



**Site Investigation No. W1029**

**ENVIRONMENTAL STATEMENT  
POTENTIAL LANDFILL CONTAMINATION  
Land off Princess Way  
Brackla, Bridgend  
December 2008**

Report Status:	Final		
Issue Number:	1		
Issue Date:	December 2008		
Prepared By:	S.Leat		
Signed:			
Checked By:	R.Adams		
Signed:			

**Client:**  
Paddle Homes Limited  
45 Preston New Road  
Blackburn  
Lancashire  
BB2 6AE

**Engineer:**  
Laurence Rae Associates  
435 Fishponds Road  
Bristol  
BS16 3AP

## **CONTENTS:**

<b>1. SUMMARY .....</b>	<b>1</b>
<b>2. INTRODUCTION .....</b>	<b>2</b>
2.1 Brief and Report Scope .....	2
2.2 Report references .....	3
2.3 Limitations .....	3
<b>3. THE SITE .....</b>	<b>4</b>
3.1 Site Location and Description .....	4
3.2 Published Geology.....	4
3.3 Hydrogeology.....	5
3.4 Hydrology.....	5
3.5 Radon.....	5
<b>4. PREVIOUS SITE INVESTIGATION INFORMATION.....</b>	<b>6</b>
<b>5. SITE HISTORY.....</b>	<b>7</b>
5.1 Historical Maps .....	7
5.2 Other Historical Information .....	10
<b>6. ENVIRONMENTAL DATABASE INFORMATION.....</b>	<b>11</b>
6.1 Environmental Database Information.....	11
6.2 Other Information - Landfills and Waste Facilities .....	13
<b>7. FIELDWORK.....</b>	<b>14</b>
7.1 General.....	14
7.2 Rotary Drilling .....	14
7.3 Trial Pitting.....	15
7.4 Groundwater / Gas Monitoring.....	15
<b>8. GROUND CONDITIONS ENCOUNTERED .....</b>	<b>16</b>
8.1 Soil Profile.....	16
8.1.1 Topsoil.....	16
8.1.2 Made Ground .....	16
8.2 Obstructions .....	16
8.3 Groundwater .....	16
8.4 Land Gas.....	17
8.5 Visual / Olfactory Evidence of Contamination.....	17
<b>9. LABORATORY WORK.....</b>	<b>18</b>
<b>10. ENVIRONMENTAL ASSESSMENT .....</b>	<b>19</b>
10.1 Introduction.....	19
10.2 Conceptual Model / Risk Assessment.....	21
10.2.1 Contaminant Sources .....	21
10.2.2 Contaminant Pathways: .....	23
10.2.3 Contaminant Receptors:.....	24
10.3 Discussion and Conclusions .....	24
10.3.1 Contaminated Soils.....	24
10.3.2 Contaminated Groundwater.....	25
10.3.3 Radon Gas and Land Gas .....	25
10.3.4 Foundations .....	28
10.3.5 Water Pipes .....	28
10.3.6 Waste Disposal.....	28
10.3.7 Site Personnel.....	29
10.3.8 Other Matters .....	29
<b>11. LIST OF REFERENCES .....</b>	<b>30</b>

**TABLES:**

**TABLE 1 - SUMMARY OF EXPLORATORY HOLES**

**TABLE 2 – SUMMARY OF LAND GAS MONITORING RESULTS**

**TABLE 3 - SUMMARY OF GROUND CONDITIONS ENCOUNTERED**

**TABLE 4 - LABORATORY SOIL CONTAMINATION RESULTS**

**TABLE 5 - LABORATORY GROUNDWATER CONTAMINATION RESULTS**

**APPENDICES:**

**HISTORICAL MAP EXTRACTS**

**ENVIRONMENTAL DATABASE INFORMATION**

**LOGSHEETS**

**LABORATORY TESTS**

Contamination Laboratory Tests

**DRAWINGS**

Site Location Plan

Borehole and Trial Pit Location Plan

## 1. SUMMARY

Appointment	<p>C.J. Associates Geotechnical Limited was instructed by Laurence Rae Associates, acting on behalf of the Client Paddle Homes Limited, to carry out a site investigation for a site in Brackla Bridgend, South Wales.</p> <p>This report presents a summary of the site work carried out, historical information and environmental information, together with recommendations on contamination risks for the proposed development.</p>
The site	<p>The site is located in the Brackla area of Bridgend, South Wales at approximate National Grid reference SS 912 768. At the time of the investigation, the site comprised rough disused ground, formerly a railway cutting (now infilled). The site is underlain by Lower Lias Strata (limestones and shales) of Jurassic age, which is generally classified as a minor aquifer. The site is not within a floodplain. The site is in a radon affected area.</p>
Site History	<p>The site and surrounding area were located on open fields with some quarrying activity nearby until sometime between 1885 and 1899 when the Vale of Glamorgan Railway was constructed through the site. Sometime between 1964 and 1971 the railway running through the site was dismantled. The railway cutting was infilled by landfill between 1985 and 1988, and the site has remained undeveloped and unchanged until present day.</p>
Environmental Database Information	<p>There are 3 Local Authority Pollution Prevention and Controls, 1 Pollution Incident to Controlled Waters, 7 BGS Recorded Mineral Sites, 1 historic landfill site, 2 Local Authority Recorded Landfill Sites and 1 Registered Landfill Site, within 500m of the site. The site itself is registered as a Landfill Site, recorded as active between 1985 and 1988, licensed to take deposited waste including Inert, Industrial and household waste.</p>
The investigation	<p>The investigation comprised rotary boreholes, trial pitting, gas and groundwater monitoring and associated soil and groundwater contamination testing.</p>
Ground conditions	<p>The exploratory holes have encountered Made Ground (landfill) to a maximum depth of 16m below existing ground level. Groundwater seepages were encountered in BH1 and BH2 at depths of 0.70m and 11.50m respectively, and TP1 at 0.23m depth. Subsequent monitoring indicated groundwater levels at depths ranging between 11.68m and 15.40m. Monitoring encountered indicated Methane levels in the range 0.2% to 0.5% by volume, Carbon Dioxide levels in the range 0.7% to 4.5% by volume, Hydrogen Sulphide levels in the range 001ppm to 002ppm and Oxygen levels in the range 14.6% to 20.5%. Visual evidence of contamination was not encountered. Hydrogen Sulphide odours were noted in the trial pits.</p>
Contamination Assessment	<p>The investigation has not encountered significant groundwater contamination or significant levels of land gas. Elevated levels of arsenic and nickel have been encountered in soils samples which. Radon protection measures will be required for new development.</p>
<p><b><i>This sheet is intended to provide a summary only of the report. It does not provide a definitive engineering analysis for the purposes of costing or construction, and is subject to the limitation of the agreed brief.</i></b></p>	

## **2.INTRODUCTION**

C.J. Associates Geotechnical Limited (CJA) was instructed by Laurence Rae Associates (LRA), acting on behalf of the Client Paddle Homes Limited (PHL), to carry out a site investigation for a site in Brackla Bridgend, South Wales. Instructions to proceed are contained in PHL's letter reference 722399tenderschedule, dated 15<sup>th</sup> October 2008.

### **2.1 Brief and Report Scope**

The general specification for the works was provided by LRA and incorporated the brief to undertake the following:

- Obtain environmental database information;
- Trial Pitting and rotary boreholes (with monitoring installations);
- Groundwater and gas monitoring;
- Laboratory contamination testing;
- Provide Factual and Interpretative Reports.

CJA have issued a Factual Report for the investigation works, and this interpretative report should be read in conjunction with that report.

This report is based upon a review of readily available historical and current information, our own geological and hydrogeological map library, and information from an Environmental Database search.

This report also presents a summary of the site work carried out, the ground conditions encountered in the exploratory holes, and the laboratory test results. All information collected has been used to provide an interpretation of the ground conditions, with recommendations on contamination risks for the proposed development.

## 2.2 Report references

Information supplied by LRA is listed below:

- Extracts from Earth Science Partnership Geoenvironmental Report Reference 1284c/R1/147 (1996) *Waunscil Avenue, Brackla Bridgend*.

## 2.3 Limitations

The recommendations and opinions expressed in this report are based on the strata observed in the exploratory holes, the results of the site and laboratory tests, and information obtained as part of the desk study or provided by others. CJA take no responsibility for conditions that have not been revealed by the exploratory holes, or which occur between them. Whilst every effort has been made to interpret the conditions between investigation locations, such information is only indicative and liability cannot be accepted for its accuracy. Information provided from other sources is taken in good faith and CJA cannot guarantee its accuracy.

The report has been prepared exclusively for the above-named Client, for the site area indicated, and for the purpose stated. CJA accepts no responsibility for any site, Client or type of development not indicated in this report.

### **3.THE SITE**

#### **3.1 Site Location and Description**

The site is located in the Brackla area of Bridgend, South Wales at approximate National Grid reference SS 912 768, and is shown on the Site Location Plan, included in the Appendices to this report, and the aerial photograph below.



At the time of the investigation, the site comprised rough disused ground, formerly a railway cutting (now infilled), bordered to the south, east, and west by residential properties and their gardens, and to the north by woodland and to the south.

#### **3.2 Published Geology**

According to the British Geological Survey (BGS) 1:50 000 scale geological map of the area (Sheet No. 261 & 262), the site is underlain by Lower Lias Strata of Jurassic age. The Lower Lias is described in the BGS Regional Guide to the area, as comprising interbedded fossiliferous limestones and grey brown shales. Although not



indicated on the geological map, Made Ground is anticipated to be present at the site, associated with infilling of former railway cutting.

