

SUPPLEMENTARY GEO-ENVIRONMENTAL SITE ASSESSMENT AND REMEDIATION STRATEGY

**Land off Watery Road
Wrexham**

**REC Report: 44391p2r1
Issued: May 2012**

Prepared for:



Doc. Ref – QR5-2

Issued – March 2012

By – A Edgar



Certificate Number 9661
ISO 9001

National Consultancy, Locally Delivered



QUALITY ASSURANCE

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	Final	Amendment to Executive summary		
Date	May 2012	June 2012		
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EXECUTIVE SUMMARY

Site Address	Land Off, Watery Road, Wrexham, LL13 7SY (nearest)
Grid Reference	E332890, N350391
Site Area	1.10 ha
Current Site Use	The wider site is divided into two halves. The eastern sector has been developed into a vehicle maintenance garage (Kwik Fit). The western half is currently undeveloped.
Environmental Setting	The site is underlain by minor aquifers (drift and solid). A process ground water abstraction is located at between 324m and 328m north west of the site boundary. The north of the site is located within an EA defined Zone 3 flood plain.
Site History	Historical maps indicate that the site was occupied by a Mill until ca. 1967 when the main building was demolished and the outbuildings retained. The site use changed at that time to a Works (oil compound). A former reservoir and well are located onsite; however they have been partially backfilled with various materials including (full) steel oil drum containers. The eastern sector of the site has been subsequently developed for a commercial (motor vehicle maintenance) use post 2008.
Hazardous Installations and Development Constraints	The backfilled reservoir is noted to contain some steel oil drum containers, the integrity of which is unknown. The well in the northern sector has been loosely backfilled and may require further investigation/assessment.
Landfill Sites & Ground Gases	A backfilled reservoir has been identified on site and has been designated as a significant source of hazardous ground gases which could impact receptors within the proposed development. Offsite, railway embankments to the west and north are also considered to be potential sources of hazardous ground gas.
Radon	In an area where 5%-10% homes above action limit – Basic radon protection measures required.
Geology, Hydrology & Hydrogeology	Drift – Northern – Alluvium (clay, silt, sand and gravel), Southern – Glaciofluvial (sand and gravel) Bedrock – Etruria Formation, Mudstone Groundwater – Minor Aquifer Flood Risk – Zone 3. Compressible Ground and Subsidence Hazards – No hazard.
Coal Mining / Land Stability	Site is located within a coal mining area. A Coal Authority report indicates that the site is in the likely zone of influence from 1 worked seam at 330m depth last worked ca. 1900. A review of geological mapping confirms that there are no recorded coal seams dipping below the site at such an angle so as to pose a risk to surface deformation from any collapse.

Intrusive Ground Investigation	
Ground Conditions	Made Ground Generally comprised of gravelly sand with some cobbles to a maximum proven depth of 5.70m bgl. Drift Comprised of very soft low strength gravelly CLAY underlain by gravelly SAND (WS104) and loose gravelly SAND underlain by firm medium strength gravelly CLAY in WS105. Solid Geology No solid geological formations were encountered. Ground Water A single groundwater strike was observed within WS105 at 3.80m bgl and was noted to be a slow seepage Permeability Characteristics Low – Encia Consulting Report (7344/1) noted an infiltration rate of 0.26m/day Topography variances The ground topography is slopes from south to north where a cut along the northern boundary of circa 4.0m exists.
Contaminated Land Risk Assessment	
Human Health	Elevated concentrations of hydrocarbon compounds (C ₁₆ -C ₃₅) and inorganic heavy metals have been identified in during the previous Geo Environmental investigations. The placement of a 600mm cover system in soft landscaped areas including POS and gardens will remove any viable exposure pathway associated with the constituents of concern.
Controlled Waters	REC identified exceedances of both the UK DWS and freshwater EQS values for the sum of 4 PAHs, Naphthalene, Benzo(a)Pyrene and TPH C₂₁-C₃₅. It is noted that the exceedances of the compounds (with the exception of C₂₁-C₃₅) are due to the level of detection being above the Tier I guideline value not actual detectable exceedances.
Ground Gas	The ground gas assessment indicates a low risk (Characterisation Situation 2) to future site users. This is based on a preliminary assessment; the final classification will be submitted as an addendum to this report.
Potable Water Infrastructure	It is likely that the identified compounds would indicate that barrier pipe would be the most likely material type for potable water infrastructure.
Detailed Quantitative Risk Assessment	
Detailed Quantitative Risk Assessment	The Detailed Quantitative Risk Assessment (DQRA) has concluded that a steady state system will occur prior to the compounds reaching the Culvert of River Gwenfro (50m) where natural attenuation has degraded the compounds to below the conservative former Drinking Water Standards for hydrocarbon compounds (<10ug/l).

Geotechnical Assessment

Underground Obstructions	Near surface obstructions were encountered during the site investigation and it is also possible that there exists a significant base to the backfilled reservoir.
Allowable Bearing Capacity	Bearing capacities in the order of between 50kN/m ² to 100kN/m ² at between 1.00m and 2.00m bgl.
Foundation Options	Shallow strip foundations with vibro granular columns for the low rise and 2.5 storey residential units.
Soak-away Drainage	The underlying strata is of low permeability and it is not considered viable to discharge surface water to soak away.
Sulphate Assessment	DS1- AC1s.
Waste Classification	It is likely that the material excavated from the former reservoir will be classified as hazardous. Where possible, this material should be treated onsite. Foundation arisings from the remainder of the site are likely to be classified as inert.

Revised Conceptual Site Model (RCSM)

The Tier I Human Health Risk Assessment has identified concentrations of constituents of concern that exceed the Tier I screening values for the protection of human health. However the exposure pathways identified could be mitigated against with the installation of a 800mm cover system in the areas of retained Made Ground.

The DQRA concluded that there is no risk to the River Gwenfro at the compliance point of 50m from the site.

The ground gas assessment indicates a low risk to future site users.

Remediation Strategy

A programme of site wide remediation and enabling works has been completed to remove all historical obstructions and manage materials in such a manner so as to facilitate re-engineering beneath plots for vibro replacement by stone column to support a shallow reinforced strip foundation.

Site remediation works will be required to remove separate phase hydrocarbon impacted soils (within former reservoir) and any other potentially hazardous materials that are unsuitable for retention within the proposed residential development.

Extensive validation testing of made ground will be completed to demonstrate that all material that is retained on-site is suitable for use and poses no unacceptable level of long term risk to the identified receptors.

Geotechnically unsuitable material should be treated on-site to ensure suitability for re-use.

Chemically suitable sub soil and topsoil will be required within all areas of gardens and POS, this would comprise of 650mm sub soil and 150mm topsoil. This material could be site derived through a soil inversion during the enabling works, or alternatively could be imported during construction phase.

A materials management plan should be devised for the site to ensure that the backfilled reservoir can be remediated in a regulatory complainant manner. REC would recommend that a watching brief be undertaken during the site works for any olfactory evidence of hydrocarbon impact in areas of the site which may not have previously been assessed.

TABLE OF CONTENTS

QUALITY ASSURANCE	1
EXECUTIVE SUMMARY	2
TABLE OF CONTENTS	5
1.0 INTRODUCTION	7
1.1 Background	7
1.2 Proposed Development	7
1.3 Objectives	7
1.4 Limitations	7
1.5 Confidentiality	7
2.0 SUMMARY OF PREVIOUS REPORTS	8
2.1 Environmental Advice Centre Report (J964/V1/07.2005)	8
2.2 Ove Arup Report (116147)	8
2.3 Encia Consulting Ltd – Geo-Environmental Appraisal (7344/1)	9
2.4 Encia Consulting Ltd - Quantitative Risk Assessment (7344/2)	9
2.5 Encia Consulting Ltd - Remediation Strategy (7344/3)	9
2.6 Regulatory Response	10
2.7 REC Ltd Initial Conceptual Site Model (ICSM)	10
2.7.1 Contaminant Sources	11
2.7.2 Potential Pathways	11
2.7.3 Potential Receptors	12
3.0 SUPPLEMENTARY SITE INVESTIGATION	13
3.1 General	13
3.2 In-Situ Standard Penetration Testing (SPT)	13
3.3 Laboratory Analysis	14
4.0 GROUND AND GROUNDWATER CONDITIONS	15
4.1 Ground Conditions	15
4.1.1 Summary of Ground Conditions	15
4.1.2 Made Ground	15
4.1.3 Drift Deposits	15
4.1.4 Solid Geology	16
4.1.5 Soil Consistency	16
4.2 Groundwater Conditions	19
4.3 Ground Gas	19
5.0 REVIEW OF CONTAMINATED LAND RISK ASSESSMENT	21
5.1 Human Health Risk Assessment	21
5.2 Controlled Waters	22
5.3 Ground Gas	24
5.4 Conceptual Model	25
6.0 DETAILED QUANTITATIVE RISK ASSESSMENT (DQRA)	26
6.1 Encia Consulting Ltd DQRA	26
6.2 Re-assessment of the Encia DQRA	26
6.3 REC Detailed Quantitative Risk Assessment (DQRA)	27
6.3.1 Remedial Soil Target Concentrations	28
6.3.2 DQRA Conclusions	30

6.4 Revised Conceptual Site Model (RCSM)	30
7.0 SITE REMEDIATION & ENABLING WORKS	32
7.1 Overview	32
7.2 Remediation / Enabling Works	33
7.3 Materials Management & Legislation Compliance	36
7.4 Post Remediation Constraints	36
7.5 Validation Sampling Protocol	37
7.6 Environmental Monitoring and Validation	38
7.6.1. Site Management	38
7.7 Record Keeping and Verification	39
7.8 Contingency Plan	39
7.8.1 Previously Unidentified Contaminants	39
8.0 GEOTECHNICAL ASSESSMENT	40
8.1 Proposed Development	40
8.2 Summary of Ground Conditions	40
8.3 Summary of Previous Geotechnical Assessments	41
8.4 Foundation Conditions and Bearing Capacity	41
8.5 Site Enabling and Remediation Works	42
8.6 Ground Floor Slabs	42
8.7 Drainage	43
8.8 Excavations	43
8.9 Re-Use of Materials	43
8.10 Construction Activity and Inspection	43
9.0 CONCLUSIONS & RECOMMENDATIONS	45

APPENDICES

Appendix I	Limitations
Appendix II	Glossary
Appendix III	Drawings
	Drawing No 44391p2/001 – Site Location Plan
	Drawing No 44391p2/002 – Proposed Development Plan
	Drawing No 44391p2/003 – Exploratory Hole Location Plan
	Drawing No 44391p2/004 – Combined Exploratory Hole Location Plan
	Drawing No 44391p2/005 – Depth of Made Ground
	Drawing No 44391p2/006 – Foundation Zoning Plan
Appendix IV	REC Exploratory Hole Logs
Appendix V	Chemical Testing Results
Appendix VI	Origin of Generic Assessment Criteria
Appendix VII	Envia Chemical Testing Results
Appendix VIII	DQRA Justification
Appendix IX	P20 Output Sheets
Appendix X	REC Method Compaction Specification

A CD containing a complete PDF version of this report is attached to hard copy of the report.

1.0 INTRODUCTION

1.1 Background

Resource and Environmental Consultants (REC) Ltd have been commissioned by Bellway Homes (North West) to undertake a supplementary Geo Environmental Investigation at the subject site off Watery Road, Wrexham. This comprised a detailed review of all third party reports, regulatory comments and the undertaking additional ground investigation, specifically addressing the outstanding issues previously raised by the regulatory authorities.

The scope of the ground investigation works comprised seven probeholes with five being completed as environmental monitoring installations. Subsequent chemical testing, a detailed quantitative risk assessment of the risk to controlled waters and a geotechnical reappraisal of the site was also undertaken

1.2 Proposed Development

Bellway Homes intend to construct 36 no residential units across the site with associated adoptable highways and service infrastructure. REC has been provided with a proposed development plan which is reproduced at drawing 44391p2/002 in Appendix III.

1.3 Objectives

The objectives of the Geo Environmental investigation are to:

- Reappraisal of all previous third party reports;
- Factual information on the work undertaken, including desk study information, sampling location plans and probehole logs;
- A conceptual model identifying potential risks from ground gas/soil/made ground and groundwater contamination;
- Factual and interpretative information relating to the site investigation, chemical testing, and provide preliminary recommendations on the most appropriate foundation options;
- A Tier 1 (qualitative) risk assessment; this will compare the concentrations of potential ground gas/soil contaminants identified against current and appropriate published guidelines, in relation to identified receptors, e.g. existing/ future end users and site neighbours;
- A Detailed Quantitative Risk Assessment for both Controlled Waters and Human Health, taking into consideration previous WCBC comments of input criteria; and,
- Updated Remediation Strategy for the site.

1.4 Limitations

The limitations of this report are presented in Appendix I.

1.5 Confidentiality

REC has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from REC; a charge may be levied against such approval.

2.0 SUMMARY OF PREVIOUS REPORTS

Three previous Site Investigation reports, one DQRA and one Remediation Strategy were provided to REC to review as part of the site re-assessment works, these included:

- Environmental Advice Centre Ltd Report reference J964/V1/07.2005 (dated February 2005);
- Ove Arup and Partners Ltd Geotechnical Report reference 116147 (dated September 2005);
- Encia Consulting Ltd, Geo-Environmental Appraisal reference 7344/1 (dated March 2008);
- Encia Consulting Ltd, Quantitative Risk Assessment reference 7344/2 (dated April 2008); and,
- Encia Consulting Ltd Remediation Strategy reference 7344/3 (dated June 2008).

The salient features of each report are highlighted and discussed below.

2.1 Environmental Advice Centre Report (J964/V1/07.2005)

- Groundwater sampling has indicated localised contamination by petroleum hydrocarbons and ammonia. Risk assessment concluded that no immediate risk is posed to human health via groundwater or surface water quality within the River Gwenfro which is afforded protection from groundwater ingress as it flows within a twin box concrete culvert of high integrity. There is no evidence that groundwater is migrating off site;
- Within the site, the presence of hydrocarbon contamination in groundwater correlates with the presence of hydrocarbon contaminated soils and drums/vessels containing residual hydrocarbon product within the Made Ground;
- In addition to the management of groundwater contamination, hydrocarbon contamination of soils also requires remediation to manage the risk related to the dermal contact and ingestion of soils and volatilisation to indoor air exposure pathways; and,
- The site is within a flood plain.

2.2 Ove Arup Report (116147)

- The site has been historically occupied by Cobden Corn Mill since the early 1900's and since the 1960's it has been used as a storage area by the Carlsberg Tetley Brewery. The buildings associated with the mill have been demolished. The demolition material is generally loose and voided and therefore, it will required re-compaction to a minimum depth of 2.0m below the final formation level prior to any construction works;
- Some drums and vessels containing residual hydrocarbon product were encountered; and
- For typical one to two storey structures it is likely that raft foundations will be suitable if some improvement of the existing fill is carried out. For multi storey structures it is likely that pile foundations will be required.

2.3 Encia Consulting Ltd – Geo-Environmental Appraisal (7344/1)

- Deep deposits of variable Made Ground, ash and clinker, brick rubble and cohesive deposits in excess of 5.0m in the western sector of the site. Typically 2.0m in the eastern sector;
- Historically the western sector of the site is thought to have been operated as an oil compound, used for the storage and blending of oils;
- Natural drift deposits generally comprised interbedded sand and gravel with clay lenses;
- Ten soil samples contained elevated hydrocarbon impact and were located primarily around the periphery of the former reservoir;
- Perched water within the former reservoir was identified dissolved concentrations of hydrocarbons and PAH's;
- Groundwater encountered within the underlying sand and gravel (minor Aquifer) have been shown to contain localised slightly elevated PAH's including Benzo(a)Pyrene;
- No significant inorganic contamination has been identified within either the perched water of the underlying sand and gravel Aquifer;
- It is recommended that excavation of the former reservoir area is undertaken and all barrels and free product encountered are removed;
- A DQRA maybe able to ascertain if hydrocarbon impacted soils can remain on site and assess the risk to controlled waters or human health; and,
- Basic Radon protection measures are required.

2.4 Encia Consulting Ltd - Quantitative Risk Assessment (7344/2)

- Using concentrations calculated for the 300m compliance point the following TPH fractions encountered upon the site exceed the required clean up criteria:
 - Aromatic: C10-C12, C12,C16, C16-C21 and C21-C35; and,
 - PAH's: Benzo(b)fluoranthene and Benzo(k)flouranthene.
- Encia consider that due to the predominantly heavy nature of the hydrocarbon contamination, the remedial target concentrations calculated are not achievable by conventional BATNEEC techniques (bio-remediation etc). Therefore Encia consider that consultations should be undertaken with the Environment Agency at the earliest possible opportunity to address this issue.

2.5 Encia Consulting Ltd - Remediation Strategy (7344/3)

- General site clearance of surface materials and vegetation;
- Break up of slabs and hardstanding;
- Removal of hydrocarbon impacted soils, barrels and free product materials from the Made Ground in the former reservoir area in the west of the site;
- Crushing of all suitable artificial hard material (i.e. concrete/brick etc.);
- Removal of localised fuel/oil contamination over the remainder of the site; with subsequent treatment and/or off-site disposal;
- Removal of below ground obstructions;

- Preparation of the ground for highway construction;
- Turnover (excavation, screening and replacement in engineered layers, with nominal compaction) of the full thickness of Made Ground;
- Treatment of the former well;
- Backfill of all resultant excavations, with nominal compaction;
- Treatment of hydrocarbon impacted soil by ex-situ on-site bioremediation, for subsequent re-use on site if feasible;
- Re-grade of site levels specified by Bellway Homes Ltd;
- Excavation of up to a maximum depth of 2.0m beneath proposed adoptable road footprints and controlled re-engineering of selected materials in layers to approximately 650mm below final road levels;
- Spreading and compaction of 6F2 graded hard material to provide a 'running surface' over the entire site; and,
- Provision of a minimum 600mm thick cover layer of 'clean' soils in all garden and landscaped areas, or 1000mm where ash and clinker deposits remain at the surface of the site.

2.6 Regulatory Response

REC has been provided with Wrexham County Borough Council's (WCBC) response (SLI/P/2008/0448 dated 17th April 2009) to the Encia reports, the salient findings of which are produced below:

- Generally the number of sample locations and types of investigation used are appropriate for the assessment however the eastern half of the site would benefit from slightly greater coverage. Additional sampling of the eastern section is required;
- Additional sampling of organic determinants in the east and the south of western half is required;
- VOCs were identified as a contaminant of concern (organic solvents) within the preliminary risk assessment however the water samples were not analysed for VOCs;
- In terms of human health the reassessment of the non-volatile compounds is considered unwarranted in the context of the proposed remediation strategy;
- The depth of the cover system over the made ground in proposed garden areas is 600mm, WCBC requires a cover system of between 800 to 1000mm;
- Re-assessment of the DQRA is required, soil permeability rate not acceptable;
- Conclusion of the ground gas monitoring is required;
- Assessment required of wider hydrocarbon impact across the site not just the former reservoir; and,
- The more down gradient boreholes appear to be free of hydrocarbon concentrations.

2.7 REC Ltd Initial Conceptual Site Model (ICSM)

REC has reviewed the available historical mapping and the previous initial conceptual site models to compile an up to date Initial Conceptual Site Model.

In accordance with Environment Agency, CLR 11 (2004) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), REC Ltd have developed an initial CSM to identify potential contamination sources, migration pathways and receptors within the study area.

2.7.1 Contaminant Sources

On-site Potential Sources

REC has identified the following on-site potential sources of contamination;

- The demolition of the Mill buildings in between the 1930s and 1960s may have led to the underlying Made Ground becoming impacted with inorganic and organic compounds;
- The historic backfilling of the former reservoir with materials such as steel drums and other nonspecific materials is a potential source of Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) compounds;
- The former site use as an oil storage depot is a potential source of TPH and Volatile Organic Compounds (VOCs);
- Previous Encia Assessments identified TPH, Inorganic Compounds and Organic Solvents; and,
- The backfilled reservoir and (possibly canalised) stream in the northern is also a potential source of ground gas.

Off-site Potential Sources

REC has identified the following on-site potential sources of contamination;

- Historical railway lines to the north and west of the site are potential sources of ground gas and PAH and TPH impact; and,
- Historical land uses within 250m of the site include a tannery and brewery, however these are noted to be down hydraulic gradient of the site and it is not considered that they are a plausible risk to the site and as such have been discounted.

2.7.2 Potential Pathways

Receptors may be potentially at risk from any on site contamination via the following pathways:

- Migration of mobile contaminants on or off site via services, sewers and manmade conduits;
- Direct contact, ingestion and inhalation of contaminants on site;
- Migration of contaminated dusts during earthworks;
- Migration of mobile contaminants into groundwater and transport into surface waters;
- Migration of mobile contaminants directly into the surface waters;
- Migration of hazardous gases;
- Uptake of toxins/phytotoxins by plants; and
- Consumption of contaminated potable waters.

2.7.3 Potential Receptors

Human receptors include:

1. Site investigation and construction workers during the redevelopment of the site from hazardous short term exposure;
2. Future users of the site and buildings; and,
3. Users of adjacent areas due to off site migration of gases, vapours or contaminated dust.

Controlled Waters

Groundwater

The site is indicated to be underlain by alluvium and glaciofluvial deposits in the form of sands and gravels. The underlying drift geology is considered by the EA to be a Secondary A Aquifer. The previous investigation only recorded low levels of PAH and TPH contamination within the groundwater.

Surface Waters

The nearest local surface water body (River Gwenfro) is located in the 40m north of the site.

Ecological Sites / Ecosystems

No areas of local ecological importance have been identified within the immediate vicinity of the site in the Groundsure Report. As no potential receptors are located in the vicinity of the site no pollutant linkages are considered to be present.

Buildings, Foundations and Services

Future redevelopment of the site will include the construction of new foundations. Elevated sulphate concentrations could affect the integrity of buried concrete structures. Services may be affected by the presence of aggressive contaminants which may corrode or penetrate services. Water supply pipes can be susceptible to penetration by hydrocarbons which may then affect the quality of the water supply.

3.0 SUPPLEMENTARY SITE INVESTIGATION

3.1 General

A supplementary ground investigation has been designed based on the findings of the previous reports and subsequent recommendations, with exploratory holes advanced to target specific potential contaminant sources and areas summarised above. The investigation has also been used to collect geotechnical information to assist in the design and construction of the development.

Exploratory fieldwork was completed on the 19th April 2012. The works are summarised in Table 3.1.

Table 3.1 Summary of Fieldwork

Potential Source/Rationale	Location Hole	Type	Maximum Depth (m bgl)	Monitoring Wells Response Zone
Additional information in SW	WS101	Window Sample	4.45	0.50-2.00
Additional information in SW	WS102	Window Sample	5.45	1.00-5.45
Additional information in SW	WS103	Window Sample	6.45	1.00-3.00
Former Reservoir	WS104	Window Sample	5.00	1.00-4.00
Additional information in Eastern Sector	WS105	Window Sample	5.45	1.00-4.00
Additional information in Eastern Sector	WS106	Window Sample	1.50	N/A
Additional information in Eastern Sector	WS106a	Window Sample	1.50	N/A

Notes

m bgl – metres below ground level.

The window sample probeholes were designed to provide geotechnical information and confirm the findings of the Initial Conceptual Site Model (ICSM).

The window sample probeholes were advanced to retrieve environmental samples, spatially distributed to offer the maximum site coverage whilst addressing the issues highlighted by the Wrexham County Borough Councils comments. The sampling locations are illustrated in Drawing 44391p2/003 (Appendix III). The ground conditions encountered and details of monitoring well response zones are indicated on the logs which are provided in Appendix IV.

Return visits were made to monitor installations for groundwater level and gas concentrations. In addition, selected wells were purged and samples of groundwater recovered for chemical analysis.

Soil and groundwater samples destined for chemical analysis were collected at regular intervals in appropriate sampling containers. All samples were subsequently stored in cooled boxes prior to submission to analytical laboratory.

All samples were collected using appropriate PPE and sampling equipment that was cleaned at each sampling location. A detailed copy of REC Ltd sampling methodology, QA procedures and laboratory chain of custody forms can be provided upon request.

3.2 In-Situ Standard Penetration Testing (SPT)

In-situ geotechnical testing was conducted using the Standard Penetration Test (SPT) and where the ground is granular, a 60° cone (SPT(C)) was used instead of the sampling tube.

The results are shown in the probehole logs in Appendix IV and presented in Table 4.2 and discussed in Section 4.

3.3 Laboratory Analysis

Selected soil samples were submitted for a range of chemical analysis comprising, total and speciated petroleum hydrocarbon (TPH), VOC and SVOCs.

Scientific Analysis Laboratories (SAL) Ltd of Manchester undertook the analytical work and the testing results are included in Appendix V and discussed in Section 5.

4.0 GROUND AND GROUNDWATER CONDITIONS

4.1 Ground Conditions

4.1.1 Summary of Ground Conditions

The ground investigation generally confirms the previous investigations and identifies the strata set out in Table 4.1 below:

Table 4.1 Summary of Strata

Strata	Typical Description	Min Depth to Top of Strata (m)	Max Depth to Top of Strata (m)	Max Thickness (m)
MG Asphalt	Black Asphalt	0.00	0.00	0.15
MG Gravelly sand	Red brown very gravelly fine to medium sand with many cobbles. Gravel is medium to coarse angular to sub-angular of brick and concrete. Cobbles are sub-angular to angular of brick and concrete.	0.00	0.00	5.70
MG Gravel	Sandy yellow brown gravel. Gravel is fine to coarse angular to sub-angular of sandstone with occasional bands of coarse sand.	1.30	1.30	3.70
MG Gravelly clay	Dark Grey gravelly clay with many cobbles. Gravel is fine to coarse angular to sub-rounded of sandstone, limestone, concrete. Cobbles are angular to sub-rounded of sandstone.	0.00	0.00	1.50
Gravelly CLAY	Very soft very sandy very gravelly red brown CLAY. Gravel is fine to coarse angular to sub-angular of sandstone.	1.20	3.00	1.80
Gravelly SAND	Fine to medium very gravelly SAND with many cobbles. Gravel is medium to coarse angular to sub-angular of sandstone and mudstone. Cobbles are sub-angular to angular of sandstone.	1.30	3.60	1.70

4.1.2 Made Ground

Made Ground was encountered within each exploratory hole location to a maximum proven depth of 5.70m bgl and generally comprise of gravelly sand with some cobbles of brick and concrete.

4.1.3 Drift Deposits

Natural deposits were encountered within two of the six probehole locations (WS104 and WS105) and comprised of very soft low strength gravelly CLAY underlain by gravelly SAND (WS104) and loose gravelly SAND underlain by firm medium strength gravelly CLAY in WS105.

4.1.4 Solid Geology

Solid geological formations were not proved within any of the exploratory hole locations.

4.1.5 Soil Consistency

Undrained shear strength values were derived from the in-situ SPT testing and are shown in Table 4.2 (overleaf) with the undrained shear strengths of cohesive strata. Results show the clay soils to vary between very soft and firm very low to medium strength. Strength test data is generally consistent with the field descriptions of the soils given above.

Table 4.2 Standard Penetration Test Results

Boreholes	Depth (m bgl) (i)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value (N ₁) ₆₀	Terzaghi& Peck Relative Density (Sands)	Eurocode Soil strength	Consistency (BS5930)	Terzaghi& Peck Approximate Undrained Shear Strength (kN/m ²)
WS101	1	MG Gravelly sand	32	37	Dense	N/A	N/A	N/A
	2	MG Gravelly sand	10	11	Medium Dense	N/A	N/A	N/A
	3	MG Gravelly sand	19	19	Medium Dense	N/A	N/A	N/A
	4	MG Gravelly sand	36	35	Dense	N/A	N/A	N/A
WS102	1	MG Clayey sand	2	2	Very Loose	N/A	N/A	N/A
	2	MG Sandy gravel	15	16	Medium Dense	N/A	N/A	N/A
	3	MG Sandy gravel	10	10	Medium Dense	N/A	N/A	N/A
	4	MG Sandy gravel	19	19	Medium Dense	N/A	N/A	N/A
	5	MG Sandy gravel	53	51	Very Dense	N/A	N/A	N/A
WS103	1	MG Gravelly sand	20	23	Medium Dense	N/A	N/A	N/A
	2	MG Gravelly sand	23	24	Medium Dense	N/A	N/A	N/A
	3	MG Gravelly sand	12	12	Medium Dense	N/A	N/A	N/A
	4	MG Gravelly sand	10	10	Medium Dense	N/A	N/A	N/A
	5	MG Gravelly sand	8	8	Loose	N/A	N/A	N/A
	6	MG Gravelly sand	16	15	Medium Dense	N/A	N/A	N/A

Table 4.3 (Cont...)

Boreholes	Depth (m bgl) (i)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value (N ₁) ₆₀	Terzaghi& Peck Relative Density (Sands)	Eurocode Soil strength	Consistency (BS5930)	Terzaghi& Peck Approximate Undrained Shear Strength (kN/m ²)
WS104	1	Gravelly CLAY	0	0	N/A	Extremely low strength	Very Soft	0.00
	2	Gravelly CLAY	8	7	N/A	Low strength	Soft	37
WS105	1	MG Gravelly sand	4	5	Loose	N/A	N/A	N/A
	2	Gravelly SAND	8	8	Medium Dense	N/A	N/A	N/A
	3	Gravelly CLAY	7	6	N/A	Low strength	Soft	30
	4	Gravelly SAND	10	10	Medium Dense	N/A	N/A	N/A
	5	Gravelly CLAY	12	10	N/A	Medium strength	Firm	50
WS106a	1	MG Gravelly clay	10	10	N/A	Medium strength	Firm	50

4.2 Groundwater Conditions

A single groundwater strike was observed within WS105 at 3.80m bgl and was noted to be a slow seepage. Subsequent groundwater monitoring was undertaken using an electronic dip meter and interface probe to record the depth to groundwater and the thickness of any free phase hydrocarbon product, if present. The groundwater levels recorded are summarised in Table 4.3 (overleaf).

4.3 Ground Gas

Concentrations of methane (CH₄), carbon dioxide (CO₂) and Oxygen (O₂) were measured using an infra red gas analyser (GA2000) calibrated to a reference standard (before and after each survey) and gas flow rates were measured using an internal flow pod.

Gas measurements were recorded for a minimum of sixty seconds at each location, at which point the maximum concentration of CH₄ and CO₂ together with the lowest concentration of O₂ were recorded. The results of the ground gas monitoring are presented in Table 4.3 overleaf.

Table 4.3 Summary of Ground Gas and Groundwater Monitoring Results

Well	Date	CH ₄ Initial %v/v	CH ₄ Steady %v/v	CH ₄ GSV l/hr	CO ₂ Initial %v/v	CO ₂ Steady %v/v	CO ₂ GSV l/hr	O ₂ %v/v	Atmos(mb)	Atmos. Dynamic	Flow (l/hr)	Depth to Base (mbgl)	Depth to Water (mbgl)
WS101	16/05/12	0.10	0.10	0.0001	0.10	0.10	0.0001	20.40	1016	Steady	0.10	2.45	2.415
	11/06/12	0.10	0.10	-0.0002	0.20	0.20	-0.0004	20.70	997	Steady	-0.20	2.45	Dry
WS102	16/05/12	0.10	0.10	-0.0001	0.20	0.20	-0.0002	20.50	1016	Steady	-0.10	4.45	Dry
	11/06/12	0.10	0.10	-0.0002	0.10	0.10	-0.0002	20.70	997	Steady	-0.20	4.45	Dry
WS103	16/05/12	0.10	0.10	-0.0001	1.70	1.70	-0.0017	19.20	1016	Steady	-0.10	2.50	Dry
	11/06/12	0.10	0.10	0.0001	2.00	2.00	0.002	19.00	997	Steady	0.10	2.50	Dry
WS104	16/05/12	0.10	0.10	0.0001	2.70	2.70	0.0027	17.30	1016	Steady	0.10	3.89	Dry
	11/06/12	0.10	0.10	0.0001	2.90	2.90	0.0029	17.10	997	Steady	0.10	3.89	Dry
WS105	16/05/12	0.10	0.10	0.0001	2.80	2.80	0.0028	16.80	1016	Steady	0.10	4.88	3.81
	11/06/12	0.10	0.10	-0.0001	1.90	1.90	-0.0019	15.10	997	Steady	0.10	4.88	3.80
WS106a	16/05/12	0.01	0.01	0.0001	3.70	3.70	0.0037	15.30	1016	Steady	0.10	1.95	Dry
	11/06/12	0.10	0.10	-0.0001	5.30	5.30	-0.0053	12.20	997	Steady	0.10	1.95	Dry

Note for Table 4.3

Windy conditions encountered during the monitoring visit may have caused a back pressure leading to a negative flow.

5.0 REVIEW OF CONTAMINATED LAND RISK ASSESSMENT

REC has undertaken a review of the Encia Tier 1 qualitative risk assessment supplemented by further chemical analysis to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

The regulatory authority (Wrexham County Borough Coouncil) agreed with the findings of the Encia Tier I Risk Assessment which concluded the following:

- Organic (hydrocarbon) impact was observed primarily around the periphery of the former reservoir in the western sector of the site;
- Perched water within the former reservoir is impacted with dissolved phase hydrocarbons including PAHs; and,
- No significant inorganic contamination has been identified within either the perched Made Ground waters or within the underlying Secondary A (minor) aquifer within the superficial drift.

REC targeted the supplementary exploratory holes to further assess the periphery of the former reservoir and also within the former reservoir itself.

5.1 Human Health Risk Assessment

At a Tier 1 stage the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published by the EA (Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (SGV)) and where absent, Generic Assessment Criteria (GACs) published by LQM/CIEH (2nd edition).

The results of this comparison have been summarised within Table 5.1 (overleaf).

