

Certificate of Analysis



**SEVERN
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Report Number: **COV/516982/2008**

Issue **1**

Laboratory Number: **10578807**

Sample **1** of **6**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913 TP1 1.50m**

Sample Date:

Sample Received

20 May 2008

Analysis Complete:

11 June 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	<0.0005	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	<0.005	mg/l	Y Cov	WAS049
pH	7.2	pH Units	Y Cov	WAS039
Sulphate as SO4	46	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.02	mg/l	Y Cov	WAS033
NRA Leachate	Analyst Comment		N Cov	PREP
Acenaphthene	<0.00	ug/l	Y Cov	GEO19
Acenaphthylene	0.00	ug/l	Y Cov	GEO19
Anthracene	0.00	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.00	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.00	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.00	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	<0.00	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.00	ug/l	Y Cov	GEO19
Chrysene	<0.00	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.00	ug/l	Y Cov	GEO19
Fluoranthene	0.00	ug/l	Y Cov	GEO19
Fluorene	0.00	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.00	ug/l	Y Cov	GEO19
Naphthalene	0.00	ug/l	Y Cov	GEO19
Phenanthrene	0.00	ug/l	Y Cov	GEO19
Pyrene	0.00	ug/l	Y Cov	GEO19
PAH,Total	0.01	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	0.002	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051

Analyst Comments for 10578807:

Monophenol sampled from 1 litre pet as no fixed subsample available.
Cyanide sampled from 1 litre pet as no subsample available.

Severn Trent Laboratories Ltd.

STL Business Centre, Torrington Avenue, Coventry, CV4 9GU Tel:+44 (0)24 7642 1213 Fax:+44 (0)24 7685 6575

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.
Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=insufficient sample

Certificate of Analysis



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**SEVERN
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STL

Report Number: **COV/516982/2008**

Issue **1**

Laboratory Number: **10578808**

Sample **2** of **6**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913 TP5 0.10m**

Sample Date:

Sample Received

20 May 2008

Analysis Complete:

11 June 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	<0.0005	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	<0.005	mg/l	Y Cov	WAS049
pH	7.2	pH Units	Y Cov	WAS039
Sulphate as SO4	<5	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.02	mg/l	Y Cov	WAS033
NRA Leachate	Analyst Comment		N Cov	PREP
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.01	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Chrysene	<0.01	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.01	ug/l	Y Cov	GEO19
Fluoranthene	<0.01	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.01	ug/l	Y Cov	GEO19
Naphthalene	0.12	ug/l	Y Cov	GEO19
Phenanthrene	0.01	ug/l	Y Cov	GEO19
Pyrene	<0.01	ug/l	Y Cov	GEO19
PAH,Total	0.13	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051

Analyst Comments for 10578808:

Monophenol sampled from 1 litre pet as no fixed subsample available.
Cyanide sampled from 1 litre pet as no subsample available.

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Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

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**SEVERN
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Report Number: **COV/516982/2008**

Issue **1**

Laboratory Number: **10578809**

Sample **3** of **6**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913 TP7 0.40m**

Sample Date:

Sample Received

20 May 2008

Analysis Complete:

11 June 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	<0.0005	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	<0.005	mg/l	Y Cov	WAS049
pH	7.7	pH Units	Y Cov	WAS039
Sulphate as SO4	<5	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.02	mg/l	Y Cov	WAS033
NRA Leachate	Analyst Comment		N Cov	PREP
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.01	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Chrysene	<0.01	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.01	ug/l	Y Cov	GEO19
Fluoranthene	<0.01	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.01	ug/l	Y Cov	GEO19
Naphthalene	<0.01	ug/l	Y Cov	GEO19
Phenanthrene	<0.01	ug/l	Y Cov	GEO19
Pyrene	<0.01	ug/l	Y Cov	GEO19
PAH,Total	<0.01	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051

Analyst Comments for 10578809:

Monophenol sampled from 1 litre pet as no fixed subsample available.
Cyanide sampled from 1 litre pet as no subsample available.

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Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcom.
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

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**SEVERN
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Report Number: **COV/516982/2008**

Issue **1**

Laboratory Number: **10578810**

Sample **4** of **6**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913 TP10 0.50m**

Sample Date:

Sample Received

20 May 2008

Analysis Complete:

11 June 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	<0.0005	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	<0.005	mg/l	Y Cov	WAS049
pH	7.3	pH Units	Y Cov	WAS039
Sulphate as SO4	<5	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.02	mg/l	Y Cov	WAS033
NRA Leachate	Analyst Comment		N Cov	PREP
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.01	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Chrysene	<0.01	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.01	ug/l	Y Cov	GEO19
Fluoranthene	<0.01	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.01	ug/l	Y Cov	GEO19
Naphthalene	0.02	ug/l	Y Cov	GEO19
Phenanthrene	<0.01	ug/l	Y Cov	GEO19
Pyrene	<0.01	ug/l	Y Cov	GEO19
PAH,Total	0.02	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051

Analyst Comments for 10578810:

Monophenol sampled from 1 litre pet as no fixed subsample available.
Cyanide sampled from 1 litre pet as no subsample available.

Severn Trent Laboratories Ltd.

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Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=insufficient sample

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Report Number: **COV/516982/2008**

Issue **1**

Laboratory Number: **10578811**

Sample **5** of **6**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913 TP12 0.60m**

Sample Date:

Sample Received

20 May 2008

Analysis Complete:

11 June 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	<0.0005	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	<0.005	mg/l	Y Cov	WAS049
pH	7.2	pH Units	Y Cov	WAS039
Sulphate as SO4	<5	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.02	mg/l	Y Cov	WAS033
NRA Leachate	Analyst Comment		N Cov	PREP
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.01	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Chrysene	0.01	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.01	ug/l	Y Cov	GEO19
Fluoranthene	0.02	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.01	ug/l	Y Cov	GEO19
Naphthalene	0.09	ug/l	Y Cov	GEO19
Phenanthrene	0.03	ug/l	Y Cov	GEO19
Pyrene	0.02	ug/l	Y Cov	GEO19
PAH,Total	0.19	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051

Analyst Comments for 10578811:

Monophenol sampled from 1 litre pet as no fixed subsample available.
Cyanide sampled from 1 litre pet as no subsample available.

Severn Trent Laboratories Ltd.

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.
Analysed at: Bri = STL Bridgend, Coy = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

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**SEVERN
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Report Number: **COV/516982/2008**

Issue **1**

Laboratory Number: **10578812**

Sample **6** of **6**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913 TP13 3.50m**

Sample Date:

Sample Received

20 May 2008

Analysis Complete:

11 June 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	<0.0005	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	<0.005	mg/l	Y Cov	WAS049
pH	7.3	pH Units	Y Cov	WAS039
Sulphate as SO4	32	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.01	mg/l	Y Cov	WAS033
NRA Leachate	Analyst Comment		N Cov	PREP
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.01	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Chrysene	<0.01	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.01	ug/l	Y Cov	GEO19
Fluoranthene	<0.01	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.01	ug/l	Y Cov	GEO19
Naphthalene	0.05	ug/l	Y Cov	GEO19
Phenanthrene	<0.01	ug/l	Y Cov	GEO19
Pyrene	<0.01	ug/l	Y Cov	GEO19
PAH, Total	0.05	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051

Analyst Comments for 10578812:

Monophenol sampled from 1 litre pet as no fixed subsample available.
Cyanide sampled from 1 litre pet as no subsample available.

Severn Trent Laboratories Ltd.

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Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

Signed:



Name: **J. Fell**

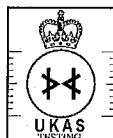
Date: **11 June 2008**

Title: **Production Manager**

APPENDIX J

LABORATORY CHEMICAL TEST RESULTS (GROUNDWATER)

Report Summary



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Mr Roger Hawkins
Integral Geotechnique
50 Cathedral Road
Cardiff
CF1 9LL

Date of Issue: **12 June 2008**

Report Number: **COV/518285/2008**

Issue **3**

Job Description: General Analysis

Job Location: Twynyrodyn

Number of Samples
included in this report **4**

Job Received: **23 May 2008**

Number of Test Results
included in this report **248**

Analysis Commenced: **24 May 2008**

Signed:

Name: **J. Fell**

Date: **12 June 2008**

Title: **Production Manager**

STL was not responsible for sampling unless otherwise stated. Sampling is not covered by our UKAS accreditation.

Information on the methods of analysis and performance characteristics are available on request.

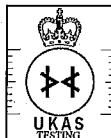
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Tests marked 'Not UKAS Accredited' in this Report/Certificate are not included in the UKAS Accreditation Schedule for our laboratory.

Severn Trent Laboratories Ltd.

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Report Number: **COV/518285/2008**

Issue **3**

Laboratory Number: **10587579**

Sample **1** of **4**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **BH1**

Sample Date: **21 May 2008**

Sample Received

23 May 2008

Analysis Complete:

12 June 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	0.0013	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	0.016	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.14	mg/l	Y Cov	WAS049
pH	6.9	pH Units	Y Cov	WAS039
Sulphate as SO4	405	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	<0.05	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	0.15	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	17	ug/l	Y Cov	GEO46

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Report Number: **COV/518285/2008**

Issue **3**

Laboratory Number: **10587579**

Sample **1** of **4**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **BH1**

Sample Date: **21 May 2008**

Sample Received

23 May 2008

Analysis Complete:

12 June 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	17	ug/l	Y Cov	GEO46
EPH>C10-C44	17	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	<10	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	17	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	17	ug/l	N Cov	GEO45/GEO46
Acenaphthene	<0.04	ug/l	Y Cov	GEO19
Acenaphthylene	<0.04	ug/l	Y Cov	GEO19
Anthracene	<0.04	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.04	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.04	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.04	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	0.05	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.04	ug/l	Y Cov	GEO19
Chrysene	0.04	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.04	ug/l	Y Cov	GEO19
Fluoranthene	0.05	ug/l	Y Cov	GEO19
Fluorene	<0.04	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.04	ug/l	Y Cov	GEO19
Naphthalene	<0.04	ug/l	Y Cov	GEO19
Phenanthrene	0.08	ug/l	Y Cov	GEO19
Pyrene	0.05	ug/l	Y Cov	GEO19
PAH,Total	0.28	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051
Toluene	0.19	ug/l	Y Cov	WAS058
Total Xylenes	<0.20	ug/l	Y Cov	WAS058

Analyst Comments for 10587579:

No Analyst Comment

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered, I/S=Insufficient sample

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Report Number: **COV/518285/2008**

Issue **3**

Laboratory Number: **10587580**

Sample **2** of **4**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **BH3**

Sample Date: **21 May 2008**

Sample Received

23 May 2008

Analysis Complete:

12 June 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	0.0013	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.12	mg/l	Y Cov	WAS049
pH	7.3	pH Units	Y Cov	WAS039
Sulphate as SO4	45	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.11	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	<0.10	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	<10	ug/l	Y Cov	GEO46

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Report Number: **COV/518285/2008**

Issue **3**

Laboratory Number: **10587580**

Sample **2** of **4**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **BH3**

Sample Date: **21 May 2008**

Sample Received

23 May 2008

Analysis Complete:

12 June 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44	<10	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	<10	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	<10	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	<10	ug/l	N Cov	GEO45/GEO46
Acenaphthene	0.03	ug/l	Y Cov	GEO19
Acenaphthylene	0.01	ug/l	Y Cov	GEO19
Anthracene	0.09	ug/l	Y Cov	GEO19
Benzo-a-anthracene	0.58	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	0.34	ug/l	Y Cov	GEO19
Benzo-a-pyrene	0.69	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	1.14	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	0.37	ug/l	Y Cov	GEO19
Chrysene	0.59	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	0.32	ug/l	Y Cov	GEO19
Fluoranthene	0.99	ug/l	Y Cov	GEO19
Fluorene	0.05	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	0.51	ug/l	Y Cov	GEO19
Naphthalene	0.11	ug/l	Y Cov	GEO19
Phenanthrene	0.40	ug/l	Y Cov	GEO19
Pyrene	0.69	ug/l	Y Cov	GEO19
PAH, Total	6.91	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051
Toluene	0.25	ug/l	Y Cov	WAS058
Total Xylenes	<0.20	ug/l	Y Cov	WAS058

Analyst Comments for 10587580:

A dilution was performed for the following PAH compounds: Benzo(ghi)perylene. As these results are above the validated calibration range of the method, they maybe an underestimate as the extraction efficiencies at these levels are unknown.

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

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Report Number: **COV/518285/2008**

Issue **3**

Laboratory Number: **10587581**

Sample **3** of **4**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **BH6**

Sample Date: **21 May 2008**

Sample Received

23 May 2008

Analysis Complete:

12 June 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	0.0035	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	0.0005	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	0.007	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.51	mg/l	Y Cov	WAS049
pH	6.5	pH Units	Y Cov	WAS039
Sulphate as SO4	147	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	1.4	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	0.20	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	12	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	<10	ug/l	Y Cov	GEO46

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Report Number: **COV/518285/2008**

Issue **3**

Laboratory Number: **10587581**

Sample **3** of **4**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **BH6**

Sample Date: **21 May 2008**

Sample Received

23 May 2008

Analysis Complete:

12 June 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	12	ug/l	Y Cov	GEO46
EPH>C10-C44	12	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	<10	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	12	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	12	ug/l	N Cov	GEO45/GEO46
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.01	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Chrysene	<0.01	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.01	ug/l	Y Cov	GEO19
Fluoranthene	<0.01	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.01	ug/l	Y Cov	GEO19
Naphthalene	<0.01	ug/l	Y Cov	GEO19
Phenanthrene	<0.01	ug/l	Y Cov	GEO19
Pyrene	<0.01	ug/l	Y Cov	GEO19
PAH,Total	<0.01	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	0.006	mg/l	Y Cov	WAS051
Toluene	0.21	ug/l	Y Cov	WAS058
Total Xylenes	<0.20	ug/l	Y Cov	WAS058

Analyst Comments for 10587581:

No Analyst Comment

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

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Report Number: **COV/518285/2008**

Issue **3**

Laboratory Number: **10587582**

Sample **4** of **4**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **R14**

Sample Date: **21 May 2008**

Sample Received

23 May 2008

Analysis Complete:

12 June 2008

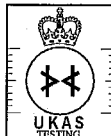
Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	0.0051	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.50	mg/l	Y Cov	WAS049
pH	6.9	pH Units	Y Cov	WAS039
Sulphate as SO4	76	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	1.4	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	<0.10	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	87	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	21	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	108	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	17	ug/l	Y Cov	GEO46

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Report Number: **COV/518285/2008**

Issue **3**

Laboratory Number: **10587582**

Sample **4** of **4**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **R14**

Sample Date: **21 May 2008**

Sample Received

23 May 2008

Analysis Complete:

12 June 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	17	ug/l	Y Cov	GEO46
EPH>C10-C44	125	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	108	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	17	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	125	ug/l	N Cov	GEO45/GEO46
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.01	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Chrysene	<0.01	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.01	ug/l	Y Cov	GEO19
Fluoranthene	<0.01	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.01	ug/l	Y Cov	GEO19
Naphthalene	<0.01	ug/l	Y Cov	GEO19
Phenanthrene	<0.01	ug/l	Y Cov	GEO19
Pyrene	<0.01	ug/l	Y Cov	GEO19
PAH,Total	<0.01	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	0.005	mg/l	Y Cov	WAS051
Toluene	<0.10	ug/l	Y Cov	WAS058
Total Xylenes	<0.20	ug/l	Y Cov	WAS058

Analyst Comments for 10587582:

No Analyst Comment

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

Signed:

Name: **J. Fell**

Date: **12 June 2008**

Title: **Production Manager**

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**SEVERN
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STL

**Mr Roger Hawkins
Integral Geotechnique
50 Cathedral Road
Cardiff
CF1 9LL**

Date of Issue: **11 July 2008**

Report Number: **COV/526500/2008**

Issue **1**

Job Description: General Analysis

Job Location: 9913 Twynyrodyn

Number of Samples
included in this report **3**

Job Received: **25 June 2008**

Number of Test Results
included in this report **186**

Analysis Commenced: **26 June 2008**

Signed:

Name: **J. Fell**

Date: **11 July 2008**

Title: **Production Manager**

STL was not responsible for sampling unless otherwise stated. Sampling is not covered by our UKAS accreditation.

Information on the methods of analysis and performance characteristics are available on request.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Tests marked 'Not UKAS Accredited' in this Report/Certificate are not included in the UKAS Accreditation Schedule for our laboratory.

Severn Trent Laboratories Ltd.

Certificate of Analysis



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**SEVERN
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Report Number: **COV/526500/2008**

Issue **1**

Laboratory Number: **10641613**

Sample **1** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/BH1**

Sample Date: **24 June 2008**

Sample Received

25 June 2008

Analysis Complete:

10 July 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	0.0008	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.064	mg/l	Y Cov	WAS049
pH	7.3	pH Units	Y Cov	WAS039
Sulphate as SO4	250	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.03	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	<0.10	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	<10	ug/l	Y Cov	GEO46

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**SEVERN
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Report Number: **COV/526500/2008**

Issue **1**

Laboratory Number: **10641613**

Sample **1** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/BH1**

Sample Date: **24 June 2008**

Sample Received

25 June 2008

Analysis Complete:

10 July 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44	<10	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	<10	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	<10	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	<10	ug/l	N Cov	GEO45/GEO46
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	0.03	ug/l	Y Cov	GEO19
Benzo-a-anthracene	0.12	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	0.14	ug/l	Y Cov	GEO19
Benzo-a-pyrene	0.13	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	0.27	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	0.07	ug/l	Y Cov	GEO19
Chrysene	0.15	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	0.05	ug/l	Y Cov	GEO19
Fluoranthene	0.19	ug/l	Y Cov	GEO19
Fluorene	0.02	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	0.08	ug/l	Y Cov	GEO19
Naphthalene	0.04	ug/l	Y Cov	GEO19
Phenanthrene	0.22	ug/l	Y Cov	GEO19
Pyrene	0.17	ug/l	Y Cov	GEO19
PAH,Total	1.67	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	0.005	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051
Toluene	0.27	ug/l	Y Cov	WAS058
Total Xylenes	<0.20	ug/l	Y Cov	WAS058

Analyst Comments for 10641613:

No Analyst Comment

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

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Report Number: **COV/526500/2008**

Issue **1**

Laboratory Number: **10641614**

Sample **2** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/BH3**

Sample Date: **24 June 2008**

Sample Received

25 June 2008

Analysis Complete:

10 July 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	0.0006	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.039	mg/l	Y Cov	WAS049
pH	7.7	pH Units	Y Cov	WAS039
Sulphate as SO4	45	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.03	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	<0.10	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	<10	ug/l	Y Cov	GEO46

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Report Number: **COV/526500/2008**

Issue **1**

Laboratory Number: **10641614**

Sample **2** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/BH3**

Sample Date: **24 June 2008**

Sample Received

25 June 2008

Analysis Complete:

10 July 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44	<10	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	<10	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	<10	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	<10	ug/l	N Cov	GEO45/GEO46
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	0.07	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	0.05	ug/l	Y Cov	GEO19
Benzo-a-pyrene	0.08	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	0.19	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	0.03	ug/l	Y Cov	GEO19
Chrysene	0.07	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	0.01	ug/l	Y Cov	GEO19
Fluoranthene	0.08	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	0.05	ug/l	Y Cov	GEO19
Naphthalene	<0.01	ug/l	Y Cov	GEO19
Phenanthrene	0.04	ug/l	Y Cov	GEO19
Pyrene	0.07	ug/l	Y Cov	GEO19
PAH, Total	0.75	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	0.006	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	0.001	mg/l	Y Cov	WAS051
Toluene	0.24	ug/l	Y Cov	WAS058
Total Xylenes	<0.20	ug/l	Y Cov	WAS058

Analyst Comments for 10641614:

No Analyst Comment

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

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**SEVERN
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Report Number: **COV/526500/2008**

Issue **1**

Laboratory Number: **10641615**

Sample **3** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/R14**

Sample Date: **24 June 2008**

Sample Received

25 June 2008

Analysis Complete:

10 July 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	0.0037	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.25	mg/l	Y Cov	WAS049
pH	7.2	pH Units	Y Cov	WAS039
Sulphate as SO4	78	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.39	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	<0.10	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	<10	ug/l	Y Cov	GEO46

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Report Number: **COV/526500/2008**

Issue **1**

Laboratory Number: **10641615**

Sample **3** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/R14**

Sample Date: **24 June 2008**

Sample Received

25 June 2008

Analysis Complete:

10 July 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44	<10	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	<10	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	<10	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	<10	ug/l	N Cov	GEO45/GEO46
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.01	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Chrysene	<0.01	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	<0.01	ug/l	Y Cov	GEO19
Fluoranthene	<0.01	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	<0.01	ug/l	Y Cov	GEO19
Naphthalene	<0.01	ug/l	Y Cov	GEO19
Phenanthrene	<0.01	ug/l	Y Cov	GEO19
Pyrene	<0.01	ug/l	Y Cov	GEO19
PAH,Total	<0.01	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	0.003	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051
Toluene	<0.10	ug/l	Y Cov	WAS058
Total Xylenes	<0.20	ug/l	Y Cov	WAS058

Analyst Comments for 10641615:

No Analyst Comment

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

Signed:

J. Fell

Name: **J. Fell**

Date: **11 July 2008**

Title: **Production Manager**

Severn Trent Laboratories Ltd.

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**SEVERN
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STL

**Mr Roger Hawkins
Integral Geotechnique
Integral House
7 Beddau Way
Castlegate Business Park
Caerphilly
CF83 2AX**

Date of Issue: **23 July 2008**

Report Number: **COV/531539/2008**

Issue **1**

Job Description: General Analysis

Job Location: 9913 Twynyrodyn

Number of Samples
included in this report **3**

Job Received: **15 July 2008**

Number of Test Results
included in this report **186**

Analysis Commenced: **16 July 2008**

Signed:

Name: **L. Ellis**

Date: **23 July 2008**

Title: **Team Leader**

STL was not responsible for sampling unless otherwise stated. Sampling is not covered by our UKAS accreditation.

Information on the methods of analysis and performance characteristics are available on request.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Tests marked 'Not UKAS Accredited' in this Report/Certificate are not included in the UKAS Accreditation Schedule for our laboratory.

Severn Trent Laboratories Ltd.

Certificate of Analysis



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**SEVERN
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Report Number: **COV/531539/2008**

Issue **1**

Laboratory Number: **10674535**

Sample **1** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/BH1**

Sample Date: **11 July 2008**

Sample Received

15 July 2008

Analysis Complete:

23 July 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	<0.0005	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	0.009	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.031	mg/l	Y Cov	WAS049
pH	7.6	pH Units	Y Cov	WAS039
Sulphate as SO4	235	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.01	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	<0.10	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	<10	ug/l	Y Cov	GEO46

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**SEVERN
TRENT**

STL

Report Number: **COV/531539/2008**

Issue **1**

Laboratory Number: **10674535**

Sample **1** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/BH1**

Sample Date: **11 July 2008**

Sample Received

15 July 2008

Analysis Complete:

23 July 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44	<10	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	<10	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	<10	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	<10	ug/l	N Cov	GEO45/GEO46
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	0.02	ug/l	Y Cov	GEO19
Benzo-a-anthracene	0.05	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	0.06	ug/l	Y Cov	GEO19
Benzo-a-pyrene	0.04	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	0.07	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	0.03	ug/l	Y Cov	GEO19
Chrysene	0.09	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	0.02	ug/l	Y Cov	GEO19
Fluoranthene	0.11	ug/l	Y Cov	GEO19
Fluorene	0.02	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	0.04	ug/l	Y Cov	GEO19
Naphthalene	0.07	ug/l	Y Cov	GEO19
Phenanthrene	0.19	ug/l	Y Cov	GEO19
Pyrene	0.11	ug/l	Y Cov	GEO19
PAH,Total	0.91	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051
Toluene	0.32	ug/l	Y Cov	WAS058
Total Xylenes	0.22	ug/l	Y Cov	WAS058

Analyst Comments for 10674535:

Sulphide run on unfixed sample.

