate sulphate content expressed as 2:1 aqueous extract of <0.1 g/l SO₄ with pH values between 5.2 – 7.3.

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

Trial Pit	Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity
TP3	0.80	74	31	43	High
TP3	1.60	53	26	27	Intermediate
TP4	1.00	51	25	26	Intermediate
TP4	2.10	-	-	-	Non Plastic
TP9	1.10	94	26	38	High

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

8.07 Insitu Testing:

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

Strata	Shear Value (KPa)
Firm clay	56, 58, 62, 56, 64, 56
Stiff clay	80

8.08 Gas Monitoring:

Gas monitoring results are summarised in the following tables:-

Date: 28 October 2014			Atmospheric Pressure 992 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
R1	Dry	51.2	2.3	0.2	0.0
R2	2.40	0.2	1.5	20.2	0.0
R3	Dry	0.2	4.1	14.9	0.0

Date: 18 November 2014			Atmospheric Pressure 996 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
R1	Dry	5.0	0.3	14.0	2.0
R2	2.45	0.2	6.4	11.2	0.0
R3	Dry	0.0	0.5	20.4	0.0

**PHASE 1 & 2 ENGINEERING & ENVIRONMENTAL
ASSESSMENT
FOR LAND ADJACENT LIDGETT LANE, PILLEY**

Date: 10 December 2014			Atmospheric Pressure 993 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
R1	Dry	47.7	3.7	0.1	3.0
R2	2.55	0.0	7.2	9.5	0.0
R3	Dry	0.1	2.2	18.1	0.0

Date: 06 January 2015			Atmospheric Pressure 995 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
R1	Dry	24.1	5.2	0.2	73.0
R2	3.90	0.2	1.7	18.1	0.0
R3	1.93	0.1	1.0	19.4	0.2

Date: 11 February 2015			Atmospheric Pressure 1005 mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
R1	Dry	51.3	3.2	0.0	33.9
R2	2.20	0.3	6.9	1.8	0.0
R3	Dry	0.1	0.8	20.0	0.0

Date: 03 March 2015			Atmospheric Pressure 993 Mb		
Borehole	Water Level (m)	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Flow Rate l/h
R1	Dry	0.2	0.3	20.7	0.0
R2	2.60	0.5	8.1	8.4	0.0
R3	Dry	0.2	0.7	20.7	0.0

Due to the levels of methane encountered in borehole R1, a gas sample was taken on 11 February 2015 for analysis. The test results are summarised in the following table:-

Determinand	Units	Concentration
Ethane	ppmv	4758
Propane	ppmv	<10
Butane	ppmv	<10
Methane	% v/v	31
Carbon Dioxide	% v/v	2.4
Carbon Monoxide (Subcon)	ppmv	<10
Hydrogen Sulphide	mg/m ³	<2.0
Hydrogen	ppmv	<50
Oxygen	% v/v	<20

9.0 CONTAMINATION - DESIGN OBJECTIVES & PHILOSOPHY**9.01 Identification of Potential Hazards:**

In March 2002 DEFRA and the Environment Agency published a series of technical research papers introducing a new approach to the assessment of risk to human health from land contamination. This research includes the development of the new CLEA model and Soil Guideline Values (SGVs). However, these guidelines at present only address a few contaminants and development of the model and SGVs is ongoing. The soil guidelines are based on assumptions on soil conditions, the existence of exposure pathways behaviour and type of contaminants. The apparent exceedence of the quoted SGV 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 CLEA model and SGVs classified particular end uses on a scale of sensitivity.

Residential with plant uptake
Residential without plant uptake
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.

9.05 Investigation:

Due to the historic site usage it was not anticipated that contamination would be present on the site.

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.