Table 5.1 Summary of Supplementary Hydrocarbon Toxicity Assessment for a Residential End Use

Determinand	Units	GAC ^{V3}	n	MC	Loc. of Ex	Pathway	Assessment
TPH C ₅ -C ₆ (aliphatic)*	mg/kg	30	6	<0.10	N/A	2	No further Action
TPH C ₆ -C ₈ (aliphatic)*	mg/kg	73	6	<0.10	N/A	2	No further Action
TPH C ₈ -C ₁₀ (aliphatic)*	mg/kg	19	6	2.1	N/A	2	No further Action
TPH C ₁₀ -C ₁₂ (aliphatic)*	mg/kg	69	6	11	N/A	2	No further Action
TPH C ₁₂ -C ₁₆ (aromatic)*	mg/kg	140	6	39	N/A	1	No further Action
TPH C₁₆-C₂₁ (aromatic)*	mg/kg	250	6	450	WS103 0.50	1	Further Action
TPH C₂₁-C₃₅ (aromatic)*	mg/kg	890	6	5000	WS103 0.50 & WS105 0.40	1	Further Action

Notes

Main Exposure Pathways: 1 = Soil Ingestion, 2 = Vapour Inhalation (indoor), 3 = Dermal Contact & Ingestion, 4 = Dust Inhalation.

Abbreviations: GAC = General Assessment Criteria, n = number of samples, MC = Maximum Concentration; Loc of Ex = Location of Exceedance.

* The Tier 1 GAC for the hydrocarbon fraction is derived from the CIEH assessment for petroleum hydrocarbons Criteria Working Group (CWG) for both aliphatic and aromatic compounds. REC has utilised the Tier 1 values for aliphatic compounds for the volatile and semi volatile fractions (C₅-C₁₂) and the Tier 1 values for aromatic compound for the non-volatile fractions (C₁₂-C₃₅). The comparison of a total (aliphatic/aromatic) compounds to an individual fraction is considered to be a conservative approach and satisfactory for the protection of human health.

(i) Benzo (b) Fluoranthene (100mg/kg) Benzo (k) Fluoranthene (140mg/kg)

(ii) GAC based on human health criteria. Ecotoxicological assessment will be made using EA guidance (EPR 8.01) on soil spreading (Cu 135mg/kg, Zinc 200mg/kg, Pb 300mg/kg)

Referring to Table 5.1, the results of the direct comparison show that screening values have been exceeded for the following determinands:

- TPH C₁₆ – C₂₁; and,
- TPH C₂₁ – C₃₅.

In the case of the identified exceedances the exposure pathway is soil ingestion. The proposed development of the site will include hard cover and then imported top soil in areas of landscaping, thus removing this pathway.

No volatile organic compounds (VOCs), BTEX and volatile TPH fractions were identified within the soils tested by REC.

REC concludes that the findings of the supplementary chemical sampling and risk assessment are in keeping with the findings of the original Encia Tier I Risk Assessment.

5.2 Controlled Waters

A Tier I risk assessment was undertaken from a groundwater sample taken from WS105 within the shallow perched aquifer with concentrations of determinants compared with the relevant thresholds. The results are presented overleaf in Table 5.2.

Table 5.2 Comparison of Groundwater Analysis with Tier 1 Screening Levels

Determinand	Units	EQS ^(V1)	Drinking Water Threshold	n	MC	Number of Exceedances	Location of Exceedances
Arsenic	µg/l	50	10	1	4.8	N/A	N/A
Cadmium	µg/l	5	5	1	0.06	N/A	N/A
Chromium	µg/l	5 – 250	50	1	15	N/A	N/A
Lead	µg/l	4 – 250	25	1	<0.3	N/A	N/A
Mercury	µg/l	1	1	1	0.36	N/A	N/A
Selenium	µg/l	-	10	1	3.7	N/A	N/A
Copper	µg/l	1-28	2000	1	6.0	N/A	N/A
Nickel	µg/l	50-200	20	1	5	N/A	N/A
Zinc	µg/l	8-125	-	1	8	N/A	N/A
Sulphate	mg/l	-	250	1	130	N/A	N/A
PAH *	µg/l	-	0.1	1	<10	1	WS105
Naphthalene	µg/l	10	-	1	<10	1	WS105
Benzo(a)pyrene	µg/l	30[†]	0.01	1	<10	1	WS105
Benzene	µg/l	30		1	<1	N/A	N/A
Toluene	µg/l	50		1	<1	N/A	N/A
Ethyl Benzene	µg/l	-		1	<1	N/A	N/A
Xylene	µg/l	50		1	<1	N/A	N/A
Total Petroleum Hydrocarbons	µg/l	-	10	1	164	1	WS105
TPH Aliphatic C5-C6	µg/l	15000 [§]	-	1	<10	N/A	N/A
TPH Aliphatic C6-C8	µg/l	15000 [§]	-	1	<10	N/A	N/A
TPH Aliphatic C8-C10	µg/l	300 [§]	-	1	<10	N/A	N/A
TPH Aliphatic C10-C12	µg/l	300 [§]	-	1	<10	N/A	N/A
TPH Aromatic C12-C16	µg/l	1000 [§]	-	1	<10	N/A	N/A
TPH Aromatic C16-C21	µg/l	90 [§]	-	1	54	N/A	N/A
TPH Aromatic C21-C35	µg/l	90[§]	-	1	110	1	WS105
VOC	µg/l	-	-	1	<1	N/A	N/A
SVOC	µg/l	-	-	1	<1	N/A	N/A

Notes

Values in **bold** greater than UK DWS, shaded cells exceed Tier 1 EQS.

* Sum of 4 most carcinogenic PAH listed in the DWS.

+ Based on the DWS and EQS values for Benzene.

**Based on the EQS and WHO values for Toluene.

+++ Based on the EQS and WHO values for Xylene.

§ WHO Guidelines (WHO/SDE/WSH/05.08/122, 2005).

† DEFRA proposed Aquatic Quality Standard (freshwater, annual average).

Other VOCs are summarised as detected

N/D None Detect

For the purposes of the Tier 1 assessment REC have compared the laboratory test data directly to the relevant Tier 1 threshold values for the protection of controlled waters. The results of this direct comparison indicates that the data exceeds the screening values for the following determinands:

- Sum of 4 PAH;
- Naphthalene;
- Benzo(a)Pyrene;
- Total Petroleum Hydrocarbons (TPH); and
- TPH C₂₁ – C₃₅.

It is noted that the exceedances of the sum of 4 PAHs, Naphthalene and Benzo(a)Pyrene compounds are due to the level of detection being above the Tier I guideline value not actual detectable exceedances.

The exceedances of the TPH and TPH C₂₁-C₃₅ are in line with the exceedances encountered within the previous reports and as such further investigation is required as to the potential to impact the River Gwenfro located at circa 50m north of the site and the underlying Secondary A aquifer.

5.3 Ground Gas

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIRIA Report 665 (*Assessing risks posed by hazardous ground gases to buildings*, 2007). However, it is recommended that the full ground gas assessment and recommended protection measures are agreed with the local authority prior to their adoption on-site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

During the monitoring visit completed to date, no significantly elevated concentrations of methane were recorded within any of the monitoring installations. Slightly elevated levels of carbon dioxide (up to 5.30% v/v) were recorded in WS106a though this was also associated with low flow rates of than 0.1 litres/hr.

During the monitoring negative flows were noted which is indicative of back pressure generated from the wind being greater than the active flow from the wells.

In accordance with the methodology outlined with the CIRIA publication C665, REC have utilised the results of the ground gas monitoring surveys to calculate a tentative Gas Screening Value (GSV). The maximum GSV calculated for methane was 0.0001 l/hr (various) and for carbon dioxide was 0.0037 l/hr (WS106a)

The GSV has been compared to the criteria outlined with CIRIA C665 to determine the level of risk to the proposed development and to ensure the appropriate remedial options are incorporated into any future building design in this area.

CIRIA C665 states that the maximum GSV for carbon dioxide and methane is <0.07 l/hr for Characteristic Situation 1 and although the GSVs for this site fall into this bracket carbon dioxide levels have been recorded in excess of 10%. Carbon dioxide is an asphyxiant and therefore only poses a risk where it can accumulate in areas where access is available. It is also heavier than air and as such the risk to above ground structures from ingress is very limited. As a precaution it is therefore recommended that characteristic situation 2 is used.

However, REC has obtained an up to dated HPA Radon assessment for the site, which indicates that it is in an area where between 5% and 10% of homes are above the Radon Action Level, therefore it is recommended that **basic Radon protection measures** are installed in all residential properties.

This is an interim assessment based on preliminary ground gas readings, the final classification will be supplied as an addendum to this report on completion of the remaining monitoring visits.

5.4 Conceptual Model

Following the completion of the intrusive site investigation, chemical analysis and risk assessment the conceptual model shown in Table 5.3 (overleaf) has been prepared for the site.

Table 5.3 Conceptual Model

Source	Exposure Pathway	Potential Receptor	Probability of Exposure	Discussion of Pollutant Linkage
Human Health				
TPH C ₁₂ -C ₃₅	Soil Ingestion, Dermal Contact and inhalation of particles	Future Site Users	Low	With the installation of a suitably designed cover system in soft landscaped areas the potential exposure pathway would be broken and the risk to the identified receptor mitigated.
		Construction Workers	Low	The correct use of personal protective equipment and good general site housekeeping would mitigate against the potential exposure pathway.
Radon	Inhalation	Future Site Users	Low	With the installation of basic radon protection measure within all residential plots, the exposure pathway would be broken.
Controlled Water				
Sum of 4 PAHs; Naphthalene; Benzo(a)Pyrene; and, TPH C ₂₁ -C ₃₅ .	Lateral Migration	River Gwenfro (40m)	Medium	It is considered that it maybe possible for the soluble Naphthalene compounds to migrate to a stretch of the River Gwenfro before it becomes culverted in a double lined concrete tunnel at circa 50m from the site.
		Groundwater Abstraction Point (Ca 300m)	Very Low	The distance to the closest groundwater abstraction (>150m) and the low solubility of the identified compounds would indicate that the probability of the identified compounds affecting the groundwater abstraction point is very low.
	Vertical Migration	Aquifer	Medium	It is considered that it maybe possible for the soluble Naphthalene compounds to migrate vertically to the underlying aquifer within the bedrock at circa 60m from the site. However, the interbedded granular and cohesive strata should offer the aquifer some protection.

6.0 Detailed Quantitative Risk Assessment (DQRA)

6.1 Encia Consulting Ltd DQRA

REC has received a copy of the Encia Consulting Ltd DQRA reference 7344/2 (dated April 2008) from which the soil and water remedial targets have been derived. This report was submitted for local authority (LA) scrutiny in April 2009, the salient findings of this review are highlighted below:

- The risk assessment has not presented a consideration of the likely fate of hydrocarbons in the groundwater;
- The TPH water quality target is outdated;
- The bulk density value is overstated;
- The F_{oc} value appears to be elevated;
- The infiltration rate is only 25% of published total rainfall;
- The effective porosity value (33%) is not considered to be conservative; and,
- The River Gwenfro needs to be included as a receptor.

6.2 Re-assessment of the Encia DQRA

REC has re-assessed the DQRA and has amended input parameters to address the issues above and has justified the changes below:

- REC has developed a new model which calculates the likely fate of hydrocarbons within the groundwater. However it should be noted, that the chemical testing results from the Encia phase of works did not highlight any significant dissolved phase hydrocarbons;
- REC has changed the bulk density value from 2.65g/cm^3 which, as the LA rightly noted was overstated. REC has utilised a bulk density value of 1.2g/cm^3 taken from Table 4.4 of EA report SR3 which is based on a Sandy Loam;
- The LA rightly noted that the F_{oc} appeared to be elevated (1.95) as stated in the Encia justification (Appendix A). However, the LA appears to have overlooked the actual P20 sheets as Encia have used an F_{oc} value of 0.02. REC has concluded that the 1.95 value stated in the Encia justification is actually an expression of the TOC value as a percentage, instead of the actual F_{oc} which is expressed as a fraction ($1.95\% = 0.02$ as a fraction);
- REC has utilised the MET office statistics for annual rainfall for Wrexham for 2010 and 2011 and devised an average value of 0.0013m/d in replacement of the Encia value of 0.0004m/d ;
- Encia had utilised an effective porosity (kd) value of 33% which does not correlate with the site derived hydraulic conductivity value or the borehole logs for the saturated zone. REC has utilised Table 4.4 from the Consim report as derived from *Physical and Chemical Hydrogeology*, Wiley, 1990 to derive a value of 15% for a clayey sand which correlates well with the saturated strata descriptions, hydraulic conductivity values and the site derived hydraulic gradient; and,
- REC has re-run each compound based on a 50m compliance point (River Gwenfro) and underlying Secondary A aquifer.

6.3 REC Detailed Quantitative Risk Assessment (DQRA)

The basic hydrogeological regime beneath the site is one of downward migrating possibly perched or trapped water body which infiltrates through the deep Made Ground into the underlying interbedded granular cohesive superficial drift, which is of a low permeability matrix. The groundwater then migrates laterally towards the River Gwenfro.

In order to assess the risk of on-site hydrocarbon migration to the River Gwenfro, REC has utilised the EA RTM model combined with the physical/chemical characteristics of the aromatic and aliphatic hydrocarbon ranges and Polycyclic Aromatic Hydrocarbon (PAH) compounds to determine the likely impact to the off-site river. REC has re-assessed all the hydrocarbon ranges and PAH compounds initially assessed by Encia, with the newly derived values as specified in Section 6.2. REC has included in Appendix VIII a tabulated justification of the DQRA input parameters.

Although separate phase hydrocarbon impact has been identified within the Made Ground deposits, REC has only reported the DQRA results for the most soluble and mobile hydrocarbon fractions (aromatic C₈-C₁₂) and naphthalene as further modelling the insoluble relatively mobile fractions, as initially assessed in the Encia report, would be pointless.

Where natural attenuation has been applied, "Handbook of Environmental Degradation Rates" by Howard *et al* has been used, adopting the conservative maximum anaerobic rates for each. Where individual hydrocarbon bands were assessed, the most soluble compound i.e. the half-life for Ethyl Benzene was utilised for C₈-C₁₀.

For the sake of simplicity, the average soil concentrations for the impact across the site have been modelled as a source for leaching to groundwater and then impact migrating off-site. The highest groundwater concentrations have been as a source for the groundwater modelling.

Tables 6.1 below shows the results of the RTM modelling. The model output sheets are included in Appendix IX.

Table 6.1 Summary of RTM Modelling for Level 3 Soil and Groundwater Migration to River Gwenfro

Source	Average Soil Concentrations (mg/kg)	Peak Water Concentration (mg/l)	Level 3 Soil Source at 50m (mg/kg)	Level 3 Groundwater at 50m (mg/l)
Aromatic C ₈ -C ₁₀ No Degradation	0.52	0.01	1.00	0.0028
Aromatic C ₈ -C ₁₀ With Degradation	0.52	0.01	ND	0.0026
Aromatic C ₁₀ -C ₁₂ No Degradation	0.31	0.01	1.00	0.0028
Aromatic C ₁₀ -C ₁₂ With Degradation	0.31	0.01	ND	0.0027
Naphthalene No Degradation	0.46	0.0001	1.00	0.0028
Naphthalene With Degradation	0.46	0.01	ND	0.0027

Referring to Table 6.1, the model shows that there would be no exceedances of the conservative former Drinking Water Standard (DWS) value of 0.01mg/l. Although the value has now been withdrawn, we consider that it is an appropriate value when considering against the World Health Organisation (WHO) value of 10ug/l for Benzene which is a significantly more volatile and soluble compound.

No account of the potential for sorption between hydrocarbon compounds and clay particles has been utilised in the P20 model, further demonstrating the conservative nature of the risk assessment.

6.3.1 Remedial Soil Target Concentrations

Table 6.2 (overleaf) shows the remedial target values for the soils both for impact to controlled waters at 50m and risk to human health on the site as derived from the P20 calculation sheets and Tier I Generic Assessment Criteria (GAC) values. REC has recommended using the lower remedial target value for each carbon range or compound.

Table 6.2 Soil Target Concentrations

Determinand	Tier 1 Human Health GAC (mg/kg)	Controlled Waters Target Concentrations To be protective of the 50m vertical (Secondary A aquifer) and horizontal (River Gwenfro) compliance point. (mg/kg)	Remedial Target Values (mg/kg)
Aliphatic			
C8-C10	19.00	24.50	19.00
C10-C12	93.00	194.00	93.00
C12-C16	740.00	4340.00	740.00
C16-C35	4.50e+ ^{U4}	4.65e+ ^{U5}	4.50e+ ^{U4}
Aromatic			
C8-C10	27.00	1.29	1.29
C10-C12	69.00	2.04	2.04
C12-C16	140.00	4.06	4.06
C16-C35	250.00	11.40	11.40
Naphthalene	1.50	0.53	0.53

6.3.2 DQRA Conclusions

In order to address concerns of the Local Authority (LA), REC has re-assessed the Encia laboratory data with specific focus on the fate of hydrocarbon compounds and the risk to the point at which the River Gwenfro is culverted (circa 50m) using the EA RTM model. REC also adjusted a number of the input parameters as detailed in Section 6.2.

Due to the relatively low concentrations of soluble compounds, the modelling has predicted that there is little or no detectable concentrations at the compliance point for both the assessment taking into account natural attenuation and the ultra-conservative no degradation test. Both the steady state no degradation and the natural attenuation modelling show concentrations for each range are less than the drinking water standard at the 50m compliance point. This suggests, combined with the lack of dissolved phase impact in the wells that the model represents a worst case situation.

REC has concluded that the risk to the River Gwenfro from the mobile soluble compounds shown in Table 6.1 is negligible. REC notes that separate phase hydrocarbon has been identified at the site in the form liquid product within the Made Ground (as noted in the exploratory hole logs). However due to the viscosity, solubility and volatility of this product, it will not pose a significant risk to controlled waters or human health (unless dermal exposure can occur), this material will however be removed in its entirety as part of the site remediation works

A piling risk assessment may be required if piling is considered to be a viable foundation option.

6.4 Revised Conceptual Site Model (RCSM)

Following the completion of the assessment of the migration of dissolved phase hydrocarbons from the site, a revised conceptual site model has been prepared for groundwater and is shown in Table 6.3.

Table 6.3 Revised CSM – Controlled Waters

Source	Exposure Pathway	Potential Receptor	Probability of Exposure	Discussion of Pollutant Linkage
Controlled Water				
Hydrocarbons	Leaching and dissolved phase migration	Shallow aquifers and River Gwenfro	Unlikely	Impact to the shallow perched aquifer is confirmed on-site. However, the deeper aquifer, which maybe in hydraulic continuity with the River is afforded protection by interbedded horizons of low permeability drift deposits. Chemical testing of the liquid product encountered show it to be predominantly low solubility hydrocarbon compounds.

Source	Exposure Pathway	Potential Receptor	Probability of Exposure	Discussion of Pollutant Linkage
	Leaching and downward migration	Bedrock aquifer	Unlikely	A borehole log from a site adjacent to the subject site, shows that there is circa 60m of superficial drift deposits, which will afford the underlying bedrock aquifer significant protection from any vertical migration of contaminants.

7.0 SITE REMEDIATION & ENABLING WORKS

7.1 Overview

A summary of the proposed site enabling / remediation works, associated management activities and validation protocols are presented in detail later within Section 7.2; the salient features of which are presented below:

The outline strategy for the site remediation and enabling works will comprise:

- Implementing the works with appropriate consultancy supervision so that the works can be fully validated, together with verification reporting, to the satisfaction of the Local Planning Authority (LPA);
- A comprehensive topographical survey of current site conditions should be undertaken to inform the design of a detailed earthworks model and requirements for the creation of a development platform;
- General site clearance, breaking out, excavation and removal of all slabs, hard-standing and buried structures to the base of the Made Ground;
- Breaking out and subsequent crushing / processing of all surface and sub-surface structures including relict roadways, foundations, redundant drains and any further buried obstacles (where present);
- Processing Made Ground stockpiles in accordance with the Engineer's Specification with requisite validation testing;
- Excavation segregation and processing of general granular and cohesive Made Ground matrices for subsequent re-use beneath the proposed hard and soft development areas respectively;
- Excavation, segregation and processing of granular 6F2 deposits and steel drums identified in the infilled reservoir;
- Re-engineering of suitable material within the excavation to enabling works level;
- Removal and disposal of any perched water from within excavations (if required);
- Assessment and subsequent remediation (preferably on-site) of any significantly impacted/suspect material identified within the former reservoir and anywhere else not previously detected on site;
- Management of all works so as to ensure that no environmental nuisance is created through dust emissions, noise or vibration levels;
- Ensure that all works are completed in a manner so as not to create any structural risk to the adjacent highways, railway lines or properties;
- Implement all temporary works as necessary to support excavations throughout the duration of the works;
- Inspection of all works by a qualified GeoEnvironmental Engineer to confirm the suitability of material for re-use;
- Provide suitable development platform to facilitate the construction of the proposed roadways, drainage infrastructure, pavements and areas of hard-standing; to be delivered in accordance with the Engineers Specification;
- Provide and place a 800mm thick soft cover system to all garden and landscaped areas within the proposed residential development;

- Removal of all soil wastes deemed unsuitable for use from site in accordance with UK Waste Management Legislation and in accordance with the UK Landfill Directive; and,
- Development of a comprehensive validation report to document the successful completion of the aforementioned works.

7.2 Remediation / Enabling Works

The rationale detailed below provides a synopsis of the proposed site enabling / remediation works required to produce the suitable platform for the construction of the proposed residential development. This is intended to demonstrate that the proposed activities are to be undertaken in full compliance with the relevant regulatory controls.

It is proposed to excavate and remediate (both environmentally and geotechnically) **all Made Ground** across the entire development site, including to the base of the reservoir. This work will be completed under the supervision of a suitably qualified Geo Environmental Consultant from REC who will inspect all materials (before, during and after excavation), undertake extensive on-site PID/FID analysis to ascertain the extent of any potentially volatile hydrocarbon fractions (and presence of visual or olfactory impact).

Where visual or olfactory impacted soils or measured PID/FID values indicate VOC concentrations in excess of 10ppm, samples will be subject to detailed laboratory analysis (Speciated TPH) to assess the actual risk through volatilisation to indoor air.

Where samples are found to have concentrations in excess of the soil remedial targets identified in Section 6.3.1, the material will be removed and treated in strict accordance with current UK Waste Management Legislation.

By undertaking the site monitoring, assessment and laboratory testing in this manner, REC will be able to demonstrate that all Made Ground that remains on-site after the remediation works are complete will be suitable for a residential use and that no risk remains to any of the identified receptors.

This approach will also remove the uncertainties within targeted and non targeted investigations and thus the requirement to use conservative assessment tools and limit the need for extensive remedial works that require excessive vehicle movements and ultimately landfill of material that poses no risk within the context of the developed conceptual site Model.

Prior to the commencement of works on-site, the contractor must establish all necessary plant, equipment and site welfare facilities as is necessary to complete the contract within the agreed timescales to the rationale as outlined below in Table 7.1.

Table 7.1 Earth Works Specification

EW1	Pre-Commencement Works
	Implementing the works with appropriate consultancy supervision so that the works can be fully validated, along with validation reporting to the satisfaction of the Local Planning Authority (LPA).
	Validation Requirements: Provide documented evidence to confirm acceptance of proposed methodologies.

EW2	Site Clearance Operations General site clearance & provision of welfare, offices and site security. Validation Requirements: Any disposal of materials of site (including vegetation if required) should be completed in accordance with UK Waste Management Legislation.
EW3	Excavation of hydrocarbon impacted soil Rationale: The Geo Environmental Investigations have identified hydrocarbon impact predominantly within the backfilled reservoir and its periphery. It is recommended that a watching brief be undertaken during the site works in areas previously untargeted. Chemical analysis and subsequent DQRA has proven that there is a risk to human health which could be mitigated against with the incorporation of an 800mm cover system. No risk to controlled waters was proven. Quantities of liquid product were identified, any such material from site which appears to be contaminated by separate (free) phase hydrocarbon should be delineated, excavated and removed from site in accordance with UK Waste Management Legislation. Any such separate phase contamination encountered will be identified by the REC engineer on site, based on visual and olfactory observations. Any impacted perched water within the excavation will be removed if necessary. Validation Requirements: The area from which excavated soils are removed will require appropriate validation to demonstrate that any residual impact does not pose a human health risk.
EW4	Excavation, Breaking and Processing of all Sub-Surface Structures and Artificial Hard Materials including the Well Rationale: All known major obstructions/foundations apart from live services previously identified are to be removed to the base of Made Ground. In these areas all artificially hard materials will be taken out in a controlled manner, screened to remove any deleterious content, crushed to nominal 6F2 grading and stockpiled for subsequent re-use as an engineered aggregate. Stockpiles will be made, validation testing undertaken, and site won material reused on site where required. Any obstructions/foundations/structures not previously encountered within the remainder of the site will be removed to the base of Made Ground. Where any very loose or soft material is present at the base of excavations, removal of material will continue, and any material excavated will be re-engineered to a

	suitable specification to minimise the risk of future settlement. Validation Requirements: Site won arisings will require testing to demonstrate that they are suitable for use with the proposed development platform. Areas will require appropriate geotechnical testing to demonstrate that the backfill material meets the required engineered standard.
EW5	Excavation, Breaking and Processing of Made Ground Materials Rationale: It is proposed that the full depth of Made Ground is to be excavated, turned and processed beneath all building footprints deemed suitable for vibro improvement. Any obstructions/foundations/structures not previously encountered within the remainder of the site will be removed to the base of Made ground. Where any very loose or soft material is present at the base of excavations, removal of material will continue, and any material excavated will be re-engineered to a suitable specification to minimise the risk of future settlement. Validation Requirements: Site won arisings will require testing to demonstrate that they are suitable for use with the proposed development platform. Areas will require appropriate geotechnical testing to demonstrate that the backfill material meets the required engineered standard.
EW6	Backfill for Remediation Excavations Rationale: On completion of the site enabling / remediation works as prescribed within EW1-5 (above) all excavations beneath the proposed buildings will be backfilled with a suitable material that conforms to the engineer's specification for future vibro compaction foundation solution. Although the main access road into the site has already been constructed, additional new estate roads in the south and west are required to tied to existing constructed roads. Materials to be placed beneath proposed adoptable roads will be compacted to a Method Compaction Specification in accordance with Section 6 of the highways design manual and the REC specification included within Appendix X. Validation Requirements: Confirmation that the material is chemically and geotechnically suitable for re-use.

EW7	Provision of Sub Soil Rationale: It will be necessary to import a chemically suitable sub-soil forming material (650mm) for use within all garden and landscaped areas as part of the clean cover system in the proposed residential development, designed to mitigate against the identified exposure pathways. Validation Requirements: Imported sub-soil will require testing in line with the schedule present within Section 7.5. The garden and landscaped areas will require depth validation to satisfy the requirement of CML in order to demonstrate that the appropriate thickness has been provided.
EW8	Provision of Top-Soil Rationale: It will be necessary to import a chemically suitable top-soil forming material (150mm) for use within all garden and landscaped areas if the existing topsoil is deemed to be chemically unsuitable to be used as the topsoil element for the clean cover system in the proposed residential development. This will then be placed on top of the 650mm of validated sub-soil. Validation Requirements: Imported top-soil will require testing in line with the schedule present within Section 7.5. The garden and landscaped areas will require depth validation to satisfy the requirement of CML in order to demonstrate that the appropriate thickness has been provided.

7.3 Materials Management & Legislation Compliance

All operations as outlined in within the Enabling Works Rationale summarised within Section 7.1 will be subject to regulation using a 'Materials Management Plan' (MMP) to be created in accordance with Version 2 of the CL:AIRE Definition of Waste - Industry Code of Practise.

The afore mentioned MMP will be created with due consideration to all proposed remediation and enabling works operations prescribed within this document and will be submitted to a Qualified Person and the signed declaration submitted to the EA prior to re-use of materials on the site.

7.4 Post Remediation Constraints

Post remediation constraints for the site will include:

- Sub surface concrete should be designed in accordance with Design Sulphate Class DS-1, Aggressive Chemical Environment for Concrete Classification (AC EC) Ac-1s in accordance with recommendations provided in BRE Special Digest 1 (2005);

- Topsoil and sub-soil to be supplied by the developer, with appropriate quality checks;
- Placement of clean sub-soil and topsoil in gardens and soft landscaped areas must be a minimum of 800mm; and,
- Disposal of arisings for services and foundation trenches, if required.

Consultations will have to be completed with the Local Authority to enable the satisfactory discharge of planning conditions associated with the planning consent for the site.

7.5 Validation Sampling Protocol

In accordance with the current requirements of the regulatory authorities, validation samples will be collected from all materials that are to either be subject to movement under the protocols outlined within this Remediation Strategy section, or for materials to be imported onto site to facilitate the proposed residential development.

Soil samples destined for chemical analysis will be collected at regular intervals in appropriate sampling containers. All samples will subsequently be stored in cooled boxes prior to submission to Scientific Analysis Laboratories (SAL) for analysis in accordance with their UKAS accreditation where applicable.

All samples will be collected using appropriate PPE and sampling equipment that will be cleaned at each sampling location.

A detailed copy of REC Ltd sampling methodology, QA procedures and laboratory chain of custody forms will be documented within the site records and presented within the final validation report for the site.

Where materials are found to contain concentrations of potential contaminants at levels in excess of the site specific screening criteria (as detailed within Appendix II), REC will undertake further assessment and recommendations on the appropriate use for the material in question.

The sampling frequency for materials to be managed under the Remediation Strategy is presented within Table 7.2.

Table 7.2 – Specification of Materials Validation Laboratory Analysis

Material Use	Testing Frequency	Suite of Analysis
Site excavated and imported granular & cohesive backfill	1 Sample Per 500m ³	B
	1 Sample Per 1000m ³	A / B / C / D
Imported Sub-Soil (650mm garden / POS cover)	1 Sample Per 50m ³	A / B / C / D
Topsoil Cover (imported)	1 sample per 50m ³	A / B / C / D

Notes – Table5.2
Suites of Analysis
A) Speciated PAH
B) Banded TPH (C5-C35)
C) Asbestos (ID)
D) CLEA Inorganic
E) Asbestos Quantification (by weight)
F) Speciated (aliphatic / aromatic) TPH.

All analysis prescribed above to be completed by UKAS accredited laboratory.

7.6 Environmental Monitoring and Validation

7.6.1. Site Management

The tracking of materials will be based on the following hierarchy:

- The Principal Contractor will have the responsibility for setting out areas of the site on the basis of the contract specification;
- Operatives will have instructions only to excavate and to emplace materials in specified areas as assigned by the Site Manager / Foreman;
- The Site Manager (employed by the Principal Contractor) will issue daily instructions to drivers regarding the placement of materials sourced from specific stockpiles or areas, ensuring that appropriate documentary evidence is collected that details which materials are going where and why;
- The strategy for each day's work will be agreed with the REC Consultant, who will be in attendance as required, prior to the commencement of the works. REC will:
 - Inspect the excavation areas and certify that the correct materials are being excavated;
 - Conduct spot checks on loaded vehicles to ensure compliance with this Remediation Strategy;
 - Ensure that any loads which fail visual, olfactory or spot checks either remain on the vehicle or if unloaded are excavated and set aside. This material will be treated according to the recommendations of the REC site engineer;

- All material imported and removed from site will have Duty of Care / Consignment Notes, copies of which will be retained on-site by the Site Manager; and,
- Materials directly reusable will be incorporated into the earthworks, subject to operational conditions and phasing of excavations, in which case they will be stockpiled prior to final placement.

7.7 Record Keeping and Verification

Using the data collated below, REC Ltd will prepare a summary report clearly referencing the origin of the materials used and testing carried out to confirm its suitability for use, where required. REC will also prepare an as built development drawing clearly detailing the materials present on-site to be cross referenced with the supporting validation documentation.

The Validation Report will include the following:

- Remediation Strategy (including copies of confirmation from regulatory authorities agreeing criteria);
- Detailed surveys of all excavations and production of 'as built' drawings for the earthworks;
- Copy of Consignment Notes and Waste Transfer Tickets relating to the movement of wastes to a licensed waste management facility and non-contaminated natural soils to direct transfer receiver sites if required;
- Detailed drawings showing all sampling locations for both chemical and geotechnical testing;
- Chemical test results;
- Geotechnical test results;
- Details of Qualified Person's signed declaration; and,
- Monitoring results if undertaken (i.e. gas, water etc.)

7.8 Contingency Plan

7.8.1 Previously Unidentified Contaminants

Should any significantly impacted material be encountered during the development, then it should be excavated and stockpiled on an impermeable material and sampled and tested for an appropriate range of determinants.

Once the laboratory analysis of the material is available an assessment should be undertaken to determine whether it can be retained on-site as part of the Material Management Operations or whether it should be disposed off-site.

Depending on the nature of any such impact it may be necessary to undertake validation testing of the excavation faces in order to demonstrate that no such materials are left in-situ.

8.0 GEOTECHNICAL ASSESSMENT

8.1 Proposed Development

It is understood that the proposed development will comprise of 36 number low rise residential units. No details on potential loadings have been supplied, as such REC has utilised an assumed line loading of 75kN/m² for the low rise and 2.5 storey houses.

It is understood that site remediation works including excavation and validation of hydrocarbon compounds will need to be undertaken prior to the commencement of site works.

Given the nature of the proposed development it is considered that the structure meets the criteria of Geotechnical Category 1 of Euro Code 7.

Given the nature of the development it is considered that acceptable risk from settlement is a total settlement value of 25mm for a masonry structure.

8.2 Summary of Ground Conditions

Ground conditions identified at the site are summarised in Table 8.1 below:

Table 8.1 Summary of Ground Conditions

Strata	Typical Description	Min Depth to Top of Strata (m)	Max Depth to Top of Strata (m)	Max Thickness (m)
MG Asphalt	Black Asphalt	0.00	0.00	0.15
MG Gravelly sand	Red brown very gravelly fine to medium sand with many cobbles. Gravel is medium to coarse angular to sub-angular of brick and concrete. Cobbles are sub-angular to angular of brick and concrete.	0.00	0.00	5.70
MG Gravel	Sandy yellow brown gravel. Gravel is fine to coarse angular to sub-angular of sandstone with occasional bands of coarse sand.	1.30	1.30	3.70
MG Gravelly clay	Dark Grey gravelly clay with many cobbles. Gravel is fine to coarse angular to sub-rounded of sandstone, limestone, concrete. Cobbles are angular to sub-rounded of sandstone.	0.00	0.00	1.50
Gravelly CLAY	Very soft very sandy very gravelly red brown CLAY. Gravel is fine to coarse angular to sub-angular of sandstone.	1.20	3.00	1.80
Gravelly SAND	Fine to medium very gravelly SAND with many cobbles. Gravel is medium to coarse angular to sub-angular of sandstone and mudstone. Cobbles are sub-angular to angular of sandstone.	1.30	3.60	1.70

8.3 Summary of Previous Geotechnical Assessments

REC has reviewed and summarised the previous geotechnical appraisals of the site and has reproduced the salient features below:

- Concrete is to be designed in line with Design Suplate Class DS1 ACEC Classification AC-1;
- Regrading of the site is considered likely. All imported materials are to be managed under a Material Management Plan, which appropriate geotechnical and chemical analysis;
- All sub surface obstructions, such as relict foundations are to be removed and a suitable material replaced and re-engineered; and,
- The in-filled former reservoir has been backfilled in an apparent loose tip manner, with a variable grade matrix including steel drums. This material will require excavation and any concrete base or side of the reservoir also removed. Once removed the void will have to be re-engineered to final finishing levels to provide a suitable construction platform. The material excavated from the reservoir is likely to be classified as hazardous due in part to the liquid product encountered in during the Encia ground investigation;

Due to the change in proposed end use since the Encia 2008 report, REC has revised the recommended foundation details and has combined the data from the Encia report and the data obtained as part of this investigation to derive the foundation options.