### **3.3 Hydrogeology**

The hydrogeology of the site area is detailed in the map, 'Groundwater Vulnerability of Mid Glamorgan', Sheet 36, published by the Environment Agency. This classifies the ground beneath the site as generally a minor aquifer (variably permeable). The southern end of the site is classified as a major aquifer (highly permeable) with an intermediate leaching potential.

### **3.4 Hydrology**

The nearest surface watercourse is the River Ogmore, 730m to the northwest. It has a River Quality B (fair). The site is not within a floodplain, the nearest area at risk of flooding is 500m to the northwest

### **3.5 Radon**

According to BGS National Geoscience Information Service records the site is in a radon affected area where between 5 and 10% of homes are above the government action level and basic radon protective measures will be necessary in the constructions of new dwellings or extensions.



#### **4. PREVIOUS SITE INVESTIGATION INFORMATION**

Extracts from a previous site investigation (ref Earth Science Partnership Geoenvironmental Report Reference 1284c/R1/147, 1996) supplied by LRA, are summarised below.

Eight No. cable percussion boreholes were sunk to depths of between 3.2m and 14.5m below existing ground level between 20th December 1995 and 6th January 1996. Gas monitoring standpipes were installed in six boreholes.

All the boreholes encountered variable Made Ground comprising sandy gravelly clay with cobbles, boulders and brick, to depths of between 3.2m and 11.4m. Limestone (likely bedrock) was encountered in BHM2B at a depth of 14m below existing round level.

## **5.SITE HISTORY**

### **5.1 Historical Maps**

The historical development of the site and surrounding area has been determined using available extracts of historical Ordnance Survey (OS) plans, the extracts of which are included in the Appendices to this report.

**In summary**, the site and surrounding area were located on open fields with some quarrying activity nearby until sometime between 1885 and 1899 when the Vale of Glamorgan Railway was constructed through the site. Between 1900 and 1919 quarries to the east expanded to within 250m of the site, and Bridgend to the east began to expand, leading to the construction of houses to the north of the site. Until 1964 the site changed little, and the surrounding area became more urban, with houses built first to the north, and then immediately to the east of the site. Sometime between 1964 and 1971 the railway running through the site was dismantled. The railway cutting was infilled by landfill between 1985 and 1988, and the site has remained undeveloped and unchanged until present day.

Details of the historical map extracts are as follows:

The **1875** and **1877** 1:2,500 OS maps show the site to be located on open fields with a small road / track running east-west across the centre, there are occasional trees around the edges of the fields. A small unmarked building is 50m to the east of the site. There are old quarries immediately to the northwest, 125m to the west, and 250m to the east of the site. There are old limekilns 75m to the west and 70m to the northeast of the site. A railway line runs northwest-southeast 450m to the northwest of the site. Two active quarries, some form of works, and a small reservoir are located 400m to the west of the site.

The **1885** 1:10,560 OS map shows no significant change to the site. The town of Bridgend can be seen on this map, the urban area starting 500m to the west of the site. The River Ogmore runs generally north-south 750m to the west of the site.

The **1899** 1:2,500 and **1900** 1:10,560 OS maps show the construction of the Vale of Glamorgan Railway along the length of the site. The small road / track now crosses

the railway at the centre of the site. A new quarry has been excavated by the reservoir, and a new building and some kilns have been constructed at the works 400m to the west of the site. Some houses have been constructed 375m to the northwest of the site.

The **1919** 1:2,500 OS map shows the expansion of the quarries to the west, to within 250m of the site. Tramways have been constructed in the quarries as they expanded. A small new quarry and a limekiln have appeared immediately to the east of the southern tip of the site. More houses have been built to within 125m northwest of the northern tip of the site, along Acland Road, Vernon Street, and Herbert Street.

The **1921** 1:10,560 OS map shows little or no significant change to the site, but the expansion of Bridgend, especially between the River Ogmore and the railway 450m to the southwest of the site.

The **1940** 1:2,500 OS map shows the expansion of the small quarry immediately southeast of the site, northwards to the east of the railway line. More housing has been constructed along Acland Road and Herbert Street. Some form of quarrying activity has taken place along the eastern side of the railway, immediately to the northeast of the site. Where there was a small quarry 125m to the west of the site there is now a small building with some trees. Electricity pylons have been erected 305m to the northeast of the site.

The **1947** and **1949** 1:10,560 scale Aerial Photographs show the construction of a large built up area, possibly industrial, starting 600m southeast of the site. Further expansion of Bridgend to the north and south can also be seen.

The **1951** and **1952** 1:10,560 OS maps show little or no significant change to the site or the surrounding area.

The **1964** 1:10,560 OS map shows little or no significant change to the site or the surrounding area.

The **1964** 1:2,500 OS map shows the construction of housing immediately to the west of the site, and along its entire length. Waunscil Avenue runs parallel to the railway, 50m to the west of the site. The small building 50m to the east of the site has had 2

sheep dips constructed, one either side of the track. A building named 'West Winds' that has tanks within its grounds has been constructed 125m to the southeast of the site.

The **1971** 1:2,500 OS map shows that the railway has been dismantled along the length of the site. The small building and sheep dips 50m to the east of the site has also been removed. The area between 250m southwest of the site and the railway 450m to the southwest of the site contains larger industrial buildings and yards along Tremains Road, including a County Council Yard and a Garage.

The **1973** and **1974** 1:10,560 OS maps show little or no significant change to the site, but show the construction of a covered reservoir and Brackla Industrial Estate 1000m to the northeast of the site. The area to the 600m to the south east of the site first seen on the 1947 and 1949 Aerial Photographs is now identified as Bridgend Industrial Estate.

The **1979** 1:2,500 OS map shows that housing has been constructed east of the site. Along 'Gwaun Coed' immediately to the east of the southern end of the site, and along 'The Willows' and surrounding roads 125m to the east of the site.

The **1982** and **1984** 1:2,500 OS maps show that further housing has been constructed to the east of the site, right up to the eastern edge of the site. Brackla Country Primary School has been constructed 375m to the northeast of the site.

The **1983** and **1986** 1:10,560 OS maps show little or no significant change to the site, but construction of housing on Brackla Hill between 500m and 100m east of the site. Bridgend has expanded further to the north, south and west.

The **1992** and **1993** 1:2,500 and **1993** 1:10,560 OS maps show little or no significant change to the site, but the construction of housing 125m to the north, and 500m to the southeast of the site.

The **1999** 1:10,560 OS map shows the northern end of the site as covered in wooded vegetation, but little or no other significant change to the surrounding area.

The **2008** 1:10,560 OS map shows the entire northern half of the site as now covered in wooded vegetation. More housing has been built on Brackla Hill to the east. A new road has been built running northeast to southwest into Bridgend 300m north of the site.

## **5.2 Other Historical Information**

According to environmental information (see Section 5.2) the site is a recorded landfill. This landfill is recorded as active between 1985 and 1988. The license holder was Datewin Construction Limited and was for Deposited Waste including Inert, Industrial and Household Waste.

## **6. ENVIRONMENTAL DATABASE INFORMATION**

### **6.1 Environmental Database Information**

As part of the investigation, an environmental database search was obtained by CJA, a copy of which is included in the Appendices to his report and summarised below.

The following summary is generally limited to locations within 500m of the central point of the site unless it is considered that installations or activities beyond that range could potentially have an impact on the site or be affected by the redevelopment of the site.

There are 3 Local Authority **Pollution Prevention and Controls** located within 500m of the site, the details of which are as follows:

- Texaco Service Station, 337m to the SW, permit reference 78 (1998). Refers to air pollution control for a petrol filling station.
- Star Tremains Self Service, 353m to the SW, permit reference 80 (1999). Refers pollution prevention and control for a petrol filling station.
- Sapphire Quality Dry Cleaners, 485m to the E, permit reference 107 (2007). Refers to pollution prevention and control for dry cleaning.

There are no **Discharge Consents** within 500m of the site.

There is 1 **Pollution Incident to Controlled Waters** within 500m of the site. Sinclair Garages, 427m to SW, Category 3 (minor incident), light oil pollution caused by runoff.

There are no registered **Substantiated Pollution Incidents** within 500m of the site.

There are no **Water Abstraction Licenses** within 500m of the site.

There are 7 **BGS Recorded Mineral Sites**, within 500m of the site, the details of which are as follows:

- Oldcastle, 151m to 460m to W/SW, 4 No. sites opencast techniques used to work limestone (now ceased).

- Tremains, 168m to SE, opencast techniques used to work limestone (now ceased).
- Station, 249m and 364m to W, 2 No. opencast techniques used to work limestone (now ceased).

Other information obtained in the environmental database check is as follows:

- **Coal mining affected areas** – in an area not be affected by coal mining.
- **Shallow mining hazards** – no hazard.
- **Potential for collapsible ground stability hazards** - no hazard.
- **Potential for compressible ground stability hazards** - no hazard.
- **Potential for ground dissolution hazards** – very low.
- **Potential for landslide subsidence hazards** - very low.
- **Potential for running sand ground stability hazards** – no hazard.
- **Potential for shrinking/swelling clay ground stability hazard** - no hazard.