9.06 Design Objectives:

- i) The objective of reclamation works is to improve any marginal land into ground suitable for its use for residential use. The standards would be in accordance with the parameters established by DEFRA and the Environment Agency.
- ii) These guidelines are incomplete and a set of Assessment Criteria is proposed utilising LQM/ CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition), as attached in Volume 2, Appendix K, to provide a more complete set of initial screening values. 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.
- iii) 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 REDEVELOPMENT PROPOSALS - DISCUSSION

10.01 Soils

The investigation has revealed made ground on the site other than topsoil in two of the trial pits. The Desk Study sections of this report have indicated little potential for contamination to be present on the site and the regime of chemical analyses adopted reflects this.

The results have been assessed using the Assessment Criteria for residential use proposed in Volume 2, Appendix K.

**PHASE 1 & 2 ENGINEERING & ENVIRONMENTAL
ASSESSMENT
FOR LAND ADJACENT LIDGETT LANE, PILLEY**

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

Contaminant	Concentration in soils mg/kg*	No. of samples tested	Assessment Criteria mg/kg	No. of Samples exceeding Assessment Criteria
Arsenic	12.0 – 16.0	4	32	0
Cadmium	<1.0	4	10	0
Chromium	19.0 – 23.0	4	3000	0
Lead	38.0 – 72.0	4	450	0
Mercury	<1.0	4	169	0
Selenium	<3.0	4	350	0
Copper	28.0 – 37.0	4	2330	0
Nickel	20.0 – 29.0	4	130	0
Zinc	83.0 – 100	4	3750	0
Boron (water soluble)	<1.0	4	291	0
Sulphate (water soluble)	<0.1 g/l	4	-	-
pH	5.1 – 7.4	4	5.0	0
PAH	0.3 – 6.6	4	#	#

* unless stated otherwise

see table below

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

PAH 16 EPA	Concentration 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 – 0.1	4	2300	0
Benzo (a) Anthracene	<0.1 – 0.7	4	3.1	0
Benzo (a) Pyrene	<0.1 – 0.7	4	0.83	0
Benzo (b) & (k) Fluoranthene	<0.1 – 0.9	4	5.6	0
Benzo (g,h,i) Perylene	<0.1 – 0.2	4	44.0	0
Chrysene	<0.1 – 0.5	4	6.0	0
Di-benzo (a,h) Anthracene	<0.1	4	0.76	0
Indeno (1, 2, 3-cd)Pyrene	<0.1 – 0.2	4	3.2	0
Fluoranthene	0.2 – 1.4	4	260	0
Fluorene	<0.1	4	160	0
Napthalene	<0.1	4	1.5	0
Phenanthrene	<0.1 – 0.8	4	92	0
Pyrene	0.1 – 1.1	4	560	0
Total	0.3 – 6.6	4	-	-

When compared with the proposed Assessment Criteria for residential use no determinants with levels in excess of Assessment Criteria were encountered in the topsoil on the site.

**PHASE 1 & 2 ENGINEERING & ENVIRONMENTAL
ASSESSMENT
FOR LAND ADJACENT LIDGETT LANE, PILLEY**

The test results from samples taken from the made ground on the site are compared in the following table:

Contaminant	Concentration in soils mg/kg*	No. of samples tested	Assessment Criteria mg/kg	No. of Samples exceeding Assessment Criteria
Arsenic	7.0	1	32	1
Cadmium	<1.0	1	10	0
Chromium	18.0	1	300	0
Lead	12.0	1	450	0
Mercury	<1.0	1	169	0
Selenium	<3.0	1	350	0
Copper	20.0	1	2330	0
Nickel	26.0	1	130	0
Zinc	55.0	1	3750	0
Boron (water soluble)	<1.0	1	291	0
Sulphate (water soluble)	<0.1 g/l	1	-	-
pH	5.2 – 8.4	1	<5	0
PAH	<1.0	1	#	#

