

Merthyr Tydfil County Borough Council

**Twynyrolyn, Mountain Hare,
Merthyr Tydfil**

Site Investigation Report

9913/GNS/08

CLIENT: Merthyr Tydfil County Borough Council

PROJECT: Twynnyroddyn, Mountain Hare Merthyr Tydfil

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1.0 INTRODUCTION

1.1 GENERAL

Merthyr Tydfil County Borough Council are proposing to sell a site at Twynnyrodyn, Mountain Hare, Merthyr Tydfil for residential end-use.

Robert Chapman and Company are the agents for the sale.

Intégral Géotechnique (Wales) Limited have been appointed as the Geotechnical Engineers to undertake a site investigation to enable a geotechnical and geo-environmental appraisal of the site and provide a basis for design.

This report presents the findings of the site investigation and gives recommendations for the design of foundations, floor slabs and other geotechnical and geo-environmental aspects of the project.

1.2 PROPOSED DEVELOPMENT

Plans for the proposed development of the site are not yet available, but it is assumed that the development will incorporate residential housing with gardens and associated access roads and car parking.

1.3 SCOPE OF WORKS

The work instructed included a site reconnaissance visit and intrusive site investigation, followed by laboratory testing, on site monitoring and geotechnical and geo-environmental reporting.

A Desk Study for the site was previously undertaken and reported by Intégral Géotechnique (Wales) Limited in May 2007. The desk study report (reference 9913/AF/07) should be read in conjunction with this report. Reference to the desk study has been made when compiling this report, and for ease of presentation and understanding, sections of the desk study are presented in this report.

1.3 SCOPE OF WORKS (CONTINUED)

The desk study information was used to make an initial assessment of the site and to design an investigation to be carried out by Intégral Géotechnique. The site investigation was designed in accordance with BS10175, the code of practice for investigation of potentially contaminated sites, 'Land Contamination: A Guide for Developers' prepared by WLGA/EAW Land Contamination Working Group, July 2006, and following the recommendations of the Coal Authority.

The site investigation comprised:

- An intrusive investigation carried out during March and April 2008 comprising trial pits/trenches, shell and auger boreholes and rotary probeholes.
- Combined gas and groundwater monitoring standpipes were installed in the shell and auger boreholes and three rotary probeholes (R3, R4 and R14) to depths of between 6.0 and 35m below ground level.
- Installation of 50mm temporary geo-logging casing in rotary probeholes R1, R5, R6, R7, R8, R10, R12 and R15.
- Detailed geophysical down hole natural gamma and density logging from surface to the base of probeholes R1, R5, R6, R7, R8, R10, R12 and R15.
- Sampling of soil/fill for laboratory chemical and physical testing.
- Monitoring for concentrations of methane, carbon dioxide, oxygen, and gas flow.
- Detailed quantitative human health and groundwater risk assessments.

1.4 LIMITATIONS

This document is intended to be a working document for further development in discussion with all concerned including Merthyr Tydfil County Borough Council (the Local Planning Authority), the Environment Agency Wales and the NHBC, as appropriate.

"Contamination" is taken throughout the report to mean the "presence of one or more potentially harmful substances as a result of human activity". The use of the term in this way does not imply that harm is being or might be caused by the contamination. It should be noted that "contamination" can have different meanings under different regulatory regimes, for example, planning, building control and Part IIA of the Environmental Protection Act 1990 (see Boxes 1 and 2 in Appendix A). Naturally elevated concentrations of potentially harmful substances (PHSs) may also be of concern (see Box 1 in Appendix A) and the significance of any that have been found is also evaluated in this report.

1.4 LIMITATIONS (CONTINUED)

It is important to recognise that there may be areas of contamination that have not been found, or that contaminants (PHSs) are present at concentrations above those that have been found. It is also important to recognise that contamination, for example from a small oil spill, may be very localised and that no investigation, however comprehensive, is capable of finding such occurrences other than by chance.

Owing to the presence of a number of underground services no intrusive exploratory works were undertaken along the eastern margin of the site or in close proximity to the existing surface water drains.

This report has been prepared for the use of Merthyr Tydfil County Borough Council and should not be passed to others without the express consent of Intégral Géotechnique (Wales) Limited.

2.0 THE SITE

2.1 SITE LOCATION AND DESCRIPTION

The site is located in Twynrodyn, Merthyr Tydfil. The centre of the site is at an approximate National Grid Reference of SO 059 057, see Figure 1.

The site is irregular in shape and occupies an area of approximately 5.6 hectares.

The site boundaries are defined by fencing and a track/road to the east and south, and the rear gardens of residential properties which front onto Wallhead Road and Aneurin Crescent to the west.

The site is generally slightly sloping towards the south and has an elevation of approximately 240m AOD at the northern boundary and 215m AOD at the southern boundary. The site is generally covered by long grass with fenced-off sections of semi mature trees and bushes.

A storm water sewer crosses the site in a north to south direction with connecting service drainage channels.

2.2 SITE OPERATIONS

At the time of the intrusive site investigation works the site was being used as public open space. The Taylor Wimpey compound that previously occupied the northern area of the site had been removed and the area levelled and seeded to grass.

2.3 SURROUNDING LAND USE

The surrounding land use consists of residential properties to the north, east and west and open grassland to the south.

2.4 AVAILABLE SITE INVESTIGATION DATA

Intégral Géotechnique (Wales) Limited have previously undertaken site investigation works within the adjacent land to the east of the site. The investigations encountered up to three coal seams from 7m depth and shallow mineworkings across much of the eastern part of the site. Drilling and grouting was subsequently undertaken across the eastern half of the site, approximately 20 to 80m east of the current site boundary. It is considered that similar coal seams are likely to exist at shallow depth beneath the current site and that shallow mineworkings are also likely to be present.

2.5 CONSULTATIONS WITH REGULATORS

No consultations with regulatory authorities have been undertaken at this point, but it is envisaged that the final report will be issued to the Local Authority and Environment Agency for regulatory approval.

3.0 SITE HISTORY

The recent history of the site was provided in the desk study report previously issued and is summarised below, although the historical maps previously issued have not been provided in this report.

The 1875 Edition shows the site area to be mostly surrounded by open fields. The site area is indicated to have comprised an undulating network of valleys and mounds of possible spoil. A brick works is indicated to have been present just inside the eastern site boundary. The Nant Cwm Blacks is indicated on or near the site's south-east boundary, flowing in a south-westerly direction. The Dowlais Railway is indicated approximately 70m north-west of the site boundary, running in a south-west to north-east direction. Various coal and ironstone shafts and levels are indicated to the north, east and south of the site.

The 1900 map indicates the presence of a coal level just inside the eastern site boundary. The Brick works is noted to have been demolished and removed by this time

The 1919 map indicates the presence of an old coal level just inside, or close to the south-eastern site boundary. An old coal shaft is also indicated at Trebbedau, approximately 10-15m east of the site boundary.

The 1951 map indicates the development of residential housing up to the western site boundary. By this time, most of the site area is indicted to have been covered by tipped materials with a prominent valley and a small stream running from north to south close to the western boundary.

In the 1980s, the site formed part of the Cwm Blacks Reclamation Scheme where the site was reclaimed and landscaped to form an area of public open space with a playground towards the northern tip of the site.

Within the last few years, residential housing has been developed within the land directly to the east of the site boundary.

Up until present, the site has remained as public open space, although the former playground area in the northern part of the site had been used as a site compound was a house developer and recently levelled and seeded to grass.

4.0 SITE ENVIRONMENTAL SETTING

4.1 PHYSICAL SETTING

The site is situated on the western side of the Cwm Blacks valley, to the east of the River Taff. The ground within the site slopes gently towards the south and there is a slight valley or depression which runs in a north-south direction through the western half of the site. The site is drained by surface drainage channels which feed into a sub-surface storm water sewer that runs beneath the site. The River Taff lies downslope and approximately 850m to the south-west of the site. Reference to the Environment Agency flood map for the area, indicates that the site is not affected by flooding.

4.2 GEOLOGY

The 1:10,560 scale geology map of the area (Sheet No SO 00 NE) indicates that the site is underlain by strata of the Carboniferous Lower Coal Measures. These strata are likely to comprise sandstones, siltstones, mudstones and occasional coal seams. The map indicates the strata to be dipping at approximately 5° in a south-easterly direction.

The geological map indicates that the rocks beneath the site and surrounding area are overlain by superficial deposits of glacial till. Across the site area, these superficial materials are overlain by made ground, including mainly spoil from coal and ironstone workings.

A summary of the anticipated geological succession is given below in Table 1.

Table 1 : Summary of Anticipated Site Geology		
Geological unit	Horizon	Description
Recent	Made ground	Various materials but predominantly colliery spoil
Pleistocene	Glacial Till	Generally cohesive deposits with cobbles and boulders
Carboniferous	Lower Coal Measures	Sandstones, siltstones and mudstones with occasional coal seams

4.3 MINING

From the geological map, the conjectural outcrop of the Lower Seven Feet coal seam is shown trending in a north-south direction down the middle of the site. The conjectured outcrop of the Gellideg coal seam is indicated to run parallel to the Lower Seven Feet coal seam approximately 30 to 40m west of the most westerly corner of the site.

The generalised vertical section of the geological map shows that the Lower Seven Feet coal seam is typically 1.5m thick. The combined Five Feet and Gellideg coal seams are indicated to lie approximately 6m below the Lower Seven Feet seam. The combined thickness of the Five Feet/Gellideg coal seams may amount to approximately 3.0m in thickness. The site is therefore likely to be underlain at shallow depths by at least one coal seam towards the west, and at least two coal seams towards the east. Both these seams are known to have been mined in the area. There is therefore a potential risk of the site being affected by shallow mining related ground subsidence.

A coal mining report had been obtained from the Coal Authority and a copy is presented in Appendix B. The report states that the site is “in the likely zone of influence from workings in 2 seams of coal at shallow to 50m depth, and last worked in 1917”...and that the site is “in the likely zone of influence from workings in one seam of ironstone at 80m depth, and last worked in 1860”.

The Coal Authority also report that there are ten mine entries within or within 20m of the site boundary. The locations of these entries are shown on the plan attached to the Coal Mining report. A larger scale plan has been obtained and is shown in Figure 3. Details of the mine entries are presented in Appendix C and summarised as follows:

306205-005 (No 1 Trebeddau Level) - No Treatment details

305205-031 (Shaft) - No Treatment details - *Onsite*

305205-021 (Level) - No Treatment details - *Onsite*

306205-045 (Level) - No Treatment details - *Onsite*

306205-034 (No 2 Trebeddau Level) - No Treatment details

306205-003 (Shaft – Trebeddau No 1)

– The position of this mine entry was investigated by Rutter Johnson Partnership in January 2000. No evidence of its presence at this location could be found

305205-053 (Simons Level) - No Treatment details - *Onsite*

306205-035 (No 3 Trebeddau Level) - No Treatment details

306205-057 (Level) - No Treatment details

305205-020 (Penrheol Level) - No Treatment details

4.3 MINING (CONTINUED)

All of the above mine entries are located close to the eastern boundary of the site and the levels are mostly indicated to have been worked in a north-easterly or easterly direction.

Some of the above shafts and levels are indicated on historical Ordnance Survey maps, as previously discussed. The Trebbedau shaft, which is shown on the 1919 historical map, is understood to be the same shaft which was previously investigated but not found (i.e. 306205-003 above). The second shaft entry (305205-031), just inside the south-eastern site boundary is not indicated on the historical maps, although an old coal level is indicated in the same vicinity on the 1920 map.

A British Coal Opencast plan dated 3.6.91, has been obtained and an extract is shown in Figure 3a. The plan shows the same mine entries and also recorded shallow mine workings near the east boundary. However, as with the site recently investigated to the east, there is a risk that unrecorded shallow workings are also present beneath the subject site. Mine entry 305205-031 is shown as a level, as indicated on the 1920 plan, which the mine entry data sheet confirms as the source information.

4.4 RADON

References to Annex A and Annex B of BRE 211, "Radon: Guidance on protective measures for new dwellings" indicate that the site is situated in an area for which a radon report is required. The report indicates that the property does not lie within an area for which radon protection measures will be required.

4.5 HYDROLOGY AND HYDROGEOLOGY

Surface drainage channels are present within the site, some of which feed into a sub-surface storm water drain running in a north to south direction beneath the site. Surface run-off is likely to flow in a general southerly direction towards the Nant Cwm Blacks and eventually, the River Taff, some 850m to the south-west of the site.

The 1:100,000 scale Groundwater Vulnerability Map, produced by the Environment Agency (Sheet No 35), has also been consulted. The map shows the rocks beneath the site to be classed as a Minor Aquifer.

Minor Aquifers (variably permeable) can be fractured or potentially fractured rocks, which do not have a high primary permeability. The aquifers would seldom produce quantities of water for abstraction, but do provide important local supplies and base flow to rivers.

4.5 HYDROLOGY AND HYDROGEOLOGY (CONTINUED)

The Groundwater Vulnerability Map classifies the soils at the site as being of high leaching potential. These soils have some ability to attenuate diffuse source pollutants and non-adsorbed diffuse source pollutants and liquid discharges have the potential to migrate to underlying strata or to shallow groundwater. Low permeability drift deposits are indicated to be present beneath the northern part of the site.

Tables 2 and 3 present a summary of the hydrological features and key hydrogeological nature of the site.

Table 2: Summary of Site Hydrology					
Feature	Distance from site	Flow	Classification	Abstraction	Discharge
Nant Cwm Blacks	Located just to the south	Not known	Not known	N/A	River Taff
River Taff	Approximately 850m to the south-west of the site	Not known	GQA Grade A	N/A	Cardiff Bay
Surface run-off	N/A	Flows into site drainage	N/A	N/A	Nant Cwm Blacks

Table 3: Summary of Site Hydrogeology				
Geological Unit	Aquifer Classification	Aquifer Characteristics	Source Protection Zone	Groundwater Abstractions
Made ground	Not classified	Highly variable permeability and porosity. Perched water may be present with variable flow directions.	No	None
Glacial till deposits	Minor aquifer	Variable low to moderate permeability and porosity with intergranular flow possible. High clay content likely to restrict flow.	No	None
Lower Coal Measures	Minor aquifer	Moderate permeability mudstones interbedded with siltstones and sandstones and occasional coal seams	No	None within 988m of the site.

There is potentially a perched and confined groundwater body within the made ground. The underlying predominantly cohesive Glacial Till deposits may act as an aquiclude and negate the downward movement of the perched water.

4.5 HYDROLOGY AND HYDROGEOLOGY (CONTINUED)

A second, and deeper groundwater body should be anticipated within the solid strata. The groundwater at depth will potentially be in hydraulic equilibrium with the made ground deposits, particularly if the Glacial Till deposits are not present in-situ.

4.6 LANDFILL SITES

The Envirocheck report provided in the Desk Study report indicated the presence of two Licensed Waste Management Facilities within 250m of the site. These are the Ael Y Bryn Landfill and the Pencoedcae Farm Landfill, approximately 225m and 200m east of the site respectively. Both these sites are indicated to take construction, demolition and dredged waste (i.e. other waste types). The Ael Y Bryn Landfill is indicated to be active and the Pencoedcae Landfill is indicated to be closed.

In addition to the above, a Local Authority Recorded Landfill site is indicated approximately 300m to the north-east of the site and is recorded to be closed.

4.7 POTENTIAL CONTAMINATION

Previous Uses

The various activities in the vicinity of the site which may have resulted in ground or water resource contamination on this site are listed below in Tables 4 and 5. Reference to CLR 8 'Potential contaminants for the assessment of land' has been made and a summary of the potential contaminants can be found in the tables.

Table 4: Potential Contaminants			
Activity	Material/Process	Contamination/Hazard (according to CLR 8)	Evidence
Coal and iron working spoil tips	Mined spoil wastes Possible combustion wastes	Inorganics including sulphates and heavy metals Low pH materials Polyaromatic Hydrocarbons Gases Spontaneous Combustion	No direct evidence other than historical and mining plans.

Existing Uses

There are no existing site uses. The site is disused and hence there is no longer any potential for additional ground or groundwater contamination.

4.7 POTENTIAL CONTAMINATION (CONTINUED)***Adjacent Site Uses***

Residential housing is located to the north, west and east of the site, with open ground situated to the south. The risk of contamination being generated from such uses is low.

5.0 PRELIMINARY CONCEPTUAL SITE MODEL

A preliminary conceptual site model/conceptual exposure model has been developed for the site. This is based on the findings of the previously issued desk study, historical review and site walk over and includes all potential sources, pathways and receptors that may be present on site. Those that have been identified as being potentially active require further investigation in the form sampling and testing of soils and groundwater, followed by appropriate risk assessment.

The preliminary conceptual site model/conceptual exposure model will be reviewed and refined following the completion of the site works and laboratory testing.

Table 5: Preliminary Conceptual Site Model/Conceptual Exposure Model

Source	Pathway	Receptor	Potential Active Pathway?	Justification/Mitigation
Potentially contaminated made ground as a result of former site uses including infilling with colliery spoil derived from coal and ironstone mining.	Dermal Contact Direct Ingestion Inhalation of Vapours	Future site residents/users	✓	Potential for made ground exposure at surface and contact with a range of inorganic and organic contaminants including heavy metals, and PAHs. Undertake soil sampling and testing to determine chemical characteristics.
	Leachate Migration via perched water or along permeable service trenches	Groundwater/neighbouring land	✓	Potential for leachate generation within made ground deposits. Undertake leachate testing.
	Leachate migration to alluvial groundwater and lateral transportation	Nant Cwm Blacks (fed by a storm water drain located on site) and the River Taff to the southwest some 850m distant	✓	Potential for leachate migration to alluvial groundwater. Undertake groundwater sampling and testing.
	Dermal Contact Direct Ingestion Inhalation of Vapours	Ground Workers	✓	Potential for exposure to made ground during site works. Undertake soil sampling and testing to determine chemical characteristics and the PPE required.
	Direct Contact	Building materials	✓	Potential contact with made ground and natural soils. Undertake soil sampling and testing to determine chemical characteristics.

Point Source (eg-UST)	Inhalation of vapours	Future Site Residents/users	X	No evidence of any potential point sources having been present on site. No evidence of any UST's.
	Groundwater transportation/migration along permeable service trenches	Groundwater	X	
	Groundwater transportation	Nant Cwm Blacks (fed by a storm water drain located on site) and the River Taff to the southwest some 850m distant	X	
	Groundwater transportation	Neighbouring land	X	
Contamination from off site sources	Surface water run-off, migration through made ground and/or services, then dermal contact, ingestion and/or inhalation	Future site residents/users	✓	Residential housing identified to the north, east and west and open ground to the south. Low risk from off site contamination sources. Undertake groundwater sampling and testing
Ground Gas	Accumulation in enclosed spaces of future buildings on site, or migration to buildings off site, leading to asphyxiation, or risk of explosion	Future site residents/neighbouring residents	✓	Potential for ground gas associated with made ground anticipated to comprise colliery spoil materials. Undertake gas monitoring programme and risk assessment

6.0 THE SITE INVESTIGATION

6.1 FIELDWORKS

A site investigation was designed in accordance with BS 10175, the code of practice for investigation of potentially contaminated sites, and 'Land Contamination: A Guide for Developers' prepared by WLGA/EAW Land Contamination Working Group, July 2006. The works were also undertaken in accordance with Coal Authority Guidance, with permits being obtained from the Coal Authority to undertake the intrusive works.