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

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**SEVERN
TRENT**

STL

Report Number: **COV/531539/2008**

Issue **1**

Laboratory Number: **10674536**

Sample **2** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/BH3**

Sample Date: **11 July 2008**

Sample Received

15 July 2008

Analysis Complete:

23 July 2008

Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	<0.0005	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	<0.005	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.035	mg/l	Y Cov	WAS049
pH	8.0	pH Units	Y Cov	WAS039
Sulphate as SO4	31	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.02	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	<0.10	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	<10	ug/l	Y Cov	GEO46

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**SEVERN
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Report Number: **COV/531539/2008**

Issue **1**

Laboratory Number: **10674536**

Sample **2** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/BH3**

Sample Date: **11 July 2008**

Sample Received

15 July 2008

Analysis Complete:

23 July 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C10-C44	<10	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	<10	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	<10	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	<10	ug/l	N Cov	GEO45/GEO46
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	0.08	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	0.12	ug/l	Y Cov	GEO19
Benzo-a-pyrene	0.06	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	0.09	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	0.05	ug/l	Y Cov	GEO19
Chrysene	0.10	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	0.03	ug/l	Y Cov	GEO19
Fluoranthene	0.11	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	0.06	ug/l	Y Cov	GEO19
Naphthalene	0.03	ug/l	Y Cov	GEO19
Phenanthrene	0.07	ug/l	Y Cov	GEO19
Pyrene	0.11	ug/l	Y Cov	GEO19
PAH, Total	0.92	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051
Toluene	0.17	ug/l	Y Cov	WAS058
Total Xylenes	<0.20	ug/l	Y Cov	WAS058

Analyst Comments for 10674536:

Sulphide run on unfixed sample.

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

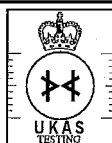
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

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**SEVERN
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Report Number: **COV/531539/2008**

Issue **1**

Laboratory Number: **10674537**

Sample **3** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/R14**

Sample Date: **11 July 2008**

Sample Received

15 July 2008

Analysis Complete:

23 July 2008

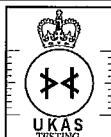
Test Description	Result	Units	Accreditation	Method
Boron in Filtrate as B	<0.3	mg/l	Y Cov	WAS049
Cadmium , Total as Cd	0.0064	mg/l	Y Cov	WAS049
Cadmium in Filtrate as Cd	<0.0005	mg/l	Y Cov	WAS049
Chromium in Filtrate as Cr	<0.005	mg/l	Y Cov	WAS049
Copper in Filtrate as Cu	<0.005	mg/l	Y Cov	WAS049
Lead in Filtrate as Pb	<0.005	mg/l	Y Cov	WAS049
Mercury , Total as Hg	<0.0001	mg/l	Y Cov	WAS013
Nickel in Filtrate as Ni	0.008	mg/l	Y Cov	WAS049
Zinc, Total as Zn	0.69	mg/l	Y Cov	WAS049
pH	7.1	pH Units	Y Cov	WAS039
Sulphate as SO4	54	mg/l	Y Cov	WAS036
Cyanide , Total as CN	<0.1	mg/l	Y Cov	WAS018
Phenols Mono (Phenol Index)	<0.1	mg/l	Y Cov	WAS019
Sulphide as S	0.44	mg/l	Y Cov	WAS033
Methyl Tertiary Butyl Ether	<0.10	ug/l	Y Cov	WAS058
Benzene	<0.10	ug/l	N Cov	WAS058
Ethyl Benzene	<0.10	ug/l	N Cov	WAS058
VPH>C5-C6-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C6-C8-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-ALIPHATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C7-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C7-C8-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C8-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-C10-AROMATIC	<10	ug/l	Y Cov	GEO45
VPH>C5-10	<10	ug/l	Y Cov	GEO45
EPH>C10-C12-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-ALIPHATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C35-ALIPHATIC	291	ug/l	Y Cov	GEO46
EPH>C35-C44-ALIPHATIC	65	ug/l	Y Cov	GEO46
EPH>C10-C44-ALIPHATIC	356	ug/l	Y Cov	GEO46
EPH>C10-C12-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C12-C16-AROMATIC	<10	ug/l	Y Cov	GEO46
EPH>C16-C21-AROMATIC	13	ug/l	Y Cov	GEO46
EPH>C21-C35-AROMATIC	117	ug/l	Y Cov	GEO46

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**SEVERN
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Report Number: **COV/531539/2008**

Issue **1**

Laboratory Number: **10674537**

Sample **3** of **3**

Sample Source: **Integral Geotechnique**

Sample Point Description: **Integral Geotechnique**

Sample Description: **9913/R14**

Sample Date: **11 July 2008**

Sample Received

15 July 2008

Analysis Complete:

23 July 2008

Test Description	Result	Units	Accreditation	Method
EPH>C35-C44-AROMATIC	36	ug/l	Y Cov	GEO46
EPH>C10-C44-AROMATIC	166	ug/l	Y Cov	GEO46
EPH>C10-C44	522	ug/l	Y Cov	GEO46
TPH>C5-C44 ALIPHATIC	356	ug/l	Y Cov	GEO45/GEO46
TPH>C5-C44 AROMATIC	166	ug/l	N Cov	GEO45/GEO46
TPH>C5-C44 SUM ALI/ARO	522	ug/l	N Cov	GEO45/GEO46
Acenaphthene	<0.01	ug/l	Y Cov	GEO19
Acenaphthylene	<0.01	ug/l	Y Cov	GEO19
Anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-a-anthracene	<0.01	ug/l	Y Cov	GEO19
Benzo-g,h,i perylene	0.02	ug/l	Y Cov	GEO19
Benzo-a-pyrene	<0.01	ug/l	Y Cov	GEO19
Benzo-b-fluoranthene	0.01	ug/l	Y Cov	GEO19
Benzo-k-fluoranthene	<0.01	ug/l	Y Cov	GEO19
Chrysene	0.01	ug/l	Y Cov	GEO19
Dibenz-a-h-anthracene	0.01	ug/l	Y Cov	GEO19
Fluoranthene	0.01	ug/l	Y Cov	GEO19
Fluorene	<0.01	ug/l	Y Cov	GEO19
Indeno 1,2,3-cd pyrene	0.01	ug/l	Y Cov	GEO19
Naphthalene	<0.01	ug/l	Y Cov	GEO19
Phenanthrene	0.02	ug/l	Y Cov	GEO19
Pyrene	0.01	ug/l	Y Cov	GEO19
PAH,Total	0.11	ug/l	Y Cov	GEO19
Arsenic (FILT) ICPMS	<0.001	mg/l	Y Cov	WAS051
Selenium, total by ICP-MS	<0.001	mg/l	Y Cov	WAS051
Toluene	<0.10	ug/l	Y Cov	WAS058
Total Xylenes	<0.20	ug/l	Y Cov	WAS058

Analyst Comments for 10674537:

Sulphide run on unfixed sample.

Accreditation Codes: Y = UKAS Accredited, N = Not UKAS Accredited, M = MCERTS, S = Sub-contracted.

Analysed at: Bri = STL Bridgend, Cov = STL Coventry, Mid = STL Midlands, Rea = STL Reading, Run = STL Runcorn.

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. I/S=Insufficient sample

Signed: *L. Ellis*

Name: **L. Ellis**

Date: **23 July 2008**

Title: **Team Leader**

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APPENDIX K

LABORATORY PHYSICAL TEST RESULTS

Summary of Laboratory Sample Descriptions

[illegible]

Note: Results on this table are in summary format and may not meet the requirements of the relevant standards, additional information is held by the laboratory


Checked by

7/08/08
Date


Approved by

7/08/08
Date



Twynyrodyn Mountain Hare

Contract No.:
GEO/6493/08
Client ref:

9913

GEO/001

Dec 05

Issue No. 1.1

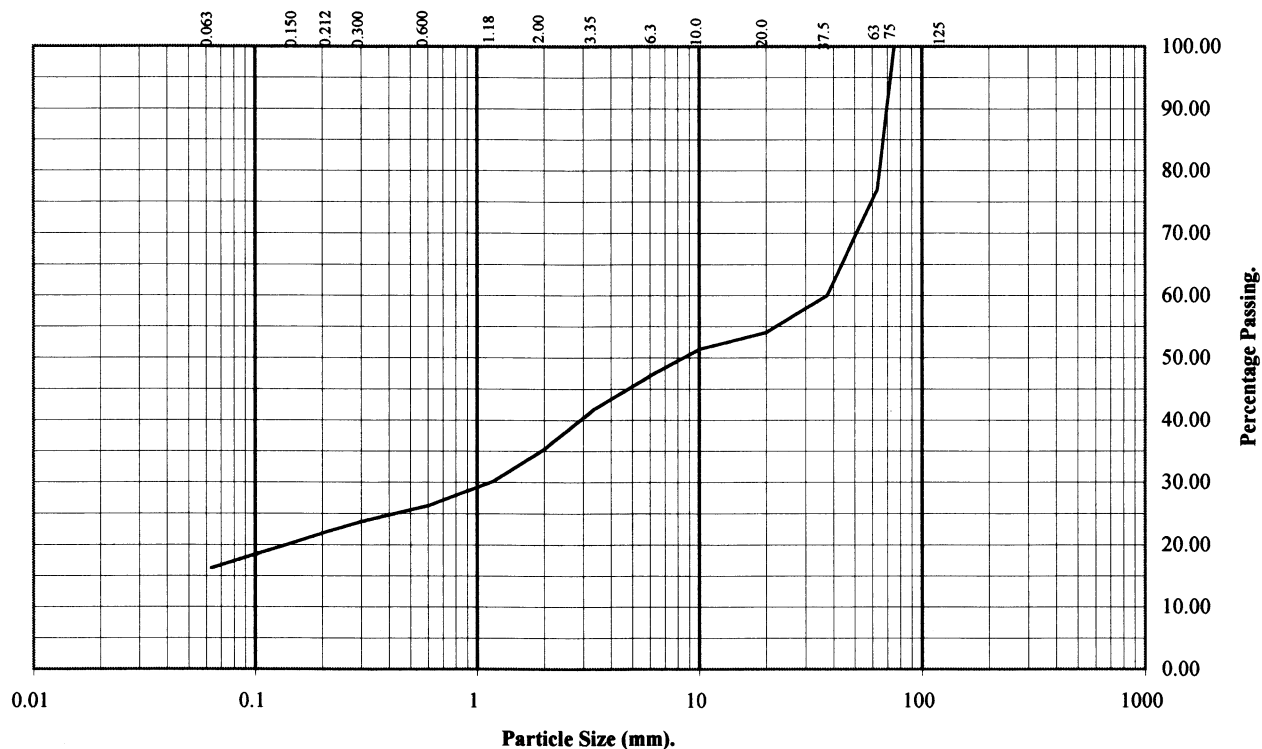
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PARTICLE SIZE DISTRIBUTION TEST

BS 1377:Part 2:1990.

Wet sieve Clause 9.2

Sample Number: TP5 Sample Number: N/A Depth (m): 1.00



BS Test Sieve	Percentage Passing
125	100
75	100
63	77
37.5	60
20	54
10	51
6.3	48
3.35	42
2	35
1.18	30
0.6	26
0.3	24
0.212	22
0.15	20
0.063	16

Soil Fraction	Total Percentage
Cobbles	23
Gravel	42
Sand	19
Silt and Clay	16

Remarks:

Checked by *[Signature]* Date 7/01/08

Approved by *[Signature]* Date 7/01/08



LABORATORY TESTING SERVICES LIMITED

GEO/004-1

Dec 05

Twynrodyn Mountain Hare

Issue No 1.2

Contract No.:
GEO/6493/08
Client Ref No:
9913



2788

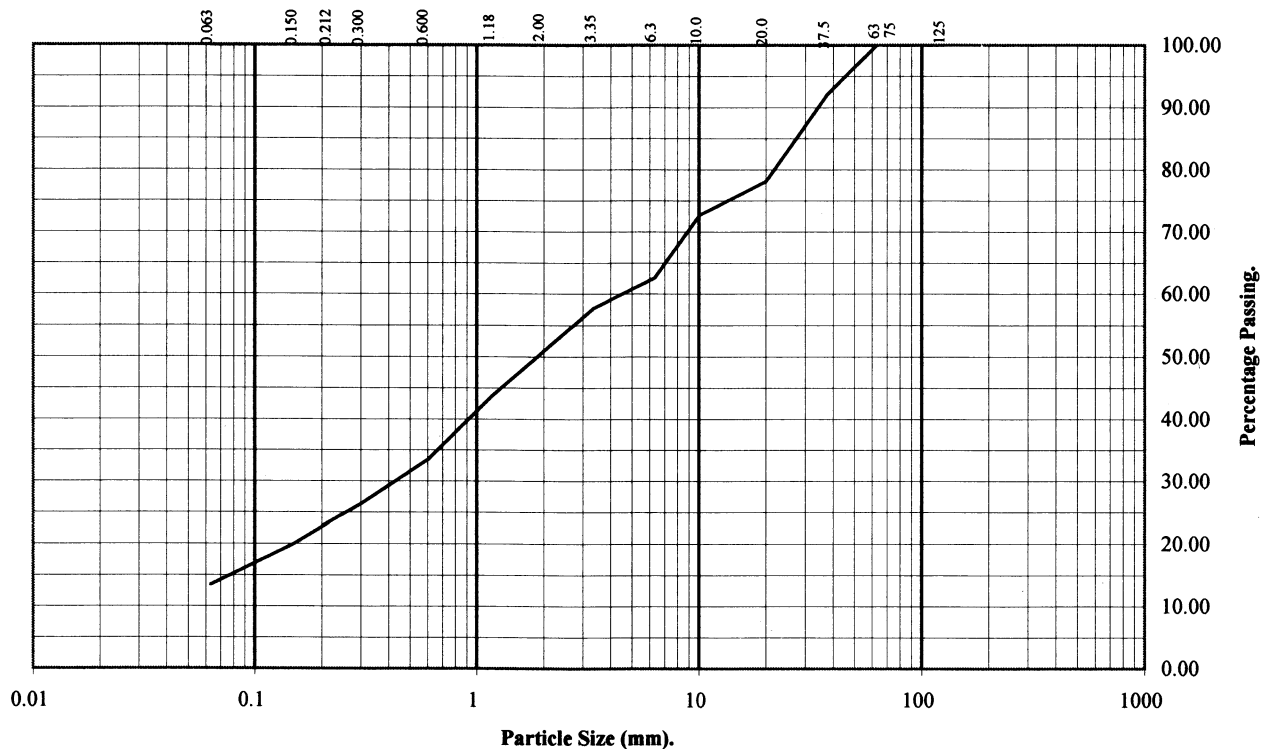
Page of

PARTICLE SIZE DISTRIBUTION TEST

BS 1377:Part 2:1990.

Wet sieve Clause 9.2

Sample Number: TP7 Sample Number: N/A Depth (m): 0.50



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	92
20	78
10	73
6.3	63
3.35	58
2	51
1.18	44
0.6	33
0.3	26
0.212	23
0.15	20
0.063	13

Soil Fraction	Total Percentage
Cobbles	0
Gravel	49
Sand	38
Silt and Clay	13

Remarks:

Checked by *[Signature]* Date 7/6/08

Approved by *[Signature]* Date 7/6/08



LABORATORY TESTING SERVICES LIMITED

GEO/004-1

Dec 05

Twynyrodyn Mountain Hare

Issue No 1.2

Contract No.:
GEO/6493/08
Client Ref No:
9913



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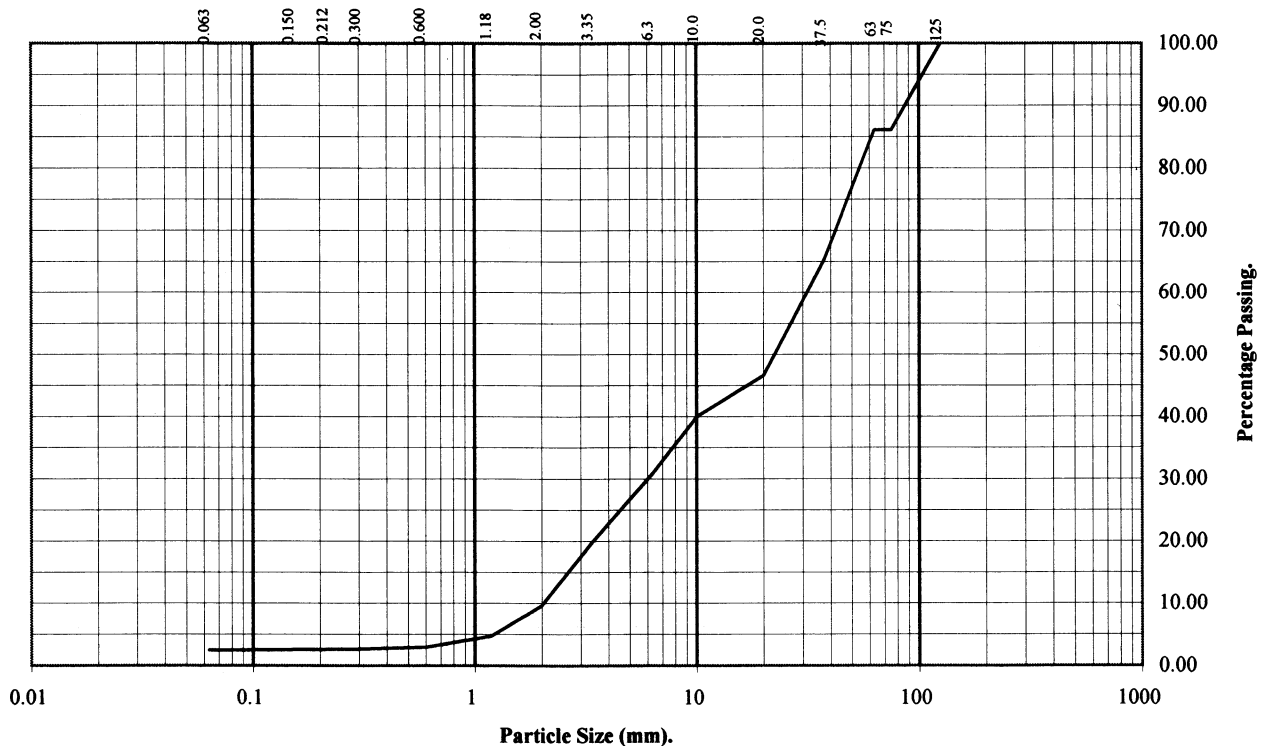
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PARTICLE SIZE DISTRIBUTION TEST

BS 1377:Part 2:1990.

Wet sieve Clause 9.2

Sample Number: TP10 Sample Number: N/A Depth (m): 1.00



BS Test Sieve	Percentage Passing
125	100
75	86
63	86
37.5	65
20	47
10	40
6.3	31
3.35	20
2	10
1.18	5
0.6	3
0.3	3
0.212	3
0.15	3
0.063	2

Soil Fraction	Total Percentage
Cobbles	14
Gravel	76
Sand	8
Silt and Clay	2

Remarks:

Checked by *[Signature]* Date *07/01/18*

Approved by *[Signature]* Date *07/01/18*



LABORATORY TESTING SERVICES LIMITED

GEO/004-1

Dec 05

Twynrodyn Mountain Hare

Issue No 1.2

Contract No.:
GEO/6493/08
Client Ref No:
9913



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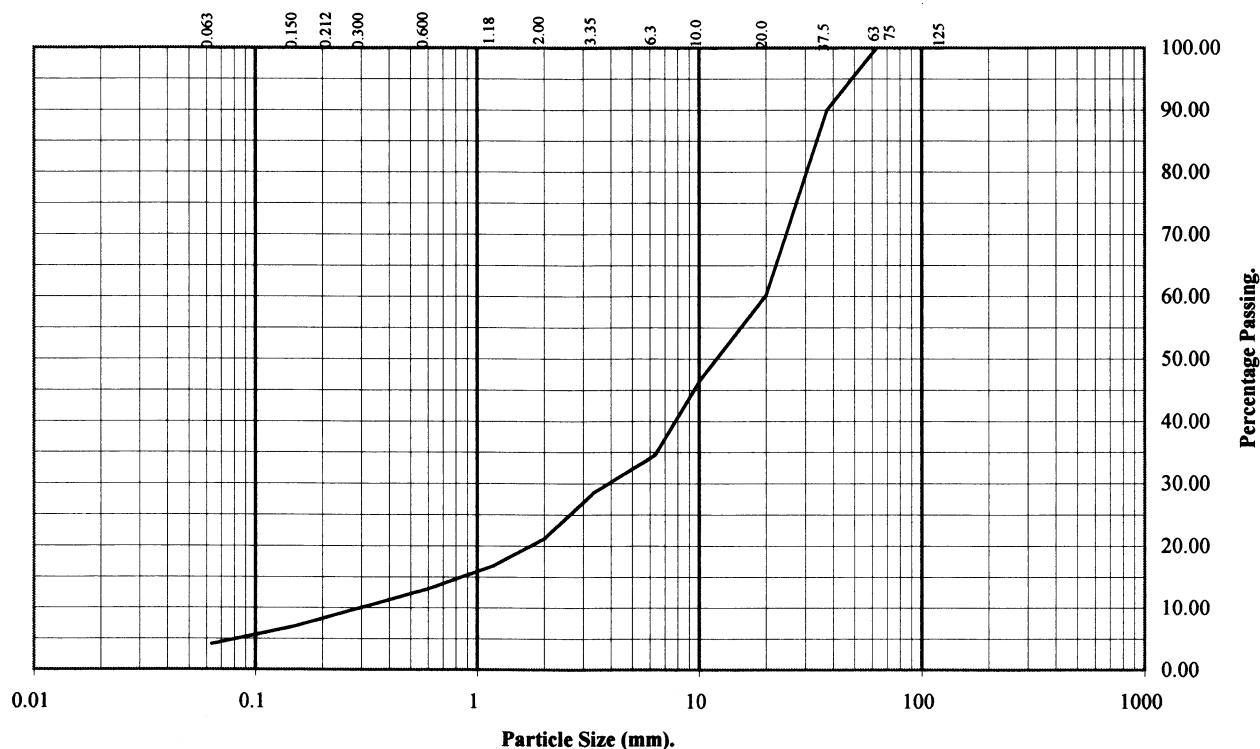
PARTICLE SIZE DISTRIBUTION TEST

BS 1377:Part 2:1990.

Wet sieve Clause 9.2

Sample Number: TP12 Sample Number: N/A

Depth (m): 1.00



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	90
20	60
10	46
6.3	35
3.35	29
2	21
1.18	17
0.6	13
0.3	10
0.212	9
0.15	7
0.063	4

Soil Fraction	Total Percentage
Cobbles	0
Gravel	79
Sand	17
Silt and Clay	4

Remarks:


Checked by

07/08/08
Date


Approved by

07/08/08
Date



Twynirodyn Mountain Hare

Contract No.:
GEO/6493/08
Client Ref No:
9913



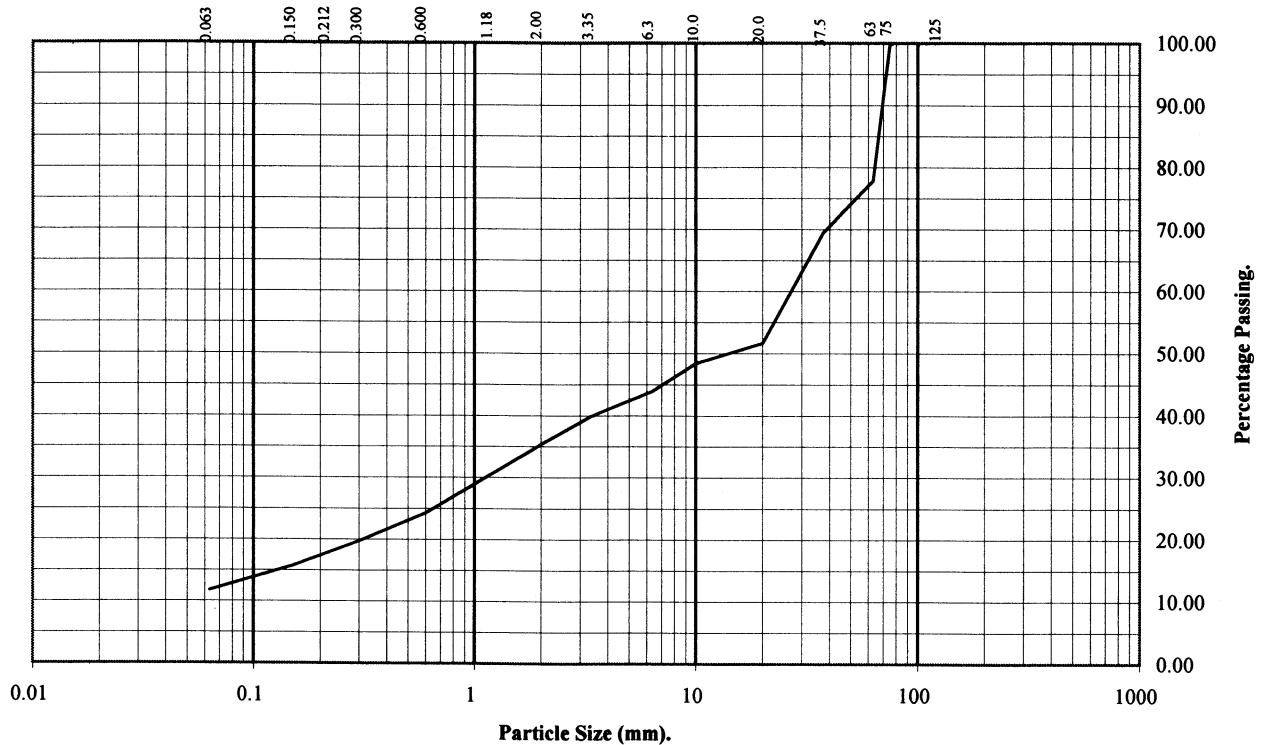
PARTICLE SIZE DISTRIBUTION TEST

BS 1377:Part 2:1990.

