Kirklees Council
Design and Property Services
Kirkgate Buildings
Byram Street
Huddersfield
HD1 1BY

Ground Gas Monitoring Report
Land Off Forge Lane
Thornhill Lees
Dewsbury
West Yorkshire
WF12 9EN

October 2011
962340125_01

Prepared by:

ARCADIS (UK) Limited
1 Whitehall
Riverside
Leeds
LS1 4BN
Tel: 01132 845 322
Fax: 01132 845 301
www.arcadis-uk.com

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		Jonathan Harris Consultant	Pamela Welburn Principal	Lara Potter Director

If you have any queries regarding this project, please contact Darren Calvert or Andrew Smith.

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List of Abbreviations that may be used in this report

ARCADIS	ARCADIS (UK) Limited
BGS	British Geological Survey
BRE	British Research Establishment
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CAT	Cable Avoidance Tool
CIRIA	Construction Industry Research and Information Association
CL:AIRE	Contaminated Land: Applications In Real Environments
CoP	Code of Practice
CPT	Cone Penetration Testing
CS	Characteristic Situation
DQRA	Detailed Qualitative Risk Assessment
EA	Environment Agency
EDD	Electronic Data Deliverable
EDMS	Environmental Data Management System
EQS	Environmental Quality Standard
GAC	Generic Assessment Criteria
GPR	Ground Penetration Radar
GPS	Global Positioning System
GSV	Gas Screening Values
HDPE	High Density Polyethylene
l/hr	Litres Per Hour
m AOD	Metres Above Ordnance Datum
m bgl	Metres Below Ground Level
MDL	Method Detection Limit
MTBE	Methyl Tertiary Butyl Ether
NAPL	Non-Aqueous Phase Liquid
NRA	National Rivers Authority
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PID	Photo Ionisation Detector
ppm	Parts Per Million
PSD	Particle Size Distribution
SGV	Soil Guideline Value
SPT	Standard Penetration Test
SPZ	Source Protection Zone
SSAC	Site Specific Assessment Criteria
SSSI	Site Special Scientific Interest
SVOC	Semi-Volatile Organic Compounds
TOC	Total Organic Content
TPH	Total Petroleum Hydrocarbons

URS	URS Corporation
VOC	Volatile Organic Compounds
WAC	Waste Acceptance Criteria
% v/v	Percentage by Volume

1 INTRODUCTION

In January 2011 ARCADIS (UK) Limited (ARCADIS) was commissioned by Kirklees Council to carry out ground gas monitoring as part of a geotechnical and environmental site investigation at a site located off Forge Lane, Dewsbury.

A site location plan is presented as Figure 1.

The works were conducted in accordance with the Stage 1B Assessment dated 24th December 2010 (ARCADIS document reference 962340001_04). This report refers only to the ground gas monitoring aspect of works included as part of Stage 1B Assessment.

This Ground Gas Monitoring Report should be read in conjunction with the correspondence and information presented by ARCADIS including the following reports:

- ARCADIS Phase II Environmental & Geotechnical Site Assessment and Generic Risk Assessment Report (ref. 9623401_02, October 2011).
- ARCADIS Detailed Quantitative Risk Assessment (DQRA) (ref. 962340126, September 2011).
- ARCADIS Assessment Findings Summary and Outline Development Constraints and Outline Remedial Strategy Summary (ref. 962340135_03 October 2011)

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1.1 Objectives

It is understood that the ultimate objective of works at site is to provide information on potential remedial strategies and development constraints that can be passed to a prospective developer. The objective of this Ground Gas Monitoring Report is to present a provisional ground gas assessment for the site to assist in this objective.

The project has been carried out within the existing legislative framework and regulatory guidance, which is outlined in Appendix A.

1.2 Reliability of Information / Limitations

A complete list of ARCADIS Study Limitations is presented in Section 5.

Is should be noted that a number of the monitoring well installations had been vandalised prior to and between each of the gas monitoring visits conducted. Measures were taken on site to mitigate the impact to the monitoring results as far as reasonably practicable, however, the integrity of the gas monitoring results from wells that had been vandalised may have been compromised.

2 ENVIRONMENTAL AND GEOTECHNICAL FIELD INVESTIGATIONS

The site investigation strategy was formulated in response to comments and discussions with the client and Kirklees Council Environmental Health Officers. The scope of works for the investigation was discussed and agreed with all of the above parties prior to mobilising to site to commence the works.