The site investigation was also designed to provide information to support and refine the preliminary conceptual site model/conceptual exposure model.

A site investigation comprising nineteen machine excavated trial pits/trenches, six shell and auger boreholes and seventeen rotary probeholes (R1 to R17) was carried out during March and April 2008, respectively. The trial pit, borehole and rotary probehole locations are shown on Figure 2.

It should be noted that at the time of the site investigation access was limited to certain site areas by the presence of footpaths, underground services and fenced off and wooded areas. This was particularly the case within the south-eastern corner of the site where the presence of a number of underground services (rising main and pumped sewers and associated easements), the presence of dense and fenced off vegetation, and numerous footpaths negated the formation of any exploratory excavation in the area of some of the reported adits.

The trial pits were excavated, by means of a 13 tonne 360° tracked excavator, down to a maximum depth of 5.6m. The trial pits/trenches were backfilled following the excavation process, with no pits left open and unattended for any length of time.

Six shell and auger boreholes (BH1 to BH6), were drilled between March and April 2008. The boreholes were located across the site and drilled to a maximum depth of 14.0m. The purpose of the boreholes was to prove the shallow soil profile and allow an assessment of the most appropriate foundation type for the proposed development. In-situ strength testing (SPT/CPTs) was carried out in the boreholes. Combined gas and groundwater monitoring standpipes were installed within the boreholes to allow groundwater to be monitored, sampled and tested, and gas monitoring to be completed.

6.1 FIELDWORKS (CONTINUED)

During the trial pitting and drilling of the shell and auger boreholes, representative samples were taken for laboratory chemical testing and placed in the appropriate sample container deemed suitable for the analysis required. Strict protocols were adopted during this process to limit the cross contamination of samples and included the use of sterile disposable gloves and stainless steel sampling equipment cleaned with de-ionised water prior to sampling. Soils deemed to have made direct contact with the sides of the excavator bucket or drilling shoe were not used for chemical analysis.

Seventeen rotary probeholes were formed by open hole drilling methods using a Klem 802 rotary drilling rig, with air and water mist used as the drill flush medium.

Combined gas and groundwater monitoring standpipes were installed in three of the probeholes (R3, R4 and R14) to depths of up to 35m.

Following the installation of the standpipes in the boreholes and probeholes, groundwater was sampled for laboratory chemical testing, with three rounds of groundwater sampling and analysis being undertaken.

A programme of gas monitoring was commenced following completion of the site works.

A 50mm diameter temporary geo-logging casing was installed to termination depth within eight of the rotary probeholes (R1, R5, R6, R7, R8, R10, R12 and R15). Detailed geophysical down hole natural gamma and density logging was undertaken from the ground surface to the base of the probeholes.

The fieldworks were supervised by a qualified Geotechnical Engineer from Intégral Géotechnique (Wales) Limited who also logged the trial pits and boreholes, and prepared their detailed engineering logs in accordance with the requirements of BS5930: 1999.

The approximate locations of the trial pits, shell and auger boreholes and rotary probeholes are shown on Figure 2, while their logs are presented in Appendices D, E and F respectively. The results of the geophysical logging are presented in Appendix G.

6.2 FIELD OBSERVATIONS

No visual or olfactory evidence of any contamination was observed during the excavation of the trial pits and drilling of the boreholes and probeholes.

6.3 LABORATORY CHEMICAL TESTING

Representative soil samples were taken from the trial pits across the site, stored at the appropriate temperature and dispatched to the laboratories of STL for laboratory chemical testing within 24 hours.

The samples were tested for a range of contaminants that reflects the historical use of the site, the findings of the desk study and the preliminary conceptual site model/conceptual exposure model. A list of the soil testing carried out is given below:

Arsenic	Cadmium
Total Chromium	Lead
Mercury	Selenium
Boron	Copper
Nickel	Total Cyanide
Zinc	Monohydric Phenol
PAH (Priority 16 by GC)	TPH VPH including BTEX and MTBE
Total Sulphate	Sulphide
Elemental Sulphur	Water Soluble Sulphate
pH	

In addition the soil samples were screened for total organic carbon (TOC) and loss on ignition (LOI). A selected number of samples were also screened for asbestos and calorific value (CV).

The potential for leachate generation and migration off site or to groundwater was identified as being active in the preliminary conceptual site model. Therefore, six soil samples were also tested for their leachability characteristics for the same suite of contaminants as the soils (excluding TOC, LOI, TPH VPH, CV and asbestos).

Upon completion of the drilling works, groundwater was sampled from each of the standpipes installed in the boreholes and probeholes where sufficient groundwater was available. The samples were also dispatched to the laboratories of STL and tested for the same elements/compounds as the soils (excluding TOC, LOI and asbestos).

The results of all the soil, leachate and groundwater testing are presented in Appendices H, I and J respectively.

6.4 LABORATORY PHYSICAL TESTING

Bulk soil samples were obtained from five trial pits across the site (TP5, TP7, TP10, TP12 and TP16) at depths of between 0.5 and 1.2m.

The samples were scheduled for particle size distribution (PSD) by wet sieving, and for compaction tests using a 2.5kg rammer.

The results of such classification and physical tests are presented in Appendix K.

6.5 GROUNDWATER MONITORING

During each groundwater monitoring round, the groundwater levels were checked and recorded. The boreholes were then purged of approximately three times the well volume using a pump. Each well was monitored in-situ during purging for groundwater parameters pH, temperature, conductivity, total dissolved solids, salinity, oxidation reduction potential and dissolved oxygen using a Hanna Multi Parameter Water Quality Meter. Representative samples of groundwater were then collected using a sterile disposable bailer and stored in the correct sample bottles during transportation to the laboratory.

The sampling equipment was cleaned between boreholes to prevent cross contamination and a single use sterile proprietary bailer used to obtain the water samples after purging. Care was also taken to ensure the sampling equipment did not become contaminated at the ground surface.

Upon completion of the sampling, the rate of recovery of the groundwater level in the borehole was observed.

A copy of the groundwater monitoring results is presented in Appendix L.

6.6 IN-SITU GAS MONITORING

Gas monitoring standpipes were installed in six shell and auger borehole and three rotary probeholes and these have been monitored at fortnightly intervals following completion of the fieldworks.

The gas monitoring programme commenced on 15 May 2008.

6.6 IN-SITU GAS MONITORING (CONTINUED)

The concentration levels of methane, carbon dioxide and oxygen were measured in the standpipes during each visit by using a GA2000 Landfill Gas Analyser. In addition, gas flow rate and the atmospheric pressure at the time of the field measurements were also recorded.

Gas monitoring was carried out over a range of atmospheric pressures to include at least one reading in low and/or falling pressure, in accordance with the recommendations made in CIRIA Report C659.

The gas monitoring programme was completed on 11 July 2008.

The results of the field gas monitoring are presented in Appendix M.

7.0 GROUND CONDITIONS

7.1 SHALLOW GROUND CONDITIONS

Detailed information regarding the shallow ground conditions was predominantly derived from the trial pits/trenches and the shell and auger boreholes. Owing to the method of rotary drilling adopted when forming the probeholes (Openhole techniques) it is difficult to log the strata being drilled, particularly the superficial deposits (made ground and glacial till), and as such these strata are linked together on the probehole logs.

A summary of the shallow ground conditions encountered across the site is presented below in Table 6.

TABLE 6 : SUMMARY OF GROUND CONDITIONS		
Depth (m)		Stratum
From	To	
0.0	0.9/14.0	MADE GROUND: Typically comprising loose to medium dense, brown, dark brown and dark grey slightly silty gravel with occasional to frequent cobbles of tabular mudstone and sandstone. Gravel is fine, medium and coarse angular and tabular mudstone and rarely sandstone and coal.
0.9/12.1	2.5/12.8	GLACIAL TILL: Typically comprising firm becoming firm to stiff grey mottled orange brown, slightly silty, slightly gravelly to gravelly CLAY with frequent cobbles and boulders (0.4 x 0.5m) of sandstone and siltstone. Gravel is fine, medium and coarse rounded and sub-rounded sandstone and siltstone. Gravel is fine, medium and coarse rounded and sub-rounded sandstone and tabular mudstone and siltstone.

Made ground was encountered at each exploratory point and extended to depths of between 0.9 and 14.0m where accurately proven. It is possible that the made ground may have extended to slightly deeper depths in the rotary probeholes.

The variable thickness of made ground was dictated by the historical topographical nature of the site, and the infilling works undertaken during the reclamation scheme of the 1980s which involved the infilling of former valleys. Hence, the thickness of made ground was variable across the site, with the greatest thicknesses identified in the former valleys, and only a thin veneer of material identified on the edge of the site (edge of the former valleys).

7.1 SHALLOW GROUND CONDITIONS (CONTINUED)

Generally the made ground was relatively consistent in physical nature and comprised relatively homogenous material comprising gravels of mudstone and sandstone.

However, increasingly heterogeneous and variable made ground was encountered in TP1, TP2 and TP7, with such deposits frequently characterised by their cohesive nature and the presence of man made materials including gravel, cobbles and rarely boulders, of brick, metal, plastic, ceramic and pottery.

It should be noted that within TP19, an apparent accumulation of mortar bonded brickwork associated with a collapsed adit/level structure was encountered at 3.5m depth. The adit comprised a concrete capped curved brick structure and extended to a depth in excess of 4.6m and was orientated in a west to east direction. The structure of the adit appeared relatively intact.

This evidence of an old level would suggest that reclamation of the site in the early 1980s did not necessarily include the treatment of the any mine entries, and therefore other potentially untreated adits may be present beneath the site surface.

The made ground was found to be underlain by either glacial till or in direct contact with the solid strata. The presence of glacial till was predominantly concentrated around the peripheral margins of the site.

No significant groundwater inflows were identified in any of the trial pit excavations, although the soils were noted to be wet/damp or minor water seepages identified in TP1, TP2, TP3, TP8, TP9 and TP12 at depths of between 1.0 and 4.1m. It is probable that such incidences are associated with the presence of perched water in the made ground deposits.

The shell and auger boreholes and rotary probeholes were noted to be dry during their excavation.

Return visits to the site have been undertaken to monitor groundwater levels in the borehole and probehole installations. During the three return visits, the majority of boreholes and probeholes remained dry, with only groundwater being recorded in BH1, BH3, BH6 and R14.

The results of groundwater monitoring are provided in Appendix L and summarised below in Table 7.

7.1 SHALLOW GROUND CONDITIONS (CONTINUED)

TABLE 7 : SUMMARY OF GROUNDWATER LEVELS			
Borehole/Probehole	Water Depth (m)		
	Run 1	Run 2	Run 3
BH1	1.61	1.04	0.44
BH3	0.91	0.81	0.92
BH6	9.67	Dry	Dry
R14	26.4	26.85	26.92

It is evident from both the observations of groundwater levels during the site investigation works, and from the later groundwater monitoring, that two groundwater bodies may exist on site.

Shallow perched water was observed periodically in the made ground and superficial deposits, whilst a deep and potentially more mobile groundwater regime has been identified at depth within the solid strata.

The perched water level has been found to fluctuate, and in fact was not present in many of the boreholes across the site. It is considered that perched water reacts to rainfall infiltrations, temporarily perching the water prior to its gradual infiltration into the ground. The perched water body is therefore not considered to represent a continuous water body flowing beneath the site, but instead pockets of accumulated water from rainfall infiltrations.

Deeper groundwater has been identified within the mudstone bedrock in borehole R14. Although groundwater has not been identified in other deep rotary boreholes, boreholes R3 and R4 were damp towards the base of the hole. It has therefore been assumed that groundwater level must be close to these depths and, together with the groundwater data from borehole R14, a deep groundwater contour plot has been created as shown on Figure 4. Groundwater flow is indicated to be in a south-westerly direction.

From the groundwater contour plot a hydraulic gradient within the mudstone bedrock of 0.003 has been calculated.

7.2 DEEP GROUND CONDITIONS

The deep rotary probeholes were principally drilled on site to profile the depth to rock head and identify the presence and nature of any shallow coal seams and associated mining voids. When using a open hole rotary drilling technique it is difficult to distinguish between made ground deposits and the superficial Glacial Till materials.

The probeholes confirmed the presence of several coal seams at shallow depths beneath the site.

Most of the probeholes encountered some 10 to 15m thickness of made ground/superficial deposits, although in the far west (R8) these were only 7.2m thick, and in the far south they increased to some 15 to 20m in thickness.

As expected from the geological map, the strata dips appear to generally trend to towards the east and south.

Generally only one coal seam was encountered beneath the west half of the site and was typically 0.5 to 1.0m in thickness. This coal seam may be the Five Feet/Gellideg seam.

A second higher seam was generally encountered under the east half of the site. This seam was generally split and up to 1.0 to 1.5m in thickness. This seam may be the Lower Seven Feet Seam, which appears to outcrop on an approximately north-south line running through the middle of the site.

A third seam appears to be present in the south-east of the site where R14 encountered a 2.6m thick coal seam at 11.7m depth, just below the rock head. This seam may be the Upper Seven Feet Seam.

Traces of past mineworkings were found in what are thought to be the Five Feet/Gellideg and the Lower Seven Feet Seams, the south-east of a line joining the R9 and R11 probeholes.

The coal seams were generally located within solid strata comprising mudstones and siltstones.

No groundwater was noted in the probeholes.

The geologging of the rotary probeholes helped to confirm the correlation, thickness and depths of these coal seams.

8.0 CONTAMINATION

8.1 AVERAGING AREAS

In order to assess the laboratory test results reliably and in context, the data has been grouped into an averaging area. An averaging area (or area of interest) is that area of soil to which a receptor is exposed or which otherwise contributes to the creation of hazardous conditions. This may be an area of historical industrial usage, e.g. gas works, a soil type, e.g. made ground, or a specific proposed end-use.

In the case of this analysis, the averaging areas have been determined according to soil type, the made ground being identified as the pertinent averaging area.

8.2 SOIL CONTAMINATION

Statistical analysis of the soil test results has been carried out for the made ground deposits in line with DEFRA and Environment Agency recommendations. The analysis used gives a contaminant concentration of the 95th percentile (US₉₅), which can be compared with the guideline concentrations. This allows the general site wide contamination to be assessed for the averaging area.

Statistical analysis has also been carried out to assess whether individual results can be regarded as statistically significant or not.

The results have been initially compared to DEFRA Soil Guideline Values (SGVs) for a residential end use. Due to a lack of appropriate guidelines for polyaromatic hydrocarbons (PAH) and total petroleum hydrocarbons (TPH), the Generic Acceptance Criteria (GSAC) derived by either Land Quality Management LQM), in conjunction with the Chartered Institute for Environmental Health (CIEH), or Atkins ATRISK^{soil} values have been.

The soil test results have been summarised and are shown in Appendix N.

With regards to inorganic contamination (metals and semi metals) none of the determinants analysed recorded concentrations above the published soil guideline values (SGVs) or alternate screening values adopted based on a residential end-use with the exception of arsenic and nickel.

8.2 SOIL CONTAMINATION (CONTINUED)

Elevated arsenic was recorded in three samples obtained from TP1, TP2 and TP10 at depths of 0.5 and 2.5m. The elevated results of 21, 22 and 23mg/kg slightly exceed the published soil guideline value of 20mg/kg.

Statistical analysis of the recorded arsenic results indicates a representative US_{95} value of 15.72mg/kg which is significantly lower than the published SGV of 20mg/kg. No outliers were recorded.

Ten out of twenty two soil samples analysed for nickel recorded elevated concentrations of between 65 and 110mg/kg from TP2, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12 and TP13, which exceed the published soil guideline value of 50mg/kg.

Statistical analysis of the recorded nickel results indicates a representative US_{95} value of 68.88mg/kg which is elevated when compared to the published SGV of 50mg/kg based on a residential with plant uptake end use. In addition, no outliers of nickel were recorded for the data set.

With regards to PAH analysis, total values (summation of all USEPA 16 determinants) of between 5.0 and 7.1mg/kg have been recorded.

Speciation of the total PAH values indicates that none of the individual PAHs were elevated when compared to the ATRISK and LQM screening values for a residential development.

Eight soil samples were screened for TPH VPH analyses (detailed aliphatic and aromatic split), BTEX compounds (benzene, toluene, ethylbenzene, and xylene) and MTBE (Methyl tertiary-butyl ether). The recorded results when compared to the ATRISK and LQM values for a residential end-use indicate that none of the individual carbon bands, BTEX compounds or MTBE exceeds the published screening values.

Four soil samples were screened for asbestos, the results of which indicate that asbestos has not been identified in any of the selected soil samples.

Four soil samples were also tested for calorific value. The results indicated a range of calorific values from 5.4MJ/kg to 7.6MJ/kg.

8.3 SOIL LEACHATE

Six soil samples taken from the site were tested for their leachable concentrations for a similar suite of contaminants as the soils. A copy of the leachate test results is presented in Appendix I.

Freshwater EQS based on typical hardness values for the Merthyr Tydfil Area (River Taff) of >100-150mg/l CaCO_3

The results of the leachate testing show that the majority of determinants screened record values below the published Environmental Quality Standards (EQS) or the UK Drinking Water Standards, with exception of total PAH.

Total PAH has been detected at concentrations in excess of the UK Drinking Water Standard in two of the soil samples, with the recorded values of 0.13 and 0.19 $\mu\text{g/l}$ slightly exceeding the UK Drinking Water Standard of 0.1 $\mu\text{g/l}$.

None of the individual PAHs are elevated when compared to the available EQS or UK Drinking Water Standards (Benzo(a)pyrene and naphthalene).

8.4 GROUNDWATER CONTAMINATION

Groundwater samples were taken from the boreholes across the site (three sampling visits have been undertaken) and analysed at the laboratories of STL for a similar suite of elements and compounds as the soils. Copies of the groundwater test results have been included in Appendix J.

It should be noted that water samples were obtained from the boreholes that contained sufficient water for sampling. The majority of the standpipes were found to be dry during sampling visits.

Most of the results were below the laboratory detection limits. A summary of all the results from the three sampling rounds have been summarised and presented in Appendix O.

The results have been compared to the freshwater Environmental Quality Standard (EQS) in order to assess the potential risk to river quality, and the UK Drinking Water Standard (UKDWS) in order to assess the potential risk to groundwater quality. The freshwater EQS has been based on a hardness of receiving waters of >100-150mg/l calcium carbonate, according to available data for the River Taff in the Merthyr Tydfil area.

8.4 GROUNDWATER CONTAMINATION (CONTINUED)

The results of samples of the perched water indicate slightly elevated concentrations of zinc, sulphate, several PAH compounds, and the aromatic TPH range C16-C44. Of these results, zinc exceeds only the freshwater EQS, sulphate exceeds both the EQS and UKDWS values, and PAH and TPH exceed only the UKDWS values.

