



Ref:13627

I & H BROWN

MAELOR WORKS, WREXHAM (SITE CODE 138S)

AREAS A AND C STAGE 1 RISK MITIGATION WORKS FACTUAL REPORT

13627-REP-002

July 2014

Head Office:

Park House
39 Boness Road
Grangemouth
Stirlingshire
FK3 8AN
Tel: +44 (0)1324 878822
Fax: +44 (0)1324 878823

Email: info@ikmconsulting.co.uk

Glasgow Office:

40 Berkeley Street
Glasgow
G3 7DW

Tel: +44 (0)141 225 5110
Fax: +44 (0)141 225 4107

Email:
glasgow@ikmconsulting.co.uk

Registered Office: Park House, 39 Boness Road, Grangemouth, Stirlingshire, FK3 8AN
Registered in Scotland: SC179251

www.ikmconsulting.co.uk

Revision History

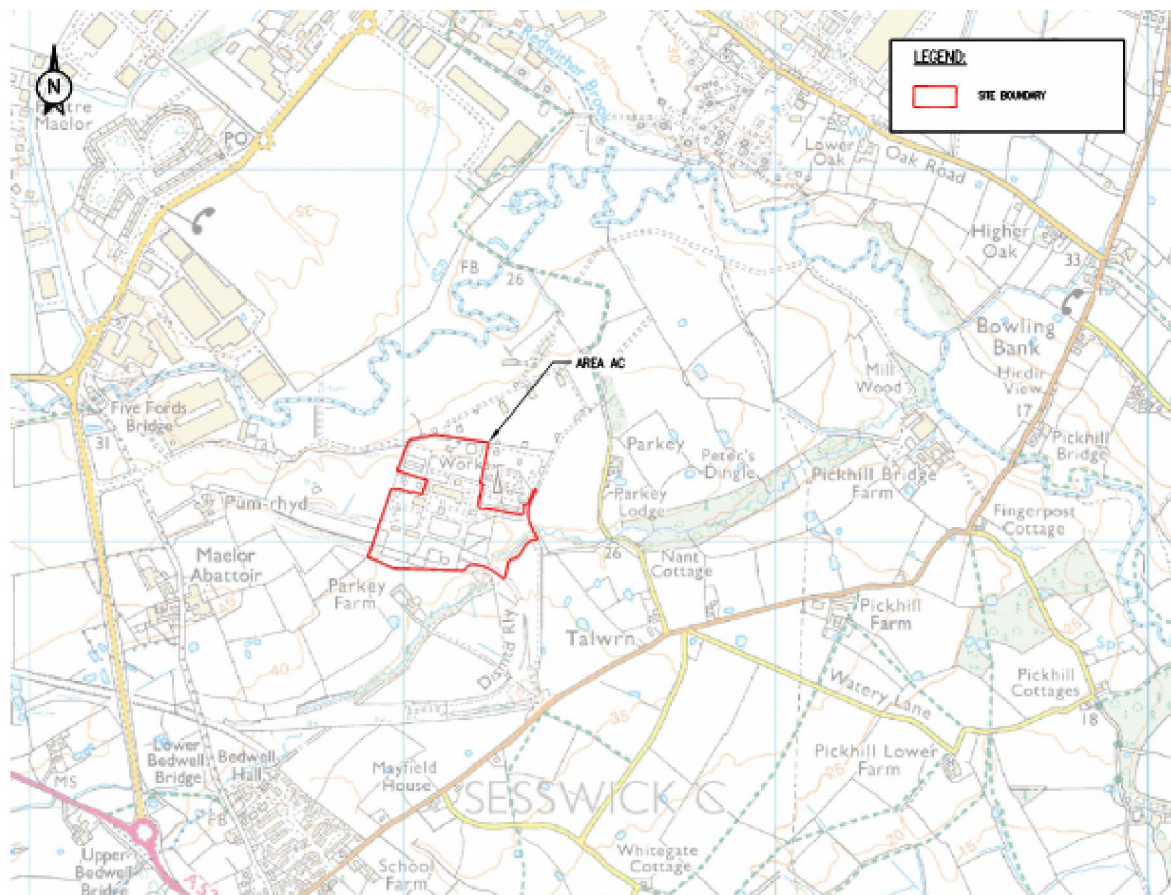
Revision History

[illegible]

National Grid Property Holdings Ltd, Maelor Works, Wrexham
Areas A and C Stage 1 Risk Mitigation Works Factual Report

13627-REP-002
Reporting Insert

Main Site Area A and C, Maelor Works, Wrexham, Clywd



Site Address:	Maelor Works, Marchwiell, Wrexham	NGP Document Tracking Code	
Report Title:	AREAS A AND C STAGE 1 RISK MITIGATION WORKS FACTUAL REPORT MAELOR WORKS, WREXHAM		
Report Type:	Contamination	Retention Period	Indefinitely
Site Code:	138S (part)	Author (Company)	IKM Consulting Ltd
Report Date:	26 June 2014	Factual/Interpretative	Factual
Draft/Final	Final	H&S File	Yes
Work Stage:*	Site Investigation		
Brief Description of Contents	Preliminary Site investigation Factual Report		
Access Permitted:	NGPH Land Regeneration Team	NGPH Contact	Matt Pearce

I & H BROWN

MAELOR WORKS, WREXHAM (SITE CODE 138S)

AREAS A AND C STAGE 1 RISK MITIGATION WORKS FACTUAL REPORT

CONTENTS

	EXECUTIVE SUMMARY	1
1.	INTRODUCTION	4
1.1	Background	4
1.2	Scope	4
1.3	Disclaimer	4
1.4	Project Contact List	5
2.	SITE INFORMATION	8
2.1	General	8
2.2	Site Occupation	10
2.3	Utilities	10
2.4	Site History	12
2.5	Adjoining Areas	13
2.6	Potentially Contaminative Land Uses	14
2.7	Nearby Sensitive Land Uses	16
2.8	Surrounding Area	16
3.	ENVIRONMENTAL SETTING	18
3.1	Geology	18
3.2	Mining	18
3.3	Hydrogeology	19
3.4	Hydrology	20
3.5	Discharge Consents	21
3.6	Landfill Sites	21
3.7	Waste Management Licenses	21
3.8	COMAH Reports	22
3.9	Conservation Areas	22

4.	HISTORICAL DEVELOPMENT	23
4.1	Previous Investigation and Remediation	24
5.	SITE INVESTIGATION AND METHODOLOGIES	25
5.1	Scope of Work	25
5.2	Fieldwork	26
5.2.1	Ecological Survey	26
5.2.2	Radiological Survey	27
5.2.3	Trial Pits and Boreholes	27
5.3	Ground Conditions	29
5.3.1	Area AC1	29
5.3.2	Area AC2	30
5.3.3	Area AC3	31
5.3.4	Area AC4	31
5.4	Field Records and Contamination Observations	32
5.5	Groundwater and Surface Water Monitoring	40
5.6	Incidents	47
5.7	Laboratory Analysis	47
5.7.1	Water	48
5.7.2	Leachate	48
5.8	Quality Assurance & Control	48
6.	REFERENCES	49

DRAWINGS

A3-13627-3057	Areas A and C Site Location Plan
A1-13627-3017	Tile Layout Plan
A1-13627-3048	Service Drawing
A1-13627-3018	Exploratory Holes Layout Plan - AC1
A1-13627-3019	Exploratory Holes Layout Plan - AC2
A1-13627-3021	Exploratory Holes Layout Plan - AC4
A1-13627-3011	Exploratory Holes Layout Plan - Area A
A1-13627-3020	Exploratory Holes Layout Plan - AC3
A1-13627-3038	Visual Contamination AC1
A1-13627-3039	Visual Contamination AC2
A1-13627-3040	Visual Contamination AC3
A1-13627-3041	Visual Contamination AC4
A1-13627-3014	Asbestos Testing Location Plan - Area A

A1-13627-3007	Area AC1 Constraints Plan
A1-13627-3008	Area AC2 Constraints Plan
A1-13627-3009	Area AC3 Constraints Plan
A1-13627-3010	Area AC4 Constraints Plan

APPENDICES

Appendix A Ecological Survey Report

Appendix B Trial Pit Photographs and Logs

Appendix C Borehole Logs

Appendix D Radiological Survey Report

Appendix E Utility Survey

Appendix F Laboratory Analysis Certificates

Appendix G Compiled Analytical Data

Appendix H Refurbishment & Demolition Survey (Asbestos)

Appendix I Photographic Records

Appendix J Historical Maps

Appendix K QA/QC Laboratory Data

Appendix L Site Diaries

Appendix M Controlled Waste Certificates

Appendix N Wrexham Service Plans

Appendix O CD Format: DETS Laboratory QA/QC Information

Appendix P CD Format: Data Tables

File Name: 13627-REP-002.doc
Version: v3

Prepared By:	Mark Sweeney	Date:	07 July 2014	Initials:	
Checked By:	Jeremy Fox	Date:	07 July 2014	Initials:	

EXECUTIVE SUMMARY

Site Information

The site is an area of mixed commercial use (open storage and offices) and unused open land, known as Areas A and C of the Maelor Works, Marchweil, Wrexham. LL13 0UW. National Grid reference: SJ38087 48086. The site forms the majority of a large NGPH landholding with Site Code Ref: 138S. The site is accessed by a dedicated private roadway leading into the site from the B5130 public highway to the south. There are also various boundary fence access points into the site from surrounding privately owned farmland.