**Contemporary trade entries** within 500m of the site, which could affect the site, are as follows:

- A-Z Cleaning Contractors, 279m to N (Commercial Cleaning Services)
- Sinclair Garages Ltd, 320m to W (Car Dealers)
- S H G Motorsave, 335m to SE (Garage Services)
- Top Car, 337m to SE (Car Dealers - Used)
- Tremains Self Serve, 353m to SW (Petrol Filling Stations – 24 Hour)
- Bridgend Motor Sales, 361m to SW (Car Dealers)
- Sinclair Audi, 361m to SW (Garage Services)
- D B S, 361m to SW (Paint Spraying Equipment & Accessories)
- M & S Johnson, 337m to SW (Petrol Filling Stations – 24 Hour)
- Bassetts Honda, 351m to SE (Car Dealers)
- Furniturepro, 353m to NW (Furniture – Repairing And Restoring)
- Arby Construction, 374m to W (Joinery Manufacturers)
- A D Underfloor Heating, 377m to W (Under Floor Heating)
- A D T Joinery, 380m to W (Joinery Manufacturers)



- J Morgan & Son, 394 to W (Mot Testing Centre)
- Llynfi Garage, 394m to W (Garage Services)
- Audi, 390m to S (Car Dealers)
- Owen G Motors, 436m to SE (Mot Testing Centres)
- Hill Motor Service, 440m to W (Garage Services)
- Edwards Autos, 450m to W (Car Body Repairs)
- Pen-Y-Bont Polishers, 450m to S (French Polishing)
- Sapphire, 486m to E (Dry Cleaners)
- D W M Motor Repairs, 495m to SW (Garage Services)

## 6.2 Other Information - Landfills and Waste Facilities

According to the Envirocheck Report there is a **Historic Landfill Site** located on the site. The landfill is recorded as active between 1985 and 1988. The license holder was Datewin Construction Limited and was licensed for Deposited Waste including Inert, Industrial and Household Waste. There is another **Historical Landfill Site** Known as Penybanc, 181m to the W of the site. It is recorded as active between 1960 and 1974 and was for Deposited Waste including Inert, Industrial and Household Waste.

There are 2 **Local Authority Recorded Landfill Sites** within 500m of the site, the details of which are as follows:

- Brackla / Tremains Road, 347m to the W, for municipal waste, last reported status is closed.
- Waunscil Avenue, 367m to the S, for inert waste, last reported status is unknown.

There is a **Registered Landfill Site** located at a Derelict Railway Cut, in Coity / Coychurch, 267m to the S of the site. The license is dated 1<sup>st</sup> March 1986, and the site was authorised to take Inert Demolition Material and Inert Excavated Natural Materials. Current status shows the license has been cancelled.

## **7.FIELDWORK**

### **7.1 General**

The fieldwork, scheduled by LRA was carried out by CJA between 16<sup>th</sup> October 2008 and 17<sup>th</sup> October 2008 and comprised rotary boreholes, installation of standpipes, trial pitting and associated sampling and in situ testing.

The fieldwork was carried out generally in accordance with BS 5930:1999 *Code of Practice for Site Investigations*, and LRA's instructions, unless otherwise stated. The exploratory hole locations were determined on site by CJA (where access permitted), and are shown approximately on the Exploratory Hole Location Plan, included in the Appendices. A summary of exploratory holes undertaken is presented in Table 1.

All exploratory hole locations were scanned for buried services using a Cable Avoidance Tool (CAT). In addition hand dug inspection pits were excavated to a maximum 1.2m depth before drilling/boring commenced to check for underground services.

On completion all samples recovered from the site were taken to CJA's laboratory for further examination and testing. Details of the depths and types of samples recovered are indicated on the attached log sheets.

### **7.2 Rotary Drilling**

Two boreholes (designated BH1 and BH2) were sunk to depths of 16m below existing ground level, using a track-mounted rotary coring rig. The boreholes were drilled using a rock roller/down the hole hammer, producing a 115mm nominal diameter hole.

Details of ground water conditions were noted where possible. Water levels may have been affected by the installation of casing to the boreholes or the use of air as a flushing medium. In addition, water level observations are those at the time of the investigation and do not necessarily reflect seasonal fluctuations.

In accordance with LRA's instructions, 50mm diameter standpipes were installed in both boreholes to 16m depth. Installation and backfill details are shown with the appropriate borehole logsheet.

### **7.3 Trial Pitting**

To supplement the borehole investigation 6 trial pits were excavated to depths of between 1.5m and 3.7m below existing ground level, using a wheeled excavator, under the direct and continuous supervision of CJA.

Representative disturbed samples were recovered from the excavated material as pitting proceeded. Details of groundwater conditions were noted. The trial pits were backfilled immediately on completion of sampling and testing.

Trial pit photographs are presented in the Appendices to this report.

### **7.4 Groundwater / Gas Monitoring**

CJA carried out groundwater and gas monitoring in standpipes after the fieldwork period on the 22<sup>nd</sup> October 2008, the results of which are summarised in Table 2, together with all other previous gas monitoring results.

## **8. GROUND CONDITIONS ENCOUNTERED**

### **8.1 Soil Profile**

The sequence of strata encountered beneath the site was:

- Topsoil
- Made Ground

The depths of the various materials encountered in each of the exploratory holes are summarised in Table 3. Details of each stratum are discussed below.

#### **8.1.1 Topsoil**

Topsoil was encountered in all the exploratory holes, thickness 0.10m to 0.20m.

#### **8.1.2 Made Ground**

Made Ground was encountered in all the exploratory holes, immediately beneath the topsoil, and proven to a maximum depth of 16m below existing ground level in BH1 and BH2.

The Made Ground comprised either sandy gravelly clay or clayey gravelly sand with concrete, brick, wood, metal, plastic, glass, clinker and porcelain.

### **8.2 Obstructions**

Underground man-made obstructions were not encountered in the exploratory holes.

### **8.3 Groundwater**

Groundwater seepages were encountered in BH1 and BH2 at depths of 0.70m and 11.50m respectively, and TP1 at 0.23m depth. The other trial pits were dry.

Subsequent monitoring (22<sup>nd</sup> October 2008) of groundwater in standpipes indicated groundwater levels at depths ranging between 11.68m and 15.40m below existing ground level.

#### **8.4 Land Gas**

Results obtained during the monitoring visit (22<sup>nd</sup> October 2008) indicated Methane (CH<sub>4</sub>) levels in the range 0.2% to 0.5% by volume, Carbon Dioxide (CO<sub>2</sub>) levels in the range 0.7% to 4.5% by volume, Hydrogen Sulphide (H<sub>2</sub>S) levels in the range 001ppm to 002ppm and Oxygen (O<sub>2</sub>) levels in the range 14.6% to 20.5%.

Gas flows were recorded as 0l/hr and borehole pressure 0Pa. The atmospheric pressure was 1018mb.

It should be noted that the concentrations and levels of mobile liquid and gaseous materials are likely to vary with time. The results obtained may therefore be representative of the conditions only at the time of sampling.

#### **8.5 Visual / Olfactory Evidence of Contamination**

Visual evidence of contamination was not encountered. Hydrogen Sulphide odours were noted in the trial pits.

## **9.LABORATORY WORK**

The environmental chemistry of the ground and groundwater was investigated by specialist chemical analysis of selected samples, scheduled by CJA as specified by LRA.

Chemical analyses were carried out on six soil samples and four groundwater samples, and were submitted for the following suite of determinants:

*Arsenic, Boron, Cadmium (total), Chromium (total), Copper, Lead, Mercury, Nickel, Selenium, Zinc, PCBs and Acetones.*

The results of the laboratory contamination tests are summarised in Tables 4 and 5, and included in the Appendices to this Report.

The range of potentially hazardous contaminants present on the site can be wide and varied, and the suite has been chosen to reflect both commonly found contaminants and others indicated by research to have a significant risk of being present. It is, however, possible that others may exist for which analyses have not been carried out. It is also possible that contaminants exist on the site but were not present at any of the exploratory hole locations.

## **10. ENVIRONMENTAL ASSESSMENT**

### **10.1 Introduction**

In accordance with current best practice, the assessment of potentially contaminated sites is normally carried out by means of a risk assessment, based on a conceptual model, which examines possible sources of contamination, potential receptors, and likely links between the two. For contamination to be a hazard, it must be demonstrated that there is an identifiable source of contamination (either inside or outside the site), potential receptors that may be at risk (occupiers of the site, for example, or the environment in general), and that there are also potential pathways through which the former may affect the latter.

Potential sources of contamination can be determined from the results of the laboratory tests that have been carried out on the soil samples. Other potential sources may be evident from the information on the history of the site and its environs. Contaminants are only a hazard if they are present in suitably high concentrations.

As part of the contamination assessment, the chemical results obtained by CJA have been screened against accepted compliance criteria, namely:

- CLEA Soil Guideline Values for soil contaminants where available.

It should be noted, at the time of writing this report, all the CLEA SGV's have been withdrawn by the Environment Agency together with the associated statistical analysis. It is understood the SGVs are to be reviewed by the Environment Agency and new SGVs will be issued in due course. For the purposes of this report the chemical results will be compared to the old SGVs, and should be reviewed once new SGVs are issued.

The CLEA Soil Guideline Values (SGVs) were published for a limited range of metals, toluene and ethylbenzene, and the Soil Guideline Values are intended to be used as a screening tool for use in the assessment of land potentially affected by contamination. They represent values, which indicate to an assessor that soil concentrations above this level might present risk to the health of site-users and that



further assessment, quantitative risk assessment, site investigation or remediation may be required.

In the absence of specific UK guidelines regarding groundwater quality in the UK, chemical results obtained by CJA have been compared with the following statutory and non statutory standards:

- Environmental Quality Standards (EQS); and
- UK Drinking Water standards<sup>(2000)</sup>.