The results show that these elevated concentrations were only detected in the first round of samples and not the second or third rounds. This indicates a declining trend.

The results of the deep groundwater indicate elevated concentrations of cadmium, zinc, and the 'heavy end' TPH ranges C16-C44 Aliphatic and C16-C44 Aromatic. Cadmium was detected in two of the three rounds of monitoring at concentrations that marginally exceed both the EQS and the UKDWS. Zinc was detected in all three rounds of testing at concentrations that exceed the EQS but not the UKDWS. The detected concentrations of TPH C16-C44 Aliphatic and TPH C16-C44 Aromatic increased between the first and third rounds of testing. No TPH was detected in the second round of sampling. The concentrations of both the detected aliphatic and aromatic TPH bands typically exceeded both the EQS and UKDWS values.

The source of the minor contamination levels detected in the deep groundwater is not readily identifiable, as no visual or olfactory evidence of hydrocarbon contamination was observed in the trial pits or boreholes. Significantly elevated concentrations of TPH have not been identified within the colliery spoil (made ground) or within the shallow perched water, and hence it is not considered that there is a potential on site TPH source giving rise to leachate or downward migration into the deep groundwater. It is therefore considered that the TPH contamination identified in the deep groundwater is being transported beneath the site from an off site source, or the TPH has been detected from a minor source adjacent to the borehole.

8.5 GROUND GASES

Ground gas was monitored on a fortnightly basis using a GA 2000 Gas Analyser. The results of the gas monitoring programme are included in Appendix M. A summary of the results is given in Table 8 below.

Table 8: Summary of Ground Gas Results				
Borehole	Maximum Methane Concentration (%)	Maximum Carbon Dioxide Concentration (%)	Minimum Oxygen Concentration (%)	Gas Flow Rate (l/hr)
BH1	0.0	3.1	17.4	0.0
BH2	0.1	1.2	18.8	0.0
BH3	0.0	0.3	19.6	0.0
BH4	0.0	0.7	18.8	0.1
BH5*	0.0	4.2	13.1	0.0
BH6	0.2	1.0	19.1	0.0
R3	0.0	1.3	18.1	0.0
R4	0.1	1.0	18.9	0.0
R14	3.1	0.8	15.2	0.0

The results show a maximum methane concentration of 3.1% and a maximum carbon dioxide concentration of 4.2%. A maximum gas flow rate of 0.0l/hr was measured during the gas monitoring programme.

It should be noted that the gas monitoring standpipe installed in BH5 was damaged by a third party after our initial gas monitoring visit.

9.0 REVISED CONCEPTUAL SITE MODEL

The preliminary conceptual site model/conceptual exposure model has been reviewed and revised to reflect the findings of the site investigation and the results of the laboratory testing of soils, soil leachate, groundwater and gas monitoring. Any previously identified in-active pathways have been removed. Pathways identified as still active require appropriate risk assessment or mitigation measures (see Section 10).

A diagrammatic conceptual site model is provided in Figure 5.

Table 9: Revised Conceptual Site Model/Conceptual Exposure Model

Source	Pathway	Receptor	Potential Active Pathway?	Justification/Mitigation
Potentially contaminated made ground as a result of former site uses including infilling with colliery spoil derived from coal and ironstone mining.	Dermal Contact Direct Ingestion Inhalation of Vapours	Future site residents/users	✓	Statistically elevated concentrations of nickel in made ground deposits which exceed the published SGV value. Site specific risk assessment to be undertaken using RBCA software to assess the risks posed to site end users.
	Leachate Migration via perched water or along permeable service trenches	Groundwater/neighbouring land	✓	Elevated concentrations of a number of determinants including cadmium, zinc, benzo(a)pyrene, and TPH have been identified in the groundwater at elevated concentrations. Undertake detailed groundwater assessment using the Environment Agency P20 model.
	Leachate migration via alluvial groundwater	Nant Cwm Blacks (fed by a storm water drain located on site) and the River Taff to the southwest some 850m distant	✓	Elevated concentrations of a number of determinants including cadmium, zinc, benzo(a)pyrene, and TPH have been identified in the groundwater at elevated concentrations. Undertake detailed groundwater assessment using the Environment Agency P20 model.
	Dermal Contact Direct Ingestion Inhalation of Vapours	Ground Workers	✓	Elevated concentrations of nickel. Appropriate health and safety measures should be carried out including the adoption of appropriate PPE.
	Direct Contact	Building materials	✓	Potential contact with made ground. Risk assessment, particularly with regard to concrete classification.

Contamination from off-site sources	Surface water run-off, migration through made ground and/or services, then dermal contact, ingestion and/or inhalation	Future site residents/users	x	Residential housing identified to the north, east and west and open ground to the south. Low risk from off site contamination sources.
Ground Gas	Accumulation in enclosed spaces of future buildings on site, or migration to buildings off site, leading to asphyxiation, or risk of explosion	Future site residents/neighbouring residents	✓	Maximum carbon dioxide and methane concentrations of 4.2 and 3.1% monitored respectively. Risk assess.

10.0 RISK ASSESSMENT

10.1 METHODOLOGY

The risk of pollution, health effects or environmental harm occurring as a result of ground contamination is dependent upon three principal factors:

- The scale of the contamination sources;
- The presence of sensitive “receptors”, eg Humans: health of the general public, site occupiers, redevelopment workers. Environment: flora, fauna, etc;
- The existence of migration pathways by which contaminants can reach the sensitive receptors.

This section assesses each of these factors in order to evaluate the overall level of risk and potential harm to receptors. The receptor may be human, a water resource, an eco-system or construction materials. Pathways connecting a perceived hazard to a receptor are referred to as exposure pathways.

The sources of contamination and the links connecting the hazards to the sensitive receptors will represent the basis for the risk assessment.

10.2 SOURCE-PATHWAY-RECEPTOR MODEL

The preliminary conceptual site model was based on the findings of the desk study. This was later reviewed and refined according to the findings of the site investigation, allowing for the ground conditions encountered and the results of laboratory testing of soil and groundwater. Any pathways considered to be inactive were removed from the model and all remaining potentially active pathways require risk assessment.

The pathways shown as potentially active in the Revised Conceptual Site Model in Section 9.0 above have been assessed below.

10.3 HUMAN HEALTH RISK ASSESSMENT

10.3.1 Site in its Present Condition

The site does not pose any risks to casual visitors or trespassers. The site is largely covered by tarmacadam or concrete and is fenced off.

10.3 HUMAN HEALTH RISK ASSESSMENT (CONTINUED)

10.3.2 Future Site Users

The contamination test results and investigation observations show elevated concentration levels in the made ground (at shallow depth) of nickel across the site.

It is therefore considered necessary to remediate the site in order to protect end users from the elevated concentrations of nickel in the shallow made ground.

Since nickel is a metal element and is not volatile, the only potentially active pathway by which a future site resident could be exposed to the nickel contamination would be via dermal contact with, or direct ingestion of, contaminated made ground. Therefore, in order to break this potential exposure pathway it is recommended that a 600mm thick clean capping layer is placed in all gardens and landscaped areas.

In order to assess whether this capping layer would provide adequate protection, a detailed risk assessment has been carried out using the RBCA Toolkit for Chemical Releases.

Since all garden and landscaped areas are to be capped, the model has been run for a modified exposure frequency of 80 days per year. Although the 600mm thick clean cap is considered adequate to prevent exposure to the underlying made ground, an exposure frequency of 80 days per year has been assumed as a worst case to allow for potential exposure via activities such as gardening. The value of 80 days per year was calculated on the basis that someone digs to this depth (0.6m) on ten occasions every month during an eight month gardening season. In reality it is considered very unlikely that a gardener would dig to this depth on 80 occasions every year and that the majority of gardening activities would take place within the 600mm thick clean imported subsoil/topsoil capping layer.

The RBCA model input and output sheets, together with a summary table of the calculated site specific target levels (SSTLs) are presented in Appendix P.

The results of the RBCA risk assessment show calculated site specific target levels (SSTLs) for arsenic and nickel of 180mg/kg and 620mg/kg respectively. The detected concentrations of these elements within the shallow made ground across the site were well below these SSTL values and hence the potential risk to future site residents is considered to be low.

10.3 HUMAN HEALTH RISK ASSESSMENT (CONTINUED)

It should be noted that the clean imported subsoil and topsoil cap should will need to be sampled and tested and meet the requirements of the DEFRA/EA soil guideline values for a residential end use.

With future site development works involving the excavation and removal of the made ground, there would be a risk to workers from contaminants in the soils and also the groundwater if it is encountered. Appropriate measures are therefore recommended for works involving the made ground materials which are known to be present beneath the site.

All excavations should be regularly checked for safe atmospheres.

Normal good hygiene practices should be adequate to protect the health and safety of redevelopment workers, and should include:

- Minimum handling of materials;
- Washing of hands prior to all meal breaks, which should be taken in a designated clean area;
- The use of standard protective clothing such as boots and overalls and gloves, where considered relevant.

In dry weather, inhalation of dust and gases should be avoided preferably by the use of dust suppression techniques to minimize fugitive emissions and minimisation of exposed materials at any particular time.

Additionally, a system should be established by which any 'unusual' materials that may be encountered are reported rapidly to the site management, so that the appropriate action may be taken, following specialist advice if necessary. An unusual material may be identified on site by colour, odour or physical nature.

Reference should be made to the Health and Safety Executive document "Protection of Workers and the General Public during the development of contaminated land" for detailed guidance on these matters.

10.4 RISKS TO VEGETATION

The elevated concentrations of nickel in the shallow made ground materials, indicate the potential for adverse effects to vegetation. To ensure viable landscape areas by preventing upward migration of contaminants into the overlying soils any garden or landscaped areas, will require the provision of a minimum 600mm thick capping layer of clean, inert subsoil and topsoil materials. This is subject to the requirements for protection against potentially combustible soils and may need to be increased to 1000mm in certain parts of the site, refer to Section 10.7 for further details.

10.5 GROUNDWATER RISK ASSESSMENT

The results of the site investigation indicated that there is one deep water body within the mudstone bedrock present beneath the site, and shallow impersistent perched water pockets at the base of the made ground.

10.5.1 Shallow Perched Water

Our investigations suggest that the shallow perched water is not a continuous water body flowing beneath the site but is instead pockets of infiltrated water that are temporarily perched while they gradually percolate into the ground. This was demonstrated by fluctuations in shallow perched water level and the majority of boreholes being dry. The results of the testing of perched water samples indicated slightly elevated concentrations of zinc, sulphate, several PAH compounds and TPH C16-C44 aromatic within the first round of samples. None of these elements and compounds were detected in significantly elevated concentrations in excess of appropriate guideline values in the subsequent second and third rounds of testing.

10.5.2 Deep Groundwater

The results of testing of the deep groundwater do not show any potential vertical linkage between the perched water and the deep groundwater. The deep groundwater was shown to contain more elevated concentrations of TPH, which were not detected in the perched water. Similarly, the perched water contained some elevated concentrations of PAH which were not detected in the deep groundwater.

Therefore, since no potential contaminative source was identified in the made ground, and in light of the above, it is considered that the perched water does not pose a significant risk to groundwater quality and the River Taff.

10.5 GROUNDWATER RISK ASSESSMENT (CONTINUED)

The test results of samples of the deep groundwater were shown to contain elevated concentrations of cadmium, zinc and TPH bands C16-C44 Aliphatic and C16-C44 Aromatic above the appropriate guideline values. However, given that no potential contaminative source has been identified on site and the depth of the water body within the bedrock, it is considered that the groundwater contamination is flowing beneath the site from an off site source or caused by a very minor localised source adjacent to the borehole.

In order to assess the potential risk of these contaminants within the groundwater to groundwater quality and the River Taff we have undertaken a more detailed groundwater risk assessment using the Environment Agency R&D P20 model.

The model input parameters used in the model have been given and justified below in Table 10.

Table 10: P20 Parameter Summary		
Parameter	Value Used	Justification
Plume width in aquifer (m)	200m	Site width (worst case)
Plume thickness at source (m)	2.80m	Assumed full mixing throughout aquifer
Saturated aquifer thickness (m)	3.00m	Maximum known thickness
Bulk density of aquifer materials (g/cm ³)	2.4	Estimate of typical mudstone bulk density
Effective porosity of aquifer (Fraction)	0.3	Typical mudstone porosity varies from 5% to 30%. 30% taken as a worst case estimate
Hydraulic gradient	0.003	Calculated from groundwater contour plot
Hydraulic conductivity (m/day)	0.1	Typical mudstone conductivity varies from 0.1 to 0.001m/day. 0.1 taken as worst case
Distance to compliance point (m)	175	Distance from borehole R14 to down gradient site boundary. Groundwater contour plot demonstrates groundwater flow to be in south westerly direction.

The P20 model output sheets are presented in Appendix Q. A summary of the results is given below in Table 11.

10.5 GROUNDWATER RISK ASSESSMENT (CONTINUED)

Table 11: Summary of P20 Model Results			
Determinand	Maximum Measured Concentration	Tier 3 Groundwater Remedial Target	Remedial Target Achieved?
Cadmium (mg/l)	0.0064	0.0179	✓
Zinc (mg/l)	0.69	0.268	X
TPH >C16-C35 Aliphatic (ug/l)	291	7.65×10^{-17}	✓
TPH >C35-C44 Aliphatic (ug/l)	65	7.65×10^{-17}	✓
TPH >C16-C21 aromatic (ug/l)	13	7.65×10^{-17}	✓
TPH >C21-C35 Aromatic (ug/l)	117	7.65×10^{-17}	✓
TPH >C35-C44 Aromatic (ug/l)	36	7.65×10^{-17}	✓

The results indicate that the maximum detected concentrations of cadmium and the TPH ranges do not pose a risk to groundwater quality beyond the down hydraulic gradient site boundary.

The P20 model indicates that the maximum measured concentration of zinc exceeds the freshwater EQS remedial target at the site boundary.

However, since the River Taff is located a further 1000m beyond the site boundary, it is considered that the zinc contamination would further attenuate to acceptable limits when it reaches the River.

Therefore, the overall level of risk is considered to be low and no groundwater remedial measures are considered necessary. However, it is recommended that further rounds of groundwater monitoring for TPH concentrations is undertaken from borehole R14 to confirm that no significant contamination is present and a decreasing trend is maintained.

10.6 GROUND GAS RISK ASSESSMENT

The results of the gas monitoring programme indicated a maximum methane concentration of 3.1% and a maximum carbon dioxide concentration of 4.2%. No gas flow was detected from the boreholes during the gas monitoring programme.

In accordance with CIRIA Report C665 a Gas Screening Value (GSV) of 0.0l/hour has been calculated. This GSV corresponds to Traffic Light classification green for a typical low rise residential development, which does not require any special gas protective measures.

However, since the maximum methane concentration exceeds 1%, it is recommended that the site is upgraded to Traffic Light classification Amber 1.

10.6 GROUND GAS RISK ASSESSMENT (CONTINUED)

This will require a minimum provision of a gas resistant membrane and a ventilated sub-floor void. All joints and penetrations of the floor slab should be sealed. Reference should be made to BRE 414 'Protective Measures for Housing on Gas Contaminated Land', when producing structural details. Structural details should be submitted to Building Control and the Local Authority Environmental Health Department for approval prior to construction.

10.7 COMBUSTIBILITY

The results of calorific value testing of four soil samples indicate a range of calorific values of between 5.4MJ/kg and 7.6MJ/kg, with an average value of 6.5MJ/kg.

ICRCL Guidance Note 61/84 Second Edition, Notes on the Fire Hazards of Contaminated Land state that it is commonly agreed that there is an unacceptable risk of smouldering when the soil calorific value exceeds 7MJ/kg.

It is therefore considered that the results of the calorific value testing do indicate some elevated results.

The recommended remedial measures are to cap the potentially combustible materials with a non-combustible material. A 600mm thick cap has been recommended in all garden and landscaped areas in order to protect future site residents from contaminants within the made ground, however, this may need to be increased in certain locations.

It is recommended that grid sampling is carried out and the samples tested for calorific value. This will allow a more accurate assessment of the parts of the site where additional capping materials are required.

10.8 RISKS TO BUILDINGS AND MATERIALS DURABILITY

10.8.1 Concrete Classification

A summary of the laboratory chemical test results for chemicals which may adversely affect the durability of building materials is presented in Appendix N.

Evidence to date does not indicate any specifically aggressive conditions, but it would be reasonable to expect a degree of sulphate and acidic aggressiveness from the made ground.

10.8 RISKS TO BUILDINGS AND MATERIALS DURABILITY (CONTINUED)

In accordance with BRE Digest SD1:2005 and adopting the assessment procedure specified therein for brownfield sites, the laboratory chemical test results indicate a characteristic value (taking the mean of the two highest results) for water soluble sulphate of 190mg/l.

Using Table C2 of BRE Digest SD1:2005, this characteristic value corresponds to Design Sulphate Class DS-1.

The groundwater regime of the site has been assessed as 'mobile' and a characteristic pH value of 5.9 has been determined (adopting the mean of the lowest 20% of test results). The Design Sulphate Class has been modified to give a site ACEC class of AC-2z.

10.8.2 Water Services

Water pipes will need to be protected from contamination within the ground. In particular the presence of arsenic and nickel should be addressed when selecting pipe materials. Measures to protect the pipes will include clean backfill to trenches and possibly alternative material selection. Reference should be made to WRAS document 9-04-03. The final design and selection of the pipe and associated backfill should be agreed with the appropriate Regulator prior to installation.

10.9 SPOIL DISPOSAL

Under the Landfill Regulations (2002) all spoil materials should be classified if they require disposal to a landfill facility. To determine the appropriate type of landfill site, there will need to be a characterisation of the materials in relation to the Waste regulations.

The made ground materials are tentatively classified as stable non reactive hazardous waste but specialised testing will be required once earthworks design and volumes are known.

Basic Characterisation

For each waste intended to be landfilled, the following information will be required, either separately or as part of the Duty of Care waste transfer note, or Special Waste consignment note:

10.9 SPOIL DISPOSAL (CONTINUED)

- Source and origin
- Standard Industry Code (SIC), process producing waste
- Treatment applied or reason not considered necessary
- Composition (including Waste Acceptability Criteria (WAC) leaching tests hazardous and inert waste where necessary)
- Appearance
- European Waste Catalogue (EWC) Code
- Hazardous properties (if hazardous waste and applicable)
- Not a waste prohibited from landfill (i.e. not corrosive, flammable etc)
- The class of landfill that waste is suitable for (i.e. hazardous)
- Likely behaviour of the waste in the landfill
- Whether waste can be recycled

The basic characterisation is the responsibility of the waste producer. The waste contractor may undertake all or part of the process of basic characterisation – including the WAC analysis. It will still be the responsibility of the waste producer to ensure that the information is correct.

In the absence of any detailed assessment of the likely areas and types of soils that may be generated for disposal (based on the ground conditions, remediation proposals and soil materials encountered at the site) the following tentative classification is proposed, based on the made ground materials.