8.4 Foundation Conditions and Bearing Capacity

General

It is considered that the Made Ground and shallow till deposits are not suitable for a founding material due to the inherent variability of the material. Foundation options are therefore:

- Raft foundations;
- Conventional strip footings on vibro granular columns; or,
- Deeper pile foundations.

These options are discussed below:

Raft Foundations

Consideration could be given to the utilisation of a raft type foundation which would mitigate against the potential for total and differential settlement. Due to the large surface area of the raft the bulb of pressure is reduced and maybe suitable for the assumed loading of 75kN/m^2 which the proposed low rise and 2.5 storey development may exert.

Raft foundations should be as shallow as possible, preferably on the surface, so that compressive strains can take place beneath them instead of transmitting direct compressive forces to their edges, and they should be constructed on a membrane to allow for lateral movement as ground movements occur below them.

It is recommended that a specialist foundation engineer is contacted to design any raft utilised for the proposed developments. They must also take into account the overall dimensions and calculate the bulb of pressure to ensure that the forces exerted in the underlying strata are within the calculated ABP range of between 50kN/m² to 100kN/m² at between 1.00m and 2.00m bgl.

Ground Improvement

The use of ground improvement techniques such as vibro granular columns will allow shallow foundations to be utilised with the Made Ground. The vibro granular columns should provide a bearing capacity of around 150kN/m² but will also remove variability within the Made Ground. Specialist advice should be sought from a suitably experienced contractor with regard to allowable bearing capacity and settlements.

Piled Foundations

As an alternative consideration maybe given to the use of piled foundations for any low rise residential units where deep Made Ground has been encountered, such as the backfilled reservoir.

Pile design should be undertaken by a specialist contractor to allow them to reduce the factor of safety based on their extensive pile testing data.

Recommendation

Raft foundations for the low rise residential units in areas where Made Ground does not exceed 1.50m in thickness would be viable, however the variability in the Made Ground would lead to a potential for unacceptable levels of differential settlement. It is considered that vibro granular columns will provide the most reliable and cost effective option for the low rise units.

8.5 Site Enabling and Remediation Works

A programme of site wide remediation and enabling works will be required to remove all historical obstructions and manage materials in such a manner so as to facilitate re-engineering beneath plots for vibro replacement by stone columns, as detailed in Section 6.0 of this report.

8.6 Ground Floor Slabs

Due to the presence of substantial thickness' of Made Ground across the site it is considered that ground bearing floor slabs, whilst viable, will require detailed design to accommodate variability of the formation and account for differential settlement.

If vibro granular columns are used for the foundations then this could be extended to the floor slab to improve formation conditions and reduce the risk of damage from settlement. However, it may be more reliable to opt for suspended floor slabs.

Where suspended floor slabs are employed ventilation of the under floor void will be required to address condensation issues. This would also assist in the mitigation of potential gas ingress issues.

8.7 Drainage

It is recommended that drain runs are designed using steeper gradients and flexible joints to allow for some differential settlement.

The soil infiltration tests show that there is little potential for soakaways within the natural underlying strata. Therefore, it is not recommended that soakaways are used for disposal of surface water runoff.

8.8 Excavations

Site observations indicated that excavations should be feasible in the near surface with normal plant. Groundwater seepage was recorded in a number of the Exploratory Holes at depths of between 2.30 and 4.00m bgl and are considered representative of the local ground water level within the granular deposits.

Dependent upon the depth of excavations, consideration must be given to the potential for instability and collapse when excavating through the granular deposits and it is considered that all excavations are supported in accordance with guidance contained within CIRIA 97.

Should excavations be deep enough to encounter groundwater then consideration must be given not only to de-watering but to the potential off-site impact of de-watering in gravels.

8.9 Re-Use of Materials

Consideration has been given to the potential re-use of site won arisings from substructure works as an engineered fill. The soils have been assessed using the following:

- Physical description of the soils encountered (variability and organic content); and,
- Guidance given in HA44/91;

Based on this it is considered that soils are suitable for re-use as a general engineered fill in accordance with Class 2A of the Specification for Highway Works.

8.10 Construction Activity and Inspection

The following activities and inspections should be incorporated in to the site works:

- Due to the variability of the soils at the site it is recommended that sufficient allowance is made for the inspection of formation and sub formations to foundations and pavement construction;
- Excavations where access is required should be subject to a risk assessment from a competent person and where appropriate mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA 97 utilised;
- It is considered that de-watering may be required, especially following periods of heavy rainfall. Removal of surface water and water within trenches should be possible with conventional sump pumping. Discharge of any water should be agreed with the relevant regulatory body and be undertaken under a trade effluent discharge, where required. Measures to remove silt and suspended solids may be required and consideration should be given to provision of space for settling tanks or an attenuation pond;
- Where access to confined spaces is required appropriate mitigation measures should be addressed within the Construction Stage Health and Safety Plan. Particular account

should be taken of the gas results; and,

- The presence of potential contamination and mitigation measures should be addressed as part of the Construction Stage Health and Safety Plan and should include measures to design out the risks, reduce their impact and finally the use of Personnel Protective Equipment (PPE).

9.0 CONCLUSIONS & RECOMMENDATIONS

Geotechnical Assessment

The in-filled former reservoir has been back filled in an apparent loose tip manner, which is geotechnical unsuitable. This material will require excavation and re-engineering to final finishing levels to provide a suitable construction platform.

Due to the variable thickness of Made Ground foundations conventional foundations are used founding on vibro granular columns used to improve the uniformity of the engineering properties of the Made Ground, cohesive and granular deposits.

Revised Conceptual Site Model

The placement of an 800mm cover system in soft landscaped areas including POS and gardens will mitigate against the elevated hydrocarbon compounds, identified in this report and the elevated inorganic compounds as noted in the Encia report.

The Detailed Quantitative Risk Assessment (DQRA) has modelled the fate and transport of soluble hydrocarbons identified on site and concludes that under steady state conditions with no natural attenuation will the compounds will not impact the 50m compliance point (Culvert of River Gwenfro) at concentrations above even the more conservative former Drinking Water Standards for hydrocarbon compounds (<10ug/l).

The ground gas assessment indicates a medium risk to future site users, owing to the presence of radon and carbon dioxide. Gas protection measures and basic radon protection measures are required at the site.

Recommendations

A material management plan (MMP) will be required to facilitate in the cost effective re-development of the site. Allowances should made for the potential abnormal development costs associated with the disposal of hydrocarbon impacted Made Ground in the vicinity of the former reservoir.

END OF REPORT

**APPENDIX I
LIMITATIONS**

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between REC Ltd and the Client as indicated in Section 1.2.
 2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.
 3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
 4. During the site walkover reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
 5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
 6. In addition to the above REC Ltd note that when investigating, or developing, potentially contaminated land it is important to recognise that sub-surface conditions may vary spatially and also with time. The absence of certain ground, ground gas, and contamination or groundwater conditions at the positions tested is not a guarantee that such conditions do not exist anywhere across the site. Due to the presence of existing buildings and structures access could not be obtained to all areas. Additional contamination may be identified following the removal of the buildings or hard standing.
 7. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
 8. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials this is for indicative purposes only and do not constitute or replace full and proper surveys.
 9. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
 10. This report presents an interpretation of the geotechnical information established by excavation, observation and testing. Whilst every effort is made in interpretative reporting to assess the soil conditions over the Site it should be noted that natural strata vary from point to point and that man made deposits are subject to an even greater diversity. Groundwater conditions are dependent on seasonal and other factors. Consequently there may be conditions present not revealed by this investigation.
 11. REC can not be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by REC is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by REC in this connection without their explicit written agreement there to by REC.
 12. Rather, this investigation has been undertaken to provide a preliminary characterisation of the existing sub-surface geotechnical characteristics and make up and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.
 13. This investigation has been undertaken to reasonably characterise existing sub-surface conditions and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.
-

APPENDIX II
GLOSSARY

TERMS

AST	Above Ground Storage Tank
BGS	British Geological Survey
BSI	British Standards Institute
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CIEH	Chartered Institute of Environmental Health
CIRIA	Construction Industry Research Association
CLEA	Contaminated Land Exposure Assessment
CSM	Conceptual Site Model
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)
DWS	Drinking Water Standard
EA	Environment Agency
EQS	Environmental Quality Standard
GAC	General Assessment Criteria
GL	Ground Level
GSV	Gas Screening Value
HCV	Health Criteria Value
ICSM	Initial Conceptual Site Model
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel, kerosene)
ND	Not Detected
LMRL	Lower Method Reporting Limit
NR	Not Recorded

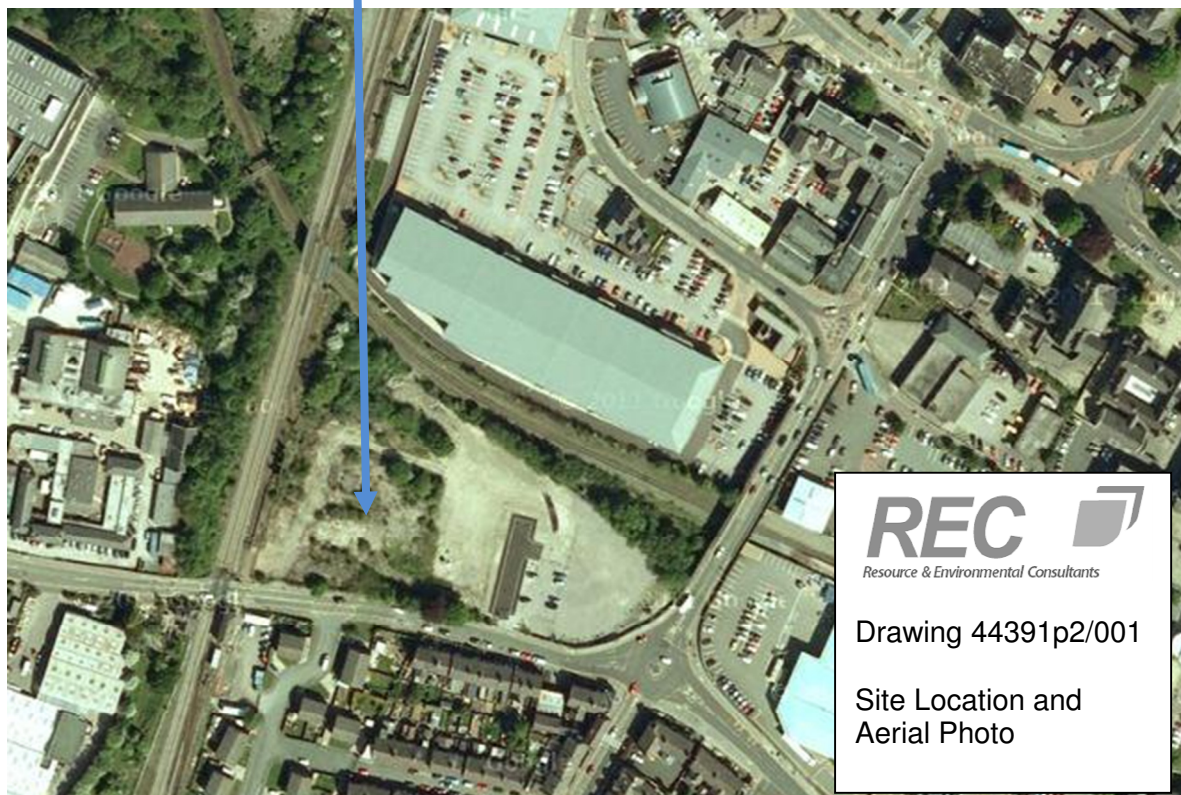
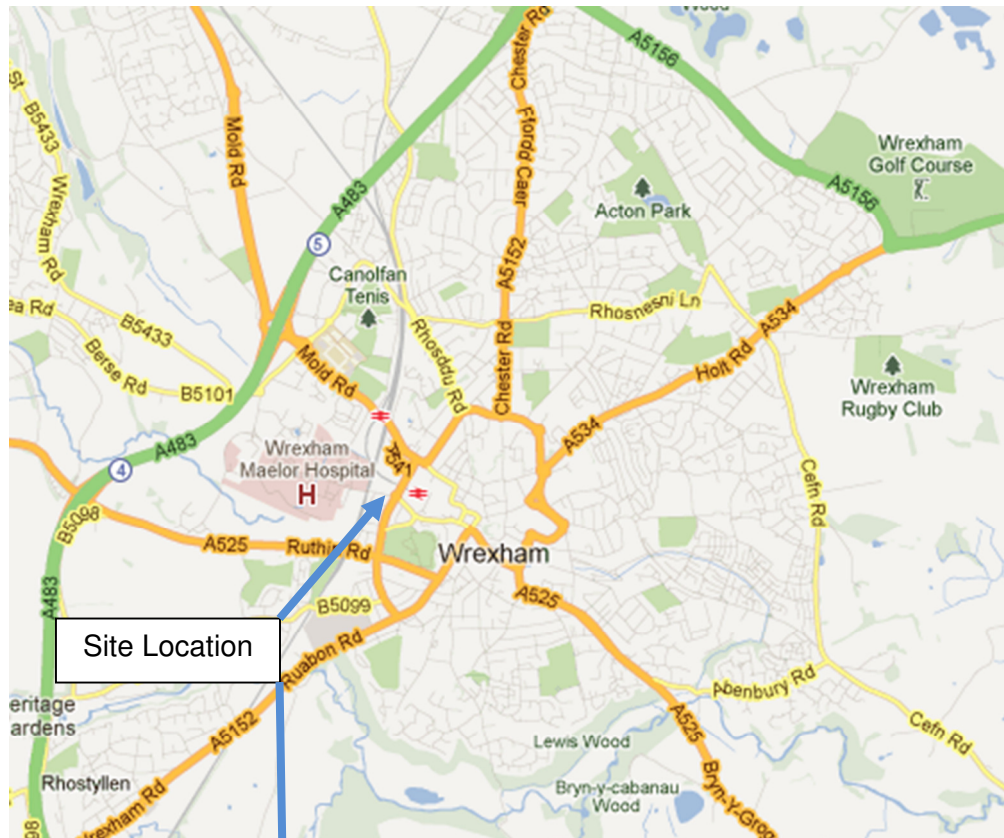
PAH	Poly Aromatic Hydrocarbon
PCB	Poly-Chlorinated Biphenyl
PID	Photo Ionisation Detector
QA	Quality Assurance
SGV	Soil Guideline Value
SPH	Separate Phase Hydrocarbon
Sp.TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)
SPT	Standard Penetration Test
SVOC	Semi Volatile Organic Compound
UST	Underground Storage Tank
VCCs	Vibro Concrete Columns
VOC	Volatile Organic Compound
WTE	Water Table Elevation

UNITS

m	Metres
km	Kilometres
%	Percent
%v/v	Percent volume in air
mb	Milli Bars (atmospheric pressure)
l/hr	Litres per hour
µg/l	Micrograms per Litre (parts per billion)
ppb	Parts Per Billion

mg/kg	Milligrams per kilogram (parts per million)
ppm	Parts Per Million
mg/m ³	Milligram per metre cubed
m bgl	Metres Below Ground Level
m bcl	Metre Below Cover Level
mAOD	Metres Above Ordnance Datum (sea level)
kN/m ²	Kilo Newtons per metre squared
µm	Micro metre

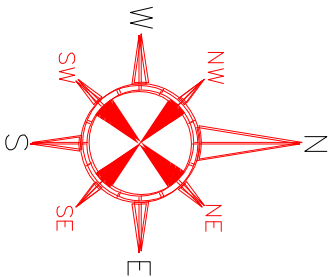
APPENDIX III
DRAWINGS



REC 
Resource & Environmental Consultants

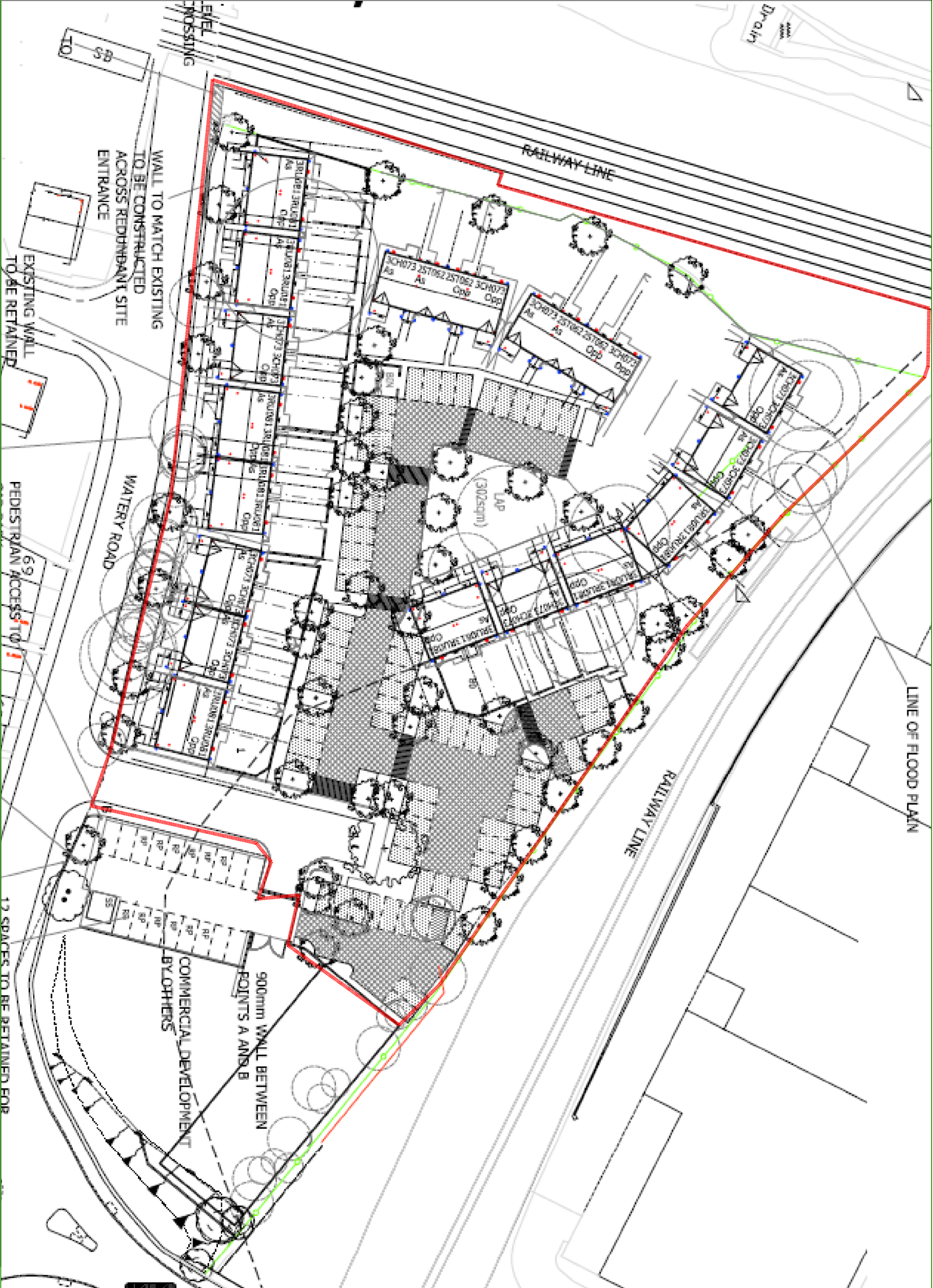
Drawing 44391p2/001

Site Location and
Aerial Photo



Key

Development Site Boundary



The client must not amend any drawing, design or other Intellectual property produced by REC Ltd, without permission in writing from REC Ltd in advance of any amendments being made.

In the event that such written permission is not obtained in advance of the amendments being made, REC Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or other Intellectual property.



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Job Title

Watery Road, Wrexham

Client

Bellway Homes

Job No: 44391

Drawn by: S. Howard

Approved by: R. Paul

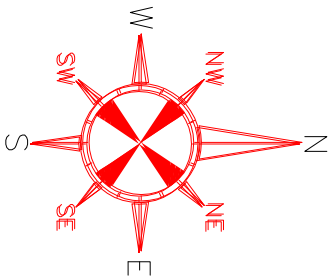
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Date: 06/2012

Notes:

Drawing Title

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Proposed Development
Plan

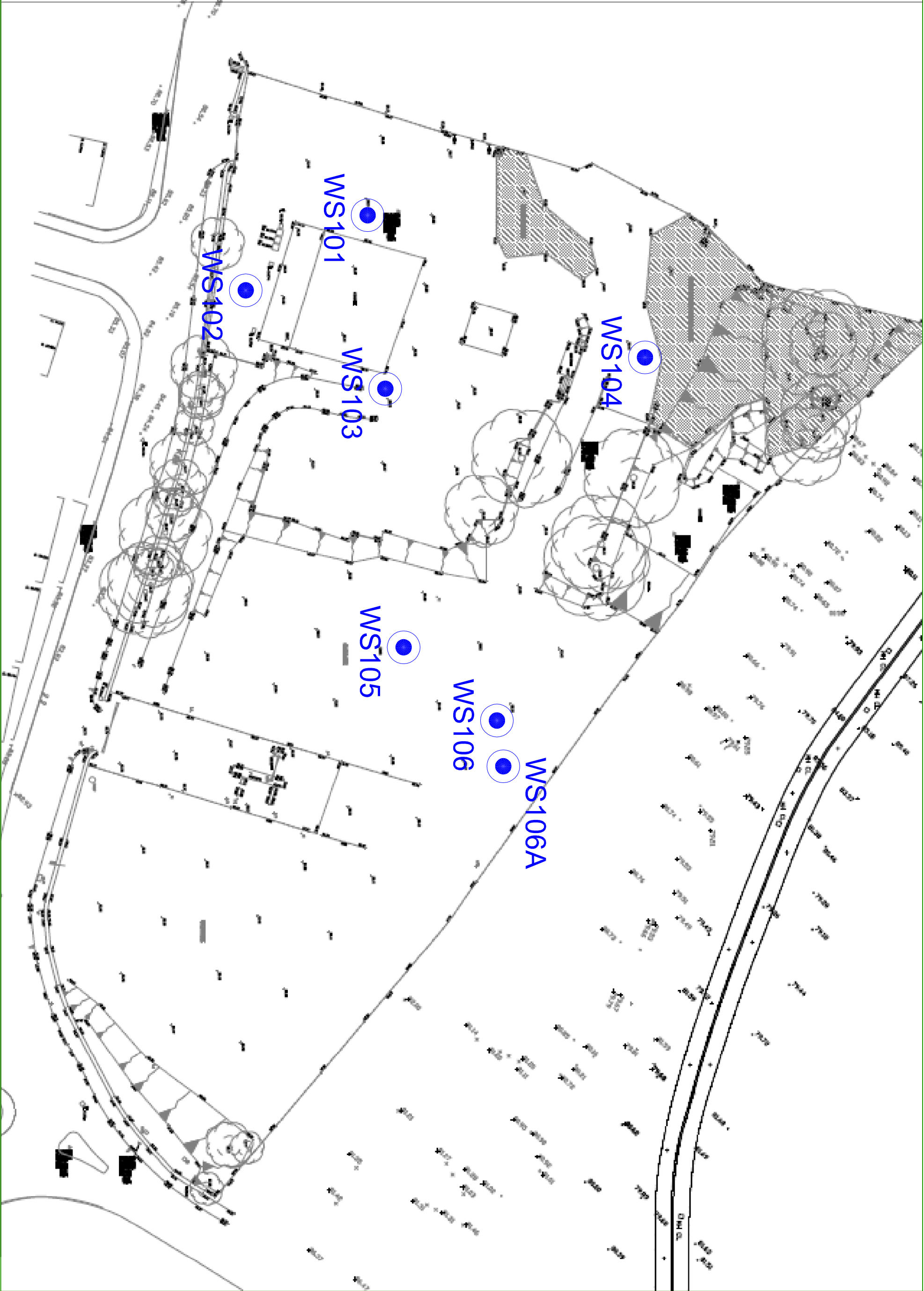


Key



WS101

Approximate Window Sample
Probehole Location



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E-mail: sales@rectl.co.uk
Website: www.rectl.co.uk

Job Title
Watery Road, Wrexham

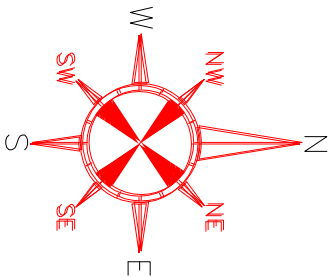
Client
Bellway Homes

Job No: 44391
Drawn by: S. Towers
Approved by: R. paul
Scale: NTS

DATE
06/2012

Notes:

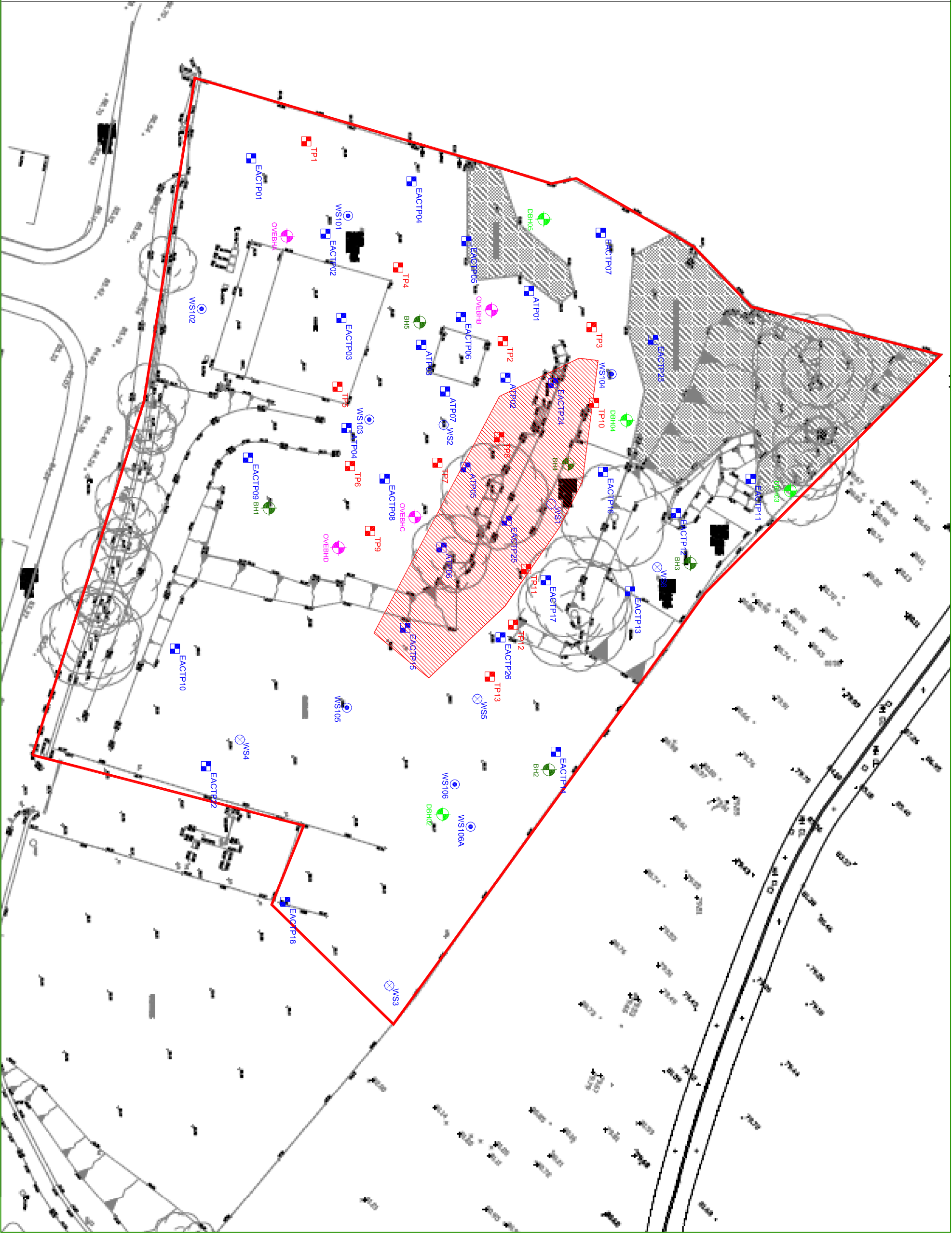
Drawing Title
44391p2-003
Exploratory Hole
Location Plan

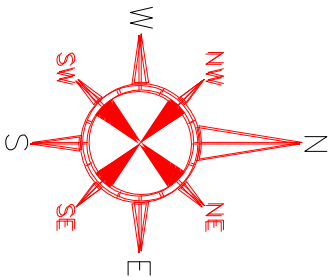


- Key
- DVE ARUP Borehole Locations 2005
- EAC Borehole Locations 2005
- DBH01
- ENCIA Borehole Location 2008
- BH1
- WS1
- ENCIA Window Sample Location 2008
- EACTP1
- EAC Trial Pit Locations 2005
- TP1
- ENCIA Trial Pit Location 2008
- WS101
- Approximate Window Sample Probehole Location
- Site Boundary
- Approximate location of former reservoir

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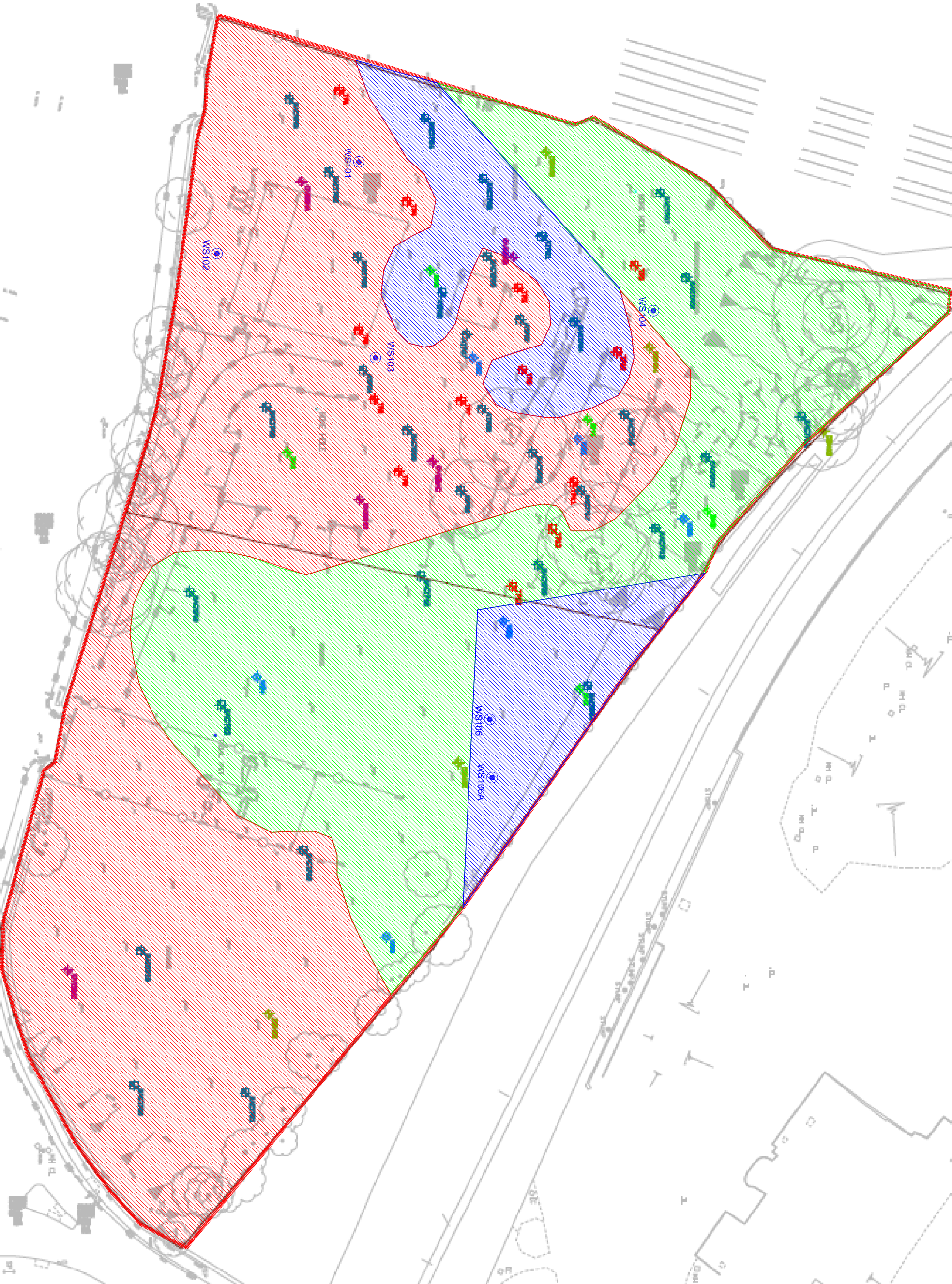
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Key

- Made Ground thickness 0.00-2.00m
- Made Ground thickness 2.00-3.00m
- Made Ground thickness >3.00m
- Site boundary



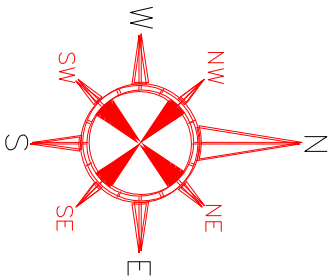
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Website: www.rectd.co.uk

Job Title		Client		Job No: 44391		DATE 06/2012		Notes:		Drawing Title	
Watery Road, Wrexham		Bellway Homes		Drawn by: S. Howard						44391p2-005	
				Approved by: R. paul						Depth to Made Ground	
				Scale: NTS							



Key

Development
Site Boundary

Vibro granular
column
foundations

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Website: www.recitd.co.uk

Job Title

Watery Road, Wrexham

Client

Bellway Homes

Job No: 44391

Drawn by: S. Howard

Approved by: R. Paul

Scale: NTS

DATE
06/2012

Notes:

Drawing Title

44391p2-006
Foundation Zoning
Plan

APPENDIX IV
REC EXPLORATORY HOLE LOGS

Borehole Record - Window Sample

Probehole Number: WS101

Project Number: 44391

Contract Name: Watery Road, Wrexham

Client: Bellway Homes (NW)

Engineer: S. Towers

Date Started: 19/04/2012

Date Completed: 19/04/2012

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Mini tracked window sampler rig



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation / Backfill
		MADE GROUND: Black asphalt.	0.15					
1.0		MADE GROUND: Fine to medium very gravelly red/brown sand with many cobbles. Gravel is medium to coarse angular to sub-angular of brick and concrete. Cobbles are sub-angular to angular of brick and concrete. ...becomes dense at 1.00m bgl		ES	0.40			
				SPT	1.00-1.45	3/10/7/5/8/12 N= 32		
2.0		...becomes medium dense at 2.00m bgl		SPT	2.00-2.45	2/2/2/2/3/3 N= 10		
				ES	2.50			
3.0				SPT	3.00-3.45	3/6/6/4/4/5 N= 19		
				ES	3.50			
4.0		...becomes dense at 4.00m bgl		SPT	4.00-4.45	10/7/8/10/10/8 N= 36		
			4.45					
5.0		Terminated at 4.45m bgl due to cobbles.						
6.0								

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

ES. Environmental Sample

Notes

Groundwater: None encountered

Services: Prior to drilling the location was scanned with a cable avoidance tool (CAT).