The assessment has been carried out assuming the site is to be redeveloped predominantly with low rise residential properties. In the southwest corner of the site two Extracare blocks of flats are proposed. A further block of flats is proposed in the eastern part of the site. Due to the varying ground conditions across the site the proposed buildings are likely to be supported on a variety of foundation types. In addition, there is likely to be a combination of suspended and ground bearing floor slabs depending upon the foundation solution adopted..

It should be noted that the current proposed development plan, *West + Machell architects, Forge Lane Dewsbury, 2776(1)P007d* provided by the Architect,, presented as Appendix B, supersedes the proposed development plan provided by Kirklees Council presented in the ARCADIS Phase II report (ref. 962340101_01, June 2011)

The site layout plan, showing trial pit and borehole locations, is presented as Figure 2.

2.1 Intrusive Investigation Strategy

2.1.1 Rationale

Previous Ground Gas Assessments
The previous reports carried out by third parties provided details of a preliminary ground gas assessment. It is detailed in the Exploration Associates Interpretive report (April 1999) that '*an on going programme of gas monitoring is underway at site and a full report on this aspect of the development will be issued in due course'*. ARCADIS has not been provided with a copy of the ground gas assessment report referred to in this statement.

Gas monitoring results were included in the Exploration Associates Limited *Forge Lane, Former Steelworks, Thornhill, Dewsbury Interpretive Report on Ground Investigation, 129148, April 2000.* Monitoring was conducted from up to 7 wells during the period 6th February to 28th November on seven separate occasions. The results detailed concentrations of 'explosive Gases/CH_4 reported at 0% v/v. A maximum CO_2 concentration of 2.9% v/v and a minimum oxygen concentration of 13.6% v/v was recorded in borehole 5. These maximum/minimum concentrations were during the visit conducted with the lowest recorded atmospheric pressure (995mb). The atmospheric pressure recorded at the time of all other visits ranged between 1008mb and 1029mb. No information was available on the trend of atmospheric pressure during each visit.

Given the time delay since this last period of monitoring conducted by Exploration Associates in 2000, it was considered likely that a current assessment in accordance with current guidance would be required, with the pervious gas monitoring data used as supplementary where applicable. In accordance with the CIRIA document C665, 'Assessing risks posed by hazardous ground gases to buildings' (2007), ground gas monitoring is required. The guidance suggests that for a residential development with a 'moderate' generation potential (considered applicable to the former on site refuse tip) a minimum of twelve gas monitoring visits is required over a period of six months. However, dependant on the gas flow rates recorded during the initial monitoring, additional visits may be required. The guidance recommends that at least two sets of readings should be at low and falling atmospheric pressure (but not restricted to periods below <1000mb) known as worst case conditions.

The scope of gas monitoring presented in this document is intended to provide a provisional assessment of ground gas characterisation, comprising the following:

- Six gas monitoring visits to site in order to record borehole flow rate, concentrations of (bulk gases) carbon dioxide, methane and oxygen and groundwater level within the monitoring wells; and
- Weather records obtained for the monitoring period in order to determine atmospheric pressure conditions associated with each monitoring event.

Further gas monitoring would likely be required at some stage in accordance with current guidance.

Up to 28 monitoring wells were monitored during each visit comprising monitoring wells installed as part of the ARCADIS Phase II Environmental & Geotechnical Site Assessment together with wells, identified as available, installed as part of previous investigations conducted by others.

2.1.2 Methodology

Bulk Soil Gas Monitoring

Gas monitoring involved the measurement of flow of gas into or out of the monitoring well followed by measurement of concentrations of carbon dioxide, methane and oxygen using an infra-red gas analyser. Both the peak and steady state gas concentrations were recorded. The pressure difference between the monitoring well and surrounding atmosphere was also recorded along with the atmospheric pressure.

Atmospheric pressure data was obtained from Weatherquest for each of the monitoring dates, including the 24 hour period either side of the date of monitoring, to indicate if ground gas monitoring was conducted under falling atmospheric pressure, a factor contributing to a “worst case” scenario.

3 SITE MONITORING FINDINGS

3.1 Groundwater

3.1.1 Groundwater Occurrence

Post borehole installation monitoring recorded groundwater encountered across site between 35.82mAOD and 37.69mAOD. Monitoring wells WS104, WS113 and WS118 were consistently reported as being dry (WS104 reported water in first monitoring visit – this was removed for water monitoring and the well was not recorded to recharge).

Groundwater wells were screened within the made ground; across the made ground and Alluvium; or within the Terrace Deposits. Resting groundwater levels generally indicated that there is one consistent groundwater body on site.