Wet sieve Clause 9.2

Sample Number: TP16 Sample Number: N/A

Depth (m): 1.20



BS Test Sieve	Percentage Passing
125	100
75	100
63	78
37.5	69
20	52
10	48
6.3	44
3.35	40
2	35
1.18	30
0.6	24
0.3	20
0.212	18
0.15	16
0.063	12

Soil Fraction	Total Percentage
Cobbles	22
Gravel	43
Sand	23
Silt and Clay	12

Remarks:

Checked by  Date 01/07/08

Approved by  Date 01/07/08



LABORATORY TESTING SERVICES LIMITED

GEO/004-1

Dec 05

Twynyrodyn Mountain Hare

Issue No 1.2

Contract No.:
GEO/6493/08
Client Ref No:
9913



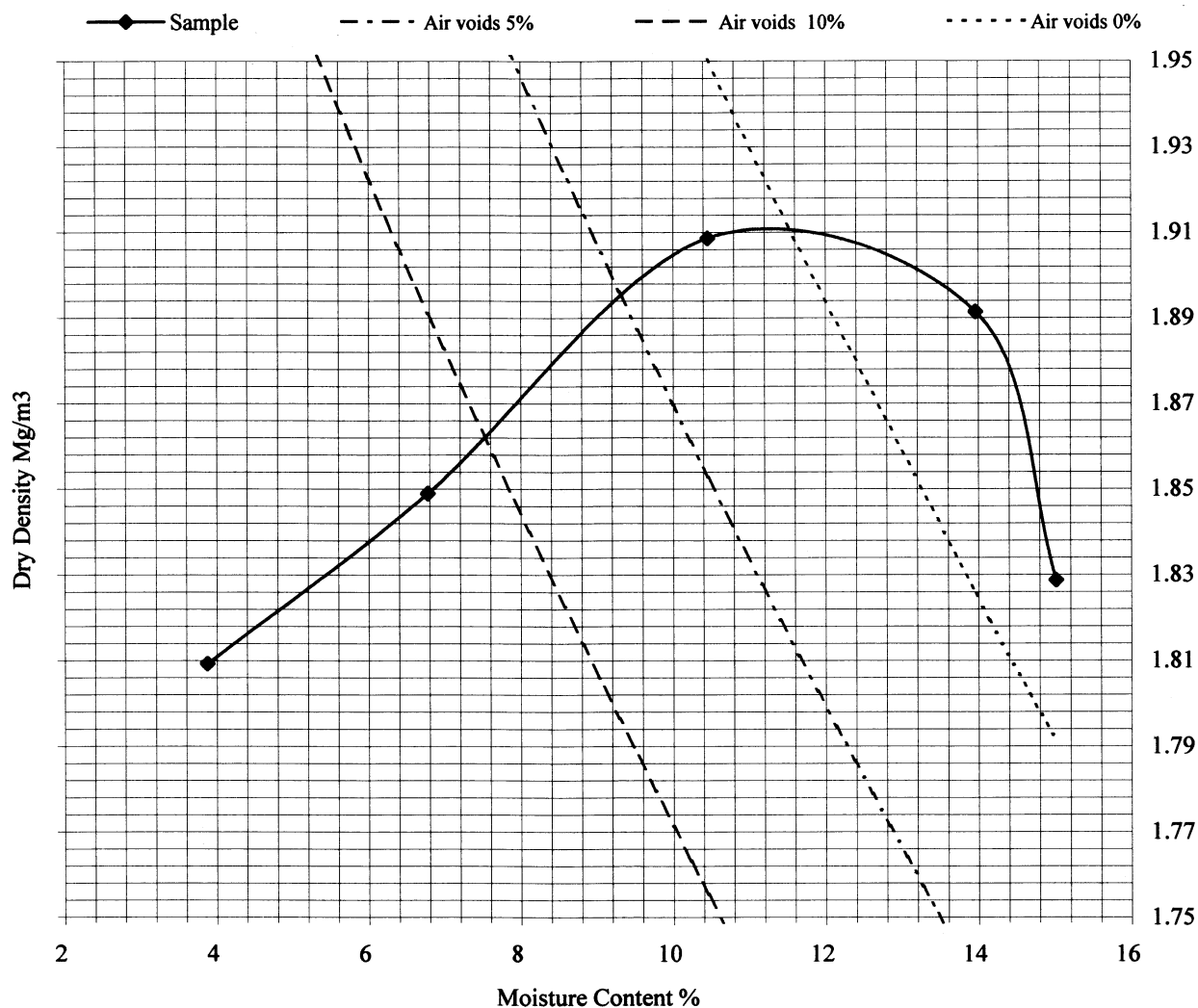
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Dry Density/Moisture Content Relationship

BS 1377:Part 4:1990

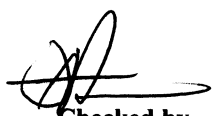
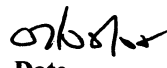
Hole Number: TP5 Sample Number: N/A Depth(m): 1.00

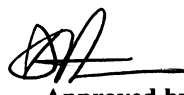
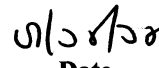


Initial Moisture Content:	14	Method of Compaction	2.5Kg Rammer / Single Sample
Particle Density (Mg/m ³):	2.45* Assumed	Material Retained on 37.5 mm Test Sieve (%):	40
Maximum Dry Density (mg/m ³):	1.91	Material Retained on 20.0 mm Test Sieve (%):	46
Optimum Moisture Content (%):	10.5	Sample Preparation Clause :	Non-Standard

* - not included in laboratory scope of accreditation

Remarks

Checked by  Date 

Approved by  Date 



Twynrodyn Mountain Hare

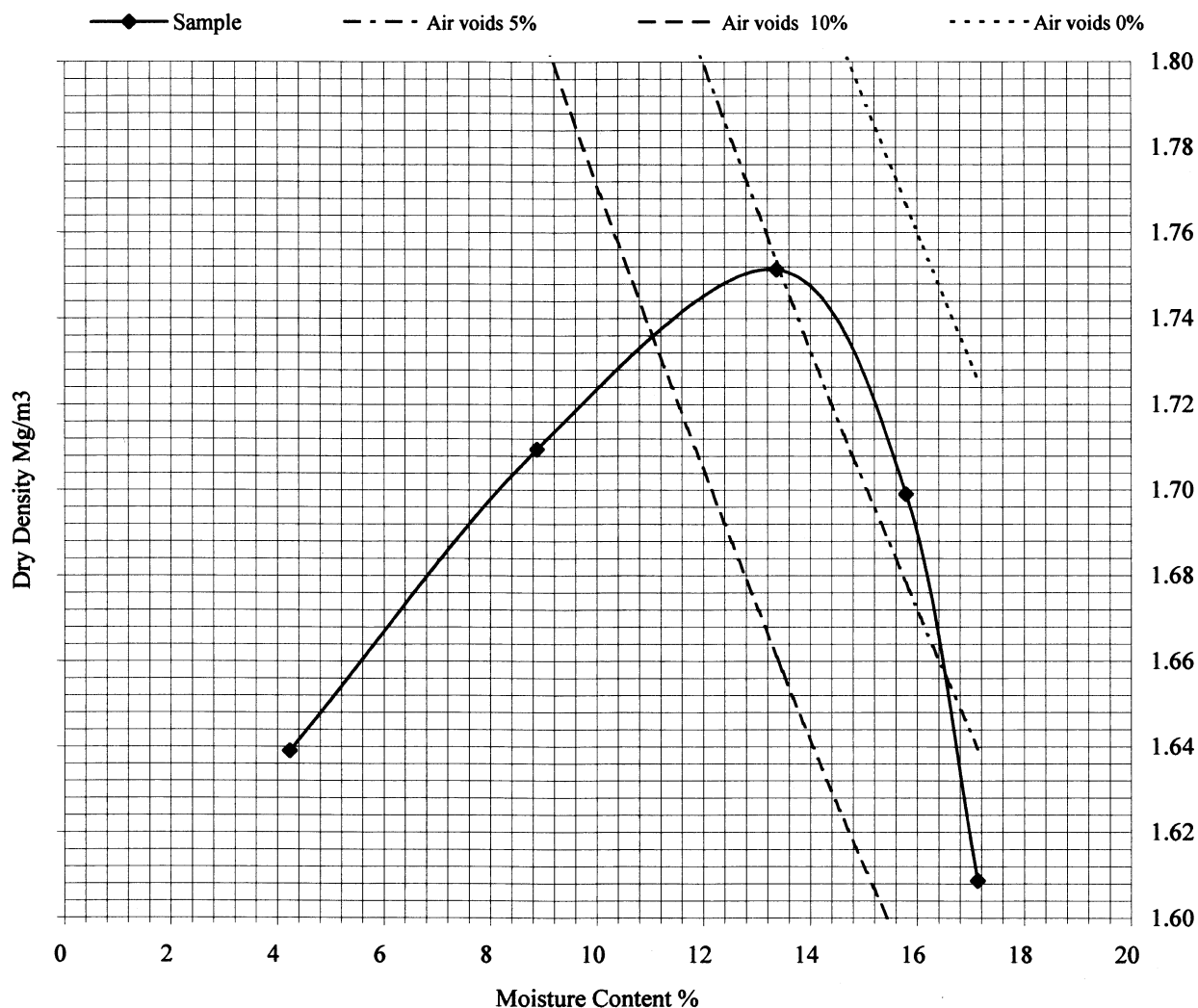
Contract No.:
GEO/6493/08
Client Ref No:
9913



Dry Density/Moisture Content Relationship

BS 1377:Part 4:1990

Hole Number: TP7 Sample Number: N/A Depth(m): 0.50



Initial Moisture Content:	13	Method of Compaction	2.5Kg Rammer / Single Sample
Particle Density (Mg/m ³):	2.45* Assumed	Material Retained on 37.5 mm Test Sieve (%):	8
Maximum Dry Density (mg/m ³):	1.75	Material Retained on 20.0 mm Test Sieve (%):	22
Optimum Moisture Content (%):	13.4	Sample Preparation Clause :	3.2.5.2

* - not included in laboratory scope of accreditation

Remarks

Checked by  Date 

Approved by  Date 



Twynrodyn Mountain Hare

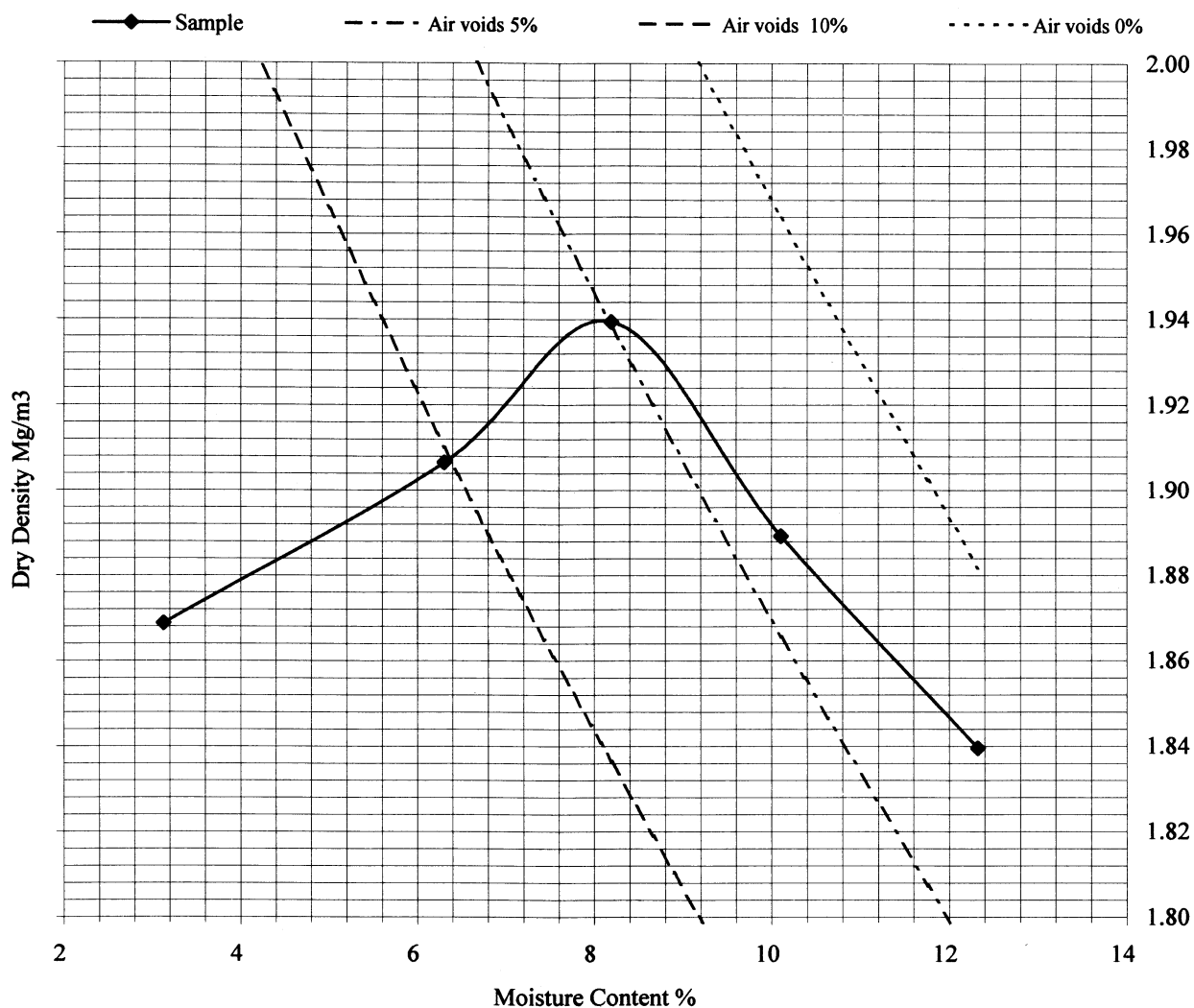
Contract No.:
GEO/6493/08
Client Ref No:
9913



Dry Density/Moisture Content Relationship

BS 1377:Part 4:1990

Hole Number: TP10 Sample Number: N/A Depth(m): 1.00



Initial Moisture Content:	6.3	Method of Compaction	2.5Kg Rammer / Single Sample
Particle Density (Mg/m3):	2.45* Assumed	Material Retained on 37.5 mm Test Sieve (%):	35
Maximum Dry Density (mg/m3):	1.94	Material Retained on 20.0 mm Test Sieve (%):	53
Optimum Moisture Content (%):	8.2	Sample Preparation Clause :	Non-Standard

* - not included in laboratory scope of accreditation

Remarks

Checked by 
Date 01/08/08

Approved by 
Date 01/08/08

Date 01/08/08



Twynrodyn Mountain Hare

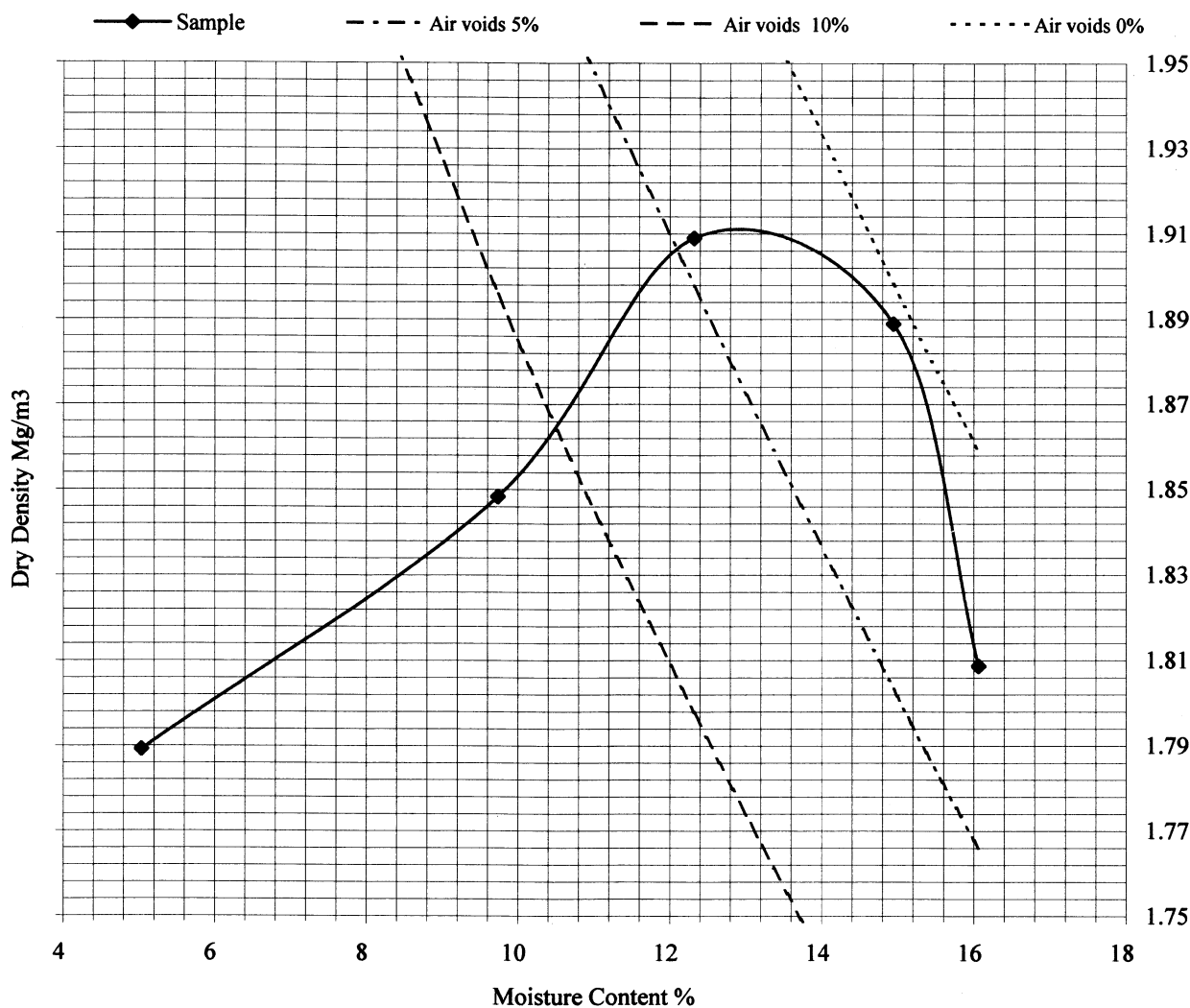
Contract No.:
GEO/6493/08
Client Ref No:
9913



Dry Density/Moisture Content Relationship

BS 1377:Part 4:1990

Hole Number: TP12 Sample Number: N/A Depth(m): 1.00



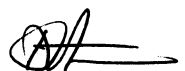
Initial Moisture Content:	9.7	Method of Compaction	2.5Kg Rammer / Single Sample
Particle Density (Mg/m ³):	2.65* Assumed	Material Retained on 37.5 mm Test Sieve (%):	10
Maximum Dry Density (mg/m ³):	1.91	Material Retained on 20.0 mm Test Sieve (%):	40
Optimum Moisture Content (%):	12.3	Sample Preparation Clause :	Non-Standard

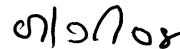
* - not included in laboratory scope of accreditation

Remarks

Checked by 
Date


Date

Approved by 
Date


Date



Twynrodyn Mountain Hare

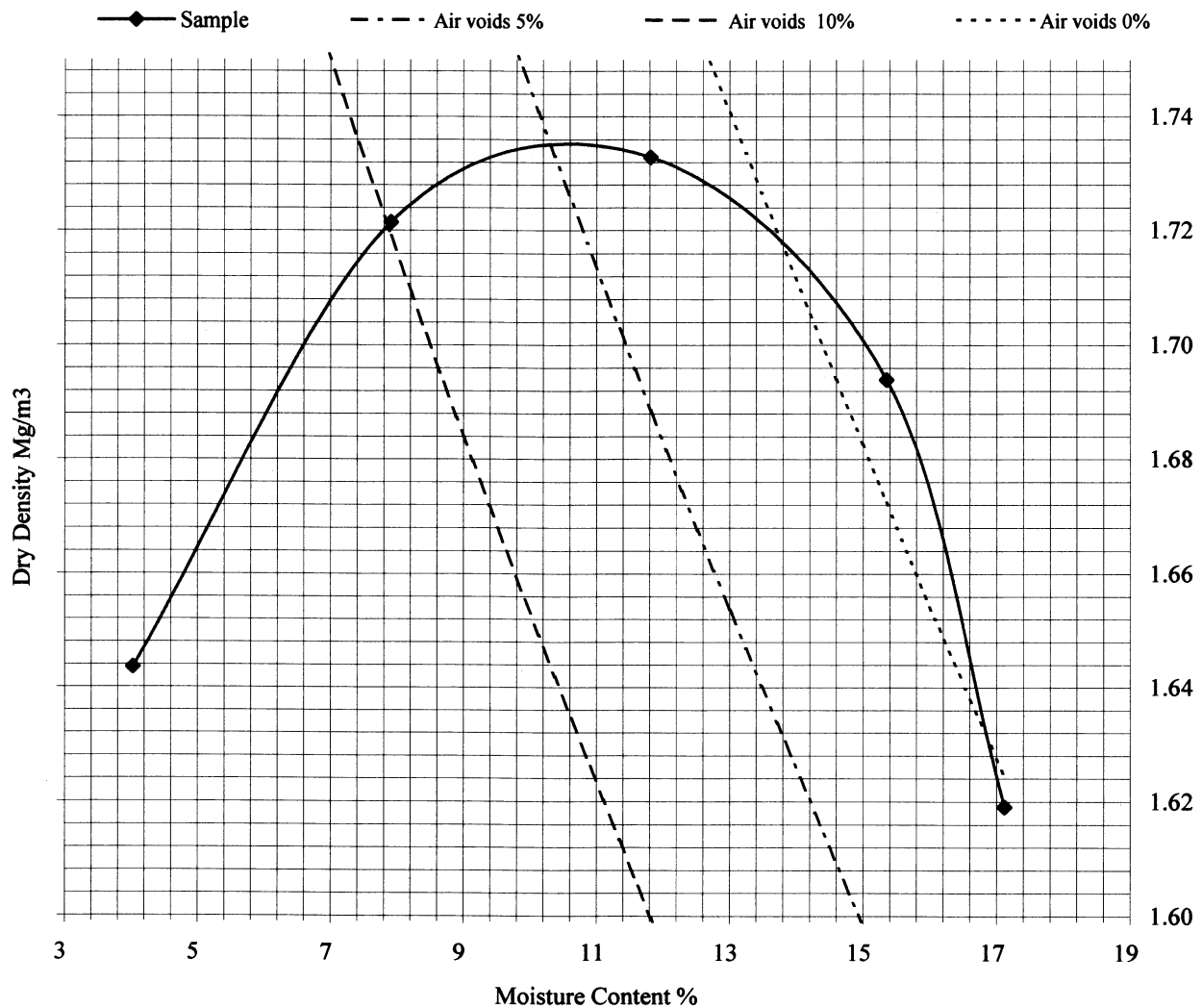
Contract No.:
GEO/6493/08
Client Ref No:
9913



Dry Density/Moisture Content Relationship

BS 1377:Part 4:1990

Hole Number: TP16 Sample Number: N/A Depth(m): 1.20



Initial Moisture Content:	15	Method of Compaction	2.5Kg Rammer / Single Sample
Particle Density (Mg/m³):	2.25* Assumed	Material Retained on 37.5 mm Test Sieve (%):	31
Maximum Dry Density (mg/m³):	1.73	Material Retained on 20.0 mm Test Sieve (%):	48
Optimum Moisture Content (%):	11.8	Sample Preparation Clause :	Non-Standard