* unless stated otherwise

see later discussion

Speciated PAH analysis of a sample from the made ground 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	1	210	0
Acenaphthylene	<0.1	1	170	0
Anthracene	<0.1	1	2300	0
Benzo (a) Anthracene	<0.1	1	3.1	0
Benzo (a) Pyrene	<0.1	1	0.83	0
Benzo (b) & (k) Fluoranthene	<0.1	1	5.6	0
Benzo (g,h,i) Perylene	<0.1	1	44.0	0
Chrysene	<0.1	1	6.0	0
Di-benzo (a,h) Anthracene	<0.1	1	0.76	0
Indeno (1, 2, 3-cd)Pyrene	<0.1	1	3.2	0
Fluoranthene	<0.1	1	260	0
Fluorene	<0.1	1	160	0
Napthalene	<0.1	1	1.5	0
Phenanthrene	<0.1	1	92.0	0
Pyrene	<0.1	1	560	0
Total	<0.1	1	-	-

When compared with the proposed Assessment Criteria for residential use no determinants with levels in excess of Assessment Criteria were encountered in the made ground on the site.

In view of the above test results no remediation measures are required on the site.

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 Issues

Coal seams were encountered in the trial pit investigation as follows:-

- TP7: 0.90m thick seam at 1.70m begl; 0.30m thick seam at 2.80m begl; 0.30m thick seam at 3.60m begl.
TP9: 0.60m thick seam at 1.70m begl; 0.35m thick seam at 2.45m begl; 0.40m thick seam at 3.40m begl.

Coal seams were encountered in the rotary borehole investigation as follows:-

- R2: 0.70m thick seam at 3.70m begl and 0.60m thick seam at 5.20m begl.

Site sections indicating the depth of the coal seams encountered on the site are indicated on Fig. 3 attached in Volume 2, Appendix L.

Based on the results of the rotary drilling undertaken on the site to date it is recommended that the footprint of each plot and the adopted highway in the southern sector of the site is probe drilled to assess whether the underlying coal seams have been worked. If workings are encountered they would need to be stabilised by concrete grouting if the depth of rock cover over the worked seam is less than 12 times the seam thickness.

Irrespective of whether coal workings are encountered on the site it is recommended that footings on the development are mesh reinforced.

It should be noted that there may be unrecorded mine entries on the site.

10.04 Tankersley Fault

Based on the investigations undertaken on the site the position of the Tankersley Fault has not been identified.

10.05 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
Shallow coal seams	Low	Low
Backfilled clay pit and/or quarry and/or sludge and filter beds within 250m of the site	Low	Very Low

Gas Pathways:

The typical ground conditions encountered during the investigation indicated clays over mudstones and sandstones. Consequently a gas migration pathway from off-site to the surface may exist, especially if the sandstone is fractured.

Gas Monitoring:

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, i.e. 9 readings over 6 months. However, initially 6 readings are proposed.

Gas monitoring at the site to date has been carried out on six occasions. Five of the monitoring visits were carried out when the 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	
R1	0.2 – 51.3	0.3 – 5.2	73.0
R2	0.0 – 0.5	1.5 – 8.1	0.0
R3	0.0 – 0.2	0.5 – 4.1	0.2

ND: None detected

Site Gas Regime:

Where Flow rates are shown as 0.0 a default value of 0.1 litres/hour has been used, representing the limit of detection of the measuring equipment.

Borehole gas screening values (GSV) for both methane and carbon dioxide have been calculated for each borehole. The table below shows the maximum GSV for both methane and carbon dioxide.

Borehole No.:	Gas Screening Value – Methane (litre/hour)	Gas Screening Value – Carbon Dioxide (litre/hour)
R1	37.4	3.8
R2	0.0005	0.0081
R3	0.0004	0.0082

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

Based on the maximum recorded concentrations of carbon dioxide, the site is categorised in accordance with the NHBC 'traffic light system' as Amber 1.

Based on the GSV obtained for methane, the site is categorised in accordance with the NHBC 'traffic light system' as Red.

