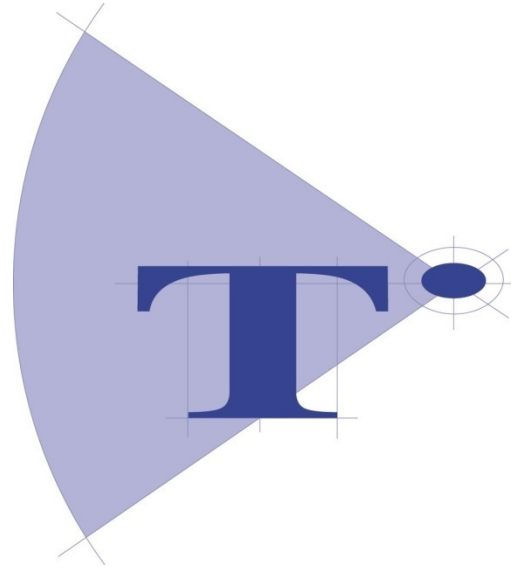




GAS PROTECTION MEASURES VERIFICATION REPORT FOR THE CONVERSION OF NEW FOUNDRY BUILDING, JOHNSTOWN, WREXHAM

ISSUE 1.0

TE1085GPMVR

20 FEBRUARY 2019

Sean Lee

Prepared For

The Watkin Jones & Son Limited
Directors Pension Scheme

Llandygai Industrial Estate,
Bangor,
Gwynedd,
LL57 4YH

Prepared By

Tier Environmental Ltd

Chadwick House,
Birchwood Park
Warrington
WA3 6AE



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No: TE1085GPMVR
Page No: i of iii
Engineer: Sean Lee
Date: 20/02/2019

DOCUMENT CONTROL

Project No. : TE1085GPMVR
Report Status: Final
Issue No.: Issue 1.0
Project Engineer: Sean Lee
Date of Issue: 20/02/2019
Signature:

This report has been prepared by Tier with all reasonable skill, care and diligence, within the best practice and guidance current at the time of issue within the scope of works which have been agreed with the client. This report is confidential to the client and Tier accepts no responsibility whatsoever to third parties to whom this report, or any part thereof is made presented, unless this is formally agreed in writing by a Director of Tier Consult Ltd before any reliance is made. Any such party relies upon the report at their own risk. Tier disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

Issue No.	Description of Issue / Revision	Date of Issue	Reviewed By	Author Initial
1.0	Final	20/02/2019	JB	SL



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No: TE1085GPMVR
Page No: ii of iii
Engineer: Sean Lee
Date: 20/02/2019

CONTENTS

1.	INTRODUCTION	1
1.1.	Background.....	1
1.2.	Objectives.....	2
2.	SITE DETAILS AND DESCRIPTION	3
3.	PREVIOUS INVESTIGATION FINDINGS	4
4.	REMEDIATION STRATEGY	6
4.1.	Hazardous Ground Gases.....	6
5.	VERIFICATION.....	8
5.1.	Variations from Remediation Strategy	8
5.2.	Ground Gas Protection Verification	8
6.	SITE CERTIFICATION.....	9
7.	REGULATORY APPROVALS.....	10
8.	REFERENCES	11

TABLES

Table 2.1.	Site Overview.....	3
------------	--------------------	---



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No: TE1085GPMVR
Page No: iii of iii
Engineer: Sean Lee
Date: 20/02/2019

APPENDICES

APPENDIX A – FIGURES AND DRAWINGS

APPENDIX B – GLOSSARY OF TERMS

APPENDIX C – DEFINITIONS OF TERMS USED IN QUALITATIVE AND QUANTITATIVE
RISK ASSESSMENTS

APPENDIX D – ASSESSMENT CRITERIA APPLIED FOR GROUND GAS

APPENDIX E – GAS VERIFICATION SITE DOCUMENTS

APPENDIX F – PRODUCT DATA SHEETS

APPENDIX G – CORRESPONDENCE WITH LOCAL AUTHORITY



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 1 of 12
Engineer: Sean Lee
Date: 20/02/2019

1. INTRODUCTION

1.1. Background

Tier Environmental was commissioned by The Watkin Jones & Son Limited Directors Pension Scheme to undertake a Preliminary Risk Assessment (hereafter referred to as 'PRA'), report reference: TE1850PRA, dated 29th March 2018 for an area of land referred to as New Foundry Buildings, Gutter Hill, Johnstown, Wrexham, LL14 1LT (the "Site"). A Remediation Strategy and Gas Protection Verification Plan (hereafter referred to as 'RSGVP'), report reference TE1085RSv1.1 dated 25th June 2018, was subsequently produced by Tier Environmental.

The existing building is being converted from commercial offices (Class B1) to 12 No. residential apartments (Class C3), with external and internal alterations, associated landscaping and other ancillary works.

The PRA identified that there is a potential for ground gas generation and source of potential contamination associated with the on-site Made Ground that was likely imported to raise ground levels on-site. A site investigation and chemical testing was required to determine whether the current shallow soils are suitable for use or whether a clean cover will be required, based on a residential without home grown produce end use.

The historic railway immediately north of the Site and the historic gas works (now a fire station) to the north of Gutter Hill may also be potential sources of gas and groundwater contamination.

It was considered that no potential pollutant linkages to controlled waters receptors will be created by the proposed conversion of the existing building.

There is a potential for hazardous ground gas generation related to radon bearing strata, on-site Made Ground associated with raised ground levels, the 2 No. disused mine shafts and potential shallow coal seams/workings.

No historic intrusive ground investigations or ground gas monitoring data were available with regard to the original construction of the existing building. Construction details for the existing building are also unavailable with regard to ground gas protection measures.

Sub floor telescopic air vents were installed at approximate 2m centres around the periphery of the building, indicating a suspended ground floor slab and below slab void. Locally, some of the vents have been partially or completely blocked or damaged.

Basic radon measurements were required as a damp proof membrane was not originally installed in the existing building.

Potential development constraints and associated mitigation measures were presented within the PRA and included:

- In order to break the direct contact, dust inhalation and ingestion pathways associated with possible metals and hydrocarbon impacted soils and inhalation pathways associated with any possible asbestos containing materials (ACMs) in areas of soft landscaping and planting, a clean cover system may be required. A minimum of 600mm 'clean cover' derived from imported topsoil and subsoil laid over a geotextile membrane will be installed if deemed necessary to prevent mixing of potentially contaminated material with the cover layer. It will also guard against ecological disturbance (e.g. moles, plant roots etc); and,



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 2 of 12
Engineer: Sean Lee
Date: 20/02/2019

- Basic radon gas protection measures are required. Ground gas protection measures may also be required, in accordance with BS8485. This will include the retrofit of a volatile resistant membrane in order to break the potential vapour pathway between the potential source within the shallow soils and the future site users receptors.

It was proposed to undertake intrusive investigations (hand excavated trial pits) during the conversion works to determine whether the 600mm of clean cover soils is required. It was agreed that the intrusive investigations would be undertaken when the remaining tenant vacated the premises; the findings of these investigations were presented in a letter report (Ref. TE1085GIRL01 dated 4th September 2018) that was submitted to the Local Authority and is reproduced in Appendix G. The findings of the ground investigation are summarised in Section 3.

Intrusive investigations of the building structure were also undertaken, with the findings presented in Appendix E and summarised in Section 3.

Selected correspondence with the Local Authority is presented in Appendix G.

1.2. Objectives

The agreed gas protection measures have been installed within the building, as specified in the Remediation Strategy, as such, the objectives of this verification report are as follows:

- To provide lines of evidence that the remediation at the site was undertaken in accordance with the aforementioned report;
- To provide documented assessment of data and permanent records of onsite verification works;
- To determine whether there is any residual risk to receptors, post remediation and whether contaminated land planning conditions should be discharged.

This report, which was designed to meet the requirements of all relevant current guidance, presents the records and data produced during the remediation of the site, an interpretation of the data obtained and recommendations relevant to the defined objectives.

The verification of the clean cover soils will be provided under separate cover as these works are yet to be completed.

This report has been prepared for the sole use of The Watkin Jones & Son Limited Directors Pension Scheme. No other third party may rely upon or reproduce the contents of this report without the written approval of Tier Environmental. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk and the authors do not owe them any Duty of Care or Skill.



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 3 of 12
Engineer: Sean Lee
Date: 20/02/2019

2. SITE DETAILS AND DESCRIPTION

Table 2.1. Site Overview.