Table 1 details maximum and minimum water levels (mbgl and mAOD) during the six monitoring events for each monitoring well. Full details of water levels recorded during each monitoring event from each well are included within Appendix C.

3.2 Ground Gas Monitoring Results

The results of the ground gas monitoring are presented as Appendix C with a summary of maximum concentrations recorded during each visit presented in Table 2. A total of six ground gas monitoring visits have been conducted over a three month period.

As detailed above the monitoring wells were generally screened in three different ways:

- Within the made ground only
- Across the made ground and Alluvium
- Within the River Terrace Deposits

At this stage the assessment has not included a differentiation between results recorded from the different types of well screening. The main potential source of ground gas at the site is considered to be the made ground. The Alluvium is also considered to be a secondary source.

A summary of the results obtained from the six gas monitoring events conducted as part of this phase of works are summarised below.

Carbon dioxide
A maximum carbon dioxide concentration of 4.8% v/v was recorded in monitoring well location WS110 on the 8th April 2011. This was associated with depleted oxygen concentrations.

Methane
A maximum methane concentration of 0.5% v/v was recorded in WS111 on the 10th May 2011. Elevated carbon dioxide and depleted oxygen concentrations were also recorded in this borehole.

Carbon monoxide
A maximum carbon monoxide concentration of 8ppm was recorded in monitoring well WS108 on 4th March 2011.

Flow Rates
A maximum and steady flow rate of 1.0 l/hr was recorded from monitoring well WS104 on 4th March 2011.

3.3 Atmospheric Pressure

Atmospheric pressure data was obtained from a weather station in Bingley, located approximately 17 miles from the site. The data obtained has been presented on graphs depicting atmospheric pressure trends before, during and after each monitoring visit. The graphs are presented as Figure 3 and the atmospheric pressure data is included in Appendix D.

A summary of atmospheric pressure data obtained for each monitoring visit conducted to date is presented in the table below:

Monitoring Event	Monitoring Date	Atmospheric Pressure Trend During Monitoring	Atmospheric Pressure Range During Monitoring (mb)
1	03-04 March2011	Falling	1039-1032
2	24 March 2011	Falling	1036-1032
3	08 April 2011	Steady	1027
4	10 May 2011	Rising towards peak	1021-1022
5	23 May 2011	Falling towards trough	1009-1007
6	03 June 2011	Rising	1026-1036

Although three of the six monitoring dates were conducted under falling pressure conditions, none of the monitoring dates were conducted under low (<1000mb) *and* falling atmospheric pressure, known as worst case conditions.

The highest flow rate was recorded during the first monitoring event. This coincides with the largest fall in atmospheric pressure recorded during the six monitoring visits, even though the atmospheric pressure remained relatively high.

4 GROUND GAS RISK ASSESSMENT

The reader is referred to ARCADIS Phase II Environmental & Geotechnical Site Assessment and Generic Risk Assessment (ref. 962340101, June 2011) for background information regarding ground conditions and proposed foundation solutions.

Since issue of the above report, a revised proposed development has been provided by the Architect (West + Machell architects, Forge Lane, Dewsbury, 2776[1]P002g) presented as Appendix B. It should be noted that the recommendations presented in the ARACDIS Phase II report are based on the previous layout as presented in the report. As detailed in Section 12.2 of the ARCADIS Phase II Environmental & Geotechnical Site Assessment and Generic Risk Assessment, potential foundation options vary across the site.

The figures included as part of the ARCADIS *Assessment Findings Summary and Outline Development Constraints and Outline Remedial Strategy Summary* were based on the most recent layout drawing, as referenced above.

The proposed development (based on drawing ref. 2776[1]P002g) predominantly comprises low rise residential housing, however, some flats are proposed in the eastern and northwest areas if the site with apartments in the south-western portion of the site. The floor slab construction is likely to be a combination of suspended and ground bearing slabs depending upon the ground conditions and the foundation solution adopted.

The foundation solution is yet to be finalised. Some of the proposed traditional low rise residential housing may be consistent with a 'Situation B' development (low rise traditional housing with ventilated clear underfloor void (min 150mm)) as defined in CIRIA C665. However, some of the proposed residential buildings may comprise foundation options that would not be consistent with 'Situation B'.

For the purposes of this report, the ground gas assessment has been conducted under Situation A, constituting all development types except those in 'Situation B'.