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

The laboratory which undertook the analysis of the gas sample taken from borehole R1 have advised that as Ethane is present as well as Methane that the source is unlikely to be mains natural gas.

Therefore British Gas will be contacted and requested to investigate the integrity of their main in Lidgett Lane which is approximately ()m from the gas well. Once these investigations are undertaken a further three sets of gas readings will be undertaken.

10.06 Foundations:

It is considered that strip foundations can be adopted on the development bearing on either:-

- medium strength silty clays designed to a safe working bearing pressure of 100 KN/m² at a minimum depth of 0.90m below finished ground level;
- weathered bedrock designed to a safe working bearing pressure of 200 KN/m² at a minimum depth of 0.60m below finished ground level.

Where plots are founded on cohesive soils within the influence zone of trees, trench footings will be required in order to found on a suitable bearing strata and/or at a sufficient depth.

Where the underside of foundations are within 2.0m of a coal seam (even if the seam has been grouted), it is recommended that the foundations are trenched to below the level of the coal seam. Alternatively piled foundations supporting ground beams can be utilised. As piles will need to be founded on bedrock below the base of the coal seams driven piles may require pre-drilling. However, advice should be sought from specialist piling contractors.

Where the underside of foundations are within 2.0 to 5.0m of a coal seam (even if the seam has been grouted) it is recommended that a semi-rigid raft foundation solution is adopted. Alternatively piled foundations supporting ground beams can be utilised. As piles will need to be founded on bedrock below the base of the coal seams driven piles may require pre-drilling. However, advice should be sought from specialist piling contractors.

Irrespective of whether coal workings are encountered on the site and, if necessary, stabilised by concrete grouting, it is recommended that where strip and trench footings are used on the development they are mesh reinforced to resist any small potential differential settlements that could occur.

Where a plot is part founded on clay and part on weathered bedrock, it is recommended that the footings are trenched down to found completely on weathered bedrock.

Notwithstanding the above, as it has not been possible to locate the position of the Tankersley Fault on the site, it is recommended that plots within 20m of the position of the fault, as indicated on geological maps, are founded on semi rigid rafts.

10.07 Ground Floor Construction:

As shallow coal seams and potentially shallow coal workings are present below the southern sector of the site and where plots are founded in cohesive soils in the influence zone of trees it is recommended that a beam and block suspended ground floor with a 350mm minimum under floor void are utilised on the development apart from where semi rigid raft foundations are utilised.

Where plots are founded on cohesive strata not in the influence zone of trees, and outside the potential zone of the Tankersley Fault, ground bearing slabs can be utilised on the development provided the sub-base thickness does not exceed 600mm.

10.08 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.

10.09 Excavations:

Excavations in clays and weathered bedrock are likely to be stable in the short term.

However, trench support should be provided in accordance with current Health & Safety Guidance.

Groundwater seepages may be encountered in shallow foundation and drainage excavations. However, it should be noted that the groundwater table is likely to be subject to seasonal variations.

10.10 Pavements:

CBR values on the medium strength clays are likely to be reasonable (circa 3%), and CBR values in weathered bedrock are likely to be high (>10%).

If localised soft clays are encountered these soils should be excavated and replaced with compacted 6F2 material.

Under drives and parking areas the formation should be proof rolled. Oversized stone should be rolled into any 'soft' clay areas to 'stiffen' the formation.

10.11 Drainage:

A conventional granular bed and surround to drainage can be adopted in clays and weathered bedrock.

11.0 CONTAMINATION ASSESSMENT

As no elevated levels of contamination have been encountered on the site a further contamination assessment is not required.

12.0 RECLAMATION 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 as required by the development.
- Protect any vegetation to be retained prior to grubbing out all redundant vegetation and remove from site to a suitably licensed tip.
- 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.
- Undertake site strip and stockpile topsoil for re-use on the development.
- 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.