Site name	New Foundry Building, Johnstown, Wrexham.
Site address	New Foundry Building, Gutter Hill, Johnstown, Wrexham, LL14 1LS. A site location plan is included as Drawing No. TE1085GIR1 within Appendix A.
National Grid Reference	329834, 346290
Location description	The Site is situated on the western edge of Johnstown, approximately 5.5km southwest of Wrexham town centre. The Site consists of 1 No. commercial property car parking and a public path running along the western and southern boundary. The Site is bounded by Gutter Hill to the north and amenity grassland to the east, south and west.
Approximate Site area	0.28ha
Site shape	The Site is irregular in shape and elongate in a northeast-southwest orientation.
General topography and ground levels	The Site is generally flat lying with topography reducing in the south-eastern area.
Land use	The Site comprised 1 No. office building in the central area of the Site with areas of associated car parking and hardstanding in the north and east of the Site.
Existing structures	1 No. commercial property with associated car parking areas.
Site ground surfaces	The majority of the Site is covered in hardstanding with areas of soft landscaping.
Sub-surface structures	Manhole covers have been noted in the western area of the Site, presumably associated with the existing building. Unrecorded services may also be present.
Existing gas protection measures	Investigations undertaken on 14 th May 2018 confirmed that approximately 70mm of concrete screed underlain by a block and beam suspended floor slab was encountered within the building. There did not appear to be an existing gas membrane beneath the screed. Plastic telescopic sub floor air vents were noted at approximate 2m centres around the periphery of the building.



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 4 of 12
Engineer: Sean Lee
Date: 20/02/2019

3. PREVIOUS INVESTIGATION FINDINGS

In producing this verification report, a number of investigation reports pertaining to the site itself been produced by Tier Environmental:

- Preliminary Risk Assessment (PRA), report reference: TE1850PRA, dated 29th March 2018;
- Remediation Strategy and Gas Protection Verification Plan (hereafter referred to as 'RSGVP'), report reference TE1085RSv1.1 dated 25th June 2018; and,
- Letter report, Ref. TE1085GIRL01 dated 4th September 2018 (presented in Appendix G).

In brief the investigations show that the Made Ground soils in the western and southern areas of the site pose a potential risk to human health due to the presence of lead, PAHs and asbestos. The associated risks will only be present in the areas where Made Ground soils remain exposed at the site surface and will need to be mitigated accordingly. It is considered that a dedicated clean cover system is required to break the associated pathways in soft landscaping areas in the western and southern parts of the Site only as all areas of hardstanding and building areas are considered physical barriers which will break the associated pathways.

It is considered that the 'ashy/granular' Made Ground soils encountered within TP4 to TP6 in the west and south of the site represent a potentially unacceptable risk to human health in proposed communal garden areas with regard to lead, PAHs and asbestos. It is therefore that mitigation measures will be required to break the potential pollutant linkage between the 'ashy/granular' Made Ground material and the end users of the site. The previously agreed Remediation Strategy and Gas Protection Verification Plan (Report No. TE1085RS v1.1 dated 25th June 2018) proposed a minimum 600mm depth of clean cover.

Due to topographical constraints at the site, it was considered likely that a reduced dig will be required to accommodate the 600mm of clean cover soils. The proximity of the trees along the western site boundary and likely roots beneath our site would make it difficult to either undertake a reduced dig to accommodate the clean cover or raise site levels above the root system without damage to third party property.

Other mitigation measures were considered that could provide adequate protection to the future residents from the 'ashy/granular' Made Ground and prevent damage to off-site property. The preferred solution is the installation of a terram/geotextile barrier fabric overlying the existing soils overlain by approximately 150mm of clean, certified and validated imported topsoil.

The details of the protection measures will be included within the site's Health and Safety Plan to ensure maintenance workers understand the need to maintain the integrity of the system. An annual inspection of the soft landscaped area by a maintenance worker, and top up of gravel or topsoil if required, may also be undertaken.

The Contaminated Land Officer raised concerns with regard to residents planting fruit trees or similar in the future. The proposed layout plan indicates that there will not be any direct access from individual apartments into the communal gardens; the only access will be via a central corridor and through the main access point to the front of the building. The soft landscaped area will also be fenced to prevent unauthorised access to the ecological wet scrape in the western landscaped area. It was therefore considered that the future residents are unlikely to plant edible produce within the communal gardens.

The verification of the clean cover soils will be undertaken under separate cover upon completion of the works.



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 5 of 12
Engineer: Sean Lee
Date: 20/02/2019

The investigations also confirmed that, based upon currently available data, the overall Site ground gas regime was assumed as CS2. This assessment has been based on the ground conditions encountered and the conceptual site model. This categorisation indicated that gas protection measures were required in accordance with BS8485:2015.



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 6 of 12
Engineer: Sean Lee
Date: 20/02/2019

4. REMEDIATION STRATEGY

Four reports relating to the remediation and subsequent verification of the site were produced:

- Remediation Strategy and Gas Protection Verification Plan (hereafter referred to as 'RSGVP'), report reference TE1085RSv1.1 dated 25th June 2018; and,
- Letter report, Ref. TE1085GIRL01 dated 4th September 2018 (presented in Appendix G).

Whilst it is not the intention of this report to repeat the information contained within the above documents in full, the salient points are covered below. This verification report follows the guidance set out in the above documents.

4.1. Hazardous Ground Gases

Tier Environmental determined that the site should be classified as Characteristic Situation 2 (low risk). Based on the characterisation of the Site and the development, it was concluded that the following gas protection measures would be appropriate:

- Installation of external air vents to the cavity walls at approximate 2m centres (above each of the sub floor vents) to prevent the accumulation of ground gases within the cavity walls;
- Replacement of the existing telescopic vents to ensure sufficient sub floor ventilation of the existing 400mm void (1.5 points); and,
- A ground gas membrane (2 points).

This combination gives a gas protection guidance value of 3.5 which meets the required value of 3.5. These measures were proposed within the Tier correspondence and have been agreed with the Local Authority.

In order to achieve the 2 points score, the gas barrier will comprise the Corden EPS Evolution VOC Barrier across the existing floor which conforms to the following criteria:

- Sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method);
- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab);
- Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc); and,
- Capable, after installation, of providing a complete barrier to the entry of the relevant gas.



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 7 of 12
Engineer: Sean Lee
Date: 20/02/2019

The product leaflet is presented in Appendix F.

It was considered that these measures conform to the following criteria:

- Sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method);
- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab);
- Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc);
- Capable, after installation, of providing a complete barrier to the entry of the relevant gas.

The full specification and all relevant product data sheets are presented in Appendix F.

In addition, 2 No. coats of Corden EPS Liquid Gas Barrier were installed within the existing lift pit as limited access prevented the installation of a gas membrane.



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 8 of 12
Engineer: Sean Lee
Date: 20/02/2019

5. VERIFICATION

It was detailed in the remediation method statement that a Verification Report should be compiled which would comprise all relevant site records and act as certification that the remedial preparation works have been carried out in accordance with the Remediation Method Statement.

The Verification Report shall include the following:

- A description of the works undertaken;
- Records of the works;
- Progress photographs;
- Waste Transfer Notes;
- Chemical verification test results;
- Results of hazardous ground gas protection measures verification; and,
- A statement that the works have been undertaken in accordance with the agreed strategy.

5.1. Variations from Remediation Strategy

There have been no variations from the approved remediation strategy.

5.2. Ground Gas Protection Verification

In order to fully qualify for the 2 points, it was required that the membrane be verified by Tier Environmental in accordance with CIRIA C735. The gas membrane was installed by Water-Line Solutions Ltd, a specialist geomembrane lining systems installer.

The ground gas protection measures were undertaken on 3 No. separate occasions. The inspection visits were to conduct a thorough verification (visual) inspection of the membrane gas barrier prior to the concrete slab pour.

The attached checklists and photographs in Appendix E show that the ground gas measures have been installed to a suitable standard and have been inspected by Tier Environmental Ltd. It is therefore considered that the final contaminated land conditions could be discharged.



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 9 of 12
Engineer: Sean Lee
Date: 20/02/2019

6. SITE CERTIFICATION

It has been demonstrated in this report that the installation of the ground gas protection measures has been undertaken at the site in accordance with the agreed remediation strategy. **It is therefore recommended that the remaining planning conditions are discharged with regard to the gas protection measures as the site is considered to be suitable for the desired land use.**



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 10 of 12
Engineer: Sean Lee
Date: 20/02/2019

7. REGULATORY APPROVALS

The conclusions and recommendations presented above are considered reasonable based on the findings of the site investigations, subsequent reporting and verification visits. However, these cannot be guaranteed to gain regulatory approval and, therefore, the report should be passed to the appropriate regulatory authorities and/or other organisations for their comment and approval prior to undertaking any works on Site.