Addition of water: None added

Casing diameter: 110mm

Date logged: 23/04/2012

Status: Prelim2

Borehole Record - Window Sample

Probehole Number: WS102

Project Number: 44391

Contract Name: Watery Road, Wrexham

Client: Bellway Homes (NW)

Engineer: S. Towers

Date Started: 19/04/2012

Date Completed: 19/04/2012

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Mini tracked window sampler rig



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation / Backfill
1.0		MADE GROUND: Fine to medium clayey gravelly sand. Gravel is fine to coarse angular to sub-angular of sandstone. ...becomes very loose at 1.00m bgl	1.30	SPT	1.00-1.45	0/0/0/0/1/1 N= 2		
2.0		MADE GROUND: Sandy yellow/brown gravel. Gravel is fine to coarse angular to sub-angular of sandstone with occasional bands of coarse sand. ...becomes medium dense at 2.00m bgl		ES	1.30			
3.0				SPT	2.00-2.45	1/2/5/4/3/3 N= 15		
4.0				SPT ES	3.00-3.45 3.00	1/2/2/3/3/2 N= 10		
5.0		becomes very dense at 5.00m bgl	5.00	SPT	4.00-4.45	3/6/6/4/4/5 N= 19		
6.0		Complete at 5.00m bgl.			5.00-5.45	3/4/6/10/19/18 N= 53		

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

ES. Environmental Sample

Notes

Groundwater: None encountered

Services: Prior to drilling the location was scanned with a cable avoidance tool (CAT).

Addition of water: None added

Casing diameter: 110mm

Date logged: 23/04/2012

Status: Prelim2

Borehole Record - Window Sample

Probehole Number: WS103

Project Number: 44391

Contract Name: Watery Road, Wrexham

Client: Bellway Homes (NW)

Engineer: S. Towers

Date Started: 19/04/2012

Date Completed: 19/04/2012

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Mini tracked window sampler rig



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation / Backfill
0.0		MADE GROUND: Fine to medium very gravelly red/brown sand with many cobbles. Gravel is medium to coarse angular to sub-angular of brick and concrete. Cobbles are sub-angular to angular of brick and concrete.		ES	0.50			
1.0		...becomes medium dense at 1.00m bgl		SPT	1.00-1.45	1/5/5/5/5 N= 20		
2.0				SPT	2.00-2.45	3/6/6/5/8/4 N= 23		
3.0				ES	2.50			
4.0				SPT	3.00-3.45	1/2/3/3/3/3 N= 12		
5.0		...becomes loose at 5.00m bgl		SPT	4.00-4.45	1/2/3/3/2/2 N= 10		
				SPT	5.00-5.45	2/2/2/2/2/2 N= 8		

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

ES. Environmental Sample

Notes

Groundwater: None encountered

Services: Prior to drilling the location was scanned with a cable avoidance tool (CAT).

Addition of water: None added

Casing diameter: 110mm

Date logged: 23/04/2012

Status: Prelim2

Borehole Record - Window Sample

Probehole Number: WS103

Project Number: 44391

Contract Name: Watery Road, Wrexham

Client: Bellway Homes (NW)

Engineer: S. Towers

Date Started: 19/04/2012

Date Completed: 19/04/2012

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Mini tracked window sampler rig



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation / Backfill
6.0		...becomes mediumd dense at 6.00m bgl	6.45	SPT	6.00-6.45	17/11/5/5/3/3 N= 16		
7.0		Complete at 6.45m bgl.						
8.0								
9.0								
10.0								

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

ES. Environmental Sample

Notes

Groundwater: None encountered

Services: Prior to drilling the location was scanned with a cable avoidance tool (CAT).

Additon of water: None added

Casing diameter: 110mm

Date logged: 23/04/2012

Status: Prelim2

Borehole Record - Window Sample

Probehole Number: WS104

Project Number: 44391

Contract Name: Watery Road, Wrexham

Client: Bellway Homes (NW)

Engineer: S. Towers

Date Started: 19/04/2012

Date Completed: 19/04/2012

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Mini tracked window sampler rig



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation / Backfill
1.0		MADE GROUND: Fine to medium very clayey grey/brown very gravelly sand with many cobbles. Gravel is medium to coarse angular to sub-angular of sandstone and brick. Cobbles are sub-angular to angular of sandstone and brick.	1.20	ES	0.50			
2.0		Very soft very low strength very sandy very gravelly red/brown CLAY. Gravel is fine to coarse angular to sub-angular of sandstone. ...becomes stiff high strength at 2.00m bgl		SPT	1.00-1.45	0/0/0/0/0/0 N= 0		
3.0			3.00	SPT	2.00-2.45	2/2/2/2/2/2 N= 8		
4.0		Very soft very low strength very sandy gravelly grey CLAY. Gravel is fine to medium angular to sub-angular of sandstone.	3.60	ES	3.50			
5.0		Fine to medium very gravelly SAND with some cobbles. Gravel is medium to coarse angular to sub-angular of sandstone and mudstone. Cobbles are sub-angular to sub-rounded of sandstone.	5.00	ES	4.00			
6.0		Complete at 5.00m bgl.						

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

ES. Environmental Sample

Notes

Groundwater: None encountered

Services: Prior to drilling the location was scanned with a cable avoidance tool (CAT).

Addition of water: None added

Casing diameter: 110mm

Date logged: 23/04/2012

Status: Prelim2

Borehole Record - Window Sample

Probehole Number: WS105

Project Number: 44391

Contract Name: Watery Road, Wrexham

Client: Bellway Homes (NW)

Engineer: S. Towers

Date Started: 19/04/2012

Date Completed: 19/04/2012

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Mini tracked window sampler rig



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation / Backfill
0.0		MADE GROUND: Medium to coarse very clayey very gravelly dark grey sand. Gravel is medium to coarse angular to sub-angular of concrete, brick, asphalt and limestone.		ES	0.40			
1.0		...becomes loose at 1.00m bgl	1.30	SPT	1.00-1.45	1/1/1/1/1 N= 4		
2.0		Fine red/brown gravelly sand. Gravel is medium to coarse angular to sub-angular of sandstone, limestone and coal.		ES	1.30			
2.0		...becomes loose at 2.00m bgl		SPT	2.00-2.45	2/2/2/2/2 N= 8		
3.0		Firm medium strength sandy gravelly CLAY. Gravel is medium to coarse angular to sub-angular of sandstone.	3.00	SPT	3.00-3.45	2/2/1/2/2/2 N= 7		
4.0		Medium strength oarse gravelly yellow brown SAND. Gravel is fine to medium angular to sub-angular of sandstone.	3.80	ES	3.80			
4.0			4.50	SPT	4.00-4.45	1/1/1/3/3/3 N= 10		
5.0		Firm to stiff sandy gravelly CLAY. Gravel is fine to medium angular to sub-angular of sandstone.	5.00	SPT	5.00-5.45	2/3/2/3/3/4 N= 12		
5.0		...becomes stiff high strength at 5.00m bgl						
6.0		Complete at 5.00m bgl.						

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

ES. Environmental Sample

Notes

Groundwater: Waterstrike at 3.80m bgl

Services: Prior to drilling the location was scanned with a cable avoidance tool (CAT).

Additon of water: None added

Casing diameter: 110mm

Date logged: 23/04/2012

Status: Prelim2

Borehole Record - Window Sample

Probehole Number: WS106

Project Number: 44391

Contract Name: Watery Road, Wrexham

Client: Bellway Homes (NW)

Engineer: S. Towers

Date Started: 19/04/2012

Date Completed: 19/04/2012

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Mini tracked window sampler rig



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation / Backfill
1.0		MADE GROUND: MADE GROUND: Medium to coarse clayey dark grey gravelly sand with many cobbles. Gravel is fine to coarse angular to sub-rounded of sandstone, limestone, concrete. Cobbles are sub-angular to sub-rounded of sandstone.	1.50					
2.0		Terminated at 1.50m bgl due to a large sandstone obstruction.						
3.0								
4.0								
5.0								
6.0								

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

ES. Environmental Sample

Notes

Groundwater: None encountered

Services: Prior to drilling the location was scanned with a cable avoidance tool (CAT).

Addition of water: None added

Casing diameter: 110mm

Date logged: 23/04/2012

Status: Prelim2

Borehole Record - Window Sample

Probehole Number: WS106a

Project Number: 44391

Contract Name: Watery Road, Wrexham

Client: Bellway Homes (NW)

Engineer: S. Towers

Date Started: 19/04/2012

Date Completed: 19/04/2012

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Mini tracked window sampler rig



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation / Backfill
1.0		MADE GROUND: Medium to coarse clayey dark grey gravelly sand with many cobbles. Gravel is fine to coarse angular to sub-rounded of sandstone, limestone, concrete. Many cobbles and boulders of sandstone.		ES	0.50			
				SPT	1.00-1.45	2/2/2/3/2 N= 10		
			1.50	SPT	1.50	50 for 0mm		
2.0		Terminated at 1.50m bgl due to a large sandstone boulder.						
3.0								
4.0								
5.0								
6.0								

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

ES. Environmental Sample

Notes

Groundwater: None encountered

Services: Prior to drilling the location was scanned with a cable avoidance tool (CAT).

Addition of water: None added

Casing diameter: 110mm

Date logged: 23/04/2012

Status: Prelim2

APPENIDIX V
CHEMICAL TESTING RESULTS



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Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Report Number: 275992-1

Date of Report: 30-Apr-2012

Customer: Resource Environmental Consultants Ltd
Osprey House
Pacific Quay
Broadway
Salford
M50 2UE

Customer Contact: Miss Steph Towers

Customer Job Reference: 44391

Date Job Received at SAL: 21-Apr-2012

Date Analysis Started: 23-Apr-2012

Date Analysis Completed: 30-Apr-2012

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs



1549

Report checked
and authorised by :
Mr Ross Walker
Customer Services Manager
(Land)

Issued by :
Mr Ross Walker
Customer Services Manager
(Land)

SAL Reference: 275992 Customer Reference: 44391 Soil Analysed as Soil REC Suite C (Banded TPH C5-C35)								
SAL Reference				275992 004	275992 006	275992 010	275992 011	
Customer Sample Reference				WS102 1.3	WS103 0.5	WS104 4.0	WS105 0.4	
Date Sampled				19-APR-2012	19-APR-2012	19-APR-2012	19-APR-2012	
Determinand	Method	Test Sample	LOD	Units				
TPH (C5-C6)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10
TPH (C6-C8)	T54	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
TPH (C8-C10)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10
TPH (C10-C12)	T8	AR	1	mg/kg	<1	⁽⁹⁾ <10	<1	1
TPH (C12-C16)	T8	AR	1	mg/kg	<1	39	<1	10
TPH (C16-C21)	T8	AR	1	mg/kg	2	450	3	70
TPH (C21-C35)	T8	AR	1	mg/kg	7	5000	3	980

SAL Reference: 275992						
Customer Reference: 44391						
Soil		Analysed as Soil				
REC TPH (CWG)						
SAL Reference					275992 009	275992 012
Customer Sample Reference					WS104 3.5	WS105 1.3
Date Sampled					19-APR-2012	19-APR-2012
Determinand	Method	Test Sample	LOD	Units		
Benzene	T54	AR	0.001	mg/kg	(13) <0.001	(13) <0.001
Toluene	T54	AR	0.001	mg/kg	<0.001	<0.001
EthylBenzene	T54	AR	0.001	mg/kg	<0.001	<0.001
M/P Xylene	T54	AR	0.001	mg/kg	<0.001	<0.001
O Xylene	T54	AR	0.001	mg/kg	<0.001	<0.001
Methyl tert-Butyl Ether	T54	AR	0.001	mg/kg	<0.001	<0.001
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	<0.010	<0.010
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	<0.010	<0.010
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	2.1	<0.010
TPH (C10-C12 aliphatic)	T8	AR	1	mg/kg	11	<1
TPH (C12-C16 aliphatic)	T8	AR	1	mg/kg	62	<1
TPH (C16-C21 aliphatic)	T8	AR	1	mg/kg	35	<1
TPH (C21-C35 aliphatic)	T8	AR	1	mg/kg	6	<1
TPH (Aliphatic) total	T85	AR		mg/kg	120	N.D.
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	<0.010	<0.010
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	<0.010	<0.010
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	0.030	<0.010
TPH (C10-C12 aromatic)	T8	AR	1	mg/kg	<1	<1
TPH (C12-C16 aromatic)	T8	AR	1	mg/kg	3	<1
TPH (C16-C21 aromatic)	T8	AR	1	mg/kg	5	<1
TPH (C21-C35 aromatic)	T8	AR	1	mg/kg	4	<1
TPH (Aromatic) total	T85	AR		mg/kg	12	N.D.
TPH (Aliphatic+Aromatic) (sum)	T85	AR		mg/ka	130	N.D.

SAL Reference: 275992 Customer Reference: 44391	
Soil	Analysed as Soil
Volatile Organic Compounds (USEPA 624)	

SAL Reference					275992 002	275992 004	275992 007	275992 009	275992 010
Customer Sample Reference					WS101 2.5	WS102 1.3	WS103 2.5	WS104 3.5	WS104 4.0
Date Sampled					19-APR-2012	19-APR-2012	19-APR-2012	19-APR-2012	19-APR-2012
Determinand	Method	Test Sample	LOD	Units					
1,1,1,2-Tetrachloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,1-Trichloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,2,2-Tetrachloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,2-Trichloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,2-Trichloroethylene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,1-Dichloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,1-Dichloroethylene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,1-Dichloropropene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,2,3-Trichloropropane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,2,4-Trimethylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-dibromoethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichlorobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichloropropane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,3,5-Trimethylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,3-Dichlorobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,3-Dichloropropane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
1,4-Dichlorobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
2,2-Dichloropropane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
2-Chlorotoluene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
4-Chlorotoluene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Benzene	T54	AR	0.001	mg/kg	(13) <0.001	(13) <0.001	(13) <0.001	(13) <0.001	(13) <0.001
Bromobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Bromochloromethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Bromodichloromethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Bromoform	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Bromomethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Carbon tetrachloride	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Chlorobenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Chlorodibromomethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroform	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Chloromethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Cis-1,2-Dichloroethylene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Cis-1,3-Dichloropropene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Dibromomethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Dichlorodifluoromethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Dichloromethane	T54	AR	0.050	mg/kg	<0.050	<0.050	<0.050	<0.050	<0.050
EthylBenzene	T54	AR	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
Isopropyl benzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
M/P Xylene	T54	AR	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
n-Propylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
O Xylene	T54	AR	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
p-Isopropyltoluene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
S-Butylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Styrene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
T-Butylbenzene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Tetrachloroethene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	T54	AR	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
Trans-1,2-Dichloroethene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Trans-1,3-Dichloropropene	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Trichlorofluoromethane	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Vinyl chloride	T54	AR	0.005	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005

9	LOD raised due to dilution of sample
13	Results have been blank corrected.
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T54	GC/MS (Headspace)
T85	Calc
T8	GC/FID

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
TPH (C5-C6)	T54	AR	0.10	mg/kg	N	004,006,010-011
TPH (C6-C8)	T54	AR	0.1	mg/kg	N	004,006,010-011
TPH (C8-C10)	T54	AR	0.10	mg/kg	N	004,006,010-011
TPH (C10-C12)	T8	AR	1	mg/kg	U	004,006,010-011
TPH (C12-C16)	T8	AR	1	mg/kg	U	004,006,010-011
TPH (C16-C21)	T8	AR	1	mg/kg	U	004,006,010-011
TPH (C21-C35)	T8	AR	1	mg/kg	U	004,006,010-011
Methyl tert-Butyl Ether	T54	AR	0.001	mg/kg	U	009,012
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	N	009,012
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	N	009,012
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	N	009,012
TPH (C10-C12 aliphatic)	T8	AR	1	mg/kg	N	009,012
TPH (C12-C16 aliphatic)	T8	AR	1	mg/kg	N	009,012
TPH (C16-C21 aliphatic)	T8	AR	1	mg/kg	N	009,012
TPH (C21-C35 aliphatic)	T8	AR	1	mg/kg	N	009,012
TPH (Aliphatic) total	T85	AR		mg/kg	N	009,012
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	N	009,012
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	N	009,012
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	N	009,012
TPH (C10-C12 aromatic)	T8	AR	1	mg/kg	N	009,012
TPH (C12-C16 aromatic)	T8	AR	1	mg/kg	N	009,012
TPH (C16-C21 aromatic)	T8	AR	1	mg/kg	N	009,012
TPH (C21-C35 aromatic)	T8	AR	1	mg/kg	N	009,012
TPH (Aromatic) total	T85	AR		mg/kg	N	009,012
TPH (Aliphatic+Aromatic) (sum)	T85	AR		mg/kg	N	009,012
1,1,1,2-Tetrachloroethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,1,1-Trichloroethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,1,2,2-Tetrachloroethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,1,2-Trichloroethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,1,2-Trichloroethylene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,1-Dichloroethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,1-Dichloroethylene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,1-Dichloropropene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,2,3-Trichloropropane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,2,4-Trimethylbenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,2-dibromoethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,2-Dichlorobenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,2-Dichloroethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,2-Dichloropropane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,3,5-Trimethylbenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,3-Dichlorobenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,3-Dichloropropane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
1,4-Dichlorobenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
2,2-Dichloropropane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
2-Chlorotoluene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
4-Chlorotoluene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Benzene	T54	AR	0.001	mg/kg	U	002,004,007,009-010,012-013
Bromobenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Bromochloromethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Bromodichloromethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Bromoform	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Bromomethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Carbon tetrachloride	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Chlorobenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Chlorodibromomethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Chloroethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Chloroform	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Chloromethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Cis-1,2-Dichloroethylene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Cis-1,3-Dichloropropene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Dibromomethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Dichlorodifluoromethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Dichloromethane	T54	AR	0.050	mg/kg	N	002,004,007,009-010,013
EthylBenzene	T54	AR	0.001	mg/kg	U	002,004,007,009-010,012-013
Isopropyl benzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
M/P Xylene	T54	AR	0.001	mg/kg	U	002,004,007,009-010,012-013
n-Propylbenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
O Xylene	T54	AR	0.001	mg/kg	U	002,004,007,009-010,012-013
p-Isopropyltoluene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
S-Butylbenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Styrene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
T-Butylbenzene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Tetrachloroethene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Toluene	T54	AR	0.001	mg/kg	U	002,004,007,009-010,012-013
Trans-1,2-Dichloroethene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Trans-1,3-Dichloropropene	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Trichlorofluoromethane	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013
Vinyl chloride	T54	AR	0.005	mg/kg	U	002,004,007,009-010,013





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Certificate of Analysis

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Report Number: 277784-1

Date of Report: 14-May-2012

Customer: Resource Environmental Consultants Ltd
Osprey House
Pacific Quay
Broadway
Salford
M50 2UE

Customer Contact: Mr Simon Howard

Customer Job Reference: 44391

Date Job Received at SAL: 04-May-2012

Date Analysis Started: 08-May-2012

Date Analysis Completed: 11-May-2012

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
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Tests covered by this certificate were conducted in accordance with SAL SOPs



1549

Report checked
and authorised by :
Mr Ross Walker
Customer Services Manager
(Land)

Issued by :
Mr Ross Walker
Customer Services Manager
(Land)

SAL Reference: 277784 Customer Reference: 44391 Water Analysed as Water REC Ltd 002W					
SAL Reference				277784 001	
Customer Sample Reference				WS105	
Date Sampled				03-MAY-2012	
Determinand	Method	Test Sample	LOD	Units	
As (Dissolved)	T281	AR	0.2	µg/l	4.8
Cd (Dissolved)	T281	AR	0.02	µg/l	0.06
Cr (Dissolved)	T281	AR	1	µg/l	15
Pb (Dissolved)	T281	AR	0.3	µg/l	<0.3
Hg (Dissolved)	T281	AR	0.05	µg/l	0.36
Se (Dissolved)	T281	AR	0.5	µg/l	3.7
Cu (Dissolved)	T281	AR	0.5	µg/l	6.0
Ni (Dissolved)	T281	AR	1	µg/l	5
Zn (Dissolved)	T281	AR	2	µg/l	8
pH	T7	AR			7.6
SO ₄ (Total)	T6	AR	50000	µg/l	130000
Cyanide(Total)	T4	AR	50	µg/l	<50
Phenols(Mono)	T4	AR	100	µg/l	<100
Chromium VI	T4	AR	30	µg/l	(IS) -

SAL Reference: 277784 Customer Reference: 44391 Water Analysed as Water REC Suite C (Banded TPH C5-C35)					
SAL Reference				277784 001	
Customer Sample Reference				WS105	
Date Sampled				03-MAY-2012	
Determinand	Method	Test Sample	LOD	Units	
TPH (C5-C6)	T215	AR	10	µg/l	<10
TPH (C6-C8)	T215	AR	10	µg/l	<10
TPH (C8-C10) DW	T215	AR	10	µg/l	<10
TPH (C10-C12) DW	T81	AR	10	µg/l	<10
TPH (C12-C16) DW	T81	AR	10	µg/l	<10
TPH (C16-C21) DW	T81	AR	10	µg/l	54
TPH (C21-C35) DW	T81	AR	10	µg/l	110

SAL Reference: 277784					
Customer Reference: 44391					
Water Analysed as Water					
Semi-Volatile Organic Compounds (USEPA 625)					
SAL Reference				277784 001	
Customer Sample Reference				WS105	
Date Sampled				03-MAY-2012	
Determinand	Method	Test Sample	LOD	Units	
1,2,4-Trichlorobenzene	T16	AR	10	µg/l	(IS) -
1,2-Dichlorobenzene	T16	AR	10	µg/l	(IS) -
1,3-Dichlorobenzene	T16	AR	10	µg/l	(IS) -
1,4-Dichlorobenzene	T16	AR	10	µg/l	(IS) -
2,4,5-Trichlorophenol	T16	AR	10	µg/l	(IS) -
2,4,6-Trichlorophenol	T16	AR	10	µg/l	(IS) -
2,4-Dichlorophenol	T16	AR	10	µg/l	(IS) -
2,4-Dimethylphenol	T16	AR	10	µg/l	(IS) -
2,4-Dinitrophenol	T16	AR	10	µg/l	(IS) -
2,4-Dinitrotoluene	T16	AR	10	µg/l	(IS) -
2,6-Dinitrotoluene	T16	AR	10	µg/l	(IS) -
2-Chloronaphthalene	T16	AR	10	µg/l	(IS) -
2-Chlorophenol	T16	AR	10	µg/l	(IS) -
2-methyl phenol	T16	AR	10	µg/l	(IS) -
2-Methylnaphthalene	T16	AR	10	µg/l	(IS) -
2-Nitroaniline	T16	AR	10	µg/l	(IS) -
2-Nitrophenol	T16	AR	10	µg/l	(IS) -
3-Nitroaniline	T16	AR	10	µg/l	(IS) -
3/4-Methylphenol	T16	AR	10	µg/l	(IS) -
4-Bromophenyl phenylether	T16	AR	10	µg/l	(IS) -
4-Chloro-3-methylphenol	T16	AR	10	µg/l	(IS) -
4-Chloroaniline	T16	AR	10	µg/l	(IS) -
4-Chlorophenyl phenylether	T16	AR	10	µg/l	(IS) -
4-Nitroaniline	T16	AR	10	µg/l	(IS) -
4-Nitrophenol	T16	AR	10	µg/l	(IS) -
Acenaphthene	T16	AR	10	µg/l	(IS) -
Acenaphthylene	T16	AR	10	µg/l	(IS) -
Anthracene	T16	AR	10	µg/l	(IS) -
Azobenzene	T16	AR	10	µg/l	(IS) -
Benzo(a)Anthracene	T16	AR	10	µg/l	(IS) -
Benzo(a)Pyrene	T16	AR	10	µg/l	(IS) -
Benzo(b/k)Fluoranthene	T16	AR	10	µg/l	(IS) -
Benzo(ghi)Perylene	T16	AR	10	µg/l	(IS) -
Bis (2-chloroethoxy) methane	T16	AR	10	µg/l	(IS) -
Bis (2-chloroethyl) ether	T16	AR	10	µg/l	(IS) -
Bis (2-chloroisopropyl) ether	T16	AR	10	µg/l	(IS) -
Bis (2-ethylhexyl)phthalate	T16	AR	10	µg/l	(IS) -
Butyl benzylphthalate	T16	AR	10	µg/l	(IS) -
Carbazole	T16	AR	10	µg/l	(IS) -
Chrysene	T16	AR	10	µg/l	(IS) -
Di-n-butylphthalate	T16	AR	10	µg/l	(IS) -
Di-n-octylphthalate	T16	AR	10	µg/l	(IS) -
Dibenzo(ah)Anthracene	T16	AR	10	µg/l	(IS) -
Dibenzofuran	T16	AR	10	µg/l	(IS) -
Diethyl phthalate	T16	AR	10	µg/l	(IS) -
Dimethyl phthalate	T16	AR	10	µg/l	(IS) -
Fluoranthene	T16	AR	10	µg/l	(IS) -
Fluorene	T16	AR	10	µg/l	(IS) -
Hexachlorobenzene	T16	AR	10	µg/l	(IS) -
Hexachlorobutadiene	T16	AR	10	µg/l	(IS) -
Hexachlorocyclopentadiene	T16	AR	10	µg/l	(IS) -
Hexachloroethane	T16	AR	10	µg/l	(IS) -
Indeno(123-cd)Pyrene	T16	AR	10	µg/l	(IS) -
Isophorone	T16	AR	10	µg/l	(IS) -
Naphthalene	T16	AR	10	µg/l	(IS) -
Nitrobenzene	T16	AR	10	µg/l	(IS) -
Pentachlorophenol	T16	AR	10	µg/l	(IS) -
Phenanthrene	T16	AR	10	µg/l	(IS) -
Phenol	T16	AR	10	µg/l	(IS) -
Pyrene	T16	AR	10	µg/l	(IS) -

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
2,4-Dinitrotoluene	T16	AR	10	µg/l	U	001
2,6-Dinitrotoluene	T16	AR	10	µg/l	U	001
2-Chloronaphthalene	T16	AR	10	µg/l	U	001
2-Chlorophenol	T16	AR	10	µg/l	U	001
2-methyl phenol	T16	AR	10	µg/l	U	001
2-Methylnaphthalene	T16	AR	10	µg/l	U	001
2-Nitroaniline	T16	AR	10	µg/l	U	001
2-Nitrophenol	T16	AR	10	µg/l	U	001
3-Nitroaniline	T16	AR	10	µg/l	U	001
3/4-Methylphenol	T16	AR	10	µg/l	U	001
4-Bromophenyl phenylether	T16	AR	10	µg/l	U	001
4-Chloro-3-methylphenol	T16	AR	10	µg/l	U	001
4-Chloroaniline	T16	AR	10	µg/l	U	001
4-Chlorophenyl phenylether	T16	AR	10	µg/l	U	001
4-Nitroaniline	T16	AR	10	µg/l	U	001
4-Nitrophenol	T16	AR	10	µg/l	U	001
Acenaphthene	T16	AR	10	µg/l	U	001
Acenaphthylene	T16	AR	10	µg/l	U	001
Anthracene	T16	AR	10	µg/l	U	001
Azobenzene	T16	AR	10	µg/l	U	001
Benzo(a)Anthracene	T16	AR	10	µg/l	U	001
Benzo(a)Pyrene	T16	AR	10	µg/l	U	001
Benzo(b/k)Fluoranthene	T16	AR	10	µg/l	U	001
Benzo(ghi)Perylene	T16	AR	10	µg/l	U	001
Bis (2-chloroethoxy) methane	T16	AR	10	µg/l	U	001
Bis (2-chloroethyl) ether	T16	AR	10	µg/l	U	001
Bis (2-chloroisopropyl) ether	T16	AR	10	µg/l	U	001
Bis (2-ethylhexyl)phthalate	T16	AR	10	µg/l	U	001
Butyl benzylphthalate	T16	AR	10	µg/l	U	001
Carbazole	T16	AR	10	µg/l	U	001
Chrysene	T16	AR	10	µg/l	U	001
Di-n-butylphthalate	T16	AR	10	µg/l	U	001
Di-n-octylphthalate	T16	AR	10	µg/l	U	001
Dibenzo(ah)Anthracene	T16	AR	10	µg/l	U	001
Dibenzofuran	T16	AR	10	µg/l	U	001
Diethyl phthalate	T16	AR	10	µg/l	U	001
Dimethyl phthalate	T16	AR	10	µg/l	U	001
Fluoranthene	T16	AR	10	µg/l	U	001
Fluorene	T16	AR	10	µg/l	U	001
Hexachlorobenzene	T16	AR	10	µg/l	U	001
Hexachlorobutadiene	T16	AR	10	µg/l	U	001
Hexachlorocyclopentadiene	T16	AR	10	µg/l	U	001
Hexachloroethane	T16	AR	10	µg/l	U	001
Indeno(123-cd)Pyrene	T16	AR	10	µg/l	U	001
Isophorone	T16	AR	10	µg/l	U	001
Naphthalene	T16	AR	10	µg/l	U	001
Nitrobenzene	T16	AR	10	µg/l	U	001
Pentachlorophenol	T16	AR	10	µg/l	U	001
Phenanthrene	T16	AR	10	µg/l	U	001
Phenol	T16	AR	10	µg/l	U	001
Pyrene	T16	AR	10	µg/l	U	001
1,1,1,2-Tetrachloroethane	T54	AR	1	µg/l	U	001
1,1,1-Trichloroethane	T54	AR	1	µg/l	U	001
1,1,1,2-Tetrachloroethane	T54	AR	1	µg/l	U	001
1,1,2-Trichloroethane	T54	AR	1	µg/l	U	001
1,1,2-Trichloroethylene	T54	AR	1	µg/l	U	001
1,1-Dichloroethane	T54	AR	1	µg/l	U	001
1,1-Dichloroethylene	T54	AR	1	µg/l	U	001
1,1-Dichloropropene	T54	AR	1	µg/l	U	001
1,2,3-Trichloropropane	T54	AR	1	µg/l	U	001
1,2,4-Trimethylbenzene	T54	AR	1	µg/l	U	001
1,2-dibromoethane	T54	AR	1	µg/l	U	001
1,2-Dichlorobenzene	T54	AR	1	µg/l	U	001
1,2-Dichloroethane	T54	AR	1	µg/l	U	001
1,2-Dichloropropane	T54	AR	1	µg/l	U	001
1,3,5-Trimethylbenzene	T54	AR	1	µg/l	U	001
1,3-Dichlorobenzene	T54	AR	1	µg/l	U	001
1,3-Dichloropropane	T54	AR	1	µg/l	U	001
1,4-Dichlorobenzene	T54	AR	1	µg/l	U	001
2,2-Dichloropropane	T54	AR	1	µg/l	U	001

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
2-Chlorotoluene	T54	AR	1	µg/l	U	001
4-Chlorotoluene	T54	AR	1	µg/l	U	001
Benzene	T54	AR	1	µg/l	U	001
Bromobenzene	T54	AR	1	µg/l	U	001
Bromochloromethane	T54	AR	1	µg/l	U	001
Bromodichloromethane	T54	AR	1	µg/l	U	001
Bromoform	T54	AR	1	µg/l	U	001
Bromomethane	T54	AR	1	µg/l	U	001
Carbon tetrachloride	T54	AR	1	µg/l	U	001
Chlorobenzene	T54	AR	1	µg/l	U	001
Chlorodibromomethane	T54	AR	1	µg/l	U	001
Chloroethane	T54	AR	1	µg/l	U	001
Chloroform	T54	AR	1	µg/l	U	001
Chloromethane	T54	AR	1	µg/l	U	001
Cis-1,2-Dichloroethylene	T54	AR	1	µg/l	U	001
Cis-1,3-Dichloropropene	T54	AR	1	µg/l	U	001
Dibromomethane	T54	AR	1	µg/l	U	001
Dichlorodifluoromethane	T54	AR	1	µg/l	U	001
Dichloromethane	T54	AR	50	µg/l	N	001
EthylBenzene	T54	AR	1	µg/l	U	001
Isopropyl benzene	T54	AR	1	µg/l	U	001
M/P Xylene	T54	AR	1	µg/l	U	001
n-Propylbenzene	T54	AR	1	µg/l	U	001
O Xylene	T54	AR	1	µg/l	U	001
p-Isopropyltoluene	T54	AR	1	µg/l	U	001
S-Butylbenzene	T54	AR	1	µg/l	U	001
Styrene	T54	AR	1	µg/l	U	001
T-Butylbenzene	T54	AR	1	µg/l	U	001
Tetrachloroethene	T54	AR	1	µg/l	U	001
Toluene	T54	AR	1	µg/l	U	001
Trans-1,2-Dichloroethene	T54	AR	1	µg/l	U	001
Trans-1,3-Dichloropropene	T54	AR	1	µg/l	U	001
Trichlorofluoromethane	T54	AR	1	µg/l	U	001
Vinyl chloride	T54	AR	1	µg/l	U	001