- The removal of any contamination 'hot spots', if encountered, are to be verified by sampling and testing of the sides and base of any such excavations.
- Excavated natural ground from the site can be used.
- Service trenches are to be backfilled with clean inert materials.
- Any engineering fill material should be compacted in accordance with the Dpt. Highways Specification.
- Arisings from the site are likely to be classified as inert but guidance should be sought from the local Waste Management Regulation Office regarding the disposal of soils from the site.

13.0 ADDITIONAL INVESTIGATION WORKS

13.01 Gas

British Gas will be contacted and requested to investigate the integrity of their main in Lidgett Lane which is approximately ()m from the gas well.

13.02 Ground Investigation

- Each plot and the adopted highway in the southern sector of the site should be probe drilled to assess whether the underlying shallow coal seams have been worked.
- Following investigation works by British Gas, a further 3 no. set of gas readings should be undertaken on the site.

14.0 SUMMARY

Site Name & Location	Lidgett Lane, Pilley
Proposal	Approximately 35 houses
Local Authority	Barnsley Metropolitan District Council.
Site History	Historic OS plans indicate that the site has not been developed. However, the area adjacent the eastern boundary of the site is recorded as being on an area of made ground and a colliery site. In addition open cast mining has occurred to the south of the site and the site is recorded as being on or adjacent to an area of open cast mining. Potentially contaminative activities in the near vicinity (within 250m) of the site have included a quarry, railway lines and sidings and spoil heaps. Potentially contaminative activities in the surrounding area have included coal pits, quarries, a blacksmiths, ironstone pits, a colliery, a sewage works, a clay pit, sludge and filter beds, a 'works', a gas works, depots, an industrial park, an open cast mine and a brickworks.
Geology	1:50,000 British Geological Survey (BGS) Geological Sheet 87 Barnsley indicates the following:- - The site is underlain by Pennine Middle Coal Measures and sandstone may be present in the northeastern sector of the site. - Drift deposits are unlikely to be present at the surface. - The Tankersley fault appears to traverse the site in a northwest to southeast direction. The Birdwell fault lies adjacent the northwest corner of the site. - Two coal seams may outcrop on the site.
Hydrogeology	The site is in a high sensitivity hydrogeological area as there is a water course within 10m of the site and the site is underlain by a Secondary Aquifer – A. However the site is not within a Source Protection Zone and there are no groundwater abstractions within 1000m of the site.
Flooding	The site is not believed to be prone to flooding and the Environment Agency flood map indicates that the site is in Flood Zone 1. Potential flooding issues are assessed further in CoDA Structures Flooding and Drainage Assessment report for the site.
Ground Conditions	The following typical soil profile was encountered in the trial pit investigation:- Topsoil 0.20 – 0.40m Clay 0.20 – 1.75m Sandstones/Mudstones/Siltstones Topsoil was encountered in all the trial pits and varied in depth between 0.20 – 0.40m. No made ground was encountered on the site. A band of firm silty clay between 0.35 and 1.20m thick was encountered directly below the topsoil in TP1, TP3, TP6A, TP8, TP9, TP10 and TP11. The upper 0.25m of the clay band in TP9, the upper 0.40m of the clay band in TP10, and the upper 0.25m of the clay band in TP11 was friable. A band of stiff silty clay 0.60m thick was encountered directly below the topsoil in TP4. A band of sandy clay 0.30m thick was encountered directly below the topsoil in TP5. A band of friable clay 0.20 and 0.35m thick was encountered directly below the topsoil in TP6 and TP7 respectively. A band of firm silty clay in TP6A was underlain by a band of stiff silty clay 0.70m thick. A band of sand, gravel and cobbles 0.65m thick was encountered in TP2 directly below the topsoil. This strata was recorded as possible made ground. Bedrock was encountered in the trial pit investigation as follows:- TP1: weak, highly weathered siltstone/sandstone at 0.60m begl; strong, slightly weathered sandstone at 1.50m begl. TP2: weak, slightly weathered mudstone and siltstone at 1.03m begl. TP3: weak, moderately weathered mudstone at 1.40m begl; weak, moderately weathered mudstone at 2.60m begl; moderately weak, slightly weathered shaley mudstone at 3.00m begl. TP4: very weak, completely to highly weathered mudstone at 0.80m begl; strong, slightly weathered mudstone at 2.00m begl. TP5: very weak, completely to highly weathered mudstone at 0.50m begl; weak, moderately weathered mudstone at 1.65m begl; moderately weak, slightly weathered mudstone at 2.50m begl.