10.9 SPOIL DISPOSAL (CONTINUED)

Source and origin	Twynnyrodyn	
Standard Industry Code (SIC), process producing waste	45.11	
Stratigraphic horizon	Made Ground	Natural Ground
Treatment applied or reason not considered necessary	Segregation applied at point of excavation	Segregation applied at point of excavation
Composition (including WAC leaching tests for hazardous and inert waste where necessary)	Refer to Section 7.0	Refer to Section 7.0
Appearance (smell, colour, consistency and physical form)	Non odorous Brown/grey/dark grey Reasonably homogeneous Granular	Non odorous Grey/mottled orange brown Reasonably homogenous Granular/cohesive
European Waste Catalogue (EWC) Code	17.05 Soil (including excavated soil from contaminated sites), stones and dredging spoil	17.05 Soil (including excavated soil from contaminated sites), stones and dredging spoil
Not a waste prohibited from landfill (i.e. corrosive, flammable etc)	No	No
The class of landfill that waste is suitable for (i.e. hazardous)	Stable Non-reactive Hazardous Waste in Non-hazardous Landfill	Inert
Likely behaviour of the waste in the Landfill	Stable	Stable
Whether waste can be recycled	Yes	Yes

This preliminary classification will require more definitive assessment and confirmation when detailed designs are produced detailing the likely areas of waste disposal if required. Alternatively, at construction stage any materials identified by the developer as waste will require Waste Acceptance Criteria (WAC) testing and characterisation prior to pre-approval from the landfill operator and ahead of export to tip.

It is recommended that a sustainable development strategy is adopted which reduces to a practicable minimum the need for export of waste to a licensed tip.

In order to minimise disposal, the materials generated should be segregated and examined, with appropriate testing as necessary, to enable the materials to be sorted or treated into lower classifications, with the resultant benefit of potentially generating re-use rather than disposal.

10.10 UNCERTAINTIES

It is important to recognise that there may be areas of contamination within the site that have not been found or that contaminants may be present at concentrations above those that have been found. It is also important to recognise that contamination may be localised and that no investigation, however comprehensive, is capable of finding such occurrences, other than by chance.

The deep groundwater within the mudstone bedrock was not sufficiently penetrated in the 'up hydraulic gradient', northern, part of the site to allow groundwater samples to be obtained.

11.0 ASSESSMENT OF RISK FROM PAST SHALLOW MINeworkINGS

11.1 UNDERGROUND WORKINGS

As discussed in Section 7.2 the site is underlain by shallow coal seams, what are thought to be the Five Feet/Gellideg seam beneath the west half, the Lower Seven Feet seam and the Five Feet/Gellideg below the east half, and in addition to these seams, the Upper Seven Feet seam below the south-east edge of the site.

These seams are potentially thick enough to have been mined locally in the area, either from recorded or unrecorded workings.

The Coal Authority Mining Report state that there are recorded workings in two seams from shallow to 50m depth. There are also 10 recorded mine entries within, or within 20m of, the site boundary. There may also be unrecorded workings or mine entries.

The probeholes encountered evidence of workings within one third of the drilled holes within the Five Feet/Gellideg and Lower Seven Feet Seams, including some voids up to 2.5m thick. All of the holes that encountered workings were located in the east and south of the site.

Of the probeholes that encountered workings, several had insufficient rock cover above the workings to prevent any associated ground subsidence reaching the surface.

Traces of workings in the Lower Seven Feet seam were encountered close to outcrop e.g. R17 where there was only 2.3m rock cover above a 1.4m high void. Therefore workings may potentially be present in this seam anywhere between the outcrop and the eastern boundary of the site. Based on the drilling findings there is insufficient rock cover over the Lower Seven Feet seam (where this is present beneath the east part of the site) to prevent shallow mining-related ground subsidence from any associated workings migrating up to the site's surface. There may also be some additional risk (in the east half of the site) of ground subsidence from workings in the Five Feet/Gellideg seam and the Upper Seven Feet seam. In the west the Five Feet/Gellideg seam is generally less than 1m thick and the thickness of the overlying rock cover is either marginal or insufficient.

Therefore based on the drilling findings, there is considered to be a moderate risk of shallow mining-related ground subsidence occurring in the west half of the site, but a high risk in the east half, largely in the latter case, due to the underlying presence of the Lower Seven Feet seam, and potentially associated workings.

11.1 UNDERGROUND WORKINGS (CONTINUED)

Therefore drilling and grouting ground stabilisation measures and/or proof drilling and/or precautionary reinforced foundation/floor slab solutions would be required for any proposed houses over the site.

Initially, at the very least, a proof drilling programme would be required across the whole of the site. Drilling and grouting is likely to become required in the east half, wherever shallow workings are encountered.

11.2 MINE ENTRIES

The Coal Authority do not have any records of any treatment of the ten mine entries recorded within, or within 20m of, the site.

However, five of the ten mine entries recorded by the Coal Authority are shown on or outside the site boundary and four out of these five are levels which are shown trending away from the site. Therefore, it is unlikely that these mine entries would affect the site other than the presence of possible deeper made ground at the adit mouth and short lengths of roadways.

The five remaining mine entries within the site are (from north to south) referenced 306205-053, 021, 045, 034 and 031. All these entries are thought to be former levels. Access restrictions (due to the presence of footpaths, tracks, wooded areas or services in the vicinity of the recorded mine entry locations) prevented searches being carried out for all of these except for the entry referenced -021. Here traces of a brick lined structure, thought to be an old level, were encountered within exploratory excavations at 3.5m depth.

This evidence of an old level would suggest that reclamation of the site in the early 1980s did not necessarily include the treatment of the mine entries, and therefore potentially untreated adits may be present beneath the site surface.

Due to the presence of a 'corridor' of services down the east edge of the site, it is likely that this part of the site may not be developed due to easement restrictions.

However, if any of the mine entries (shown within or near to the site) are located in or near areas where development is proposed, then it is recommended that follow-up attempts should be made to physically locate them (as has successfully been done with entry -021) once access becomes available. The physical searches may need to be carried out by large scale excavations or with probeholes, or with a combination.

11.2 MINE ENTRIES (CONTINUED)

The entrances and any associated underground tunnels within the site boundaries should be treated by infilling and sealing, in order to minimise any future ground subsidence risks.

Infilling may be achieved either by excavation and controlled backfilling (where they are within excavatable depths) or by drilling and grouting methods (where they become deeper, or where access restrictions would make excavations difficult/impossible).

12.0 ENGINEERING CONSIDERATIONS AND RECOMMENDATIONS

Potential developers should note the course of the culverted water course and open storm water drains feeding to the culverted water course that passes beneath the site in an approximate north to south direction, see Figure 2. The investigation of the condition of this feature was beyond the scope of this commission.

The potential developer should satisfy themselves with regard to the condition and level of the culvert and any easement width which the statutory regulators may apply to this feature.

Furthermore, a number of underground services (including a pumping station, rising main and storm and foul sewers) run along/within the eastern boundary of the site, see Figure 2. Prior to developing the site, discussions should be commenced with Welsh Water and the accurate location(s) and easements of these services noted.

It may be such that development cannot be undertaken in close proximity to the services as they are likely to have considerable easements enforced upon them.

12.1 DETAILS OF PROPOSED DEVELOPMENT

Plans for the proposed development of the site are not yet available, but it is assumed that the development will incorporate residential housing with gardens and associated access roads and car parking.

12.2 SITE PREPARATION

Prior to commencing construction works, the additional proof drilling and remedial works recommended in Section 11.0 should be completed satisfactory.

Due to the sloping nature of the site it is recommended that the stripping of grass and topsoil is done in phases so as to avoid large quantities of the loose exposed soils present below the ground surface being exposed to weathering. If these materials are exposed to prolonged weathering, site surface formations are likely to deteriorate rapidly and silts and sands are likely to be carried by surface water flow across and off the site. It is recommended that once areas of the site have been stripped, measures are put in place to control surface water run off.

12.2 SITE PREPARATION (CONTINUED)

All topsoil should be stripped from engineering formations. All cut materials should be protected from weathering in sealed stockpiles prior to possible reuse. Any soft spots within prepared formations should be excavated and replaced with inert structural fill. Engineered fill should be of granular nature, rolled and compacted over benched formations, and placed in accordance with Department of Transport Specification for Highways Works.

A number of shallow soil samples have been tested for Particle Size Distribution and compaction tests using a 2.5kg rammer. The results of such analysis are included in Appendix.

The results indicate that the made ground deposits within 1.2m of the ground surface are predominantly granular in nature and may be suitable for re-use and compaction during the anticipated cutting and filling of the site.

In areas of cut and/or fill, the slopes should be topsoiled and seeded with grass in order to minimise any future maintenance problems caused by surface water run-offs.

As a further aid to stability, cut-off drains should be provided at the top and French drainage at the bottom of any cut and/or fill areas. If large sections of cut and/or fill are required, then it may also be prudent to provide a system of herringbone drainage on the slopes.

Following the site strip, the exposed surface of the site will deteriorate in poor weather and due to trafficking of plant. We therefore recommend that to protect this surface from damage in wet weather, and provide a suitable working platform for construction plant, the site should be surfaced with a 300mm thick layer of single size granular material (particularly in highly trafficked areas).

The combined groundwater/gas monitoring wells installed during these works should be protected if further gas monitoring rounds, or groundwater monitoring and sampling is required.

A number of buried services are present running through the site (particularly along the sites eastern boundary and along the site central area) and these will need to be either protected or diverted prior to site works commencing. It is therefore essential that consultation is undertaken with the statutory authorities prior to undertaking any works within their vicinity.

12.2 SITE PREPARATION (CONTINUED)

Allowances should be made for encountering and dealing with possible existing land drains and/or springs. Surface water culverts are known to dissect the site at various locations.

There are mature trees/hedges within and around the site. Allowances should therefore be made for the removal of any associated roots that may become exposed in the proposed earthworks. Any such works should be conducted in accordance with the code of practice recommended by the National House Building Council (NHBC).

12.3 FOUNDATIONS AND FLOOR SLABS

The following recommendations are made on the assumption that the underground mine workings and adits will be stabilised following the recommended works detailed in Section 11.0 of this report.

Additionally the following recommendations assume that the site will be developed with two to three storey detached, semi-detached and/or terraced residential properties. If heavier structures, for example apartment blocks, are planned, a further review of the foundation recommendations given below will be required.

Due to the variable thickness (from 1m to 14m), nature, composition and density of the underlying made ground material the use of conventional shallow foundations is not considered feasible, as such foundations would be subject to unacceptable levels of settlements and distortion.

Consideration has been given to the use of pile type foundations utilising reinforced concrete ground beams. In order to successfully construct the required piles it would be necessary to found end bearing piles, socketed within bedrock at levels below any stabilised/grouted mine workings. Due to this requirement it is considered that the use of piled foundations would not be cost effective across the majority of the site. Additionally, if this approach was adopted, further rotary proof drilling would be required to determine the exact depths to the next worked seam below the grouted seam. These works would be required to ensure that sufficient rock head cover was in place to support the pile. It is considered probable that pile lengths may extend to depths in excess of 40m at some locations, with piles to be formed by boring techniques.

12.3 FOUNDATIONS AND FLOOR SLABS (CONTINUED)

However, if properties are planned over or in close proximity to the culverted water course and/or the services maintained by Welsh Water running along/within the eastern boundary of the site, piled foundations may be required in order that the planned structures do not surcharge the culvert/Welsh Water services and would not be effected by maintenance excavations to the culvert under easement rights.

Properties may be founded on made ground subject to adequate vibro stabilisation. The properties should utilise reinforced concrete ground beams or reinforced concrete rafts bearing over the vibro stabilisation stone columns.

The vibro stabilised ground should be capable of supporting a safe working load in the range of 50-100kN/m². It is anticipated that the maximum of depth of vibro stabilisation required would be in the region of 8 to 10m.

Vibro stone columns will require to be sealed at the surface in the temporary condition prior to construction of the foundations to ensure rainwater migration down the stone column does not compromise column and surrounding soil integrity. Additionally it should be noted that the top 600mm of the vibro stone columns are likely to be sacrificial.

If the ground surface has become over compacted it may be necessary to loose the near surface soils prior to the vibro stabilisation works.

The advice of a specialist vibro stabilisation contractor should be sought with regard to the detailed design of the vibro stabilisation works, particularly with regard to the potential for self weight settlement of the made ground materials in relation to vibro columns (although the risk of this occurring when considering the time elapsed since the reclamation works in the 1980s is considered low).

Allowances should be made for a period of suitable physical testing of the vibro stabilised formations.

Consideration may also been given in certain areas to the use of raft foundations bearing onto re-engineered made ground subject to the provisions made later in this section.. In order to achieve a suitable formation for raft foundations, it will be necessary to excavate the top 2m of existing made ground below the underside of the raft. The excavated made ground spoil will require screening, possible crushing, and stored in sealed stockpiles. The reduced level formation will require proof rolling prior to replacement of the processed made ground spoil in controlled and compacted layers in accordance with Department of Transport (DTp) Specification for Highway Works.

12.3 FOUNDATIONS AND FLOOR SLABS (CONTINUED)

However, this foundation solution is inappropriate in areas of the site where made ground thicknesses are known, or are believed to vary significantly, underlying the proposed plots. If this foundation solution is proposed to be adopted for areas of the site, fill thicknesses would be required to be more accurately proven on a plot by plot basis as there are no available accurate surveys of the base of the fill. Therefore, it would be necessary to carry out further proof drilling in area of deeper made ground and trial pitting in areas of shallower made ground to confirm fill depths. It is assumed that the majority of these areas would be in the central spine of the site trending in a north to south orientation, over the deeper made ground.

12.4 EXCAVATIONS AND FORMATIONS

All excavations should be possible with normal soil excavating machinery. Allowances should be made for the use of pneumatic breaker attachments, or similar tools, should any buried obstructions be encountered.

Excavations to depths of typically 2m are unlikely to encounter significant groundwater inflows. Any groundwater inflows/seepages are likely to be slight, and these, together with any rainfall infiltrations, should be dealt with by conventional pumping techniques.

The sides of excavations deeper than 1m should be fully supported by planking and strutting, or temporarily battered at gradients of typically 30°.

As discussed above in Section 12.2, the exposed formations are likely to be prone to deterioration as a result of prolonged exposure to weathering. Due to the sloping nature of the site it is recommended that measures are put into place to control surface water run off and deterioration of the exposed formations.

12.5 ACCESS ROADS AND CAR PARKING AREAS

For access roads and car parking formations within the made ground, a California Bearing Ratio value of approximately 1-3% could be assumed for conceptual design purposes. Consideration should be given to engineering the made ground underlying the highway to achieve a CBR value of greater than 5%.

It will be important to maintain this performance and hence it is recommended that in-situ testing is carried out on the prepared formation.

12.5 ACCESS ROADS AND CAR PARKING AREAS (CONTINUED)

All formations should be well proof rolled and inspected for 'soft spots/areas'. Allowances should be made for the removal of any 'soft spots/areas', and their subsequent replacement with well compacted imported granular fill materials. All formations should be inspected for any obstructions that may create 'hardspots'.

APPENDIX A

CONTAMINATED LAND DEFINITIONS

Box 1: Contamination and contaminated land in a planning context

Annex 2 of Planning Policy Statement 23 (3) states that:

To avoid confusion with the statutory term "contaminated land" and its definition [i.e. in Part IIA of the Environmental Protection Act 1990] and to reflect the different context of planning control, this Annex uses the wider term "land affected by contamination". This is intended to cover all cases where the actual or suspected presence of substances in, on or under the land may cause risks to people, property human activities, or the environment, regardless of whether or not the land meets the statutory definition in Part IIA.

Annex 2 also states:

Potentially hazardous substances, such as radon, methane or elevated concentrations of metallic elements may also be present in the ground due to the underlying geology. Since these may pose a risk to human health or to the environment, their presence is a material consideration.

Box 2: The Building Regulations – Approved Document C(4)

Contamination is dealt with in requirement C1 which concerns 'Preparation of site and resistance to moisture'.

C1(1) requires that:

The ground to be covered by the building shall be reasonably free from any material that might damage the building or affect its stability, including vegetable matter, top-soil and pre-existing foundations.

C1(2) requires that:

Reasonable precautions shall be taken to avoid danger to health and safety caused by contaminants on or in the ground covered, or to be covered by the building and any land associated with the building.

C1(3) requires that:

Adequate sub-soil drainage shall be provided if it is needed to avoid –

- (a) the passage of ground moisture to the interior of the building;
- (b) damage to be building, including damage through the transport of water-borne contamination to the foundations of the building.

Contaminant is defined as (C1(4)):

Any substance which is or may become harmful to persons or buildings, including substances which corrosive, explosive, flammable or radioactive or toxic.

The "building and land associated with the building" means:

The building and all land forming the site subject to building operations which includes land under the building and the land around it which may have an effect on the building or its users.

Requirement C1(2) applies to new construction and under Regulation 6, whenever there is a "material change of use" of the whole building. "Material change of use" is defined in Regulation 5.

APPENDIX B

COAL AUTHORITY MINING REPORT

Issued by:

The Coal Authority, Mining Reports Office, 200 Lichfield Lane, Berry Hill, Mansfield, Nottinghamshire NG18 4RG
On-Line Service: www.coalminingreports.co.uk - Phone: 0845 762 6848 - DX 716176 MANSFIELD 5

OFFICE MANAGER,
INTEGRAL GEOTECHNIQUE (WALES) LTD.,
50 CATHEDRAL ROAD,
CARDIFF,
SOUTH GLAMORGAN,
CF11 9LL

Person dealing with this matter:

Paul Heap

Our reference:

00050390-07

Your reference:

9913 AF

Electronic Ref:

RRUID:

007.00017960000001

Date of your enquiry:

16 May 2007

Date we received your enquiry:

16 May 2007

Date of issue:

21 May 2007

This report is for the property described in the address below and the attached plan.

Coal and Brine Report

Site At, Twynyrodyn, Moutain Hare, Merthyr Tydhil, Mid Glamorgan

This report is based on and limited to the records held by, the Coal Authority, and the Cheshire Brine Subsidence Compensation Board's records, at the time we answer the search.

Coal mining	Yes
Brine extraction	No

Information from the Coal Authority

Underground Coal Mining

Past

The property is in the likely zone of influence from workings in 2 seams of coal at shallow to 50m depth, and last worked in 1917.

The property is in the likely zone of influence from workings in 1 seam of ironstone at 80m depth, and last worked in 1860.

Present

The property is not in the likely zone of influence of any present underground coal workings.

Future

The property is not in an area for which the Coal Authority is determining whether to grant a licence to remove coal using underground methods.

The property is not in an area for which a licence has been granted to remove coal using underground methods.

The property is not in an area that is likely to be affected at the surface from any planned future workings.

However reserves of coal exist in the local area which could be worked at some time in the future.

No notice of the risk of the land being affected by subsidence has been given under section 46 of the Coal Mining Subsidence Act 1991.