This verification report and the preceding ground investigation reports and remediation strategy should be included within the H&S File for the site so that they can be referenced/inspected by future site occupiers, maintenance workers and utility providers.



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 11 of 12
Engineer: Sean Lee
Date: 20/02/2019

8. REFERENCES

BRE (1999). Radon: Guidance on Protective Measures for New Dwellings. IHS BRE Press, Bracknell.

BS 10175:2011 Investigation of Potentially Contaminated Sites - Code of Practice. British Standards Institution, London.

BS 8485:2015 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. British Standards Institution, London.

CIRIA (1995a) Protecting Development from Methane. Report 149, CIRIA, London.

CIRIA (1995b) Methane Investigation Strategies. Report 150, CIRIA, London.

CIRIA (1995c) Interpreting Measurement of Gas in the Ground Report 151, CIRIA, London.

CIRIA (1995d) Risk Assessment for Methane and Other Gases from the Ground. Report 152, CIRIA, London.

CIRIA (1996) A Guide for Safe Working on Contaminated Sites. Report 132, CIRIA, London.

CIRIA (2014) Good practice on the testing and verification of protection systems for buildings against hazardous ground gases. Report 735, CIRIA, London

DEFRA and Environment Agency (2002a) Assessment of Risks to Human Health from Land Contamination: An Overview of the Development of Soil Guideline Values and Related Research. R&D Report CLR7, Environment Agency, Bristol.

DEFRA and Environment Agency (2002b) Potential Contaminants for the Assessment of Land. Report CLR8, Environment Agency, Bristol.

DEFRA and Environment Agency (2002c) Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Report CLR9, Environment Agency, Bristol.

DEFRA and Environment Agency (2002d) The contaminated land exposure assessment (CLEA) model: technical basis and algorithms. Report CLR10, Environment Agency, Bristol.

DEFRA and Environment Agency (2002e) Model Procedures for the Management of Land Contamination. Report CLR11, Environment Agency, Bristol.

Environment Agency (2000) Technical Aspects of Site Investigation. Report P5-065/TR, Environment Agency, Bristol.

Environment Agency (2002) Guidance on Monitoring Landfill Leachate, Groundwater and Surface Water. Report LFTGN02, Environment Agency, Bristol.

Environment Agency (2007) Evaluation of Models for Predicting Plant Uptake of Chemicals from Soil. Report SC050021/SR, Environment Agency, Bristol.



**GAS PROTECTION MEASURES
VERIFICATION REPORT FOR THE
CONVERSION OF NEW FOUNDRY
BUILDING, JOHNSTOWN, WREXHAM**

Project No : TE1085GPMVR
Page No : 12 of 12
Engineer: Sean Lee
Date: 20/02/2019

Environment Agency (2008) Science Report SC050021/SR7 Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values.

Highways Agency (2006) Design of Pavement Foundations. Document HD 25/IAN 73/06.

HSE (1991) Protection of Workers and the General Public During the Development of Contaminated Land. HMSO, London.

WHO (2000) Air Quality Guidelines for Europe. 2nd edition, WHO Regional Office for Europe, Copenhagen.

Yorkshire and Lincolnshire Pollution Advisory Group (2016) Verification Requirements for Gas Protection Systems. Version 1.1. YALPAG, Leeds.

APPENDIX A - FIGURES AND DRAWINGS



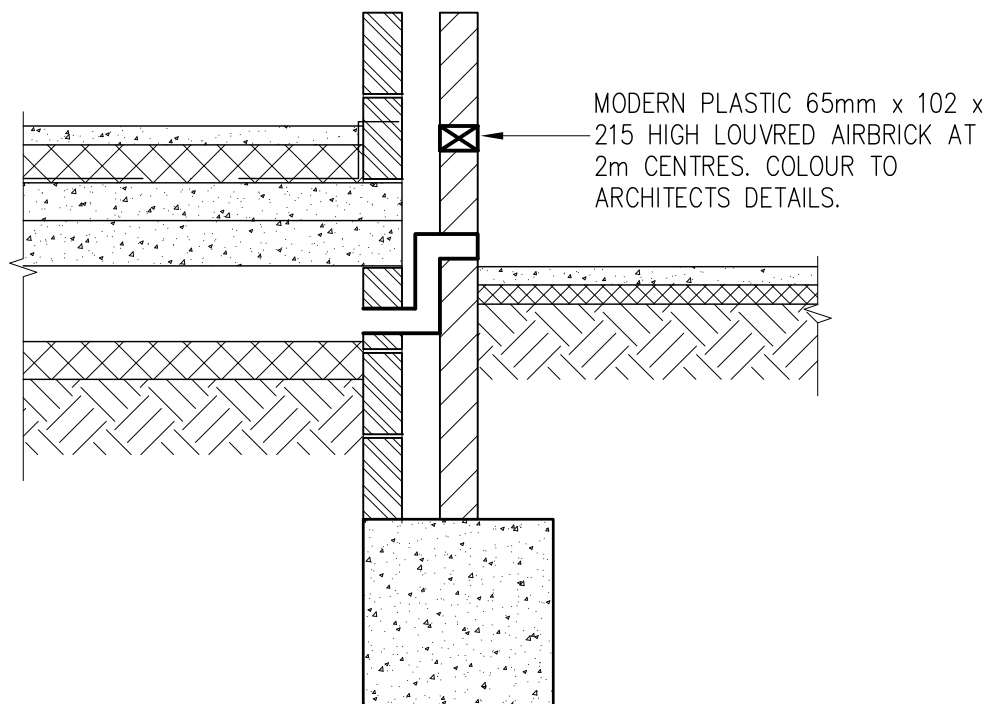
Site Location Plan

Contract Number	TE1085
Contract	New foundry Buildings, Wrexham
Client	Watkin Jones & Son



Reproduced from the Ordnance Survey 1:25,000 scale map with the permission of The Controller of Her Majesty's Stationary Office, © Crown Copyright. All rights reserved.

Scale	NTS	
Drawn by: NG	Approved: SL	
Drawing Number: TE1085PRA1		



CAVITY VENT DETAIL FOR EXTERNAL WALL

Scale = 1:20

C1 04/09/18 RN ISSUED FOR CONSTRUCTION

PROJECT:

NEW FOUNDRY BUILDING, WREXHAM

TITLE:

CAVITY VENT DETAIL FOR
EXTERNAL WALL

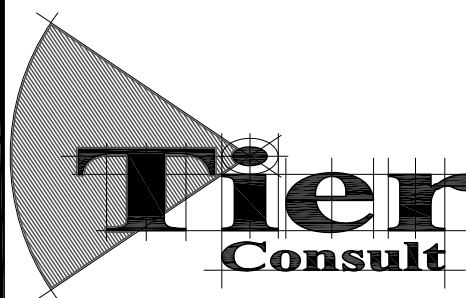
PROJECT No:
T/18/2096

DRAWING No:

SK01

REV:

C1



Tier Consult Ltd.
Elm House Farm
Saighton
Chester
CH3 6EN

Telephone:
01244 333080
Fax:
01244 333081
Mobile:
07966 687066
Email:
info@tieruk.com

APPENDIX B - GLOSSARY OF TERMS

ACEC	Aggressive Chemical Environment for Concrete (classification)
aOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
Designated location	Site (and the ecosystem on that site) protected under national or international legislation. A potential ecological receptor to be considered as part of the assessment of land contamination. Example designated locations include SSSIs (q.v.), SACs (q.v.), national nature reserves, Ramsar sites and bird special protection areas.
DQA	Data Quality Assessment
DQO	Data Quality Objective
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
K _{ow}	Octanol-water partition coefficient
LEL	Lower Explosive Limit
LL	Liquid Limit
LoD	Limit of Detection (analytical)
LoQ	Limit of Quantification (analytical)
Mean Value Test	Statistical test (described in the CIEH Guidance) to estimate the mean value of a normally distributed population of data at a given level of confidence. Normally for contaminated land assessment, the 95th percentile (referred to as the 95%UCL or US95) is applied as a reasonable but conservative estimate of the mean concentration for comparison with the relevant assessment criteria.
Maximum Value Test	Statistical test (described in the CIEH Guidance) to identify whether an elevated concentration within a normally distributed data set forms part of the underlying population from which it has been sampled or whether it is an outlier (such as a localised area of contamination) that merits further consideration.
MC	Moisture Content
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
PI	Plasticity Index
PID	Photoionisation Detector
PL	Plastic Limit
ppm	Parts per million
ppmv	Parts per million by volume

QA	Quality Assurance
QC	Quality Control
SAC	Special Area of Conservation
SOM	Soil Organic Matter
SPT	Standard Penetration Test
SPZ	Source Protection Zone (see Appendix E)
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest
SVOC	Semi-Volatile Organic Compound
TEF	Toxicity Equivalent Factor
TPH	Total Petroleum Hydrocarbons
TWA	Time Weighted Average
US95	95 th percentile estimate of the true mean value of a data population (also known as 95%UCL).
VOC	Volatile Organic Compound

APPENDIX C - DEFINITIONS OF TERMS USED IN QUALITATIVE AND QUANTITATIVE RISK ASSESSMENTS

For the qualitative and quantitative assessment of risks posed by potential pollutant linkages have been undertaken using the risk matrix adapted from CIRIA C552 and outlined in the table below.