* - not included in laboratory scope of accreditation

Remarks

Checked by 
Date 01/07/08

Approved by 
Date 01/07/08



Twynrodyn Mountain Hare

Contract No.:
GEO/6493/08
Client Ref No:
9913



APPENDIX L

GROUNDWATER MONITORING RESULTS

Groundwater Quality Monitoring Results													
Site:		Twynyrodyn			Job No:		9913						
Date:		21.05.08			Weather:		Sunny						
Name of Engineer:		RH											
Sample No.	Water level (mbgl)	Well Base Level (mbgl)	pH (pH Units)	Temperature (°C)	Conductivity (uS/cm)	Total dissolved solids (ppm)	Salinity (PSU)	Oxygen Reduction Potential (mV)	Disolved Oxygen (%)	Comments			
BH1	1.61	5.63	6.74	12.41	1378	689	0.70	110.1	15.8				
BH2	Dry	10.94											
BH3	0.91	5.19	6.61	12.33	549	275	0.27	93.1	12.2				
BH4	Dry	13.45											
BH5	Vandalized	5.05											
BH6	9.67	11.31	6.69	12.21	727	364	0.36	124.4	10.2				
R3	Dry	>33											
R4	Dry	>33											
R14	26.4	31.00	6.72	12.04	651	326	0.32	119.3	18.9				
Notes:													
1. Instrument Used:		HI Multiparameter											
2. Typical Accuracy:		Water											
		Temperature		+/- 0.15 °C		DO		+/- 1%		PSU		+/- 2% or +/- 0.01 PSU	
		pH		+/- 0.01 pH		Conductivity		+/- 1% or +/- 1uS/cm		Resistivity		+/- 1% or +/- 1mg/L	
		ORP		+/- 1mV									
3. N/R		= No Reading Taken											
Intégral Géotechnique													

Groundwater Quality Monitoring Results													
Site:		Twynyrodyn			Job No:		9913						
Date:		24.06.08			Weather:		Sunny						
Name of Engineer:		RH											
Sample No.	Water level (mbgl)	Well Base Level (mbgl)	pH (pH Units)	Temperature (°C)	Conductivity (uS/cm)	Total dissolved solids (ppm)	Salinity (PSU)	Oxygen Reduction Potential (mV)	Disolved Oxygen (%)	Comments			
BH1	1.04	5.63	7.12	13.84	962	481	0.48	-81.4	9.6				
BH2	Dry	10.94											
BH3	0.81	5.19	6.89	13.72	551	275	0.27	-68.8	15.2				
BH4	Dry	13.45											
BH5	Vandalized	5.05											
BH6	Dry	11.31											
R3	Dry	>33											
R4	Dry	>33											
R14	26.85	31.00	6.81	13.24	621	310	0.30	-38.6	7.1				
Notes:													
1. Instrument Used:		HI Multiparameter											
2. Typical Accuracy:		Water											
		Temperature		+/- 0.15 °C		DO		+/- 1%		PSU		+/- 2% or +/- 0.01 PSU	
		pH		+/- 0.01 pH		Conductivity		+/- 1% or +/- 1uS/cm		Resistivity		+/- 1% or +/- 1mg/L	
		ORP		+/- 1mV									
3. N/R		= No Reading Taken											
Intégral Géotechnique													

Groundwater Quality Monitoring Results													
Site:		Twynyrodyn			Job No:		9913						
Date:		11.07.08			Weather:		Sunny						
Name of Engineer:		RH											
Sample No.	Water level (mbgl)	Well Base Level (mbgl)	pH (pH Units)	Temperature (°C)	Conductivity (uS/cm)	Total dissolved solids (ppm)	Salinity (PSU)	Oxygen Reduction Potential (mV)	Disolved Oxygen (%)	Comments			
BH1	0.44	5.63	7.28	13.97	841	414	0.41	-63.1	14.5				
BH2	Dry	10.94											
BH3	0.92	5.19	7.11	13.84	502	297	0.23	-74.1	21.1				
BH4	Dry	13.45											
BH5	Vandalized	5.05											
BH6	Dry	11.31											
R3	Dry	>33											
R4	Dry	>33											
R14	26.92	31.00	6.74	13.11	535	287	0.27	-78.1	18.4				
Notes:													
1. Instrument Used:		HI Multiparameter											
2. Typical Accuracy:		Water											
		Temperature		+/- 0.15 °C		DO		+/- 1%		PSU		+/- 2% or +/- 0.01 PSU	
		pH		+/- 0.01 pH		Conductivity		+/- 1% or +/- 1uS/cm		Resistivity		+/- 1% or +/- 1mg/L	
		ORP		+/- 1mV									
3. N/R		= No Reading Taken											
Intégral Géotechnique													

Groundwater Quality Monitoring Results													
Site:		Twynyrodyn			Job No:		9913						
Date:		11.08.08			Weather:		Cloudy						
Name of Engineer:		RH											
Sample No.	Water level (mbgl)	Well Base Level (mbgl)	pH (pH Units)	Temperature (°C)	Conductivity (uS/cm)	Total dissolved solids (ppm)	Salinity (PSU)	Oxygen Reduction Potential (mV)	Disolved Oxygen (%)	Comments			
R3	Damp	36.2		Wet and Silty at the bottom for about 20 - 30 cm									
R4	Damp	32.4		Wet and Silty at the bottom for about 10 - 20 cm									
R14	27.12	31.65											
Notes:													
1. Instrument Used:		HI Multiparameter											
2. Typical Accuracy:		Water											
		Temperature		+/- 0.15 °C		DO		+/- 1%		PSU		+/- 2% or +/- 0.01 PSU	
		pH		+/- 0.01 pH		Conductivity		+/- 1% or +/- 1uS/cm		Resistivity		+/- 1% or +/- 1mg/L	
		ORP		+/- 1mV									
3. N/R		= No Reading Taken											
Intégral Géotechnique													

APPENDIX M

IN-SITU GAS MONITORING RESULTS

Field Gas Monitoring Results	
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Site:	Twyniodyd	Job No:	9913
Date:	15.05.08	Weather:	Cloudy
Name of Engineer:	RH	Barometric Pressure (Millibars):	983

[illegible]

Notes:

1. Instrument Used:	GA 2000 Gas Analyser					
2. Typical Accuracy:	Gas	0-5% Volume	5-15% Voume	15%-FS	Gas	0-FS
	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+/1 10%FS
	%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+/1 10%FS
	%O ₂	+/- 1%	+/- 1%	+/- 3%		
3. LEL	= Lower Explosive Limit					
4. N/R	= No Reading Taken					

Intégral Géotechnique

Field Gas Monitoring Results	
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Site:	Twyniordyn	Job No:	9913
Date:	02.06.08	Weather:	Sunny
Name of Engineer:	RH	Barometric Pressure (Millibars):	984

[illegible]

1. Instrument Used:	GA 2000 Gas Analyser					
2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+1 10%FS
	%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+1 10%FS
	%O ₂	+/- 1%	+/- 1%	+/- 3%		
3. LEL	= Lower Explosive Limit					
4. N/R	= No Reading Taken					

Intégral Géotechnique

Field Gas Monitoring Results	
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Site:	Twynnyrodyn	Job No:	9913
Date:	10.06.08	Weather:	Sunny
Name of Engineer:	RH	Barometric Pressure (Millibars):	1028

[illegible]

Notes:

1. Instrument Used:	GA 2000 Gas Analyser					
2. Typical Accuracy:	Gas	0-5% Volume	5-15% Voume	15%-FS	Gas	0-FS
	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+1 10%FS
	%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+1 10%FS
	%O ₂	+/- 1%	+/- 1%	+/- 3%		
3. LEL	= Lower Explosive Limit					
4. N/R	= No Reading Taken					

Intégral Géotechnique

Field Gas Monitoring Results	
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Site:	Twynnyrodyn	Job No:	9913
Date:	19.06.08	Weather:	Sunny
Name of Engineer:	RH	Barometric Pressure (Millibars):	1007

[illegible]

1. Instrument Used:	GA 2000 Gas Analyser					
2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+1 10%FS
	%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+1 10%FS
	%O ₂	+/- 1%	+/- 1%	+/- 3%		
3. LEL	= Lower Explosive Limit					
4. N/R	= No Reading Taken					

Intégral Géotechnique

Field Gas Monitoring Results	
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Site:	Twynnyrodyn	Job No:	9913
Date:	30.06.08	Weather:	Sunny
Name of Engineer:	RH	Barometric Pressure (Millibars):	1018

[illegible]

Notes:

1. Instrument Used:	GA 2000 Gas Analyser
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1. Instrument Used:	GA 2000 Gas Analyser
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%		CO	+1 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%		CO	+1 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%		CO	+1 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%		CO	+1 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%		CO	+1 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%		CO	+1 10%FS
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	%CO ₂	+/- 2%	+/- 1%	+/- 3%		H ₂ S	+/- 10%FS
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	%CO ₂	+/- 2%	+/- 1%	+/- 3%		H ₂ S	+/- 10%FS
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	%CO ₂	+/- 2%	+/- 1%	+/- 3%		H ₂ S	+/- 10%FS
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	%CO ₂	+/- 2%	+/- 1%	+/- 3%		H ₂ S	+/- 10%FS
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	%CO ₂	+/- 2%	+/- 1%	+/- 3%		H ₂ S	+/- 10%FS
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	%CO ₂	+/- 2%	+/- 1%	+/- 3%		H ₂ S	+/- 10%FS
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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3. LEL = Lower Explosive Limit

3. LEL = Lower Explosive Limit

4. N/R	= No Reading Taken
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4. N/R	= No Reading Taken
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Intégral Géotechnique

Field Gas Monitoring Results	
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Site:	Twyniordyn	Job No:	9913
Date:	11.07.08	Weather:	Cloudy
Name of Engineer:	RH	Barometric Pressure (Millibars):	984

[illegible]

Notes:

1. Instrument Used:	GA 2000 Gas Analyser
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1. Instrument Used:	GA 2000 Gas Analyser
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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2. Typical Accuracy:	Gas	0-5% Volume	5-15% Volume	15%-FS	Gas	0-FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+/- 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+/- 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+/- 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+/- 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+/- 10%FS
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	%CH ₄	+/- 1%	+/- 1%	+/- 3%	CO	+/- 10%FS
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%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+/- 10%FS
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%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+/- 10%FS
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%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+/- 10%FS
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%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+/- 10%FS
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%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+/- 10%FS
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%CO ₂	+/- 2%	+/- 1%	+/- 3%	H ₂ S	+/- 10%FS
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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	%O ₂	+/- 1%	+/- 1%	+/- 3%
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3. LEL = Lower Explosive Limit

3. LEL = Lower Explosive Limit

4. N/R	= No Reading Taken
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4. N/R	= No Reading Taken
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Intégral Géotechnique

APPENDIX N

STATISTICAL ASSESSMENT OF CHEMICAL RESULTS (SOILS)

SUMMARY OF LABORATORY CHEMICAL TEST RESULTS

Job Number: 9913

Site: Twyniodyd

Client: Merthyr Tydfil County Borough Council

Determinand		Number of Samples	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Concentration (mg/kg)	Outliers	Representative US ₉₅ Concentration (mg/kg)	Guideline Concentration (mg/kg)	Source	Summary of Contamination
METALS	Cadmium	22	0.50	0.50	0.50	No Outliers	0.50	2	DEFRA	No Action Required
	Chromium	22	5.00	44.00	20.34	No Outliers	25.11	130	DEFRA	No Action Required
	Copper	22	23.00	110.00	63.23	No Outliers	73.27	653	ATRISK	No Action Required
	Lead	22	13.00	120.00	45.64	No Outliers	57.05	450	DEFRA	No Action Required
	Mercury	22	0.25	0.47	0.27	Outlier(s) Identified	0.25	8	DEFRA	No Action Required
	Nickel	22	11.00	110.00	57.32	No Outliers	68.88	50	DEFRA	General Contaminant of Concern
	Zinc	22	11.00	270.00	122.55	No Outliers	149.93	330	LQM	No Action Required
SEMI-METALS & NON-METALS	Arsenic	22	5.80	23.00	13.63	No Outliers	15.72	20	DEFRA	Generally OK although exceedence(s) present
	Boron	22	0.25	1.50	0.78	No Outliers	0.88	3	EA	No Action Required
	Cyanide	22	2.50	2.50	2.50	No Outliers	2.50	34	ATRISK	No Action Required
	Selenium	22	0.30	2.30	0.87	No Outliers	1.10	35	DEFRA	No Action Required
	Elemental Sulphur	22	100.00	260.00	107.27	Outlier(s) Identified	100.00	5000	EA	No Action Required
	Total Sulphate	22	240.00	5900.00	1348.64	No Outliers	1916.54	2000	BRE	Generally OK although exceedence(s) present
	Sulphide	22	7.50	120.00	12.61	Outlier(s) Identified	7.50	250	EA	No Action Required
	Monohydric Phenol	22	0.50	0.88	0.53	Outlier(s) Identified	0.50	78	DEFRA	No Action Required
	pH	22	5.40	8.40	7.16	No Outliers	7.48	5	-	No Action Required
PAH	Acenaphthene	22	0.50	0.50	0.50	No Outliers	0.50	536	ATRISK	No Action Required
	Acenaphthylene	22	0.50	0.50	0.50	No Outliers	0.50	536	IG	No Action Required
	Anthracene	22	0.50	0.50	0.50	No Outliers	0.50	4300	ATRISK	No Action Required
	Benzo(a)anthracene	22	0.50	0.50	0.50	No Outliers	0.50	5	ATRISK	No Action Required
	Benzo(a)pyrene	22	0.50	0.50	0.50	No Outliers	0.50	1.1	LQM	No Action Required
	Benzo(b)fluoranthene	22	0.50	0.53	0.50	Outlier(s) Identified	0.50	6	ATRISK	No Action Required
	Benzo(ghi)perylene	22	0.50	0.50	0.50	No Outliers	0.50	63	ATRISK	No Action Required
	Benzo(k)fluoranthene	22	0.50	0.50	0.50	No Outliers	0.50	55	ATRISK	No Action Required
	Chrysene	22	0.50	0.50	0.50	No Outliers	0.50	479	ATRISK	No Action Required
	Dibenzo(ah)anthracene	22	0.50	0.50	0.50	No Outliers	0.50	1.1	LQM	No Action Required
	Fluoranthene	22	0.50	1.50	0.60	Outlier(s) Identified	0.51	796	ATRISK	No Action Required
	Fluorene	22	0.50	0.50	0.50	No Outliers	0.50	454	ATRISK	No Action Required
	Indeno(123cd)pyrene	22	0.50	0.50	0.50	No Outliers	0.50	6.04	ATRISK	No Action Required
	Naphthalene	22	0.50	1.40	0.66	Outlier(s) Identified	0.70	4.4	ATRISK	No Action Required
	Phenanthrene	22	0.50	2.60	0.87	No Outliers	1.08	4.4	IG	No Action Required
	Pyrene	22	0.50	1.10	0.54	Outlier(s) Identified	0.50	590	ATRISK	No Action Required
TPH	Aliphatic C5-C6	8	0.11	0.34	0.15	Outlier(s) Identified	0.13	8.2	ATRISK	No Action Required
	Aliphatic C6-C8	8	0.10	0.18	0.13	No Outliers	0.15	19	ATRISK	No Action Required
	Aliphatic C8-C10	8	0.10	0.16	0.12	No Outliers	0.14	1.46	LQM	No Action Required
	Aliphatic C10-C12 EPH	8	1.00	4.10	2.18	No Outliers	2.90	8.53	LQM	No Action Required
	Aliphatic C12-C16 EPH	8	1.00	4.00	2.75	No Outliers	3.49	40.7	LQM	No Action Required
	Aliphatic C16-C35 EPH	8	1.00	18.00	12.24	No Outliers	16.03	72900	ATRISK	No Action Required
	Aliphatic C35-C44 EPH	8	1.00	1.80	1.31	No Outliers	1.49	16300	LQM	No Action Required
	Aromatic C5-C7	8	0.01	0.20	0.03	Outlier(s) Identified	0.01	0.575	LQM	No Action Required
	Aromatic C7-C8	8	0.01	0.06	0.02	Outlier(s) Identified	0.01	3	ATRISK	No Action Required
	Aromatic C8-C10	8	0.10	0.12	0.11	No Outliers	0.11	1.4	ATRISK	No Action Required
	Aromatic C10-C12 EPH	8	1.00	3.10	1.98	No Outliers	2.61	6.7	ATRISK	No Action Required
	Aromatic C12-C16 EPH	8	1.00	6.90	4.75	No Outliers	5.90	26	ATRISK	No Action Required
	Aromatic C16-C21 EPH	8	1.00	19.00	10.25	No Outliers	13.90	115	LQM	No Action Required
	Aromatic C21-C35 EPH	8	1.00	29.00	16.54	No Outliers	22.22	157	LQM	No Action Required
	Aromatic C35-C40 EPH	8	1.00	5.60	3.00	No Outliers	3.84	157	LQM	No Action Required
BUILDING MATERIALS DURABILITY	Monohydric Phenol	22	0.50	0.88	0.53	Outlier(s) Identified	0.50	78	DEFRA	No Action Required
	Elemental Sulphur	22	100.00	260.00	107.27	Outlier(s) Identified	100.00	5000	EA	No Action Required
	Total Sulphate	22	240.00	5900.00	1348.64	No Outliers	1916.54	2000	BRE	Generally OK although exceedence(s) present
	Water Soluble Sulphate (g/l)	22	0.06	0.24	0.08	Outlier(s) Identified	0.06	0.5	BRE	No Action Required
	Sulphide	22	7.50	120.00	12.61	Outlier(s) Identified	7.50	250	EA	No Action Required
	pH	22	5.40	8.40	7.16	No Outliers	7.48	5	-	No Action Required

Note: All concentrations in mg/kg unless stated

Exceedence Representative US₉₅ concentration exceeds guideline concentration

LABORATORY CHEMICAL TEST RESULTS SUMMARY

9913 Twynnyrodyn

METALS, SEMI-METALS & NON-METALS

No.	Location	Depth (m)	Arsenic as As, dry weight (mg/kg)	Boron as B, hot water sol dw (mg/kg)	Cadmium as Cd, dry weight (mg/kg)	Chromium as Cr, dry weight (mg/kg)	Copper (Total BG Spec) (mg/kg)	Lead (Total BG Spec) (mg/kg)	Mercury as Hg, dry weight (mg/kg)	Nickel as Ni, dry weight (mg/kg)	Selenium as Se, dry weight (mg/kg)	Zinc as Zn, dry weight (mg/kg)
1	TP1	0.4	11	0.45	0.5	6.3	45	30	0.3	37	1.3	63
2	TP1	1.5	23	1.4	0.5	17	69	120	0.25	45	0.91	130
3	TP2	0.5	19	0.85	0.5	11	75	49	0.47	65	2.3	97
4	TP2	2.5	21	1	0.5	16	23	57	0.25	11	0.88	41
5	TP3	0.6	13	0.61	0.5	6.5	53	32	0.25	33	1.7	68
6	TP4	1.3	8.6	0.25	0.5	20	33	38	0.25	39	0.3	87
7	TP5	0.1	18	0.77	0.5	25	110	85	0.25	98	0.3	270
8	TP6	0.5	10	0.75	0.5	30	67	45	0.25	77	0.3	160
9	TP7	0.4	19	0.79	0.5	42	110	110	0.25	94	0.68	240
10	TP8	0.4	18	0.72	0.5	39	96	120	0.25	95	0.87	210
11	TP9	0.2	18	0.71	0.5	21	96	58	0.35	68	2.2	140
12	TP10	0.5	22	0.7	0.5	44	100	78	0.25	110	0.3	210
13	TP11	0.4	6.4	0.78	0.5	31	61	43	0.25	71	0.3	140
14	TP12	0.6	20	0.67	0.5	40	100	100	0.25	110	0.36	250
15	TP13	0.2	12	0.84	0.5	21	59	52	0.25	47	0.3	110
16	TP13	3.5	5.8	0.86	0.5	20	49	35	0.25	90	0.3	160
17	TP14	0.1	13	0.67	0.5	10	44	31	0.25	34	0.78	83
18	TP15	0.7	8.9	1.5	0.5	5	42	25	0.25	18	1	43
19	TP16	0.3	6	0.4	0.5	27	30	13	0.25	16	0.38	11
20	TP17	0.4	6.5	0.75	0.5	5.2	38	20	0.25	40	0.83	65
21	TP18	0.3	9.6	0.82	0.5	5.5	47	27	0.25	33	1.2	63
22	TP19	0.5	11	0.82	0.5	5	44	27	0.25	30	1.6	55
Soil Guidance value (SGV)			20.0	3.0	2.0	130.0	653.0	450.0	8.0	50.0	35.0	330.0
Source of SGV			DEFRA	EA	DEFRA	DEFRA	ATRISK	DEFRA	DEFRA	DEFRA	DEFRA	LQM

LABORATORY CHEMICAL TEST RESULTS SUMMARY

9913 Twynroddyn

INORGANIC CHEMICALS & OTHERS

No.	Location	Depth (m)	Cyanide (Total), dry weight (mg/kg)	Loss on ignition, dried solids (%)	Monohydric phenols dw (mg/kg)	pH (pH units)	Sulphate as SO ₄ , Water Soluble (g/l)	Sulphate Total as SO ₄ DW (mg/kg)	Sulphide (mg/kg)	Sulphur (Elemental) (mg/kg)	TOC (Ignition in O ₂) (%)
1	TP1	0.4	2.5	16	0.5	8.1	0.1	2600	7.5	100	16
2	TP1	1.5	2.5	16	0.74	7.8	0.24	760	7.5	260	12
3	TP2	0.5	2.5	23	0.5	7.1	0.14	2000	7.5	100	24
4	TP2	2.5	2.5	16	0.88	6.9	0.06	240	7.5	100	5.9
5	TP3	0.6	2.5	27	0.5	7	0.06	2400	7.5	100	26
6	TP4	1.3	2.5	5.1	0.5	6.2	0.06	240	7.5	100	2.4
7	TP5	0.1	2.5	6	0.5	8.4	0.06	240	7.5	100	2.6
8	TP6	0.5	2.5	3.8	0.5	8.3	0.06	240	7.5	100	1.2
9	TP7	0.4	2.5	7.9	0.5	8.3	0.06	280	7.5	100	5.8
10	TP8	0.4	2.5	7.2	0.5	8.3	0.06	840	7.5	100	5.1
11	TP9	0.2	2.5	16	0.5	6.8	0.06	2100	7.5	100	15
12	TP10	0.5	2.5	4.8	0.5	7.8	0.06	240	7.5	100	1.8
13	TP11	0.4	2.5	3.3	0.5	7.6	0.06	240	7.5	100	0.88
14	TP12	0.6	2.5	4	0.5	7.4	0.06	240	7.5	100	0.91
15	TP13	0.2	2.5	4.8	0.5	5.8	0.06	880	7.5	100	2
16	TP13	3.5	2.5	5.2	0.5	6.2	0.06	430	7.5	100	1.5
17	TP14	0.1	2.5	13	0.5	6.6	0.06	730	7.5	100	12
18	TP15	0.7	2.5	19	0.5	5.4	0.062	5900	7.5	100	19
19	TP16	0.3	2.5	4.4	0.5	7.5	0.092	430	120	100	3.5
20	TP17	0.4	2.5	20	0.5	7.3	0.06	940	7.5	100	22
21	TP18	0.3	2.5	17	0.5	6.3	0.13	3200	7.5	100	16
22	TP19	0.5	2.5	19	0.5	6.4	0.083	4500	7.5	100	17
Soil Guidance value (SGV)			34.0	10.0	78.0	5.0	0.5	2000.0	250.0	5000.0	10.0
Source of SGV			ATRISK	EA	DEFRA	-	BRE	BRE	EA	EA	EA

LABORATORY CHEMICAL TEST RESULTS SUMMARY

9913 Twynrodyn

POLY AROMATIC HYDROCARBONS (PAH)