Mine entries

Within, or within 20 metres of, the boundary of the property there are 10 mine entries, the approximate positions of which are shown on the attached plan.

Coal Authority records disclose the following information:

306205-005. No treatment details.

305205-031. No treatment details.

305205-021. No treatment details.

306205-045. No treatment details.

306205-034. No treatment details.

306205-003. The position of this mine entry was investigated by Rutter Johnson Partnership in January 2000. No evidence of its presence at this location could be found. .

305205-053. No treatment details.

306205-035. No treatment details.

306205-057. No treatment details.

305205-020. No treatment details.

Records may be incomplete. Consequently, there may exist in the local area mine entries of which the Coal Authority has no knowledge.

Coal-mining geology

At the surface, there are no known faults or other lines of weakness due to coal mining that have made the property unstable.

Opencast Coal Mining

Past

The property is not within the boundary of an opencast site from which coal has been removed by opencast methods.

Present

The property does not lie within 200 metres of the boundary of an opencast site from which coal is being removed by opencast methods.

Future

The property is not within 800 metres of the boundary of an opencast site for which the Coal Authority is determining whether to grant a licence to remove coal by opencast methods.

The property is within 800 metres of the boundary of the FFOS-Y-FRAN opencast site for which a licence to remove coal by opencast methods was granted in October 1994. The grant of this licence is conditional on the applicant securing any other rights, permissions (including planning permissions) and consents to enable operations to be carried out.

Coal-mining subsidence

The Coal Authority has not received a damage notice or claim for the property since 1 January 1984. There is no current Stop Notice delaying the start of remedial works or repairs to the property.

The Coal Authority has not received a request to carry out preventive work before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

Mine gas

There is no record of a mine gas emission requiring action by the Coal Authority within the boundary of the property.

Hazards related to coal mining

The property has not been subject to remedial works, by or on behalf of the Authority, following the reporting of an alleged coal mining related hazard under its Emergency Surface Hazard Call Out procedures.

Withdrawal of Support

The property is not in an area for which a notice of entitlement to withdraw support has been published.

The property is not in an area for which a notice has been given under section 41 of the Coal Industry Act 1994, revoking the entitlement to withdraw support.

Working Facilities Orders

The property is not in an area for which an Order has been made under the provisions of the Mines (Working Facilities and Support) Acts 1923 and 1966 or any statutory modification or amendment thereof.

Payments to Owners of Former Copyhold Land

The property is not in an area for which a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

Comments on Coal Authority information

Where development proposals are being considered, technical advice should be obtained before beginning work on site. All proposals should apply good engineering practice developed for mining areas. No development should be undertaken that intersects, disturbs or interferes with any coal or mines of coal without the permission of the Coal Authority.

A site investigation was carried out in 2000 by Rutter, Johnson Partnership Vale Industrial Estate, Star Lane Howich, Bolton BL6 5HR.

Information from the Cheshire Brine Subsidence Compensation Board

The property lies outside the Cheshire Brine Compensation District.

Additional remarks

This report is prepared in accordance with the Law Society's Guidance Notes 2006, the User Guide 2006 and the Coal Authority and Cheshire Brine Board's Terms and Conditions 2006. The report is compliant with Home Information Pack requirements.

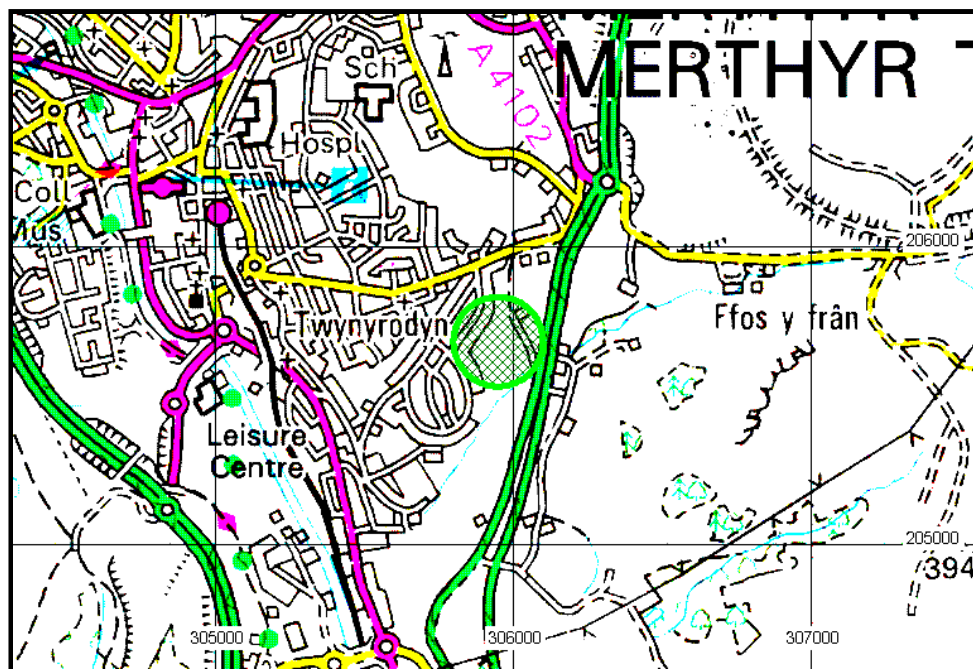
The Coal Authority owns the copyright in this report. The information we have used to write this report is protected by our database right. All rights are reserved and unauthorised use is prohibited. If we provide a report for you, this does not mean that copyright and any other rights will pass to you. However, you can use the report for your own purposes.

Ordnance Survey (OS) has carried out a Positional Accuracy Improvement Programme to make sure that the maps it produces are accurate. We have no control over who is using the improved information. In some cases, the position of surface features and mining features on the map may change because of this programme. We will update our database in line with Ordnance Survey's improved maps. However, at the moment we are producing mining reports using Ordnance Survey's maps from before the improvement programme.

Location map



Approximate
position
of property



Enquiry boundary

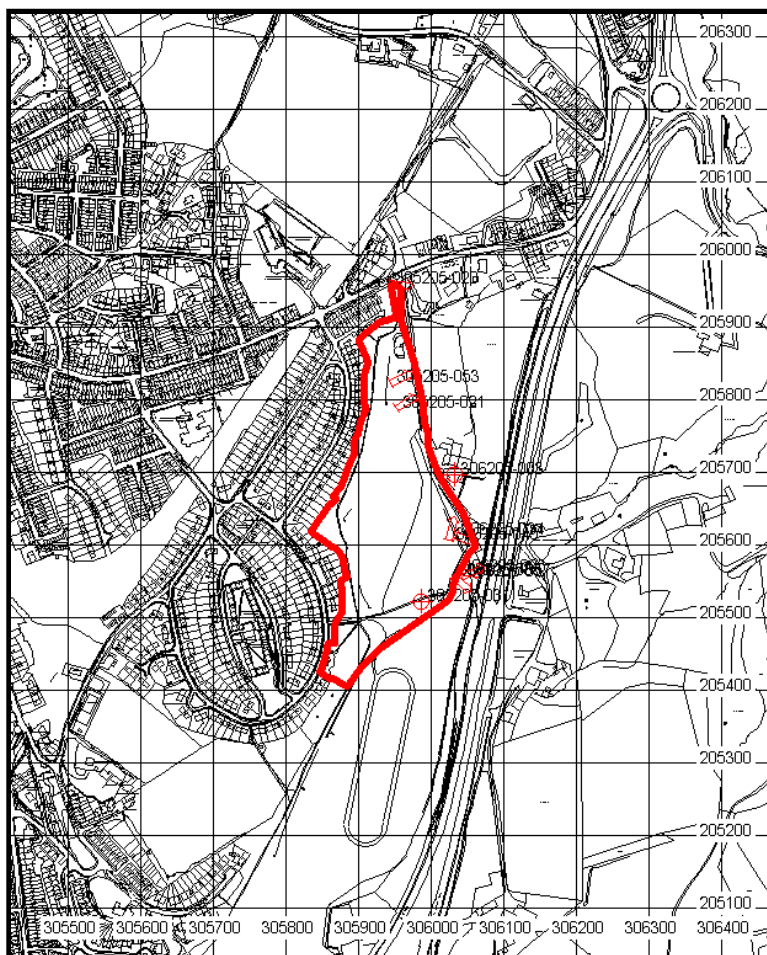
These maps are reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. The Coal Authority. Licence number: 100020315. [2006]

Key

Approximate position of enquiry boundary shown



Disused Adit or Mineshaft



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APPENDIX C

MINE ENTRY DATA SHEETS

INTEGRAL GEOTECHNIQUE (WALES) LTD,
INTEGRAL GEOTECHNIQUE (WALES) LTD.,
50 CATHEDRAL ROAD,
CARDIFF,
SOUTH GLAMORGAN,
CF11 9LL

This matter is being dealt with by Paul Heap

Our Ref: **00025028-08**

Your Ref: 9913/GNS/KEF

RRUID: 007.00022342060001

Date: 02 April 2008

Dear Sir,

Coal Mining Report
LAND AT, TWYNYRODYN, MOUNTAIN HARE, MERTHYR TYDFIL

I refer to your enquiry dated 2 April 2008, received 2 April 2008, in connection with the above.

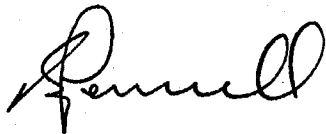
This report relates to the address given above and the location plan where supplied.

As requested I enclose the mine entry data sheet(s) held for the shaft(s) referred to.

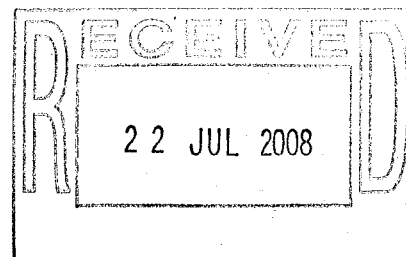
Ordnance Survey (O.S.) is undertaking a Positional Accuracy Improvement Programme of its mapping data. The Coal Authority (CA) has no control over the timing of issue of Positionally Improved mapping data by O.S. or over users of that data. In some instances the relative position between surface features and coal mining features may alter as a consequence of this programme. The CA has taken steps to ensure that the integrity of its database is maintained by replotting certain mining information to ensure that the relationship between that mining information and the improved O.S. surface positions is accurate.

We acknowledge receipt of your remittance in payment of our fee.

Yours faithfully



Stephen Pennell
Director of Mining Information and Services



Mine Entry Data

Shaft/Adit: Adit

Mine Entry Reference: 306205-034

Source: Ab plans SWR3152 SWR3187 Other: Source Plan 33X (Pigeon hole in Ystrad Fawr Plan Room) 55N 61F

Colliery Name: Unknown

Entry Name: No 2 Trebeddau Level

Date Abandoned: N/A

Depth of Superficial Deposits (m): Unknown

Depth of Shaft (m): Unknown

Diameter of Shaft (m): Unknown

Probable Adit Azimuth: 110

Treatment Details: None

Conveyance: N/A

Other Information: N

Mine Entry Data (Continued)

Shaft/Adit:	Shaft
Mine Entry Reference:	305205-031
Source:	1/2500 O.S Sheet Glam 12:6 1920 Ed
Colliery Name:	Unknown
Entry Name:	
Date Abandoned:	N/A
Depth of Superficial Deposits (m):	Unknown
Depth of Shaft (m):	Unknown
Diameter of Shaft (m):	Unknown
Probable Adit Azimuth:	0
Treatment Details:	None
Conveyance:	N/A
Other Information:	N

Mine Entry Data (Continued)

Shaft/Adit:	Adit
Mine Entry Reference:	306205-005
Source:	1/2500 O.S Sheet Glam 12:6 1920 Ed Ab plans SW221 SWR3152 SWR3187 Geological Sheet Glam 12:NW 1920 Ed
Colliery Name:	Unknown
Entry Name:	No.1 Trebeddau Level
Date Abandoned:	N/A
Depth of Superficial Deposits (m):	Unknown
Depth of Shaft (m):	Unknown
Diameter of Shaft (m):	Unknown
Probable Adit Azimuth:	96
Treatment Details:	None
Conveyance:	N/A
Other Information:	N

Mine Entry Data (Continued)

Shaft/Adit:	Adit
Mine Entry Reference:	306205-035
Source:	Ab plans SWR3152 SWR3187 Geological Sheet Glam 12: NW 1920 Ed - Site of Other: Source Plan 33X (Pigeon hole in Ystrad Fawr Plan Room) 48Q 55N 61F
Colliery Name:	Unknown
Entry Name:	No 3 Trebeddau Level
Date Abandoned:	N/A
Depth of Superficial Deposits (m):	Unknown
Depth of Shaft (m):	Unknown
Diameter of Shaft (m):	Unknown
Probable Adit Azimuth:	129
Treatment Details:	None
Conveyance:	N/A
Other Information:	N

Mine Entry Data (Continued)

Shaft/Adit:	Adit
Mine Entry Reference:	305205-020
Source:	1/2500 O.S Sheet Glam 12:5 1870 1900 1920 Ed and SO0505 N.G Ed Ab plans 6767 6768A 8194 SWR2510 SWR3152 SWR2985 SWR3111 SWR3131 Geological Sheet Glam 12:NW
Colliery Name:	Unknown
Entry Name:	Penrheol Level
Date Abandoned:	N/A
Depth of Superficial Deposits (m):	Unknown
Depth of Shaft (m):	Unknown
Diameter of Shaft (m):	Unknown
Probable Adit Azimuth:	94
Treatment Details:	None
Conveyance:	N/A
Other Information:	None

Mine Entry Data (Continued)

Shaft/Adit:	Adit
Mine Entry Reference:	306205-045
Source:	Ab plan SWR3192
Colliery Name:	Unknown
Entry Name:	
Date Abandoned:	N/A
Depth of Superficial Deposits (m):	Unknown
Depth of Shaft (m):	Unknown
Diameter of Shaft (m):	Unknown
Probable Adit Azimuth:	14
Treatment Details:	None
Conveyance:	N/A
Other Information:	N

Mine Entry Data (Continued)

Shaft/Adit:	Shaft
Mine Entry Reference:	306205-003
Source:	1/2500 O.S Sheet Glam 12:6 1870 1920 Ed Ab plans 5196 6702 SW221 SW323 SWR3152 SWR3192
Colliery Name:	Unknown
Entry Name:	Trebeddau No 1
Date Abandoned:	N/A
Depth of Superficial Deposits (m):	Unknown
Depth of Shaft (m):	Unknown
Diameter of Shaft (m):	Unknown
Probable Adit Azimuth:	0
Treatment Details:	The position of this mine entry was investigated by Rutter Johnson Partnership in January 2000. No evidence of its presence at this location could be found.
Conveyance:	N/A
Other Information:	Y

Mine Entry Data (Continued)

Shaft/Adit:	Adit
Mine Entry Reference:	305205-021
Source:	1/2500 O.S Sheet Glam 12:5 1900 Ed
Colliery Name:	Unknown
Entry Name:	
Date Abandoned:	N/A
Depth of Superficial Deposits (m):	Unknown
Depth of Shaft (m):	Unknown
Diameter of Shaft (m):	Unknown
Probable Adit Azimuth:	58
Treatment Details:	None
Conveyance:	N/A
Other Information:	None

Mine Entry Data (Continued)

Shaft/Adit:	Adit
Mine Entry Reference:	305205-053
Source:	Ab plans 5196 SWR3152 Other: Source Plan 33X (Pigeon hole in Ystrad Fawr Plan Room)
Colliery Name:	Unknown
Entry Name:	Simons Level
Date Abandoned:	N/A
Depth of Superficial Deposits (m):	Unknown
Depth of Shaft (m):	Unknown
Diameter of Shaft (m):	Unknown
Probable Adit Azimuth:	66
Treatment Details:	None
Conveyance:	N/A
Other Information:	None

Mine Entry Data (Continued)

Shaft/Adit:	Adit
Mine Entry Reference:	306205-057
Source:	Ab plan SWR3152
Colliery Name:	Unknown
Entry Name:	
Date Abandoned:	N/A
Depth of Superficial Deposits (m):	Unknown
Depth of Shaft (m):	Unknown
Diameter of Shaft (m):	Unknown
Probable Adit Azimuth:	65
Treatment Details:	None
Conveyance:	N/A
Other Information:	N

GENERAL CONDITIONS OF CONTRACT FOR THE SUPPLY OF MINING INFORMATION

1. In the General Conditions, the Coal Authority is referred to as the CA and the Company, firm or person to whom the information and/or material is to be supplied is referred to as the Purchaser. The supply of any information and/or material by the CA to the Purchaser shall be subject to these General Conditions of Contract.

2. The following should be taken into account by the Purchaser when making use of any information and/or material supplied.

(1) The information supplied is constantly updated. The CA will supply the Purchaser with the most up to date information and/or material at the time of supply, but give no warranty or representation that such information and/or material will not become obsolete or incorrect over any period of time.

(2) Information supplied should not be enlarged to any greater scale than that at which it is supplied or accuracy will be affected.

3. The information and/or material supplied is composed from data based in many cases on measurements and records of various standards of reliability and age. Under no circumstances should the information and/or material be relied on as the sole or major basis for any production, construction or financial decisions. The CA make no financial decisions. The CA make no representations and do not warrant the accuracy or completeness of the information and/or material.

4.(1) Subject to sub-clause 3 of this Condition, the CA shall indemnify the Purchaser against all and any claims for loss or damage suffered or expense incurred arising out of death or personal injury to any person to the extent that such death or injury results from negligence in the supply of the information and/or material by the CA or its employees.

(2) Save as set out in the sub-clause 1 of this Condition, the CA's liability to the purchaser for the loss or damage suffered or expenses incurred to persons and property arising directly or indirectly from the supply of the information and/or material by the CA and/or its interpretation by the Purchaser or any third party shall be limited to a sum equal to the total sum payable by the Purchaser to the CA for the supply of information and/or material; but there shall be no liability whatsoever on the CA (save as set out in sub-clause 1) where the information and/or material is supplied free of charge.

(3) In any event, the CA shall not be liable for any indirect economic loss (including, but not limited to, loss of profits, loss of value, loss of contracts, loss of production or wastage of labour) arising directly or indirectly out of the supply of the information and/or material and/or its use or interpretation by the Purchaser or any third party.

(4) The Purchaser shall fully indemnify the CA and its employees against all and any claims for loss or damage suffered or expense incurred save for death or personal injury resulting from the CA's negligence (but including any indirect or consequential loss or damage to CA property) arising directly or indirectly from the supply of the information and/or material by the CA and/or its use or interpretation by the Purchaser or any third party.

(5) The Purchaser shall insure his liabilities under this Condition with an insurer acceptable to the CA and shall, if required by the CA, produce satisfactory evidence that such a policy of insurance has been affected and maintained in full.

5.(1) Copyright in any information supplied remains with the CA and the Purchaser shall only use the information and/or material for the purpose of the assignment to which their request for information and/or material relates.

(2) All information and/or material and any interpretation thereof shall be kept strictly confidential and shall not be supplied to any third party (or any employee or member or officer of the Purchaser not directly employed by the Purchaser in the assignment to which the request for information and/or material relates) without the written consent of the CA. Any Consent shall be on such conditions as the CA thinks fit.