EQS values have been derived to protect surface water, and the nearest surface watercourse is the River Ogmore, located approximately 700m to the northwest of the site. For the purposes of this report it is considered the most appropriate EQS data for the river are those established for freshwater.

A large number of the EQS values lie just above the method detection limit for particular parameters and as such, are extremely conservative. In the absence of EQS values, Drinking Water Standards have been used for comparison of results. Again these standards are highly conservative, especially in this site context.

The use of these reference values for initial screening purposes does not imply that they are categoric indicators of whether contamination conditions are significant, this being subject to a more detailed risk assessment.

In the case of possible receptors, one of the most significant factors is the proposed future use of the site (as some potential uses are much less sensitive to the presence of contamination than others). It is understood it is proposed to redevelop the site for residential purposes. Therefore for the purposes of this report, the following sections compare the results of contamination analyses to all residential end development (with and without plant uptake) and also commercial/industrial (i.e. hardcover areas such as car parking roads etc) for comparison.

## 10.2 Conceptual Model / Risk Assessment

### 10.2.1 Contaminant Sources

Based on the current and historical uses of the site and its surroundings, and the findings of the investigation, it is concluded that the following contaminant sources should be considered:

**Historical/Current Site Sources:** The site was formerly a railway cutting which has been infilled with landfill (during the late 1980s), which potentially could be a source of contamination.

**Materials present on the site:** No visual evidence of contamination was seen on the site surface, however given the significant thickness of Made Ground (old landfill) encountered beneath parts of the site, this should be considered a potential source of contamination.

SGVs as derived from the Contaminated Land Exposure Assessment (CLEA) model were used to assess the risk to human health from some published contaminants typically encountered on contaminated land sites.

The CLEA model indicates soil guideline values (SGVs) for various parameters (shown in the table below). A direct comparison was made between the soils analyses results and the CLEA SGVs for residential end use with plant uptake, residential end use without plant uptake, allotments and commercial/industrial end use.

**Soil Results Comparison with CLEA SGVs**

Determinand	CLEA SGV (mg/kg)				No. of Samples	Min. (mg/kg)	Max. (mg/kg)	No. of Exceedences
	Residential Plant uptake	Residential No plant uptake	allotments	Commercial / Industrial				
Arsenic	20	20	20	500	6	20.5	44.7	6
Cadmium	1 (pH=6)	30	1 (pH=6)	1400	6	0.6	1.2	0
	2 (pH=7)		2 (pH=7)		6			0
	8 (pH=8)		8 (pH=8)		6			0
Chromium	130	200	130	5000	6	26	65	0
Mercury	8	15	8	480	6	<0.5	<0.5	0
Nickel	50	75	50	5000	6	22	52	1
Selenium	35	260	35	8000	6	1.1	2.3	0
Lead	450	450	450	750	6	54	150	0

In general the samples have shown most contaminants at levels below the recommended SGVs, for residential purposes, with the exception of the following:

- All samples from the trial pits have elevated levels of **Arsenic**, in the range 20.5mg/kg to 44.7mg/kg, above the recommended SGVs for residential development.
- The sample from TP3 (0.8m depth), has a slightly elevated level of **Nickel** (52mg/kg) above the recommended SGV for residential end use with plant uptake and allotments (50mg/kg).

The following contaminants were not assessed with respect to risks posed to Human Health as they are not generally considered to represent a significant risk to Human Health (CLR 8); copper, zinc and boron. Copper, zinc and boron are phytotoxic and harmful to plants.

The soil contamination tests results have given values for PCBs and acetone below the detection limit of the test.

**Ground Water:** Groundwater seepages were encountered in BH1 and BH2 at depths of 0.70m and 11.50m respectively, and TP1 at 0.23m depth. Subsequent monitoring indicated groundwater levels ranging between 11.68m and 15.40m.

A direct comparison was made between the groundwater analyses results and the EQS and Drinking Water Standards, and the results are summarised in the following table:

***Groundwater Results Comparison***

Determinand	(1) EQS value (µg/l unless otherwise stated)	(2) Drinking Water Quality Value (µg/l unless otherwise stated)	No. of Samples	Min. (µg/l)	Max. (µg/l)	No. of Exceedences
Arsenic	50	10	4	<5	11	1
Cadmium	5.0	5.0	4	<1	<1	0
Chromium	150-250**	50	4	<5	8	0
Copper	10	2000	4	<5	8	0
Lead	50-250**	25	4	<1	<1	0
Mercury	1.0	1.0	4	<0.1	<0.1	0
Selenium	-	10	4	<5	<5	0
Nickel	50-200**	20	4	4	9	0
Zinc	75-500**	-	4	21	37	0

In general the laboratory analyses encountered levels of contamination below the EQS and Drinking Water Standards, with the exception of the following:

- A slightly elevated level of **arsenic** (11µg/l) was encountered in BH2 above the recommended Drinking Water Value of 10µg/l.

**Land Gas:** Another potential source of contamination is land gas, due to the presence of landfill across the site.

Results obtained during the monitoring visit (22<sup>nd</sup> October 2008) indicated Methane (CH<sub>4</sub>) levels in the range 0.2% to 0.5% by volume, Carbon Dioxide (CO<sub>2</sub>) levels in the range 0.7% to 4.5% by volume, Hydrogen Sulphide (H<sub>2</sub>S) levels in the range 001ppm to 002ppm and Oxygen (O<sub>2</sub>) levels in the range 14.6% to 20.5%. Gas flows were recorded as 0l/hr and borehole pressure 0Pa. The atmospheric pressure was 1018mb.

Results obtained during the previous investigation in 1996 (see Table 2) indicated Methane (CH<sub>4</sub>) levels in the range 0.0% to 0.06% by volume, Carbon Dioxide (CO<sub>2</sub>) levels in the range 0.0% to 3.2% by volume, and Oxygen (O<sub>2</sub>) levels in the range 17.5% to 20.9%.

**Contamination arising from external sources:** Based on historical maps and environmental database information, it is unlikely that areas near to the site are considered likely to contain elevated concentrations of some contaminants, which might affect the site itself.

#### 10.2.2 Contaminant Pathways:

Contaminants can reach potential receptors through various routes. The following are considered to be applicable to this site:

- **Ingestion:** Some contaminants can be harmful if ingested directly, either after handling contaminated soils, or due to eating plants grown in such soils that may not be thoroughly clean.
- **Absorption through Plants:** Other contaminants can be taken up by plants grown in contaminated soils, and ingested by anybody eating such plants.

- **Leachate:** Soluble fractions of some contaminants can leach into the ground, contaminating groundwater.
- **Services / Drains:** Contaminants in solution can be transported from one part of the site to another, or from outside the site to within the site, through old drains, or other service trenches which may be present.
- **Foundations;** some types of foundations (e.g. piling) could form preferential flow horizons for contaminants and also mobilise contaminants into the underlying soils/groundwater.

#### 10.2.3 Contaminant Receptors:

The following potential receptors are considered to be applicable to this site:

- **Future Site Occupants:** Future site occupants could be at risk from the effects of any contaminants in the soil and groundwater, and also from land gas.
- **Construction Workers:** The personnel involved in the construction of the proposed development are also at risk.
- **Groundwater:** As well as being a potential source of contamination, the groundwater also needs to be considered as a potential receptor of further contamination.
- **Vegetation:** New planting on the site could be at risk from contamination.

### 10.3 Discussion and Conclusions

The possible actions considered appropriate for the proposed development, together with other precautionary measures, are given below:

#### 10.3.1 Contaminated Soils

As discussed in the above sections, the contamination tests indicate generally low concentrations of the potential contaminants, with the exception of elevated levels of arsenic and nickel.

Based on the type of redevelopment proposed, the most sensitive areas will be gardens. It is therefore considered that, all garden areas should be capped with a minimum 600mm thickness of clean inert topsoil. Depending on finished site levels, this may require excavation and removal of some near surface material.

Where hardstanding and buildings are located it is unlikely these areas will require capping with clean topsoil, (subject to Local Authority approval) as materials are effectively being sealed beneath hardstanding and contaminant levels are well below SGVs for commercial/industrial (i.e. hardcover) end use.

Given the limited number of samples tested and nature of the underlying materials the possible presence of higher levels of contamination on areas of the site not covered by this investigation should not be discounted. It is essential additional spot checks are undertaken, particularly during groundworks. Should any elevated levels of contamination be found in such areas, the advice of a suitably qualified engineer should be sought.

#### 10.3.2 Contaminated Groundwater

Due to the low levels of contamination found at the site and the depth to groundwater, it is not considered likely that there would be a hazard to the groundwater beneath the site, and no remedial action should be necessary.

#### 10.3.3 Radon Gas and Land Gas

As indicated in Section 3.5 basic protection against the ingress of radon gas into the new building is required. Appropriate construction techniques are detailed in the BRE document *Radon: guidance on protective measures for new dwellings*<sup>(1999)</sup>.

Ground gas is largely generated by the decomposition of organic matter, both in natural soils such as peat, and man made materials such as landfill or other fill materials. The gases that are normally associated with these materials, which can pose a risk to health, include methane (which is toxic and potentially explosive) and carbon dioxide (which is toxic). Oxygen depletion is also a consequence of the generation of these other gases.

The potential risk associated with gases being generated in the ground (whether from natural or man-made sources) depends on the concentrations of gas and its flow rate to the surface. These factors are assessed by monitoring of the gas installations in the boreholes. The variable nature of gas generation and the effect of barometric pressure on gas flow, means that the volume of gas potentially reaching the ground surface is normally inconsistent over time.