No.	Location	Depth (m)	Acenaphthene mg/kg 313	Acenaphthylene mg/kg 313	Anthracene mg/kg 313	Benzo(a)anthracene mg/kg 313	Benzo(a)pyrene mg/kg 313	Benzo(b)fluoranthene mg/kg 313	Benzo(ghi)perylene mg/kg 313	Benzo(k)fluoranthene mg/kg 313	Chrysene mg/kg 313	Dibenzo(ah)anthracene mg/kg 313	Fluoranthene mg/kg 313	Fluorene mg/kg 313	Indeno(123cd)pyrene mg/kg 313	Naphthalene mg/kg 313	Phenanthrene mg/kg 313	Pyrene mg/kg 313
			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
1	TP1	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.53	0.5	0.5	0.82	1.2	0.5
2	TP1	1.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.57	0.5	0.5	0.5	0.62	0.5
3	TP2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.81	1	0.5
4	TP2	2.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.69	0.5	0.5	0.5	0.5	0.58
5	TP3	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.87	0.5	0.5	1.1	1.7	0.66
6	TP4	1.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	TP5	0.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8	TP6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
9	TP7	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
10	TP8	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
11	TP9	0.2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.64	0.91	0.5
12	TP10	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
13	TP11	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
14	TP12	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15	TP13	0.2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
16	TP13	3.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
17	TP14	0.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.99	0.5
18	TP15	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.8	0.5
19	TP16	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
20	TP17	0.4	0.5	0.5	0.5	0.5	0.5	0.53	0.5	0.5	0.5	0.5	1.5	0.5	0.5	1.4	2.6	1.1
21	TP18	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.89	0.5	0.5	1.1	1.8	0.64
22	TP19	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.68	0.5	0.5	0.83	1.5	0.5
Soil Guidance value (SGV)			536.0	536.0	4300.0	4.8	1.1	5.5	62.6	55.4	479.0	1.1	796.0	454.0	6.0	4.4	4.4	590.0
Source of SGV			ATRISK	IG	ATRISK	ATRISK	LQM	ATRISK	ATRISK	ATRISK	ATRISK	LQM	ATRISK	ATRISK	ATRISK	ATRISK	IG	ATRISK

LABORATORY CHEMICAL TEST RESULTS SUMMARY

9913 Twynrodyn

TOTAL PETROLEUM HYDROCARBONS (TPH)

No.	Location	Depth (m)	Aliphatic C5-C6 (mg/kg)	Aliphatic C6-C8 (mg/kg)	Aliphatic C8-C10 (mg/kg)	Aliphatic C10- C12 EPH (mg/kg)	Aliphatic C12- C16 EPH (mg/kg)	Aliphatic C16- C35 EPH (mg/kg)	Aliphatic C35- C44 EPH -	Aromatic C5-C7	Aromatic C7-C8	Aromatic C8-C10	Aromatic C10- C12 EPH	Aromatic C12- C16 EPH	Aromatic C16- C21 EPH	Aromatic C21- C35 EPH	Aromatic C35- C40 EPH
1	TP1	0.4	0.34	0.13	0.13	3.1	4	16	1.4	0.011	0.011	0.11	2.7	5.5	13	19	2.9
2	TP1	1.5															
3	TP2	0.5	0.11	0.15	0.15	2.5	3.9	18	1.4	0.011	0.011	0.11	2.8	5.8	14	22	2.8
4	TP2	2.5															
5	TP3	0.6															
6	TP4	1.3															
7	TP5	0.1	0.12	0.11	0.11	1.1	1.5	6.9	1.1	0.011	0.011	0.11	1.1	3.8	5.4	8.3	2.4
8	TP6	0.5															
9	TP7	0.4	0.18	0.11	0.11	2.5	3.6	12	1.1	0.011	0.011	0.11	1.1	5.1	8	21	5.6
10	TP8	0.4															
11	TP9	0.2	0.11	0.14	0.11	1.1	2.1	15	1.8	0.011	0.011	0.11	2.9	5.2	12	17	3.2
12	TP10	0.5															
13	TP11	0.4	0.13	0.1	0.1	1	1	1	1	0.01	0.01	0.1	1	1	1	1	1
14	TP12	0.6															
15	TP13	0.2															
16	TP13	3.5															
17	TP14	0.1	0.11	0.11	0.11	4.1	3.1	12	1.5	0.011	0.011	0.11	1.1	4.7	9.6	15	2.7
18	TP15	0.7															
19	TP16	0.3															
20	TP17	0.4															
21	TP18	0.3															
22	TP19	0.5	0.13	0.18	0.16	2	2.8	17	1.2	0.2	0.063	0.12	3.1	6.9	19	29	3.4
Soil Guidance value (SGV)			8.2	19.0	1.5	8.5	40.7	72900.0	16300.0	0.6	3.0	1.4	6.7	26.0	115.0	157.0	157.0
Source of SGV			ATRISK	ATRISK	LQM	LQM	LQM	ATRISK	LQM	LQM	ATRISK	ATRISK	ATRISK	ATRISK	LQM	LQM	LQM

APPENDIX O

SUMMARY OF GROUNDWATER TEST RESULTS

Groundwater Testing Summary

Determinand		Groundwater Monitoring												Guideline Value	
		BH1 - Perched Water			BH3 - Perched Water			BH6 - Perched Water			R14 - Deep Groundwater			Freshwater EQS*	UK Drinking Water Standard
		Round 1 21.05.08	Round 2 24.06.08	Round 3 11.07.08	Round 1 21.05.08	Round 2 24.06.08	Round 3 11.07.08	Round 1 21.05.08	Round 2 24.06.08	Round 3 11.07.08	Round 1 21.05.08	Round 2 24.06.08	Round 3 11.07.08		
Boron in Filtrate as B	mg/l	-	-	-	-	-	-	-			-	-	-	2	2
Cadmium , Total as Cd	mg/l	0.0013	0.0008	-	0.0013	0.0006	-	0.0035			0.0051	0.0037	0.0064	0.005	0.005
Cadmium in Filtrate as Cd	mg/l	-	-	-	-	-	-	-			-	-	-	0.005	0.005
Chromium in Filtrate as Cr	mg/l	-	-	-	-	-	-	-			-	-	-	0.02	0.05
Copper in Filtrate as Cu	mg/l	-	-	-	-	-	-	-			-	-	-	0.04	3
Lead in Filtrate as Pb	mg/l	-	-	-	-	-	-	-			-	-	-	0.01	0.05
Mercury , Total as Hg	mg/l	-	-	-	-	-	-	0.0005			-	-	-	0.001	0.001
Nickel in Filtrate as Ni	mg/l	0.016	0.005	0.009	-	-	-	0.007			0.005	-	0.008	0.15	0.05
Zinc, Total as Zn	mg/l	0.14	0.064	0.031	0.12	0.039	0.035	0.51			0.5	0.25	0.69	0.075	5
pH		6.9	7.3	7.6	7.3	7.7	8	6.5			6.9	7.2	7.1		
Sulphate as SO4	mg/l	405	250	235	45	45	31	147			76	78	54	400	250
Cyanide , Total as CN	mg/l	-	-	-	-	-	-	-			-	-	-		0.05
Phenols Mono (Phenol Index)	mg/l	-	-	-	-	-	-	-			-	-	-	0.03	0.0005
Sulphide as S	mg/l	-	0.03	0.01	0.11	0.03	0.02	1.4			1.4	0.39	0.44		
Methyl Tertiary Butyl Ether	ug/l	-	-	-	-	-	-	-			-	-	-		
Benzene	ug/l	0.15	-	-	-	-	-	0.2			-	-	-	30	1
Ethyl Benzene	ug/l	-	-	-	-	-	-	-			-	-	-		
VPH>C5-C6-Aliphatic	ug/l	-	-	-	-	-	-	-			-	-	-		
VPH>C6-C8-Aliphatic	ug/l	-	-	-	-	-	-	-			-	-	-		
VPH>C8-C10-Aliphatic	ug/l	-	-	-	-	-	-	-			-	-	-		
VPH>C5-C10-Aliphatic	ug/l	-	-	-	-	-	-	-			-	-	-		
VPH>C5-C7-Aromatic	ug/l	-	-	-	-	-	-	-			-	-	-		
VPH>C7-C8-Aromatic	ug/l	-	-	-	-	-	-	-			-	-	-		
VPH>C8-C10-Aromatic	ug/l	-	-	-	-	-	-	-			-	-	-		
VPH>C5-C10-Aromatic	ug/l	-	-	-	-	-	-	-			-	-	-		
VPH>C5-C10	ug/l	-	-	-	-	-	-	-			-	-	-		
EPH>C10-C12-Aliphatic	ug/l	-	-	-	-	-	-	-			-	-	-		
EPH>C12-C16-Aliphatic	ug/l	-	-	-	-	-	-	-			-	-	-		
EPH>C16-C35-Aliphatic	ug/l	-	-	-	-	-	-	-			87	-	291	30~	10
EPH>C35-C44-Aliphatic	ug/l	-	-	-	-	-	-	-			21	-	65		
EPH>C10-C44-Aliphatic	ug/l	-	-	-	-	-	-	-			108	-	356		
EPH>C10-C12-Aromatic	ug/l	-	-	-	-	-	-	-			-	-	-		
EPH>C12-C16-Aromatic	ug/l	-	-	-	-	-	-	-			-	-	-		
EPH>C16-C21-Aromatic	ug/l	-	-	-	-	-	-	12			-	-	13		
EPH>C21-C35-Aromatic	ug/l	17	-	-	-	-	-	-			17	-	117		
EPH>C35-C44-Aromatic	ug/l	-	-	-	-	-	-	12			-	-	36		
EPH>C10-C44-Aromatic	ug/l	17	-	-	-	-	-	12			17	-	166		
EPH>C10-C44	ug/l	17	-	-	-	-	-	-			125	-	522		
TPH>C5-C44 Aliphatic	ug/l	-	-	-	-	-	-	12			108	-	356		
TPH>C5-C44 Aromatic	ug/l	17	-	-	-	-	-	12			17	-	166		
TPH>C5-C44 Sum Ali/Aro	ug/l	17	-	-	-	-	-	-			125	-	522		
Acenaphthene	ug/l	-	-	-	0.03	-	-	-			-	-	-		
Acenaphthylene	ug/l	-	-	-	0.01	-	-	-			-	-	-		
Anthracene	ug/l	-	0.03	0.02	0.09	-	0.01	-			-	-	-		
Benzo-a-anthracene	ug/l	-	0.12	0.05	0.58	0.07	0.08	-			-	-	-		
Benzo-g,h,i perylene	ug/l	-	0.14	0.06	0.34	0.05	0.12	-			-	-	0.02		
Benzo-a-pyrene	ug/l	-	0.13	0.04	0.69	0.08	0.06	-			-	-	-		
Benzo-b-fluoranthene	ug/l	0.05	0.27	0.07	1.14	0.19	0.09	-			-	-	0.01		
Benzo-k-fluoranthene	ug/l	-	0.07	0.03	0.37	0.03	0.05	-			-	-	-		
Chrysene	ug/l	0.04	0.15	0.09	0.59	0.07	0.1	-			-	-	0.01	10#	0.2
Dibenz-a-h-anthracene	ug/l	-	0.05	0.02	0.32	0.01	0.03	-			-	-	0.01		
Fluoranthene	ug/l	0.05	0.19	0.11	0.99	0.08	0.11	-			-	-	0.01		
Fluorene	ug/l	-	0.02	0.02	0.05	-	-	-			-	-	-		
Indeno 1,2,3-cd pyrene	ug/l	-	0.08	0.04	0.51	0.05	0.06	-			-	-	0.01		
Naphthalene	ug/l	-	0.04	0.07	0.11	-	0.03	-			-	-	-		
Phenanthrene	ug/l	0.08	0.22	0.19	0.4	0.04	0.07	-			-	-	0.02		
Pyrene	ug/l	0.05	0.17	0.11	0.69	0.07	0.11	-			-	-	0.01		
PAH,Total	ug/l	0.28	1.67	0.91	6.91	0.75	0.92	-			-	-	0.11		
Arsenic (FILT) ICPMS	mg/l	-	0.005	-	-	0.006	-	-			-	0.003	-	0.05	0.01
Selenium, total by ICP-MS	mg/l	-	-	-	-	0.001	-	0.006			0.005	-	-		0.01
Toluene	ug/l	0.19	0.27	0.32	0.25	0.24	0.17	0.21			-	-	-	50	
Total Xylenes	ug/l	-	-	0.22	-	-	-	-			-	-	-	30	

* Freshwater EQS based on hardness of receiving waters of >100-150mg/l CaCO3 - Taken from Environment Agency website data for River Taff in Merthyr Tydfil area

~ Freshwater EQS for Benzene used for all TPH bands as a worst case screen

Freshwater EQS for Naphthalene used for all PAH compounds

APPENDIX P

SSTL SUMMARY AND RBCA MODEL – INPUTS AND OUTPUTS

Site Specific Target Level Summary

Determinand	Exposure Pathway			SSTL (mg/kg)
	Dermal Contact & Direct Ingestion (mg/kg)	Outdoor Air Inhalation of Vapours (mg/kg)	Indoor Air Inhalation of Vapours (mg/kg)	
Arsenic	180.00	47,000.00	>1.3E+7	180.00
Nickel	620.00	420,000.00	>6.4E+7	620.00

Exposure Pathway Flowchart

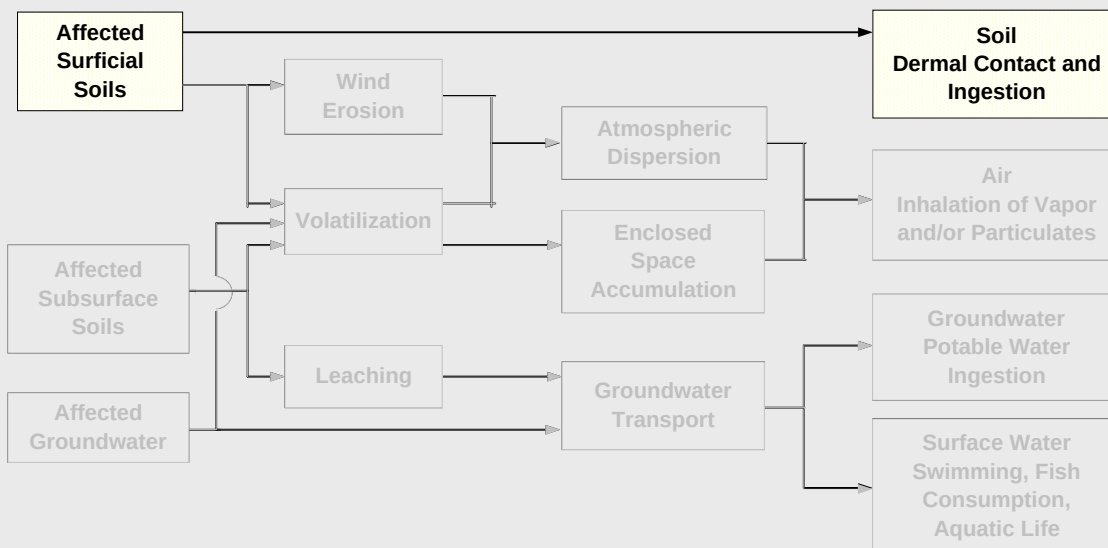
Site Name: Twynyrodyn Job ID: 9913
 Location: Merthyr Tydfil Date: 18.07.08
 Compl. By: RB

Source Media

Transport Mechanisms

Exposure Media

Receptors



	On-site	Off-site1	Off-site2
Residential			
Outdoor Air:	None	None	None
Indoor Air:	None	NA	NA
	None	None	None
	NA	NA	NA

SOURCE

TRANSPORT

RECEPTOR

Commands and Options

Main Screen

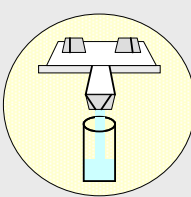
Print Sheet

Help

Exposure Factors and Target Risk Limits

1. Exposure Parameters

	Residential			Commercial		
	Age Adjustment?	Adult	(Age 0-6)	(Age 0-16)	Chronic	Construc.
Averaging time, carcinogens (yr)		6				
Averaging time, non-carcinogens (yr)		6			25	1
Body weight (kg)		13.5	13.5	13.5	70	
Exposure duration (yr)		6	6	6	25	1
Exposure frequency (days/yr)		80			250	180
Dermal exposure frequency (days/yr)		80			250	
Skin surface area, soil contact (cm ²)	☒	706		706	5800	5800
Soil dermal adherence factor (mg/cm ² /day)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☒	100	100		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☐	0.05	0.5			
Skin surface area, swimming (cm ²)	☐	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				



Site Name: Twynyrodyn

Location: Merthyr Tydfil

Compl. By: RB

Job ID: 9913

Date: 18.07.08

2. Risk Goal Calculation Options

- ☐ Individual Constituent Risk Goals Only
☒ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcin.)	1.0E-5	1.0E-5
Target Risk (Class C carcinogens)	1.0E-5	
Target Hazard Quotient	1.0E+0	
Target Hazard Index		1.0E+0

4. Commands and Options

[Return to Exposure Pathways](#)
[Use Default Values](#)
[Print Sheet](#)
[Help](#)

RBCA SITE ASSESSMENT

Input Parameter Summary

Site Name: Twynyrodyn
Site Location: Merthyr Tydfil

Completed By: RB
Date Completed: 18.07.08

Job ID: 9913

1 OF 1

Exposure Parameters		Residential			Commercial/Industrial	
		Adult	(1-6yrs)	(1-16 yrs)	Chronic	Construc.
AT _c	Averaging time for carcinogens (yr)	6				
AT _n	Averaging time for non-carcinogens (yr)	6			25	1
BW	Body weight (kg)	13.5	13.5	13.5	70	
ED	Exposure duration (yr)	6	6	6	25	1
τ	Averaging time for vapor flux (yr)	6			25	1
EF	Exposure frequency (days/yr)	80			250	180
EF _D	Exposure frequency for dermal exposure	80			250	
IR _w	Ingestion rate of water (L/day)	2			1	
IR _s	Ingestion rate of soil (mg/day)	100	100		50	100
SA	Skin surface area (dermal) (cm²)	706		706	5800	5800
M	Soil to skin adherence factor	1				
ET _{swim}	Swimming exposure time (hr/event)	3				
EV _{swim}	Swimming event frequency (events/yr)	12	12	12		
IR _{swim}	Water ingestion while swimming (L/hr)	0.05	0.5			
SA _{swim}	Skin surface area for swimming (cm²)	23000		8100		
IR _{fish}	Ingestion rate of fish (kg/yr)	0.025				
F _{fish}	Contaminated fish fraction (unitless)	1				

Complete Exposure Pathways and Receptors	On-site	Off-site 1	Off-site 2
Groundwater:			
Groundwater Ingestion	None	None	None
Soil Leaching to Groundwater Ingestion	None	None	None
Applicable Surface Water Exposure Routes:			
Swimming			NA
Fish Consumption			NA
Aquatic Life Protection			NA
Soil:			
Direct Ingestion and Dermal Contact	Residential		
Outdoor Air:			
Particulates from Surface Soils	None	None	None
Volatilization from Soils	None	None	None
Volatilization from Groundwater	None	None	None
Indoor Air:			
Volatilization from Subsurface Soils	None	NA	NA
Volatilization from Groundwater	None	NA	NA

Receptor Distance from Source Media	On-site	Off-site 1	Off-site 2	(Units)
Groundwater receptor	NA	NA	NA	(m)
Soil leaching to groundwater receptor	NA	NA	NA	(m)
Outdoor air inhalation receptor	NA	NA	NA	(m)

Target Health Risk Values	Individual	Cumulative
TR _{ab} Target Risk (class A&B carcinogens)	1.0E-5	1.0E-5
TR _c Target Risk (class C carcinogens)	1.0E-5	
THQ Target Hazard Quotient (non-carcinogenic risk)	1.0E+0	1.0E+0

Modeling Options	
RBCA tier	Tier 2
Outdoor air volatilization model	NA
Indoor air volatilization model	NA
Soil leaching model	NA
Use soil attenuation model (SAM) for leachate?	NA
Air dilution factor	NA
Groundwater dilution-attenuation factor	NA

NOTE: NA = Not applicable

Surface Parameters	General	Construction	(Units)
A	Source zone area	NA	(m²)
W	Length of source-zone area parallel to wind	NA	(m)
W _{gw}	Length of source-zone area parallel to GW flow	NA	(m)
U _{air}	Ambient air velocity in mixing zone	NA	(m/s)
δ _{air}	Air mixing zone height	NA	(m)
P _a	Areal particulate emission rate	NA	(g/cm²/s)
L _{ss}	Thickness of affected surface soils	NA	(m)

Surface Soil Column Parameters		Value			(Units)
h_{cap}	Capillary zone thickness	NA			(m)
h_v	Vadose zone thickness	NA			(m)
ρ_s	Soil bulk density	NA			(g/cm ³)
f_{oc}	Fraction organic carbon	NA			(-)
θ_T	Soil total porosity	NA			(-)
K_{vs}	Vertical hydraulic conductivity	NA			(cm/d)
k_v	Vapor permeability	NA			(m ² /2)
L_{gw}	Depth to groundwater	NA			(m)
L_s	Depth to top of affected soils	NA			(m)
L_{base}	Depth to base of affected soils	NA			(m)
L_{subs}	Thickness of affected soils	NA			(m)
pH	Soil/groundwater pH	NA			(-)
		<u>capillary</u>	<u>vadose</u>	<u>foundation</u>	
θ_w	Volumetric water content	NA	NA	NA	(-)
θ_a	Volumetric air content	NA	NA	NA	(-)

Building Parameters	Residential	Commercial	(Units)
L _b	Building volume/area ratio	NA	(m)
A _b	Foundation area	NA	(m²)
X _{crk}	Foundation perimeter	NA	(m)
ER	Building air exchange rate	NA	(1/s)
L _{crk}	Foundation thickness	NA	(m)
Z _{crk}	Depth to bottom of foundation slab	NA	(m)
η	Foundation crack fraction	NA	(-)
dP	Indoor/outdoor differential pressure	NA	(g/cm/s²)
Q _s	Convective air flow through slab	NA	(m³/s)

Groundwater Parameters	Value	(Units)
δ _{gw}	Groundwater mixing zone depth	NA (m)
I _t	Net groundwater infiltration rate	NA (cm/yr)
U _{gw}	Groundwater Darcy velocity	NA (cm/d)
V _{gw}	Groundwater seepage velocity	NA (cm/d)
K _s	Saturated hydraulic conductivity	NA (cm/d)
i	Groundwater gradient	NA (-)
S _w	Width of groundwater source zone	NA (m)
S _d	Depth of groundwater source zone	NA (m)
θ _{eff}	Effective porosity in water-bearing unit	NA (-)
f _{oc-sat}	Fraction organic carbon in water-bearing unit	NA (-)
pH _{sat}	Groundwater pH	NA (-)
	Biodegradation considered?	NA

Transport Parameters	Off-site 1	Off-site 2	Off-site 1	Off-site 2	(Units)
Lateral Groundwater Transport					
α _x	Longitudinal dispersivity	NA	NA	NA	(m)
α _y	Transverse dispersivity	NA	NA	NA	(m)
α _z	Vertical dispersivity	NA	NA	NA	(m)
Lateral Outdoor Air Transport					
σ _y	Transverse dispersion coefficient	NA	NA	NA	(m)
σ _z	Vertical dispersion coefficient	NA	NA	NA	(m)
ADF	Air dispersion factor	NA	NA	NA	(-)

Surface Water Parameters	Off-site 2	(Units)
Q _{sw}	Surface water flowrate	NA (m³/s)
W _{pl}	Width of GW plume at SW discharge	NA (m)
δ _{pl}	Thickness of GW plume at SW discharge	NA (m)
DF _{sw}	Groundwater-to-surface water dilution factor	NA (-)

RBCA SITE ASSESSMENT

Site Name: Twynyrodyn

Completed By: RB

Job ID: 9913

Site Location: Merthyr Tydfil

Date Completed: 18.07.08

1 OF 1

SOIL (0 - 12 m) SSTL VALUES

Target Risk (Class A & B) 1.0E-5

Target Risk (Class C) 1.0E-5

Target Hazard Quotient 1.0E+0

Groundwater DAF Option:

SSTL Results For Complete Exposure Pathways ("X" if Complete)

CONSTITUENTS OF CONCERN			Representative Concentration	Soil Leaching to Groundwater Ingestion / Discharge to Surface Water			Soil Vol. to Indoor Air	Soil Volatilization and Surface Soil Particulates to Outdoor Air			X	Surface Soil Ingestion and Dermal Contact		Applicable SSTL	SSTL Exceeded ?	Required CRF
				On-site (0 m)	Off-site 1 (0 m)	Off-site 2 (0 m)	On-site (0 m)	On-site (0 m)		Off-site 1 (0 m)	Off-site 2 (0 m)	On-site (0 m)				
CAS No.	Name		(mg/kg)	None	None	None	None	None	Construction Worker	None	None	Residential	Construction Worker	(mg/kg)	■ if yes	Only if "yes" left
7440-38-2	Arsenic*			NA	NA	NA	NA	NA	NA	NA	NA	1.8E+2	NA	1.8E+2	□	NA
7440-02-0	Nickel*			NA	NA	NA	NA	NA	NA	NA	NA	6.2E+2	NA	6.2E+2	□	NA

* = Chemical with user-specified data

">" indicates risk-based target concentration greater than constituent residual saturation value. NA = Not applicable. NC = Not calculated.