(3) The information and/or material or any interpretation thereof shall not be published by the Purchaser (or any employee not directly employed by the Purchaser in the assignment to which the request for information relates) either independently or as part of any other document without the prior written consent of the CA. Any consent shall be on such conditions as the CA thinks fit.

(4) The Purchaser shall maintain such security as is necessary to ensure that it complies with its obligations under this Condition and that the information and/or material and any interpretation thereof remains secure and is not obtained by any person not directly employed by the Purchaser in the assignment to which their request for information relates, without the Purchaser's knowledge.

6. Unless payment is made in advance, the CA shall issue an invoice to the Purchaser on supply of the information and/or material and payment shall be made by the Purchaser to:

Finance Department, The Coal Authority, 200 Lichfield Lane
Berry Hill, Mansfield, Notts, NG18 4RG

within 30 days from the date of the invoice. Any sums outstanding after 30 days shall bear interest, at the rate of 5% per annum above the Lloyds TSB Bank PLC base, from the date of the invoice to the date of actual payment. In the event that payment is not made within 30 days from the date of invoice, the CA shall have the absolute right to require the return of the information and/or material forthwith by written notice.

7. Copies of any results from tests on materials, or based on information, supplied by the CA will be made available to the CA free of charge.

8. The Purchaser shall ensure that these General Conditions (and in particular Conditions 2, 3 and 5) are brought to the attention of any of its employees using the information and/or material and any other person to whom the information and/or material is disclosed with the consent of the CA.

Our Ref: 00025028-08

Your Ref: 9913/GNS/KEF

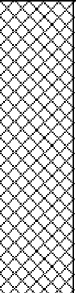
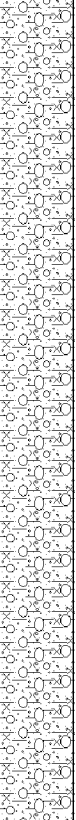
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Date: 17 July 2008

APPENDIX D

TRIAL PIT/TRENCH LOGS

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com		Project Name : Twynyrodyn		Project No.: 9913		Trial Pit No.: TP2 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil		Client : Merthyr Tydfil County Borough Council		Logged By : GNS		Scale : 1:30	
Equipment : Case CX130		Coordinates : -		Dimensions Depth : 4.60m 0.70m 2.50m			
Date Excavated : 23/04/2008		Level : -					
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.50	D					Grass onto dark grey, brown and black slightly clayey slightly sandy gravel with occasional to frequent angular and tabular cobbles of mudstone, siltstone and rarely sandstone. Gravel is fine, medium and coarse angular mudstone, sandstone, coal and rare brick, with plastic carrier bag (MADE GROUND).	0
2.50	D		2.20			Firm to stiff dark grey mottled light brown and yellow brown slightly silty slightly gravelly clay with rare cobbles of angular mudstone and sandstone. Gravel is fine, medium and coarse angular mudstone, sandstone and rare coal, ceramic and brick (MADE GROUND).	1
			4.10			Stiff grey, yellow brown and brown slightly sandy slightly gravelly CLAY with occasional cobbles and rare boulders (0.3 x 0.4m) of sandstone. Gravel is fine, medium and coarse rounded and subrounded sandstone and siltstone.	2
			4.60			Trial Pit Complete at 4.60 m	
							3
							4
							5
							6
Remarks: 1. Trial pit sides stable in the short term.		Groundwater : Minor water seepage at 4.1m depth.		Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			
		Stability :					

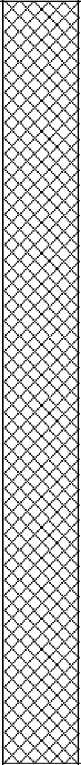
 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com			Project Name : Twynyrodyn			Project No.: 9913		Trial Pit No.: TP4 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil			Client : Merthyr Tydfil County Borough Council			Logged By : GNS		Scale : 1:30	
Equipment : Case CX130			Coordinates : -			Dimensions 3.00m			
Date Excavated : 23/04/2008			Level : -			Depth : 4.50m			
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
Depth (m)	Type	Results							
1.30	D		1.20			Grass onto medium dense to dense angular and tabular gravel with frequent cobbles and boulders (0.4 x 0.5m) of tabular mudstone. Gravel is fine, medium and coarse tabular mudstone (MADE GROUND).			
						Firm becoming firm to stiff grey mottled orange brown slightly silty slightly gravelly to gravelly CLAY with frequent cobbles and boulders (0.4 x 0.5m) of sandstone and siltstone. Gravel is fine, medium and coarse rounded and subrounded sandstone and tabular mudstone and siltstone.			
			4.50			Trial Pit Complete at 4.50 m			
Remarks: 1. Slight pit side instability in Made Ground.			Groundwater : Dry			Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			
			Stability :						

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com			Project Name : Twynyrodyn			Project No.: 9913		Trial Pit No.: TP5 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil			Client : Merthyr Tydfil County Borough Council			Logged By : GNS		Scale : 1:30	
Equipment : Case CX130			Coordinates : -			Dimensions 3.50m			
Date Excavated : 23/04/2008			Level : -			Depth : 2.50m			
Samples & In-situ Testing			Stratum Description						
Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend				
0.10	D					Grass onto medium dense to dense dark grey and brown slightly sandy gravel with frequent cobbles of mudstone and siltstone. Gravel is fine, medium and coarse angular and tabular mudstone (MADE GROUND).			
1.50	D					Firm becoming firm to stiff and stiff slightly sandy slightly gravelly CLAY with frequent cobbles and boulders (0.4 x 0.5m) of subrounded sandstone and tabular mudstone. Gravel is fine, medium and predominantly coarse subrounded and rounded sandstone and tabular mudstone.			
						Trial Pit Complete at 2.50 m			
Remarks: 1. Trial pit sides stable in the short term. 2. Slow progress of excavation below 1.5m depth.			Groundwater : Dry Stability :			Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			

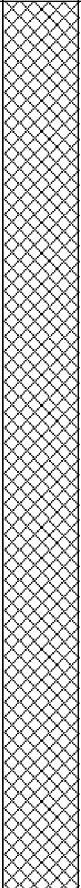
 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com			Project Name : Twynyrodyn			Project No.: 9913		Trial Pit No.: TP7 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil			Client : Merthyr Tydfil County Borough Council			Logged By : GNS		Scale : 1:30	
Equipment : Case CX130			Coordinates : -			Dimensions 4.00m			
Date Excavated : 23/04/2008			Level : -			Depth : 5.00m			
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
Depth (m)	Type	Results							
0.40	D		0.20			Grass and moss onto soft dark grey and black silty slightly sandy gravelly clay. Gravel is fine and medium angular mudstone (MADE GROUND).			
						Dense dark grey occasionally brown slightly clayey slightly sandy gravel with frequent angular cobbles of brick, pot, mudstone, siltstone and sandstone. Gravel is fine, medium and coarse angular mudstone, sandstone and siltstone with rare brick and coal. Localised small sheets of plastic and metal (A4 paper size) (MADE GROUND).			
2.10	D		2.00			Medium dense brown, dark brown and dark grey slightly clayey silty gravel with occasional cobbles of angular mudstone, brick and ceramic. Gravel is fine, medium and coarse angular brick, mudstone, coal, ceramic, pottery and metal (MADE GROUND).			
			2.60			Medium dense dark grey and brown slightly silty gravel with frequent cobbles of angular mudstone and siltstone. Gravel is fine, medium and coarse angular and tabular mudstone (MADE GROUND).			
			5.00			Trial Pit Complete at 5.00 m			
			5.00	-					
Remarks: 1. Trial pit sides unstable below 2.6m depth.			Groundwater : Dry			Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			
			Stability :						

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com			Project Name : Twynyrodyn			Project No.: 9913		Trial Pit No.: TP8 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil			Client : Merthyr Tydfil County Borough Council			Logged By : GNS		Scale : 1:30	
Equipment : Case CX 130			Coordinates : -			Dimensions 3.50m			
Date Excavated : 23/04/2008			Level : -			Depth : 5.50m			
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
Depth (m)	Type	Results							
0.40	D					Grass and moss onto loose to medium dense dark grey and occasionally brown slightly silty gravel with occasional cobbles of tabular mudstone. Gravel is fine, medium and coarse angular mudstone, siltstone and rare brick, pottery and coal (MADE GROUND).			
2.50	D					Soft to firm dark grey and black silty gravelly clay. Gravel is fine, medium and coarse angular mudstone and rare coal and brick (MADE GROUND).			
			5.50			Trial Pit Complete at 5.50 m			
Remarks: 1. Trial pit sides unstable below 2.1m.			Groundwater : Soils damp below 2.1m.			Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			
			Stability :						

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com			Project Name : Twynyrodyn			Project No.: 9913		Trial Pit No.: TP9 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil			Client : Merthyr Tydfil County Borough Council			Logged By : GNS		Scale : 1:30	
Equipment : Case CX130			Coordinates : -			Dimensions 3.50m			
Date Excavated : 24/04/2008			Level : -			Depth : 4.00m			
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
Depth (m)	Type	Results							
0.20	D					Grass onto loose to medium dense dark grey occasionally brown slightly silty gravel with occasional cobbles of tabular mudstone and sandstone. Gravel is fine, medium and coarse tabular and angular mudstone with occasional metal wire (MADE GROUND).			
1.50	D								
			4.00			Trial Pit Complete at 4.00 m			
Remarks: 1. Trial pit sides unstable leading to overbreak to ground level and the removal of between 0.5 and 1.0m of each pit side. 2. Unable to excavate deeper due to pit			Groundwater : Soils damp below 1.0m depth. Stability :			Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			

		Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com		Project Name : Twynyrodyn		Project No.: 9913		Trial Pit No.: TP10 Sheet 1 of 1			
Location : Mountain Hare, Merthyr Tydfil				Client : Merthyr Tydfil County Borough Council				Logged By : GNS		Scale : 1:30	
Equipment : Case CX130				Coordinates : -				Dimensions 3.00m Depth : 3.00m 0.70m			
Date Excavated : 24/04/2008				Level : -							
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description					
Depth (m)	Type	Results									
0.50	D					Grass and moss onto loose to medium dense brown slightly silty gravel with occasional to frequent cobbles and occasional boulders (0.4 x 0.5m) of angular and tabular mudstone. Gravel is fine, medium and coarse tabular and angular mudstone (MADE GROUND).	0				
2.00	D						1				
							2				
							3				
			3.00				4				
							5				
							6				
Remarks: 1. Trial pit sides extremely unstable leading to overbreak to ground level and the removal of 1.0 to 1.5m of each pit side. 2. Unable to excavate deeper due to pit				Groundwater : Dry Stability :				Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			

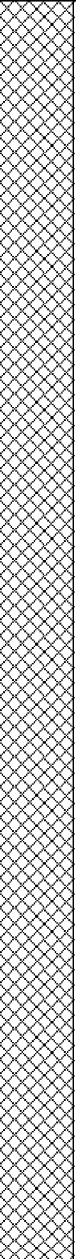
 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com		Project Name : Twynyrodyn		Project No.: 9913		Trial Pit No.: TP11 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil		Client : Merthyr Tydfil County Borough Council		Logged By : GNS		Scale : 1:30	
Equipment : Case CX130		Coordinates : -		Dimensions Depth : 3.00m 0.70m 3.20m			
Date Excavated : 24/04/2008		Level : -					
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.40	D					Grass and moss onto loose to medium dense brown slightly silty gravel with occasional to frequent cobbles and occasional boulders (0.4 x 0.5m) of angular and tabular mudstone. Gravel is fine, medium and coarse tabular and angular mudstone (MADE GROUND).	0
							1
							2
							3
			3.00			Trial Pit Complete at 3.00 m	3
							4
							5
							6
Remarks: 1. Trial pit sides extremely unstable leading to overbreak to ground level and the removal of 1.0 to 1.5m of each pit side. 2. Unable to excavate deeper due to pit			Groundwater : Dry Stability :		Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample		

		Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com		Project Name : Twynyrodyn		Project No.: 9913		Trial Pit No.: TP12 Sheet 1 of 1			
Location : Mountain Hare, Merthyr Tydfil				Client : Merthyr Tydfil County Borough Council				Logged By : GNS		Scale : 1:30	
Equipment : Case CX130				Coordinates : -				Dimensions 3.00m Depth : 3.50m 0.70m			
Date Excavated : 24/04/2008				Level : -							
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description					
Depth (m)	Type	Results									
0.60	D					Grass and moss onto loose to medium dense brown slightly silty gravel with occasional to frequent cobbles and occasional boulders (0.4 x 0.5m) of angular and tabular mudstone. Gravel is fine, medium and coarse tabular and angular mudstone (MADE GROUND).	0				
2.00	D						1				
							2				
							3				
			3.50			Trial Pit Complete at 3.50 m	4				
							5				
							6				
Remarks: 1. Trial pit sides extremely unstable leading to overbreak to ground level and the removal of 1.0 to 1.5m of each pit side. 2. Unable to excavate deeper due to pit				Groundwater : Soils damp below 1.0m depth. Stability :				Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com			Project Name : Twynyrodyn			Project No.: 9913		Trial Pit No.: TP13 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil			Client : Merthyr Tydfil County Borough Council			Logged By : GNS		Scale : 1:30	
Equipment : Case CX130			Coordinates : -			Dimensions 3.50m			
Date Excavated : 24/04/2008			Level : -			Depth : 5.60m			
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
Depth (m)	Type	Results							
0.20	D					Grass and moss onto loose to medium dense brown slightly silty gravel with frequent cobbles and occasional boulders (0.4 x 0.5m) of angular and tabular mudstone. Gravel is fine, medium and coarse tabular and angular mudstone (MADE GROUND).			
3.50	D								
Remarks: 1. Trial pit sides unstable leading to overbreak to ground level and the removal of 0.5m of each pit side.			Groundwater : Dry			Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			
			Stability :						

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com			Project Name : Twynyrodyn			Project No.: 9913		Trial Pit No.: TP14 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil			Client : Merthyr Tydfil County Borough Council			Logged By : GNS		Scale : 1:30	
Equipment : Case CX130			Coordinates : -			Dimensions 4.00m			
Date Excavated : 24/04/2008			Level : -			Depth : 5.50m			
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
Depth (m)	Type	Results							
0.10	D		0.40			Grass onto dark grey, black and brown silty gravelly sand. Gravel is fine, medium and coarse angular mudstone and coal (MADE GROUND).			
1.00	D					Stiff dark grey, black and brown silty slightly sandy gravelly clay with frequent cobbles and rare boulders (0.3 x 0.4m) of angular and tabular mudstone, siltstone, sandstone and brick with subrounded sandstone. Gravel is fine, medium and coarse angular mudstone, siltstone, coal and rarely brick with subrounded sandstone (MADE GROUND).			
5.00	D		4.70			Medium dense dark grey, brown and yellow brown slightly silty slightly sandy gravel with frequent cobbles and boulders (0.4 x 0.4m) of tabular mudstone. Gravel is fine, medium and coarse tabular mudstone (MADE GROUND).			
			5.50			Trial Pit Complete at 5.50 m			
Remarks: 1. Trial pit sides unstable below 4.7m depth.			Groundwater : Dry			Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			
			Stability :						

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com		Project Name : Twynyrodyn		Project No.: 9913		Trial Pit No.: TP16 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil		Client : Merthyr Tydfil County Borough Council		Logged By : GNS		Scale : 1:30	
Equipment : Case CX130		Coordinates : -		Dimensions Depth : 4.00m 0.70m 3.50m			
Date Excavated : 24/04/2008		Level : -					
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.30	D					Grass onto brown and red brown slightly silty slightly sandy gravel. Gravel is fine, medium and coarse angular and subangular ash, clinker, slag, brick and rubber (MADE GROUND).	0
			0.50			Medium dense grey and brown silty gravel. Gravel is fine, medium and coarse angular mudstone (MADE GROUND).	
1.00	D		0.80			Firm dark grey, brown and black silty slightly sandy gravelly clay with frequent cobbles and boulders (0.4 x 1.0m) of mudstone and rarely metal, rubber and brick. Gravel is fine, medium and coarse angular mudstone, coal, siltstone and brick with subrounded sandstone (MADE GROUND).	1
			2.00			Medium dense dark grey and brown slightly sandy gravel with frequent cobbles of tabular mudstone and siltstone. Gravel is fine, medium and coarse tabular and angular mudstone and siltstone (MADE GROUND).	2
							3
			4.00			Trial Pit Complete at 4.00 m	4
							5
							6
Remarks: 1. Trial pit sides unstable below 2.0m depth, promoting overbreak to ground level and the removal of 0.5 to 1.0m of each pit side.			Groundwater : Dry		Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample		
			Stability :				

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Location : Mountain Hare, Merthyr Tydfil			Client : Merthyr Tydfil County Borough Council			Logged By : GNS		Scale : 1:30	
Equipment : Case CX 130			Coordinates : -			Dimensions 4.00m			
Date Excavated : 25/04/2008			Level : -			Depth : 5.00m			
Samples & In-situ Testing			Stratum Description						
Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend				
0.40	D					Grass onto medium dense to dense dark grey and black slightly clayey slightly silty slightly sandy gravel with frequent and rare boulders (0.4 x 0.5m) of tabular and angular mudstone, sandstone and brick. Gravel is fine, medium and coarse angular and subangular mudstone, sandstone, coal and rare brick and pottery (MADE GROUND).			
2.00	D								
			5.00			Trial Pit Complete at 5.00 m			
			5.00	-					
Remarks: 1. Trial pit sides stable in the short term.			Groundwater : Dry			Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			
			Stability :						

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Location : Mountain Hare, Merthyr Tydfil			Client : Merthyr Tydfil County Borough Council			Logged By : GNS		Scale : 1:30	
Equipment : Case CX 130			Coordinates : -			Dimensions 7.50m			
Date Excavated : 24/04/2008			Level : -			Depth : 5.50m			
Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
Depth (m)	Type	Results							
0.30	D					Grass and moss onto medium dense slightly silty slightly sandy gravel with frequent cobbles and rarely boulders (0.4 x 0.5m) of angular and tabular mudstone and brick with subrounded sandstone. Gravel is fine, medium and coarse angular mudstone, sandstone, coal and rarely brick with subrounded sandstone (MADE GROUND).			
3.20	D		2.90			Firm to stiff brown, dark grey and grey slightly sandy gravelly clay with frequent cobbles and boulders (0.4 x 0.3m) of mudstone, sandstone and brick. Gravel is fine, medium and coarse angular mudstone, sandstone, coal and rare brick (MADE GROUND).			
			5.50			Trial Pit Complete at 5.50 m			
Remarks: 1. Trial pit sides stable in the short term.			Groundwater : Dry			Key : D - Small disturbed sample B - Bulk disturbed sample ES - Environmental soil sample W - Water sample			
			Stability :						

APPENDIX E

SHELL & AUGER BOREHOLE LOGS

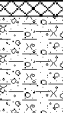
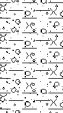
 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn				Project No.: 9913		Borehole No.: BH1 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council				Coordinates : - -		Hole Type : Cable	
Equipment : Dando 2000				Diameter of Casing :				Level : -		Scale : 1:50	
Diameter of Boring : 200mm				Depth of Casing :				Dates 23/04/2008 - 24/04/2008		Logged By : GNS	
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					0.20		Grass onto soft brown silty clay (MADE GROUND).	0			
		1.00 1.00	CPT B	N=13 (2,3,4,3,3,3)			Medium dense dark grey, black and brown clayey slightly silty sandy gravel with occasional cobbles of angular mudstone, sandstone and rarely brick. Gravel is fine, medium and coarse angular and tabular mudstone, siltstone, sandstone, brick, coal and rarely metal (MADE GROUND).	1			
		2.00	CPT	N=12 (1,2,3,3,4,2)				2			
		3.00 3.00	CPT B	N=17 (2,3,3,4,5,5)				3			
		4.00	CPT	N=16 (5,6,3,4,5,4)				4			
		5.00 5.00	CPT B	N=10 (2,2,2,3,2,3)				5			
					5.20		Firm grey, brown and yellow brown slightly sandy slightly gravelly CLAY with frequent cobbles and suspected boulders of sandstone. Gravel is fine, medium and coarse rounded and subrounded sandstone and siltstone.				
					6.00		End of Borehole at 6.00 m	6			
								7			
								8			
							9				
							10				

Remarks :
 1. Borehole remained dry during drilling.