For the assessment of sites, in terms of the potential for ground gas to present a hazard, the risk based methodology ('Traffic Light System') detailed in the NHBC Guidance on Methane and Carbon Dioxide (Edition No. 4, March 2007) is used for low-rise residential development.

This is a risk based approach that is designed to allow quick and easy design of gas protection for a low-rise housing development by comparing the measured gas emission rates to generic Traffic Lights. The Traffic Lights include 'Typical Maximum Concentrations' and are provided for initial screening purposes and risk based Gas Screening Values (GSVs) for consideration where the typical maximum concentrations are exceeded. The GSVs equate to the borehole gas volume flow rate as defined by Wilson and Card<sup>(1999)</sup> as the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered.

For the purposes of this evaluation the calculations will be carried out for both carbon dioxide and methane and the worst case adopted in order to establish the appropriate protection measures, as follows:

- Carbon dioxide: maximum flow rate = 0.0l/hr, max concentration = 6.2%
- Methane: maximum flow rate = 0.0l/hr, max concentration = 0.5%.

Based on the above figures, the GSV is calculated as:

- Carbon dioxide:  $GSV = 0.0 \times 0.026 = 0.0\text{l/hr}$
- Methane:  $GSV = 0.0 \times 0.004 = 0.0\text{l/hr}$ .

The above results suggest the site can be classified as 'Green' and gas protection measures will not be required, in accordance with the following tables, taken from the NHBC Guidance:



Gas Risk Assessment – Traffic Lights with Typical Maximum Concentrations and Gas Screening Values

Traffic Light Classification	Methane <sup>1</sup>		Carbon Dioxide <sup>1</sup>	
	Typical maximum concentration <sup>3</sup> (%v/v)	Gas Screening Value <sup>2,4</sup> (l/hr)	Typical maximum concentration <sup>3</sup> (%v/v)	Gas Screening Value <sup>2,4</sup> (l/hr)
Green	1	0.16	5	0.78
Amber 1	5	0.63	10	1.56
Amber 2	20	1.56	30	3.10
Red				

**Notes:**

- 1 The worst case ground gas regime identified on site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated.
- 2 Gas Screening Value is the borehole Gas Volume Flow Rate, in litres per hour, as defined in Wilson and Card (1999), which is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered.
- 3 The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Model indicate it is safe to do so.
- 4 The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site specific conditions.

Ground Gas Protection Measures Required for the Traffic Lights

Traffic Light	Ground Gas Protection Measures Required
Green	Ground gas protection measures not required.
Amber1	Low-level ground gas protection measures are required, using a membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE414. Ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24hrs.
Amber2	High level ground gas protection measures are required, creating a permeability contrast to prevent ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE414. <b>Membranes used should always be fitted by a specialist contractor and should be fully certified.</b> As with Amber1, ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24hrs.
Red	Standard residential housing is not normally acceptable without further Ground Risk Assessment and/or possible remedial mitigation measures to reduce/remove the source of the ground gases. In certain circumstances, active protection methods could be applied, but only when there is a legal agreement assuring the management and maintenance of the system for the life of the property.

It should be noted that at the time of writing this report limited gas monitoring had been undertaken. It is recommended further monitoring is carried out and the above section reviewed accordingly.

#### 10.3.4 Foundations

All site operations, including foundations should take into consideration the potential presence of land gas within the landfill.

Where foundations, such as piles are used, appropriate measures should be taken to protect personnel and equipment from the effects of land gas. Appropriate PPE and safety measures undertaken for personnel entering any excavations.

#### 10.3.5 Water Pipes

It is considered that, due to the levels of contamination on the site, non-standard materials may be required for new water pipes. Further advice should be sought from the local water company.

A direct comparison was made between the soils analyses results and the values given in the Water Regulations Advisory Scheme (WRAS) Guidance Note No. 9-04-03<sup>(2002)</sup>, and is summarised in the following table:

**Soil Results Comparison with WRAS Guidance Note 9-04-03**

Contaminant		Threshold Level (mg/kg)	No. of Samples	Min. (mg/kg)	Max. (mg/kg)	No. of Exceedences
Toxic Substances	Arsenic	10	6	20.5	44.7	6
	Cadmium	3	6	0.6	1.2	0
	Chromium (total)	600	6	26	65	0
	Lead	500	6	54	150	0
	Mercury	1	6	<0.5	<0.5	0
	Selenium	3	6	1.1	2.3	0

#### 10.3.6 Waste Disposal

Any materials removed from site should be disposed of at suitable landfill site, registered to take the levels of contamination encountered in this investigation. In this context Waste Acceptance Criteria (WAC) testing is likely to be required to assist in classifying the material as inert/non-hazardous or hazardous. It is recommended in the first instance the advice of the designated landfill is sought as to the type of waste classification testing required for that landfill site.

#### 10.3.7 Site Personnel

As with all construction sites, personnel working on the site during the construction period should be encouraged to maintain a high standard of personal hygiene and on site washing facilities should be available.

#### 10.3.8 Other Matters

Due diligence is required during the construction period, and should any further evidence of contamination be found, appropriate investigation and / or action should be taken. The significance of any contamination not discovered by this investigation is outside the scope of this report.

It is emphasised that only a small number of tests for contamination have been carried out, and that the possibility of further contamination existing elsewhere on the site cannot be ruled out. CJA does not accept any liability for contamination.

## **11. LIST OF REFERENCES**

Institution of Civil Engineers, Site Investigation Steering Group, *Site investigation in construction series, Part 3: Specification for Ground Investigation*, Thomas Telford Ltd, 1993.

British Standards Institute, *BS 5930: Code of Practice for Site Investigations*, 1999.

British Standards Institute, *BS 1377: British Standard Methods of Test for Soils for Civil Engineering Purposes*, Parts 1 - 9, 1990.

British Geological Survey, Natural Environment Research Council, *1:63360 and 1:50000 Geological maps of England and Wales, map no. 261 & 262*.

British Standards Institute, *BS 10175: Investigation of potentially contaminated sites*, 2001.

Department for Environment, Food and Rural Affairs and the Environment Agency, *Potential Contaminants for the Assessment of Land, CLR 8*. March 2002.

Wilson SA and Card GB, *Reliability and Risk in Gas Protection Design*, Ground Engineering (1999).

NHBC *Guidance on evaluation and development proposals on sites where methane and carbon dioxide are present* Report Edition No. 4 March 2007.

Water Regulations Advisory Scheme Information and Guidance Note (October 2002) No. 9-04-03.

**TABLE 1 - SUMMARY OF EXPLORATORY HOLES**

Hole	Type*	Depth (m)	Date Started	Date Finished	Chainage	Backfill Details**
BH1	RO	16.00	16/10/08	16/10/08	295m	SP
BH2	RO	16.00	17/10/08	17/10/08	150m	SP
TP1	TP	1.50	16/10/08	16/10/08	72m	A
TP2	TP	3.50	16/10/08	16/10/08	145m	A
TP3	TP	3.70	16/10/08	16/10/08	212m	A
TP4	TP	2.10	16/10/08	16/10/08	258m	A
TP5	TP	2.00	16/10/08	16/10/08	325m	A
TP6	TP	3.60	16/10/08	16/10/08	398m	A

\*RO = rotary open hole, TP = Trial Pit,

\*\*A = Arisings, SP = standpipe

**TABLE 2 – SUMMARY OF GAS MONITORING RESULTS**

Hole	Monitoring Date	MONITORING RESULTS					
		Atmospheric Pressure	BH Flow (l/hr)	BH Pressure (Pa)	Methane CH <sub>4</sub> (%)	Carbon Dioxide CO <sub>2</sub> (%)	Oxygen (O <sub>2</sub> ) (%)
BH1 <sup>(2008)</sup>	22/10/2008	1018	0	0	0.5	1.9	14.6
BH2 <sup>(2008)</sup>	22/10/2008	1018	0	0	0.2	0.7	20.5
BHM1 <sup>(1996)</sup>	22/10/2008	1018	0	0	0.3	4.5	17.2
	16/10/2008	1016	0	0	0.2	6.2	15.6
	08/10/2008	1017	0	0	0.0	0.0	18.4
	14/03/1996	1004	-	-	0.06	3.16	17.5
	19/01/1996	1010	-	-	0.6	0.95	19.2
BHM2 <sup>(1996)</sup>	14/03/1996	1004			0.2	1.0	19.8
	19/01/1996	1010			0.02	2.23	17.8
BHM3 <sup>(1996)</sup>	14/03/1996	1004			0.0	0.8	20.2
	19/01/1996	1010			0.02	1.06	20.8
BHM4 <sup>(1996)</sup>	14/03/1996	1004			0.0	0.4	20.9
	19/01/1996	1010			0.02	1.62	19.5
BHM5 <sup>(1996)</sup>	14/03/1996	1004			0.0	0.0	20.8
	19/01/1996	1010			0.02	1.62	19.7
BHM6 <sup>(1996)</sup>	14/03/1996	1004			0.0	0.9	20.0
	19/01/1996	1010			0.02	2.64	18.5