Site History

The site was originally open farmland that was developed into a small part of the extensive former Royal Ordnance Factory (ROF) Wrexham, the majority of which lay to the north of the site. Following closure of the ROF, the site was redeveloped as a large coal and ultimately oil fuelled town gas manufacturing works. Following closure of the gasworks in the 1970s, the site has been used for a variety of gas distribution related activities, with some new office buildings constructed over the footprint of the former gasworks. Other parts of the site have been used for the storage of containerised gas (Flogas) and portions of the site have been sold to a separate gas utility company (Wales and West Utilities). Large parts of the northern and southeastern sectors of the site have essentially been disused since the closure of the gasworks operations.

Geology

The site is underlain by significant thicknesses of glacial drift, including laterally impersistent sands and gravels that have been deposited on extensive cohesive Boulder Clay strata, thought to extend right across the site area and to depths in excess of 10 metres below ground level.

Due to the extensive earthworks and levelling associated with the site development and the subsequent demolition of major gasworks structures, Made Ground is present across the entire surface of the site, with a wide variety of composition and thicknesses proven.

The depth to bedrock, indicated on maps as being Triassic Sherwood Sandstone or Carboniferous Coal Measures, is unknown.

Hydrology and Hydrogeology

Due to its artificial landform, the majority of the site does not contain any natural watercourses, or receive runoff from surrounding land. Artificial surface water drainage systems are provided for the whole of the developed area of the site, with discharges from these drains known to be directed either to agricultural ditches to the north, or to the Bedwell Brook surface watercourse that actually flows through the south easternmost corner of the site.

The next nearest surface water course is the River Clywedog, approximately 120m northwest of the site, known to be connected to the site area via agricultural ditches and field drains.

Granular drift deposits on the site are water bearing at shallow depth, with the underlying clay rich glacial drift (Boulder Clay) effectively preventing free drainage of shallow groundwater into bedrock aquifers.

Site Works

Recent site investigations were conducted as part of Stage 1 Risk Mitigation investigations for the Maelor Works site as a whole. The works included a preliminary ecological appraisal report; a programme of trial pitting and drilling for sub-surface visual inspection and sampling; a radiological survey to confirm the absence of significant radiation issues arising from identified historical oil gas manufacturing activities; monitoring and sampling of groundwater beneath the site area and surface water courses around the site boundaries; and utility and building (pre-demolition asbestos) surveys within the main site area.

Previous Investigation and Remediation

The site has been subject to extensive previous site investigations, dating back at least to 1999. A number of small scale remediation projects have also been undertaken, within the site area and on land owned by WWU. These have involved the emptying of tar tanks in the west of the site; the removal of spent oxide deposits in the northern sector; and the removal of hydrocarbon contaminated soil in the southern sector and on the western WWU land area. The remainder of the former gasworks operational area has been levelled, but remains unremediated below the ground surface.

1. INTRODUCTION

1.1 Background

Land nominated (by National Grid Property Holdings – NGPH) as Areas A and C is part of a large landholding that covers the majority of the Maelor Works site, which in turn was previously a large coal and oil town gas manufacturing site.

1.2 Scope

IKM Consulting Limited has been commissioned by I&H Brown Limited (IHB) to act as their designers for the Maelor Works Gasworks Remediation Project. As part of their project brief, IKM has undertaken an initial site assessment and outline remediation design (of the whole Maelor Works site) as part of the original project tender submission, followed by additional site investigations to supplement existing site information, as a precursor to detailed risk assessment and remediation design work.

This report presents the results of the additional site investigation works carried out on selected parts of the site in November/December 2013, and relates only to the main site area (Area AC). Separate Factual Reports are available for the adjacent NGPH land (Area B).

1.3 Disclaimer

This report is based upon the information available to IKM Consulting Ltd at the time of preparing the report. The information provided to IKM Consulting Ltd by other consultants in connection with the preparation of this report is believed to be accurate to the best of IKM's knowledge. IKM shall not be held responsible for the negligence, error or omissions of other consultants. IKM Consulting Ltd does not accept any responsibility for the use of this report by any third party other than those third parties identified in the term deed.

1.4 Project Contact List

Client	National Grid Property Holdings Ltd	Contact Mobile No	Matt Pearce 07768 036925
	National Grid House Warwick Technology Park Gallows Hill Warwick CV34 6DA	Embedded AOC Mobile No	Sarah Helby 0758 4496003
Principal Contractor	I & H Brown Ltd PO Box 51 Dunkeld Road Perth PH1 3YD	Contact Tel No	Alex Mark 01738 637171
		Mobile No	07775 818204
		Design Co-ordinator Tel No	James Wood 01738 637171
Consultant	IKM Consulting Ltd Park House 39 Bo'ness Road Grangemouth FK3 9AR	Mobile No	07917 410236
		Contact Tel No	Liz Copland 01324 878822
		Lead Engineer Mobile No	Mark Sweeney 07934 396404
		Mobile No	David Cooke 07966 126240
CDM Co-ordinator	Parsons Brinckerhoff Manchester Technology Centre Oxford Road Manchester M1 7ED United Kingdom	Director Tel No	Alistair Kean 01324 878822
		Contact Tel No	TBC
		Mobile No	
Contractors	<u>Service Tracing and Equipment</u> L & M Survey Services Ltd Netherton House West Netherton Street Kilmarnock KA1 4BU	Contact Tel No	Tracey Boyd 01563 533368

Contractors (cont.)	<u>Sample Analysis (Soils and Groundwater)</u> Derwentside Environmental Testing Services Unit 2 Park Road Industrial Estate Consett Co Durham DH8 5PY	Contact Tel No	Adam Fenwick 01207 582333
	<u>Topographical Survey</u> Cheshire Surveys Ltd Unit 18 Barrowmore Enterprise Estate Barnhouse Lane Chester Cheshire CH3 7JS	Contact Tel No	Martin Crank 01829 741859
	<u>Drilling/Trial Pits</u> Rotary Test Drilling Marshes Farm Coach Road West Houghton Bolton BL5 2BT	Contact Tel No	R T Dainton 01942 810348
	<u>Radiological Survey</u> Aurora Health Physics Services Ltd 3 The Terrace Library Avenue Harwell Oxford Oxfordshire OX11 0SG	Contact Tel No	Allan May 01235 820049
	<u>Pump Test</u> Geo2 Remediation Ltd Units 7 Ferrybridge Workspace Pontefract Road Ferrybridge WF11 8PL	Contact Tel No	Adam Wilson 01977 674113
	<u>Soil Stabilisation Contractor</u> HBR Ltd Coggeshall Road Earls Colne Essex CO6 2JX	Contact Tel No Mobile No	Dr Chris Evans 01787 222768 07748 760887

Contractors (cont.)	<u>Ecological Survey</u> Evolution Ecology Ltd Park Hall Farm Brookhouse Road (Trimpos) Cheadle Staffordshire ST10 2NJ	Contact Mobile No	Dr. Paul Keeling 07838377612
Engineering Consultant	WorleyParsons 3-8 Redcliffe Parade West Bristol BS1 6SP	Project Manager Mobile No	Sam Martin 07717 822192
		NEC Project Manager Tel No Mobile No	Allen Murray 0117 910511 0767 528480
Public Relations	JBP The white House 6 Whiteladies Road Lifton Bristol BS8 1PD	Contact Tel No Mobile No	Matthew Thompson 01179 072713 07525 071692

2. SITE INFORMATION

2.1 General

The site is known as Maelor Works, Marchwiel, Wrexham LL13 0UW. The centre of the site has a National Grid Reference SJ38087 48086. The site area forms the majority of the wider NGPH landholding at Maelor Works, with the site reference number 138S.

The site is situated in a largely rural setting, albeit that the surrounding area was formerly part of the Royal Ordnance Factory (ROF) Wrexham facility, which consisted of widely scattered manufacturing and small storage facilities in the predominantly open land to the north. The main manufacturing area for the ROF is now occupied by Wrexham Industrial Estate, approximately one kilometre to the northwest. A few remnant brick built buildings from the ROF lie in the fields immediately to the north of the site.

The shallow River Clwedog river valley lies immediately to the north of the site, with the river some 120m away at its closest point. The river flows west to east past the site. A second smaller watercourse, Bedwell Brook, flows towards the site from the west and passes through a culvert under the former railway line embankment, on the southern boundary of the site, before entering and flowing in a steep sided valley through the south easternmost corner of the site area.

A number of long established farms are located around the site boundary to the west, south and northeast.

The site is accessed via a private access road that leads north from the B5130 public road to the south of the site. The site area is completely surrounded by a boundary fence, with a number of secured access points from the surrounding third party agricultural land, including a long established un-surfaced track way that passes the northwest corner of the site and continues along the northern boundary and away to the northeast.

The following text has been taken from Ref 4 (Worley Parsons, 2012). Worley Parsons – *Environmental Assessment Site Investigation Report, Maelor Works, Wrexham*. Report No. 50065-29, January 2012.

“The site is generally flat and lies at an average elevation of approximately 35 metres above ordnance datum (mAOD). The site is believed to have been built up during its development as the site is higher than the surrounding land. The site boundaries generally consist of steep slopes leading to the lower land beyond the site boundary.