Key :
 D - Small disturbed sample W - Water sample
 B - Bulk disturbed sample U - Undisturbed sample
 ES - Environmental soil sample TCR - Total Core Recovery
 SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery
 CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation



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Location : Mountain Hare, Merthyr Tydfil		Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type : Cable				
Equipment : Dando 2000		Diameter of Casing :		Level : -		Scale : 1:50				
Diameter of Boring :		Depth of Casing :		Dates 27/03/2008		Logged By : GNS				
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description		
		Depth (m)	Type	Results						
								Grass and moss onto loose to medium dense dense brown slightly silty gravel with frequent cobbles and occasional boulders (0.4 x 0.5m) of angular and tabular mudstone and rare brick. Gravel is fine, medium and coarse tabular and angular mudstone (MADE GROUND).	0	
		1.00 1.00	CPT B	N=10 (2,2,2,3,3,2)					1	
		2.00	CPT	N=20 (12,10,4,4,5,7)					2	
		3.00 3.00	CPT B	N=37 (2,6,10,10,10,7)					3	
		4.00	SPT	N=24 (3,4,3,4,8,9)					4	
		5.00 5.00	CPT B	N=30 (6,7,6,7,8,9)					5	
		6.50	CPT	N=25 (3,4,5,4,7,9)					7	
		8.00 8.00	CPT B	N=43 (7,8,9,12,10,12)					8	
		9.50	CPT	N=38 (5,9,10,11,8,9)					9	
		Depth (m)	Type	Results				(Continued next sheet)	10	
Remarks : 1. Borehole remained dry during drilling. 2. Chiselling undertaken between 3.4 and 3.6m, 8.6 and 9.0m and 11.2 and 11.5m for 0.5, 0.5 and 1.5 hours respectively.						Key : D - Small disturbed sample W - Water sample B - Bulk disturbed sample U - Undisturbed sample ES - Environmental soil sample TCR - Total Core Recovery SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation				

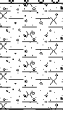
 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn				Project No.: 9913		Borehole No.: BH2 Sheet 2 of 2	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council				Coordinates : - -		Hole Type : Cable	
Equipment : Dando 2000				Diameter of Casing :				Level : -		Scale : 1:50	
Diameter of Boring :				Depth of Casing :				Dates 27/03/2008		Logged By : GNS	
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		10.00	B		10.10		 Grass and moss onto loose to medium dense brown slightly silty gravel with frequent cobbles and occasional boulders (0.4 x 0.5m) of angular and tabular mudstone and rare brick. Gravel is fine, medium and coarse tabular and angular mudstone (MADE GROUND).	10			
		11.00 11.00	CPT B	N=75 (3,4,11,12,26,26)	11.50		 Firm becoming stiff, grey, yellow brown and brown slightly sandy slightly gravelly CLAY with occasional cobbles and suspected boulders of rounded and subrounded sandstone. Gravel is fine, medium and coarse rounded and subrounded sandstone.	11			
								End of Borehole at 11.50 m	12		
									13		
									14		
									15		
									16		
									17		
									18		
									19		
									20		
Remarks : 1. Borehole remained dry during drilling. 2. Chiselling undertaken between 3.4 and 3.6m, 8.6 and 9.0m and 11.2 and 11.5m for 0.5, 0.5 and 1.5 hours respectively.							Key : D - Small disturbed sample W - Water sample B - Bulk disturbed sample U - Undisturbed sample ES - Environmental soil sample TCR - Total Core Recovery SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation				



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Location : Mountain Hare, Merthyr Tydfil		Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type : Cable			
Equipment : Dando 2000		Diameter of Casing :		Level : -		Scale : 1:50			
Diameter of Boring :		Depth of Casing :		Dates 31/03/2008		Logged By : GNS			
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.50	B		0.90			Grass onto loose to medium dense dark grey and brown slightly sandy gravel with frequent cobbles of mudstone and siltstone. Gravel is fine, medium and coarse angular and tabular mudstone (MADE GROUND).	0
		1.00	CPT	N=5 (1,1,1,1,1,2)				Soft becoming firm to stiff and stiff brown, yellow brown and grey slightly sandy slightly gravelly CLAY with frequent cobbles and suspected boulders of rounded and subrounded sandstone and tabular mudstone. Gravel is fine, medium and predominantly coarse subrounded and rounded sandstone and tabular mudstone.	1
		2.00	CPT	N=17 (2,3,4,4,3,6)				2	
		2.00	B						
		3.00	CPT	N=22 (3,4,5,4,6,7)				3	
		3.00	B						
		4.00	CPT	N=23 (2,4,6,5,6,6)				4	
		5.00	CPT	N=33 (3,5,4,5,8,16)			5		
		5.00	B						
		6.00	CPT	50/70mm (25,50)	6.00			End of Borehole at 6.00 m	6
									7
									8
									9
									10
Remarks : 1. Borehole remained dry during drilling. 2. Chiselling undertaken between 5.8 and 6.0m for 1 hour.								Key : D - Small disturbed sample W - Water sample B - Bulk disturbed sample U - Undisturbed sample ES - Environmental soil sample TCR - Total Core Recovery SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation	

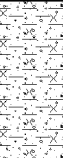


 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com		Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: BH4 Sheet 1 of 2				
Location : Mountain Hare, Merthyr Tydfil		Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type : Cable				
Equipment : Dando 2000		Diameter of Casing :		Level : -		Scale : 1:50				
Diameter of Boring :		Depth of Casing :		Dates 25/03/2008 - 26/03/2008		Logged By : GNS				
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description		
		Depth (m)	Type	Results						
								Grass and moss onto medium dense and dense dark grey locally brown slightly sandy gravel with frequent cobbles and suspected boulders of tabular mudstone and siltstone. Gravel is fine, medium and coarse angular and tabular mudstone, siltstone, sandstone and rare coal (MADE GROUND).	0	
		1.00 1.00	CPT B	N=28 (1,5,4,9,8,7)					1	
		2.00	CPT	N=12 (2,3,2,3,4,3)					2	
		3.00 3.00	CPT B	N=28 (8,8,8,6,7,7)					3	
		4.00	CPT	N=11 (2,3,3,2,3,3)					4	
		5.00 5.00	CPT B	N=26 (6,7,3,5,9,9)					5	
		6.50	CPT	N=33 (4,10,11,7,8,7)					6	
		7.00	B						7	
		8.00	CPT	50/0mm (25,50)					8	
		9.50	CPT	N=42 (6,8,10,13,9,10)					9	
		Depth (m)	Type	Results				(Continued next sheet)	10	
Remarks : 1. Borehole remained dry during drilling. 2. Chiselling undertaken between 5.1 and 5.3m, 8.0 and 8.2m, 10.5 and 10.8m, 12.5 and 12.7m and 13.5 and 1.4m for 0.5, 0.5, 1.0, 0.5 and 2.0 hours respectively						Key : D - Small disturbed sample W - Water sample B - Bulk disturbed sample U - Undisturbed sample ES - Environmental soil sample TCR - Total Core Recovery SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation				

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Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council				Coordinates : - -		Hole Type : Cable	
Equipment : Dando 2000				Diameter of Casing :				Level : -		Scale : 1:50	
Diameter of Boring :				Depth of Casing :				Dates 25/03/2008 - 26/03/2008		Logged By : GNS	
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
		Depth (m)	Type	Results							
								Grass and moss onto medium dense and dense dark grey locally brown slightly sandy gravel with frequent cobbles and suspected boulders of tabular mudstone and siltstone. Gravel is fine, medium and coarse angular and tabular mudstone, siltstone, sandstone and rare coal (MADE GROUND).	10		
		11.00	CPT	N=31 (3,4,8,9,6,8)					11		
		12.50	CPT	50/70mm (25,50)	12.10			Stiff brown and grey silty slightly sandy slightly gravelly CLAY.	12		
		13.50	B		12.80			Very weak grey brown MUDSTONE (recovered as coarse angular mudstone gravel).	13		
		14.00	CPT	50/70mm (22,38,50)	14.00		End of Borehole at 14.00 m		14		
									15		
									16		
									17		
									18		
									19		
									20		
Remarks : 1. Borehole remained dry during drilling. 2. Chiselling undertaken between 5.1 and 5.3m, 8.0 and 8.2m, 10.5 and 10.8m, 12.5 and 12.7m and 13.5 and 1.4m for 0.5, 0.5, 1.0, 0.5 and 2.0 hours respectively							Key : D - Small disturbed sample W - Water sample B - Bulk disturbed sample U - Undisturbed sample ES - Environmental soil sample TCR - Total Core Recovery SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation				



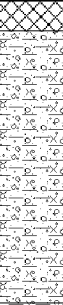
 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com		Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: BH5 Sheet 1 of 2			
Location : Mountain Hare, Merthyr Tydfil		Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type : Cable			
Equipment : Dando 2000		Diameter of Casing :		Level : -		Scale : 1:50			
Diameter of Boring :		Depth of Casing :		Dates 19/03/2008 - 20/03/2008		Logged By : GNS			
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
								Grass onto loose and medium dense and dense dark grey and black occasionally brown slightly silty sandy gravel with occasional cobbles of tabular mudstone and sandstone. Gravel is fine, medium and coarse tabular and angular mudstone, metal, glass, coal and ash (MADE GROUND).	0
		1.00 1.00	CPT B	N=10 (6,4,3,2,2,3)					1
		2.00	CPT	N=5 (1,0,1,1,1,2)					2
		3.00 3.00	CPT B	N=31 (3,3,4,8,11,8)					3
		4.00	CPT	N=22 (6,3,2,3,3,14)	4.10				4
		4.50	B					Stiff brown and grey slightly silty slightly sandy slightly gravelly CLAY with occasional cobbles and suspected boulders of rounded and subrounded sandstone, siltstone and rarely mudstone. Gravel is fine, medium and coarse sandstone, mudstone and siltstone.	
		5.00	CPT	N=25 (2,7,8,6,5,6)					5
		6.50 6.50	CPT B	N=32 (4,6,6,7,9,10)					6
		8.00	CPT	N=19 (9,6,4,4,5,6)					7
		9.50 9.50	CPT B	N=25 (5,5,6,6,6,7)	9.20				8
								Stiff grey and brown slightly silty slightly sandy CLAY with frequent tabular mudstone lithorelicts.	9
		Depth (m)	Type	Results				(Continued next sheet)	10
Remarks : 1. Borehole remained dry during drilling. 2. Chiselling undertaken between 5.8 and 6.1m and 11.1 and 11.3m for 1.0 and 2.0 hours respectively.						Key : D - Small disturbed sample W - Water sample B - Bulk disturbed sample U - Undisturbed sample ES - Environmental soil sample TCR - Total Core Recovery SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation			

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Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council			Coordinates : - -		Hole Type : Cable	
Equipment : Dando 2000				Diameter of Casing :			Level : -		Scale : 1:50	
Diameter of Boring :				Depth of Casing :			Dates 19/03/2008 - 20/03/2008		Logged By : GNS	
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		11.00	CPT	50/0mm (15,10,50)	11.10		 Stiff grey and brown slightly silty slightly sandy CLAY with frequent tabular mudstone lithorelicts.	10		
					11.30		 Very weak grey MUDSTONE (recovered as coarse angular mudstone gravel). End of Borehole at 11.30 m	11		
								12		
								13		
								14		
								15		
								16		
								17		
								18		
								19		
								20		
		Depth (m)	Type	Results						
Remarks : 1. Borehole remained dry during drilling. 2. Chiselling undertaken between 5.8 and 6.1m and 11.1 and 11.3m for 1.0 and 2.0 hours respectively.							Key : D - Small disturbed sample W - Water sample B - Bulk disturbed sample U - Undisturbed sample ES - Environmental soil sample TCR - Total Core Recovery SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation			



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Location : Mountain Hare, Merthyr Tydfil		Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type : Cable			
Equipment : Dando 2000		Diameter of Casing :		Level : -		Scale : 1:50			
Diameter of Boring :		Depth of Casing :		Dates 22/04/2008 - 23/04/2008		Logged By : GNS			
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		1.00 1.00	CPT B	N=18 (3,2,3,4,5,6)				Grass onto loose to medium dense and dense dark grey, brown and black very clayey slightly sandy gravel with frequent cobbles and suspected boulders of mudstone, sandstone, siltstone, brick and metal. Gravel is fine, medium and coarse angular, subangular, subrounded and tabular mudstone, sandstone, coal, ash, clinker, slag, brick, metal, glass and rubber (MADE GROUND).	0
									1
		2.00 2.00	CPT	N=12 (6,6,3,3,3,3)					2
		3.00 3.00	CPT B	N=9 (1,2,1,2,3,3)					3
		4.00 4.00	CPT	N=18 (1,5,6,5,3,4)					4
		5.00 5.00	CPT B	N=6 (1,2,1,2,1,2)					5
		6.50 6.50	CPT	N=46 (8,10,11,10,12,13)			6		
		7.00 7.00	B				7		
		8.00 8.00	CPT	N=20 (5,6,7,4,4,5)			8		
		9.50 9.50	CPT	N=37 (3,6,5,6,9,17)			9		
								10	
		Depth (m)	Type	Results			(Continued next sheet)		
Remarks : 1. Borehole remained dry during drilling. 2. Chiselling undertaken between 7.1 and 7.3m, 9.4 and 9.7m and 11.8 and 12.0m for 0.5, 0.5 and 1.0 hours respectively.							Key : D - Small disturbed sample W - Water sample B - Bulk disturbed sample U - Undisturbed sample ES - Environmental soil sample TCR - Total Core Recovery SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation		



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Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council			Coordinates : - -		Hole Type : Cable	
Equipment : Dando 2000				Diameter of Casing :			Level : -		Scale : 1:50	
Diameter of Boring :				Depth of Casing :			Dates 22/04/2008 - 23/04/2008		Logged By : GNS	
Well	Water Strikes	Samples & In-situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					10.20		Grass onto loose to medium dense and dense dark grey, brown and black very clayey slightly sandy gravel with frequent cobbles and suspected boulders of mudstone, sandstone, siltstone, brick and metal. Gravel is fine, medium and coarse angular, subangular, subrounded and tabular mudstone, sandstone, coal, ash, clinker, slag, brick, metal, glass and rubber (MADE GROUND).	10		
					11.00 11.00		CPT B	N=13 (2,3,2,3,4,4)	11	
					12.00		CPT	50/0mm (25,50)	12	
					12.00		Soft to firm brown and grey slightly silty slightly sandy gravelly CLAY with frequent cobbles and suspected boulders of rounded and subrounded sandstone, siltstone and mudstone. Gravel is fine, medium and coarse rounded and subrounded sandstone and siltstone.			
							End of Borehole at 12.00 m			
									13	
									14	
									15	
									16	
									17	
									18	
									19	
									20	
Remarks : 1. Borehole remained dry during drilling. 2. Chiselling undertaken between 7.1 and 7.3m, 9.4 and 9.7m and 11.8 and 12.0m for 0.5, 0.5 and 1.0 hours respectively.							Key : D - Small disturbed sample W - Water sample B - Bulk disturbed sample U - Undisturbed sample ES - Environmental soil sample TCR - Total Core Recovery SPT - Standard Penetration Test (split spoon) SCR - Solid Core Recovery CPT - Standard Penetration Test (solid cone) RQD - Rock Quality Designation			



APPENDIX F

ROTARY PROBEHOLE LOGS

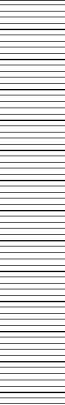
 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: R1 Sheet 1 of 2	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type RO	
Equipment : Klemm 802				Diameter of Casing :		Level : -		Scale : 1:150	
Diameter of Boring :				Depth of Casing :		Dates : 24/04/2008		Drilled By : MO	
Well	Water Strikes	Depth (m)	Level (m AOD)	Legend	Stratum Description	Comments			
					MADE GROUND/SUPERFICIAL DEPOSITS				0
									1
									2
									3
									4
									5
		6.00			MADE GROUND/SUPERFICIAL DEPOSITS				6
									7
									8
									9
									10
									11
		12.00			MUDSTONE (Drillers description).				12
									13
		13.70			SILTSTONE (Drillers description).				14
									15
		15.10			MUDSTONE (Drillers description).				16
									17
									18
									19
		20.10			COAL (Drillers description).				20
		20.60			MUDSTONE BANDS (Drillers description).				21
									22
									23
									24
									25
									26
									27
									28
									29
									30
		Depth (m)	Level		(Continued next sheet)				
Remarks : 1. 50mm diameter geologging pipe installed to base of probehole.									
									

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: R3 Sheet 1 of 2	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type RO	
Equipment : Klemm 802				Diameter of Casing :		Level : -		Scale : 1:150	
Diameter of Boring :				Depth of Casing :		Dates : 24/04/2008 - 25/04/2008		Drilled By : MO	
Well	Water Strikes	Depth (m)	Level (m AOD)	Legend	Stratum Description	Comments			
					MADE GROUND/SUPERFICIAL DEPOSITS				0
									1
									2
									3
									4
									5
									6
									7
									8
									9
									10
									11
		11.70			MADE GROUND/SUPERFICIAL DEPOSITS				12
									13
									14
		15.00			MUDSTONE (Drillers description).				15
									16
									17
									18
									19
									20
									21
									22
									23
		24.10			COAL (Drillers description).				24
		24.90			MUDSTONE (Drillers description).				25
									26
									27
									28
									29
									30
		Depth (m)	Level		(Continued next sheet)				
Remarks : 1. Combined gas and groundwater monitoring standpipe installed to 35m depth.									
									