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Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

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Report Number: 278859-1

Date of Report: 17-May-2012

Customer: Resource Environmental Consultants Ltd
Osprey House
Pacific Quay
Broadway
Salford
M50 2UE

Customer Contact: Mr Simon Howard

Customer Job Reference: 44391

Date Job Received at SAL: 14-May-2012

Date Analysis Started: 15-May-2012

Date Analysis Completed: 17-May-2012

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs



1549

Report checked
and authorised by :
Mr Ross Walker
Customer Services Manager
(Land)

Issued by :
Mr Ross Walker
Customer Services Manager
(Land)

SAL Reference: 278859					
Customer Reference: 44391					
Water Analysed as Water					
Semi-Volatile Organic Compounds (USEPA 625)					
SAL Reference				278859 001	
Customer Sample Reference				WS105	
Date Sampled				14-MAY-2012	
Determinand	Method	Test Sample	LOD	Units	
1,2,4-Trichlorobenzene	T16	AR	10	µg/l	<10
1,2-Dichlorobenzene	T16	AR	10	µg/l	<10
1,3-Dichlorobenzene	T16	AR	10	µg/l	<10
1,4-Dichlorobenzene	T16	AR	10	µg/l	<10
2,4,5-Trichlorophenol	T16	AR	10	µg/l	<10
2,4,6-Trichlorophenol	T16	AR	10	µg/l	<10
2,4-Dichlorophenol	T16	AR	10	µg/l	<10
2,4-Dimethylphenol	T16	AR	10	µg/l	<10
2,4-Dinitrophenol	T16	AR	10	µg/l	(36) <30
2,4-Dinitrotoluene	T16	AR	10	µg/l	<10
2,6-Dinitrotoluene	T16	AR	10	µg/l	<10
2-Chloronaphthalene	T16	AR	10	µg/l	<10
2-Chlorophenol	T16	AR	10	µg/l	<10
2-methyl phenol	T16	AR	10	µg/l	<10
2-Methylnaphthalene	T16	AR	10	µg/l	<10
2-Nitroaniline	T16	AR	10	µg/l	<10
2-Nitrophenol	T16	AR	10	µg/l	<10
3-Nitroaniline	T16	AR	10	µg/l	<10
3/4-Methylphenol	T16	AR	10	µg/l	<10
4-Bromophenyl phenylether	T16	AR	10	µg/l	<10
4-Chloro-3-methylphenol	T16	AR	10	µg/l	<10
4-Chloroaniline	T16	AR	10	µg/l	<10
4-Chlorophenyl phenylether	T16	AR	10	µg/l	<10
4-Nitroaniline	T16	AR	10	µg/l	<10
4-Nitrophenol	T16	AR	10	µg/l	(36) <30
Acenaphthene	T16	AR	10	µg/l	<10
Acenaphthylene	T16	AR	10	µg/l	<10
Anthracene	T16	AR	10	µg/l	<10
Azobenzene	T16	AR	10	µg/l	<10
Benzo(a)Anthracene	T16	AR	10	µg/l	<10
Benzo(a)Pyrene	T16	AR	10	µg/l	<10
Benzo(b/k)Fluoranthene	T16	AR	10	µg/l	<10
Benzo(ghi)Perylene	T16	AR	10	µg/l	<10
Bis (2-chloroethoxy) methane	T16	AR	10	µg/l	<10
Bis (2-chloroethyl) ether	T16	AR	10	µg/l	<10
Bis (2-chloroisopropyl) ether	T16	AR	10	µg/l	<10
Bis (2-ethylhexyl)phthalate	T16	AR	10	µg/l	<10
Butyl benzylphthalate	T16	AR	10	µg/l	<10
Carbazole	T16	AR	10	µg/l	<10
Chrysene	T16	AR	10	µg/l	<10
Di-n-butylphthalate	T16	AR	10	µg/l	<10
Di-n-octylphthalate	T16	AR	10	µg/l	<10
Dibenzo(ah)Anthracene	T16	AR	10	µg/l	<10
Dibenzofuran	T16	AR	10	µg/l	<10
Diethyl phthalate	T16	AR	10	µg/l	<10
Dimethyl phthalate	T16	AR	10	µg/l	<10
Fluoranthene	T16	AR	10	µg/l	<10
Fluorene	T16	AR	10	µg/l	<10
Hexachlorobenzene	T16	AR	10	µg/l	<10
Hexachlorobutadiene	T16	AR	10	µg/l	<10
Hexachlorocyclopentadiene	T16	AR	10	µg/l	<10
Hexachloroethane	T16	AR	10	µg/l	<10
Indeno(123-cd)Pyrene	T16	AR	10	µg/l	<10
Isophorone	T16	AR	10	µg/l	<10
Naphthalene	T16	AR	10	µg/l	<10
Nitrobenzene	T16	AR	10	µg/l	<10
Pentachlorophenol	T16	AR	10	µg/l	<10
Phenanthrene	T16	AR	10	µg/l	<10
Phenol	T16	AR	10	µg/l	(36) <30
Pyrene	T16	AR	10	µg/l	<10

Index to symbols used in 278859-1

Value	Description
AR	As Received
36	LOD Raised due to low Matrix spike recovery
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T4	Colorimetry
T16	GC/MS

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Chromium VI	T4	AR	50	µg/l	N	001
1,2,4-Trichlorobenzene	T16	AR	10	µg/l	U	001
1,2-Dichlorobenzene	T16	AR	10	µg/l	U	001
1,3-Dichlorobenzene	T16	AR	10	µg/l	U	001
1,4-Dichlorobenzene	T16	AR	10	µg/l	U	001
2,4,5-Trichlorophenol	T16	AR	10	µg/l	U	001
2,4,6-Trichlorophenol	T16	AR	10	µg/l	U	001
2,4-Dichlorophenol	T16	AR	10	µg/l	U	001
2,4-Dimethylphenol	T16	AR	10	µg/l	U	001
2,4-Dinitrophenol	T16	AR	10	µg/l	U	001
2,4-Dinitrotoluene	T16	AR	10	µg/l	U	001
2,6-Dinitrotoluene	T16	AR	10	µg/l	U	001
2-Chloronaphthalene	T16	AR	10	µg/l	U	001
2-Chlorophenol	T16	AR	10	µg/l	U	001
2-methyl phenol	T16	AR	10	µg/l	U	001
2-Methylnaphthalene	T16	AR	10	µg/l	U	001
2-Nitroaniline	T16	AR	10	µg/l	U	001
2-Nitrophenol	T16	AR	10	µg/l	U	001
3-Nitroaniline	T16	AR	10	µg/l	U	001
3/4-Methylphenol	T16	AR	10	µg/l	U	001
4-Bromophenyl phenylether	T16	AR	10	µg/l	U	001
4-Chloro-3-methylphenol	T16	AR	10	µg/l	U	001
4-Chloroaniline	T16	AR	10	µg/l	U	001
4-Chlorophenyl phenylether	T16	AR	10	µg/l	U	001
4-Nitroaniline	T16	AR	10	µg/l	U	001
4-Nitrophenol	T16	AR	10	µg/l	U	001
Acenaphthene	T16	AR	10	µg/l	U	001
Acenaphthylene	T16	AR	10	µg/l	U	001
Anthracene	T16	AR	10	µg/l	U	001
Azobenzene	T16	AR	10	µg/l	U	001
Benzo(a)Anthracene	T16	AR	10	µg/l	U	001
Benzo(a)Pyrene	T16	AR	10	µg/l	U	001
Benzo(b/k)Fluoranthene	T16	AR	10	µg/l	U	001
Benzo(ghi)Perylene	T16	AR	10	µg/l	U	001
Bis (2-chloroethoxy) methane	T16	AR	10	µg/l	U	001
Bis (2-chloroethyl) ether	T16	AR	10	µg/l	U	001
Bis (2-chloroisopropyl) ether	T16	AR	10	µg/l	U	001
Bis (2-ethylhexyl)phthalate	T16	AR	10	µg/l	U	001
Butyl benzylphthalate	T16	AR	10	µg/l	U	001
Carbazole	T16	AR	10	µg/l	U	001
Chrysene	T16	AR	10	µg/l	U	001
Di-n-butylphthalate	T16	AR	10	µg/l	U	001
Di-n-octylphthalate	T16	AR	10	µg/l	U	001
Dibenzo(ah)Anthracene	T16	AR	10	µg/l	U	001
Dibenzofuran	T16	AR	10	µg/l	U	001
Diethyl phthalate	T16	AR	10	µg/l	U	001
Dimethyl phthalate	T16	AR	10	µg/l	U	001
Fluoranthene	T16	AR	10	µg/l	U	001
Fluorene	T16	AR	10	µg/l	U	001
Hexachlorobenzene	T16	AR	10	µg/l	U	001
Hexachlorobutadiene	T16	AR	10	µg/l	U	001

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Hexachlorocyclopentadiene	T16	AR	10	µg/l	U	001
Hexachloroethane	T16	AR	10	µg/l	U	001
Indeno(123-cd)Pyrene	T16	AR	10	µg/l	U	001
Isophorone	T16	AR	10	µg/l	U	001
Naphthalene	T16	AR	10	µg/l	U	001
Nitrobenzene	T16	AR	10	µg/l	U	001
Pentachlorophenol	T16	AR	10	µg/l	U	001
Phenanthrene	T16	AR	10	µg/l	U	001
Phenol	T16	AR	10	µg/l	U	001
Pyrene	T16	AR	10	µg/l	U	001



APPENDIX VI
ORIGIN OF TIER 1 VALUES

ORIGIN OF REC TIER I VALUES

Constituent	Origin of Risk Assessment Value
Arsenic	2009 SGV
Cadmium	LQM CIEH 2 nd Edition 2009
Chromium	LQM CIEH 2 nd Edition 2009
Lead	Residential Half 2003 EA SGV based on planned target blood lead level reduction to 5µg/l.
	Commercial Calculated using commercial exposure equation within lead SGV 2003 with revised input data from HPA and taking proposed blood lead levels into account.
Mercury	2009 SGV
Nickel	2009 SGV
Selenium	Soil guideline value, DEFRA/Environment Agency
Copper	LQM CIEH 2 nd Edition 2009
Zinc	LQM CIEH 2 nd Edition 2009
Cyanide - Total	CLEA 1.06 Derived Value
Phenols - Total.	LQM CIEH 2 nd Edition 2009 – 1% SOM
Naphthalene	General Assessment Criteria (GAC) developed by CIEH / LQM the using CLEA 1-06 with supporting data from SR3, SR7 and existing Tox report where applicable. 1% SOM
Acenaphthylene	
Acenaphthene	
Fluorene	
Phenanthrene	
Anthracene	
Fluoranthene	

Pyrene	
Benzo(a)Anthracene ⁽ⁱ⁾	
Chrysene	
Benzo(b/k)Fluoranthene ⁽ⁱⁱⁱ⁾	
Benzo(a)Pyrene	
Indeno(123-cd)Pyrene	
Dibenzo(a,h)Anthracene	
Benzo(ghi)Perylene	
TPH C ₅ -C ₆ (aliphatic)	
TPH C ₆ -C ₈ (aliphatic)	
TPH C ₈ -C ₁₀ (aliphatic)	
TPH C ₁₀ -C ₁₂ (aliphatic)	
TPH C ₁₂ -C ₁₆ (aromatic)	
TPH C ₁₆ -C ₂₁ (aromatic)	
TPH C ₂₁ -C ₃₅ (aromatic)	

APPENDIX VII
ENCIA CHEMICAL TESTING RESULTS

Validated ☒
Preliminary ☐

ALcontrol Laboratories Analytical Services

Table Of Results

* ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Sample Identity	TP1	TP1	TP2	TP2	TP3	TP3	TP3	TP3	TP5	Method Code	LoD/Units
Depth (m)	0.50	1.50	1.50	2.10	0.50	2.00	2.50	3.50	1.50		
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID		
Sampled Date	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08		
Sample Received Date	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08		
Batch	1	1	1	1	1	1	1	1	1		
Sample Number(s)	21-22	23-24	29-30	31-32	33-34	37-38	39-44	45-46	55-56		
Total Sulphate	1200	-	710	-	-	-	-	-	1600	TM129 ^M	<100 mg/kg
Boron Water Soluble	<3.5	-	<3.5	-	<3.5	<3.5	-	-	<3.5	TM129 ^M	<3.5 mg/kg
Total Sulphate BRE	-	0.16	-	-	-	-	-	0.03	-	TM149	<0.01 %
Arsenic	5	-	4	-	8	4	-	-	9	TM129 ^M	<3.0 mg/kg
Barium	140	-	110	-	220	280	-	-	130	TM129 ^M	<6.0 mg/kg
Beryllium	<0.4	-	<0.4	-	0.6	<0.4	-	-	<0.4	TM129	<0.4 mg/kg
Cadmium	3.0	-	<0.3	-	0.4	<0.3	-	-	2.9	TM129	<0.3 mg/kg
Chromium	15	-	10	-	17	15	-	-	12	TM129 ^M	<4.5 mg/kg
Copper	24	-	66	-	38	19	-	-	36	TM129 ^M	<6 mg/kg
Lead	110	-	120	-	83	28	-	-	150	TM129 ^M	<2 mg/kg
Mercury	<0.6	-	<0.6	-	<0.6	<0.6	-	-	<0.6	TM129 ^M	<0.6 mg/kg
Nickel	16	-	15	-	21	18	-	-	16	TM129 ^M	<0.9 mg/kg
Selenium	<3	-	<3	-	<3	<3	-	-	<3	TM129 ^M	<3 mg/kg
Vanadium	26	-	25	-	26	15	-	-	26	TM129 ^M	<1.5 mg/kg
Zinc	700	-	68	-	150	51	-	-	540	TM129 ^M	<2.5 mg/kg
ANC at pH4	-	-	-	-	-	-	0.35	-	-	TM182 ^B	<0.03 mol/kg
ANC at pH6	-	-	-	-	-	-	0.06	-	-	TM182 ^B	<0.03 mol/kg
Ammonium as NH4 in 2:1 Extract BRE	-	<0.0003	-	-	-	-	-	0.0010	-	TM099 ^B	<0.0003 g/l
Easily Liberated Sulphide	<15	-	<15	-	-	-	-	-	<15	TM180 ^B	<15 mg/kg
Total Organic Carbon	-	-	-	-	-	-	4.7	-	-	TM132 ^M	<0.2 %
Phenols Monohydric	-	-	-	-	-	-	<0.15	-	-	TM062 ^M	<0.15 mg/kg
Total Cyanide	-	-	<1	-	-	-	-	-	<1	TM153 ^M	<1 mg/kg
Free Cyanide	-	-	<1	-	-	-	-	-	<1	TM153	<1 mg/kg
Asbestos Presence Screen	No Fibres Detected	-	-	-	No Fibres Detected	-	-	-	-	TM001	NONE
Calorific Value	-	-	-	-	-	-	-	-	-	TM132 ^B	<100 KJ/Kg
Chloride 2:1 water/soil extract BRE	-	0.040	-	-	-	-	-	0.005	-	TM097 ^B	<0.001 g/l
Magnesium 2:1 water/soil extract BRE	-	<0.001	-	-	-	-	-	0.002	-	TM129 ^B	<0.001 g/l
Nitrate 2:1 water/soil extract BRE	-	0.0016	-	-	-	-	-	<0.0003	-	TM102 ^B	<0.0003 g/l
pH Value	9.19	9.04	9.43	-	8.88	8.48	7.07	7.83	9.57	TM133 ^M	<1.00 pH Units
Soluble Sulphate 2:1 Extract as SO4 BRE	-	0.16	-	-	-	-	-	0.032	-	TM098 ^B	<0.003 g/l
Total Sulphur	0.11	0.16	0.13	-	-	-	-	0.12	0.16	TM068 ^B	<0.01 %

All results expressed on a dry weight basis.

Date 20.02.2008

- # ISO 17025 accredited
- M MCERTS accredited
- * Subcontracted test
- » Shown on prev. report

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

[illegible]

All results expressed on a dry weight basis.

Date 20.02.2008

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» Shown on prev. report

Client Contact: Phil Hill

Date 20.02.2008

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ALcontrol Laboratories Analytical Services

Table Of Results

* ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Sample Identity	TP1	TP1	TP2	TP2	TP3	TP3	TP3	TP3	TP5	Method Code	LoD/Units
Depth (m)	0.50	1.50	1.50	2.10	0.50	2.00	2.50	3.50	1.50		
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID		
Sampled Date	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08		
Sample Received Date	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08		
Batch	1	1	1	1	1	1	1	1	1		
Sample Number(s)	21-22	23-24	29-30	31-32	33-34	37-38	39-44	45-46	55-56		
Volatile Organic Compounds											
Dichlorodifluoromethane	-	-	-	<4	-	-	-	-	-	TM116 ^g	<4 ug/kg
Chloromethane	-	-	-	<7	-	-	-	-	-	TM116 ^g	<7 ug/kg
Vinyl Chloride	-	-	-	<10	-	-	-	-	-	TM116 ^g _M	<10 ug/kg
Bromomethane	-	-	-	<13	-	-	-	-	-	TM116 ^g	<13 ug/kg
Chloroethane	-	-	-	<14	-	-	-	-	-	TM116 ^g	<14 ug/kg
Trichlorofluoromethane	-	-	-	<6	-	-	-	-	-	TM116 ^g _M	<6 ug/kg
trans-1-2-Dichloroethene	-	-	-	<11	-	-	-	-	-	TM116 ^g	<11 ug/kg
Dichloromethane	-	-	-	<10	-	-	-	-	-	TM116 ^g	<10 ug/kg
Carbon Disulphide	-	-	-	<7	-	-	-	-	-	TM116 ^g _M	<7 ug/kg
1,1-Dichloroethene	-	-	-	<10	-	-	-	-	-	TM116 ^g _M	<10 ug/kg
1,1-Dichloroethane	-	-	-	<8	-	-	-	-	-	TM116 ^g _M	<8 ug/kg
Methyl Tertiary Butyl Ether	-	-	-	<11	-	-	-	-	-	TM116	<11 ug/kg
cis-1-2-Dichloroethene	-	-	-	<5	-	-	-	-	-	TM116 ^g _M	<5 ug/kg
Bromochloromethane	-	-	-	<14	-	-	-	-	-	TM116 ^g	<14 ug/kg
Chloroform	-	-	-	<8	-	-	-	-	-	TM116 ^g _M	<8 ug/kg
2,2-Dichloropropane	-	-	-	<12	-	-	-	-	-	TM116 ^g	<12 ug/kg
1,2-Dichloroethane	-	-	-	<5	-	-	-	-	-	TM116 ^g	<5 ug/kg
1,1,1-Trichloroethane	-	-	-	<7	-	-	-	-	-	TM116 ^g _M	<7 ug/kg
1,1-Dichloropropene	-	-	-	<11	-	-	-	-	-	TM116 ^g _M	<11 ug/kg
Benzene	-	-	-	<9	-	-	-	-	-	TM116 ^g _M	<9 ug/kg
Carbontetrachloride	-	-	-	<14	-	-	-	-	-	TM116 ^g _M	<14 ug/kg
Dibromomethane	-	-	-	<9	-	-	-	-	-	TM116 ^g	<9 ug/kg
1,2-Dichloropropane	-	-	-	<12	-	-	-	-	-	TM116 ^g _M	<12 ug/kg
Bromodichloromethane	-	-	-	<7	-	-	-	-	-	TM116 ^g _M	<7 ug/kg
Trichloroethene	-	-	-	<9	-	-	-	-	-	TM116 ^g _M	<9 ug/kg
cis-1-3-Dichloropropene	-	-	-	<14	-	-	-	-	-	TM116 ^g _M	<14 ug/kg
trans-1-3-Dichloropropene	-	-	-	<14	-	-	-	-	-	TM116 ^g _M	<14 ug/kg
1,1,2-Trichloroethane	-	-	-	<10	-	-	-	-	-	TM116 ^g	<10 ug/kg
Toluene	-	-	-	<5	-	-	-	-	-	TM116 ^g _M	<5 ug/kg
1,3-Dichloropropane	-	-	-	<7	-	-	-	-	-	TM116 ^g	<7 ug/kg

All results expressed on a dry weight basis.

Date 20.02.2008

Validated ☒
Preliminary ☐

ALcontrol Laboratories Analytical Services

Table Of Results

* ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Sample Identity	TP1	TP1	TP2	TP2	TP3	TP3	TP3	TP3	TP5	Method Code	LoD/Units
Depth (m)	0.50	1.50	1.50	2.10	0.50	2.00	2.50	3.50	1.50		
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID		
Sampled Date	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08		
Sample Received Date	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08		
Batch	I	I	I	I	I	I	I	I	I		
Sample Number(s)	21-22	23-24	29-30	31-32	33-34	37-38	39-44	45-46	55-56		
Volatile Organic Compounds (cont)											
Dibromochloromethane	-	-	-	<13	-	-	-	-	-	TM116 ^g	<13 ug/kg
1,2-Dibromoethane	-	-	-	<12	-	-	-	-	-	TM116 ^g	<12 ug/kg
Tetrachloroethene	-	-	-	<5	-	-	-	-	-	TM116 ^g	<5 ug/kg
1,1,1,2-Tetrachloroethane	-	-	-	<10	-	-	-	-	-	TM116 ^g _M	<10 ug/kg
Chlorobenzene	-	-	-	<5	-	-	-	-	-	TM116 ^g _M	<5 ug/kg
Ethylbenzene	-	-	-	<4	-	-	-	-	-	TM116 ^g	<4 ug/kg
p/m-Xylene	-	-	-	<14	-	-	-	-	-	TM116 ^g	<14 ug/kg
Bromoform	-	-	-	<10	-	-	-	-	-	TM116 ^g	<10 ug/kg
Styrene	-	-	-	<10	-	-	-	-	-	TM116 ^g	<10 ug/kg
1,1,1,2,2-Tetrachloroethane	-	-	-	<10	-	-	-	-	-	TM116 ^g	<10 ug/kg
o-Xylene	-	-	-	<10	-	-	-	-	-	TM116 ^g	<10 ug/kg
1,1,2,3-Trichloropropane	-	-	-	<17	-	-	-	-	-	TM116 ^g	<17 ug/kg
Isopropylbenzene	-	-	-	<5	-	-	-	-	-	TM116 ^g	<5 ug/kg
Bromobenzene	-	-	-	<10	-	-	-	-	-	TM116 ^g _M	<10 ug/kg
2-Chlorotoluene	-	-	-	<9	-	-	-	-	-	TM116 ^g	<9 ug/kg
Propylbenzene	-	-	-	<11	-	-	-	-	-	TM116 ^g	<11 ug/kg
4-Chlorotoluene	-	-	-	<12	-	-	-	-	-	TM116 ^g	<12 ug/kg
1,2,4-Trimethylbenzene	-	-	-	<9	-	-	-	-	-	TM116 ^g	<9 ug/kg
4-Isopropyltoluene	-	-	-	<11	-	-	-	-	-	TM116 ^g	<11 ug/kg
1,3,5-Trimethylbenzene	-	-	-	<8	-	-	-	-	-	TM116 ^g	<8 ug/kg
1,2-Dichlorobenzene	-	-	-	<12	-	-	-	-	-	TM116 ^g _M	<12 ug/kg
1,4-Dichlorobenzene	-	-	-	<5	-	-	-	-	-	TM116 ^g _M	<5 ug/kg
sec-Butylbenzene	-	-	-	<10	-	-	-	-	-	TM116 ^g	<10 ug/kg
tert-Butylbenzene	-	-	-	<12	-	-	-	-	-	TM116 ^g	<12 ug/kg
1,3-Dichlorobenzene	-	-	-	<6	-	-	-	-	-	TM116 ^g	<6 ug/kg
n-Butylbenzene	-	-	-	<10	-	-	-	-	-	TM116 ^g	<10 ug/kg
1,2-Dibromo-3-chloropropane	-	-	-	<14	-	-	-	-	-	TM116 ^g	<14 ug/kg
1,2,4-Trichlorobenzene	-	-	-	<6	-	-	-	-	-	TM116 ^g	<6 ug/kg
Naphthalene	-	-	-	<13	-	-	-	-	-	TM116 ^g	<13 ug/kg
1,2,3-Trichlorobenzene	-	-	-	<11	-	-	-	-	-	TM116 ^g	<11 ug/kg

All results expressed on a dry weight basis.

Date 20.02.2008

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Table Of Results

M MCERTS accredited

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Matrix: SOLID

Location: WATERY RD, WREXHAM

Client Contact: Phil Hill

Volatile Organic Compounds (cont)

Hexachlorobutadiene

TM116th

<12 ug/kg

All results expressed on a dry weight basis.

Date 20.02.2008

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ALcontrol Laboratories Analytical Services

Table Of Results

* ISO 17025 accredited
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* Subcontracted test
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Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Sample Identity	TP6	TP7	TP7	TP8	TP8	TP8	TP9	TP10	TP10	Method Code	LOD/Units
Depth (m)	0.50	1.50	2.50	1.00	2.00	3.50	2.00	0.50	0.90		
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID		
Sampled Date	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08		
Sample Received Date	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08		
Batch	1	1	1	1	1	1	1	1	1		
Sample Number(s)	59-60	67-68	69-70	73-74	75-76	79-80	85-86	89-90	91-92		
Total Sulphate	970	-	-	-	-	-	-	-	-	TM129 ^g _M	<100 mg/kg
Boron Water Soluble	<3.5	-	-	<3.5	-	<3.5	<3.5	<3.5	-	TM129 ^g _M	<3.5 mg/kg
Total Sulphate BRE	-	0.13	-	-	0.05	0.02	-	-	-	TM149	<0.01 %
Arsenic	4	-	-	7	-	4	16	27	-	TM129 ^g _M	<3.0 mg/kg
Barium	120	-	-	150	-	65	290	260	-	TM129 ^g _M	<6.0 mg/kg
Beryllium	0.9	-	-	0.4	-	<0.4	0.5	0.7	-	TM129	<0.4 mg/kg
Cadmium	0.3	-	-	0.3	-	<0.3	0.5	<0.3	-	TM129	<0.3 mg/kg
Chromium	10	-	-	15	-	22	16	20	-	TM129 ^g _M	<4.5 mg/kg
Copper	45	-	-	47	-	19	37	36	-	TM129 ^g	<6 mg/kg
Lead	44	-	-	120	-	27	220	68	-	TM129 ^g _M	<2 mg/kg
Mercury	<0.6	-	-	<0.6	-	<0.6	<0.6	1.2	-	TM129 ^g _M	<0.6 mg/kg
Nickel	25	-	-	22	-	23	20	28	-	TM129 ^g _M	<0.9 mg/kg
Selenium	<3	-	-	<3	-	<3	<3	<3	-	TM129 ^g _M	<3 mg/kg
Vanadium	31	-	-	25	-	21	24	34	-	TM129 ^g _M	<1.5 mg/kg
Zinc	80	-	-	130	-	68	130	210	-	TM129 ^g _M	<2.5 mg/kg
ANC at pH4	-	-	-	-	-	-	-	-	NDP	TM182 ^g	<0.03 mol/kg
ANC at pH6	-	-	-	-	-	-	-	-	NDP	TM182 ^g	<0.03 mol/kg
Ammonium as NH4 in 2:1 Extract BRE	-	<0.0003	-	-	<0.0003	<0.0003	-	-	-	TM099 ^g	<0.0003 g/l
Easily Liberated Sulphide	18	-	-	-	-	-	-	-	-	TM180 ^g	<15 mg/kg
Total Organic Carbon	-	-	4.0	-	-	-	-	-	43	TM132 ^g _M	<0.2 %
Phenols Monohydric	-	-	<0.15	-	-	-	-	-	-	TM062 ^g _M	<0.15 mg/kg
Total Cyanide	<1	-	-	<1	-	-	<1	<1	-	TM153 ^g _M	<1 mg/kg
Free Cyanide	<1	-	-	<1	-	-	<1	<1	-	TM153	<1 mg/kg
Asbestos Presence Screen	No Fibres Detected	-	-	No Fibres Detected	-	-	No Fibres Detected	No Fibres Detected	-	TM001	NONE
Calorific Value	5400	-	-	-	-	-	-	-	-	TM132 ^g	<100 KJ/Kg
Chloride 2:1 water/soil extract BRE	-	0.006	-	-	0.005	0.003	-	-	-	TM097 ^g	<0.001 g/l
Magnesium 2:1 water/soil extract BRE	-	<0.001	-	-	0.002	0.002	-	-	-	TM129 ^g	<0.001 g/l
Nitrate 2:1 water/soil extract BRE	-	0.0032	-	-	<0.0003	0.0004	-	-	-	TM102 ^g	<0.0003 g/l
pH Value	7.86	9.39	-	8.01	7.99	7.68	8.41	8.38	7.55	TM133 ^g _M	<1.00 pH Units
Soluble Sulphate 2:1 Extract as SO4 BRE	-	0.085	-	-	0.033	<0.003	-	-	-	TM098 ^g	<0.003 g/l
Total Sulphur	0.24	0.14	-	-	0.09	0.02	-	-	-	TM068 ^g	<0.01 %

All results expressed on a dry weight basis.

Date 20.02.2008

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Table Of Results

M MCERTS accredited

- Subcontracted test

» Shown on prev. report

Matrix: SOLID

Location: WATERY RD, WREXHAM

Client Contact: Phil Hill

[illegible]

All results expressed on a dry weight basis.

Date 20.02.2008

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[#] ISO 17025 accredited

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- Subcontracted test

» Shown on prev. report

Matrix: SOLID

Location: WATERY RD, WREXHAM

Client Contact: Phil Hill

[illegible]

All results expressed on a dry weight basis.

Date 20.02.2008

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ALcontrol Laboratories Analytical Services

Table Of Results

ISO 17025 accredited
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* Subcontracted test
» Shown on prev. report

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Sample Identity	TP10	TP10	TP10	TP10	TP11	TP11	TP11	TP12	TP12	Method Code	LoD/Units
Depth (m)	1.30	2.00	3.00	3.60	0.50	1.50	2.50	0.50	1.50		
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID		
Sampled Date	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08		
Sample Received Date	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08		
Batch	1	1	1	1	1	1	1	1	1		
Sample Number(s)	93-94	97-98	99-104	105-110	111-112	117-118	119-123	124-125	126-127		
Total Sulphate	1700	-	-	-	-	-	-	-	-	TM129 [#] _M	<100 mg/kg
Boron Water Soluble	<3.5	-	-	-	<3.5	-	<3.5	-	<3.5	TM129 [#] _M	<3.5 mg/kg
Total Sulphate BRE	-	0.11	-	-	-	-	-	0.17	-	TM149	<0.01 %
Arsenic	22	-	-	-	6	-	15	-	64	TM129 [#] _M	<3.0 mg/kg
Barium	360	-	-	-	440	-	230	-	470	TM129 [#] _M	<6.0 mg/kg
Beryllium	1.4	-	-	-	<0.4	-	1.0	-	3.9	TM129	<0.4 mg/kg
Cadmium	0.5	-	-	-	<0.3	-	2.0	-	2.2	TM129	<0.3 mg/kg
Chromium	18	-	-	-	7.9	-	15	-	25	TM129 [#] _M	<4.5 mg/kg
Copper	130	-	-	-	32	-	91	-	200	TM129 [#]	<6 mg/kg
Lead	81	-	-	-	47	-	190	-	1300	TM129 [#] _M	<2 mg/kg
Mercury	<0.6	-	-	-	<0.6	-	2.2	-	<0.6	TM129 [#] _M	<0.6 mg/kg
Nickel	42	-	-	-	6.0	-	37	-	58	TM129 [#] _M	<0.9 mg/kg
Selenium	<3	-	-	-	<3	-	<3	-	<3	TM129 [#] _M	<3 mg/kg
Vanadium	34	-	-	-	13	-	18	-	56	TM129 [#] _M	<1.5 mg/kg
Zinc	230	-	-	-	49	-	840	-	1100	TM129 [#] _M	<2.5 mg/kg
ANC at pH4	-	-	0.60	0.03	-	-	-	-	-	TM182 [#]	<0.03 mol/kg
ANC at pH6	-	-	0.03	<0.03	-	-	-	-	-	TM182 [#]	<0.03 mol/kg
Ammonium as NH4 in 2:1 Extract BRE	-	<0.0003	-	-	-	-	-	<0.0003	-	TM099 [#]	<0.0003 g/l
Easily Liberated Sulphide	<15	-	-	-	-	-	-	-	-	TM180 [#]	<15 mg/kg
Total Organic Carbon	-	-	8.7	48	-	47	-	-	-	TM132 [#] _M	<0.2 %
Phenols Monohydric	-	-	<0.15	<0.15	-	<0.15	-	-	-	TM062 [#] _M	<0.15 mg/kg
Total Cyanide	<1	-	-	-	<1	-	<1	-	<1	TM153 [#] _M	<1 mg/kg
Free Cyanide	<1	-	-	-	<1	-	<1	-	<1	TM153	<1 mg/kg
Asbestos Presence Screen	-	-	-	-	-	-	-	-	-	TM001	NONE
Calorific Value	8600	-	-	-	-	-	-	-	-	TM132 [#]	<100 KJ/Kg
Chloride 2:1 water/soil extract BRE	-	0.030	-	-	-	-	-	0.010	-	TM097 [#]	<0.001 g/l
Magnesium 2:1 water/soil extract BRE	-	0.001	-	-	-	-	-	0.006	-	TM129 [#]	<0.001 g/l
Nitrate 2:1 water/soil extract BRE	-	0.0055	-	-	-	-	-	0.0019	-	TM102 [#]	<0.0003 g/l
pH Value	7.80	7.95	7.66	7.20	7.54	-	7.65	7.94	7.73	TM133 [#] _M	<1.00 pH Units
Soluble Sulphate 2:1 Extract as SO4 BRE	-	0.12	-	-	-	-	-	0.13	-	TM098 [#]	<0.003 g/l
Total Sulphur	0.51	0.19	-	-	-	-	-	0.26	-	TM068 [#]	<0.01 %

All results expressed on a dry weight basis.