Groundcover at the site is a mixture of hardcover, gravel and made ground with areas vegetated with grass, trees and shrubs. The following summarises the approximate percentage of each type of cover:

Buildings/structures – 25 %

Hardstanding – 20 %

Exposed soil – not present

Vegetation/scrub/landscaped areas – 35 %

Gravel/loose fill – 20 %

The north of the site is predominantly vegetated with grass, trees and shrubs, particularly on the northern boundary which borders with an access lane, beyond which is agricultural land. The centre of the site is covered with buildings and hard standing comprising concrete and tarmac. The north-west corner of the site is covered in concrete hard standing, the footprint of the former purifiers. Trees are growing through cracked portions of the concrete. In the south-west of the site to the north of the workshops buildings tenanted by W&WU, the ground comprises compacted gravel often with loose limestone chippings above. In addition, occasional landscaped embankments exist along the roadways. In the far south of the site within the FloGas compound, the LPG bottle storage area is formed of compacted gravels. The far south east of the site comprises grass fields leading to Bedwell Brook.”

2.2 Site Occupation

The site can be split into two main areas (nominated by NGPH as Area A and Area C), with the following land uses:

- Area A – the central part of the site, including most of the former gas works manufacturing and processing areas; now occupied by administrative and workshop buildings, large areas of open storage compounds and car parking, as well as a large derelict office building. Occupied offices are a mixture of modern buildings built since the cessation of gas manufacture and reused gasworks buildings.
- Area C – a large area of un-occupied, vacant land across the whole northern sector of the site area. This part of the site has some hardstanding and foundation slabs from previous development, but is largely covered by exposed Made Ground materials. A single brick built former ROF building (known as the Paint Store) sits in the centre of the area, with a small ephemeral pond in the open ground just to the west.
- Land immediately to the east of Area C and a small compound between Area A and Area C on the western boundary of the site are both owned by Wales and West Utilities Limited (WWU) and are excluded from the NGPH site area and from investigations recorded in this report.
- Small parts of the NGPH landholding outwith the current perimeter fence have been nominated as Areas B East and West and are also excluded from consideration in this report. Separate Factual Reports are available for these areas.

Current land ownership boundaries and site area designations are shown in Drawing A1-13627-3017.

2.3 Utilities

The site area is heavily constrained by a wide variety of underground service constraints, associated with both historical activities and current utility provision and surface water drainage.

Previous site investigation reports have attempted to compile underground and over ground service records for the site, most recently as Figure 3 in the Worley Parsons 2012 Factual Report (Ref. 4).

In addition, L and M Survey Services Limited (L&M) were present on site for two days from 18/11/13, for a service survey of the main site in advance of the Stage 1 intrusive investigations being reported here. Vacuum extraction was also performed at the start of the works under supervision of IHB to expose the location of several of the major gas services across site prior to excavation works commencing.

All identified services are shown on Drawing A1-13627-3048, based on Figure 3 from the Worley Parsons 2012 report.

The original plans from the L&M surveys can be found in Appendix E.

A high pressure gas mains runs west to east across the south of the site area, before diverting northeast, towards an Above Ground Installation (AGI) compound owned by WWU to the east of Area C. A high pressure gas main also runs east to west across the site, to the north of the workshops and former North East Wales district offices.

A medium pressure gas main enters the site in the southwest (at the boundary with Area B West), and runs to the east, passing through the access gate to the FloGas butane storage area and leads in a south easterly direction out of the site.

Underground low pressure gas mains; electricity and telephone cables; and water and foul drainage pipes transverse across the majority of the site area in dense service corridors or individually, between on-site buildings.

A dense network of largely historical surface drainage is also present across the majority of the site area. Area C surface water drains are believed to lead largely to field drains and ditches in the land to the north of the site, while the majority of Area A, including the extensive car park and open storage yards, are believed to lead to discharge points on the northern bank of Bedwell Brook in the southeast corner of the site.

Water mains enter the site from the north and are thought to be split between those intended to act as firewater supply and those supplying water to the various occupied buildings. It is known that there are a number of long standing leaks within the site area (exact location not determined) and due to concerns over the quality of the water supply, it is no longer used for potable supply.

2.4 Site History

The land use history for the site and surrounding area has been summarised using the series of Ordnance Survey (OS) maps included in an Envirocheck report (Landmark, 2006) from Ref 4 (WP 2011 Factual Report). Copies of the OS maps are contained in Appendix J. Photographs of the construction of the gasworks and an article on the works provided by W&WU (also taken for Ref. 4) have been used to supplement this discussion (copies also contained in Appendix J).

The OS plans provide a broad indication of site details only. In most cases, the names of buildings are not provided on the OS maps hence these titles have been inferred from gas board plans available to previous assessors.

Relevant extracts from Ref. 4 are provided below:

“Prior to 1940 the site was open farmland. In 1940 the area was incorporated into the Royal Ordnance Factory (ROF) Marchwiel. ROF Marchwiel consisted of a number of production units, widely separated to minimise the damage done should there be an explosion. The site of the Maelor Works occupies what was an extension area to ROF Marchwiel. It is believed that this area was only used for dry storage and that no manufacturing or bulk storage of liquids took place in this particular location. ROF Marchwiel was closed down shortly after the end of World War II.

The Maelor gasworks was opened in 1953 after three years of construction. Construction scenes are depicted in many of the historical photos (see Appendix J). An article written by the Wales Gas Board in 1953 described the construction of the works (see Appendix J), Buildings and infrastructure present on the NGPH land included:

- vertical retort house comprising 25 chambers each of 3.65 tons capacity;
- coal handling plant;

- coke quenching and handling equipment;
- coke grading and storage plant;
- Carburetted Water Gas (CWG) house containing two solid fuel boilers;
- compressor and power house;
- laboratory and office block;
- two vertical water cooled condensers;
- detarrer, ammonia washer and naphthalene washer;
- five reinforced concrete above ground purifiers;
- gasholder 1, above ground with a capacity of 500,000 cu ft.;
- relief gasholder for CWG plant, above ground with a capacity of 250,000 cu ft.;
and
- underground tar and liquor storage with a total capacity of 280,000 gallons.

Maelor works supplied gas to the Wrexham, Rhos, Cefn Maew and Llangollen areas. It is estimated that the works carbonised 36,000 tonnes of coal per annum producing 2,900,000 therms of gas, 18,000 tons of coke and 435,000 gallons of tar. The plant continued to operate, without further expansion until 1968 when a new oil-gas plant, built to the north of the retort house, took over gas production.

The oil gas plant was completed in August 1968 and used a distillate of oil as a feedstock. On site storage existed for 168,000 gallons of feedstock although the exact location of this storage is unknown, it is believed that the old LDF storage tanks were used”.

2.5 Adjoining Areas

Table 1 and the text in sections 2.5 to 2.8 has been taken from Ref 4 (Worley Parsons, 2012). Worley Parsons – *Environmental Assessment Site Investigation Report, Maelor Works, Wrexham*. Report No. 50065-29, January 2012.

Land use near the site is summarised in Table 1

Table 1: Adjacent and Proximal Land Use

Boundary	Adjacent Land Use	Proximal Land Use (within 100m of site boundary)
North	Agricultural pasture and W&WU AGI compound and access lane.	Agricultural pasture and TetraPak (Wrexham) factory to the north-west.
East	W&WU AGI compound and access land beyond which is agricultural pasture.	Agricultural pasture.
South	Agricultural pasture.	Agricultural pasture and Parkey Farm to the south. Bedwell Brook, a tributary of the River Clywedog lies to the southeast. Rum Rhyd Farm lies to the south-west.
West	Agricultural pasture.	Agricultural pasture.

2.6 Potentially Contaminative Land Uses

An Envirocheck report was obtained from Landmark Information Group. This provides details of hydrological information, waste, hazardous substances, and industrial land uses within 1km of the site. A summary of pertinent information from locations within 1km of the site is summarised below and in appropriate sections throughout the report as referenced:

- There are no discharge consents held by the site although 24 discharge consents are held, within 1km of the site, many of which are expired. The closest discharge consent that is current is at 430m northwest of the site and relates to discharge of sewage from a domestic property to soakaway.
- There are two Integrated Pollution Control (IPC) licences within 1km of the site. The closest is 875m southeast of the site held by 'The First Milk Cheese Company'. The licence permits the treating of animal raw materials.
- There are two Local Authority Integrated Pollution Control (LAIPC) licences within 1km of the site. The closest is 362m to the west of the site held by 'Animal Waste Services Ltd' for an incinerator.

- One Local Authority Pollution Prevention Control (LAPPC) licence exists at the site for the process of odorising natural and liquefied petroleum gas. The licence is held by Wales & West Utilities. The nearest offsite LAPPC is at 169m northwest of the site held by TetraPak (Wrexham) Ltd for printing of flexible packaging.
- There are 33 pollution incidents to controlled waters within the vicinity of the site. The closest was at 147m northeast, occurred in 1996 and involved algae as a pollutant. No further information was given. It was categorised as a minor incident by the Environment Agency.
- There are two permits of registered radioactive substances held at the site by National Grid Transco. The permits are for disposal of radioactive waste under S13 RSA. One of the licences has been revoked and the other is suspended.
- One historical landfill site is recorded at 486m southeast of the site at School Farm, Cross Lanes. The licence is held by Mr Bryan Griffiths. Waste deposited included inert waste and the last deposition occurred in October 1981. A registered landfill site (at 350m south of the site) at the same location as the historical landfill site. Authorised waste included; hardcore, concrete, builder's rubble, soil and clay.
- There is one registered waste treatment or disposal site 291m to the northwest of the site and relates to Maelor Abattoir.
- There are two Control of Major Hazard Sites (COMAH) registrations at the site. One is registered to British Gas, which has ceased and the other belongs to FloGas UK Ltd, which is active.
- There is one Notification of Installations Handling Hazardous Substances (NIHHS) which relates to the site "belonging to British Gas Plc", this has ceased.