	Category	Definition
Potential severity	Severe	Acute (short term) risk to human health, Major pollution of sensitive controlled waters, ecosystems or habitat. Catastrophic damage to buildings or property or crops.
	Medium	Chronic (Medium / long term) risk to human health Pollution of sensitive controlled waters, ecosystems or species, Significant damage to crops, buildings or structures
	Mild	Easily preventable permanent health effects on humans. Pollution of non-sensitive controlled waters. Minor damage to buildings or structures.
	Minor	Easily preventable non-permanent health effects on humans, or no effects. Minor, low level and localised contamination of on-site soil. Easily repairable damage to buildings or structures.
Probability of risk	High Likelihood	Pollutant linkage may be present and the risk is almost certain to occur , or there is evidence of harm already occurring.
	Likely	Pollutant linkage may be present and it is probable that the risk will occur over the long term.
	Low Likelihood	Pollutant linkages may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
	Unlikely	Pollutant linkage may be present but the circumstances under which harm would occur are improbable.

		Potential Severity			
		Severe	Medium	Mild	Minor
Probability of risk	High Likelihood	Very high	High	Moderate	Moderate/Low
	Likely	High	Moderate	Moderate/Low	Low
	Low Likelihood	Moderate	Moderate/Low	Low	Negligible
	Unlikely	Moderate/Low	Low	Negligible	Negligible

APPENDIX D - ASSESSMENT CRITERIA APPLIED FOR GROUND GAS

Monitoring for the following is generally performed as part of ground gas assessment:

- Methane (CH₄): an odourless, flammable gas. Mixtures of methane with air containing between 5 and 15% v/v methane are explosive.
- Carbon dioxide (CO₂): an asphyxiant at elevated concentrations. Denser than air, it can accumulate in excavations, and within low points inside buildings
- Oxygen (O₂): important in the assessment of the potential formation of explosive mixtures with methane. Monitoring normally measures both methane and oxygen concentrations in ground gas to derive an indication of the risk of explosive mixture formation, expressed as a percentage of the Lower Explosive Limit (LEL). Low concentrations of oxygen in ground gas can also exacerbate the risk of CO₂ asphyxiation.
- Hydrogen sulphide (H₂S): odorous and toxic, capable of forming flammable mixtures with air.
- Volatile Organic Compounds (VOCs): present as chemical contaminants of soil and sometimes also biologically produced in low concentrations.

Assessment of methane (CH₄) and carbon dioxide (CO₂)

Methane and CO₂ can arise from natural geological sources, mine workings, rotting organic matter (peat, landfilled materials, etc.) and/or contaminant biodegradation. Assessment of ground gas composition and flows is therefore an essential part of site assessment. The need to adequately address potential risks from ground gas on development sites is therefore required under the planning regime.

In order to appropriately assess the site risks, the Construction Industry Research and Information Association (CIRIA) and others have issued several guidance documents on landfill and ground gas that are intended to provide advice on how to investigate and deal with gas contaminated ground with respect to development. These are:

- Report 149: 'Protecting Development from Methane' (CIRIA, 1995a)
- Report 150: 'Methane Investigation Strategies' (CIRIA, 1995b)
- Report 151: 'Interpreting Measurement of Gas in the Ground' (CIRIA, 1995c)
- Report 152: 'Risk Assessment for Methane and Other Gases from the Ground' (CIRIA, 1995d)

More recent guidance has been published to update the documents detailed above to collaborate and promote industry 'good practice'. These are:

- CIRIA Report 665: 'Assessing risks posed by hazardous ground gases to buildings (CIRIA, 2008)
- NHBC: 'Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present' (NHBC, 2007)
- BS8485: Code of Practice for the characterisation and remediation from ground gas in affected developments (BSI Group, 2007)

The earlier CIRIA 149 approach is now considered to be too conservative. A more realistic measure of the risk posed by methane and CO₂ in ground gas can be established by determining an appropriate Gas Screening Value (GSV), using the methods described in the NHBC and CIRIA 659 documents. These values are based upon earlier work undertaken by Wilson and Card (1999).

GSVs are calculated by multiplying the borehole flow rate (l/hr) by the percentage (% v/v) concentration in the gas stream of the specific component, i.e.:

$$\text{GSV} = (\text{Concentration} / 100) \times \text{Flow rate}.$$

A risk-based methodology for deriving GSVs is defined for two situations (designated A and B), which are adequate for the great majority of site cases:

- Situation A: All development types except low rise housing with gardens
- Situation B: Low rise housing with gardens.

Under Situation A, classification of the scope of protection required is determined from the site GSV, summarised in Table 1. For Situation B, GSVs derived are used in a 'Traffic Light' classification (summarised in Table 2) which determines the required level and scope of protection measures. Tables 1 and 2 are summaries only: the details provided in the body text, footnotes and appendices of the above-referenced documents should be read in conjunction with the results to determine the appropriate level of protection.

For conservatism, Tier Environmental uses the maximum concentration and gas flow rate of methane detected in any borehole during all of the monitoring visits in deriving recommendations on appropriate protection measures. This represents the worst-case risk of forming an explosive mixtures. For CO₂, steady state concentrations and flow data are applied, as these determine the development of an asphyxiating mixture. All values are selected whether or not they occurred in the same borehole or during the same monitoring event.

Exceedences of the maximum concentrations used in a Tier 1 Gas Risk Assessment can be tolerated, when the conceptual model indicates that it is safe to do so. However, GSV values must never be exceeded - where site-specific circumstances permit the derivation of alternative GSVs according to the defined conceptual model, then the appropriate GSV values should be applied.

Table 1. GSV Categories Defined for Situation A (Summarised from CIRIA Report 665).

Risk classification	GSV (CH ₄ or CO ₂ ; l/hr)	Additional factors	Characteristic situation
Very low	<0.07	Typically methane <=1% and/or CO ₂ <=5%, otherwise consider increase to Low Risk.	1
Low	<0.7	Typically borehole ground gas flow rate <=70 l/hr; otherwise consider increase to Moderate Risk.	2
Moderate	<3.5	---	3
Moderate to high	<15	QRA required to evaluate scope of remediation measures.	4
High	<70	---	5
Very high	>70	---	6

Table 2. GSV Categories Defined for Situation B (Summarised from NHBC, 2007).

Methane		CO ₂		“Traffic light” classification
Typical max. conc. (% v/v)	GSV (l/hr)	Typical max. conc. (% v/v)	GSV (l/hr)	
				Green
1	0.13	5	0.78	Amber 1
5	0.63	10	1.60	Amber 2
20	1.60	30	3.10	Red

Assessment of hydrogen sulphide (H₂S)

H₂S is toxic and highly odorous (“rotten eggs”) gas. It is often a minor component within mine gases, in ground gas within or overlying strata rich in pyrites or other sulphide-rich ores, and in most natural gas fields.

H₂S can be generated biologically in significant concentrations by the decomposition by sulphate-reducing bacteria of natural or anthropogenic organic matter under oxygen-free conditions. Its potential generation will be greater in environments containing elevated sulphate concentrations (including sea water). H₂S is therefore common within the gas arising from estuarine and marine sediments, pond sediment, stagnant water bodies, bogs and marshlands and landfilled waste, for example.

It must be noted that H₂S normally occurs together with other potentially hazardous ground gases. The measures adopted for protection against these will prove equally protective against H₂S.

There are no standards by which H₂S concentrations in ground gas can be assessed directly. Therefore, the significance of measured H₂S concentrations in ground gas must be evaluated on a case-by-case basis, taking into account the measured concentrations of other components and the specific conceptual site and exposure models. To assist in this process, the following standards and guidance may be applied.