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: R8 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type RO	
Equipment : Klemm 802				Diameter of Casing :		Level : -		Scale : 1:150	
Diameter of Boring :				Depth of Casing :		Dates : 02/05/2008		Drilled By : MO	
Well	Water Strikes	Depth (m)	Level (m AOD)	Legend	Stratum Description	Comments			
					MADE GROUND/SUPERFICIAL DEPOSITS				
		7.20			MUDSTONE (Drillers description).				
		17.10			COAL (Drillers description).				
		18.00			MUDSTONE with subordinate siltstone bands (Drillers description).				
		Depth (m)	Level		End of Borehole at 30.00 m				
Remarks : 1. Geologging pipe installed to 30m depth.									

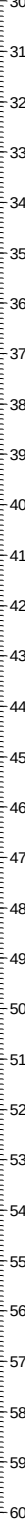


 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: R9 Sheet 1 of 2	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type RO	
Equipment : Klemm 802				Diameter of Casing :		Level : -		Scale : 1:150	
Diameter of Boring :				Depth of Casing :		Dates : 30/04/2008		Drilled By : MO	
Well	Water Strikes	Depth (m)	Level (m AOD)	Legend	Stratum Description	Comments			
					MADE GROUND/SUPERFICIAL DEPOSITS				
		14.20			MUDSTONE (Drillers description).				
		15.30			COAL (Drillers description).				
		16.40			MUDSTONE (Drillers description).				
		25.00			COAL (Drillers description).				
		25.80			MUDSTONE (Drillers description).				
		Depth (m)	Level		(Continued next sheet)				
Remarks :									

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: R11 Sheet 1 of 2	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type RO	
Equipment : Klemm 802				Diameter of Casing :		Level : -		Scale : 1:150	
Diameter of Boring :				Depth of Casing :		Dates : 29/04/2008		Drilled By : MO	
Well	Water Strikes	Depth (m)	Level (m AOD)	Legend	Stratum Description	Comments			
					MADE GROUND/SUPERFICIAL DEPOSITS				0
									1
									2
									3
									4
									5
									6
									7
									8
									9
									10
									11
									12
									13
		14.00			MUDSTONE (Drillers description).				14
									15
									16
		17.00			COAL (Drillers description).				17
		17.80			MUDSTONE (Drillers description).				18
									19
									20
									21
									22
									23
									24
									25
		26.00			VOID (Drillers description).				26
		27.00			Void back fill (Drillers description)				27
		28.50			MUDSTONE (Drillers description).				28
									29
									30
		Depth (m)	Level	(Continued next sheet)					
Remarks :									



		Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com		Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: R12 Sheet 1 of 2	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type RO	
Equipment : Klemm 802				Diameter of Casing :		Level : -		Scale : 1:150	
Diameter of Boring :				Depth of Casing :		Dates : 01/05/2008		Drilled By : MO	
Well	Water Strikes	Depth (m)	Level (m AOD)	Legend	Stratum Description	Comments			
					MADE GROUND/SUPERFICIAL DEPOSITS				
					MADE GROUND/SUPERFICIAL DEPOSITS				
					MUDSTONE (Drillers description).				
					COAL (Drillers description).				
					SILTSTONE (Drillers description).				
					(Continued next sheet)				
Remarks : 1. Geologging pipe installed to 35m depth.									
									

 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: R12 Sheet 2 of 2	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type RO	
Equipment : Klemm 802				Diameter of Casing :		Level : -		Scale : 1:150	
Diameter of Boring :				Depth of Casing :		Dates : 01/05/2008		Drilled By : MO	
Well	Water Strikes	Depth (m)	Level (m AOD)	Legend	Stratum Description	Comments			
					SILTSTONE (Drillers description).				
					Back filled VOID (Drillers description).				
					MUDSTONE (Drillers description).				
				End of Borehole at 37.00 m					
		Depth (m)	Level						
Remarks : 1. Geologging pipe installed to 35m depth.									



 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: R14 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type RO	
Equipment : Klemm 802				Diameter of Casing :		Level : -		Scale : 1:150	
Diameter of Boring :				Depth of Casing :		Dates : 02/05/2008		Drilled By : MO	
Well	Water Strikes	Depth (m)	Level (m AOD)	Legend	Stratum Description	Comments			
					MADE GROUND/SUPERFICIAL DEPOSITS				0
									1
									2
									3
									4
									5
									6
									7
									8
									9
									10
									11
		11.30			MUDSTONE (Drillers description).				12
		11.70			COAL (Drillers description).				13
									14
		14.30			MUDSTONE (Drillers description).				15
									16
									17
									18
		19.20			COAL (Drillers description).				19
		19.70			SILTSTONE (Drillers description).				20
									21
									22
		22.50			COAL (Drillers description).				23
		23.10			MUDSTONE (Drillers description).				24
									25
									26
									27
									28
									29
									30
		Depth (m)	Level		End of Borehole at 30.00 m				
Remarks : 1. Combined gas and groundwater standpipe installed to 30m depth.									

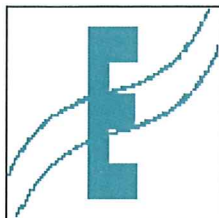


 Intégral House, 7 Beddau Way Castlegate Business Park Caerphilly CF83 2AX Tel. 029 20807991 Fax. 029 20862176 mail@integralgeotec.com				Project Name : Twynyrodyn		Project No.: 9913		Borehole No.: R17 Sheet 1 of 1	
Location : Mountain Hare, Merthyr Tydfil				Client: Merthyr Tydfil County Borough Council		Coordinates : - -		Hole Type RO	
Equipment : Klemm 802				Diameter of Casing :		Level : -		Scale : 1:150	
Diameter of Boring :				Depth of Casing :		Dates : 30/04/2008		Drilled By : MO	
Well	Water Strikes	Depth (m)	Level (m AOD)	Legend	Stratum Description	Comments			
					MADE GROUND/SUPERFICIAL DEPOSITS				
		13.80			MUDSTONE (Drillers description).				
		16.10			VOID back filled (Drillers description).				
		17.50			MUDSTONE (Drillers description).				
		22.00			VOID back filled (Drillers description).				
		24.50			MUDSTONE (Drillers description).				
		27.00			End of Borehole at 27.00 m				
		Depth (m)	Level						
Remarks :									



APPENDIX G

DOWN HOLE GEOPHYSICAL LOGGING RESULTS



EUROPEAN GEOPHYSICAL SERVICES LTD

Client: **Integral Geotechnique**

Log Type:

Nat Gamma /Density

Borehole: **1**

TWYNYRODYN

Location: **Mountain Hare, Merthyr Tydfil** Area: **South Wales**

Grid Ref:

Elevation:

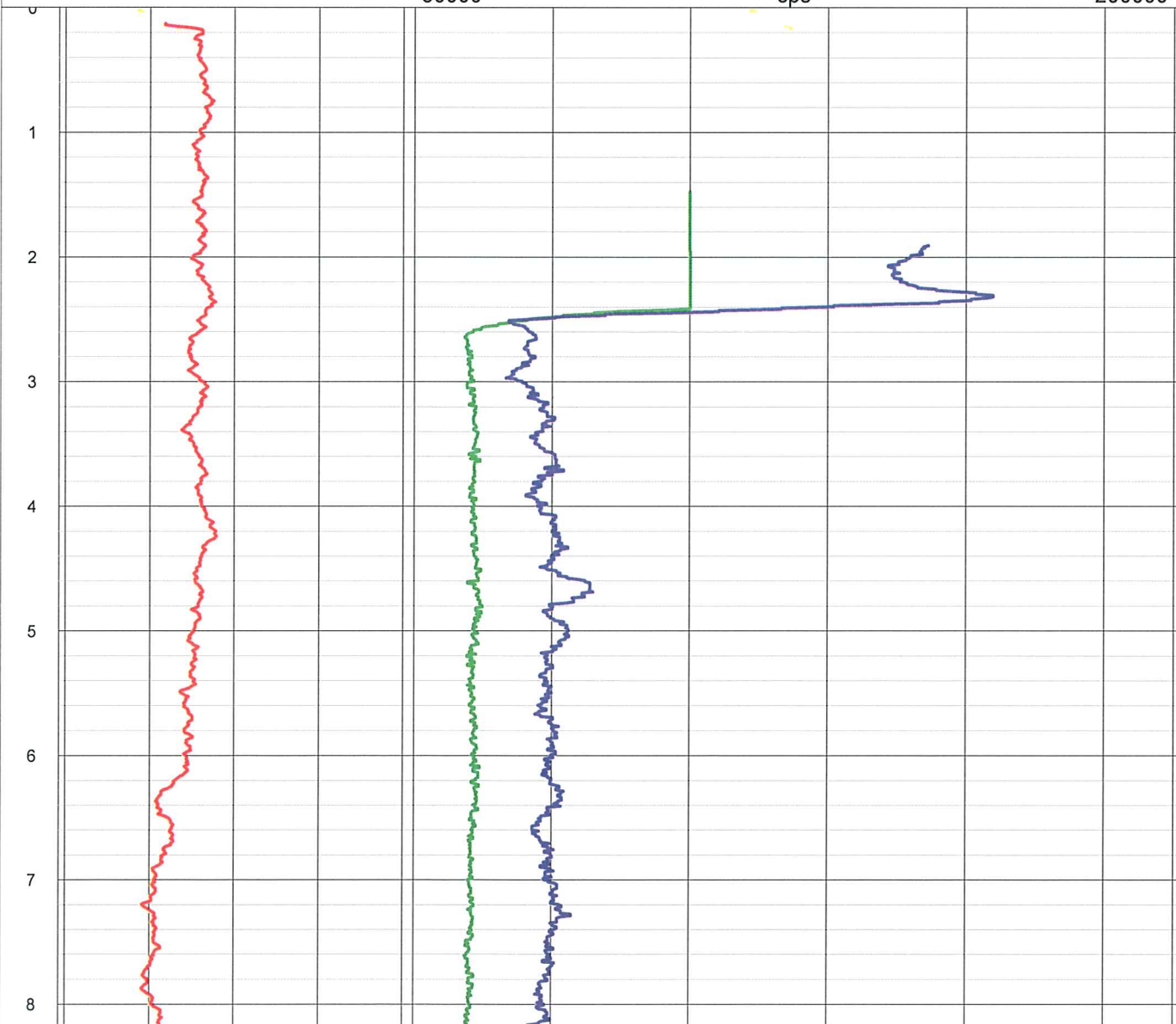
Drilled Depth:		Date:	5.06.08
Logged Depth:	35m	Recorded By:	James Whitford
Logging Datum:	Ground Level	Remarks: Ref:	
Logged Interval:	2.1 - 35m		
Fluid Level:	<1m		

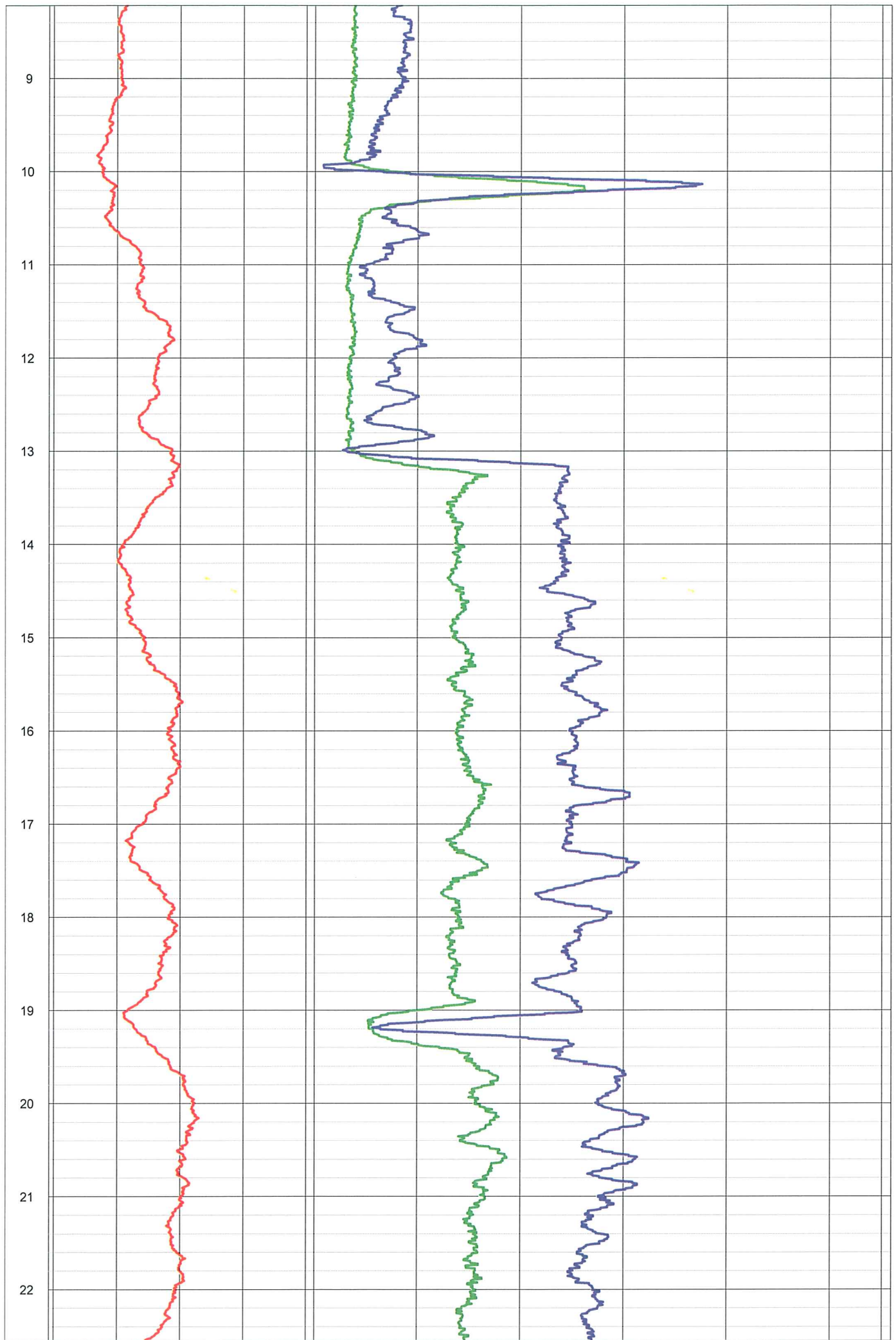
BOREHOLE RECORD

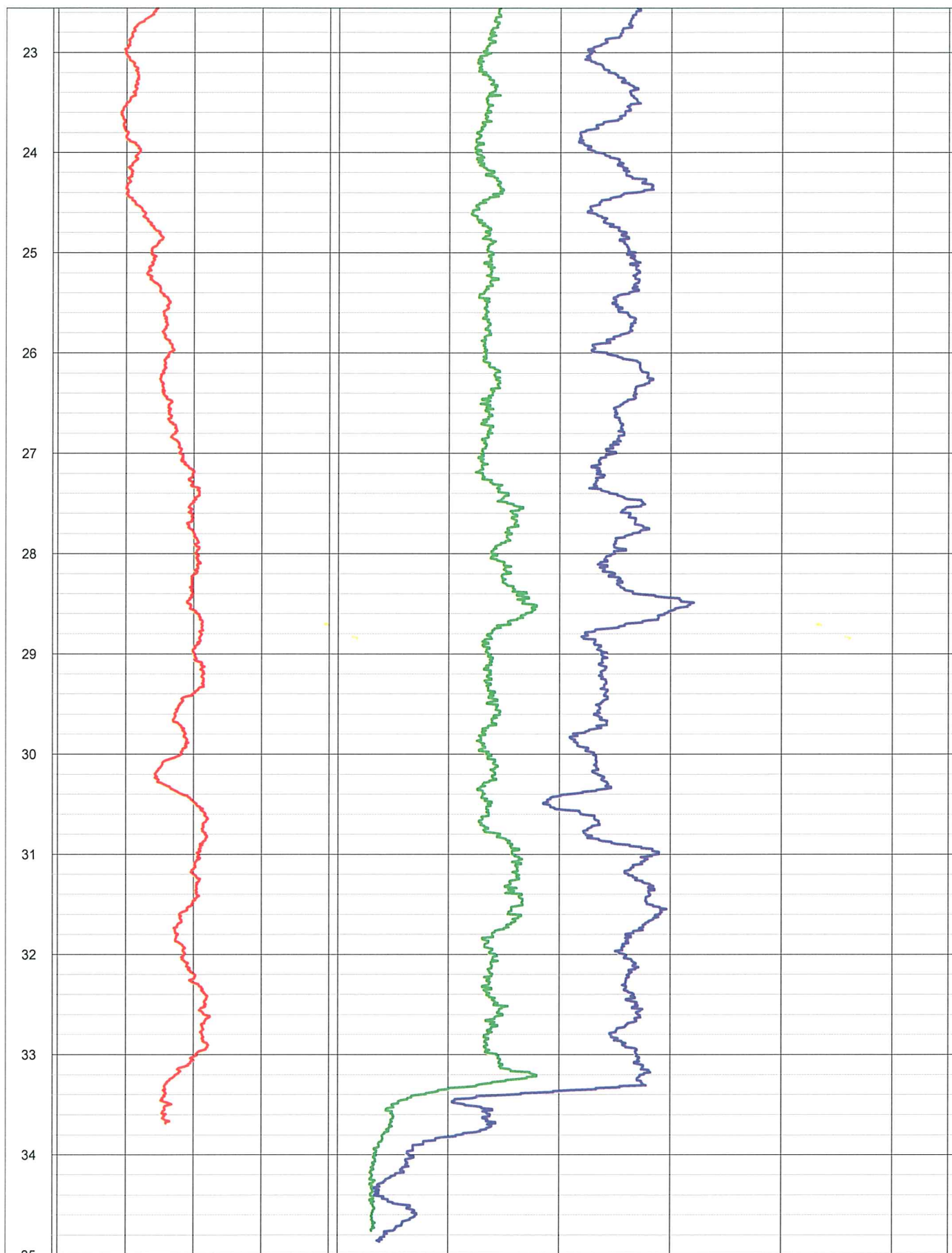
Bit	From	To

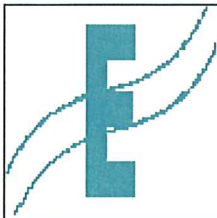
CASING RECORD

Type	Size	From.	To.
Plastic	50mm	0m	~10m









EUROPEAN GEOPHYSICAL SERVICES LTD

Client: **Integral Geotechnique**

Log Type:

Nat Gamma /Density

Borehole: **5**

TWYNYRODYN

Location: **Mountain Hare, Merthyr Tydfil** Area: **South Wales**

Grid Ref:

Elevation:

Drilled Depth:		Date:	5.06.08
Logged Depth:	32.3m	Recorded By:	James Whitford
Logging Datum:	Ground Level	Remarks: Ref: Merthyr Bh5.wcl	
Logged Interval:	2.3 - 32.3m		
Fluid Level:			

BOREHOLE RECORD

CASING RECORD

Bit	From	To	Type	Size	From.	To.
			Plastic	50mm	0m	TD