Exposure Pathway Flowchart

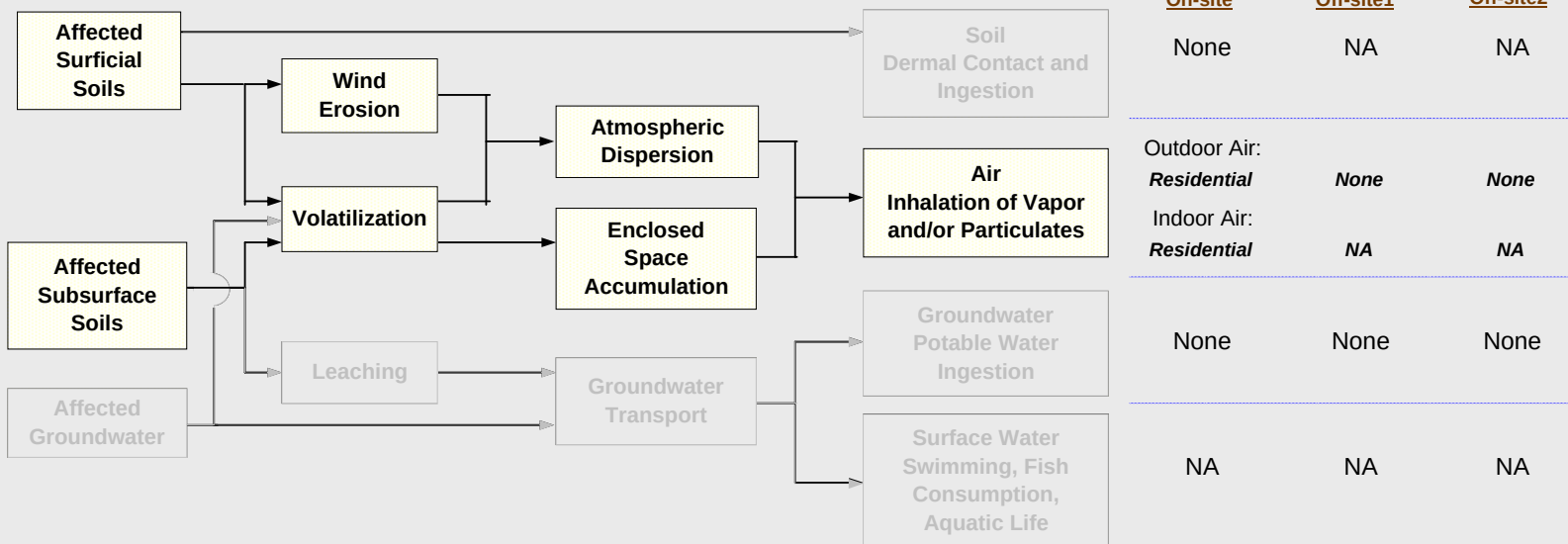
Site Name: Twynyrodyn Job ID: 9913
 Location: Merthyr Tydfil Date: 18.07.08
 Compl. By: RB

Source Media

Transport Mechanisms

Exposure Media

Receptors



On-site **Off-site1** **Off-site2**

None NA NA

Outdoor Air:
Residential None None

Indoor Air:
Residential NA NA

None None None

NA NA NA

SOURCE

TRANSPORT

RECEPTOR

Commands and Options

Main Screen

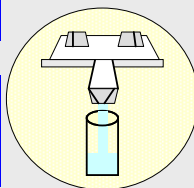
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Help

Exposure Factors and Target Risk Limits

1. Exposure Parameters

	<i>Residential</i>			<i>Commercial</i>		
	Age Adjustment?	Adult	(Age 0-6)	(Age 0-16)	Chronic	Construc.
Averaging time, carcinogens (yr)		6				
Averaging time, non-carcinogens (yr)		6			25	1
Body weight (kg)		13.5	13.5	13.5	70	
Exposure duration (yr)		6	6	6	25	1
Exposure frequency (days/yr)		365			250	180
Dermal exposure frequency (days/yr)		365			250	
Skin surface area, soil contact (cm ²)	☒	706		706	5800	5800
Soil dermal adherence factor (mg/cm ² /day)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☒	100	100		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☐	0.05	0.5			
Skin surface area, swimming (cm ²)	☐	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				



Site Name: Twynyrodyn

Location: Merthyr Tydfil

Compl. By: RB

Job ID: 9913

Date: 18.07.08

2. Risk Goal Calculation Options

- ☐ Individual Constituent Risk Goals Only
☒ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcin.)	1.0E-5	1.0E-5
Target Risk (Class C carcinogens)	1.0E-5	
Target Hazard Quotient	1.0E+0	
Target Hazard Index		1.0E+0

4. Commands and Options

[Return to Exposure Pathways](#)
[Use Default Values](#)
[Print Sheet](#)
[Help](#)

Site-Specific Soil Parameters

1. Soil Source Zone Characteristics

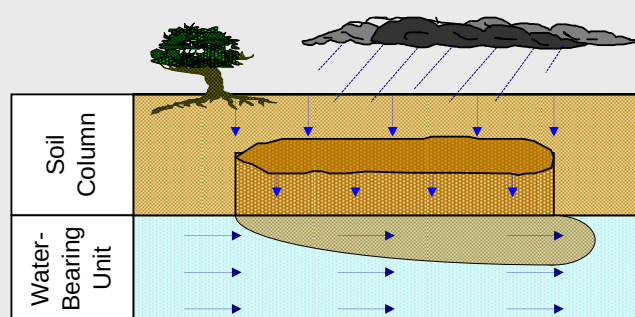
Hydrogeology

General Case Construction

Depth to water-bearing unit (m)
 Capillary zone thickness (m)
 Soil column thickness (m)

Affected Soil Zone

Depth to top of affected soils (m)
 Depth to base of affected soils (m)
 Affected soil area (m²)
 Length of affected soil parallel to
 assumed wind direction (m)
 Length of affected soil parallel to
 assumed GW flow direction (m)



Site Name: Twynyrodyn

Job ID: 9913

Location: Merthyr Tydfil

Date: 18.07.08

Compl. By: RB

2. Surface Soil Column

Vadose Zone Capillary Fringe

Predominant USCS Soil Type

or

Calculate

Total porosity (-)
 Volumetric water content (-)
 Volumetric air content (-)
 Dry bulk density (kg/L)
 Vertical hydraulic conductivity (cm/d)
 Vapor permeability (m²)
 Capillary zone thickness (m)

Net Rainfall Infiltration

Net infiltration estimate (cm/yr)

or

NA

↑ or

Average annual precipitation (cm/yr)

Partitioning Parameters

Fraction organic carbon (-)
 Soil/water pH (-)

3. Commands and Options

Main Screen

Use Default
Values

Print Sheet

Set Units

Help

Site-Specific Air Parameters

1. Outdoor Air Pathway

Dispersion in Air

Distance to offsite air receptor

or

NA

Off-site 1 Off-site 2 (m)

Horizontal dispersivity

Vertical dispersivity

Air Source Zone

Air mixing zone height

0.93 (m)

Ambient air velocity in mixing zone

3 (m/s)

Areal particulate emission flux

6.9E-14 (g/cm²/s)

2. Indoor Air Pathway

Building Parameters

Building volume/area ratio

Residential 2 Commercial 3 (m)

Foundation area

74.1 70 (m²)

Foundation perimeter

34.4 34 (m)

Building air exchange rate

1.4E-4 2.3E-4 (1/s)

Depth to bottom of foundation slab

0.15 0.15 (m)

Convective air flow through cracks

0.0E+0 0.0E+0 (m³/s)

Foundation thickness

0.15 (m)

Foundation crack fraction

0.01 (-)

Volumetric water content of cracks

0.12 (-)

Volumetric air content of cracks

0.26 (-)

Indoor/Outdoor differential pressure

0 (g/cm/s²)

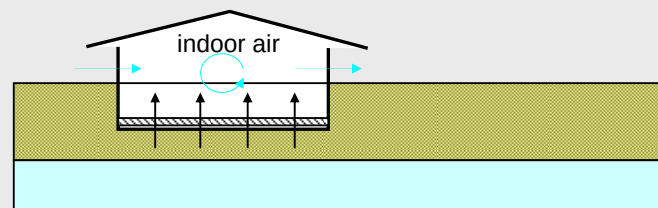
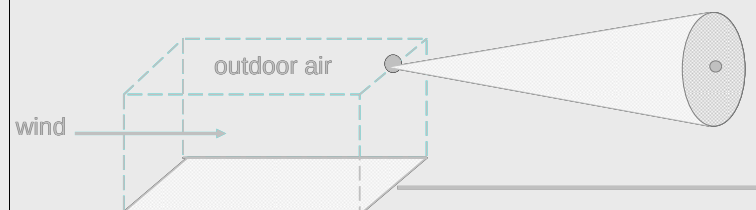
Site Name: Twynyrodyn

Job ID: 9913

Location: Merthyr Tydfil

Date: 18.07.08

Compl. By: RB



3. Commands and Options

Main Screen

Use Default
Values

Print Sheet

Set Units

Help

RBCA SITE ASSESSMENT

Input Parameter Summary

Site Name: Twynyrodyn
Site Location: Merthyr Tydfil

Completed By: RB
Date Completed: 18.07.08

Job ID: 9913

1 OF 1

Exposure Parameters		Residential			Commercial/Industrial	
		Adult	(1-6yrs)	(1-16 yrs)	Chronic	Construc.
AT _c	Averaging time for carcinogens (yr)	6				
AT _n	Averaging time for non-carcinogens (yr)	6			25	1
BW	Body weight (kg)	13.5	13.5	13.5	70	
ED	Exposure duration (yr)	6	6	6	25	1
τ	Averaging time for vapor flux (yr)	6			25	1
EF	Exposure frequency (days/yr)	365			250	180
EF _D	Exposure frequency for dermal exposure	365			250	
IR _w	Ingestion rate of water (L/day)	2			1	
IR _s	Ingestion rate of soil (mg/day)	100	100		50	100
SA	Skin surface area (dermal) (cm²)	706		706	5800	5800
M	Soil to skin adherence factor	1				
ET _{swim}	Swimming exposure time (hr/event)	3				
EV _{swim}	Swimming event frequency (events/yr)	12	12	12		
IR _{swim}	Water ingestion while swimming (L/hr)	0.05	0.5			
SA _{swim}	Skin surface area for swimming (cm²)	23000		8100		
IR _{fish}	Ingestion rate of fish (kg/yr)	0.025				
F _{fish}	Contaminated fish fraction (unitless)	1				

Complete Exposure Pathways and Receptors	On-site	Off-site 1	Off-site 2
Groundwater:			
Groundwater Ingestion	None	None	None
Soil Leaching to Groundwater Ingestion	None	None	None
Applicable Surface Water Exposure Routes:			
Swimming			NA
Fish Consumption			NA
Aquatic Life Protection			NA
Soil:			
Direct Ingestion and Dermal Contact	None		
Outdoor Air:			
Particulates from Surface Soils	Residential	None	None
Volatilization from Soils	Residential	None	None
Volatilization from Groundwater	None	None	None
Indoor Air:			
Volatilization from Subsurface Soils	Residential	NA	NA
Volatilization from Groundwater	None	NA	NA

Receptor Distance from Source Media	On-site	Off-site 1	Off-site 2	(Units)
Groundwater receptor	NA	NA	NA	(m)
Soil leaching to groundwater receptor	NA	NA	NA	(m)
Outdoor air inhalation receptor	0	NA	NA	(m)

Target Health Risk Values	Individual	Cumulative
TR _{ab} Target Risk (class A&B carcinogens)	1.0E-5	1.0E-5
TR _c Target Risk (class C carcinogens)	1.0E-5	
THQ Target Hazard Quotient (non-carcinogenic risk)	1.0E+0	1.0E+0

Modeling Options	
RBCA tier	Tier 2
Outdoor air volatilization model	Surface & subsurface models
Indoor air volatilization model	Johnson & Ettinger model
Soil leaching model	NA
Use soil attenuation model (SAM) for leachate?	NA
Air dilution factor	NA
Groundwater dilution-attenuation factor	NA

NOTE: NA = Not applicable

Surface Parameters	General	Construction	(Units)
A Source zone area	5.6E+4	NA	(m²)
W Length of source-zone area parallel to wind	2.0E+2	NA	(m)
W _{gw} Length of source-zone area parallel to GW flow	NA		(m)
U _{air} Ambient air velocity in mixing zone	3.0E+0		(m/s)
δ _{air} Air mixing zone height	9.3E-1		(m)
P _a Areal particulate emission rate	6.9E-14		(g/cm²2/s)
L _{ss} Thickness of affected surface soils	1.0E+0		(m)

Surface Soil Column Parameters		Value			(Units)
h_{cap}	Capillary zone thickness	NA			(m)
h_v	Vadose zone thickness	NA			(m)
ρ_s	Soil bulk density	1.6E+0			(g/cm ³)
f_{oc}	Fraction organic carbon	1.0E-2			(-)
θ_T	Soil total porosity	4.6E-1			(-)
K_{vs}	Vertical hydraulic conductivity	8.6E+2			(cm/d)
k_v	Vapor permeability	1.0E-12			(m ² /s)
L_{gw}	Depth to groundwater	NA			(m)
L_s	Depth to top of affected soils	0.0E+0			(m)
L_{base}	Depth to base of affected soils	1.2E+1			(m)
L_{subs}	Thickness of affected soils	1.2E+1			(m)
pH	Soil/groundwater pH	7.5E+0			(-)
		<u>capillary</u>	<u>vadose</u>	<u>foundation</u>	
θ_w	Volumetric water content	0.369	0.15	0.12	(-)
θ_a	Volumetric air content	0.091	0.31	0.26	(-)

Building Parameters	Residential	Commercial	(Units)
L _b Building volume/area ratio	2.00E+0	NA	(m)
A _b Foundation area	7.41E+1	NA	(m²2)
X _{crk} Foundation perimeter	3.44E+1	NA	(m)
ER Building air exchange rate	1.40E-4	NA	(1/s)
L _{crk} Foundation thickness	1.50E-1	NA	(m)
Z _{crk} Depth to bottom of foundation slab	1.50E-1	NA	(m)
η Foundation crack fraction	1.00E-2	NA	(-)
dP Indoor/outdoor differential pressure	0.00E+0	NA	(g/cm/s²2)
Q _s Convective air flow through slab	0.00E+0	NA	(m³3/s)

Groundwater Parameters	Value	(Units)
δ _{gw} Groundwater mixing zone depth	NA	(m)
I _t Net groundwater infiltration rate	NA	(cm/yr)
U _{gw} Groundwater Darcy velocity	NA	(cm/d)
V _{gw} Groundwater seepage velocity	NA	(cm/d)
K _s Saturated hydraulic conductivity	NA	(cm/d)
i Groundwater gradient	NA	(-)
S _w Width of groundwater source zone	NA	(m)
S _d Depth of groundwater source zone	NA	(m)
θ _{eff} Effective porosity in water-bearing unit	NA	(-)
f _{oc-sat} Fraction organic carbon in water-bearing unit	NA	(-)
pH _{sat} Groundwater pH	NA	(-)
Biodegradation considered?	NA	

Transport Parameters	Off-site 1	Off-site 2	Off-site 1	Off-site 2	(Units)
Lateral Groundwater Transport					
α _x Longitudinal dispersivity	NA	NA	NA	NA	(m)
α _y Transverse dispersivity	NA	NA	NA	NA	(m)
α _z Vertical dispersivity	NA	NA	NA	NA	(m)
Lateral Outdoor Air Transport					
σ _y Transverse dispersion coefficient	NA	NA	NA	NA	(m)
σ _z Vertical dispersion coefficient	NA	NA	NA	NA	(m)
ADF Air dispersion factor	NA	NA	NA	NA	(-)

Surface Water Parameters	Off-site 2	(Units)
Q _{sw} Surface water flowrate	NA	(m³3/s)
W _{pl} Width of GW plume at SW discharge	NA	(m)
δ _{pl} Thickness of GW plume at SW discharge	NA	(m)
DF _{sw} Groundwater-to-surface water dilution factor	NA	(-)

RBCA SITE ASSESSMENT

Site Name: Twynyrodyn

Completed By: RB

Job ID: 9913

Site Location: Merthyr Tydfil

Date Completed: 18.07.08

1 OF 1

SOIL (0 - 12 m) SSTL VALUES

Target Risk (Class A & B) 1.0E-5

Target Risk (Class C) 1.0E-5

Target Hazard Quotient 1.0E+0

Groundwater DAF Option:

SSTL Results For Complete Exposure Pathways ("X" if Complete)

CONSTITUENTS OF CONCERN			Representative Concentration	Soil Leaching to Groundwater Ingestion / Discharge to Surface Water			X	Soil Vol. to Indoor Air	X	Soil Volatilization and Surface Soil Particulates to Outdoor Air			Surface Soil Inhalation, Ingestion, Dermal Contact		Applicable SSTL	SSTL Exceeded ?	Required CRF
				On-site (0 m)	Off-site 1 (0 m)	Off-site 2 (0 m)	On-site (0 m)	On-site (0 m)		Off-site 1 (0 m)	Off-site 2 (0 m)	On-site (0 m)					
				None	None	None	Residential	Residential	Construction Worker	None	None	None	Construction Worker	(mg/kg)			
CAS No.	Name	(mg/kg)	NA	NA	NA	>1.3E+7	4.7E+4	NA	NA	NA	NA	NA	NA	4.7E+4	□	NA	
7440-38-2	Arsenic*		NA	NA	NA	>1.3E+7	4.7E+4	NA	NA	NA	NA	NA	NA	4.7E+4	□	NA	
7440-02-0	Nickel*		NA	NA	NA	>6.4E+7	4.2E+5	NA	NA	NA	NA	NA	NA	4.2E+5	□	NA	

* = Chemical with user-specified data

">" indicates risk-based target concentration greater than constituent residual saturation value. NA = Not applicable. NC = Not calculated.

APPENDIX Q

GROUNDWATER RISK ASSESSMENT – P20 MODEL SHEETS



R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Date of Workbook Issue: April 2002

This worksheet has been produced in combination with the document 'Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources' - Environment Agency R&D Publication 20, (1999).

Users of this worksheet should always refer to the User Manual, to R&D Publication 20 and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error fun

Details to be completed for each assessment			
Site Name:	Twynyrodyn		
Site Address:	Mountain Hare, Merthyr Tydfil		
Completed by:	GNS		
Date:	07-Aug-08	Version:	x.xx
Contaminant	Cadmium		
Target Concentration (C_T)	5.00E-03 mg/l	Origin of C_T:	UK EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Tier 1 Soil, Tier 2 Soil and Tier 3 Soil) or to determine remedial targets for groundwater (Tier 3 Groundwater). For Tier 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Tier 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menu or require a "0", "1" or "2" to be entered. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The worksheet also calculates a number of frequently used hydrogeological equations.

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu)

Contaminant	Cadmium
Target Concentration	C _T 5.00E-03 mg/l

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

1

Enter '1' if biodegradation rate is for the substance in water,

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

1

Initial contaminant concentration in groundwater at plume core	C ₀	6.40E-03	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	9.00E+99	days	Site specific Data - R14
Calculated decay rate	λ	7.70E-101	days ⁻¹	Physical and chemical properties data sheet
Width of plume in aquifer at source (perpendicular to flow)	SZ	2.00E+02	m	Dispersivity
Plume thickness at source	Sy	2.80E+00	m	Calculate dependant on distance to compliance point (0)
Saturated aquifer thickness	da	3.00E+00	m	specify dispersivity (1), or calc after Xu & Eckstein (2) ?
Bulk density of aquifer materials	ρ	2.40E+00	g/cm ³	Enter value Calc value Xu & Eckstein
Effective porosity of aquifer	n	3.00E-01	fraction	ax 0.00E+00 1.75E+01 5.83E-01 m
Hydraulic gradient	i	3.00E-03	fraction	az 0.00E+00 1.75E+00 5.83E-01 m
Hydraulic conductivity of aquifer	K	1.00E-01	m/d	ay 0.00E+00 1.75E-01 5.83E-02 m
Distance to compliance point	x	1.75E+02	m	Longitudinal dispersivity
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	Transverse dispersivity
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	Vertical dispersivity
Time since pollutant entered groundwater	t	9.90E+99	days	For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Parameters values determined from options			
Partition coefficient	Kd	7.50E+01	l/kg
Longitudinal dispersivity	ax	17.500	m
Transverse dispersivity	az	1.750	m
Vertical dispersivity	ay	0.175	m

Calculated Parameters

Groundwater flow velocity	v	1.00E-03	m/d
Retardation factor	Rf	6.01E+02	fraction
Decay rate used	λ	1.28E-103	d ⁻¹
Rate of contaminant flow due to retardation	u	1.66E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.79E-03	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	9.09E-04	mg/l
Attenuation factor (one way vertical dispersion, Q ² C _{ED})	AF	3.58E+00	
Attenuation factor (two way vertical dispersion, Q ² C _{ED})	AF	7.04E+00	

Remedial Targets

Remedial Target	LTC3	1.79E-02	mg/l
Ogata Banks			

For comparison with measured groundwater concentration.

Distance to compliance point 175 m

Concentration of contaminant at compliance point C_{ED}/C₀ 1.79E-03 mg/l Ogata Banks
after 9.9E+99 daysCare should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)	Kd	7.50E+01	l/kg
Soil water partition coefficient			
Entry for non-polar organic chemicals (option)	foc		fraction
Fraction of organic carbon in aquifer			
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)	K _{oc,0}		l/kg
Sorption coefficient for related species	K _{oc,i}		l/kg
Sorption coefficient for ionised species	pH		
pH value	pKa		
acid dissociation constant			

Soil water partition coefficient

Physical and chemical properties data sheet

Dispersivity

Calculate dependant on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity

Transverse dispersivity

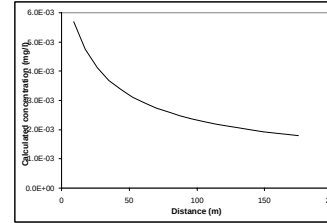
Vertical dispersivity

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.44}; az = ax/10, ay = ax/100 are assumed

No offset

time variant options only



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Tier 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

mg/l	
8.8	5.7E-03
17.5	4.7E-03
26.3	4.1E-03
35.0	3.7E-03
43.8	3.4E-03
52.5	3.1E-03
61.3	2.9E-03
70.0	2.7E-03
78.8	2.6E-03
87.5	2.5E-03
96.3	2.4E-03
105.0	2.3E-03
113.8	2.2E-03
122.5	2.1E-03
131.3	2.1E-03
140.0	2.0E-03
148.8	1.9E-03
157.5	1.9E-03
166.3	1.8E-03
175.0	1.8E-03

Site being assessed: Twynhydym
Completed by: GNS
Date: #####
Version: x.xx



R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Date of Workbook Issue: April 2002

This worksheet has been produced in combination with the document 'Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources' - Environment Agency R&D Publication 20, (1999).

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error fun

<u>Details to be completed for each assessment</u>			
Site Name:	Twynyrodyn		
Site Address:	Mountain Hare, Merthyr Tydfil		
Completed by:	RB	Version:	x.xx
Date:	20.08.08		
Contaminant	Zinc		
Target Concentration (C_T)	7.50E-02 mg/l	Origin of C_T:	UK EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Tier 1 Soil, Tier 2 Soil and Tier 3 Soil) or to determine remedial targets for groundwater (Tier 3 Groundwater). For Tier 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Tier 1, 2 and 3 Worksheets.

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Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The worksheet also calculates a number of frequently used hydrogeological equations.