General protection of land users

There are no UK air quality standards for general exposure to H₂S. The World Health Organisation has derived ambient air quality standards (WHO, 2000) for this gas, which may be used to inform risk assessment and decision-making:

- The 24 hour average exposure guideline value for ambient air: 0.15 mg/m³ (0.1 ppmv, approx.; this was derived by the application of a 100x safety factor to the LOAEL for long-term exposure).
- This is significantly above the odour threshold, which is typically around 0.01 mg/m³. To avoid substantial nuisance odour complaints, WHO (2000) recommends that the 30 minute average H₂S concentration in ambient air should not exceed: 0.007 mg/m³ (0.005 ppmv, approx.).

Occupational exposures

For occupational exposure, the HSE (2005) limits for H₂S are applicable:

- 8 hour time weighted average occupational exposure limit: 5 ppmv (7 mg/m³).
- Short-term exposure limit (15 minute reference period): 10 ppmv (14 mg/m³).

Assessment of VOC data

The assessment of VOC concentrations is not covered by above-referenced reports. These data can be used to inform the human health risk assessment for site occupants but should not be relied upon to assess human health risk due to uncertainties in the ground gas flow regime, variability in the (generally low) contaminant concentrations measured and inaccuracies in the concentrations measured by PID instruments.

Data on the VOC concentration in ground gas can also help inform potential occupational exposure risks to construction and similar workers. For this purpose, the measured values can be compared to the relevant occupational exposure limit (OEL) for the contaminant(s) of concern, as given in HSE (2005). In cases of doubt as to the identity of the organic contaminants within the ground gas or when these are present as a complex mixture, then the 8 hour time-weighted average (TWA) exposure limit for benzene (1 ppmv) will be applied for screening purposes. This is a reasonably conservative approach since the OEL for benzene is lower than that for the great majority of organic contaminants commonly encountered in soil and groundwater at contaminated sites

APPENDIX E - GAS VERIFICATION SITE DOCUMENTS



VISUAL INSPECTION OF GAS PROTECTION MEASURES

VISIT: 1 of 3

Site name:	New Foundry Building, Johnstown, Wrexham	Gas characteristic situation:	Assumed CS2
Job number:	TE1085	Type of development and building:	Conversion of commercial property to residential (apartments)
Date:	17.09.18	Building description:	Steel frame with blockwork and brickwork walls
Visit by:	Sean Lee	Foundation type:	Piled
Weather:	Warm and sunny	Gas protection type:	Ventilated subfloor void and retro-fitted gas membrane to the ground floor

No.	Item	Comments
1 Gas membrane		
1.1	Condition of sub-grade and/or underside of gas membrane	Existing suspended block and beam floor with sand/cement screed
1.2	Gas membrane type	N/A
1.3	Gas membrane condition	N/A
1.4	Joining tape product	N/A
1.5	Lapping design	N/A
1.6	Laps, welds and joint seals	N/A
1.7	Service entries seals	N/A
2 Passive venting		
2.1	Sub-floor void	Minimum 400mm void present.
2.2	External wall airbricks	Telescopic vents present at approximate 2m centres for subfloor ventilation. Plastic covers to be replaced. Some vents blocked by access ramp; to be cleared. Plastic air bricks to be installed to ventilate the wall cavities.
2.3	Internal sleeper walls	Present with sufficient gaps to allow air flow.
2.4	External vent trenches/ducts	N/A
3 Active venting		
3.1	System details	N/A
Additional notes:		

Photographs

No.	Description
1	Trench to install new drainage, showing the existing suspended floor slab and subfloor void.
2	Gap through sleeper wall to allow subfloor ventilation.
3	Subfloor void (minimum 400mm) to allow subfloor ventilation (25.07.18).



Photograph 1: Trench to install new drainage, showing the existing suspended floor slab and subfloor void.



Photograph 2: Approximate 200mm gap through sleeper wall to allow subfloor ventilation (25.07.18).



Photograph 3: Subfloor void (minimum 400mm) to allow subfloor ventilation (25.07.18).

The gas protection measures inspected are:	Ongoing. Subfloor void satisfactory.
--	--------------------------------------

Name: Sean Lee

Signature:

Date: 17.09.18



VISUAL INSPECTION OF GAS PROTECTION MEASURES

VISIT: 2 of 3

Site name:	New Foundry Building, Johnstown, Wrexham	Gas characteristic situation:	Assumed CS2
Job number:	TE1085	Type of development and building:	Conversion of commercial property to residential (apartments)
Date:	30.09.18	Building description:	Steel frame with blockwork and brickwork walls
Visit by:	Sean Lee	Foundation type:	Piled
Weather:	Mild and overcast	Gas protection type:	Ventilated subfloor void and retro-fitted gas membrane to the ground floor

No.	Item	Comments
1	Gas membrane	
1.1	Condition of sub-grade and/or underside of gas membrane	Existing suspended block and beam floor with sand/cement screed
1.2	Gas membrane type	Corden EPS Evolution VOC Barrier across the existing floor. 2 No. coats of Corden EPS Liquid Gas Barrier within the lift pit.
1.3	Gas membrane condition	Good condition
1.4	Joining tape product	Corden EPS GRM Self Adhesive Membrane
1.5	Lapping design	Minimum 100mm overlap.
1.6	Laps, welds and joint seals	Heat bonded welds for the majority of the joints. Self adhesive gas tape for up-stands/seals against internal walls and stanchions and minor repairs/patches.
1.7	Service entries seals	Self adhesive gas tape around service entries.
2	Passive venting	
2.1	Sub-floor void	Minimum 400mm void present.
2.2	External wall airbricks	Telescopic vents present at approximate 2m centres for subfloor ventilation. Plastic covers to be replaced. Some vents blocked by access ramp; to be cleared. Plastic air bricks to be installed to ventilate the wall cavities.
2.3	Internal sleeper walls	Present with sufficient gaps to allow air flow.
2.4	External vent trenches/ducts	N/A
3	Active venting	
3.1	System details	N/A

Additional notes:

Minor repairs were locally required around adjacent to some of the stanchions where better adhesion was required.

1 No. minor patch was required at the end of a welded joint (tab hadn't been cut far enough).

All remedial works were undertaken under the supervision of Tier Environmental.

Photographs

No.	Description
1	Detail of welded joints and cut-out tab.
2	General photograph of the Evolution VOC membrane across the existing ground floor.
3	Corner detail with self adhesive membrane.
4	Liquid Corden EPS Liquid Gas Barrier within the lift pit.



Photograph 1: Detail of welded joints and cut-out tab.



Photograph 2: General photograph of the Evolution VOC membrane across the existing ground floor.



Photograph 3: Corner detail with self adhesive membrane.



Photograph 4: Liquid Corden EPS Liquid Gas Barrier within the lift pit.

The gas protection measures inspected are:

Satisfactory to date. Sub floor gas vent to be replaced and cavity wall vents to be installed.

Name: Sean Lee

Signature:

Date: 30.09.18



VISUAL INSPECTION OF GAS PROTECTION MEASURES

VISIT: 3 of 3

Site name:	New Foundry Building, Johnstown, Wrexham	Gas characteristic situation:	Assumed CS2
Job number:	TE1085	Type of development and building:	Conversion of commercial property to residential (apartments)
Date:	20.02.19	Building description:	Steel frame with blockwork and brickwork walls
Visit by:	Sean Lee	Foundation type:	Piled
Weather:	Mild and Overcast	Gas protection type:	Ventilated subfloor void and retro-fitted gas membrane to the ground floor

No.	Item	Comments
1	Gas membrane	
1.1	Condition of sub-grade and/or underside of gas membrane	Existing suspended block and beam floor with sand/cement screed
1.2	Gas membrane type	Corden EPS Evolution VOC Barrier across the existing floor. 2 No. coats of Corden EPS Liquid Gas Barrier within the lift pit.
1.3	Gas membrane condition	N/A
1.4	Joining tape product	Corden EPS GRM Self Adhesive Membrane
1.5	Lapping design	Minimum 100mm overlap.
1.6	Laps, welds and joint seals	Heat bonded welds for the majority of the joints. Self adhesive gas tape for up-stands/seals against internal walls and stanchions and minor repairs/patches.
1.7	Service entries seals	Self adhesive gas tape around service entries.
2	Passive venting	
2.1	Sub-floor void	Minimum 400mm void present.
2.2	External wall airbricks	The plastic covers of all of the telescopic vents for the subfloor ventilation have been replaced. Plastic air vents have been installed into the cavity wall above all of the subfloor vents. All vents are clear. The former access ramp at the north of the building has been removed. Plastic air bricks to be installed to ventilate the wall cavities.
2.3	Internal sleeper walls	Present with sufficient gaps to allow air flow.
2.4	External vent trenches/ducts	N/A
3	Active venting	
3.1	System details	N/A
Additional notes: No remedial works required.		