4.1 Bulk Ground Gas Assessment Methodology

The CIRIA 665 document uses a risk based approach that is designed to allow an identification of gas protection for residential (and other) housing development by comparing the measured gas emission rates to generic "Characteristic Situation" (CS) scenarios.

To calculate which Characteristic Situation a given site could fall into, a risk based approach is used which is based upon the potential of source to generate gas and the sensitivity of the site end-use. Once this risk has been established (very low to very high) a monitoring regime can be adopted to assess the ground gas regime on site.

To establish which Characteristic Situation the site is in, a Gas Screening Value (GSV) is calculated for both methane and carbon dioxide.

The GSV are calculated as follows:

Gas Screening Value (GSV) = Gas Concentration (% v/v) x Measured Borehole Flow Rate (l/hr)

The derivation of GSV used for this assessment, have initially been based on the six monitoring events conducted as part of this phase of works. The maximum carbon dioxide/methane concentration recorded in the boreholes is multiplied by the maximum flow rate recorded during the same monitoring event regardless of the borehole it occurred in.

This methodology is used as an initial assessment in order to provide a level of conservatism. The assessment can then be refined to look at a borehole by borehole scenario if deemed necessary.

Gas emissions can vary depending upon a number of factors including changes in atmospheric pressure and groundwater levels as well as conditions such as waterlogged or frozen soils. It is therefore important that a number of gas monitoring events are undertaken in order to assess the gassing regime over a period of time, including at least one monitoring event carried out during low and falling atmospheric pressure.

4.2 Bulk Ground Gas Risk Assessment

The assessment below was carried out with respect to proposed residential development in order to assess the risk associated with gas generation from the ground migrating into the new buildings.

The maximum methane GSV and carbon dioxide GSV, based on the above methodology, was calculated from gas monitoring results obtained on 4th March 2011 as follows.

GSV for carbon dioxide = 4.3% x 1.0 l/hr = **0.043 l/hr**

It should be noted that higher maximum carbon dioxide concentrations were recorded during other monitoring events (during which flow rates were lower), at a maximum of 4.8% v/v. If this maximum value was used the GSV would increase to 0.048 l/hr.

The two wells located within the pond/slurry waste (WS119 and WS120) and a number of wells located within the western portion of site (in the area of the former glass and steel works (WS102, WS103, WS105 and WS106)) consistently reported gas concentrations of carbon dioxide above method detection but lower than 5%.

As the GSV is less than 0.07% and there were no concentrations of methane or carbon dioxide recorded above 1% and 5% respectively, the site is tentatively placed into Characteristic Situation 1 (CS1), where no gas protection measures are deemed necessary. However, the following should be noted:

- The results have shown that there were several monitoring wells that had concentrations of carbon dioxide that were close to the 5% trigger concentration where consideration needs to be given to increasing the characteristic situation 2.
- The results are based on only 6 monitoring visits instead of the recommended 12.
- While the three of the monitoring visits were carried out during periods of falling atmospheric pressure, the overall pressure remained relatively high.

The bulk ground gas monitoring results detailed in reports conducted by others (as detailed in Section 2.11) were generally consistent to the results obtained by ARACDIS. It was noted however that the monitoring conducted by others did not include assessment of gas flow rates as such a GSV could not be calculated for these monitoring events Nevertheless, the results from the previous reports are considered to support the assessment above.

4.3 VOC Vapours

The DQRA indicated that there were concentrations of two contaminants of concern (benzene and naphthalene) in three locations that exceeded the SSAC derived for protection of site residents residing in a house. This was based on the vapour intrusion pathway. It should be noted that two of the locations only showed marginal exceedances and the remaining location lay outside the development area.

4.4 Conclusions and Recommendations

The provisional ground gas assessment presented in this report places the site in to CS1. However, it is considered that the gas monitoring conducted to date is not sufficiently robust to suitably characterise the ground gas risk and the results recorded are not considered representative of “worse case conditions”.

In addition, as stated previously, CIRIA document C665 recommends for a site such as this, 12 visits should be carried out over six months (compared to the six visits over three months currently undertaken).

In consideration of the above, as a conservative assessment in the absence of further gas monitoring results, it is recommended that gas protection measures applicable to CS2 are included in the development.

In accordance with the CIRIA guidance, it is recommended that further monitoring and assessment is carried out at site (six visits over next three months targeted to represent worst case conditions) with results used to confirm or modify the provisional assessment presented here. However, as the proposed development will involve movement of materials/reprofiling, the potential requirement and programme for the further gas monitoring in relation to the proposed movement of materials should be discussed and agreed with the Local Authority prior to conducting further gas monitoring at the site.