- There is one planning Hazardous Substance Consents for the site belonging to British Gas Plc for the storage of liquefied petroleum gas (LPG), the consent is active.
- There are six groundwater abstractions within 1km of the site. All relate to Calypso Soft Drinks Ltd and abstract groundwater for food and drink process water. The closest water abstraction is 660m east of the site.

2.7 Nearby Sensitive Land Uses

There is limited sensitive land use near to the site. Those particularly worthy of note include:

- Agricultural land which surround the site.
- The land lies within a Source Protection Zone II (outer protection) and Zone III (total protection). The source protection zones relate to groundwater abstraction by Calypso Drinks Ltd.
- Residential areas including farm houses are within 100m of the site.

2.8 Surrounding Area

Agricultural land surrounds the site. Parkey Farm lies 70m south of the site, with Rum Rhyd Farm to the south-west and a TetraPak factory to the north-west.

The River Clywedog runs west to east, approximately 130m north-west of the site at its closest point.

The surrounding fields have sporadic buildings (from additional information it is known that these were associated with an ammunitions factory (Royal Ordnance Factory (ROF) Marchwiel). The factory extends beyond 1km north from the site).

Mineral railway passes the south of the site from the northwest and heads in a south-westerly direction. Maelor Abattoir is located 750m to the south-west of the site.

The mineral railway is shown as dismantled.

Some of the buildings associated with the former ammunitions factory are no longer shown. Wrexham Industrial Estate is shown at 360m west of the site at its closest point.”

3. ENVIRONMENTAL SETTING

3.1 Geology

According to published mapping, the site is underlain by substantial thicknesses of glacial drift, with bedrock at depths in excess of fifty metres below ground. Bedrock is indicated as sandstone from the Triassic Sherwood Sandstone formation, although the boundary between this rock formation and Carboniferous Coal Measures is postulated as being close by.

Previous site investigations have revealed the site area to be underlain by a variable range of clayey, silty, sandy and gravelly alluvium and ultimately by stiff, cohesive, silty clay of glacial origin (Boulder Clay). The bedrock surface is anticipated to be covered by many metres of low permeability glacial boulder clay laid down under a former ice sheet, with the boulder clay in turn draped with variable thicknesses of clays, silts and sands and gravels laid down by flowing water following the retreat of the ice sheet.

Due to the artificial nature of the site foundations, there are no natural soils or strata exposed at the site surface. Made Ground deposits have either been laid directly over the alluvial strata, or laid on top of re-graded alluvial deposits.

Ground conditions across the site area are described in more detail in Section 5.5 of this report.

The site is considered effectively isolated from the natural bedrock, both physically and hydrogeologically.

3.2 Mining

The site is considered to be unaffected by historical underground mining or surface quarrying activity and is not likely to be underlain by any strata that may be targeted by mining or quarrying in the future.

3.3 Hydrogeology

No natural soils are exposed at the site surface and a shallow groundwater table has been developed, perched on the low permeability boulder clay beneath the alluvium. Groundwater movement in the shallow alluvial soils is largely controlled by local variations in permeability and recharge, with a groundwater high apparent in the western central area of the site in the vicinity of the former tar tank and groundwater flow paths being generally to the northwest and north and to the southeast and south of this point. Most of the flow occurs within a layer of sand / sand and gravel that typically lies immediately above the Boulder Clay and varies in thickness from less than 1m to over 3m across the majority of the site area. Groundwater flowing northwest from the groundwater highpoint is likely to discharge directly into a French Drain that has been installed along the western perimeter of the site, cut into the original ground, below the level of the site and typical groundwater surface levels.

The sand stratum does extend across the majority of the south and eastern site area, but along the north bank of the Bedwell Brook valley feature, tipped Made Ground deposits have been placed directly on the Boulder Clay surface. Shallow groundwater is thought to flow through this Made Ground deposit along the Boulder Clay interface and to discharge to the brook at the foot of the tipped slope.

A degree of interaction between surface water drainage and the shallow groundwater in the granular alluvium is suspected, but has not been quantified.

The bedrock strata at depth beneath the site are known to form designated aquifers (classified by National Resources Wales as a Principal Aquifer), but the groundwater is effectively isolated from surface impacts by the intervening cohesive drift deposits.

The site area lies within the outer zone (Zone 2) source protection zone of a bedrock water abstraction borehole in Wrexham Industrial Estate approximately 2km to the north of the site. Up to date details are available on the Environment Agency website.

3.4 Hydrology

The site sits on a watershed between the River Clywedog to the north and Bedwell Brook to the southeast (although Bedwell Brook itself flows into the River Clywedog approximately one kilometre to the east of the site). The Clywedog sits in a broad, shallow valley that is drained by a network of mostly artificial agricultural drainage ditches and field drains, some of which are associated with the former ROF facility. Bedwell Brook is similarly fed by ditches and drains in land to the south of the site, but is a much smaller watercourse than the Clywedog. Bedwell Brook enters the site area beneath the former railway embankment in the southeastern corner of the site and flows in a valley through this part of the site. The northern flank of the valley has been steepened and constrained by tipping activities within the site, but the brook appears to continue to flow in its original bed up to the culvert beneath the access road on the eastern boundary of the site.

The majority of the site area is largely flat and level and does not contain any open, flowing water courses. An extensive surface water drainage system has been installed at the site, presumably at the time of the original construction of the gasworks site. The majority of the site area and the northeastern WWU area, excluding all of Area C and a small part of Area A in the northwest of the site, drains into three main branches, all of which ultimately discharge to the Bedwell Brook in the southeast of the site. The integrity and status of this drainage system has not been confirmed and many of the manhole entry points are not accessible without powered mechanical aids (not available to the current investigation).

The remainder of the site area is thought to be provided with informal drainage that leads to the external network of field drains and ditches to the north of the site. A French Drain interceptor installed along the western boundary of this part of the site is also connected into this drainage network at the northwestern corner of the site.

Previous site reporting (Ref.1 2 and 4) states that the collection efficiency of the drainage has not been tested, but groundwater levels are known to react quickly to rainfall events, suggesting that most infiltration through the general site surface reaches the groundwater directly rather than being intercepted by the drains.

Subsequent seepage of groundwater onto low lying agricultural land to the north of the site is documented as having generated complaints from third party land owners in the past.

All known drainage services are included on Drawing A1-13627-3048.

3.5 Discharge Consents

There are no reported discharge consents held by the site occupiers.

Previous reporting including reference to commercially available consent listings, with 24 discharge consents listed, within 1km of the site, many of which are expired. The closest discharge consent reported as current (2011) is some 430m northwest of the site and relates to discharge of sewage from a domestic property to soak away (Ref 4).

3.6 Landfill Sites

There are no licensed landfill deposits within the site area or in the immediate vicinity. Tipped material in the southeast corner of the site is not part of a licensed disposal facility.

Commercial listings of licensed sites report one historical landfill site 486m southeast of the site at School Farm, Cross Lanes. The licence is held by Mr Bryan Griffiths. Waste deposited included inert waste and the last deposition occurred in October 1981. A further registered landfill site lies 350m south of the site, at the same location as a separate, historical landfill site. Authorised waste included: hardcore, concrete, builders rubble, soil and clay (Ref 4).

3.7 Waste Management Licenses

There are two Integrated Pollution Control (IPC) licences within 1km of the site. The closest is 875m south east of the site held by the "The First Milk Cheese Company". The licence permits the treating of animal raw materials.

There are two Local Authority Integrated Pollution Control (LAIPC) licences within 1km of the site. The closest is 362m to the west of the site held by “Animal Waste Services Ltd” for an incinerator, assumed to be associated with the Maelor Abattoir site.

One Local Authority Pollution Prevention Control (LAPPC) licence exists at the site for the process of odorising natural and liquefied petroleum gas. The license is held by WWU. The nearest off-site LAPPC is at 169m northwest of the site held by Tetra Pak (Wrexham) Limited for printing of flexible packaging.

There are two permits of registered radioactive substances held at the site by the National Grid Transco. The permits are for disposal of radioactive waste under S13 RSA. One of the licenses has been revoked and the other is superseded.

3.8 COMAH Reports

There are two Control of Major Hazards Sites (COMAH) registrations at the site. One is registered to British Gas, which has ceased and the other belongs to FloGas UK Ltd, which is active.

3.9 Conservation Areas

No part of the site or immediate surroundings has any registered statutory protection for reasons of scientific or archaeological interest or ecological sensitivity.

4. HISTORICAL DEVELOPMENT

The site was initially developed as part of the Marchwiel Royal Ordnance Factory, when it is understood the site was used for the bulk dry storage of cordite in small scattered buildings across the northern sector of the site (and beyond). It is understood that no munitions were produced within the vicinity of the Area AC site, with the main production site being further to the northwest, where the Wrexham Industrial Estate is now sited.

The development of the large gasworks site in the 1950s required the formation of a roughly square area of up-filled and levelled land to the immediate northwest of the existing Bedwell Brook valley. Historical plans show that the former land surface was gently undulating in character, such that the creation of a level surface means that the thickness of Made Ground beneath the site varies significantly over quite short distances (being deeper in former “valley” features and very thin, almost absent on former “ridges”).

The gasworks site contained all of the typical features of coal gas production, including retorts; tar processing, gas purifying and by-product handling areas which remained in use until the late 1960s when gas manufacture from oil feedstock took over, with gas production finally ceasing in the 1970s.

Details of the decommissioning and demolition of the main production areas are not available, but the majority of plant was removed down to ground level only, with many below ground tanks and foundations etc left in-situ.