TP6: very weak, completely to highly weathered mudstone at 0.60m begl; weak, moderately weathered mudstone at 1.60m begl; moderately weak, slightly weathered mudstone at 2.30m begl.

TP6A: weak, slightly weathered mudstone at 2.10m begl; moderately weak mudstone at 3.20m begl.

TP7: very weak, highly to moderately weathered mudstone at 0.60m begl; very weak, moderately weathered mudstone at 0.90m begl; weak, slightly weathered mudstone at 1.50m begl; weak, moderately weathered mudstone at 2.60m begl; weak mudstone at 3.10m begl.

TP8: very weak, moderately weathered mudstone at 1.60m begl; weak, slightly weathered mudstone at 2.20m begl; weak, moderately to slightly weathered mudstone at 2.30m begl; strong, slightly weathered siltstone at 3.10m begl.

TP9: very weak, moderately weathered mudstone at 1.40m begl; very weak, moderately weathered mudstone at 1.55m begl; weak, moderately weathered mudstone at 2.30m begl; weak, slightly weathered mudstone at 2.80m begl; strong, slightly weathered mudstone at 3.80m begl.

TP10: very weak, highly weathered mudstone at 1.20m begl; very weak, moderately weathered mudstone at 1.35m begl; weak, slightly weathered mudstone at 1.60m begl.

TP11: weak, moderately weathered shaley mudstone at 1.40m begl; weak, slightly weathered mudstone at 1.65m begl.

In TP7 a 0.90m thick coal seam was encountered at 1.70m begl over a 0.20m thick band of weak moderately weathered mudstone over a 0.30m thick coal seam at 2.80m begl over a 0.50m band of weak silty mudstone over a 0.30m thick coal seam. However, the base of the lower coal seam was not proved.

In TP9 a 0.60m thick coal seam was encountered at 1.70m begl over a 0.15m thick band of weak moderately weathered mudstone over a 0.35m thick coal seam at 2.45m begl over a 0.60m band of weak silty mudstone over a 0.40m thick band of coal.

The following soil profiles were encountered in the rotary boreholes:-

R1	
Strata	Thickness (m)
Topsoil	0.40
Soft Brown Soil and Clay (possibly fill)	2.10
Weak Orange Brown Sandstone	0.30
Weak Grey to Dark Grey Sandstone	1.60
Moderately Strong Orange Brown Sandstone	0.70
Strong Grey/Brown Mudstone	1.80
Moderately Strong Light Brown Mudstone	0.50
Strong Light Grey Mudstone/Siltstone	4.10
Strong Dark Grey to Grey Mudstone	2.50
Strong Light Grey Mudstone	1.00
Very Strong Light Grey Mudstone/Siltstone	15.00

R2	
Strata	Thickness (m)
Topsoil over Brown Clay	1.80
Weak Brown Mudstone/Sandstone	0.70
Moderately Strong Brown/Grey Sandstone	0.30
Weak Orange Sandstone	0.90
Coal	0.70
Moderately Strong Grey Mudstone	0.80
Coal	0.60
Moderately Strong Light Grey Mudstone	12.60
Strong Light Grey Brown Mudstone	1.40
Strong Light Grey Mudstone/Siltstone	10.20