Furthermore, as detailed in Section 1.3, a number of monitoring well installations had been vandalised. Measures should be taken prior to conducting further monitoring to repair /re-install the monitoring well covers where necessary.

If the additional monitoring results are consistent with those presented in this report, and assuming results are considered to represent worst case conditions, it may be possible to suitably characterise the site as CS1.

4.4.1 Risk to Residential Buildings -Typical Scope of Protective Measures for Residential building (not those which belong to Situation B)

The risk assessment has indicated that the proposed residential development, based on the currently available information, is likely to be placed into CS2. The typical scope of gas protective measures for residential buildings (not those which belong to Situation B) for CS 2 are as set out below:

- Reinforced concrete cast in situ floor slab (suspended, non suspended or raft) with at least 1200g DPM and underfloor venting;
- Block and beam or pre-cast concrete and 2000 g DPM/reinforced gas membrane and underfloor venting; and
- All joints and penetrations sealed.

It is considered that the above precautions would also assist in reducing the ingress of VOC vapours into the buildings.

Gas protection measures should be as prescribed in BRE Report 414 (Johnson 2001). Membranes should always be fitted by a specialist contractor. Certification that these protection measures have been installed correctly should be provided.

Gas protection measures should be detailed by the house builder and be compatible with the selected foundation design and construction to mitigate the impact of preferential pathways.

In accordance with good practice it is also recommended that:

- All joints and penetrations of the membrane should be carefully sealed. Membrane joints should be sealed using a welding technique and not simply taped as the presence of VOC can affect the integrity of the tape;
- There should be minimum penetration of the floor slab by services and minimum number of confined spaces such as cupboards above the floor slab; and
- All confined spaces should be ventilated.

4.4.2 Risk to Construction Workers

Oxygen concentrations below 19% can be hazardous to human health and in the range 6 to 10% can result in nausea and vomiting and may even be fatal below 6%. The table below details the physiological effects of depleted oxygen. Oxygen depleted conditions (<19%) have been reported in the majority of locations across site with concentrations levels reaching a minimum of 7.5% in WS120.

Oxygen %	Physiological effects
19 – 21	Normal range of oxygen in atmospheric air
17	Faster, deeper breathing; slight impairment of judgement
16 – 10	Initial signs of anoxia leading to emotional upsets
10 – 6	Nausea, vomiting and unconsciousness, may lead to collapse
<6	Convulsion, gasping respiration, death

Low oxygen and/or elevated carbon dioxide/methane/carbon monoxide concentrations are only really of concern within confined spaces during excavation and remediation works. It would therefore be prudent to monitor all but shallow excavations for the presence of ground gases before entry, to ensure that there is no significant risk from reduced oxygen levels.

5 STUDY LIMITATIONS

IMPORTANT. This section should be read before reliance is placed on any of the information, opinions, advice, recommendations or conclusions contained in this report.

1. This report has been prepared by Arcadis (UK) Ltd (ARCADIS), with all reasonable skill, care and diligence within the terms of the Appointment and with the resources and manpower agreed with Kirklees Council (the 'Client'). ARCADIS does not accept responsibility for any matters outside the agreed scope.

2. This report has been prepared for the sole benefit of the Client unless agreed otherwise in writing.

3. Unless stated otherwise, no consultations with authorities or funders or other interested third parties have been carried out. ARCADIS are unable to give categorical assurance that the findings will be accepted by these third parties as such bodies may have unpublished, more stringent objectives. Further work may be required by these parties.

4. All work carried out in preparing this report has used, and is based on, ARCADIS' professional knowledge and understanding of current relevant legislation. Changes in legislation or regulatory guidance may cause the opinion or advice contained in this report to become inappropriate or incorrect. In giving opinions and advice pending changes in legislation, of which ARCADIS is aware, have been considered. Following delivery of the report ARCADIS have no obligation to advise the Client or any other party of such changes or their repercussions.

5. This report is only valid when used in its entirety. Any information or advice included in the report should not be relied upon until considered in the context of the whole report.

6. Whilst this report and the opinions made are to the best of ARCADIS' belief, ARCADIS cannot guarantee the accuracy or completeness of any information provided by third parties.

7. This report has been prepared based on the information reasonably available during the project programme. All information relevant to the scope may not have received.

8. This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of changes in the condition of the site since the time of the investigation.

9. The content of this report represents the professional opinion of experienced environmental consultants. ARCADIS does not provide specialist legal or other professional advice. The advice of other professionals may be required.