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu)

Contaminant	Zinc
Target Concentration	C _T 7.50E-02 mg/l

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

1

Enter '1' if biodegradation rate is for the substance in water,

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

1

Initial contaminant concentration in groundwater at plume core	C ₀	6.90E-01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	9.00E+99	days	Site specific Data - R14
Calculated decay rate	λ	7.70E-101	days ⁻¹	Physical and chemical properties data sheet
Width of plume in aquifer at source (perpendicular to flow)	SZ	2.00E+02	m	Dispersivity
Plume thickness at source	Sy	2.80E+00	m	Calculate dependant on distance to compliance point (0)
Saturated aquifer thickness	da	3.00E+00	m	specify dispersivity (1), or calc after Xu & Eckstein (2) ?
Bulk density of aquifer materials	ρ	2.40E+00	g/cm ³	Enter value Calc value Xu & Eckstein
Effective porosity of aquifer	n	3.00E-01	fraction	ax 0.00E+00 1.75E+01 5.83E-01 m
Hydraulic gradient	i	3.00E-03	fraction	az 0.00E+00 1.75E+00 5.83E-01 m
Hydraulic conductivity of aquifer	K	1.00E-01	m/d	ay 0.00E+00 1.75E-01 5.83E-02 m
Distance to compliance point	x	1.75E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	

Parameters values determined from options			
Partition coefficient	Kd	6.20E+01	l/kg see options
Longitudinal dispersivity	ax	17.500	m see options
Transverse dispersivity	az	1.750	m see options
Vertical dispersivity	ay	0.175	m see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.00E-03	m/d
Retardation factor	Rf	4.97E+02	fraction
Decay rate used	λ	1.55E-103	d ⁻¹
Rate of contaminant flow due to retardation	u	2.01E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.93E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	9.80E-02	mg/l
Attenuation factor (one way vertical dispersion, Q ² C _{ED})	AF	3.58E+00	
Attenuation factor (two way vertical dispersion, Q ² C _{ED})	AF	7.04E+00	

Remedial Targets

Remedial Target	LTC3	2.68E-01	mg/l
Ogata Banks			

For comparison with measured groundwater concentration.

Distance to compliance point 175 m

Concentration of contaminant at compliance point C_{ED}/C₀ 1.93E-01 mg/l Ogata Banks
after 9.9E+99 days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)	Kd	6.20E+01	l/kg
Soil water partition coefficient			
Entry for non-polar organic chemicals (option)	foc		fraction
Fraction of organic carbon in aquifer			
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)	K _{oc,0}		l/kg
Sorption coefficient for related species	K _{oc,i}		l/kg
Sorption coefficient for ionised species	pH		
pH value	pKa		
acid dissociation constant			

Soil water partition coefficient	Kd	6.20E+01	l/kg
----------------------------------	----	----------	------

Dispersivity

Calculate dependant on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity ax

Transverse dispersivity az

Vertical dispersivity ay

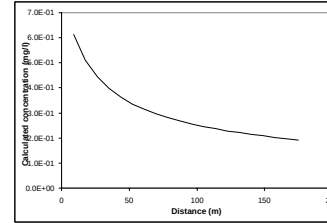
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Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.44}; az = ax/10, ay = ax/100 are assumed

No offset

No offset

time variant options only



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Tier 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

Site being assessed: Twynrodyn
Completed by: RB
Date: 20.08.08
Version: x.xx



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
8.8	6.1E-01
17.5	5.1E-01
26.3	4.4E-01
35.0	4.0E-01
43.8	3.6E-01
52.5	3.4E-01
61.3	3.1E-01
70.0	3.0E-01
78.8	2.8E-01
87.5	2.7E-01
96.3	2.6E-01
105.0	2.5E-01
113.8	2.4E-01
122.5	2.3E-01
131.3	2.2E-01
140.0	2.1E-01
148.8	2.1E-01
157.5	2.0E-01
166.3	2.0E-01
175.0	1.9E-01



R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Date of Workbook Issue: April 2002

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error fun

Details to be completed for each assessment			
Site Name:	Twynyrodyn		
Site Address:	Mountain Hare, Merthyr Tydfil		
Completed by:	RB		
Date:	20.08.08	Version:	x.xx
Contaminant	TPH C16-C35 Aliphatic		
Target Concentration (C_T)	1.00E-02 mg/l	Origin of C_T:	UK EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Tier 1 Soil, Tier 2 Soil and Tier 3 Soil) or to determine remedial targets for groundwater (Tier 3 Groundwater). For Tier 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Tier 1, 2 and 3 Worksheets.

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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The worksheet also calculates a number of frequently used hydrogeological equations.

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu)

Contaminant	TPH C16-C35 Aliphatic
Target Concentration	C _T 1.00E-02 mg/l

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

1

Enter '1' if biodegradation rate is for the substance in water,

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

1

Initial contaminant concentration in groundwater at plume core	C ₀	2.91E-01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	5.00E+02	days	Site specific Data - R14
Calculated decay rate	λ	1.39E-03	days ⁻¹	Physical and chemical properties data sheet
Width of plume in aquifer at source (perpendicular to flow)	SZ	2.00E+02	m	Dispersivity
Plume thickness at source	Sy	2.80E+00	m	Site width
Saturated aquifer thickness	da	3.00E+00	m	Full mixing in aquifer assumed
Bulk density of aquifer materials	p	2.40E+00	g/cm ³	Mask known thickness
Effective porosity of aquifer	n	3.00E-01	fraction	Assumed
Hydraulic gradient	i	3.00E-03	fraction	Worst case
Hydraulic conductivity of aquifer	K	1.00E-01	m/d	Measured from site data
Distance to compliance point	x	1.75E+02	m	Estimate
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	Measured from R14 to boundary
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	No offset
Time since pollutant entered groundwater	t	9.90E+99	days	No offset
Parameters values determined from options				time variant options only
Partition coefficient	Kd	3.15E+06	l/kg	see options
Longitudinal dispersivity	ax	17.500	m	see options
Transverse dispersivity	ay	1.750	m	see options
Vertical dispersivity	ay	0.175	m	see options

Calculated Parameters

Groundwater flow velocity	v	1.00E-03	m/d
Retardation factor	Rf	2.52E+07	fraction
Decay rate used	λ	5.49E-11	d ⁻¹
Rate of contaminant flow due to retardation	u	3.96E-11	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ed}	3.81E-21	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ed}	1.93E-21	mg/l
Attenuation factor (one way vertical dispersion, Q ² C _{ed})	AF	7.65E+19	
Attenuation factor (two way vertical dispersion, Q ² C _{ed})	AF	1.51E+20	

Remedial Targets

Remedial Target	LTC3	7.65E+17	mg/l
Ogata Banks			

For comparison with measured groundwater concentration.

Distance to compliance point	175	m
Concentration of contaminant at compliance point	C _{ed} /C ₀	3.81E-21
after		9.9E+99
		days

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient

Kd 1/kg

Fraction of organic carbon in aquifer

foc 5.00E-03 fraction

Organic carbon partition coefficient

Koc 6.31E+08 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species

K_{oc,r} 1/kg

Sorption coefficient for ionised species

K_{oc,i} 1/kg

pH value

pH 1/kg

acid dissociation constant

pKa 1/kg

Soil water partition coefficient

Kd 3.15E+06 l/kg

Physical and chemical properties data sheet

Dispersivity

Calculate dependant on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity

ax 1.75E+01 m

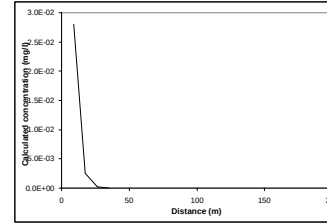
Transverse dispersivity

az 0.00E+00 m

Vertical dispersivity

ay 1.75E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.44}; az = ax/10, ay = ax/100 are assumed

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Tier 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

8.8	2.8E-02
17.5	2.5E-03
26.3	2.4E-04
35.0	2.3E-05
43.8	2.3E-06
52.5	2.2E-07
61.3	2.3E-08
70.0	2.3E-09
78.8	2.4E-10
87.5	2.4E-11
96.3	2.5E-12
105.0	2.6E-13
113.8	2.7E-14
122.5	2.8E-15
131.3	3.0E-16
140.0	3.1E-17
148.8	3.3E-18
157.5	3.4E-19
166.3	3.6E-20
175.0	3.8E-21

Site being assessed: Twynrodyn
Completed by: RB
Date: 20.08.08
Version: x.xx



R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Date of Workbook Issue: April 2002

This worksheet has been produced in combination with the document 'Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources' - Environment Agency R&D Publication 20, (1999).

Users of this worksheet should always refer to the User Manual, to R&D Publication 20 and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error fun

Details to be completed for each assessment			
Site Name:	Twynyrodyn		
Site Address:	Mountain Hare, Merthyr Tydfil		
Completed by:	RB		
Date:	20.08.08	Version:	x.xx
Contaminant	TPH C35-C44 Aliphatic		
Target Concentration (C_T)	1.00E-02 mg/l	Origin of C_T:	UK EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Tier 1 Soil, Tier 2 Soil and Tier 3 Soil) or to determine remedial targets for groundwater (Tier 3 Groundwater). For Tier 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Tier 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menu or require a "0", "1" or "2" to be entered. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The worksheet also calculates a number of frequently used hydrogeological equations.

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu)

Contaminant	TPH C35-C44 Aliphatic
Target Concentration	C _T 1.00E-02 mg/l

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

1

Enter '1' if biodegradation rate is for the substance in water,

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

1

Initial contaminant concentration in groundwater at plume core	C ₀	6.50E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	5.00E+02	days	Site specific Data - R14
Calculated decay rate	λ	1.39E-03	days ⁻¹	Physical and chemical properties data sheet
Width of plume in aquifer at source (perpendicular to flow)	SZ	2.00E+02	m	Dispersivity
Plume thickness at source	Sy	2.80E+00	m	Calculate dependant on distance to compliance point (0)
Saturated aquifer thickness	da	3.00E+00	m	specify dispersivity (1), or calc after Xu & Eckstein (2) ?
Bulk density of aquifer materials	p	2.40E+00	g/cm ³	Enter value Calc value Xu & Eckstein
Effective porosity of aquifer	n	3.00E-01	fraction	ax 0.00E+00 1.75E+01 5.83E-01 m
Hydraulic gradient	i	3.00E-03	fraction	az 0.00E+00 1.75E+00 5.83E-01 m
Hydraulic conductivity of aquifer	K	1.00E-01	m/d	ay 0.00E+00 1.75E-01 5.83E-02 m
Distance to compliance point	x	1.75E+02	m	For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	Xu & Eckstein (1995) report ax = 0.83(log ax) ^{2.44} ; az = ax/10, ay = ax/100 are assumed
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	No offset
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	3.15E+06	l/kg	see options
Longitudinal dispersivity	ax	17.500	m	see options
Transverse dispersivity	az	1.750	m	see options
Vertical dispersivity	ay	0.175	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.00E-03	m/d
Retardation factor	Rf	2.52E+07	fraction
Decay rate used	λ	5.49E-11	d ⁻¹
Rate of contaminant flow due to retardation	u	3.96E-11	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ed}	8.50E-22	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ed}	4.32E-22	mg/l
Attenuation factor (one way vertical dispersion, Q ² C _{ed})	AF	7.65E+19	
Attenuation factor (two way vertical dispersion, Q ² C _{ed})	AF	1.51E+20	

Remedial Targets

Remedial Target	LTC3	7.65E+17	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		175	m	
Concentration of contaminant at compliance point	C _{ed} /C ₀	8.50E-22	mg/l	Ogata Banks
after		9.9E+99	days	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	Kd	l/kg
Soil water partition coefficient	K _{oc}	l/kg
Entry for non-polar organic chemicals (option)	f _{oc}	fraction
Fraction of organic carbon in aquifer	K _{oc}	l/kg
Organic carbon partition coefficient	K _{oc}	l/kg
Entry for ionic organic chemicals (option)	K _{ow}	l/kg
Sorption coefficient for related species	K _{ow}	l/kg
Sorption coefficient for ionised species	pH	l/kg
pH value	pKa	l/kg
acid dissociation constant		

Soil water partition coefficient	Kd	3.15E+06	l/kg
----------------------------------	----	----------	------

Dispersivity			
--------------	--	--	--

Calculate dependant on distance to compliance point (0)			
---	--	--	--

specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
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Longitudinal dispersivity	ax		
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Transverse dispersivity	az		
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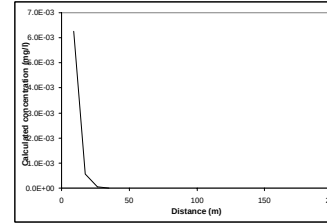
Vertical dispersivity	ay		
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For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
---	--	--	--

Xu & Eckstein (1995) report ax = 0.83(log ax) ^{2.44} ; az = ax/10, ay = ax/100 are assumed			
---	--	--	--

No offset			
-----------	--	--	--

time variant options only			
---------------------------	--	--	--



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

Distance	Concentration
mg/l	
8.8	6.3E-03
17.5	5.6E-04
26.3	5.3E-05
35.0	5.1E-06
43.8	5.0E-07
52.5	5.0E-08
61.3	5.1E-09
70.0	5.2E-10
78.8	5.3E-11
87.5	5.4E-12
96.3	5.6E-13
105.0	5.8E-14
113.8	6.1E-15
122.5	6.3E-16
131.3	6.6E-17
140.0	6.9E-18
148.8	7.3E-19
157.5	7.7E-20
166.3	8.1E-21
175.0	8.5E-22

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.
By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Tier 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

Site being assessed: Twynrodyn
Completed by: RB
Date: 20.08.08
Version: x.xx



R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Date of Workbook Issue: April 2002

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error fun

Details to be completed for each assessment			
Site Name:	Twynyrodyn		
Site Address:	Mountain Hare, Merthyr Tydfil		
Completed by:	RB		
Date:	20.08.08	Version:	x.xx
Contaminant	TPH C16-C21 Aromatic		
Target Concentration (C_T)	1.00E-02 mg/l	Origin of C_T:	UK EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Tier 1 Soil, Tier 2 Soil and Tier 3 Soil) or to determine remedial targets for groundwater (Tier 3 Groundwater). For Tier 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Tier 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menu or require a "0", "1" or "2" to be entered. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The worksheet also calculates a number of frequently used hydrogeological equations.

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu)

Contaminant	TPH C16-C21 Aromatic
Target Concentration	C _T 1.00E-02 mg/l

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

1

Enter '1' if biodegradation rate is for the substance in water,

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

1

Initial contaminant concentration in groundwater at plume core	C ₀	1.30E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	5.00E+02	days	Site specific Data - R14
Calculated decay rate	λ	1.39E-03	days ⁻¹	Physical and chemical properties data sheet
Width of plume in aquifer at source (perpendicular to flow)	SZ	2.00E+02	m	Dispersivity
Plume thickness at source	Sy	2.80E+00	m	Site width
Saturated aquifer thickness	da	3.00E+00	m	Full mixing in aquifer assumed
Bulk density of aquifer materials	ρ	2.40E+00	g/cm ³	Max known thickness
Effective porosity of aquifer	n	3.00E-01	fraction	Assumed
Hydraulic gradient	i	3.00E-03	fraction	Worst case
Hydraulic conductivity of aquifer	K	1.00E-01	m/d	Measured from site data
Distance to compliance point	x	1.75E+02	m	Estimate
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	Measured from R14 to boundary
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	No offset
Time since pollutant entered groundwater	t	9.90E+99	days	No offset
Parameters values determined from options				time variant options only
Partition coefficient	Kd	7.92E+01	l/kg	see options
Longitudinal dispersivity	α _x	17.500	m	see options
Transverse dispersivity	α _z	1.750	m	see options
Vertical dispersivity	α _y	0.175	m	see options

Calculated Parameters

Groundwater flow velocity	v	1.00E-03	m/d
Retardation factor	Rf	6.35E+02	fraction
Decay rate used	λ	2.18E-06	d ⁻¹
Rate of contaminant flow due to retardation	u	1.57E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ed}	1.70E-22	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ed}	8.63E-23	mg/l
Attenuation factor (one way vertical dispersion, Q ² C _{ed})	AF	7.65E+19	
Attenuation factor (two way vertical dispersion, Q ² C _{ed})	AF	1.51E+20	

Remedial Targets

Remedial Target	LTC3	7.65E+17	mg/l
Ogata Banks			

For comparison with measured groundwater concentration.

Distance to compliance point	175	m
Concentration of contaminant at compliance point	C _{ed} /C ₀	1.70E-22
after		9.9E+99
		days

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	Kd		l/kg
Soil water partition coefficient	K _{oc}	5.00E-03	fraction
Entry for non-polar organic chemicals (option)	f _{oc}	1.58E+04	l/kg
Fraction of organic carbon in aquifer	K _{oc}		l/kg
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)	K _{oc,0}		l/kg
Sorption coefficient for related species	K _{oc,i}		l/kg
Sorption coefficient for ionised species	pH		
pH value	pKa		
acid dissociation constant			

Soil water partition coefficient

Physical and chemical properties data sheet

Dispersivity

Calculate dependant on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity

Transverse dispersivity

Vertical dispersivity

For calculated value, assumes α_x = 0.1 * x, α_z = 0.01 * x, α_y = 0.001 * xXu & Eckstein (1995) report α_x = 0.83(log α_x)^{2.44}; α_z = α_x/10, α_y = α_x/100 are assumed

No offset

No offset

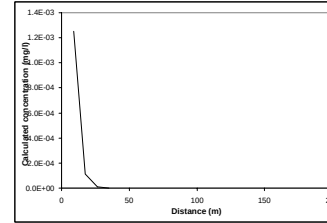
time variant options only

see options

see options

see options

see options



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
8.8	1.3E-03
17.5	1.1E-04
26.3	1.1E-05
35.0	1.0E-06
43.8	1.0E-07
52.5	1.0E-08
61.3	1.0E-09
70.0	1.0E-10
78.8	1.1E-11
87.5	1.1E-12
96.3	1.1E-13
105.0	1.2E-14
113.8	1.2E-15
122.5	1.3E-16
131.3	1.3E-17
140.0	1.4E-18
148.8	1.5E-19
157.5	1.5E-20
166.3	1.6E-21
175.0	1.7E-22

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Tier 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

Site being assessed: Twynrodyn
Completed by: RB
Date: 20.08.08
Version: x.xx



R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Date of Workbook Issue: April 2002

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error fun

Details to be completed for each assessment			
Site Name:	Twynyrodyn		
Site Address:	Mountain Hare, Merthyr Tydfil		
Completed by:	RB		
Date:	20.08.08	Version:	x.xx
Contaminant	TPH C21-C35 Aromatic		
Target Concentration (C_T)	1.00E-02 mg/l	Origin of C_T:	UK EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Tier 1 Soil, Tier 2 Soil and Tier 3 Soil) or to determine remedial targets for groundwater (Tier 3 Groundwater). For Tier 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Tier 1, 2 and 3 Worksheets.

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The worksheet also calculates a number of frequently used hydrogeological equations.

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu)

Contaminant	TPH C21-C35 Aromatic
Target Concentration	C _T 1.00E-02 mg/l

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

1

Enter '1' if biodegradation rate is for the substance in water,

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

1

Initial contaminant concentration in groundwater at plume core	C ₀	1.17E-01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	5.00E+02	days	Site specific Data - R14
Calculated decay rate	λ	1.39E-03	days ⁻¹	Physical and chemical properties data sheet
Width of plume in aquifer at source (perpendicular to flow)	SZ	2.00E+02	m	Dispersivity
Plume thickness at source	Sy	2.80E+00	m	Calculate dependant on distance to compliance point (0)
Saturated aquifer thickness	da	3.00E+00	m	specify dispersivity (1), or calc after Xu & Eckstein (2) ?
Bulk density of aquifer materials	p	2.40E+00	g/cm ³	Enter value Calc value Xu & Eckstein
Effective porosity of aquifer	n	3.00E-01	fraction	ax 0.00E+00 1.75E+01 5.83E-01 m
Hydraulic gradient	i	3.00E-03	fraction	az 0.00E+00 1.75E+00 5.83E-01 m
Hydraulic conductivity of aquifer	K	1.00E-01	m/d	ay 0.00E+00 1.75E-01 5.83E-02 m
Distance to compliance point	x	1.75E+02	m	For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	Xu & Eckstein (1995) report ax = 0.83(log ax) ^{2.44} ; az = ax/10, ay = ax/100 are assumed
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	No offset
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	6.29E+02	l/kg	see options
Longitudinal dispersivity	ax	17.500	m	see options
Transverse dispersivity	az	1.750	m	see options
Vertical dispersivity	ay	0.175	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.00E-03	m/d
Retardation factor	Rf	5.04E+03	fraction
Decay rate used	λ	2.75E-07	d ⁻¹
Rate of contaminant flow due to retardation	u	1.99E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ed}	1.53E-21	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ed}	7.77E-22	mg/l
Attenuation factor (one way vertical dispersion, Q ² C _{ed})	AF	7.65E+19	
Attenuation factor (two way vertical dispersion, Q ² C _{ed})	AF	1.51E+20	

Remedial Targets

Remedial Target	LTC3	7.65E+17	mg/l
Ogata Banks			

For comparison with measured groundwater concentration.

Distance to compliance point	175	m
Concentration of contaminant at compliance point	C _{ed} /C ₀	1.53E-21
after		9.9E+99
		days

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient

Kd 0 l/kg

Fraction of organic carbon in aquifer

foc 5.00E-03 fraction

Organic carbon partition coefficient

Koc 1.28E+05 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species

K_{oc,r} 0 l/kg

Sorption coefficient for ionised species

K_{oc,i} 0 l/kg

pH value

pH 0 l/kg

acid dissociation constant

pKa 0

Soil water partition coefficient

Kd 6.29E+02 l/kg

Physical and chemical properties data sheet

Dispersivity

Calculate dependant on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity

ax 0.00E+00 1.75E+01 5.83E-01 m

Transverse dispersivity

az 0.00E+00 1.75E+00 5.83E-01 m

Vertical dispersivity

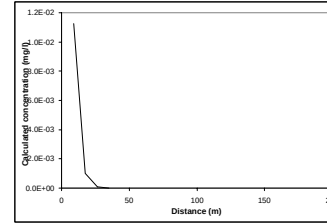
ay 0.00E+00 1.75E-01 5.83E-02 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = 0.83(log ax)^{2.44}; az = ax/10, ay = ax/100 are assumed

No offset

time variant options only



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
8.8	1.1E-02
17.5	1.0E-03
26.3	9.5E-05
35.0	9.2E-06
43.8	9.0E-07
52.5	9.0E-08
61.3	9.1E-09
70.0	9.3E-10
78.8	9.5E-11
87.5	9.8E-12
96.3	1.0E-12
105.0	1.1E-13
113.8	1.1E-14
122.5	1.1E-15
131.3	1.2E-16
140.0	1.2E-17
148.8	1.3E-18
157.5	1.4E-19
166.3	1.5E-20
175.0	1.5E-21

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.
By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Tier 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

Site being assessed: Twynrodyn
Completed by: RB
Date: 20.08.08
Version: x.xx



R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Date of Workbook Issue: April 2002

This worksheet has been produced in combination with the document 'Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources' - Environment Agency R&D Publication 20, (1999).

Users of this worksheet should always refer to the User Manual, to R&D Publication 20 and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

© Environment Agency, 2002. (Produced by the Agency's National Groundwater and Contaminated Land Centre and Enviros Aspinwall)

This calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the NGWCLC.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error fun

Details to be completed for each assessment			
Site Name:	Twynyrodyn		
Site Address:	Mountain Hare, Merthyr Tydfil		
Completed by:	RB		
Date:	20.08.08	Version:	x.xx
Contaminant	TPH C35-C44 Aromatic		
Target Concentration (C_T)	1.00E-02 mg/l	Origin of C_T:	UK EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Tier 1 Soil, Tier 2 Soil and Tier 3 Soil) or to determine remedial targets for groundwater (Tier 3 Groundwater). For Tier 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Tier 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menu or require a "0", "1" or "2" to be entered. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The worksheet also calculates a number of frequently used hydrogeological equations.