Subsequent use of the site has been for gas distribution and ancillary gas supply business and a separate LPG storage and distribution business. Previous remediation works have focused on the former above ground gas holders and localised areas around the former effluent tar tank, oil gas feedstock storage area and a spent oxide deposit in the north-eastern part of the site area.

4.1 Previous Investigation and Remediation

The site has been the subject of an extensive series of investigations since 1996, aimed at both general characterisation of the contamination status of the site and the detailed examination of a number of individual issues arising. Key data, in the form of trial pit and borehole logs, field measurements and chemical data from the analytical testing of solid and liquid samples, is available in a number of Factual Reports that were used as the basis for the additional site works presented in this report.

Of particular significance are records of:

- visible “blue billy” spent oxide waste within site Made Ground deposits;
- visible free phase tar contamination in Made Ground deposits and underlying soils;
- elevated concentrations of iron, ammonia and cyanide in the shallow groundwater underlying parts of the site area and in surface water receiving site drainage from the northwest sector of the site;
- the restricted area and thickness of the shallow, water bearing alluvial sand and gravel beneath the site and apparent absence of hydraulic connectivity with underlying bedrock water bodies; and
- the apparent absence of significant impacts associated with site contamination on either the River Clywedog or Bedwell Brook.

Documented historical remediation work at the site is restricted to the local removal of spent oxide and hydrocarbon contamination from isolated, separate hotspots in the north and south of the site, and the removal of the contents of a former tar tank in the western central part of the site, adjacent to the current Training Centre building. Records of the removal of accumulated spent oxide, tars and other by-products of gas manufacture following closure of the gas manufacturing processes have not been previously made available or reported. Additional remediation, in the form of removal of tar contaminated Made Ground materials, has been reported for the small WWU owned parcel of land in the area of the former gasworks Benzol Plant and Ammonia Liquor Well.

5. SITE INVESTIGATION AND METHODOLOGIES

5.1 Scope of Work

A programme of additional site investigations was completed in November / December 2013 / January 2014, which consisted of:

- an ecological survey walkover and update report;
- an updated utilities survey;
- an instrumental radiological survey of the accessible site surface area and monitoring of radiation levels in materials exposed by the sub-surface site investigation work;
- the drilling of boreholes to reveal typical sub-surface ground conditions and permit the collection of soil samples;
- the excavation of trial pits to reveal typical sub-surface ground conditions and permit the collection of soil samples for chemical testing and treatment trials;
- the installation of groundwater monitoring wells in selected borehole locations;
- two rounds of monitoring of rest water levels and three rounds groundwater samples from selected existing and newly installed wells;
- visual inspection and collection of water samples from an interceptor and specific drainage locations sampled in previous site investigations;
- surface water sampling of outfalls and surface waters surrounding and across the site;
- sediment sampling of surface waters in the vicinity of the site;
- a topographical survey of site investigation locations; and
- the production of a Factual Report presenting site data produced by the works.

5.2 Fieldwork

Site diaries by the IKM engineers on site can be found in Appendix L

5.2.1 Ecological Survey

A walkover inspection of the site was conducted by Evolution Ecology Limited (EEL), in November 2013, in advance of the site works. The scope of the survey was to assess the possible presence of protected species and provide an update on the current ecological status of the site (from that which had previously been reported by others). The EEL report from this survey is included in Appendix A.

The main features noted of relevance to the site were:

- Mammals: No mammals were actually seen on site during the survey; however, in excess of 100 rabbit warren entrances and droppings were recorded along the north and northwestern boundary of Area C, mostly within the Made Ground embankment.
- No signs of water vole, otter or bat species were recorded, even within the Bedwell Brook valley. The derelict buildings on-site have limited potential to act as refuge / roosting sites for bats.
- Birds: The survey was carried outside of nesting season, but potential nest sites were identified, primarily within the tree cover in the northwestern and southeastern site sectors and within one of the derelict buildings in Area C, to the east of the pond.
- Insects: No insect species were noted on-site during the survey, but this is not surprising given the time of year the survey was carried out. Vegetated open land and areas of hardstanding across the site could provide good foraging / basking opportunities for insects in the spring and summer months.

- Reptiles/Amphibians: No clear signs of usage were identified; however, the site is thought to have a high potential for housing reptiles or amphibians, within the unused burrows situated in the woodland to the northwest of Area C. This includes possible use by hibernating Great Crested Newts (GCN). Hard standing areas nearby were also considered to provide suitable basking areas for GCN and other reptiles and amphibians, such as the Grass Snake.

It is noted that GCNs are a protected species and cannot be allowed to be intentionally / foreseeably disturbed or injured / killed by site activities or development.

5.2.2 Radiological Survey

In response to the former use of radioactive catalyst (nickel/depleted uranium) material during the operation of the gasworks site, a site wide radiological survey was carried out by specialist radiological risk assessment contractors, Aurora Health Physics Services Limited (Aurora).

The survey included the instrumental measurement of radiation levels across the whole of the open site surface (where this was accessible to the manually carried instrumentation), within occupied and unoccupied buildings and in accessible underground services (drains). In addition, Aurora carried out monitoring of radiation levels in materials exposed by all of the trial pitting and borehole drilling conducted across the site during the site works.

The Aurora Limited survey report for the area is included as Appendix D with other areas results which are not relevant crossed out.

5.2.3 Trial Pits and Boreholes

Site investigations consisted of:

- the excavation of forty-three trial pits;
- sinking of six window sampler boreholes; and
- drilling of eight cable percussive boreholes.

Twenty-two trial pits, one window sampler and eight cable percussive boreholes were excavated in the northern and northwestern area of the site (Area C and the northernmost sector of Area A – Area AC1) in the vicinity of previously reported spent oxide process structures and near surface, visible spent oxide deposits.

Eleven trial pits and five window sampler boreholes were excavated in the former gasworks process area, in the western sector of Area A (Area AC2).

Ten trial pits were excavated in the southeastern corner of the site (Area AC4), within the tipped material on the northern flank of the Bedwell Brook valley.

Each sample location was included in the site wide topographical survey following completion of the works and that information has been used in the production of the location plans provided in this report (Drawing Nos. A1-13627-3018, 3019 and 3021).

Trial pitting was conducted using a backhoe excavator under the supervision of the I&H Brown site manager and IKM field staff. Spoil was temporarily placed on plastic sheeting during trial pitting, before being backfilled in approximate reverse order of excavation and the location being levelled and tidied on completion.

Window sampling and cable percussive drilling was carried out by Rotary Test Drilling Limited, under the supervision of the I&H Brown site manager and IKM field staff. All spoil and debris was removed from the area on completion and returned to the Maelor Works compound for off-site disposal. Controlled waste certificates are located in Appendix M.

On the instruction of the IKM field supervisor, selected boreholes were installed as monitoring wells for future groundwater monitoring and sampling.

Drawing No. A1-13627-3011 shows the location of each completed trial pit and borehole in relation to historical investigation locations for Area AC as a whole.

5.3 Ground Conditions

The four different areas subject to investigation during the IKM 2013 site investigation have been defined as follows:

- Area AC1 – the northern site sector, largely open land to the north of the occupied site buildings.
- Area AC2 – the western site sector, previously occupied by gasworks process structures.
- Area AC3 – the southernmost sector of the site, previously occupied by the oil feedstock tanks associated with oil gas manufacture.
- Area AC4 – the Bedwell Brook valley area.

Drawing A1-13627-3017 shows the location and extent of each of these areas. Identified site constraints are shown for each area in Drawing Nos. A1-13627-3007, 3008, 3009 and 3010. Ground conditions are described in the following sections.

5.3.1 Area AC1

Twenty-two trial pits and nine boreholes were excavated in this area during the works. The north-eastern area to the south of the former gas holder and paint store consists of an area of soft standing which is grazed by rabbits and has sections of fencing dividing parts of the area. Trial pitting in this area found Made Ground overlying firm brown sandy clay. Made Ground deposits were observed from ground level to between 0.3m and 2.1m below ground level (bgl). The Made Ground consisted of re-worked clay with some demolition waste including bricks and wood.

The trial pits in the vicinity of the old bullet storage vessel were found to consist of gravel on to a concrete base 0.3m thick with re-bar and clay underneath. Some Made Ground consisting of coal was found in IKM 2013 trial pit TP21 at 1.2-2.1m bgl. The area to the south of the old bullet storage vessel was previously used for spent oxide re-vivification. This area is covered in hard standing consisting of concrete with re-bar 0.3m thick. Beneath the hard standing is Made Ground up to 3.2m in depth which included reworked

clay and sand and gravels. Beneath the Made Ground was sandy clay with bands of gravel observed in IKM 2013 boreholes BH 5, 6, and 7. The depth to the underlying Boulder Clay was proven at 4.50m, 5.10m and 4.55m bgl respectively.

In the area housing the old purifier's (below ground concrete bunker type structures), two IKM 2013 boreholes (BH4 and BH4A) and 4 trial pits were excavated. BH4 and 4A drilled through Made Ground to a concrete base at 2.1mbgl. The Made Ground consisted of road and pavement excavation arisings including mixed cobbles of brick and concrete and tarmac. Similar strata of Made Ground with waste such as plastic pipes, tar macadam was observed in IKM 2013 trial pits TP 23-26. A chamber like structure was seen in TP25.

IKM 2013 trial pits TP10-13 were excavated in the area to the south of the purifiers which was also covered by a concrete slab used for the re-vivification of spent oxide. Made Ground was observed from ground level to 2.5mbgl with sandy silty clay beneath.