10. Where intrusive investigation techniques have been employed they have been designed to provide a reasonable level of assurance on the conditions. Given the discrete nature of sampling, no investigation technique is capable of identifying all conditions present in all areas. In some cases the investigation is further limited by site operations, underground obstructions and above ground structures. Unless otherwise stated, areas beyond the boundary of the site have not been investigated.

11. If below ground intrusive investigations have been conducted as part of the scope, service tracing for safe location of exploratory holes has been carried out. The location of underground services shown on any drawing in this report has been determined by visual observations and electromagnetic techniques. No guarantee can be given that all services have been identified. Additional services, structures or other below ground obstructions, not indicated on the drawing, may be present on site.

12. Unless otherwise stated the report provides no comment on the nature of building materials, operational integrity of the facility or on any regulatory compliance issues.

13. Unless otherwise stated, samples from the site (soil, groundwater, building fabric or other samples) have NOT been analysed or assessed for waste classification purpose.

TABLES

Table 1
Groundwater Elevation

Location	Borehole elevation (mASD)	02-04/03/2011		24/03/2011		08/04/2011		10/05/2011		23/05/2011		02/06/2011		Minimum Values		Maximum Values	
		m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD
BH5*	38.51	1.76	36.75	1.90	36.62	2.00	36.52	2.19	36.32	2.17	36.34	2.19	36.32	1.76	36.75	2.19	36.32
BH2*	38.73	-	-	1.84	36.89	1.83	36.90	1.97	36.76	2.03	36.70	2.24	36.49	1.83	36.90	2.24	36.49
BH15*	41.41	-	-	4.75	36.66	4.82	36.60	4.98	36.43	5.00	36.41	-	-	4.75	36.66	5.00	36.41
BH5A*	40.32	-	-	4.17	36.15	4.26	36.06	4.28	36.04	4.33	35.99	-	-	4.17	36.15	4.33	35.99
CP101	38.12	-	-	1.29	36.83	1.52	36.60	1.56	36.56	1.63	36.49	2.08	36.04	1.29	36.83	2.08	36.04
CP102	38.15	1.29	36.86	1.41	36.75	1.54	36.61	1.70	36.46	1.75	36.41	1.73	36.42	1.29	36.86	1.75	36.41
CP103	38.03	1.06	36.96	1.15	36.88	1.27	36.76	-	-	-	-	-	-	1.06	36.96	1.27	36.76
CP104	38.85	1.83	37.02	1.96	36.89	2.08	36.77	2.22	36.63	2.34	36.51	2.38	36.47	1.83	37.02	2.38	36.47
WS101	38.28	1.46	36.82	1.65	36.63	1.70	36.58	1.84	36.44	1.90	36.38	2.01	36.27	1.46	36.82	2.01	36.27
WS102	38.73	1.76	36.97	1.97	36.76	2.00	36.73	2.07	36.66	-	-	-	-	1.76	36.97	2.07	36.66
WS103	38.65	2.02	36.64	2.32	36.33	2.29	36.36	2.42	36.23	2.48	36.17	2.38	36.27	2.02	36.64	2.48	36.17
WS104	38.00	1.24	36.76	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	1.24	36.76
WS105	38.41	1.50	36.92	1.62	36.79	1.72	36.69	1.91	36.51	1.92	36.50	2.04	36.37	1.50	36.92	2.04	36.37
WS106	38.35	1.66	36.69	1.77	36.58	1.84	36.50	1.98	36.37	2.04	36.30	2.07	36.28	1.66	36.69	2.07	36.28
WS107	38.53	1.80	36.72	1.91	36.61	2.00	36.53	2.17	36.36	2.22	36.30	2.21	36.32	1.80	36.72	2.22	36.30
WS108	37.86	0.97	36.88	1.09	36.77	1.18	36.67	1.32	36.53	1.45	36.40	1.56	36.30	0.97	36.88	1.56	36.30
WS109	37.84	0.87	36.97	1.03	36.81	1.15	36.69	1.26	36.59	1.36	36.48	1.41	36.43	0.87	36.97	1.41	36.43
WS110	37.77	0.67	37.10	0.80	36.97	0.98	36.79	1.10	36.67	1.16	36.61	1.14	36.63	0.67	37.10	1.16	36.61
WS111	37.58	0.52	37.06	0.65	36.93	0.77	36.81	0.90	36.68	1.11	36.47	-	-	0.52	37.06	1.11	36.47
WS112	37.28	-	-	0.44	36.84	0.56	36.73	0.65	36.63	0.77	36.51	0.82	36.46	0.44	36.84	0.82	36.46
WS113	40.96	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
WS114	38.61	2.80	35.82	2.02	36.59	1.57	37.04	1.54	37.07	1.50	37.12	1.38	37.23	1.38	37.23	2.80	35.82
WS115	39.52	2.49	37.03	2.60	36.91	2.78	36.74	2.83	36.69	2.95	36.57	3.04	36.48	2.49	37.03	3.04	36.48
WS116	38.10	1.07	37.03	1.28	36.82	1.47	36.63	1.52	36.58	1.58	36.52	1.69	36.41	1.07	37.03	1.69	36.41
WS117	38.87	1.80	37.07	1.94	36.93	2.10	36.77	2.24	36.63	2.30	36.57	2.40	36.47	1.80	37.07	2.40	36.47
WS118	38.39	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
WS119	38.64	1.61	37.03	1.73	36.91	1.94	36.70	2.09	36.55	2.09	36.55	2.14	36.50	1.61	37.03	2.14	36.50
WS120	39.76	2.07	37.69	2.26	37.50	2.68	37.08	2.71	37.05	2.78	36.98	2.32	37.44	2.07	37.69	2.78	36.98