Photographs

No.	Description
1	Replaced sub floor air vents and newly installed air vents within cavity wall.
2	Replaced sub floor air vents and newly installed air vents within cavity wall.



Photograph 1: Replaced sub floor air vents and newly installed air vents within cavity wall.



Photograph 2: Replaced sub floor air vents and newly installed air vents within cavity wall.

The gas protection measures inspected are:

Name: Sean Lee

Signature:

Date: 20.02.19

APPENDIX F - PRODUCT DATA SHEETS

CORDEN EPS TITAN

EPS Evolution VOC – Gas and Hydrocarbon Barrier is a multi-layer, polyethylene membrane.

EPS Evolution VOC is specifically designed and manufactured to perform as a Methane, Carbon Dioxide, Radon, Ground Gas, VOC, air & Moisture, and Hydrocarbon protection system.

EPS Evolution VOC complies with the latest codes of practice as published by BRE, CIRIA (C748) and BSI (BS 8485:2015). Suitable for use as Ground Gas/Hydrocarbon protection for NHBC **GREEN**, **AMBER 1**, **AMBER 2**, and **RED** site characterisations.

Corden EPS Evolution VOC - GROUND GAS and HYDROCARBON BARRIER			
Characteristic	Test Method	Unit	EPS Evolution VOC
Physical Properties			
Thickness	EN 1849-2	mm	0.5
Width	EN 1849-2	M	2
Length	EN 1849-2	M	50
Weight	EN 1849-2	g/m2	500
Hydraulic Properties			
Permeability of Liquids	EN 14150	m3/m2/day	1.0 x 10-6
Resistance to water penetration	EN 13967, EN 1928	-	PASS
Watertightness	EN 1928	-	PASS
Mechanical Properties			
Resistance to Static Load	EN 12730 - B	Kg	>20
Tensile Strength (MD)	EN 12311 -1	N/mm2	25
Tensile Strength (CMD)	EN 12311 -1	N/mm2	25
Tensile Elongation (MD)	EN 12311 -1	%	400
Tensile Elongation (CMD)	EN 12311 -1	%	400
Puncture Resistance	EN 12236	kN	2
Resistance to tearing (nail shank)	MD EN 12310 - 1	N	500
Vapour Permeability			
Transmission rate of Benzene	BS EN ISO 15105 - 2	mg/m2/day	2250
Transmission rate of Toluene	BS EN ISO 15105 - 2	mg/m2/day	2370
Transmission rate of Ethyl Benzene	BS EN ISO 15105 - 2	mg/m2/day	400
Transmission rate of Xylene (m,p,o)	BS EN ISO 15105 - 2	mg/m2/day	690
Gas Permeability			
Methane Permeability (WELDED JOINT)	BS EN ISO 15105 - 1	ml/m2/day/atm	1.00
Carbon Dioxide Permeability	BS EN ISO 15105 - 1	ml/m2/day/atm	3.01
Radon Permeability	SP Method 3873	m2/s	3.0 x 10-9
Compliance and Certification			
CE Mark - EN13967:2012			
NHBC Standards Compliant			
BS 8485:2015 Compliant			
CIRIA C748 Compliant			

Chemical Resistance - SULFURIC ACID (10% solution of Sulfuric Acid (H ₂ SO ₄)) 50° for 56 days	EN 14414 - A	Tensile strength Retained	100%
		Result	PASS
Chemical Resistance - BASIC (Calcium Hydroxide saturated suspension) 50° for 56 days	EN 14414 - B	Tensile strength Retained	100%
		Result	PASS
Chemical Resistance - SOLVENTS (35% Diesel, 35% Paraffin, 30% Oil HD30 (vol) 50° for 56 days	EN 14414 - C	Tensile strength Retained	100%
		Result	PASS
Chemical Resistance - SYNTHETIC LEACHATE (Mixture of 14 acids, chlorides, sulphates and phosphate) 50° for 56 days	EN 14414 - D	Tensile strength Retained	100%
		Result	PASS
Resistance to Leaching - HOT WATER (Deionised water) 50° for 56 days.	EN 14415 - A	Tensile strength Retained	100%
		Result	PASS
Resistance to Leaching - AQUEOUS ALKALINE (Saturated Calcium Hydroxide) 50° for 56 days.	EN 14415 - B	Tensile strength Retained	100%
		Result	PASS
Resistance to Leaching - ORGANIC ALCOHOL (30% methanol, 30% isopropanol, 40% glycol) 50° for 56 days	EN 14415 - C	Tensile strength Retained	100%
		Result	PASS

**Values are Typical, with the exception of Thickness, which is Nominal. Typical indicates the mean value derived from the samples taken for any one test as defined in the BS EN ISO standard - usually the mean of five samples. Nominal is a guide value.*

DESCRIPTION

EPS Evolution VOC Hydrocarbon Barrier is a multi-layer flexible membrane, with a unique core component which is designed and manufactured to provide a barrier to the most aggressive chemicals and to comply with current guidance on Hydrocarbons.

Manufactured using the latest extrusion technology and drawing on our extensive knowledge and expertise in gas protection, we have developed a new membrane suitable in applications that are affected by Hydrocarbons. There is a common misconception that monolithic polyolefin barriers, such as HDPE and LLDPE are effective barriers to resist Hydrocarbons. This is an incorrect assumption, as Hydrocarbons will readily permeate through monolithic polyolefin barriers.

The product is available in roll format, 2.0m x 50m, (other dimensions available on request) in Black and Silver colour.

EPS Evolution VOC Hydrocarbon Barrier offers a safe solution for the protection of buildings and occupiers against all levels of hydrocarbons, methane, carbon dioxide and radon ingress. Typically, these are sites previously used as petrol stations, coalfields landfill sites, contaminated industrial sites, Fracking sites, and heavily contaminated sites. The membrane also acts as a damp-proof membrane. Due to the flexible nature, the EPS Evolution VOC Hydrocarbon Barrier also provides a flexible membrane suitable for various applications unlike rigid HDPE rich membranes. EPS Evolution VOC is designed to withstand the most aggressive environments.

Testing has been completed in accordance with BS8485:2015 and C748 to determine the permeation rates for Methane, Carbon Dioxide, and a range of VOC's. Immersion testing has also been completed to for Chemical Resistance to EN 14414 and EN 14415.

ISO15105-2 Rate of Permeation (mg/m ² /day)	BENZENE	TOLUENE	ETHYL BENZENE	XYLENE (M,P,O)
EPS EVOLUTION VOC	2250	2370	400	690
PURAFLEX	3846	3763	494	767
HDPE (1.0mm)	146626	151725	117912	114672



EPS Evolution VOC has market leading performance as a Hydrocarbon Barrier and chemical resistant barrier with exceptional resistance to a wide range of pollutants including hydrocarbons, industrial chemicals, toxic waste, natural and radioactive gases; it also acts as a high performance DPM.

Note – there are materials on the market, declaring compliance with BS8485:2015 and C748, with listed test values for a range of challenge chemicals. Be wary of values reported as ‘MDV’ (manufacturer declared value), and always check the units of measurement against the ISO 15105-2 test. It is unethical and illegal for suppliers of material to mislead end users with falsified information.

HANDLING

Roll weights can be in excess of 20kg and hence appropriate care and equipment is required for unloading and handling.

STORAGE

Rolls of EPS GP-TITAN should be stored on stable/level ground and stacked not more than five rolls high, with no other material stacked on top. The rolls can be stored outdoors when packaged, but should be protected from exposure to UV.

INSTALLATION

EPS Evolution VOC should be installed in accordance with the product installation guidelines, and in accordance with BS 8485:2015.

JOINTING AND SEALING

It is recommended EPS Evolution VOC be heat welded where possible, with welding carried out by competent personnel with suitable qualifications in accordance with best practice, and guidance contained within BS 8485:2015. EPS Evolution VOC should be overlapped by at least 100mm. If taping joints, only suitable tape must be used, ensuring application with a silicone roller to remove trapped air. EPS pre-formed details, or Self-Adhesive Gas Membrane are available for sealing around protuberances.

ACCESSORY PRODUCTS

A wide range of accessories are available for use with the EPS Evolution VOC Barrier.

ADDITIONAL INFORMATION

For additional information or assistance, please contact Corden EPS directly.

CORDEN EPS LIQUID GAS BARRIER

Corden EPS Liquid Gas Barrier is a ready for use specialist styrene butadiene latex based liquid applied membrane. It offers a simple, continuous passive gas prevention barrier against the ingress of methane, carbon dioxide, radon, ground gas, VOC, air & moisture into buildings. Corden EPS Liquid Gas Barrier also acts as a waterproofing membrane complying with requirement C2 and C4 schedule 1 of the Building Regulations 1991 for England and Wales.