R3	
Strata	Thickness (m)
Topsoil	0.40
Weak Yellow Brown Clay	0.20

**PHASE 1 & 2 ENGINEERING & ENVIRONMENTAL
ASSESSMENT
FOR LAND ADJACENT LIDGETT LANE, PILLEY**

Weak Brown Sandstone	0.80
Moderately Strong Dark Brown Mudstone	2.00
Weak Dark Orange and Brown Mudstone	0.80
Weak to Moderately Strong Grey Mudstone	5.20
Weak Grey to Light Grey Mudstone	1.50
Very Weak Grey Mudstone	0.30
Strong Grey to Dark Grey Mudstone	1.30
Strong to Very Strong Light Grey Mudstone	6.00
Very Strong Light Grey Siltstone	8.50

Groundwater:

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

TP7: ground damp at 2.80m begl.

TP10: ground damp at 3.30m begl

TP11: groundwater seepage at 3.00m begl.

Groundwater was encountered in the rotary borehole investigation.

R1: slow groundwater inflow at 11.50m begl.

R2: slow groundwater inflow at 18.40m begl.

Groundwater was encountered in the trial trench investigation as follows:-

TT1a: localised slow groundwater entry at 1.10m begl.

TT2: localised slow groundwater entry at 1.20m begl.

TT3: localised groundwater seepage at 1.70m begl.

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

Borehole	Date					
	28.10.14	18.11.14	10.12.14	06.01.15	11.02.15	03.03.15
R1	Dry	Dry	Dry	Dry	Dry	Dry
R2	2.40	2.45	2.55	3.90	2.20	2.60
R3	Dry	Dry	Dry	1.93	Dry	Dry

Mining Issues

Coal seams were encountered in the trial pit investigation as follows:-

TP7: 0.90m thick seam at 1.70m begl; 0.30m thick seam at 2.80m begl; 0.30m thick seam at 3.60m begl.

TP9: 0.60m thick seam at 1.70m begl; 0.35m thick seam at 2.45m begl; 0.40m thick seam at 3.40m begl.

Coal seams were encountered in the rotary borehole investigation as follows:-

R2: 0.70m thick seam at 3.70m begl and 0.60m thick seam at 5.20m begl.

Based on the results of the rotary drilling undertaken on the site to date it is recommended that the footprint of each plot and the adopted highway in the southern sector of the site is probe drilled to assess whether the underlying coal seams have been worked. If workings are encountered they would need to be stabilised by concrete grouting if the depth of rock cover over the worked seam is less than 12 times the seam thickness.

Irrespective of whether coal workings are encountered on the site it is recommended that footings on the development are mesh reinforced.

It should be noted that there may be unrecorded mine entries on the site.

Tankersley Fault

Based on the investigations undertaken on the site, the position of the Tankersley Fault has not been identified.

Foundations

It is considered that strip foundations can be adopted on the development bearing on either:-

- medium strength silty clays designed to a safe working bearing pressure of 100 KN/m² at a minimum depth of 0.90m below finished ground level;
- weathered bedrock designed to a safe working bearing pressure of 200 KN/m² at a minimum depth of 0.60m below finished ground level.

Where plots are founded on cohesive soils within the influence zone of trees, trench footings will be required in order to found on a suitable bearing strata and/or at a sufficient depth.

Where the underside of foundations are within 2.0m of a coal seam (even if the seam has been grouted), it is recommended that the foundations are trenched to below the level of the coal seam. Alternatively piled foundations supporting ground beams can be utilised. As piles will need to be founded on bedrock below the base of the coal seams driven piles may require pre-drilling. However, advice should be sought from specialist piling contractors.