Notes:
- Did not record
* Monitoring well installed as previous Exploration Associates site investigation
m AOD metres above ordnance datum
m bgl metres below ground level

Table 2
Ground Gas Data Summary Sheet

Date of Monitoring Visit	Maximum Methane LEL		Maximum Methane		Maximum Carbon-dioxide		Maximum Oxygen		Maximum CO	Maximum H_2S	Maximum Gas Flow Rate		Maximum Gas Screening Values* (l/hr)	
	Peak (%)	Steady (%)	Peak (%v/v)	Steady (%v/v)	Peak (%v/v)	Steady (%v/v)	Minimum (%v/v)	Steady (%v/v)	Peak (ppm)	Peak (ppm)	Peak (l/hr)	Steady (l/hr)	Methane	Carbon-dioxide
02-04/03/11	1	1	0.1	0.1	4.3	4.3	14.0	14.1	8	<1	1.0	1.0	<0.01	0.043
24/03/2011	1	1	0.1	0.1	4.6	4.6	7.5	7.5	3	<1	0.3	0.1	<0.01	0.0138
08/04/2011	<1	<1	<0.1	<0.1	4.8	4.8	14.0	14.0	<1	<1	<0.1	<0.1	<0.01	<0.01
10/05/2011	9	9	0.5	0.5	3.9	3.9	14.7	14.7	<1	<1	<0.1	<0.1	<0.01	<0.01
23/05/2011	1	1	0.1	0.1	4.1	4.1	16.0	16.4	<1	<1	0.1	<0.1	<0.01	<0.01
02/06/2011	2	1	0.1	0.1	4.0	3.9	14.9	14.8	3	<1	<0.1	<0.1	<0.01	<0.01