Date 20.02.2008

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ALcontrol Laboratories Analytical Services Table Of Results

ISO 17025 accredited

M MCERTS accredited

- Subcontracted test

» Shown on prev. report

Job Number: 08/02262/02/01

Matrix: SOLID

Client: Encia Consulting

Location: WATERY RD, WREXHAM

Client Ref. No.: 7344

Client Contact: Phil Hill

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All results expressed on a dry weight basis.

Date 20.02.2008

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11

Table Of Results

M MCERTS accredited

- Subcontracted test

» Shown on prev. report

Matrix: SOLID

Location: WATERY RD, WREXHAM

Client Contact: Phil Hill

[illegible]

All results expressed on a dry weight basis.

Date 20.02.2008

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11

Table Of Results

» Shown on prev. report

Client Contact: Phil Hill

[illegible]

Date 20.02.2008

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ALcontrol Laboratories Analytical Services

Table Of Results

* ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Sample Identity	TP12	TP12	TP13	TP13	TP13	TP13	WS1	WS1	WS1	Method Code	LoD/Units
Depth (m)	2.00	3.00	0.50	1.30	1.60	2.50	1.50	2.60	3.30		
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID		
Sampled Date	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08		
Sample Received Date	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08		
Batch	I	I	I	I	I	I	I	I	I		
Sample Number(s)	128-131	132-133	136-137	138-139	140-141	142-143	150-151	152-153	154-155		
Total Sulphate	-	-	230	-	-	-	-	-	-	TM129 ^g _M	<100 mg/kg
Boron Water Soluble	-	-	<3.5	-	<3.5	-	<3.5	-	-	TM129 ^g _M	<3.5 mg/kg
Total Sulphate BRE	-	-	-	-	-	-	-	-	-	TM149	<0.01 %
Arsenic	-	-	<3	-	5	-	10	-	-	TM129 ^g _M	<3.0 mg/kg
Barium	-	-	220	-	140	-	290	-	-	TM129 ^g _M	<6.0 mg/kg
Beryllium	-	-	0.5	-	0.5	-	<0.4	-	-	TM129	<0.4 mg/kg
Cadmium	-	-	0.6	-	0.3	-	<0.3	-	-	TM129	<0.3 mg/kg
Chromium	-	-	11	-	17	-	<4.5	-	-	TM129 ^g _M	<4.5 mg/kg
Copper	-	-	54	-	23	-	28	-	-	TM129 ^g	<6 mg/kg
Lead	-	-	73	-	51	-	38	-	-	TM129 ^g _M	<2 mg/kg
Mercury	-	-	<0.6	-	<0.6	-	<0.6	-	-	TM129 ^g _M	<0.6 mg/kg
Nickel	-	-	31	-	27	-	4.3	-	-	TM129 ^g _M	<0.9 mg/kg
Selenium	-	-	<3	-	<3	-	<3	-	-	TM129 ^g _M	<3 mg/kg
Vanadium	-	-	36	-	15	-	8.4	-	-	TM129 ^g _M	<1.5 mg/kg
Zinc	-	-	140	-	110	-	28	-	-	TM129 ^g _M	<2.5 mg/kg
ANC at pH4	NDP	3.4	-	-	0.10	-	-	-	NDP	TM182 ^g	<0.03 mol/kg
ANC at pH6	NDP	0.15	-	-	0.03	-	-	-	NDP	TM182 ^g	<0.03 mol/kg
Ammonium as NH4 in 2:1 Extract BRE	-	-	-	-	-	-	-	-	-	TM099 ^g	<0.0003 g/l
Easily Liberated Sulphide	-	-	<15	-	-	-	-	-	-	TM180 ^g	<15 mg/kg
Total Organic Carbon	30	23	-	13	1.4	0.7	-	54	32	TM132 ^g _M	<0.2 %
Phenols Monohydric	<0.15	<0.15	-	<0.15	-	<0.15	-	<0.15	-	TM062 ^g _M	<0.15 mg/kg
Total Cyanide	-	-	<1	-	-	-	<1	-	-	TM153 ^g _M	<1 mg/kg
Free Cyanide	-	-	<1	-	-	-	<1	-	-	TM153	<1 mg/kg
Asbestos Presence Screen	-	-	-	-	-	-	-	-	-	TM001	NONE
Calorific Value	-	-	3700	-	-	-	-	-	-	TM132 ^g	<100 KJ/Kg
Chloride 2:1 water/soil extract BRE	-	-	-	-	-	-	-	-	-	TM097 ^g	<0.001 g/l
Magnesium 2:1 water/soil extract BRE	-	-	-	-	-	-	-	-	-	TM129 ^g	<0.001 g/l
Nitrate 2:1 water/soil extract BRE	-	-	-	-	-	-	-	-	-	TM102 ^g	<0.0003 g/l
pH Value	7.12	7.29	7.94	-	6.97	-	7.50	-	7.01	TM133 ^g _M	<1.00 pH Units
Soluble Sulphate 2:1 Extract as SO4 BRE	-	-	-	-	-	-	-	-	-	TM098 ^g	<0.003 g/l
Total Sulphur	-	-	0.15	-	-	-	-	-	-	TM068 ^g	<0.01 %

All results expressed on a dry weight basis.

Date 20.02.2008

Validated

Preliminary



ALcontrol Laboratories Analytical Services

ISO 17025 accredited

M MCERTS accredited

- ★ **Subcontracted test**

» Shown on prev. report

Job Number: 08/02262/02/01

Client: Encia Consulting

Client Ref. No.: 7344

Matrix: SOLID

Location: WATERY RD, WREXHAM

Client Contact: Phil Hill

[illegible]

All results expressed on a dry weight basis.

Date 20.02.2008

- * ISO 17025 accredited
- M MCERTS accredited
- * Subcontracted test
- » Shown on prev. report

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

[illegible]

All results expressed on a dry weight basis.

Date 20.02.2008

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11

Table Of Results

M MCERTS accredited

» Shown on prev. report

» Shown on pre

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

PCBs (vs Aroclor 1254)

Date 20.02.2008

Validated ☒
Preliminary ☐

ALcontrol Laboratories Analytical Services

Table Of Results

ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Sample Identity	WS3	WS3	WS4	WS4	WS4	WS5	WS5	WS5	WS6	Method Code	LoD/Units
Depth (m)	0.20	0.60	0.40	0.80	1.80	1.50	2.50	4.20	0.50		
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID		
Sampled Date	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08	29.01.08		
Sample Received Date	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08	31.01.08		
Batch	I	I	I	I	I	I	I	I	I		
Sample Number(s)	160-161	162-163	164-165	166-167	168-169	176-177	178-179	182-183	186-187		
Total Sulphate	-	-	530	-	-	-	-	-	1000	TM129 [#] _M	<100 mg/kg
Boron Water Soluble	-	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	-	<3.5	TM129 [#] _M	<3.5 mg/kg
Total Sulphate BRE	0.01	-	-	-	-	-	-	-	-	TM149	<0.01 %
Arsenic	-	11	6	9	4	6	6	-	24	TM129 [#] _M	<3.0 mg/kg
Barium	-	160	170	220	49	81	160	-	260	TM129 [#] _M	<6.0 mg/kg
Beryllium	-	0.6	0.6	0.8	<0.4	0.6	0.4	-	1.0	TM129	<0.4 mg/kg
Cadmium	-	0.9	<0.3	0.4	<0.3	0.6	<0.3	-	0.8	TM129	<0.3 mg/kg
Chromium	-	16	15	13	19	12	13	-	20	TM129 [#] _M	<4.5 mg/kg
Copper	-	130	62	77	15	18	14	-	150	TM129 [#]	<6 mg/kg
Lead	-	210	48	83	25	100	34	-	290	TM129 [#] _M	<2 mg/kg
Mercury	-	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	-	<0.6	TM129 [#] _M	<0.6 mg/kg
Nickel	-	26	41	44	19	25	22	-	53	TM129 [#] _M	<0.9 mg/kg
Selenium	-	<3	<3	<3	<3	<3	<3	-	<3	TM129 [#] _M	<3 mg/kg
Vanadium	-	29	49	45	20	15	13	-	54	TM129 [#] _M	<1.5 mg/kg
Zinc	-	330	87	140	61	100	69	-	280	TM129 [#] _M	<2.5 mg/kg
ANC at pH4	-	-	-	-	-	-	-	-	-	TM182 [#]	<0.03 mol/kg
ANC at pH6	-	-	-	-	-	-	-	-	-	TM182 [#]	<0.03 mol/kg
Ammonium as NH4 in 2:1 Extract BRE	<0.0003	-	-	-	-	-	-	-	-	TM099 [#]	<0.0003 g/l
Easily Liberated Sulphide	-	-	<15	-	-	-	-	-	<15	TM180 [#]	<15 mg/kg
Total Organic Carbon	-	-	-	-	0.6	-	-	0.7	-	TM132 [#] _M	<0.2 %
Phenols Monohydric	-	-	-	-	-	-	-	<0.15	-	TM062 [#] _M	<0.15 mg/kg
Total Cyanide	-	<1	-	<1	-	<1	-	-	<1	TM153 [#] _M	<1 mg/kg
Free Cyanide	-	<1	-	<1	-	<1	-	-	<1	TM153	<1 mg/kg
Asbestos Presence Screen	-	No Fibres Detected	-	No Fibres Detected	-	No Fibres Detected	-	-	-	TM001	NONE
Calorific Value	-	-	2900	-	-	-	-	-	7200	TM132 [#]	<100 KJ/Kg
Chloride 2:1 water/soil extract BRE	0.007	-	-	-	-	-	-	-	-	TM097 [#]	<0.001 g/l
Magnesium 2:1 water/soil extract BRE	<0.001	-	-	-	-	-	-	-	-	TM129 [#]	<0.001 g/l
Nitrate 2:1 water/soil extract BRE	0.0027	-	-	-	-	-	-	-	-	TM102 [#]	<0.0003 g/l
pH Value	8.37	8.01	7.68	7.95	7.47	7.59	7.50	-	8.18	TM133 [#] _M	<1.00 pH Units
Soluble Sulphate 2:1 Extract as SO4 BRE	0.020	-	-	-	-	-	-	-	-	TM098 [#]	<0.003 g/l
Total Sulphur	0.11	-	0.14	-	-	-	-	-	0.35	TM068 [#]	<0.01 %

All results expressed on a dry weight basis.

Date 20.02.2008

Validated

Preliminary



ALcontrol Laboratories Analytical Services

ISO 17025 accredited

M MCERTS accredited

- **Subcontracted test**

» Shown on prev. report

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

[illegible]

All results expressed on a dry weight basis.

Date 20.02.2008

- # ISO 17025 accredited
- M MCERTS accredited
- * Subcontracted test
- » Shown on prev. report

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

[illegible]

All results expressed on a dry weight basis.

Date 20.02.2008

Validated ☒
Preliminary ☐

ALcontrol Laboratories Analytical Services

Table Of Results

ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Sample Identity	WS6	WS6	WS6							Method Code	LoD/Units
Depth (m)	0.90	2.50	3.50								
Sample Type	SOLID	SOLID	SOLID								
Sampled Date	29.01.08	29.01.08	29.01.08								
Sample Received Date	31.01.08	31.01.08	31.01.08								
Batch	1	1	1								
Sample Number(s)	188-189	192-193	194-195								
Total Sulphate	-	-	-							TM129 ^g _M	<100 mg/kg
Boron Water Soluble	<3.5	-	-							TM129 ^g _M	<3.5 mg/kg
Total Sulphate BRE	0.06	-	0.02							TM149	<0.01 %
Arsenic	10	-	-							TM129 ^g _M	<3.0 mg/kg
Barium	130	-	-							TM129 ^g _M	<6.0 mg/kg
Beryllium	1.0	-	-							TM129	<0.4 mg/kg
Cadmium	0.4	-	-							TM129	<0.3 mg/kg
Chromium	15	-	-							TM129 ^g _M	<4.5 mg/kg
Copper	48	-	-							TM129 ^g	<6 mg/kg
Lead	200	-	-							TM129 ^g _M	<2 mg/kg
Mercury	<0.6	-	-							TM129 ^g _M	<0.6 mg/kg
Nickel	41	-	-							TM129 ^g _M	<0.9 mg/kg
Selenium	<3	-	-							TM129 ^g _M	<3 mg/kg
Vanadium	32	-	-							TM129 ^g _M	<1.5 mg/kg
Zinc	130	-	-							TM129 ^g _M	<2.5 mg/kg
ANC at pH4	-	-	-							TM182 ^g	<0.03 mol/kg
ANC at pH6	-	-	-							TM182 ^g	<0.03 mol/kg
Ammonium as NH4 in 2:1 Extract BRE	<0.0003	-	<0.0003							TM099 ^g	<0.0003 g/l
Easily Liberated Sulphide	-	-	-							TM180 ^g	<15 mg/kg
Total Organic Carbon	-	0.3	-							TM132 ^g _M	<0.2 %
Phenols Monohydric	-	<0.15	-							TM062 ^g _M	<0.15 mg/kg
Total Cyanide	-	-	-							TM153 ^g _M	<1 mg/kg
Free Cyanide	-	-	-							TM153	<1 mg/kg
Asbestos Presence Screen	-	-	-							TM001	NONE
Calorific Value	-	-	-							TM132 ^g	<100 KJ/Kg
Chloride 2:1 water/soil extract BRE	0.034	-	0.005							TM097 ^g	<0.001 g/l
Magnesium 2:1 water/soil extract BRE	0.004	-	0.001							TM129 ^g	<0.001 g/l
Nitrate 2:1 water/soil extract BRE	0.0016	-	0.0004							TM102 ^g	<0.0003 g/l
pH Value	8.19	-	7.65							TM133 ^g _M	<1.00 pH Units
Soluble Sulphate 2:1 Extract as SO4 BRE	0.098	-	0.032							TM098 ^g	<0.003 g/l
Total Sulphur	0.15	-	0.03							TM068 ^g	<0.01 %

All results expressed on a dry weight basis.

Date 20.02.2008

- # ISO 17025 accredited
- M MCERTS accredited
- * Subcontracted test
- » Shown on prev. report

Matrix: SOLID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

[illegible]

All results expressed on a dry weight basis.

Date 20.02.2008

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11

Table Of Results

^M MCERTS accredited

- * Subcontracted test

» Shown on prev. report

» Shown on pre

Matrix: LEACHATE
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Date 20.02.2008

Date 20.02.2008

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Table Of Results

M MCERTS accredited

- Subcontracted test

» Shown on prev. report

» Shown on pre

Matrix: LEACHATE
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

[illegible]

Date 20.02.2008

ALcontrol Laboratories Analytical Services

Table Of Results - Appendix

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Report Key :

NDP	No Determination Possible	*	Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03x10 ⁻⁷
NFD	No Fibres Detected	»	Subcontracted test
#	ISO 17025 accredited	M	Result previously reported (Incremental reports only)
PFD	Possible Fibres Detected	EC	MCERTS Accredited
			Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

Method No.	Reference	Description	Accredited	ISO 17025	MCERTS Accredited	Wet/Dry Sample ¹	Surrogate Corrected
TM001	In - house Method	Screening of Soils for Fibres				WET	
TM062	MEWAM BOOK 124 1988.HMSO/ Method 17.7, Second Site property, March 2003	Determination of Phenolic compounds by HPLC with electro-chemical detection	✓	✓		WET	
TM068	ASTM D-1552	Total sulphur determination by combustion method	✓			DRY	
TM070	Modified: US EPA Method 8250 & 625	Determination of Total Polychlorinated Biphenyls (PCB's) as Aroclor 1254 by GC-MS in Soils	✓			DRY	
TM074	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS. MCERTS Accreditation on Soils for Naphthalene except when Kerosene present.	✓			DRY	
TM074	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS. MCERTS Accreditation on Soils for Naphthalene except when Kerosene present.	✓	✓		DRY	
TM089	Modified: US EPA Methods 8020 & 602	Determination of Gasoline Range Hydrocarbons (GRO) and BTEX (MTBE) compounds by Headspace GC-FID (C4-C12)				WET	
TM089	Modified: US EPA Methods 8020 & 602	Determination of Gasoline Range Hydrocarbons (GRO) and BTEX (MTBE) compounds by Headspace GC-FID (C4-C12)	✓			WET	
TM089	Modified: US EPA Methods 8020 & 602	Determination of Gasoline Range Hydrocarbons (GRO) and BTEX (MTBE) compounds by Headspace GC-FID (C4-C12)	✓	✓		WET	
TM097	Modified: US EPA Method 325.1 & 325.2	Determination of Chloride using the Kone Analyser	✓			DRY	
TM098	Method 4500E, AWWA/APHA, 20th Ed., 1999	Determination of Sulphate using the Kone Analyser	✓			DRY	
TM099	BS 2690: Part 7:1968 / BS 6068: Part2.11:1984	Determination of Ammonium in Water Samples using the Kone Analyser	✓			WET	
TM102	Method 4500H, AWWA/APHA, 20th Ed., 1999	Determination of Total Oxidised Nitrogen using the Kone Analyser	✓			DRY	
TM116	Modified: US EPA Method 8260, 8120, 8020, 624, 610 & 602	Determination of Volatile Organic Compounds by Headspace / GC-MS				WET	

¹ Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

ALcontrol Laboratories Analytical Services

Table Of Results - Appendix

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Report Key :

NDP	No Determination Possible	*	Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03x10 ⁻⁷
NFD	No Fibres Detected	»	Subcontracted test
#	ISO 17025 accredited	M	Result previously reported (Incremental reports only)
PFD	Possible Fibres Detected	EC	MCERTS Accredited
			Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

Method No.	Reference	Description	Accredited	ISO 17025	MCERTS Accredited	Wet/Dry Sample ¹	Surrogate Corrected
TM116	Modified: US EPA Method 8260, 8120, 8020, 624, 610 & 602	Determination of Volatile Organic Compounds by Headspace / GC-MS	✓			WET	
TM116	Modified: US EPA Method 8260, 8120, 8020, 624, 610 & 602	Determination of Volatile Organic Compounds by Headspace / GC-MS	✓	✓		WET	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer				DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓			DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓	✓		DRY	
TM132	In - house Method	ELTRA CS800 Operators Guide	✓			DRY	
TM132	In - house Method	ELTRA CS800 Operators Guide	✓	✓		DRY	
TM133	BS 1377: Part 3 1990	Determination of pH in Soil and Water using the GLpH pH Meter	✓	✓		WET	
TM149	BS 1377: Part 3 1990 (Extraction)	Analysis of Total Sulphate using ICP-OES Spectrophotometer				DRY	
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS				NA	
TM153	Method 4500A,B,C, I, M AWWA/APHA, 20th Ed., 1999	Determination of Total Cyanide, Free (Easily Liberatable) Cyanide and Thiocyanate using the "Skalar SANS+ System" Segmented Flow Analyser				WET	
TM153	Method 4500A,B,C, I, M AWWA/APHA, 20th Ed., 1999	Determination of Total Cyanide, Free (Easily Liberatable) Cyanide and Thiocyanate using the "Skalar SANS+ System" Segmented Flow Analyser	✓	✓		WET	
TM173		Determination of Speciated Extractable Petroleum Hydrocarbons in Soils by GC-FID	✓			DRY	
TM180	Sulphide in waters and waste waters 1991 ISBN 01 175 7186 SCA rec. 2007 (unpublished)	The Determination Of Easily Liberated Sulphide In Soil Samples by Ion Selective Electrode Technique	✓			WET	

¹ Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

ALcontrol Laboratories Analytical Services Table Of Results - Appendix

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Report Key :

Report Key:		
NDP	No Determination Possible	* Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03x10 ⁻⁷
NFD	No Fibres Detected	» Subcontracted test
#	ISO 17025 accredited	M Result previously reported (Incremental reports only)
PFD	Possible Fibres Detected	EC MCERTS Accredited
		EC Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

[illegible]

¹ Applies to Solid samples only. **DRY** indicates samples have been dried at 35°C. **NA** = not applicable.

ALcontrol Laboratories Analytical Services Table Of Results - Appendix

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Summary of Coolbox temperatures

[illegible]

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11

Table Of Results

» Shown on prev. report

Matrix: LIQUID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Date 03.03.2008

Date 03.03.2008

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ALcontrol Laboratories Analytical Services Table Of Results

[#] ISO 17025 accredited

M MCERTS accredited

- Subcontracted test

» Shown on prev. report

Job Number: 08/02262/02/01

Client: Encia Consulting

Client Ref. No.: 7344

Matrix: LIQUID

Location: WATERY RD, WREXHAM

Client Contact: Phil Hill

[illegible]

Date 03.03.2008

Validated

ALcontrol Laboratories Analytical Services Table Of Results

• **ISO 17025 accredited**

^M MCERTS accredited

- **Subcontracted test**

» Shown on prev. report

Job Number: 08/02262/02/01

Client: Encia Consulting

Client Ref. No.: 7344

Matrix: LIQUID

Location: WATERY RD, WREXHAM

Client Contact: Phil Hill

[illegible]

Date 03.03.2008

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104

- # ISO 17025 accredited
- M MCERTS accredited
- * Subcontracted test
- » Shown on prev. report

Matrix: LIQUID
Location: WATERY RD, WREXHAM
Client Contact: Phil Hill

Date 03.03.2008

Date 03.03.2008

ALcontrol Laboratories Analytical Services

Table Of Results - Appendix

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Report Key :

NDP No Determination Possible * Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03×10^{-7}
NFD No Fibres Detected » Subcontracted test
ISO 17025 accredited M Result previously reported (Incremental reports only)
PFD Possible Fibres Detected EC MCERTS Accredited
EC Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

Method No.	Reference	Description	Accredited	ISO 17025 Accredited	MCERTS Accredited	Wet/Dry Sample ¹	Surrogate Corrected
TM043	Method 2320B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part 109 1984	Determination of alkalinity in aqueous samples	✓			NA	
TM059	In - house Method	Determination of whole oil by gas chromatography (C4-C40)				NA	
TM062	MEWAM BOOK 124 1988.HMSO/ Method 17.7, Second Site property, March 2003	Determination of Phenolic compounds by HPLC with electro-chemical detection	✓			NA	
TM089	Modified: US EPA Methods 8020 & 602	Determination of Gasoline Range Hydrocarbons (GRO) and BTEX (MTBE) compounds by Headspace GC-FID (C4-C12)				NA	
TM089	Modified: US EPA Methods 8020 & 602	Determination of Gasoline Range Hydrocarbons (GRO) and BTEX (MTBE) compounds by Headspace GC-FID (C4-C12)	✓			NA	
TM097	Modified: US EPA Method 325.1 & 325.2	Determination of Chloride using the Kone Analyser	✓			NA	
TM099	BS 2690: Part 7:1968 / BS 6068: Part 2.11:1984	Determination of Ammonium in Water Samples using the Kone Analyser	✓			NA	
TM101	Method 4500B & C, AWWA/APHA, 20th Ed., 1999	Determination of Sulphide in soil and water samples using the Kone Analyser				NA	
TM102	Method 4500H, AWWA/APHA, 20th Ed., 1999	Determination of Total Oxidised Nitrogen using the Kone Analyser	✓			NA	
TM120	Method 2510B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part 9:1970	Determination of Electrical Conductivity using a Conductivity Meter	✓			NA	
TM133	BS 1377: Part 3 1990	Determination of pH in Soil and Water using the GLpH pH Meter	✓			NA	
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS	✓			NA	
TM174		Determination of Speciated Extractable Petroleum Hydrocarbons in Waters by GC-FID				NA	
TM178	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS in Waters				NA	

¹ Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

ALcontrol Laboratories Analytical Services Table Of Results - Appendix

Job Number: 08/02262/02/01
Client: Encia Consulting
Client Ref. No.: 7344

Report Key :

Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03×10^{-7}

NDP **No Determination Possible**

Subcontracted test

NFD **No Fibres Detected**

» **Result previously reported (Incremental reports only)**

ISO 17025 accredited

M MCERTS Accredited

[illegible]

EC Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

[illegible]

¹ Applies to Solid samples only. **DRY** indicates samples have been dried at 35°C. **NA** = not applicable.

Job Name: Watery Road, Wrexham
Job Number: 7344

Analytical Data

Material Type	Data (mg/kg)	Log Data
Cohesive Made Ground	6	0.7782
	15	1.1761
	10	1.0000
	6	0.7782
	21.3	1.3284

Mean Value Test

n	t	t value
2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	2.132
6	2.0150	
7	1.9430	
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

Outlier Test

T _{crit} 10%	T _{crit} V
1.420	
1.600	1.600
1.730	
1.830	
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Arsenic
No. of samples:	5
SGV:	20.00
t value:	2.132
mean (x):	11.66
st.dev (s):	6.54
95% ile:	17.89
Is the Mean Value Test Higher or Lower than the SGV?	Lower
Y max:	1.328
Y mean:	1.012
Y st.dev.:	0.243
T value	1.300
Comparator	1.600
Maximum Value Test Result:	Maximum is within a Normal Distribution
Outlier Test?	

Job Name: Watery Road, Wrexham

Job Number: 7344

Analytical Data

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

Granular MG	8	0.9031
	7	0.8451
	27	1.4314
	22	1.3424
	11	1.0414
	9	0.9542
	6	0.7782
	10	1.0000
	20	1.3010
	14.3	1.1553
	28.2	1.4502
	19.4	1.2878
	12.4	1.0934
	64	1.8062

Mean Value Test

n	t	t value
---	---	---------

2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	
6	2.0150	
7	1.9430	
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	1.771
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

Outlier Test

T _{crit} 10%	T _{crit} V
-----------------------	---------------------

1.420	
1.600	
1.730	
1.830	
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	2.210
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Arsenic
--------------	---------

No. of samples:	14
SGV:	20.00

t value:	1.771
mean (x):	18.45
st.dev (s):	15.00
95% ile:	25.55

Is the Mean Value Test Higher or Lower than the SGV?	Higher
--	--------

Y max:	1.806
Y mean:	1.171
Y st.dev.:	0.283
T value	2.246
Comparator	2.210

Maximum Value Test Result:	Maximum Is an Outlier
Outlier Test?	

Job Name: Watery Road, Wrexham

Job Number: 7344

Analytical Data

Mean Value Test

Outlier Test

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

n	t	t value
---	---	---------

 $T_{crit} = 10\% T_{crit} V$ [illegible]

2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	
6	2.0150	
7	1.9430	
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	1.782
14	1.7710	
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

1.420	
1.600	
1.730	
1.830	
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	2.170
2.210	
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Arsenic
No. of samples:	13
SCV:	20.00
t value:	1.782
mean (x):	14.95
st.dev (s):	7.58
95% ile:	18.69

Is the Mean Value Test Higher or Lower than the SGV?
Higher or Lower **Lower**

Y max:	1.450
Y mean:	1.122
Y st.dev.:	0.225
T value	1.462
Comparator	2.170

Maximum Value Test Result:
Outlier Test? Maximum is within a Normal Distribution

Job Name: Watery Road, Wrexham
Job Number: 7344

Analytical Data

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

Ash & Clinker	4	0.6021
	3	0.4771
	6	0.7782
	24	1.3802
	29.3	1.1669
	17.8	1.2504
	46.7	1.6693

Mean Value Test

n	t	t value
---	---	---------

2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	
6	2.0150	
7	1.9430	1.943
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

Outlier Test

T _{crit} 10%	T _{crit} V
-----------------------	---------------------

1.420	
1.600	
1.730	
1.830	1.830
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Arsenic
No. of samples:	7
SGV:	20.00
t value:	1.943
mean (x):	18.69
st.dev (s):	16.07
95% ile:	30.49

Is the Mean Value Test Higher or Lower than the SGV?	Higher
Higher or Lower	

Y max:	1.669
Y mean:	1.089
Y st.dev.:	0.465
T value	1.247
Comparator	1.830

Maximum Value Test Result:	Maximum is within a Normal Distribution
Outlier Test?	

Job Name: Watery Road, Wrexham
Job No: 7344

Analytical Data

Material Type	Data (mg/kg)	Log Data
Granular MG	38	1.5798
	47	1.6721
	36	1.5563
	130	2.1139
	200	2.3010
	130	2.1139
	77	1.8865
	18	1.2553
	48	1.6812
	230	2.3917
	32.2	1.5079
	105	2.0212
	44.3	1.6464
	20.3	1.3075

Mean Value Test

n	t	t value
2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	
6	2.0150	
7	1.9430	
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	1.771
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

Outlier Test

T _{crit} 10%	T _{crit} V
1.420	
1.600	
1.730	
1.830	
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	2.210
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Copper
--------------	--------

No. of samples:	14
SGV:	200.00

t value:	1.771
mean (x):	82.56
st.dev (s):	67.50
95% ile:	114.50

Is the Mean Value Test Higher or Lower than the SGV?	Lower
--	-------

Y max:	2.362
Y mean:	1.786
Y st.dev.:	0.351
T value	1.639
Comparator	2.210

Maximum Value Test Result:	Maximum is within a Normal Distribution
Outlier Test?	

Job Name: Watery Road, Wrexham

Job No: 7344

Analytical Data

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

Mean Value Test

n	t	t value
---	---	---------

Outlier Test

T_{ent} 10% T_{ent} V

[illegible]

2	6,3140	
3	2,9200	
4	2,3530	
5	2,1370	
6	2,0150	
7	1,9430	
8	1,8950	
9	1,8600	1,860
10	1,8330	
11	1,8120	
12	1,7960	
13	1,7820	
14	1,7710	
15	1,7610	
16	1,7530	
17	1,7460	
18	1,7400	
19	1,7340	
20	1,7290	
21	1,7250	
22	1,7210	
23	1,7170	
24	1,7140	
25	1,7110	
26	1,7080	
27	1,7060	
28	1,7030	
29	1,7010	
30	1,6990	
31	1,6970	
32	1,6955	
33	1,6940	
34	1,6925	
35	1,6910	
36	1,6895	
37	1,6880	
38	1,6870	
39	1,6860	
40	1,6850	

1.420	
1.600	
1.730	
1.830	
1.910	
1.980	1.980
2.040	
2.085	
2.130	
2.170	
2.210	
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand: **Copper**

No. of samples:	9
SGV:	200.00

t value:	1.860
mean (x):	38.99
st.dev (s):	66.94
95% ile:	80.49

Is the Mean Value Test Higher or Lower than the SGV?
Higher or Lower **Lower**

Y max:	2.337
Y mean:	1.329
Y st.dev.:	0.404
T value	2.494
Comparator	1.980

Maximum Value Test Result: Outlier Test?	Maximum is an Outlier
---	-----------------------

Job Name: Watery Road, Wrexham

Job Number: 7344

Analytical Data

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

Granular MG	83	1.9191
	120	2.0792
	68	1.8325
	81	1.9085
	1300	3.1139
	210	2.3222
	83	1.9191
	100	2.0000
	200	2.3010
	291	2.4639
	82.3	1.9154
	395.5	2.5971
	1527.8	3.1841
	601.9	2.7795

Mean Value Test

n	t	t value
---	---	---------

2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	
6	2.0150	
7	1.9430	
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	1.771
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

Outlier Test

T _{crit} 10%	T _{crit} V
-----------------------	---------------------

1.420	
1.600	
1.730	
1.830	
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	2.210
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Lead
No. of samples:	14
SGV:	450.00
t value:	1.771
mean (x):	367.39
st.dev (s):	470.52
95% ile:	590.10

Is the Mean Value Test Higher or Lower than the SGV?	Higher
--	--------

Y max:	3.184
Y mean:	2.310
Y st.dev.:	0.459
T value	1.906
Comparator	2.210

Maximum Value Test Result:	Maximum Is within a Normal Distribution
Outlier Test?	