5.3.2 Area AC2

Eleven trial pits and five boreholes were excavated in this area during the works.

The northern section consists of the existing training centre building, with a gravel covered lay down area to the west and the southern area contains the existing garage building also with a lay down area to the west. These lay down areas are currently used for pipe, trailer and small excavator storage. These areas are covered in Type 1 gravel, with some areas of hard standing for storage of tarmac and trailers. During excavation works 0-0.8m of Made Ground was observed over brown clay 0.5-2.7m thick and sand 1.3-2.8m. The thickness of the gravels was not proven. A concrete tank was observed in IKM 2013 trial pit TP7 which was full of tar impacted demolition waste.

IKM 2013 trial pits TP8 and 9 consisted of Made Ground to 0.6mbgl over clay 2.2m thick with sand beneath. TP8A had a band of gravel from 1.6-2.4m bgl. The total thicknesses of granular alluvium were not proven.

One borehole was drilled inside the training centre and one borehole was drilled just outside to the south. IKM 2013 borehole BH1, inside the training centre, required coring through a 0.27m thick concrete slab into gravel sub-base to 1m, with silt and sand extending to Boulder Clay at 3m bgl. IKM 2013 borehole BH2 saw Made Ground of gravel and clay to 0.7m bgl, with sand, silt and a thick layer of sandy gravel to 3.85m bgl with Boulder Clay beneath.

Within IKM 2013 trial pits TP4, TP5, TP6 to the west of the garage the ground conditions were observed to be of Made Ground (of gravel and clay) from ground level to a maximum of 0.6m bgl. This was underlain by sand (with a thin band of clay observed in TP4 from 1-1.4mbgl) varying in thickness up to 0.8m with water saturated gravel underneath (not observed in TP6). The thickness of the gravels was not proven due to the instability of the trial pits due to water ingress.

IKM 2013 trial pits TP1, 2 and 3 were underlain by Made Ground comprising of demolition waste including bricks and concrete which was contaminated with tar and oil. Brick foundations were observed in TP1 at 0.1mbgl, which may have been left from the old CWG plant. The sand and gravels in all the trial pits in the southern area of AC2 were contaminated with tar impacted groundwater.

5.3.3 Area AC3

No intrusive investigation went on in this area but water and sediment samples were taken at the outfall and the pond in the east of the area (see drawing A1-13626-3020). A sediment sample was also taken in the centre of the pond which was of a clay based Made Ground. Drain covers were lifted at MH1 and MH2 (see drawing A1-13627-3011) and no visual or olfactory contamination was observed.

5.3.4 Area AC4

Ten trial pits were excavated in area AC4 during the site works.

This area was previously used for tipping of waste materials from the site and consists of an area of flat open space, with short grass, with a steep densely vegetated slope down to Bedwell Brook to the south. The southern bank of Bedwell Brook is less steep and tree covered to the site boundary beyond. Ten trial pits were excavated, all in the tip area to the north of the brook. The majority of the pits consisted of reworked clay including some waste concrete with re-bar and bricks. A concrete structure was observed at 0.2mbgl in IKM 2013 trial pit TP33 which may be the top of the outfall which eventually enters Bedwell Brook. TP32 was contaminated with waste including bricks and tiles mixed in with clay and coal tar from 1.8mbgl.

5.4 Field Records and Contamination Observations

Logs and photographs of all the trial pit and hand pit locations are contained in Appendix B.

Measurements of the headspace above soil samples, taken from the site investigation locations and placed in sealed containers, were carried out using a photo-ionisation detector to provide an indication of the presence of volatile organic compounds (VOCs). Table 2 provides a compilation of these measurements for each sampling location. This data is also recorded on the trial pit logs in Appendix B.

Table 2: PID Measurements from Soil Sample Headspace

Exploratory Hole IKM 2013	Total Volatile Organic Compound (TVOC) Concentration (ppm)	Comments
TP07	0.66	TVOC reading taken from soil samples at 0.8m bgl.
TP10	3.3	TVOC reading taken from soil samples at 1.8m bgl.
TP10	4.4	TVOC reading taken from soil samples at 2m bgl.
TP8A	10	TVOC reading taken from soil samples at 1.7m bgl.
TP8A	10.7	TVOC reading taken from soil samples at 2.4m bgl.

Exploratory Hole IKM 2013	Total Volatile Organic Compound (TVOC) Concentration (ppm)	Comments
TP6	0.3	Background ambient reading besides trial pit.
TP32	14.6	TVOC reading taken from soil samples at 2m bgl.
BH23	4.8	TVOC reading taken from soil samples at 2.6m bgl.
BH23	0.5	TVOC reading taken from soil samples at 2m bgl.

In addition to the PID measurements, visible or olfactory signs of contamination were noted within each of the site investigation areas as follows:

Area AC1

IKM 2013 boreholes BH3, 3A, 5, 6 and 7 were noted to emit an oil/chemical odour from the top 3m of strata, whilst drilling.

Area AC2

In IKM 2013 trial pit TP7, free phase tar, mixed with waste within a concrete tank like structure was observed. Tar and oil contamination was observed in the groundwater and in the sand and gravel in IKM 2013 trial pits TP4 to 6. A pocket of blue ceramic spacers (associated with the uranium/nickel radioactive catalyst previously used on site) were observed within the Made Ground in trial pit TP3, at 0.25mbgl. A redundant pipe observed at 0.2mbgl in trial pit IKM 2013 trial pit TP2 and relic foundations and the Made Ground in TP1 were tar impacted. No visual or olfactory contamination was observed in IKM 2013 boreholes BH23 and BH24, but hydrocarbon impacted gravels and sands were observed in BH23, BH1 and BH2.

A manhole lid was lifted and a water sample taken at SS11-09-1 (see drawing A1-13627-3019). There was a hydrocarbon sheen on the water sample and free phase tar was observed on the outside of the bucket used to take the sample. A strong gas works odour was observed in the road drain gullies, along the road south of the old retort house. A sample of the drain sediment was taken at location GP1. The manhole lids in this area were not able to be lifted for further inspection / sampling.

Area AC3

At location SD3, a sediment sample taken from the outfall to the pond was hydrocarbon impacted and had a strong odour and sheen visible, as did the water taken at the same location SS11-03-1 (see photo 14-16). A sediment sample taken from the centre of the pond did not show visual or olfactory signs of contamination. Drain covers were lifted at MH1 and MH2 (see drawing A1-13627-3011) and no visual or olfactory contamination was observed.

Area AC4

Orange stained groundwater was observed in IKM 2013 trial pit TP30. No groundwater was observed in any of the other trial pits in this area, apart from TP38, which had some groundwater ingress but did not appear contaminated. The soil in TP32 contained visible waste material, including bricks and tiles, mixed with clay and coal tar from 1.8mbgl. A leachate outbreak was noted around the outfall flowing into Bedwell Brook (see photos 20 and 21). The leachate appeared around the outfall head works and was orange / brown in colour and had a hydrocarbon sheen. The leachate outbreak combines with flows from the outfall before entering the brook. A further orange / brown patch of leachate outbreak was also observed at Location RB1, in the brook bank (see drawing A1-13627-3021 and photo 22). Globules of free phase tar were observed in sediment samples SD2 and SD4 (see photos 23-26), these were black and mobile and separated to form a hydrocarbon sheen on the water surface when disturbed. Empty oil drums were observed on the surface on the north bank of the tip (see photo 28) and on the opposite south bank, along with other waste, including a car engine and bonnet and a wheel barrow. No visual or olfactory contamination was observed in the water or sediment sampled upstream or downstream, from locations CULV UP and SDCULV or SS11-08-1 and SD1 (see drawing A1-13627-3021). Contamination appears to be confined between the two culverts (old railway and road to site entrance) in this section of the brook.

The locations of visible tar or spent oxide contamination in areas AC1-4 are shown in drawings A1-13627-3038 to A1-13627-3041. Table 3 provides a compiled listing of the locations where visible contamination was observed during the 2013/4 investigations and recorded on logs from previous investigations.

Table 3: Compiled Visible or Odorous Contamination Records

Location	Contamination Description
Komex Clarke Bond Investigation 1995	
MW1	Black staining
MW2	Spent oxide
	Black staining
MW3	HC on groundwater, Visible tar
MW4	HC odour, spent oxide, Visible tar
MW5	No visible contamination
MW6	Black Staining, HC odour
TP1	HC odour
TP2	HC odour and HC on groundwater
TP3	HC odour
TP4	No visible contamination
TP5	HC odour, Spent oxide
TP6	No visible contamination
TP7	Spent oxide
TP8	Spent oxide
TP9	HC odour
TP10	No visible contamination
TP11	No visible contamination
TP12	HC odour
TP13	No visible contamination
TP14	No visible contamination
TP15	HC odour
TP16	No visible contamination
TP17	No visible contamination
TP18	HC odour, spent oxide
TP19	No visible contamination
TP20	HC odour, Visible tar, HC sheen
TP21	HC odour
TP22	No visible contamination

Location	Contamination Description
TP23	HC odour, HC on groundwater, visible tar
TP24	HC odour
TP25	No visible contamination
TP26	No visible contamination
TP27	HC odour, spent oxide
TP28	No visible contamination
TP29	Spent oxide, visible tar
Komex Clarke Bond Investigation 1999	
TP99-101	No visible contamination
TP99-102	No visible contamination
TP99-103	Spent oxide, visible tar
TP99-104	No visible contamination
TP99-105	HC odour, visible tar
TP99-106	No visible contamination
TP99-107	Visible tar
TP99-108	No visible contamination
TP99-109	HC odour
TP99-110	No visible contamination
TP99-111	No visible contamination
TP99-112	No visible contamination
TP99-113	No visible contamination
TP99-113A	HC odour
TP99-115	No visible contamination
TP99-116	No visible contamination
TP99-117	HC odour
TP99-118	Black staining, HC odour
TP99-119	No visible contamination
TP99-120	No visible contamination
TP99-121	No visible contamination
TP99-122	No visible contamination
TP99-123	Spent oxide
MW99-101	Spent oxide, Black staining