FIGURES

LEGEND

- SITE LOCATION

NOTES

TITLE : **SITE LOCATION PLAN**

SITE : **FORGE LANE, THORNHILL LEES**

CLIENT : **KIRKLEES COUNCIL**

PROJECT :	96234.01	FIGURE	1
DATE :	31/01/11	DRAWN BY :	RV
DRG No :	962340103.apr / SLP		
SCALE :	1 : 50,000	PRINT :	A4

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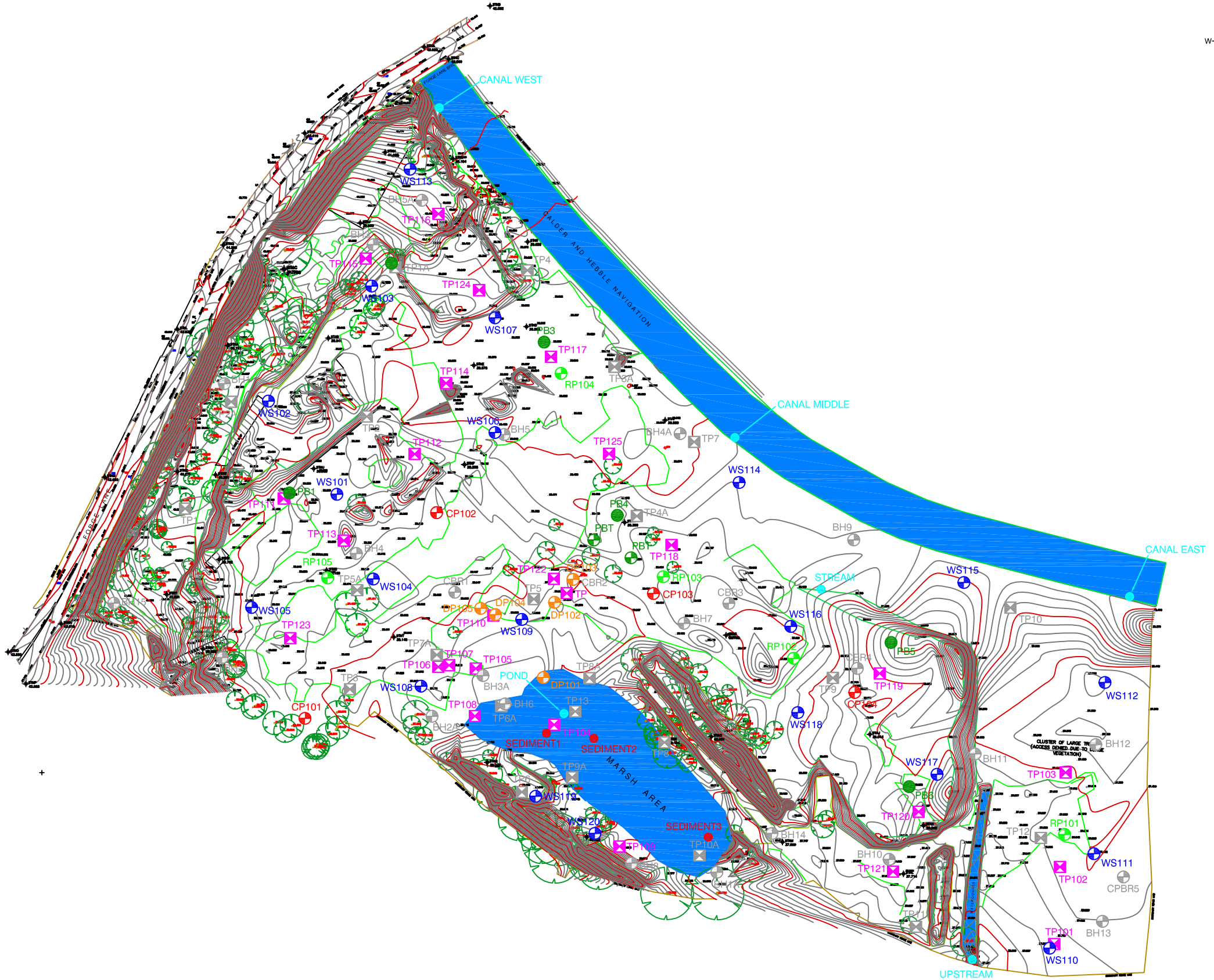

KEY

- BOREHOLE LOCATION - WINDOW SAMPLE
- BOREHOLE LOCATION - CABLE PERCUSSION
- BOREHOLE LOCATION - DYNAMIC PROBE
- BOREHOLE LOCATION - ROTARY PROBE
- TRIAL PIT LOCATION
- HISTORICAL BOREHOLE - APPROX. LOCATION
- HISTORICAL TRIAL PIT - APPROX. LOCATION
- SURFACE WATER SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION
- APPROXIMATE LOCATION OF PLATE BEARING TEST

NOTES

BASED ON DRAWING BY AECOM.
DRAWING No: 60140787_LS013D REV. -
DATE: 25/11/2009

REV	DATE	COMMENT	CAD
A	03.06.11	PLATE BEARING TEST LOCATIONS	RJW
		ADDED TO PLAN	

TITLE: EXISTING SITE LAYOUT, EXPLORATORY HOLE AND SAMPLING LOCATION PLAN

SITE: FORGE LANE

CLIENT: KIRKLEES COUNCIL

PROJECT: 96234.01 | FIGURE 2

DATE: 28/03/11 | DRAWN: BNB | REV: A

DRG.No.: 962340117-CAD | PRINT: A3

NOTE: ALL ENTITIES SHOWN ON THIS DRAWING ARE TO BE REGARDED AS APPROXIMATE AND ARE INDICATIVE ONLY. NO MEASUREMENTS TAKEN FROM THIS DRAWING SHOULD BE USED FOR THE LOCATION OF INTRUSIVE INVESTIGATION WORKS ON SITE. SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE. - CONTACT ARCADIS UK IN CASE OF ANY QUERY

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