Job Name: Watery Road, Wrexham

Job Number: 7344

Analytical Data

Mean Value Test

Outlier Test

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

n	t	t value
---	---	---------

 $T_{crit} 10\% T_{crit} V$

Granular MG	21	1.3222
22	1.3424	
28	1.4472	
42	1.6232	
58	1.7634	
26	1.4150	
44	1.6435	
25	1.3979	
41	1.6128	
28.3	1.4518	
23.8	1.3766	
29.7	1.4728	
31.3	1.4955	
29.3	1.4669	

2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	
6	2.0150	
7	1.9430	
8	1.8950	
9	1.8600	
10	1.8350	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	1.771
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

1.420	
1.600	
1.730	
1.830	
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	2.210
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Nickel
No. of samples:	14
SGV:	50.00
t value:	1.771
mean (x):	32.10
st.dev (s):	10.44
95% ile:	37.04

Is the Mean Value Test Higher or Lower than the SGV?
Higher or Lower **Lower**

Y max:	1.763
Y mean:	1.488
Y st.dev.:	0.128
T value	2.157
Comparator	2.210

Maximum Value Test Result: Outlier Test?	Maximum is within a Normal Distribution
---	---

Job Name: Watery Road, Wrexham

Job Number: 7344

Analytical Data

Mean Value Test

Outlier Test

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

n	t	t value
---	---	---------

$$T_{crit} = 10\% \quad T_{crit} V$$
[illegible]

2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	
6	2.0150	
7	1.9430	1.943
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

1.420	
1.600	
1.730	
1.830	1.830
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Nickel
No. of samples:	7
SGV:	50.00
t value:	1.943
mean (x):	68.10
st.dev (s):	67.92
95% ile:	117.98

Is the Mean Value Test Higher or Lower than the SGV?
Higher or Lower **Higher**

Y max:	2.342
Y mean:	1.717
Y st.dev.:	0.306
T value	2.044
Comparator	1.830

Maximum Value Test Result: Outlier Test?	Maximum is an Outlier
---	-----------------------

Job Name: Watery Road, Wrexham

Job Number: 7344

Analytical Data

Mean Value Test

Outlier Test

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

n	t	t value
---	---	---------

$$T_{crit} = 10\% T_{crit} V$$
[illegible]

2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	
6	2.0150	2.015
7	1.9430	
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

1.420	
1.600	
1.730	1.730
1.830	
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Nickel
No. of samples:	6
SGV:	50.00
t value:	2.015
mean (x):	42.85
st.dev (s):	13.41
95% ile:	53.88

Is the Mean Value Test Higher or Lower than the SGV?	
Higher or Lower	Higher

Y max:	1.784
Y mean:	1.613
Y stdev:	0.145
T value	1.180
Comparator	1.730

Maximum Value Test Result:	
Outlier Test?	Maximum is within a Normal Distribution

Job Name: Watery Road, Wrexham

Job Number: 7344

Analytical Data

Mean Value Test

Outlier Test

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

n	t	t value
---	---	---------

 $T_{crit} 10\% \quad T_{crit} V$ [illegible]

2	6,3140	
3	2,9200	
4	2,3530	
5	2,1320	
6	2,0150	
7	1,9430	
8	1,8950	
9	1,8600	1,860
10	1,8330	
11	1,8120	
12	1,7960	
13	1,7820	
14	1,7710	
15	1,7610	
16	1,7530	
17	1,7460	
18	1,7400	
19	1,7340	
20	1,7290	
21	1,7250	
22	1,7210	
23	1,7170	
24	1,7140	
25	1,7110	
26	1,7080	
27	1,7060	
28	1,7030	
29	1,7010	
30	1,6990	
31	1,6970	
32	1,6955	
33	1,6940	
34	1,6925	
35	1,6910	
36	1,6895	
37	1,6880	
38	1,6870	
39	1,6860	
40	1,6850	

1.420	
1.600	
1.730	
1.830	
1.910	
1.980	1.980
2.040	
2.085	
2.130	
2.170	
2.210	
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand:	Nickel
No. of samples:	9
SGV:	50.00
t value:	1.860
mean (x):	32.67
st.dev (s):	27.12
95% ile:	49.48

Is the Mean Value Test Higher or Lower than the SGV?
Higher or Lower **Lower**

Y max:	2.014
Y mean:	1.437
Y st.dev.:	0.240
T value	2.405
Comparator	1.980

Maximum Value Test Result: Outlier Test?	Maximum is an Outlier
---	-----------------------

Job Name: Watery Road, Wrexham
Job No: 7344

Analytical Data

Material Type	Data (mg/kg)	Log Data
Granular MG	150	2.1761
	130	2.1139
	210	2.3222
	230	2.3617
	1100	3.0414
	330	2.5185
	140	2.1461
	100	2.0000
	130	2.1139
	217	2.3365
	112.6	2.0515
	517.7	2.7141
	136.5	2.1351
	86.7	1.9380

Mean Value Test

n	t	t value
2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	
6	2.0150	
7	1.9430	
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	1.771
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

Outlier Test

T _{crit} 10%	T _{crit} V
1.420	
1.600	
1.730	
1.830	
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	2.210
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand: **Zinc**

No. of samples: **14**
SGV: **450.00**

t value: **1.771**
mean (x): **256.46**
st.dev (s): **268.17**
95% ile: **383.39**

Is the Mean Value Test Higher or Lower than the SGV?
Higher or Lower **Lower**

Y max: **3.041**
Y mean: **2.284**
Y st.dev.: **0.302**
T value **2.506**
Comparator **2.210**

Maximum Value Test Result: **Maximum is an Outlier**
Outlier Test?

Job Name: Watery Road, Wrexham

Job No: 7344

Analytical Data

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

Mean Value Test

n	t	t value
---	---	---------

Outlier Test

 $T_{crit} 10\%$ $T_{crit} V$ [illegible]

2	6,3140	
3	2,9200	
4	2,3530	
5	2,1320	
6	2,0150	
7	1,9430	1,943
8	1,8950	
9	1,8600	
10	1,8330	
11	1,8120	
12	1,7960	
13	1,7820	
14	1,7710	
15	1,7610	
16	1,7530	
17	1,7460	
18	1,7400	
19	1,7340	
20	1,7290	
21	1,7250	
22	1,7210	
23	1,7170	
24	1,7140	
25	1,7110	
26	1,7080	
27	1,7060	
28	1,7030	
29	1,7010	
30	1,6990	
31	1,6970	
32	1,6955	
33	1,6940	
34	1,6925	
35	1,6910	
36	1,6895	
37	1,6880	
38	1,6870	
39	1,6860	
40	1,6850	

1.420	
1.600	
1.730	
1.830	1.830
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand: **Zinc**

No. of samples:	7
SGV:	450.00

t value:	1.943
mean (x):	253.66
st.dev (s):	203.94
95% ile:	403.43

Is the Mean Value Test Higher or Lower than the SGV?
Higher or Lower **Lower**

Y max:	2.818
Y mean:	2.293
Y st.dev.:	0.333
T value	1.577
Comparator	1.830

Maximum Value Test Result:
Outlier Test? **Maximum is within a Normal Distribution**

Job Name: Watery Road, Wrexham

Job No: 7344

Analytical Data

Material Type	Data (mg/kg)	Log Data
---------------	--------------	----------

Mean Value Test

n	t	t value
---	---	---------

Outlier Test

 $T_{crit} 10\% \quad T_{crit} V$ [illegible]

2	6.3140	
3	2.9200	
4	2.3530	
5	2.1320	2.132
6	2.0150	
7	1.9430	
8	1.8950	
9	1.8600	
10	1.8330	
11	1.8120	
12	1.7960	
13	1.7820	
14	1.7710	
15	1.7610	
16	1.7530	
17	1.7460	
18	1.7400	
19	1.7340	
20	1.7290	
21	1.7250	
22	1.7210	
23	1.7170	
24	1.7140	
25	1.7110	
26	1.7080	
27	1.7060	
28	1.7030	
29	1.7010	
30	1.6990	
31	1.6970	
32	1.6955	
33	1.6940	
34	1.6925	
35	1.6910	
36	1.6895	
37	1.6880	
38	1.6870	
39	1.6860	
40	1.6850	

1.420	
1.600	1.600
1.730	
1.830	
1.910	
1.980	
2.040	
2.085	
2.130	
2.170	
2.210	
2.245	
2.280	
2.305	
2.330	
2.355	
2.380	

Determinand: **Zinc**

No. of samples:	5
SGV:	450.00

t value:	2.132
mean (x):	1112.60
st.dev (s):	1966.79
95% ile:	2987.86

Is the Mean Value Test Higher or Lower than the SGV?
Higher or Lower **Higher**

Y max:	3.661
Y mean:	2.312
Y st.dev.:	0.942
T value	1.431
Comparator	1.600

Maximum Value Test Result:	Maximum Value within a Normal Distribution
Outlier Test?	

APPENDIX VIII
DQRA JUSTIFICATION

DQRA JUSTIFICATION OF INPUT PARAMETERS

Parameter	Value		Data Source
Level 1			
Contaminants considered	Aromatic	C8-C10	Most soluble compounds encountered during the Encia investigation ca. 2008.
		C10-C12	
	Naphthalene		
Target Concentration	0.01mg/l		The WHO guidance ³ states that the application of the lowest WHO guideline value for (aliphatic) hydrocarbons (0.3mg/l for C12-C16) to a total hydrocarbon measurement in water will provide a conservative level of protection. REC has opted for a 0.01mg/l target concentration to be even more conservative.
Water porosity (fraction)	0.33		SR3 Table 4.4 – Based on a sandy Loam.
Air porosity (fraction)	0.20		
Bulk Density (g/cm ³)	1.21		SR3 Table 4.4 – Based on a sandy Loam due to gravel content.
Henry’s Law Constant (dimensionless)	Aromatic		Table 9-14 LQM CIEH.
	C8-C10	0.25	
	C10-C12	0.0722	
	Naphthalene	0.00662	Converted from Table 3.38 SR7.
Soil water partition co-efficient	N/A		Not applicable for organic compounds.
Fraction of organic	0.047		Taken from the average of the 2 most conservative

carbon (FOC)			saturated zone TOCs.
Organic carbon partition co-efficient (L/kg)	Aromatic		Table 9-14 LQM CIEH.
	C8-C10	1584.90	
	C10-C12	2511.89	
	Naphthalene	645.70	Table 10-51 LQM CIEH.
Sorption co-efficient	N/A		Not applicable for organic compounds.
Level 2			
Infiltration (m/day)	0.0013		Average of MET office annual rainfall stats for Wrexham in 2010 and 2011.
Area of contaminant source (m ²)	630		Based on site derived information.
Length of contaminant source in direction of groundwater flow (m)	14		
Saturated aquifer thickness (m)	10		Average depth of sand and gravel deposits (conservative as primarily granular horizons within cohesive matrix).
Hydraulic conductivity (m/day)	0.26		Based on in-situ falling head permeability tests.
Hydraulic gradient (fraction)	0.006		Based on site derived information.
Width of source perpendicular to groundwater flow (m)	45		
Background concentration of contaminant in groundwater beneath	N/A		Not applicable

the site.		
Mixing zone depth (m)	N/A	Calculated from P20 sheet.
Level 3 Soils and Groundwater		
Soil Concentration (mg/kg)	Aromatic	
	C8-C10	0.52
	C10-C12	0.31
	Naphthalene	0.46
Half-life degradation of contaminants (days)	Aromatic	
	C8-C10	712
	C10-C12	1750
	Naphthalene	258
Width of plume in aquifer (m)	50	Based on site derived information.
Plume thickness in aquifer (m)	1	
Bulk density of aquifer material (g/cm ³)	1.2	Table 4.4 of SR3
Effective porosity of aquifer (%)	0.25	Table 4.2 Consim
Hydraulic gradient and conductivity (%)	0.584	Calculated from Level 2
Distance to compliance point (m)	50	Based on distance to River Gwenfro.
Time since pollutant entered groundwater	N/A	Not considered.

APPENDIX IX
P20 OUTPUT SHEETS

Remedial Targets Worksheet , Release 3.1

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		C8-C10 Aromatic		from Level 1
Target Concentration	Ct	0.01	mg/l	from Level 1
Dilution Factor	DF	1.72E+00		from Level 2

Enter method of defining partition co-efficient (using pull down list)
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	4.70E-02	fraction
Organic carbon partition coefficient	Koc	1.58E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction

Soil water partition coefficient	Kd	7.45E+01	l/kg
----------------------------------	----	----------	------

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

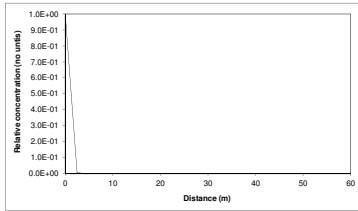
Enter value	Calc value	Xu & Eckstein	
ax	0.00E+00	5.00E+00	0.00E+00 m
az	0.00E+00	5.00E-01	0.00E+00 m
ay	0.00E+00	5.00E-02	0.00E+00 m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; $az = ax/10$, $ay = ax/100$ are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Distance	Relative concentration	Concentration
	(No units)	mg/l
0	1.0E+00	4.05E-03
2.5	5.74E-03	2.32E-05
5.0	3.30E-05	1.33E-07
7.5	1.89E-07	7.66E-10
10.0	1.09E-09	4.40E-12
12.5	6.24E-12	2.53E-14
15.0	3.58E-14	1.45E-16
17.5	2.06E-16	8.33E-19
20.0	1.18E-18	4.79E-21
22.5	6.79E-21	2.75E-23
25.0	3.90E-23	1.58E-25
27.5	2.24E-25	9.06E-28
30.0	1.29E-27	5.20E-30
32.5	7.36E-30	2.99E-32
35.0	4.24E-32	1.72E-34
37.5	2.43E-34	9.85E-37
40.0	1.40E-36	5.65E-39
42.5	8.02E-39	3.25E-41
45.0	4.60E-41	1.86E-43
47.5	2.64E-43	1.07E-45
50.0	1.52E-45	6.14E-48

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), 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 (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 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 9.9E+99.

Site being assessed:	Watery Road, Wrexham
Completed by:	Simon Howard
Date:	#####
Version:	1.1

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value.)

Variable	Value	Unit	Source of parameter value
Enter source concentration			
Enter soil concentration	0.52	mg/kg	
Half life for degradation of contaminant in water	t _{1/2}	days	
Calculated decay rate	λ	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	m	from Level 2
Plume thickness in aquifer at source	Sy	m	from Level 2
Bulk density of aquifer materials	ρ	g/cm ³	SR3 Table 4.4
Effective porosity of aquifer	n	fraction	Conservative based on gravel
Hydraulic gradient	i	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	m/d	from Level 2
Distance to compliance point	x	m	Distance to culverted river
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	7.45E+01	l/kg see options
Longitudinal dispersivity	ax	5.000	m see options
Transverse dispersivity	az	0.500	m see options
Vertical dispersivity	ay	0.050	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable		
Groundwater flow velocity	v	1.49E-02 m/d
Retardation factor	Rf	3.59E+02 fraction
Decay rate used	λ	9.74E-04 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	1.44E-02 fraction
Rate of contaminant flow due to retardation	u	4.17E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	1.52E-45 fraction
Attenuation factor (C ₀ /C _{cp})	AF	6.59E+44 fraction
Calculated soil leachate concentration	Co	6.95E-03 mg/l

Remedial Targets

Level 3 Remedial Target	1.13E+43	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	8.47E+44	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	50	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	1.52E-45	fraction 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



R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	C8-C10 Aromatic	from Level 1
Target Concentration	C _T 1.00E-02	mg/l from Level 1

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 2 directions
--

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-02	mg/l	Site data
Half life for degradation of contaminant in water	t _{1/2}	7.12E+02	days	Canada Wide Standards for PHC in Soils
Calculated decay rate	λ	9.74E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	4.50E+01	m	Estimated from site data
Plume thickness at source	Sy	1.60E+00	m	Estimated from site data
Saturated aquifer thickness	da	1.00E+01	m	Estimated from site data
Bulk density of aquifer materials	ρ	1.20E+00	g/cm ³	Estimated from site data
Effective porosity of aquifer	n	2.50E-01	fraction	consaim
Hydraulic gradient	I	5.80E-01	fraction	Calculated from site data
Hydraulic conductivity of aquifer	K	2.60E-01	m/d	Calculated from site data
Distance to compliance point	x	5.00E+01	m	Estimated from site data
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+11	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	7.45E+01	l/kg	see options
Longitudinal dispersivity	ax	5.00E+00	m	see options
Transverse dispersivity	ay	5.00E-01	m	see options
Vertical dispersivity	ay	5.00E-02	m	see options

Calculated Parameters

Groundwater flow velocity	v	6.03E-01	m/d
Retardation factor	Rf	3.59E+02	fraction
Decay rate used	λ	2.72E-06	d ⁻¹
Rate of contaminant flow due to retardation	u	1.68E-03	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	2.58E-03	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	3.88E+00	

Remedial Targets

Remedial Target	3.88E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	2.58E-03	mg/l Ogata Banks
after	1.0E+11	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)

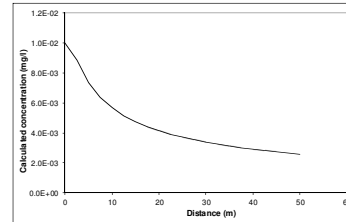
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	4.70E-02 fraction
Organic carbon partition coefficient	Koc	1.58E+03 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	7.45E+01 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	5.00E-01	2.99E+00
Transverse dispersivity	az	0.00E+00	5.00E-01	2.99E-01
Vertical dispersivity	ay	0.00E+00	5.00E-02	3.99E-02
Note values of dispersivity must be > 0				
For calculated value, assumes $ax = 0.1 \cdot x$, $az = 0.01 \cdot x$, $ay = 0.001 \cdot x$				
Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; $az = ax/10$, $ay = ax/100$ 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.

Note

This sheet calculates the Level 3 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 Level 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 9.9E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed: Watery Road, Wrexham
Completed by: Simon Howard
Date: #####
Version: 1.1

Remedial Targets Worksheet , Release 3.1

Level 3 - Soil

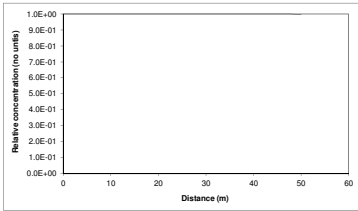
See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		C8-C10 Aromatic		from Level 1
Target Concentration	Ct	0.01	mg/l	from Level 1
Dilution Factor	DF	1.72E+00		from Level 2

Enter method of defining partition co-efficient (using pull down list)
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer f_{oc} 4.70E-02 fraction
Organic carbon partition coefficient K_{oc} 1.58E+03 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{oc,n} l/kg
Sorption coefficient for ionised species K_{oc,i} l/kg
pH value pH
Acid dissociation constant pKa
Fraction of organic carbon in aquifer f_{oc} fraction



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks		
From calculation sheet		
Distance	Relative concentration	Concentration
	(No units)	mg/l
0	1.0E+00	4.05E-03
2.5	1.00E+00	4.05E-03
5.0	1.00E+00	4.05E-03
7.5	1.00E+00	4.05E-03
10.0	1.00E+00	4.05E-03
12.5	1.00E+00	4.05E-03
15.0	1.00E+00	4.05E-03
17.5	1.00E+00	4.05E-03
20.0	1.00E+00	4.05E-03
22.5	1.00E+00	4.05E-03
25.0	1.00E+00	4.05E-03
27.5	1.00E+00	4.05E-03
30.0	1.00E+00	4.05E-03
32.5	1.00E+00	4.05E-03
35.0	1.00E+00	4.05E-03
37.5	1.00E+00	4.05E-03
40.0	1.00E+00	4.05E-03
42.5	9.99E-01	4.05E-03
45.0	9.99E-01	4.04E-03
47.5	9.99E-01	4.04E-03
50.0	9.98E-01	4.04E-03

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

Ogata Banks Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value.)

Variable	Value	Unit	Source of parameter value
Soil concentration as mg/kg			
Enter soil concentration	0.52	mg/kg	
Half life for degradation of contaminant in water	1.00E+16	days	
Calculated decay rate	6.93E-17	days ⁻¹	calculated
Width of plume in aquifer at source	4.50E+01	m	from Level 2
Plume thickness in aquifer at source	8.37E+00	m	from Level 2
Bulk density of aquifer materials	1.20E+00	g/cm ³	SR3 Table 4.4
Effective porosity of aquifer	2.50E-01	fraction	Conservative based on gravel
Hydraulic gradient	1.44E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	2.60E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to culverted river
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	9.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	7.45E+01	l/kg see options
Longitudinal dispersivity	ax	5.000	m see options
Transverse dispersivity	az	0.500	m see options
Vertical dispersivity	ay	0.050	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable		
Groundwater flow velocity	v	1.49E-02 m/d
Retardation factor	Rf	3.59E+02 fraction
Decay rate used	λ	6.93E-17 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	1.44E-02 fraction
Rate of contaminant flow due to retardation	u	4.17E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	9.98E-01 fraction
Attenuation factor (C ₀ /C _{cp})	AF	1.00E+00 fraction
Calculated soil leachate concentration	Co	6.95E-03 mg/l

Remedial Targets

Level 3 Remedial Target			
Ogata Banks			
	1.72E-02	mg/l	For comparison with measured pore water concentration.
	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	1.29E+00	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	50	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	9.98E-01	fraction 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

Define dispersivity (click brown cell and use pull down list)
Dispersivities 10%, 1%, 0.1% of pathway length

Enter value Calc value Xu & Eckstein
Longitudinal dispersivity ax 0.00E+00 5.00E+00 0.00E+00 m
Transverse dispersivity az 0.00E+00 5.00E-01 0.500E-01 m
Vertical dispersivity ay 0.00E+00 5.00E-02 0.500E-02 m
Note values of dispersivity must be > 0
Xu & Eckstein (1995) report ax = 0.83(log₁₀ax)²⁺¹⁴; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), 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 (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 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 9.9E+99.

Site being assessed: Watery Road, Wrexham
Completed by: Simon Howard
Date: #####
Version: 1.1

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	C8-C10 Aromatic	from Level 1
Target Concentration	C _T 1.00E-02	mg/l from Level 1

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

Ogata Banks	Equations in HRA publication
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Approach for simulating vertical dispersion:

Simulate vertical dispersion in 2 directions
--

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-02	mg/l	Site data
Half life for degradation of contaminant in water	t _{1/2}	1.00E+10	days	Canada Wide Standards for PHC in Soils
Calculated decay rate	λ	6.93E-17	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	4.50E+01	m	Estimated from site data
Plume thickness at source	Sy	1.60E+00	m	Estimated from site data
Saturated aquifer thickness	da	1.00E+01	m	Estimated from site data
Bulk density of aquifer materials	p	1.20E+00	g/cm ³	Estimated from site data
Effective porosity of aquifer	n	2.50E-01	fraction	consaim
Hydraulic gradient	I	5.82E-01	fraction	Calculated from site data
Hydraulic conductivity of aquifer	K	2.60E-01	m/d	Calculated from site data
Distance to compliance point	x	5.00E+01	m	Estimated from site data
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+11	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	7.45E+01	l/kg	see options
Longitudinal dispersivity	ax	5.00E+00	m	see options
Transverse dispersivity	az	5.00E-01	m	see options
Vertical dispersivity	ay	5.00E-02	m	see options

Calculated Parameters

Groundwater flow velocity	v	6.03E-01	m/d
Retardation factor	Rf	3.59E+02	fraction
Decay rate used	λ	1.93E-19	d ⁻¹
Rate of contaminant flow due to retardation	u	1.68E-03	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	2.79E-03	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	3.58E+00	

Remedial Targets

Remedial Target	3.58E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	2.79E-03	mg/l Ogata Banks
after	1.0E+11	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)

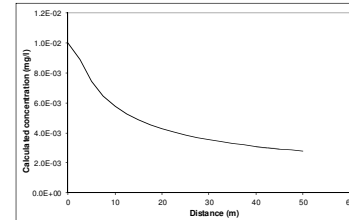
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	4.70E-02 fraction
Organic carbon partition coefficient	Koc	1.58E+03 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,ij}	l/kg
Sorption coefficient for ionised species	K _{ow,ij}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	7.45E+01 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein	m
Transverse dispersivity	az	0.00E+00	5.00E-01	0.00E+00 m
Vertical dispersivity	ay	0.00E+00	5.00E-02	0.00E+00 m
Note values of dispersivity must be > 0				
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x				
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ X) ^{0.411} ; 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.

Note

This sheet calculates the Level 3 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 Level 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.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed: Watery Road, Wrexham
Completed by: Simon Howard
Date: #####
Version: 1.1

Remedial Targets Worksheet , Release 3.1

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		C10-C12 Aromatic		from Level 1
Target Concentration	Ct	0.01	mg/l	from Level 1
Dilution Factor	DF	1.44E+01		from Level 2

Enter method of defining partition co-efficient (using pull down list)
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	4.70E-02
Organic carbon partition coefficient	Koc	2.51E+03
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	
Sorption coefficient for ionised species	K _{oc,i}	
pH value	pH	
Acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	

Soil water partition coefficient	Kd	1.18E+02	l/kg
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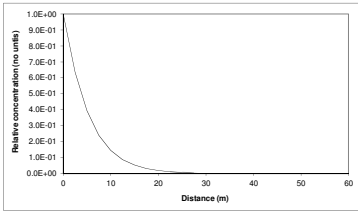
Define dispersivity (click brown cell and use pull down list)
Dispersivities 10%, 1%, 0.1% of pathway length

Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00 5.00E+00 0.00E+00
Transverse dispersivity	az	0.00E+00 5.00E-01 0.00E+00
Vertical dispersivity	ay	0.00E+00 5.00E-02 0.00E+00

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; $az = ax/10$, $ay = ax/100$ are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Distance	Relative concentration	Concentration
	(No units)	mg/l
0	1.0E+00	1.82E-04
2.5	6.35E-01	1.16E-04
5.0	3.95E-01	7.21E-05
7.5	2.41E-01	4.40E-05
10.0	1.46E-01	2.66E-05
12.5	8.84E-02	1.61E-05
15.0	5.37E-02	9.79E-06
17.5	3.27E-02	5.96E-06
20.0	1.99E-02	3.64E-06
22.5	1.22E-02	2.23E-06
25.0	7.49E-03	1.37E-06
27.5	4.60E-03	8.40E-07
30.0	2.84E-03	5.18E-07
32.5	1.75E-03	3.20E-07
35.0	1.08E-03	1.96E-07
37.5	6.70E-04	1.22E-07
40.0	4.16E-04	7.58E-08
42.5	2.58E-04	4.71E-08
45.0	1.60E-04	2.93E-08
47.5	9.97E-05	1.82E-08
50.0	6.21E-05	1.13E-08

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), 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 (e.g. 9.9E9) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 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 9.9E+99.

Site being assessed:	Watery Road, Wrexham
Completed by:	Simon Howard
Date:	#####
Version:	1.1

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

Ogata Banks	Equations in HRA publication
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Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value,)

Variable	Value	Unit	Source of parameter value
Enter source concentration			
Enter soil concentration	0.31	mg/kg	
Half life for degradation of contaminant in water	1.75E+03	days	
Calculated decay rate	3.96E-04	days ⁻¹	calculated
Width of plume in aquifer at source	4.50E+01	m	from Level 2
Plume thickness in aquifer at source	1.60E+00	m	from Level 2
Bulk density of aquifer materials	1.20E+00	g/cm ³	SR3 Table 4.4
Effective porosity of aquifer	2.50E-01	fraction	Conservative based on gravel
Hydraulic gradient	6.28E-01	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	2.60E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to culverted river
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	9.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.18E+02	l/kg see options
Longitudinal dispersivity	ax	5.000	m see options
Transverse dispersivity	az	0.500	m see options
Vertical dispersivity	ay	0.050	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable		
Groundwater flow velocity	v	6.53E-01 m/d
Retardation factor	Rf	5.68E+02
Decay rate used	λ	3.96E-04 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	6.28E-01
Rate of contaminant flow due to retardation	u	1.15E-03 m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	6.21E-05
Attenuation factor (C ₀ /C _{cp})	AF	1.61E+04
Calculated soil leachate concentration	Co	2.62E-03 mg/l

Remedial Targets

Level 3 Remedial Target	2.31E+03	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	2.74E+05	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	50	m	
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	6.21E-05	fraction 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

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	C10-C12 Aromatic	from Level 1
Target Concentration	C _T 1.00E-02	mg/l from Level 1

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

Ogata Banks	Equations in HRA publication
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Approach for simulating vertical dispersion:

Simulate vertical dispersion in 2 directions
--

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-02	mg/l	Site data
Half life for degradation of contaminant in water	t _{1/2}	1.75E+03	days	Canada Wide Standards for PHC in Soils
Calculated decay rate	λ	3.96E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	4.50E+01	m	Estimated from site data
Plume thickness at source	Sy	1.60E+00	m	Estimated from site data
Saturated aquifer thickness	da	1.00E+01	m	Estimated from site data
Bulk density of aquifer materials	p	1.20E+00	g/cm ³	Estimated from site data
Effective porosity of aquifer	n	2.50E-01	fraction	consaim
Hydraulic gradient	I	5.80E-01	fraction	Calculated from site data
Hydraulic conductivity of aquifer	K	2.60E-01	m/d	Calculated from site data
Distance to compliance point	x	5.00E+01	m	Estimated from site data
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+11	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	1.18E+02	l/kg	see options
Longitudinal dispersivity	ax	5.00E+00	m	see options
Transverse dispersivity	ay	5.00E-01	m	see options
Vertical dispersivity	ay	5.00E-02	m	see options

Calculated Parameters

Groundwater flow velocity	v	6.03E-01	m/d
Retardation factor	Rf	5.68E+02	fraction
Decay rate used	λ	6.98E-07	d ⁻¹
Rate of contaminant flow due to retardation	u	1.06E-03	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	2.70E-03	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	3.70E+00	

Remedial Targets

Remedial Target	3.70E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	2.70E-03	mg/l Ogata Banks
after	1.0E+11	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)

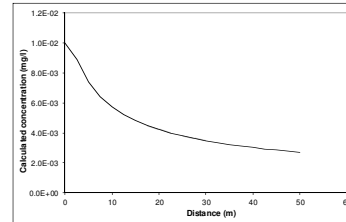
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	1.18E+02 l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	4.70E-02 fraction
Organic carbon partition coefficient	Koc	2.51E+03 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,ij}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	1.18E+02 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	5.00E+00	5.00E+00	5.00E+00	m
Transverse dispersivity	ay	0.00E+00	5.00E-01	5.00E-01	m
Vertical dispersivity	ay	0.00E+00	5.00E-02	5.00E-02	m
Note values of dispersivity must be > 0					
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x					
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ X) ^{0.411} ; 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.

Note

This sheet calculates the Level 3 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 Level 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 9.9E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed: Watery Road, Wrexham
Completed by: Simon Howard
Date: #####
Version: 1.1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

0	mg/l
2.5	1.0E-02
5.0	8.89E-03
7.5	7.40E-03
10.0	6.41E-03
12.5	5.73E-03
15.0	5.21E-03
17.5	4.82E-03
20.0	4.49E-03
22.5	4.23E-03
25.0	4.00E-03
27.5	3.81E-03
30.0	3.64E-03
32.5	3.49E-03
35.0	3.36E-03
37.5	3.24E-03
40.0	3.13E-03
42.5	3.03E-03
45.0	2.94E-03
47.5	2.85E-03
50.0	2.77E-03

Remedial Targets Worksheet , Release 3.1

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		C10-C12 Aromatic		from Level 1
Target Concentration	Ct	0.01	mg/l	from Level 1
Dilution Factor	DF	1.72E+00		from Level 2

Enter method of defining partition co-efficient (using pull down list)
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	4.70E-02	fraction
Organic carbon partition coefficient	Koc	2.51E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction

Soil water partition coefficient Kd 1.18E+02 l/kg

Define dispersivity (click brown cell and use pull down list)
Dispersivities 10%, 1%, 0.1% of pathway length

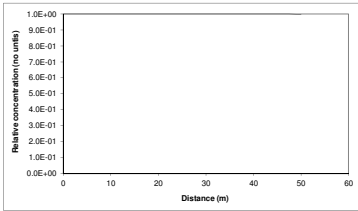
Enter value	Calc value	Xu & Eckstein	
ax	0.00E+00	5.00E+00	0.00E+00 m
az	0.00E+00	5.00E-01	0.00E+00 m
ay	0.00E+00	5.00E-02	0.00E+00 m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; $az = ax/10$, $ay = ax/100$ are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks	From calculation sheet	Relative concentration	Concentration
Distance	(No units)		mg/l
0	1.0E+00		1.53E-03
2.5	1.00E+00		1.53E-03
5.0	1.00E+00		1.53E-03
7.5	1.00E+00		1.53E-03
10.0	1.00E+00		1.53E-03
12.5	1.00E+00		1.53E-03
15.0	1.00E+00		1.53E-03
17.5	1.00E+00		1.53E-03
20.0	1.00E+00		1.53E-03
22.5	1.00E+00		1.53E-03
25.0	1.00E+00		1.53E-03
27.5	1.00E+00		1.53E-03
30.0	1.00E+00		1.53E-03
32.5	1.00E+00		1.53E-03
35.0	1.00E+00		1.53E-03
37.5	1.00E+00		1.53E-03
40.0	1.00E+00		1.52E-03
42.5	9.99E-01		1.52E-03
45.0	9.99E-01		1.52E-03
47.5	9.99E-01		1.52E-03
50.0	9.98E-01		1.52E-03

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), 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 (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 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 9.9E+99.

Site being assessed:	Watery Road, Wrexham
Completed by:	Simon Howard
Date:	#####
Version:	1.1

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

Ogata Banks Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value,)

Variable	Value	Unit	Source of parameter value
Enter source concentration			Soil concentration as mg/kg
Enter soil concentration	0.31	mg/kg	
Half life for degradation of contaminant in water	t _{1/2}	1.00E+16 days	
Calculated decay rate	λ	6.93E-17 days ⁻¹	calculated
Width of plume in aquifer at source	Sz	4.50E+01 m	from Level 2
Plume thickness in aquifer at source	Sy	8.37E+00 m	from Level 2
Bulk density of aquifer materials	p	1.20E+00 g/cm ³	SR3 Table 4.4
Effective porosity of aquifer	n	2.50E-01 fraction	Conservative based on gravel
Hydraulic gradient	i	1.44E-02 fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.60E-01 m/d	from Level 2
Distance to compliance point	x	5.00E+01 m	Distance to culverted river
Distance (lateral) to compliance point perpendicular to flow direction	z		
Distance (depth) to compliance point perpendicular to flow direction	y		
Time since pollutant entered groundwater	t	9.00E+99 days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.18E+02 l/kg	see options
Longitudinal dispersivity	ax	5.000 m	see options
Transverse dispersivity	az	0.500 m	see options
Vertical dispersivity	ay	0.050 m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.49E-02 m/d
Retardation factor	Rf	5.68E+02 fraction
Decay rate used	λ	6.93E-17 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	1.44E-02 fraction
Rate of contaminant flow due to retardation	u	2.63E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	9.98E-01 fraction
Attenuation factor (C ₀ /C _{cp})	AF	1.00E+00 fraction
Calculated soil leachate concentration	Co	2.62E-03 mg/l

Remedial Targets

Level 3 Remedial Target	1.72E-02	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	2.04E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	50	m	
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	9.98E-01	fraction 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

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant	C10-C12 Aromatic			from Level 1
Target Concentration	C _T	1.00E-02	mg/l	from Level 1

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

Ogata Banks	Equations in HRA publication
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Approach for simulating vertical dispersion:

Simulate vertical dispersion in 2 directions
--

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value	Variable	Value	Unit	Source
Site data	C ₀	1.00E-02	mg/l	
Site data	t _{1/2}	1.00E+10	days	
Canada Wide Standards for PHC in Soils	λ	6.93E-17	days ⁻¹	
Estimated from site data	Sz	4.50E+01	m	
Estimated from site data	Sy	1.60E+00	m	
Estimated from site data	da	1.00E+01	m	
Estimated from site data	p	1.20E+00	g/cm ³	
consaim	n	2.50E-01	fraction	
Calculated from site data	I	5.82E-01	fraction	
Calculated from site data	K	2.60E-01	m/d	
Estimated from site data	x	5.00E+01	m	
	z		m	
	y		m	
time variant options only	t	1.00E+11	days	
see options	Kd	1.18E+02	l/kg	
see options	ax	5.00E+00	m	
see options	az	5.00E-01	m	
see options	ay	5.00E-02	m	

Calculated Parameters

Variable	Value	Unit	Source
Groundwater flow velocity	v	6.03E-01	m/d
Retardation factor	Rf	5.68E+02	fraction
Decay rate used	λ	1.22E-19	d ⁻¹
Rate of contaminant flow due to retardation	u	1.06E-03	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	2.79E-03	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	3.58E+00	

Remedial Targets

Remedial Target	3.58E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	2.79E-03	mg/l
after	1.0E+11	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)

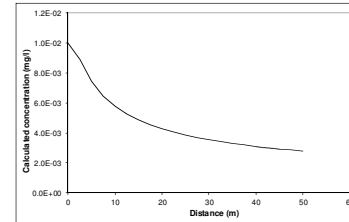
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	Kd		l/kg
Soil water partition coefficient			
Entry for non-polar organic chemicals (option)	foc	4.70E-02	fraction
Fraction of organic carbon in aquifer			
Organic carbon partition coefficient	Koc	2.51E+03	l/kg
Entry for ionic organic chemicals (option)	K _{oc,ij}		l/kg
Sorption coefficient for related species			
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.18E+02	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Enter value	Calc value Xu & Eckstein	m
ax	5.00E+00	5.00E+00
az	5.00E-01	5.00E-01
ay	5.00E-02	5.00E-02
Note values of dispersivity must be > 0		
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x		
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ X) ^{0.411} ; 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.