**TABLE 3 - SUMMARY OF GROUND CONDITIONS ENCOUNTERED**

HOLE	Depth to Stratum (m)			GROUNDWATER
	TOPSOIL	MADE GROUND		
		Sandy gravelly CLAY with concrete, brick, wood, plastic, glass, metal, clinker, porcelain	Clayey gravelly SAND with concrete, brick, wood, plastic, clinker, metal,porcelain	
BH1	-	GL – 16.00m		Seepage at 0.70m
BH2	-	GL – 16.00m		Seepage at 11.50m
TP1	GL-0.15	0.15 – 1.30	1.30 – 1.50	Seepage at 0.23m
TP2	GL-0.15	0.70 – 3.50	0.15 – 0.70	Dry
TP3	GL-0.15	0.15 – 3.70		Dry
TP4	GL-0.10	0.10 – 2.10		Dry
TP5	GL-0.10	1.55 – 2.00	0.10 – 1.55	Dry
TP6	GL-0.20	0.20 – 3.60		Dry

**TABLE 4 – LABORATORY SOIL CONTAMINATION TEST RESULTS**

Exploratory Hole		TP1	TP2	TP3	TP4	TP5	TP6
Depth (m)		0.60	0.70	0.80	1.00	1.80	0.30
Contaminant	Units						
Arsenic	mg/kg	21.6	20.5	44.7	38.1	23.0	27.8
Cadmium	mg/kg	0.6	0.8	1.2	0.9	0.9	1.2
Chromium	mg/kg	26	38	65	36	36	42
Lead	mg/kg	68	87	125	72	150	54
Mercury	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	mg/kg	24	22	52	37	29	27
Copper	mg/kg	33	25	59	25	17	18
Zinc	mg/kg	139	174	989	655	157	276
Selenium	mg/kg	1.3	1.1	2.0	1.7	1.5	2.3
Water Soluble Boron	mg/kg	1.0	0.9	<0.5	<0.5	<0.5	<0.5
PCB28	µg/kg	<10	<10	<10	<10	<10	<10
PCB52	µg/kg	<10	<10	<10	<10	<10	<10
PCB101	µg/kg	<10	<10	<10	<10	<10	<10
PCB118	µg/kg	<10	<10	<10	<10	<10	<10
PCB138	µg/kg	<10	<10	<10	<10	<10	<10
PCB153	µg/kg	<10	<10	<10	<10	<10	<10
PCB180	µg/kg	<10	<10	<10	<10	<10	<10
Acetone	µg/kg	<10	<10	<10	<10	<10	<10

**TABLE 5 – LABORATORY GROUNDWATER CONTAMINATION TEST RESULTS**

Exploratory Hole		BH1	BH2	BH1	BH2
Sample Type		Drilling Sample	Drilling Sample	Monitoring Sample	Monitoring Sample
Contaminant	Units				
Arsenic	µg/l	<5	<5	11	6
Cadmium	µg/l	<1	<1	<1	<1
Chromium	µg/l	<5	<5	7	8
Lead	µg/l	<1	<1	<1	<1
Nickel	µg/l	4	5	9	9
Copper	µg/l	5	8	<5	8
Zinc	µg/l	37	28	21	25
Mercury	µg/l	<0.1	<0.1	<0.1	0.1
Selenium	µg/l	<5	<5	<5	<5
Boron	µg/l	392	357	<5	<5
PCB28	µg/l	<0.1	<0.1	<0.1	<0.1
PCB52	µg/l	<0.1	<0.1	<0.1	<0.1
PCB101	µg/l	<0.1	<0.1	<0.1	<0.1
PCB118	µg/l	<0.1	<0.1	<0.1	<0.1
PCB138	µg/l	<0.1	<0.1	<0.1	<0.1
PCB153	µg/l	<0.1	<0.1	<0.1	<0.1
PCB180	µg/l	<0.1	<0.1	<0.1	<0.1
Acetone	µg/l	<1	<1	<1	<1



## **APPENDICES**

# HISTORICAL MAP EXTRACTS

# Historical Mapping Legends

## Ordnance Survey County Series and Ordnance Survey Plan 1:2,500

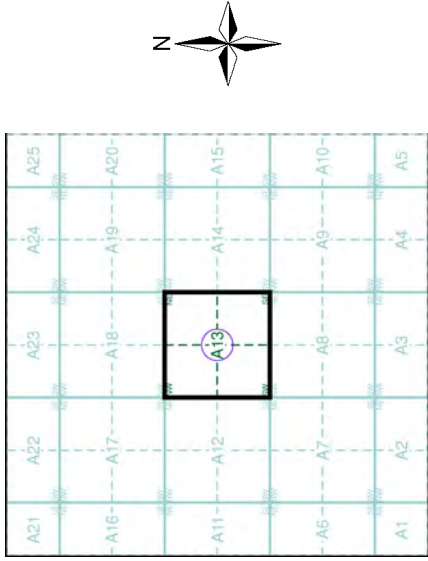

## Ordnance Survey Plan, Additional SIMs and Supply of Unpublished Survey Information 1:2,500 and 1:1,250


## Large-Scale National Grid Data 1:2,500 and 1:1,250


## Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Glamorganshire	1:2,500	1875 - 1877	2
Glamorganshire	1:2,500	1899	3
Glamorganshire	1:2,500	1919	4
Glamorganshire	1:2,500	1940 - 1941	5
Ordnance Survey Plan	1:1,250	1964 - 1982	6
Additional SIMs	1:1,250	1964 - 1985	7
Ordnance Survey Plan	1:1,250	1968 - 1990	8
Ordnance Survey Plan	1:2,500	1971	9
Additional SIMs	1:1,250	1983 - 1992	10
Ordnance Survey Plan	1:1,250	1987	11
Additional SIMs	1:2,500	1987	12
Additional SIMs	1:2,500	1989	13
Additional SIMs	1:1,250	1989 - 1993	14
Additional SIMs	1:1,250	1992	15
Large-Scale National Grid Data	1:1,250	1993	16
Large-Scale National Grid Data	1:1,250	1993 - 1995	17
Large-Scale National Grid Data	1:1,250	1994	18
Large-Scale National Grid Data	1:1,250	1994	19
Large-Scale National Grid Data	1:1,250	1996	20

## Historical Map - Segment A13



## Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

## Site Details

Waunscoil Avenue, Brackla, Bridgend

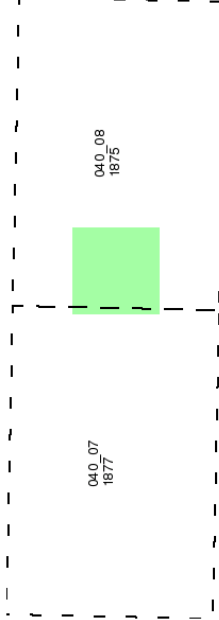
Glamorganshire

Published 1875 - 1877

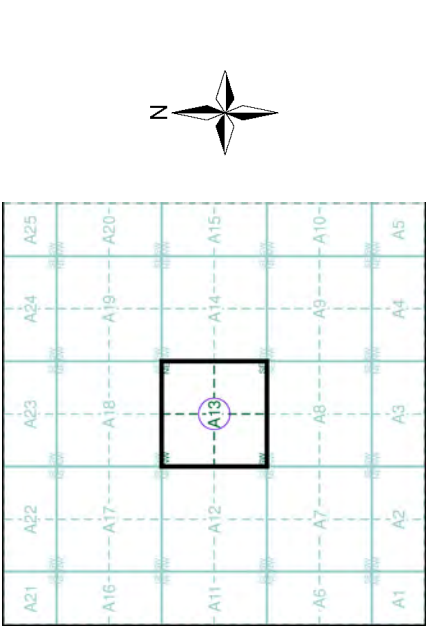
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunscoil Avenue, Brackla, Bridgend



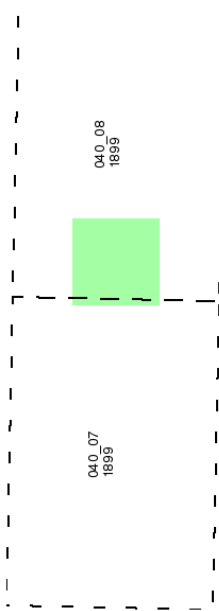
Glamorganshire

Published 1899

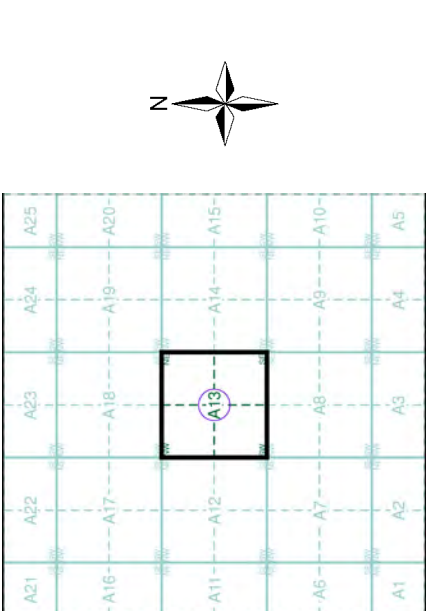
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunscoil Avenue, Brackla, Bridgend