PRODUCT SPECIFICATION

Corden EPS Liquid Gas Barrier			
Characteristic	Test Method	Unit	Liquid Gas Barrier
Physical Properties			
Applied Thickness		mm	>1.0
Form Supplied			Viscous Liquid
Pack Size			15kg
Colour			Green
Chemical Composition			Advanced SBS with speciality
Hydraulic Properties			
Water tightness	EN 1296, EN 1367, EN 1928	-	Pass
Gas Permeability			
Methane Permeability	BS EN ISO 15105 – 1	ml/m ² /day/atm	0.01
Radon Permeability	Saarland University, GER	mm	>1.0mm applied thickness provides a complete barrier to radon

PROPERTIES

Corden EPS Liquid Gas Barrier can be used to protect most building surfaces from the effect of liquid and water vapour, carbonation and as a gas barrier to prevent the ingress of methane, carbon dioxide and radon. As the product is a barrier to moisture it can be used as a DPM on floors and walls.

COVERAGE

Corden EPS Liquid Gas Barrier may be applied by brush, roller or airless spray. **A minimum dry coated thickness of 1.0mm** is needed to provide a gas barrier. To achieve 1.0mm thickness, a total of 2kg/m² is required, therefore a 15kg tub will cover an area of 7.5m².

Application

The background surface should be smooth or have a light even texture, and masonry should be flush pointed and defects in the surfaces made good prior to application. The surface should be clean, sound, free of dust, loose material and surface water. Corden EPS Liquid Gas Barrier should not be applied in wet conditions or where inclement weather is expected before the membrane has dried. The membrane should not be applied in temperatures below 7°C.

Where multiple coats are applied, it is recommended that the coats are applied at right angles to each other. Before application of secondary coats it is necessary to let the first coat become touch dry.

The time required to reach touch dry condition will vary dependant on site conditions within the working area, but typically be in order of 1-2 hours in favourable conditions. It is preferable that secondary coats are applied within 24 hours.

Handling

Material is supplied in tubs of 15kg weight. Appropriate care must be taken with handling. Clean tools with water immediately after use.

Storage

Store tub in conditions between 5°C and 30°C; Shelf life 12 months unopened.

Jointing/Sealing/Compatibility

Corden EPS Liquid Gas Barrier is compatible with loose laid membranes in the Corden EPS range.

Additional Information

For additional information or assistance, please contact Corden EPS directly.



APPENDIX G - CORRESPONDENCE WITH LOCAL AUTHORITY

From: [Angela Guy](#)
To: [Sean Lee](#)
Cc: [Liam Doyle](#)
Subject: RE: New Foundry Building, Johnstown P/2017/0755
Date: 26 September 2018 17:06:48
Attachments: [image008.png](#)
[image009.png](#)
[image010.png](#)
[image011.png](#)
[image012.png](#)
[image013.png](#)
[image014.jpg](#)

Sean

Thanks for the update. I've now heard from my colleague and can confirm we have no concerns provided the installation of the gas protection measures is in accordance with manufacturers guidance and recommendations.

I would have been interested to visit whilst the installation is taking place but unfortunately am not available on Sunday, although I may be able to visit briefly on the Saturday, would you be able to let me know the name of the person in charge of the works so that I can speak to them on arrival if I do have chance on Saturday.

Regards Angela

Ms Angela Guy BSc (Hons) MSc

Contaminated Land Officer

Swyddog Tir wedi ei Halogi



01978 298771



Environment and Planning Department, 16 Lord Street, Wrexham LL11 1LG



Adran Amgylchedd a Chynllunio, 16 Stryt yr Arglwydd, Wrecsam LL11 1LG



wrexham.gov.uk | wrecsam.gov.uk



twitter.com/wrexhamcbc | twitter.com/cbswrecsam



facebook.com/wrexhamcouncil | facebook.com/cyngorwrecsam

From: Sean Lee [mailto:Sean.Lee@tieruk.com]
Sent: 25 September 2018 13:50
To: Angela Guy
Cc: Liam Doyle
Subject: RE: New Foundry Building, Johnstown P/2017/0755

Angela

Just to let you know that the gas membrane will be installed this weekend. Tier will be attending site on Sunday to undertake the verification works.

Regards

Sean



Sean Lee MSc, BSc (Hons), FGS
Principal Geo-environmental Consultant

Tier Environmental Ltd
Chadwick House, Birchwood Park, Warrington, WA3 6AE

Tel: (01925) 818388
Fax: (01244) 333081
Mob: 07879 338 737
Web: www.tieruk.com

The contents of this email are intended to be read / used by the person to whom it has been directed. If you have received this email by mistake please ignore the contents and delete the email from your mailbox.

From: Angela Guy [mailto:Angela.Guy@wrexham.gov.uk]
Sent: 13 September 2018 13:58
To: Sean Lee
Cc: Liam Doyle
Subject: RE: New Foundry Building, Johnstown P/2017/0755

Sean

Apologies again for the delay in responding. I can confirm that the revised remediation solution for soils required on the area of the site to the north (generally covered by trial pits 4-6) is sufficient. A plan showing the area where the remediation is required and the specification of the terram/geotextile membrane should be provided, and confirmation of whether this will also be considered as a warning barrier? When this information is provided I will be able to recommend discharge of planning condition 5 of permission P/2017/0755.

I am consulting a colleague regarding the revised gas protection measures detailed in your email below and will be in touch next week about this (as I am out of the office all day tomorrow).

As you are aware, all remediation works require validation and a verification report to be submitted for approval for discharge of condition 6.

Ms Angela Guy BSc (Hons) MSc
Contaminated Land Officer
Swyddog Tir wedi ei Halogi



01978 298771



Environment and Planning Department, 16 Lord Street, Wrexham LL11 1LG



Adran Amgylchedd a Chynllunio, 16 Stryt yr Arglwydd, Wreccsam LL11 1LG



wrexham.gov.uk | wreccsam.gov.uk



twitter.com/wrexhamcbc | twitter.com/cbswreccsam



facebook.com/wrexhamcouncil | facebook.com/cyngorwreccsam

From: Sean Lee [<mailto:Sean.Lee@tieruk.com>]

Sent: 11 September 2018 11:27

To: Angela Guy

Cc: Liam Doyle

Subject: RE: New Foundry Building, Johnstown P/2017/0755

This email's attachments were cleaned of potential threats by Wrexham Council's Security Gateway.
Click [here](#) if the original attachments are required (justification needed).

Angela

Have you had chance to review our GI letter report and proposal for the clean cover system attached to our email below?

The contractor undertaking the works has confirmed that the following products will be used for the ground gas protection measures (data sheets attached):

- Corden EPS Evolution VOC Barrier as the loose laid membrane across the ground floor.
- Corden EPS GRM Self-adhesive membrane to bond and seal the above loose laid membrane to the existing internal blockwork and staircase.
- Corden EPS Liquid Gas Barrier applied in two coats to the existing lift pit to achieve a 1mm thickness.

All joints in Corden EPS Evolution Barrier will be welded and the loose laid membrane will lap directly onto Corden EPS Liquid Gas Barrier applied to the lift Pit.

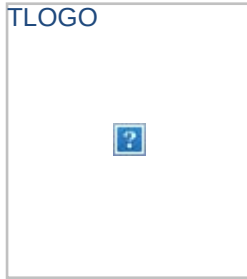
Air vents will also be installed at approximate 2m centres to prevent the build up of ground gas within the cavity walls (section attached).

Could you please confirm that the above is satisfactory? Tier Environmental will be verifying the installation of the clean cover soils and the gas protection measures.

If you have any queries, please do not hesitate to contact us.

Regards

Sean



Sean Lee MSc, BSc (Hons), FGS

Principal Geo-environmental Consultant

Tier Environmental Ltd

Chadwick House, Birchwood Park, Warrington, WA3 6AE

Tel: (01925) 818388

Fax: (01244) 333081

Mob: 07879 338 737

Web: www.tieruk.com

The contents of this email are intended to be read / used by the person to whom it has been directed. If you have received this email by mistake please ignore the contents and delete the email from your mailbox.

From: Sean Lee
Sent: 04 September 2018 12:39
To: 'Angela Guy'
Cc: Liam Doyle
Subject: RE: New Foundry Building, Johnstown P/2017/0755

Angela

As previously discussed, please find attached our ground investigation letter report, including a revised remediation strategy for the western area of the site.

Could you please confirm that the proposals are acceptable so that these works can commence?