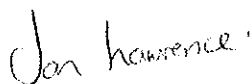
Where the underside of foundations are within 2.0 to 5.0m of a coal seam (even if the seam has

	been grouted) it is recommended that a semi-rigid raft foundation solution is adopted. Alternatively piled foundations supporting ground beams can be utilised. As piles will need to be founded on bedrock below the base of the coal seams driven piles may require pre-drilling. However, advice should be sought from specialist piling contractors. Irrespective of whether coal workings are encountered on the site and, if necessary, stabilised by concrete grouting, it is recommended that where strip and trench footings are used on the development they are mesh reinforced to resist any small potential differential settlements that could occur. Where a plot is part founded on clay and part on weathered bedrock, it is recommended that the footings are trenched down to found completely on weathered bedrock. Notwithstanding the above, as it has not been possible to locate the position of the Tankersley Fault on the site, it is recommended that plots within 20m of the position of the fault, as indicated on geological maps, are founded on semi rigid rafts.
Ground Floor Slabs	As shallow coal seams and potentially shallow coal workings are present below the southern sector of the site and where plots are founded in cohesive soils in the influence zone of trees, it is recommended that a beam and block suspended ground floor with a 350mm minimum under floor void are utilised on the development apart from where semi rigid raft foundations are utilised. Where plots are founded on cohesive strata not in the influence zone of trees, and outside the potential zone of the Tankersley Fault, ground bearing slabs can be utilised on the development provided the sub-base thickness does not exceed 600mm.
Building Near Trees	Applicable as cohesive soils are present on the site.
Pavements	CBR values on the medium strength clays are likely to be reasonable (circa 3%), and CBR values in weathered bedrock are likely to be high (>10%). If localised soft clays are encountered these soils should be excavated and replaced with compacted 6F2 material. Under drives and parking areas the formation should be proof rolled. Oversized stone should be rolled into any 'soft' clay areas to 'stiffen' the formation.
Dewatering	Groundwater seepages may be encountered in shallow foundation and drainage excavations but seepages should be expected. However, it should be noted that the groundwater table is likely to be subject to seasonal variations.
Excavations	Excavations in clays and weathered bedrock are likely to be stable in the short term. However, 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.
Contamination Assessment – Soils	When compared with the proposed Assessment Criteria for the site no determinants with levels in excess of Assessment Criteria were encountered in the topsoil on the site. When compared with the proposed Assessment Criteria for the site no determinants with levels in excess of Assessment Criteria were encountered in the made ground on the site. When compared to the proposed Assessment Criteria for the site, no determinants with elevated levels of contamination were encountered in the natural ground on the site.
Controlled Waters	The levels of contamination encountered on the site are not considered to pose a significant risk to controlled waters. It should be noted that there are no groundwater abstractions within 1000m of the site and the site is not within a Source Protection Zone.
Remediation Proposals	None required.
Remediation Statement	Not required.
Gas Precautions	Subject to the investigation of a possible leak to the gas main in Lidgett Lane and further gas monitoring.
Radon	No protection measures are required on the development.
Foul Water Drainage	See CoDa Structures Flooding and Drainage Assessment report for the site. A conventional granular bed and surround to drainage can be adopted in clays and weathered bedrock.
Surface Water Drainage	See CoDa Structures Flooding and Drainage Assessment report for the site. A conventional granular bed and surround to drainage can be adopted in clays and weathered

	bedrock.
Unforeseen Circumstances	Should any areas of previously unidentified potentially contaminated soil be encountered during site 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.
Further Investigation Work	Gas: British Gas will be contacted and requested to investigate the integrity of their main in Lidgett Lane which is approximately ()m from the gas well. Ground Investigation: - Each plot and the adopted highway in the southern sector of the site should be probe drilled to assess whether the underlying shallow coal seams have been worked. - Following investigation works by British Gas, a further 3 no. set of gas readings should be undertaken on the site.

15.0 CAVEATS

- 15.01 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.
- 15.02 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 reports.
- 15.03 This report has been prepared for the sole use of Jaguar Estates Ltd and Wortley Construction Ltd and their development funders unless agreed otherwise in writing by CoDA Structures.



Signed:

J Lawrence B Eng C Eng M I Struct E