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu)

Contaminant	TPH C35-C44 Aromatic
Target Concentration	C _T 1.00E-02 mg/l

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

1

Enter '1' if biodegradation rate is for the substance in water,

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

1

Initial contaminant concentration in groundwater at plume core	C ₀	3.60E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	5.00E+02	days	Site specific Data - R14
Calculated decay rate	λ	1.39E-03	days ⁻¹	Physical and chemical properties data sheet
Width of plume in aquifer at source (perpendicular to flow)	SZ	2.00E+02	m	Dispersivity
Plume thickness at source	Sy	2.80E+00	m	Calculate dependant on distance to compliance point (0)
Saturated aquifer thickness	da	3.00E+00	m	specify dispersivity (1), or calc after Xu & Eckstein (2) ?
Bulk density of aquifer materials	p	2.40E+00	g/cm ³	Enter value Calc value Xu & Eckstein
Effective porosity of aquifer	n	3.00E-01	fraction	ax 0.00E+00 1.75E+01 5.83E-01 m
Hydraulic gradient	i	3.00E-03	fraction	az 0.00E+00 1.75E+00 5.83E-01 m
Hydraulic conductivity of aquifer	K	1.00E-01	m/d	ay 0.00E+00 1.75E-01 5.83E-02 m
Distance to compliance point	x	1.75E+02	m	Longitudinal dispersivity
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	Transverse dispersivity
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	Vertical dispersivity
Time since pollutant entered groundwater	t	9.90E+99	days	For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Parameters values determined from options				Xu & Eckstein (1995) report ax = 0.83(log ax) ^{2.44} ; az = ax/10, ay = ax/100 are assumed
Partition coefficient	Kd	6.29E+02	l/kg	time variant options only
Longitudinal dispersivity	ax	17.500	m	see options
Transverse dispersivity	az	1.750	m	see options
Vertical dispersivity	ay	0.175	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.00E-03	m/d
Retardation factor	Rf	5.04E+03	fraction
Decay rate used	λ	2.75E-07	d ⁻¹
Rate of contaminant flow due to retardation	u	1.99E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	4.71E-22	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	2.39E-22	mg/l
Attenuation factor (one way vertical dispersion, Q ² C _{ED})	AF	7.65E+19	
Attenuation factor (two way vertical dispersion, Q ² C _{ED})	AF	1.51E+20	

Remedial Targets

Remedial Target	LTC3	7.65E+17	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		175	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	4.71E-22	mg/l	Ogata Banks
after		9.9E+99	days	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient

Kd l/kg

Fraction of organic carbon in aquifer

foc 5.00E-03 fraction

Organic carbon partition coefficient

Koc 1.28E+05 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species

K_{oc,r} l/kg

Sorption coefficient for ionised species

K_{oc,i} l/kg

pH value

pH

acid dissociation constant

pKa

Kd 6.29E+02 l/kg

Soil water partition coefficient

Kd 6.29E+02 l/kg

Physical and chemical properties data sheet

Dispersivity

Calculate dependant on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity

ax

Transverse dispersivity

az

Vertical dispersivity

ay

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = 0.83(log ax)^{2.44}; az = ax/10, ay = ax/100 are assumed

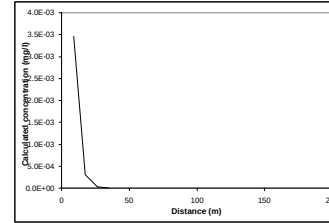
time variant options only

see options

see options

see options

see options



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Tier 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.



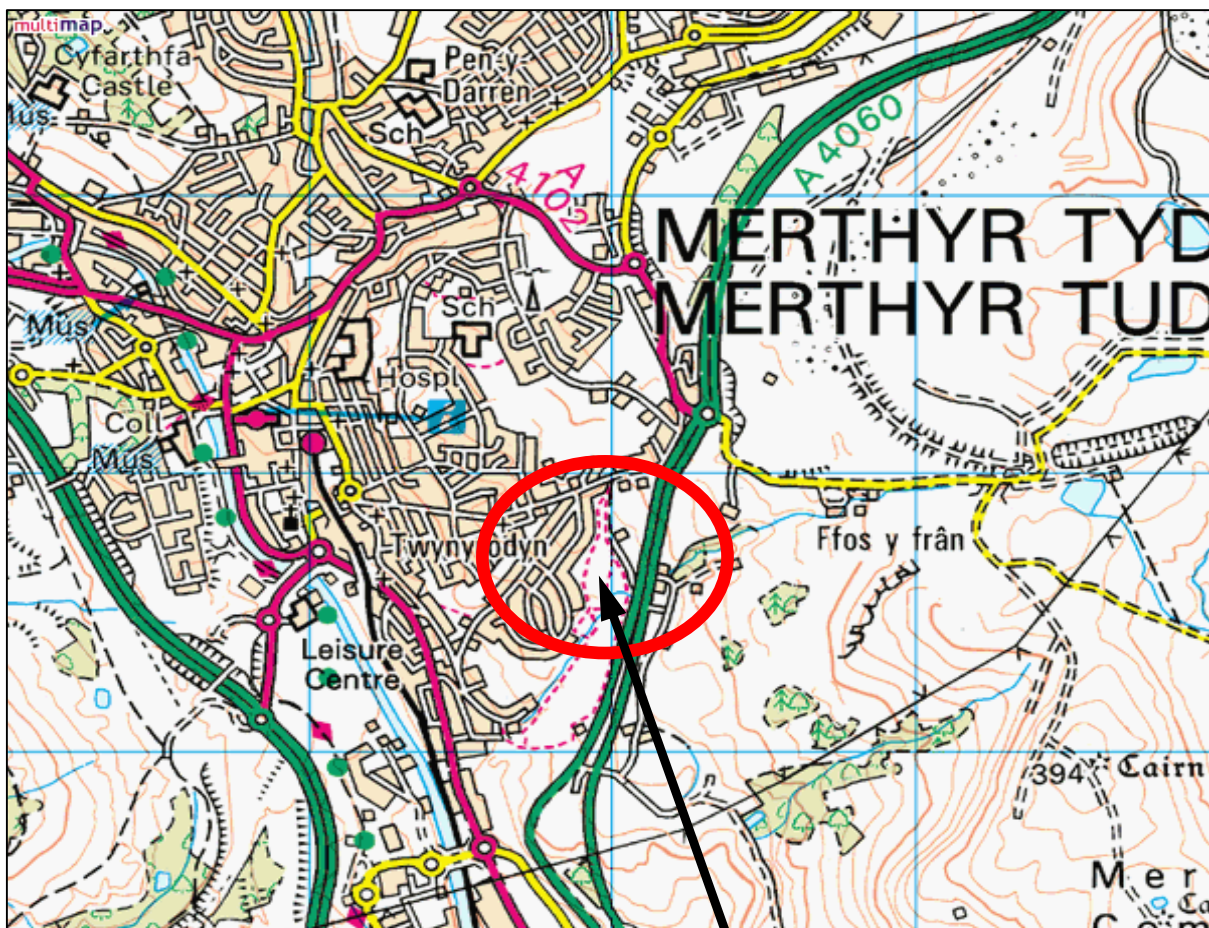
Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
8.8	3.5E-03
17.5	3.1E-04
26.3	2.9E-05
35.0	2.8E-06
43.8	2.8E-07
52.5	2.8E-08
61.3	2.8E-09
70.0	2.9E-10
78.8	2.9E-11
87.5	3.0E-12
96.3	3.1E-13
105.0	3.2E-14
113.8	3.4E-15
122.5	3.5E-16
131.3	3.7E-17
140.0	3.8E-18
148.8	4.0E-19
157.5	4.2E-20
166.3	4.5E-21
175.0	4.7E-22

Site being assessed: Twynrodyn
Completed by: RB
Date: 20.08.08
Version: x.xx

FIGURES



Scale = 1:25,000

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SITE LOCATION



NORTH

FIGURE 1 - SITE LOCATION

Twynyrodyn, Mountain Hare, Merthyr Tydfil

Intégral
Géotechnique

50 Cathedral Road
Cardiff
CF11 9LL
Tel: 029 2022 0462
Fax: 029 2034 0789

APPROXIMATE SITE BOUNDARY

APPROXIMATE TRIAL PIT/TRENCH LOCATION

APPROXIMATE BOREHOLE LOCATION

APPROXIMATE PROBEHOLE LOCATION

APPROXIMATE LINE OF CULVERT

APPROXIMATE SCALE = 1:2,500

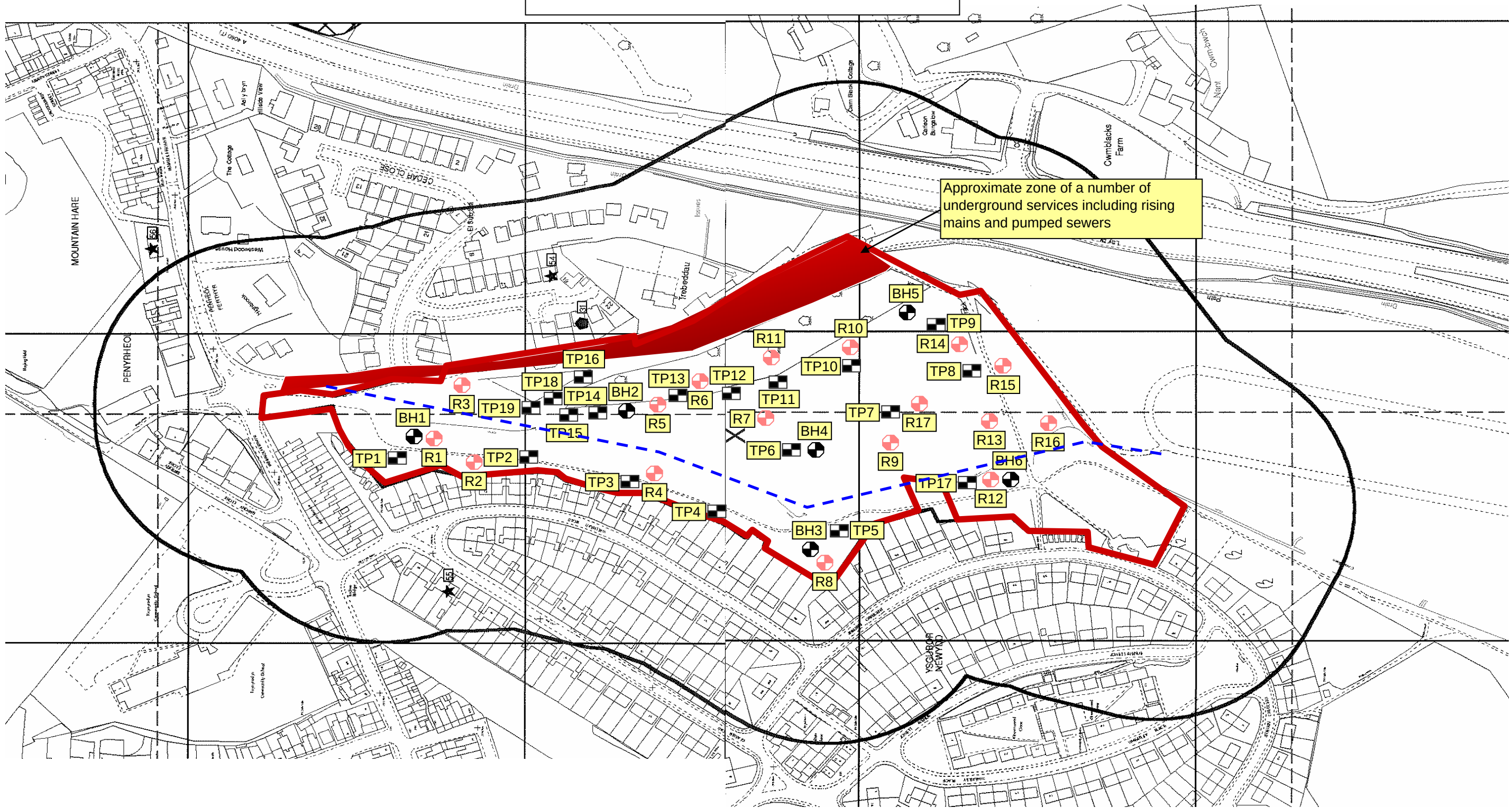
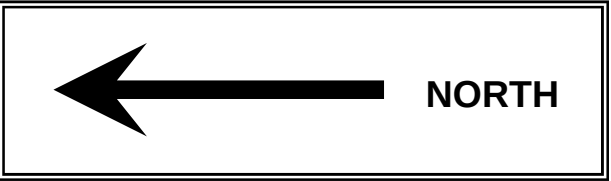


FIGURE 2 - SITE PLAN

Twynyrodyn, Mountain Hare, Merthyr Tydfil

Intégral

Géotechnique

50 Cathedral Road
Cardiff
CF11 9LL
Tel: 029 20220462
Fax: 029 20340789

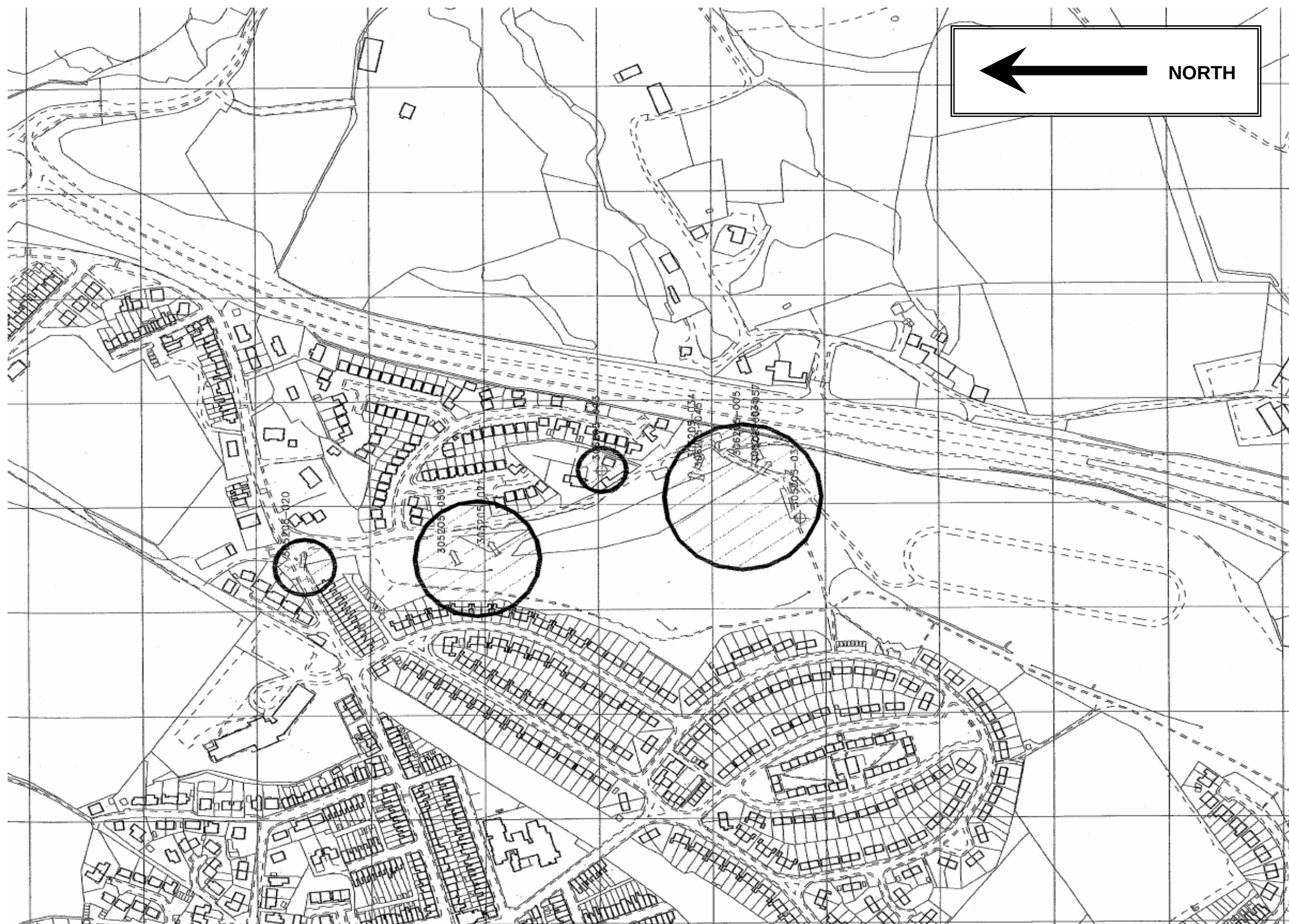


FIGURE 3 - COAL AUTHORITY MINING PLAN

Twynrodyn, Mountain Hare, Merthyr Tydfil

Intégral
Géotechnique

50 Cathedral Road
Cardiff
CF11 9LL
Tel: 029 20220462
Fax: 029 20340789

LEGEND



APPROXIMATE SITE BOUNDARY



APPROXIMATE TRIAL PIT/TRENCH LOCATION



APPROXIMATE BOREHOLE LOCATION



APPROXIMATE PROBEHOLE LOCATION

APPROXIMATE SCALE = 1:2,500



APPROXIMATE GROUNDWATER CONTOUR



APPROXIMATE GROUNDWATER FLOW DIRECTION

CALCULATED HYDRAULIC GRADIENT = 0.003



NORTH

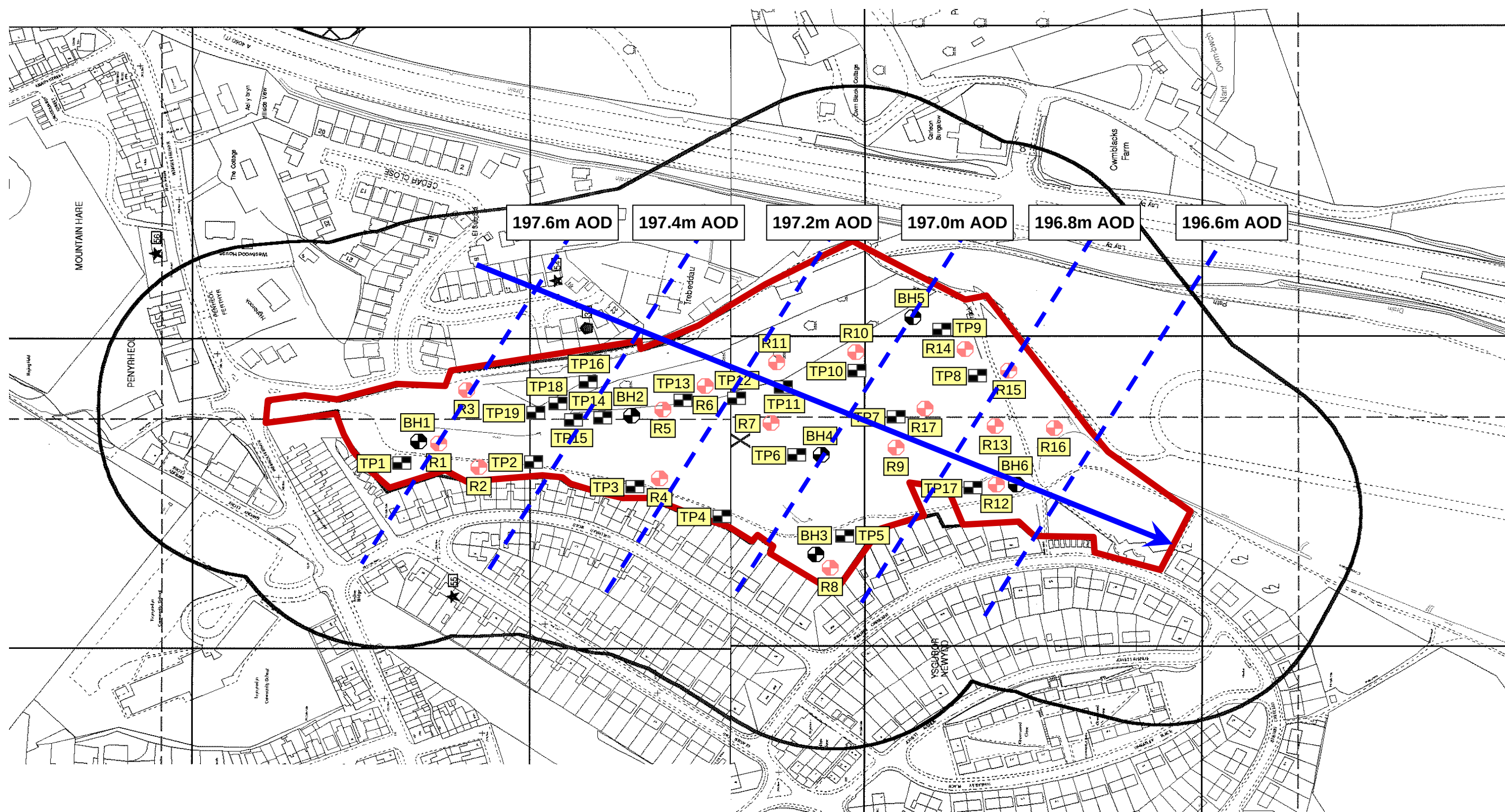


FIGURE 4 - GROUNDWATER CONTOUR PLOT

Twynyrodyn, Mountain Hare, Merthyr Tydfil

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50 Cathedral Road
Cardiff
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Fax: 029 20340789

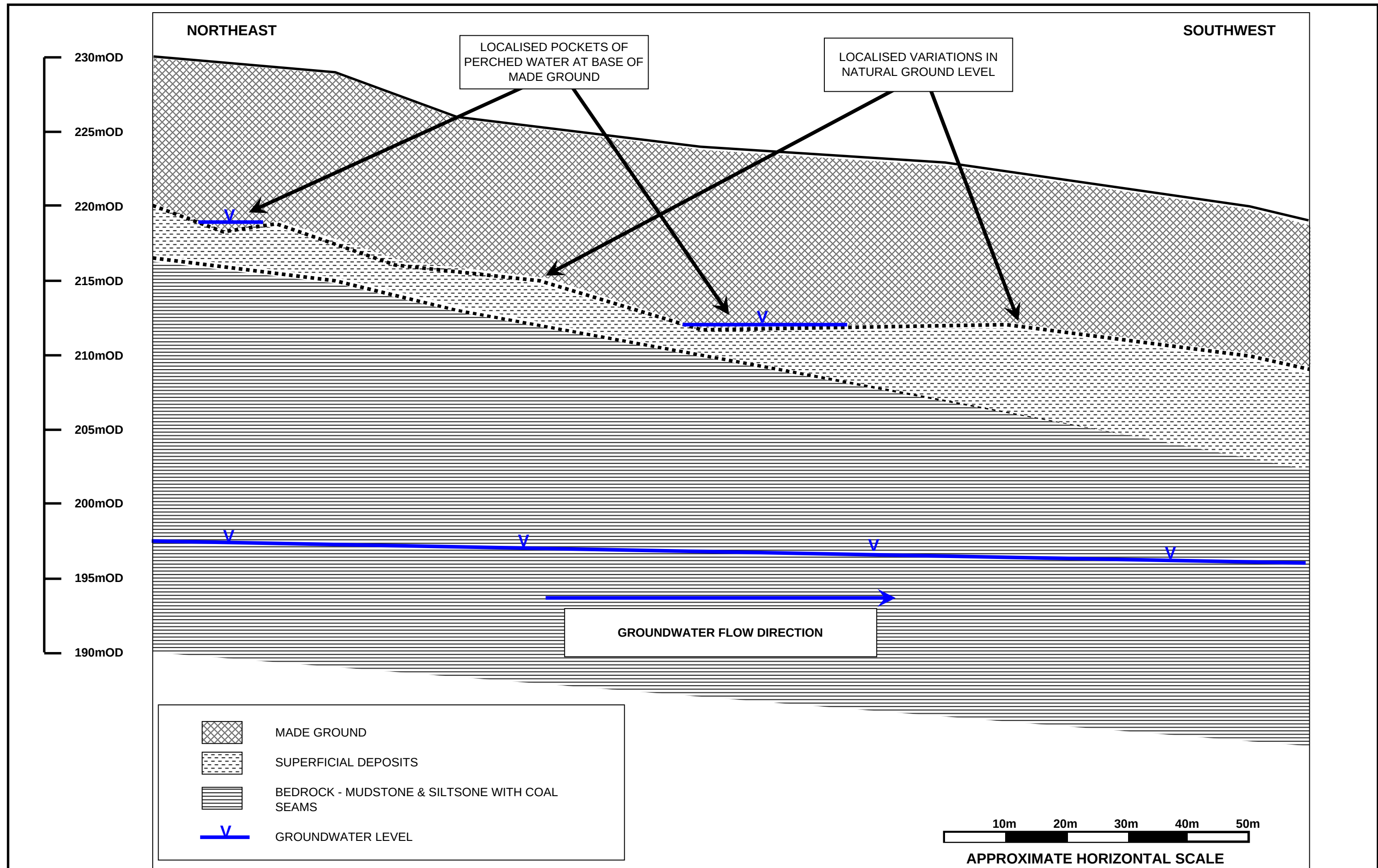


FIGURE 5 - CONCEPTUAL SITE MODEL

Twynnyrodyn, Mountain Hare, Merthyr Tydfil



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Fax: 029 20340789