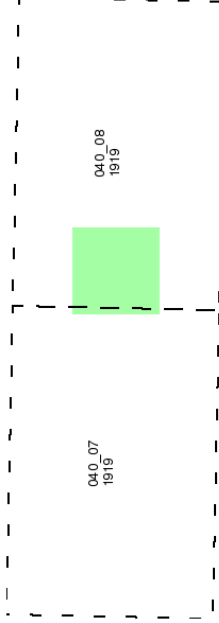
Glamorganshire

Published 1919

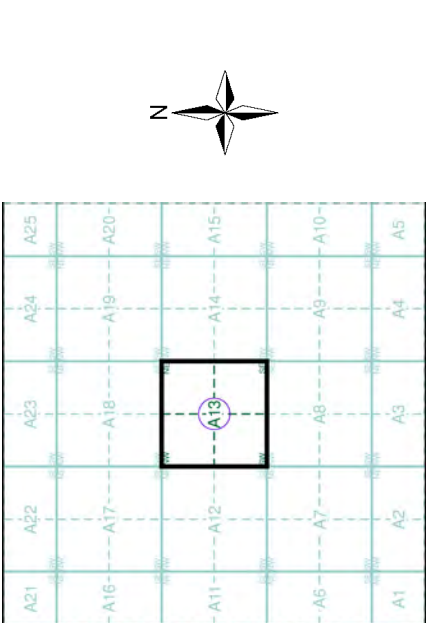
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunsell Avenue, Brackla, Bridgend



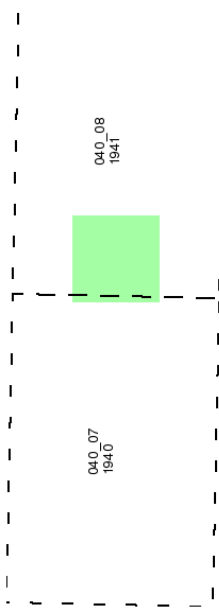
Glamorganshire

Published 1940 - 1941

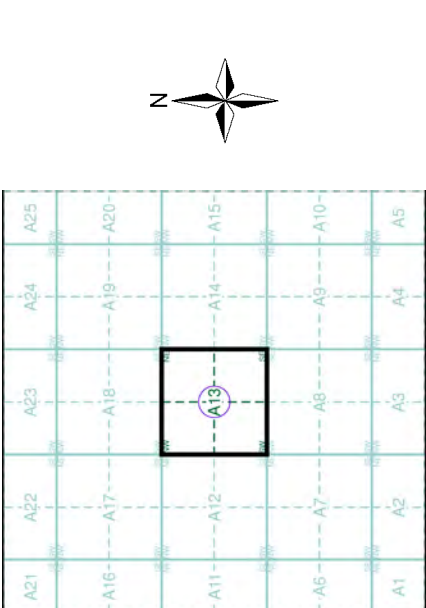
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunscoil Avenue, Brackla, Bridgend



Ordinance Survey Plan

Published 1964 - 1982

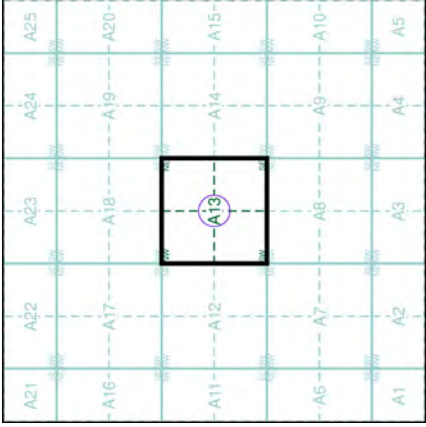
Source map scale - 1:1,250

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)

SS9080SE 1964	SS9180SW 1964	SS9180SE 1981
SS9079NE 1964	SS9179NW 1964	SS9179NE 1982

Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunsell Avenue, Brackla, Bridgend



Additional SIMs

Published 1964 - 1985

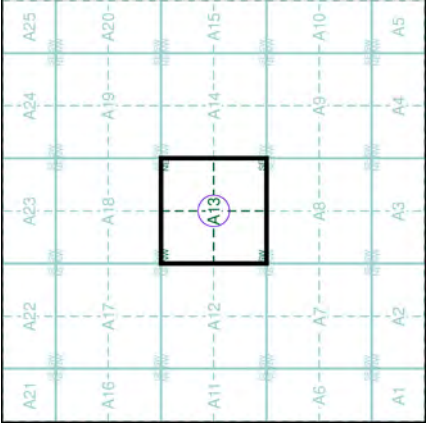
Source map scale - 1:1,250

The SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SS0080SE	SS9180SW	SS9180SE
1985	1964	1984
SS079NE	SS9179NW	SS9179NE
1978	1979	1985

Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Wauonscil Avenue, Brackla, Bridgend



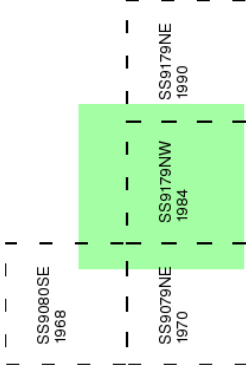
Ordinance Survey Plan

Published 1968 - 1990

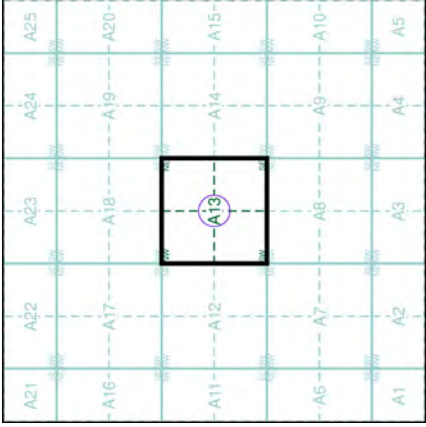
Source map scale - 1:1,250

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunscoil Avenue, Brackla, Bridgend



Ordnance Survey Plan

Published 1971

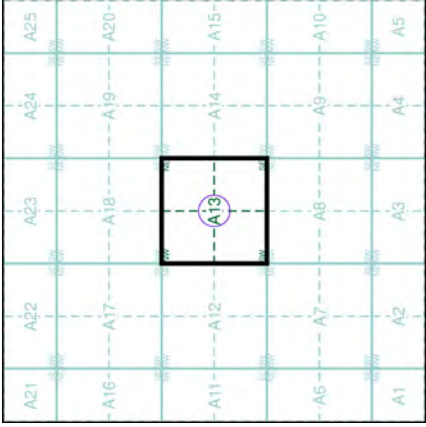
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)

SS9080	1971	SS9180	1971
SS9079	1971	SS9179	1971

Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunscoil Avenue, Brackla, Bridgend



Additional SIMs

Published 1983 - 1992

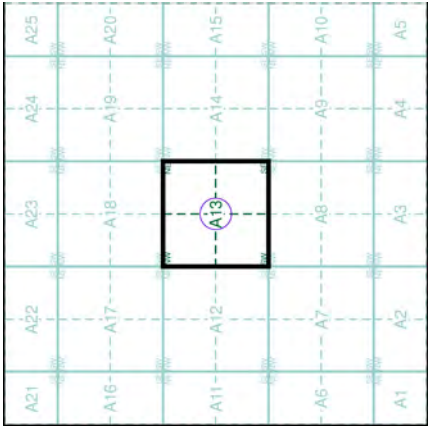
Source map scale - 1:1,250

The SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SS9080SE	1991	SS9180SW	1983	SS9180SE	1990
SS9079NE	1984	SS9179NW	1992	SS9179NE	1987

Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunscoil Avenue, Brackla, Bridgend

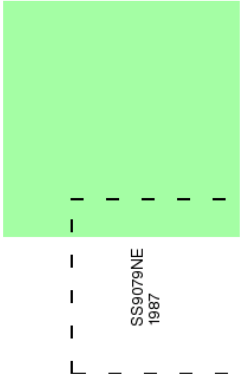
Ordinance Survey Plan

Published 1987

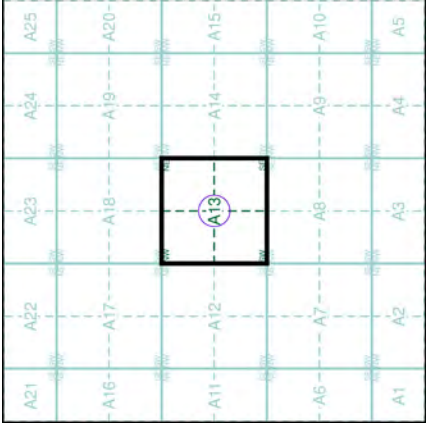
Source map scale - 1:1,250

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1

Customer Ref: W1029

National Grid Reference: 291230, 179860

Slice: A

Site Area (Ha): 0.01

Search Buffer (m): 100

Site Details

Waunscoil Avenue, Brackla, Bridgend





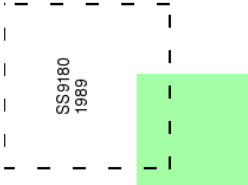
Additional SIMs

Published 1989

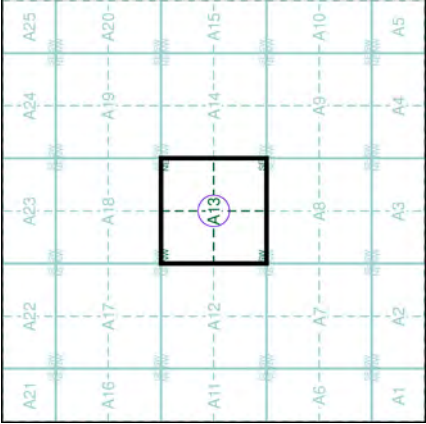
Source map scale - 1:2,500

The SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunscoil Avenue, Brackla, Bridgend