If you have any queries, please do not hesitate to contact us.

Regards

Sean

Sean Lee MSc, BSc (Hons), FGS

TLOGO



Principal Geo-environmental Consultant

Tier Environmental Ltd

Chadwick House, Birchwood Park, Warrington, WA3 6AE

Tel: (01925) 818388

Fax: (01244) 333081

Mob: 07879 338 737

Web: www.tieruk.com

The contents of this email are intended to be read / used by the person to whom it has been directed. If you have received this email by mistake please ignore the contents and delete the email from your mailbox.

From: Angela Guy [<mailto:Angela.Guy@wrexham.gov.uk>]
Sent: 29 August 2018 18:33
To: Sean Lee
Cc: Liam Doyle; James Blyth
Subject: RE: New Foundry Building, Johnstown P/2017/0755

Sean

Thank you for your email and I note the findings for the area in question and the potential solutions you are now considering. I am not in the office until next Tues and will then be out of the office again until Friday, apologies that we will not be able to speak this week but as mentioned when we spoke last week, you are not bound to the remediation solution originally proposed, a new proportionate approach taking account of constraints is acceptable.

Regards Angela

Ms Angela Guy BSc (Hons) MSc

Contaminated Land Officer

Swyddog Tir wedi ei Halogi



01978 298771



Environment and Planning Department, 16 Lord Street, Wrexham LL11 1LG



Adran Amgylchedd a Chynllunio, 16 Stryt yr Arglwydd, Wrecsam LL11 1LG



wrexham.gov.uk | wrecsam.gov.uk



twitter.com/wrexhamcbc | twitter.com/cbswrecsam



facebook.com/wrexhamcouncil | facebook.com/cyngorwrecsam

From: Sean Lee [<mailto:Sean.Lee@tieruk.com>]
Sent: 22 August 2018 16:49
To: Angela Guy
Cc: Liam Doyle; James Blyth
Subject: New Foundry Building, Johnstown P/2017/0755

Angela

As discussed earlier today, please find attached a photograph of the rear of the property with the footpath and trees adjacent to the western site boundary.

Based on the results of the chemical testing undertaken to date, there will be a requirement for clean cover in the western and southern area of the site due to the presence of elevated lead, PAHs and asbestos within the 'ashy' Made Ground. We previously stated within the Remediation Strategy that 600mm of clean cover would be required if the shallow soils were identified as not being suitable for use within the proposed residential (without home grown produce). We have produced a letter report to summarise the findings of the intrusive investigations that we will forward for your review. The letter report will include remedial options but at this stage, we just wanted to discuss the constraints to providing the 600mm of clean cover.

As can be seen from the attached photograph, the close proximity of the trees and likely roots beneath our site would make it difficult to either undertake a reduced dig to accommodate the clean cover or raise site levels above the root system.

We are therefore assessing other systems that could protect the future residents from the 'ashy' Made Ground. Potential solutions include:

- Traditional hardstanding, either concrete, asphalt/macadam or slabs, although these may affect air ingress to roots, surface water runoff rates and ecology.
- Permeable hardstanding, such as porous asphalt.
- Installation of a terram / geotextile barrier fabric overlying the existing soils overlain by approximately 150mm of clean, certified and validated imported topsoil.
- The installation of grasscrete or similar (<https://www.grasscrete.com/docs/paving/grasscrete.html>).
- The installation of Grassroad or similar (<https://www.grasscrete.com/docs/paving/grassroad.html>).
- The installation of a geocell (<http://www.terram.com/products/geocells/tree-root-protection-geocell.html>). We have previously agreed this approach for a similar situation at a college site.

The details of the protection measures would need inclusion within the site's Health and Safety Plan to ensure groundsmen/maintenance workers understand the need to maintain

the integrity of the system. An annual inspection of the soft landscaped area by a groundskeeper/maintenance worker and top up of gravel or topsoil if required.

We acknowledge that you are concerned if residents are allowed to plant fruit trees in the future; this will need to be confirmed by our client. There will not be any direct access from individual apartments into the communal gardens; the only access will be via a central corridor and through the front door.

We will call you next week to discuss the options. The proposed protection system will also need to be agreed with the Planners with regard to ecology.

Enjoy your long weekend.

Regards

Sean



Sean Lee MSc, BSc (Hons), FGS
Principal Geo-environmental Consultant

Tier Environmental Ltd
Chadwick House, Birchwood Park, Warrington, WA3 6AE

Tel: (01925) 818388
Fax: (01244) 333081
Mob: 07879 338 737
Web: www.tieruk.com

The contents of this email are intended to be read / used by the person to whom it has been directed. If you have received this email by mistake please ignore the contents and delete the email from your mailbox.

Rydym yn croesawu gohebiaeth yn Gymraeg. Byddwn yn ymateb i unrhyw ohebiaeth yn Gymraeg ac ni fydd hyn yn arwain at unrhyw oedi.

Ewch i weld - mi fedrwch chi dalu, rhoi gwybod, gwneud cais, dweud eich dweud, a dod o hyd i wybodaeth ar-lein yn www.wreccsam.gov.uk. Arbedwch bapur - meddylwch cyn argraffu!

Mae'r neges e-bost hon ac unrhyw atodiadau wedi eu bwriadu ar gyfer yr unigolyn neu'r sefydliad y?i cyfeirir atynt yn unig. Am yr amodau llawn

ynghl?n ? chynnwys a defnyddio?r neges e-bost hon, ac unrhyw atodiadau, cyfeiriwch at www.wreccsam.gov.uk/top_navigation/disclaimersw.htm

We welcome correspondence in Welsh. We will respond to any correspondence in Welsh and this will not lead to any delay.

Take a look - you can pay, report, request, have your say and find information online at www.wrexham.gov.uk. Save paper - think before you print!

This e-mail message and any attachments are intended solely for the individual or organisation to whom it is addressed. For full conditions in relation to content and use of this e-mail message and any attachments, please refer to www.wrexham.gov.uk/top_navigation/disclaimers.htm

Rydym yn croesawu gohebiaeth yn Gymraeg. Byddwn yn ymateb i unrhyw ohebiaeth yn Gymraeg ac ni fydd hyn yn arwain at unrhyw oedi.

Ewch i weld - mi fedrwch chi dalu, rhoi gwybod, gwneud cais, dweud eich dweud, a dod o hyd i wybodaeth ar-lein yn www.wreccsam.gov.uk. Arbedwch bapur - meddylwch cyn argraffu!

Mae'r neges e-bost hon ac unrhyw atodiadau wedi eu bwriadu ar gyfer yr unigolyn neu?r sefydliad y?i cyfeirir atynt yn unig. Am yr amodau llawn ynghl?n ? chynnwys a defnyddio?r neges e-bost hon, ac unrhyw atodiadau, cyfeiriwch at www.wreccsam.gov.uk/top_navigation/disclaimersw.htm

We welcome correspondence in Welsh. We will respond to any correspondence in Welsh and this will not lead to any delay.

Take a look - you can pay, report, request, have your say and find information online at www.wrexham.gov.uk. Save paper - think before you print!

This e-mail message and any attachments are intended solely for the individual or organisation to whom it is addressed. For full conditions in relation to content and use of this e-mail message and any attachments, please refer to www.wrexham.gov.uk/top_navigation/disclaimers.htm

Rydym yn croesawu gohebiaeth yn Gymraeg. Byddwn yn ymateb i unrhyw ohebiaeth yn Gymraeg ac ni fydd hyn yn arwain at unrhyw oedi.

Ewch i weld - mi fedrwch chi dalu, rhoi gwybod, gwneud cais, dweud eich dweud, a dod o hyd i wybodaeth ar-lein yn www.wreccsam.gov.uk. Arbedwch bapur - meddylwch cyn argraffu!

Mae'r neges e-bost hon ac unrhyw atodiadau wedi eu bwriadu ar gyfer yr unigolyn neu?r sefydliad y?i cyfeirir atynt yn unig. Am yr amodau llawn ynghl?n ? chynnwys a defnyddio?r neges e-bost hon, ac unrhyw atodiadau, cyfeiriwch at www.wreccsam.gov.uk/top_navigation/disclaimersw.htm

We welcome correspondence in Welsh. We will respond to any correspondence in Welsh and this will not lead to any delay.

Take a look - you can pay, report, request, have your say and find information online at www.wrexham.gov.uk. Save paper - think before you print!

This e-mail message and any attachments are intended solely for the individual or organisation to whom it is addressed. For full conditions in relation to content and use of this e-mail message and any attachments, please refer to www.wrexham.gov.uk/top_navigation/disclaimers.htm