Location	Contamination Description
MW99 - 102	Spent oxide
MW99-103	No visible contamination
MW99-104	Black staining, HC odour
MW99-105	Spent oxide
MW99 - 106	HC odour
MW99-107	No visible contamination
MW99-108	No visible contamination
MW99 -109	HC odour, visible tar
MW99-110	No visible contamination
MW99-201	No visible contamination
MW99-202	No visible contamination
MW99-203	No visible contamination
MW99 - 204	Black staining
MW99 - 205	Visible tar
Worley Parsons Investigation 2011	
MW11-01	No visible contamination
MW11-02	No visible contamination
MW11-03	No visible contamination
MW11-04	No visible contamination
MW11-05	HC odour
MW11-06	No visible contamination
MW11-07	Black staining, HC odour
MW11-08A	HC odour
MW11- 08B	Black staining, HC odour, HC on groundwater
MW11-10	No visible contamination
MW11-12	No visible contamination
MW11-13	No visible contamination
MW11-14	No visible contamination
MW11-15	No visible contamination
MW11-16	No visible contamination
TP11-01	No visible contamination
TP11-02	No visible contamination

Location	Contamination Description
TP11-03	No visible contamination
TP11-04	No visible contamination
TP11-05	No visible contamination
TP11-06A	No visible contamination
TP11-06B	No visible contamination
TP11-07	HC Odour
TP11-08	HC Odour
IKM Investigation 2013	
HP13-48	No visible contamination
13-01	Visible tar, HC odour, HC sheen on water
13-02	HC sheen on water, HC odour
13-03	Blue spacers, HC sheen on water, HC odour
13-04	HC sheen on water
13-05	HC odour
13-06	HC sheen on water
13-07	Visible tar, HC odour, HC sheen on water
13-08	HC odour
13-08A	HC odour
13-09	HC odour
13-10	HC odour, HC sheen on water
13-11	No visible contamination
13-12	No visible contamination
13-13	No visible contamination
13-15	No visible contamination
13-16	No visible contamination
13-17	No visible contamination
13-18	No visible contamination
13-19	No visible contamination
13-20	No visible contamination
13-21	No visible contamination
13-22	No visible contamination
13-23	No visible contamination
13-24	No visible contamination

Location	Contamination Description
13-25	No visible contamination
13-26	No visible contamination
13-27	No visible contamination
13-28	No visible contamination
13-29	No visible contamination
13-30	Ground water red in colour
13-31	No visible contamination
13-32	Visible tar, HC odour
13-33	No visible contamination
13-34	No visible contamination
13-35	No visible contamination
13-36	No visible contamination
13-37	No visible contamination
13-38	No visible contamination
13-39	No visible contamination
13-40	No visible contamination
13-41	No visible contamination
13-49	No visible contamination
13-50	No visible contamination
13-51	No visible contamination
BH1	HC odour, HC sheen on groundwater
BH2	HC odour, HC sheen on groundwater
BH3	HC odour
BH3A	HC odour
BH4	No visible contamination
BH4A	No visible contamination
BH4B	No visible contamination
BH5	HC odour
BH6	HC odour
BH7	HC odour
BH8A	HC odour
BH22	No visible contamination
BH23	HC odour, HC sheen on groundwater

Location	Contamination Description
SD1	No visible contamination
SD2	Visible tar
SD3	HC sheen on groundwater
SD3A	No visible contamination
SD4	Visible tar
SS11-01-1	No visible contamination
SS11-08-1	No visible contamination
SS11-02-1	No visible contamination
SS11-02-2	No visible contamination
SS11-02-3	No visible contamination
SS11-03-1	HC sheen on groundwater
SS11-05-1	Red sediment
SS11-06-1	No visible contamination
SS11-07-1	No visible contamination
RB1	Red staining

<i>Visible Tar</i>	<i>Visible free tar in matrix or coating spoil surfaces</i>
<i>Spent oxide</i>	<i>Visible spent oxide materials</i>
<i>Black staining</i>	<i>Black hydrocarbon or tarry staining observed in excavation</i>
<i>HC odour</i>	<i>Hydrocarbon Odour noted during excavation</i>
<i>HC sheen</i>	<i>Hydrocarbon sheen observed on water during sampling</i>
<i>HC on groundwater</i>	<i>Free phase hydrocarbon layer floating on groundwater</i>
<i>Red sediment</i>	<i>Ferruginous orange / red sediment observed in groundwater</i>
<i>Red staining</i>	<i>Ferruginous orange / red staining observed in soil</i>
<i>Groundwater red in colour</i>	<i>Ferruginous colouration to trial pit groundwater ingress</i>

5.5 Groundwater and Surface Water Monitoring

Selected new borehole locations were installed as groundwater monitoring locations. The installed wells were monitored on two occasions for rest water level and groundwater samples were obtained from where volumes permitted. Groundwater monitoring details are provided in Table 4. Well installation details are provided on the borehole logs in Appendix C.

In area AC1, all the wells were screened across the Made Ground and underlying granular and cohesive drift. This is to maximise the capture of groundwater from all horizons.

In area AC2, all the wells were screened in the shallow granular drift beneath the Made Ground, so as to target the most visibly impacted horizon.

Surface water samples were taken upstream and downstream of the site from the River Clywedog, and from the ox-bow lake (which was flooded and part of the main river in January 2014 - see photo 1). Sediment and water samples were also taken from drainage on and around the site (see drawing A1-13627-3011) where possible and drains visually inspected during sampling. Samples were taken from a pond located in Area AC3 and the outfall into this pond. Further samples were taken along Bedwell Brook (both on and off site) and outfalls flowing into Bedwell Brook. These locations are shown in drawing A1-13627-3021.

Samples of groundwater were obtained from newly installed and established monitoring wells within boreholes across the site area.

Two rounds of sampling were undertaken in December 2013 and January 2014.

Measurements of rest water levels and total borehole depths were made on each occasion. Table 4 provides a compilation of all available water level measurements for boreholes across the site.

Table 4: Groundwater Monitoring Records

Borehole	Response Zone	Elevation (mAOD)	A - March/ April 1999	B - March/ April 1999	C - April 1999	D - June 2011	E - July 2011	F - August 2011	G - December 2013	H - January 2014
			Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)
MW99-101	SAND	35.96	34.22	34.22	34.22	-	-	-	-	-
MW99-102	CLAY/SAND	36.38	34.90	34.90	34.86	34.30	34.25	34.16	-	-
MW99-103	SAND	36.48	34.94	34.94	34.96	34.31	34.27	34.17	-	-
MW99-104	SAND	36.52	33.95	33.95	-	33.46	33.51	33.18	33.84	34.15
MW99-105	SAND/ GRAVEL	36.37	34.86	34.86	-	-	-	-	-	-
MW99-106	GRAVEL	36.81	35.13	35.12	35.13	34.60	33.49	34.33	35.25	35.7
MW99-107	CLAY/SAND	36.73	35.40	35.41	35.38	-	-	-	-	-
MW99-108	SAND	36.9	36.51	36.54	36.6	-	-	-	-	-
MW99-109	MADE GROUND	37	-	36.43	36.48	-	-	-	-	-
MW99-110	GRAVEL	36.68	-	35.29	35.28	34.88	35.00	34.81	-	-
MW99-201	GRAVEL	36.34	34.75	34.77	34.77	-	-	-	-	-
MW99-202	MADE GROUND	34.00	-	31.26	31.25	30.77	30.70	30.69	31.10	31.84
MW99-203	MADE GROUND	36.85	-	DRY	DRY	-	-	-	-	-
MW99-204	SAND/ GRAVEL	35.83	-	34.50	34.50	34.72	34.57	34.63	-	-
MW99-205	CLAY/SAND	36.71	-	36.10	36.10	-	-	-	-	-

Borehole	Response Zone	Elevation (mAOD)	A - March/ April 1999	B - March/ April 1999	C - April 1999	D - June 2011	E - July 2011	F - August 2011	G - December 2013	H - January 2014
			Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)
MW2	CLAY	33.79	-	DRY	DRY	-	-	-	-	-
MW3	SAND/ GRAVEL/ CLAY	37.19	35.80	35.80	-	35.86	35.78	35.64	-	-
MW4	MADE GROUND	36.04	33.50	33.47	-	-	-	-	-	-
MW5	SAND	37.52	35.90	35.89	35.87	35.84	35.81	35.72	-	-
MW6	SAND/CLAY	36.62	36.47	36.46	-	-	-	-	-	-
MW11-01	CLAY	33.29	-	-	-	33.01	32.90	32.68	-	-
MW11-02	MADE GROUND/ CLAY	37.05	-	-	-	34.93	34.46	34.33	35.68	36.04
MW11-05	MADE GROUND	36.73	-	-	-	36.33	36.24	36.01	36.27	36.53
MW11-06	GRAVEL/ SAND	36.50	-	-	-	36.18	35.96	35.75		
MW11-07	MADE GROUND/ GRAVEL/ CLAY	36.75	-	-	-	36.03	35.96	35.8	36.04	36.75
MW11-08B	MADE GROUND/ GRAVEL/ CLAY	36.7	-	-	-	36.60	35.72	35.46	35.61	35.83