Additional SIMs

Published 1992

Source map scale - 1:1,250

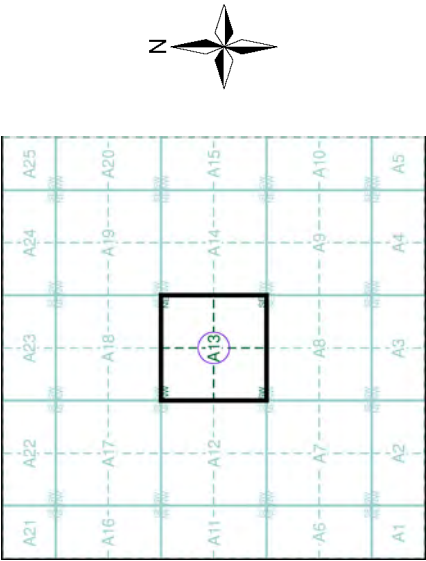
The SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SS9180SW

1992

Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunsell Avenue, Brackla, Bridgend

Large-Scale National Grid Data

Published 1993

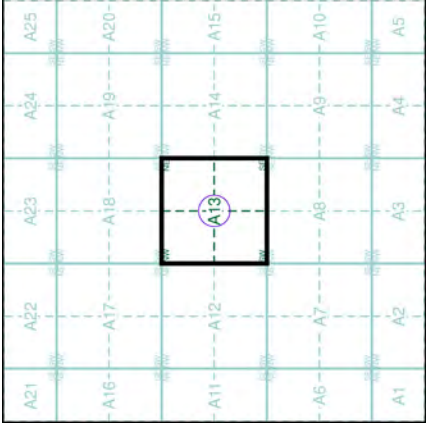
Source map scale - 1:1,250

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the forerunners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SS9080SE 1993	SS9180SW 1993	SS9180SE 1993
SS9079NE 1993	SS9179NW 1993	SS9179NE 1993

Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunscoil Avenue, Brackla, Bridgend



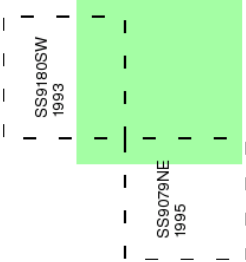
Large-Scale National Grid Data

Published 1993 - 1995

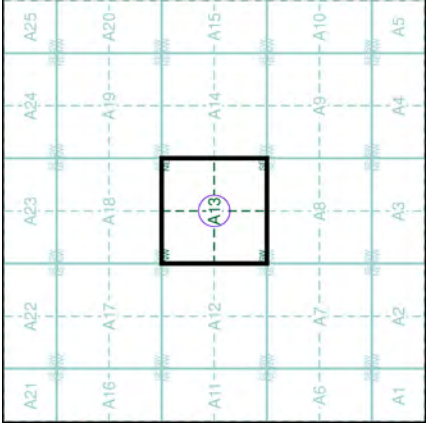
Source map scale - 1:1,250

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the forerunners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunsell Avenue, Brackla, Bridgend

Large-Scale National Grid Data

Published 1994

Source map scale - 1:1,250

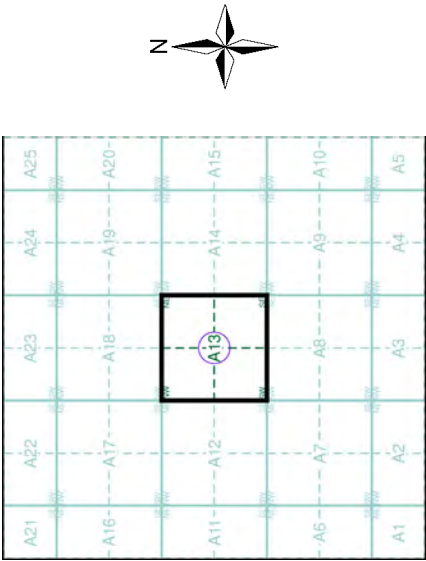
'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SS9180SW

1994

Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunsell Avenue, Brackla, Bridgend



Large-Scale National Grid Data

Published 1996

Source map scale - 1:1,250

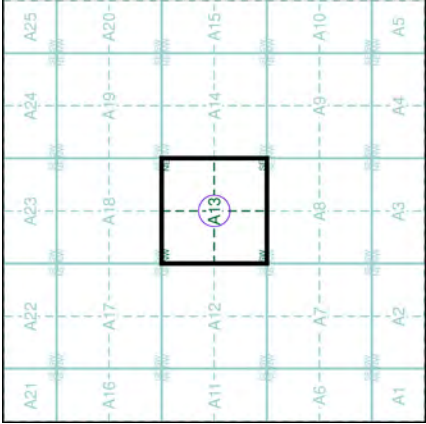
'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SS9180SW

1996

Historical Map - Segment A13



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860  
Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 100

Site Details

Waunsell Avenue, Brackla, Bridgend



Historical Mapping Legends

Ordnance Survey County Series and  
Ordnance Survey Plan 1:10,560

Gravel Pit

Quarry

Osiers

Mixed Wood

Fir

Sand Pit

Shingle

Reeds

Deciduous

Furze

Other Pits

Orchard

Marsh

Brushwood

Rough Pasture

Arrow denotes flow of water

Site of Antiquities

Pump, Guide Post, Signal Post

Surface Level

Trigonometrical Station

Bench Mark

Well, Spring, Boundary Post

Ordnance Survey Plan 1:10,000

Chalk Pit, Clay Pit or Quarry

Sand Pit

Refuse or Slag Heap

Dunes

Coniferous Trees

Orchard

Bracken

Marsh

Building

Glasshouse

Gravel Pit

Disused Pit or Quarry

Lake, Loch or Pond

Boulders

Non-Coniferous Trees

Coppice

Rough Grassland

Saltings

Direction of Flow of Water

Shingle

Sand

1:10,000 Raster Mapping

Gravel Pit

Rock

Boulders

Shingle

Sand

Slopes

General detail

Overhead detail

Multi-track railway

County boundary (England only)

District, Unitary, Metropolitan, London Borough boundary

Area of wooded vegetation

Non-coniferous trees (scattered)

Coniferous trees (scattered)

Orchard

Rough Grassland

Scrub

Water feature

Mean high water (springs)

Telephone line (where shown)

Bench mark (where shown)

Point feature (e.g. Guide Post or Mile Stone)

Site of (antiquity)

General Building

Refuse tip or slag heap

Rock (scattered)

Boulders (scattered)

Mud

Sand Pit

Top of cliff

Underground detail

Narrow gauge railway

Single track railway

Civil, parish or community boundary

Constituency boundary

Non-coniferous trees

Coniferous trees

Positioned tree

Coppice or Osiers

Heath

Marsh, Salt Marsh or Reeds

Flow arrows

Mean low water (springs)

Electricity transmission line (with poles)

Triangulation station

Pylon, flare stack or lighting tower

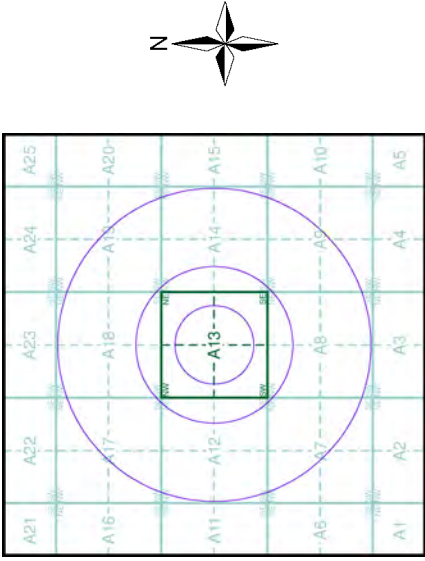
Glasshouse

Important Building

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Glamorganshire	1:10,560	1885	2
Glamorganshire	1:10,560	1900	3
Glamorganshire	1:10,560	1921	4
Historical Aerial Photography	1:10,560	1947 - 1949	5
Historical Aerial Photography	1:10,560	1947	6
Glamorganshire	1:10,560	1951 - 1952	7
Ordnance Survey Plan	1:10,560	1964	8
Ordnance Survey Plan	1:10,000	1972 - 1974	9
Ordnance Survey Plan	1:10,000	1983 - 1987	10
Ordnance Survey Plan	1:10,000	1992 - 1995	11
10K Raster Mapping	1:10,000	1999	12
10K Raster Mapping	1:10,000	2008	13

Historical Map - Slice A



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860

Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 1000

Site Details

Waunscoil Avenue, Brackla, Bridgend



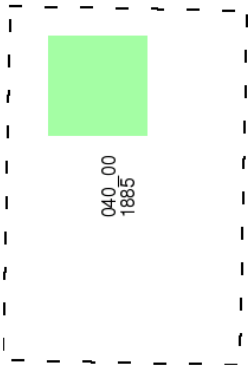
Glamorganshire

Published 1885

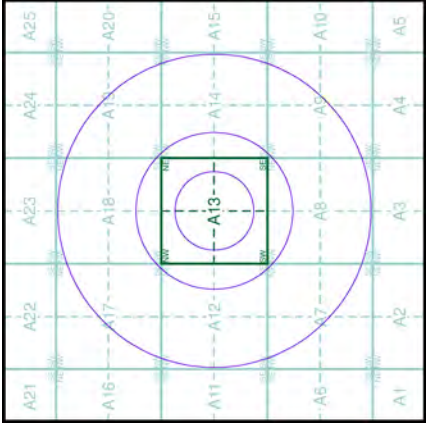
Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number: 26614908\_1\_1  
Customer Ref: W1029  
National Grid Reference: 291230, 179860

Slice: A  
Site Area (Ha): 0.01  
Search Buffer (m): 1000

Site Details

Waunscoil Avenue, Brackla, Bridgend