Borehole	Response Zone	Elevation (mAOD)	A - March/ April 1999	B - March/ April 1999	C - April 1999	D - June 2011	E - July 2011	F - August 2011	G - December 2013	H - January 2014
			Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)
MW11-10	MADE GROUND/ GRAVEL	35.38	-	-	-	-	35.30	35.18	-	-
MW11-11	MADE GROUND/ SAND/ CLAY	36.79	-	-	-	36.33	35.96	35.9	-	-
MW11-12	SAND/ GRAVEL/ CLAY	36.65	-	-	-	34.79	34.84	34.66	-	-
MW11-13	CLAY	36.31	-	-	-	34.94	35.00	34.82	-	-
MW11-16	CLAY/SAND	36.49	-	-	-	33.44	32.97	32.915	34.11	34.13
BH1	SAND	-	-	-	-	-	-	-	-	-
BH2	SILT/GRAVEL	36.73	-	-	-	-	-	-	35.83	36.07
BH3	CLAY/ GRAVEL	36.55	-	-	-	-	-	-	34.79	35.00
BH4	CLAY/ GRAVEL	36.91	-	-	-	-	-	-	35.15	35.36
BH5	MADE GROUND/ CLAY/ GRAVEL	36.43	-	-	-	-	-	-	33.58	34.26
BH9	MADE GROUND/ SILT/ CLAY	34.16	-	-	-	-	-	-	33.16	33.26

Borehole	Response Zone	Elevation (mAOD)	A - March/ April 1999	B - March/ April 1999	C - April 1999	D - June 2011	E - July 2011	F - August 2011	G - December 2013	H - January 2014
			Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)	Rest Water Level (mAOD)
BH12	SILT	34.30	-	-	-	-	-	-	33.94	34.30
BH17	SAND	36.98	-	-	-	-	-	-	36.58	36.78
BH21	CLAY	36.65	-	-	-	-	-	-	32.136	36.46
BH23	GRAVEL/ SAND	36.93	-	-	-	-	-	-	35.81	34.64
BH24	SAND	37.86	-	-	-	-	-	-	36.23	35.80

Groundwater occurrences were also recorded in trial pit excavations, although reduced rest water level measurements were not possible for these observations. Details are provided on the trial pit logs in Appendix B.

Area AC1

Monitoring wells monitored in this area recorded rest water levels between 33-36m above Ordnance Datum (AOD). No groundwater was observed in trial pits in the area south of old paint house and gas holder. Perched groundwater in trial pits excavated in the old purifier area was observed at 1.5 – 1.6m bgl.

On the northern site boundary there is water flowing out of location SS11-05-1 (see drawing A1-13627-3018 and photos 5-7), apparently from a surface drain onto surrounding land. The outflow is accompanied by orange sediment and the drain cover was lifted to reveal the drain line was also full of similar orange sediment. The outfall from the site, at SS11-06-1 to river was not found. Further orange / brown leachate breakout was observed in the same location as previously reported along the northwestern site boundary fence line.

Area AC2

Monitoring wells in this area recorded rest water levels of between 34-36 mAOD. In the trial pits, groundwater was observed between 1-2.7mbgl to the west of the training centre. Groundwater strikes were recorded at 1.1mbgl in IKM 2013 borehole BH1 and 1.6mbgl in BH2 beneath the building itself. The water sampled from BH1 and BH2 had a strong hydrocarbon odour and sheen on the surface. During monitoring of historical borehole MW11-08B, adjacent to the garage building, free product was observed on the dip meter and the water sampled from MW11-08B appeared very contaminated, and had a very strong hydrocarbon odour (see photo 13).

Area AC3

Water sampled from the outfall SS11-03-1 had a hydrocarbon sheen on the surface (see photos 14-16).

Area AC4

All the culverts in this area were observed to be partially blocked with wood and other waste and in need of clearance/maintenance work (see photos 17-19). One of the culverts below the old railway line was blocked completely and there was no visible flow (see photo 18).

During trial pitting, groundwater was observed in two of the trial pits, at 2.1mbgl in IKM 2013 trial pit TP30 and 2.5mbgl in TP38.

The second round of monitoring in January 2014 took place after a period of heavy rainfall and localised flooding was noted around the site. Bedwell Brook had burst its banks, leaving a strong odour and slight sheen over the surrounding area. Water levels prevented sampling at exactly the same location as in December.

Historical borehole MW99-202 was monitored and sampled, with a rest water level of 31m AOD.

5.6 Incidents

All works were conducted in accordance with prior agreed method statements and risk assessments developed for the main site investigation. Full records were maintained by the I&H Brown site manager.

Nevertheless, an unrecorded water main was struck on 26th November 2013, during trial pitting in the eastern sector of Area AC1, close to where TP40 was excavated (see drawing A1-13627-3018). Works were stopped and the incident dealt with by the IHB site manager, who organised for the main to be repaired before the site investigation works were completed.

No further incidents or near misses were reported during the works.

5.7 Laboratory Analysis

Water, sediment and soil samples during the investigation works were placed in appropriate laboratory supplied containers and dispatched to the laboratory by overnight courier.

All sample analysis was conducted by Derwentside Environmental Testing Services Ltd (DETS) in accordance with their standard laboratory methods, the majority of which are UKAS accredited. Soil

A total of 68 soil samples (including sediment samples) were collected from trial pit, borehole and sediment sampling locations during the site works. 20 soil/sediment samples were collected from area AC1, 33 soil/sediment samples were collected from area AC2 and 15 soil/sediment samples were collected from area AC4.

Samples were collected from Made Ground and underlying natural strata, both visibly contaminated and apparently uncontaminated.

All soil samples were subject to analysis for the standard National Grid suite of typical inorganic and organic contaminants, including screening for asbestos fibres. Compiled results tables for this analysis are provided in Appendix G.

Drawing No. A1-13627-3014 shows the location of samples tested for asbestos fibres and indicates the level of fibres found in each case (not detected, detected at less than 0.001% by mass, or detected at greater than 0.001% by mass).

5.7.1 Water

All water samples were subject to the same standard National Grid suite as the soil samples, with the exception of asbestos screening. Compiled results tables for water analysis are also presented in Appendix G.

5.7.2 Leachate

Leachate testing was performed on one soil sample taken at 2mbgl from TP32. Leachate was tested for the same suite of contaminants as the water samples. Results are included in the Tables in Appendix G.

5.8 Quality Assurance & Control

All DETS testing is subject to rigorous internal QA/QC, developed as an integral part of the testing methodology, and with records available on request. A total of two duplicate soil samples and five duplicate waters were obtained from site and submitted to identical testing regime as the standard samples. A field blank and trip blank were also submitted to an identical testing regime as the standard samples. No significant discrepancies were noted. DETS QA and QC data is located in Appendix K.

6. REFERENCES

References contained in the current report are:

Ref 1 (KCB, 1996). Komex Clarke Bond – *Final Environmental Assessment Factual Report, Maelor Works, Wrexham*. Report No. 50065, February 1996.

Ref 2 (KCB, 1999). Komex Clarke Bond – *Factual Additional Site Investigation, Maelor Works, Wrexham*. Report No. 50065-6, November 1999.

Ref 3 (Worley Parsons, 2006). Worley Parsons Komex– *Factual Site Report, Area A, Maelor Works, Wrexham*. Report No. 50065-25, August 2006.

Ref 4 (Worley Parsons, 2012). Worley Parsons – *Environmental Assessment Site Investigation Report, Maelor Works, Wrexham*. Report No. 50065-29, January 2012.

Ref 5 (Worley Parsons, 2012) Worley Parsons – Site Information, Maelor Works, Wrexham Report No. 50065-30, November 2012.

DRAWINGS

A3-13627-3057

Areas A and C Site Location Plan

A1-13627-3017
Tile Layout Plan

A1-13627-3048
Service Drawings

A1-13627-3018

Exploratory Holes Layout Plan - AC1

A1-13627-3019

Exploratory Holes Layout Plan - AC2

A1-13627-3021

Exploratory Holes Layout Plan - AC4

A1-13627-3011

Exploratory Holes Layout Plan - Area A

A1-13627-3020

Exploratory Holes Layout Plan - AC3

A1-13627-3038

Visual Contamination AC1

A1-13627-3039

Visual Contamination AC2

A1-13627-3040

Visual Contamination AC3

A1-13627-3041

Visual Contamination AC4

A1-13627-3014

Asbestos Testing Location Plan - Area A

A1-13627-3007
Area AC1 Constraints Plan

A1-13627-3008
Area AC2 Constraints Plan

A1-13627-3009
Area AC3 Constraints Plan

A1-13627-3010
Area AC4 Constraints Plan

APPENDICES

Appendix A
Ecological Survey Report

Appendix B
Trial Pit Photographs and Logs

Appendix C

Borehole Logs

Appendix D
Radiological Survey Report

Appendix E
Utility Survey

Appendix F
Laboratory Analysis Certificates

Appendix G
Compiled Analytical Data

Appendix H
Refurbishment & Demolition Survey (Asbestos)

Appendix I
Photographic Records

Appendix J

Historical Maps

Appendix K
QA/QC Laboratory Data

Appendix L
Site Diaries

Appendix M
Controlled Waste Certificates

Appendix N
Wrexham Service Plans

Appendix O
CD Format: DETS Laboratory AQ/AC Information

Appendix P
CD Format: Data Tables