Note

This sheet calculates the Level 3 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 Level 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.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed: Watney Road, Wrexham
Completed by: Simon Howard
Date: #####
Version: 1.1

Remedial Targets Worksheet , Release 3.1

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Napthalene		from Level 1
Target Concentration	Ct	0.01	mg/l	from Level 1
Dilution Factor	DF	1.72E+00		from Level 2

Enter method of defining partition co-efficient (using pull down list)
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer f_{oc} 4.70E-02 fraction
Organic carbon partition coefficient K_{oc} 6.46E+02 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{oc,n} l/kg
Sorption coefficient for ionised species K_{oc,i} l/kg
pH value pH
Acid dissociation constant pKa
Fraction of organic carbon in aquifer f_{oc} fraction

Soil water partition coefficient Kd 3.03E+01 l/kg

Define dispersivity (click brown cell and use pull down list)
Dispersivities 10%, 1%, 0.1% of pathway length

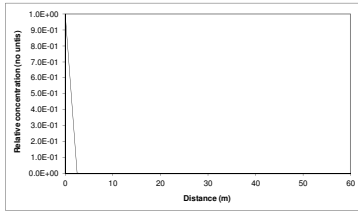
Enter value Calc value Xu & Eckstein
Longitudinal dispersivity ax 0.00E+00 5.00E+00 0.00E+00 m
Transverse dispersivity az 0.00E+00 5.00E-01 0.00E+00 m
Vertical dispersivity ay 0.00E+00 5.00E-02 0.00E+00 m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; $az = ax/10$, $ay = ax/100$ are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks	From calculation sheet	Relative concentration	Concentration
Distance	(No units)		mg/l
0	1.0E+00		8.75E-03
2.5	4.10E-03		3.58E-05
5.0	1.68E-05		1.47E-07
7.5	6.88E-08		6.02E-10
10.0	2.82E-10		2.47E-12
12.5	1.16E-12		1.01E-14
15.0	4.74E-15		4.14E-17
17.5	1.94E-17		1.70E-19
20.0	7.95E-20		6.96E-22
22.5	3.26E-22		2.85E-24
25.0	1.34E-24		1.17E-26
27.5	5.47E-27		4.79E-29
30.0	2.24E-29		1.96E-31
32.5	9.19E-32		8.04E-34
35.0	3.77E-34		3.29E-36
37.5	1.54E-36		1.35E-38
40.0	6.32E-39		5.53E-41
42.5	2.59E-41		2.27E-43
45.0	1.06E-43		9.29E-46
47.5	4.35E-46		3.80E-48
50.0	1.78E-48		1.56E-50

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), 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 (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 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 9.9E+99.

Site being assessed: Watery Road, Wrexham
Completed by: Simon Howard
Date: #####
Version: 1.1

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

Ogata Banks Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value,)

Variable	Value	Unit	Source of parameter value
Enter source concentration			Soil concentration as mg/kg
Enter soil concentration	0.46	mg/kg	
Half life for degradation of contaminant in water	2.58E+02	days	
Calculated decay rate	2.69E-03	days ⁻¹	calculated
Width of plume in aquifer at source	4.50E+01	m	from Level 2
Plume thickness in aquifer at source	8.37E+00	m	from Level 2
Bulk density of aquifer materials	1.20E+00	g/cm ³	SR3 Table 4.4
Effective porosity of aquifer	2.50E-01	fraction	Conservative based on gravel
Hydraulic gradient	1.44E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	2.60E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to culverted river
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+21	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	3.03E+01	l/kg see options
Longitudinal dispersivity	ax	5.000	m see options
Transverse dispersivity	az	0.500	m see options
Vertical dispersivity	ay	0.050	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters Variable

Groundwater flow velocity	v	1.49E-02	m/d
Retardation factor	Rf	1.47E+02	fraction
Decay rate used	λ	2.69E-03	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	1.44E-02	fraction
Rate of contaminant flow due to retardation	u	1.02E-04	m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	1.78E-48	fraction
Attenuation factor (C ₀ /C _{cp})	AF	5.61E+47	fraction
Calculated soil leachate concentration	Co	1.50E-02	mg/l

Remedial Targets

Level 3 Remedial Target	9.64E+45	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	2.95E+47	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	50	m	
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	1.78E-48	fraction 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



R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Naphthalene	from Level 1
Target Concentration	C _T 1.00E-02	mg/l from Level 1

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

Ogata Banks	Equations in HRA publication
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Approach for simulating vertical dispersion:

Simulate vertical dispersion in 2 directions
--

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-04	mg/l	Site data
Half life for degradation of contaminant in water	t _{1/2}	1.75E+03	days	Canada Wide Standards for PHC in Soils
Calculated decay rate	λ	3.96E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	4.50E+01	m	Estimated from site data
Plume thickness at source	Sy	1.60E+00	m	Estimated from site data
Saturated aquifer thickness	da	1.00E+01	m	Estimated from site data
Bulk density of aquifer materials	p	1.20E+00	g/cm ³	Estimated from site data
Effective porosity of aquifer	n	2.50E-01	fraction	consaim
Hydraulic gradient	I	5.80E-01	fraction	Calculated from site data
Hydraulic conductivity of aquifer	K	2.60E-01	m/d	Calculated from site data
Distance to compliance point	x	5.00E+01	m	Estimated from site data
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+11	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	3.03E+01	l/kg	see options
Longitudinal dispersivity	ax	5.00E+00	m	see options
Transverse dispersivity	ay	5.00E-01	m	see options
Vertical dispersivity	ay	5.00E-02	m	see options

Calculated Parameters

Groundwater flow velocity	v	6.03E-01	m/d
Retardation factor	Rf	1.47E+02	fraction
Decay rate used	λ	2.70E-06	d ⁻¹
Rate of contaminant flow due to retardation	u	4.11E-03	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	2.70E-05	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	3.70E+00	

Remedial Targets

Remedial Target	3.70E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	2.70E-05	mg/l
after		1.0E+11	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

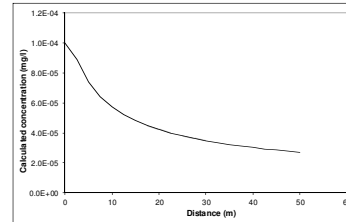
Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd		l/kg
Soil water partition coefficient (option)			
Fraction of organic carbon in aquifer	foc	4.70E-02	fraction
Organic carbon partition coefficient	Koc	6.46E+02	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		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	3.03E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein	m
Transverse dispersivity	ay	0.00E+00	5.00E-01	5.99E-01
Vertical dispersivity	ay	0.00E+00	5.00E-02	5.99E-02
Note values of dispersivity must be > 0				
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x				
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ X) ^{0.411} ; 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.

Note

This sheet calculates the Level 3 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 Level 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 9.9E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed: Watery Road, Wrexham
Completed by: Simon Howard
Date: #####
Version: 1.1

APPENDIX X
REC METHOD COMPACTION SPECIFICATION

EARTHWORKS

#601 Classification, Definitions and Uses of Earthworks Materials

General Classification

1 Earthworks materials shall fall into one or other of the following general classifications:

- (i) acceptable material: material excavated from within the Site or imported on to the Site which meets the requirements of Table 6/1 and Appendix 6/1 for acceptability for use in the Permanent Works;

- (ii) (11/04) unacceptable material Class U1A as defined in sub-Clauses 2(i)(a) and 2(i)(b) of this Clause: material excavated from within the Site which, unless processed so that it meets the requirements of Table 6/1 and Appendix 6/1, shall not be used in the Permanent Works;

- (iii) (11/04) unacceptable material Class U1B as defined in sub-Clause 2(ii)(a) of this Clause: material excavated from within the Site which, unless processed so that it meets the requirements of Table 6/1 and Appendix 6/1, shall not be used in the Permanent Works; and

- (iv) (11/04) unacceptable material Class U2 as defined in sub-Clause 3(i) of this Clause: material excavated from within the Site which shall not be used in the Permanent Works.

(11/04) Unacceptable Materials

2 (11/04) Unacceptable material Classes U1A and U1B:

- (i) (11/04) unacceptable material Class U1A shall be:
- (a) (11/04) material which does not comply with the permitted constituents and material properties of Table 6/1 and Appendix 6/1 for acceptable material; and

- (b) (11/04) material, or constituents of materials, composed of the following unless otherwise described in Appendix 6/1:

- peat, materials from swamps, marshes and bogs;
- logs, stumps and perishable material;
- materials in a frozen condition;
- clay having a liquid limit determined in accordance with BS 1377 : Part 2, exceeding 90 or plasticity index determined in accordance with BS 1377 : Part 2, exceeding 65;

- material susceptible to spontaneous combustion except unburnt colliery spoil complying with sub-Clause 15 of this Clause;

- (ii) (11/04) unacceptable material Class U1B shall be:

- (a) (11/05) contaminated materials, including controlled wastes (as defined in the Environmental Protection Act 1990 Part IIA) whose level of contamination is above that given either in Appendix 6/14 or in Appendix 6/15, but excluding all hazardous wastes (as defined in the Hazardous Waste (England and Wales) Regulations 2005) and radioactive wastes (as defined in the Radioactive Substances Act 1993).

3 Unacceptable material Class U2 shall be:

- (i) (11/05) hazardous waste (as defined in the Hazardous Waste (England and Wales) Regulations 2005) and radioactive waste (as defined in the Radioactive Substances Act 1993).

- 4 (11/04) Where required in Appendix 6/1, unacceptable material (other than Class U2) shall be processed by mechanical, chemical or other means to render the material acceptable for use in the Permanent Works in accordance with the requirements of Table 6/1 and Appendix 6/1.

Definitions

5 Chalk shall mean:

- (i) any porous material of natural origin composed essentially of calcium carbonate

and identified as chalk on the maps produced by the British Geological Survey;

- (ii) material designated as Class 3 in Appendix 6/1.

6 Argillaceous rock shall mean shales mudstones siltstones slates and micaceous schists composed of particles of clay and silt and mica. It shall include unburnt colliery spoil.

7 Pulverised-fuel ash shall mean solid material extracted by electrostatic and mechanical means from the flue gases of furnaces fired with pulverised bituminous coal. It shall have a maximum particle size of 3 mm.

8 Furnace bottom ash shall mean agglomerated pulverised-fuel ash obtained from the bottom of the power station furnace and having particle size no larger than 10 mm.

9 Formation shall be the top surface of capping. Where no capping is required formation shall be the top surface of earthworks at the underside of sub-base, unless otherwise shown on the Drawings.

10 Sub-formation shall be the top surface of earthworks at the underside of capping.

11 (05/01) Stabilisation shall mean the spreading of cement or lime or both on a layer of deposited or intact granular or cohesive material, and the subsequent process of pulverising and mixing followed by appropriate compaction to form the whole or a constituent layer of a capping.

12 (11/07) Where 'recycled aggregate' is used in this Series, the material shall be aggregate resulting from the processing of material used in a construction process. The aggregate shall have been tested in accordance with Clause 710, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass. Where 'recycled aggregate except recycled asphalt' is used in this Series, the aggregate shall have been tested in accordance with Clause 710. Content of asphalt (mineral aggregate with a bituminous binder) shall not exceed 2% by mass, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass.

Use of Fill Materials

13 (05/01) In addition to any grading requirements the maximum particle size of any fill material shall be no more than two-thirds of the compacted layer thickness except that cobbles having an equivalent diameter of more than 150 mm shall not be deposited beneath verges or central reserves within 1.30 m of the finished surface.

14 (11/07) Material shall not be deposited within 500 mm, or other distances described in Appendix 6/3, of concrete, cement bound materials, other cementitious materials or stabilised capping forming part of the Permanent Works if, when tested in accordance with TRL Report 447 either:

- (i) (11/05) the water-soluble sulfate (WS) content exceeds 1500 mg of sulfate (as SO_4) per litre (Test No.1); or

- (ii) (11/07) the oxidisable sulfides (OS) content exceeds 0.3 % of sulfate (as SO_4) (Test Nos. 2 and 4).

(11/07) At least five samples of each material shall be tested for WS and OS. The mean of the highest two values shall be used for comparison with the limiting values. This also applies if six to nine results are available. If ten or more results are available, the mean of the highest 20% of the results shall be used for comparison with the limiting values.

15 (11/07) Material shall not be deposited within 500 mm, or other distances described in Appendix 6/3, of metallic structural elements forming part of the Permanent Works if, when tested in accordance with TRL Report 447 either:

- (i) (11/05) the water-soluble sulfate (WS) content exceeds 300 mg of sulfate (as SO_4) per litre (Test No.1); or

- (ii) the oxidisable sulfides (OS) content exceeds 0.06 % of sulfate (as SO_4) (Test Nos. 2 and 4).

(11/05) At least five samples of each material shall be tested for WS and OS. The mean of the highest two values shall be used for comparison with the limiting values. This also applies if six to nine results are available. If ten or more results are available, the mean of the highest 20% of the results shall be used for comparison with the limiting values.

(11/07) The requirements in (i) and (ii) above shall not apply to metallic items protected by concrete and ancillary metallic items such as the tops of chambers and gullies.

16 (05/01) Unburnt colliery spoil may be used as general fill provided it is compacted in compliance with Clause 612 and complies with the requirements of Appendix 6/1.

17 (05/01) Pulverised-fuel ash shall not be placed within the dimension described in Appendix 6/3, below sub-formation or formation.

18 (05/01) Where pulverised-fuel ash is used, the Contractor shall for each consignment, make available to the Overseeing Organisation a record of the type and

source of the material and the name of the power station from which it was obtained and a certificate of results of tests showing that the material complies with the requirements of Table 6/1.

602 General Requirements

- 1 The Contractor shall employ only plant and working methods which are suited to the materials to be handled and traversed. He shall be responsible for maintaining the nature of the acceptable material so that when it is placed and compacted it remains acceptable in accordance with the Contract. Acceptability shall be determined in accordance with Table 6/1 and any special requirements in Appendix 6/1.
- 2 Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition to ensure compliance with Clause 612.
- 3 (11/04) No excavated acceptable material or unacceptable material required to be processed, other than surplus to the requirements of the Contract, shall be removed from the Site unless indicated otherwise in Appendix 6/1. Material which is unacceptable only by reason of being frozen shall be retained on Site when in that condition. Where the Contractor is permitted to remove acceptable material, or unacceptable material required to be processed, from the Site to suit his operational procedure, then he shall make good any consequent deficit of material arising therefrom. Environmental requirements for processing of Class U1B material, in terms of limiting values of contaminants or other requirements, shall be set out in Appendix 6/1 in the earthworks Class for which the processed material is to be used.
- 4 If any acceptable material or unacceptable material required to be processed is, where permitted by Appendix 6/1, used by the Contractor for purposes other than for general fill, sufficient acceptable fill material to occupy, after full compaction, a volume corresponding to that which the excavated material occupied shall be provided by the Contractor.
- 5 (11/04) Acceptable material (other than Class 5A or any Class 5B material replacing Class 5A material in accordance with sub-Clause 3 of this Clause) surplus to the total requirements of the Permanent Works and all unacceptable material Class U1A not required to be processed shall, unless indicated otherwise in Appendix 6/1, be run to spoil in tips provided by the Contractor. In the case of unacceptable material, Class U1B and Class U2, the Contractor shall comply with any specific requirements for disposal described in Appendix 6/2.
- 6 Where the excavation reveals a combination of acceptable and unacceptable materials the Contractor shall, unless indicated otherwise in Appendix 6/3, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the Permanent Works without contamination by the unacceptable materials. Unless otherwise described in the Contract Classes of fill material required to be deposited separately shall be excavated separately without contamination by other Classes of material.
- 7 The Contractor shall make his own arrangements for stockpiling of acceptable material, and unacceptable material to be processed, and for the provision of sites for the purpose.
- 8 The Contractor shall ensure that he does not adversely affect the stability of excavations or fills by his methods of stockpiling materials, use of plant or siting of temporary buildings or structures.
- 9 (05/01) Existing topsoil material shall, except where it is to be left in place in the locations described in Appendix 6/8, be stripped to depths as described in Appendix 6/8 for Class 5A material from all areas of cutting and from all areas to be covered by embankment or by other areas of fill. Where stated in Appendix 6/8 existing topsoil shall be stripped as turf in accordance with sub-Clause 3005.13.
- 10 (05/01) Topsoil shall wherever practicable be used immediately after its stripping and if not shall be stored in stockpiles of heights not exceeding 2 m or other heights stated in Appendix 6/8. Unless otherwise stated in Appendix 6/8, topsoil shall not be stockpiled for more than two years. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.
- 11 All Class 5A topsoil arising from the Site, or any Class 5B material replacing Class 5A material in accordance with sub-Clause 3 of this Clause, in excess of the requirements for topsoiling, shall be subject to the requirements described in Appendix 6/8.
- 12 Excavations for foundations and trenches shall be adequately supported at all times, and except where otherwise described in Appendix 6/3, shall not be battered. Where excavations are permitted to be battered they shall be benched as described in Appendix 6/3 prior to backfilling and compaction. The additional work and materials shall be provided by the Contractor. Sheeting and other excavation supports shall be removed as filling proceeds except where they are required in Appendix 6/3 to be left in position.
- 13 Excavations requiring backfilling shall remain open only for the minimum period necessary.

- (i) Class 6N, 6P, 7A or 7B selected fill material complying with Clause 610 including compaction requirements;
- (ii) Class 6M selected fill material, deposited and compacted in accordance with Clause 623, above the foundation of arch profile corrugated steel buried structures;
- (iii) another class of selected fill or general fill complying with Table 6/1 deposited and compacted in compliance with Clauses 608 and 612 and in addition be subject to sub-Clauses 610.4 and 5.

612 Compaction of Fills

General

- 1 Except for dynamic compaction, which shall comply with Clause 630, and unless otherwise described in Appendix 6/3, the Contractor shall carry out compaction in compliance with this Clause, as soon as practicable after deposition, on all those Classes of fill in Table 6/1 which require to be compacted.
- 2 Compaction shall be either method or end-product as required for the Class of fill in Table 6/1, using plant appropriate to the Class of fill and the site conditions.
- 3 The Contractor shall obtain permission from the Overseeing Organisation before carrying out compaction outside normal working hours.

Method Compaction

- 4 Where method compaction is required to be adopted it shall comply with sub-Clauses 5 to 10 of this Clause.
- 5 Except as stated in sub-Clause 6 of this Clause, method compaction shall be undertaken using the plant and methods in Table 6/4 appropriate to the compaction requirements as listed in Table 6/1 for the Class of material being compacted.
- 6 Plant and methods not included in Table 6/4 shall only be used providing the Contractor demonstrates at site trials that a state of compaction is achieved by the alternative method equivalent to that obtained using the specified method.
- 7 Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account when assessing the amount of compaction required for any layer.

- 8 If more than one Class of material is being used in such a way that it is not practicable to define the areas in which each Class occurs, the Contractor shall compact with plant operating as if only the material which requires the greater compactive effort is being compacted.
- 9 The Contractor or Overseeing Organisation may carry out field dry density tests as described in sub-Clause 15 of this Clause on material compacted to method requirements at a frequency defined in Appendix 6/3. If the results of field tests show densities which indicate the state of compaction to be inadequate, then if this is due to failure of the Contractor to comply with the requirements of the Contract, the Contractor shall carry out such further work as is required to comply with the Contract.

10 For the purposes of Table 6/4 the following shall apply:

- (i) The minimum number of passes N is the minimum number of times that each point on the surface of the layer being compacted shall be traversed by the item of compaction plant in its operating mode, or struck by power rammers or falling weight compactors. D is the maximum depth of the compacted layer.
- (ii) In column headed N # the number of passes shown is to be doubled for material Classes 1A, 1B, 2A, 2B, 2C and 2D when such materials occur within 600 mm of sub-formation (if capping is required) or formation. Such extra compaction shall, unless otherwise described in Appendix 6/3, either be carried out for the full width of the embankment or, in other areas of fill which are to receive a pavement, between the outer extremities of the verges.
- (iii) The compaction plant in Table 6/4 is categorised in terms of static mass. The mass per metre width of roll is the total mass on the roll divided by the total roll width. Where a smooth wheeled roller has more than one axle the category of the machine shall be determined on the basis of the axle giving the highest value of mass per metre width.
- (iv) A grid roller is a machine with a compacting roll or rolls constructed of heavy steel mesh of square pattern.
- (v) A deadweight tamping roller is a machine with a roll or rolls from which 'feet' project and where the projected end area of each 'foot' exceeds 0.01 m² and the sum of the

areas of the feet exceeds 15% of the area of the cylinder-swept by the ends of the feet. The requirements for tamping rollers apply to machines that have 2 rolls in tandem. If only one tamping roll traverses each point on the surface of the layer on any one pass of the machine, the minimum number of passes shall be twice the number given in Table 6/4 plus any further doubling required to satisfy (ii) above.

- (vi) For pneumatic-tyred rollers the mass per wheel is the total mass of the roller divided by the number of wheels. In assessing the number of passes of pneumatic-tyred rollers the effective width shall be the sum of the widths of the individual wheel tracks together with the sum of the spacings between the wheel tracks provided that each spacing does not exceed 230 mm. Where the spacings exceed 230 mm the effective width shall be the sum of the widths of the individual wheel tracks only.

- (vii) A vibratory tamping roller, which may be self-propelled or towed, is a machine having a means of applying mechanical vibration to one or more rolls. The roll or rolls have projecting feet where the height of each foot exceeds 10% of the radius of the roll drum, the projected end area of each foot exceeds 0.1% of the roll drum surface area, and the sum of the areas of the feet exceeds 10% of the area of the cylinder swept by the ends of the feet.

The requirements for the operation of vibratory tamping rollers shall be the same as those stated for vibratory rollers in sub-Clause (viii) except that vibratory tamping rollers operating without vibration will be classified as deadweight tamping rollers.

- (viii) Vibratory rollers are self-propelled or towed smooth-wheeled rollers having means of applying mechanical vibration to one or more rolls except that vibratory rollers employed for Method 5 compaction shall be single roll types.

Vibratory rollers operating without vibration will be classified as smooth-wheeled rollers.

The requirements for vibratory rollers are based on the use of the lowest gear on a self-propelled machine with mechanical transmission and a speed of 1.5 to 2.5 km/h for a towed machine, or a self-propelled machine with hydrostatic transmission. If higher gears or speeds are used an increased

number of passes shall be provided in proportion to the increase in speed of travel. Where the mechanical vibration is applied to two rolls in tandem, the minimum number of passes shall be half the number given in Table 6/4 for the appropriate mass per metre width of one vibrating roll but if one roll differs in mass per metre width from the other the number of passes shall be calculated as for the roll with the smallest value. Alternatively the minimum number of passes may be determined by treating the machine as having a single vibrating roll with a mass per metre width equal to that of the roll with the higher value.

Vibratory rollers shall be operated with their vibratory mechanism operating only at the frequency of vibration recommended by the manufacturers. Where more than one amplitude setting is available and/or a range of frequencies is recommended, the machine shall be operated at the maximum amplitude setting and at the maximum recommended frequency for that setting.

Vibratory rollers shall be equipped or provided with devices indicating the frequency at which the mechanism is operating and the speed of travel. Both devices shall be capable of being read by an inspector alongside the machine.

- (ix) Vibrating-plate compactors are machines having a base-plate to which is attached a source of vibration consisting of one or two eccentrically weighted shafts and:

- (a) the mass per square metre of the base-plate of a vibrating-plate compactor is calculated by dividing the total mass of the machine in its working condition by its area in contact with compacted material;

- (b) vibrating-plate compactors shall be operated at the frequency of vibration recommended by the manufacturers. They shall normally be operated at travelling speeds of less than 1 km/h but if higher speeds are necessary the number of passes shall be increased in proportion to the increase in speed of travel.

- (x) Vibro-tampers are machines in which an engine-driven reciprocating mechanism acts on a spring system through which oscillations are set up in a base-plate.

- (xi) Power rammers are machines which are actuated by explosions in an internal combustion cylinder, each explosion being controlled manually by the operator.
- (xii) Dropping weight compactors are machines in which a dead weight is dropped from a controlled height using a hoist mechanism and they include self-propelled machines with mechanical traversing mechanisms capable of compacting soil in trenches and close to structures.
- (xiii) In the case of power rammers and dropping-weight compactors one pass will be considered as made when the compacting shoe has made one strike on the area in question.
- (xiv) For items marked * in the Method 3 column of Table 6/4 the roller shall be towed by track-laying tractors. Self-propelled rollers are unsuitable.
- (xv) Where combinations of different types or categories of plant are used, the following shall apply:
 - (a) the depth of layer shall be that for the type of plant requiring the least depth of layer; and
 - (b) the number of passes shall be that for the type of plant requiring the greatest number of passes.

End-product Compaction

- 11 Where end-product compaction is required it shall comply with sub-Clauses 12 to 15 of this Clause.
- 12 (05/01) The Contractor shall at least 7 days before commencement of end-product compaction make available the following to the Overseeing Organisation:
 - (i) the values of maximum dry density and the optimum moisture content obtained in accordance with BS 1377 : Part 4 using the 2.5 kg rammer method or vibrating hammer method as appropriate for each of the fills he intends to use which meet the requirements of the permitted Class or Classes (where within any Class of material the fill contains material having different maximum dry densities and optimum moisture contents the Class shall be further sub-divided, by extending the identification system, in order to monitor the compacted density);
 - (ii) a graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum

moisture content were determined and, for Class 7A material, a plot of the 5% air voids curve for each sub-division.

- 13 Once the information contained in sub-Clause 12 of this Clause has been made available to the Overseeing Organisation it shall form the basis for compaction.

- 14 Fill compacted to end-product requirements shall have a field dry density, measured in accordance with sub-Clause 15 of this Clause, equal to or greater than the percentage given in Table 6/1 of the maximum dry density for the relevant Class of fill previously made available to the Overseeing Organisation in accordance with sub-Clause 12 of this Clause.

- 15 The field dry density referred to in sub-Clause 14 of this Clause shall be measured in accordance with BS 1377 : Part 9, except that nuclear methods shall only be used where required or permitted in Appendix 6/3. Where nuclear methods are used, the gauge shall be calibrated in accordance with BS 1377 : Part 9.

613 Sub-formation and Capping

- 1 (05/01) Capping shall be provided only in those locations, and to the extent, particularly stated in Appendix 6/7 to be constructed with capping. It shall comply with this Clause and in addition, for stabilised capping, with Clauses 614, 615 and 643 as appropriate.
- 2 (05/04) Capping shall be constructed with Class 6F1, 6F2, 6F3, 6F4, 6F5, 6S, 9A, 9B, 9C, 9D, 9E or 9F material as required or permitted in Appendix 6/7 and complying with Table 6/1.
- 3 (05/04) Unless otherwise described in Appendix 6/7, capping shall either consist of one Class of capping material throughout its depth laid in one or more layers of compacted thickness complying with Clause 612, or be formed of not more than two elements of different capping materials. Each element shall be formed of one or more layers of the same capping material, each of compacted thickness complying with Clause 612. Class 9D or 9E stabilised capping material shall not be placed or constructed above Class 6F granular capping material or Class 6S granular filter layer material.
- 4 Where required in Appendix 6/7, before commencing the construction of capping in the Permanent Works, the Contractor shall demonstrate the methods, equipment and materials he proposes to use by constructing an area, or areas as appropriate, of capping on a typical prepared sub-formation to the same thickness as required in the Permanent Works. The area of each capping construction demonstration shall be not less than 700 m².

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
G E N E R A L	1	A	-	Well graded granular material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract. (Properties (i), (ii) and (iv) in next column, shall not apply to chalk). Recycled aggregate	(i) grading	BS 1377 : part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	1	A	-
					(ii) uniformity coefficient		See Note 5	10	-					
					(iii) mc		BS 1377 : Part 2	App 6/1	App 6/1					
					(iv) MCV		Clause 632	App 6/1	App 6/1					
					(v) IDD of chalk		Clause 634	-	App 6/1					
G R A N U L A R	1	B	-	Uniformly graded granular material	General Fill	Any material, or combination of materials, other than chalk. Recycled aggregate	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	1	B	-
					(ii) uniformity coefficient		See Note 5	-	10					
					(iii) mc		BS 1377 : Part 2	App 6/1	App 6/1					
					(iv) MCV		Clause 632	App 6/1	App 6/1					
F I L L	1	C	-	Coarse granular material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract. (Properties (i) and (ii) in next column, shall not apply to chalk). Recycled aggregate	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 5	1	C	-
					(ii) uniformity coefficient		See Note 5	5	-					
					(iii) Los Angeles coefficient		Clause 635	-	50					

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
GENERAL COHESIVE FILL	2	A	-	Wet cohesive material	General Fill	Any material, or combination of materials, other than chalk.	(i) grading	BS 1377 : part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 1 except for materials with liquid limit greater than 50, determined by BS1377 : Part 2. only deadweight tamping or vibratory tamping rollers or grid rollers shall be used.	2	A	-
							(ii) plastic limit (PL)	BS 1377 : part 2	-	-				
							(iii) mc	BS 1377 : Part 2	PL -4%	App 6/1				
							(iv) MCV	Clause 632	App 6/1	App 6/1				
							(v) Undrained shear strength of remoulded material	Clause 633	App 6/1	App 6/1				
	2	B	-	Dry cohesive material	General Fill	Any material, or combination of materials, other than chalk	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	B	-
							(ii) plastic limit (PL)	BS 1377 : Part 2	-	-				
							(iii) mc	BS 1377 : Part 2	App 6/1	PL -4%				
							(iv) MCV	Clause 632	App 6/1	App 6/1				
							(v) undrained shear strength of remoulded material	Clause 633	App 6/1	App 6/1				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
GENERAL COHESIVE FILL	2	C	-	Stony cohesive material	General Fill	Any material, or combination of materials, other than chalk	(i) grading	BS 1377 : part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	C	-
							(ii) plastic limit (PL)	BS 1377 : part 2	-	-				
							(iii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iv) MCV	Clause 632	App 6/1	-				
							(v) Undrained shear strength of remoulded material	Clause 633	App 6/1	-				
	2	D	-	Silty cohesive material	General Fill	Any material, or combination of materials, other than chalk	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	2	D	-
							(ii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) undrained shear strength of remoulded material	Clause 633	App 6/1	App 6/1				
	2	E	-	Reclaimed pulverised fuel ash cohesive material	General Fill	Reclaimed material from lagoon or stockpile containing not more than 20% furnace bottom ash	(i) mc	BS 1377 : Part 2	To enable compaction to Clause 612		End product 95% of maximum dry density of BS 1377 : Part 4 (2.5 kg rammer method)	2	E	-
							(ii) bulk density	BS 1377 : Part 9	App 6/1	App 6/1				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
G F E I N L L C H A L K	3	-	-	Chalk	General Fill	Chalk and associated materials all designated as Class 3 in the Contract	(i) mc	BS 1377 : Part 2	-	App 6/1	Tab 6/4 Method 4, or Method 1 if required in App 6/1. All types of vibratory rollers of Categories over 1800 kg shall not be used	3	-	-
							(ii) IDD	Clause 634	App 6/1	App 6/1				
L F A I N L D L S C A P E	4	-	-	Various	Fill to landscape areas	See App 6/1	(i) grading	BS 1377 : Part 2	App 6/1	App 6/1	See Clause 620 and App 6/1	4	-	-
							(ii) mc	BS 1377 : Part 2	-	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
T O P S O I L	5	A	-	Topsoil, or turf, existing on site	Topsoiling	Topsoil or turf designated as Class 5A in the Contract	(i) grading	Clause 618	-	Clause 618	-	5	A	-
	5	B	-	Imported topsoil	Topsoiling	General purpose grade complying with BS 3882	-	-	-	-	-	5	B	-

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	A	-	Selected well graded granular material	Below water	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil or any combination thereof. (Properties (i) and (ii) in next column, shall not apply to chalk.) Recycled aggregate	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	No compaction	6	A	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) uniformity	See Note 5	10	-				
							(iii) SMC of chalk index	Clause 634	-	20%				
							(iv) plasticity index	BS 1377 : Part 2	Non-plastic					
	6	B	-	Selected coarse granular material	Starter layer	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. (Properties (ii) and (iii) in next column, shall not apply to chalk.) Recycled aggregate	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 5	6	B	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) plasticity index	BS 1377 : Part 2	Non-plastic					
							(iii) Los Angeles coefficient	Clause 635	-	50				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	C	-	Selected uniformly graded granular material	Starter layer	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. (Property (iii) in next column, shall not apply to chalk.) Recycled aggregate	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	C	-
								BS EN 933-2 (Off-site)	Table 6/5	Tab 6/5				
							(ii) uniformity coefficient	See Note 5	-	10				
							(iii) plasticity index	BS 1377 : Part 2	Non-plastic					
							(iv) Los Angeles coefficient	Clause 635	-	50				
							(v) mc	BS 1377 : Part 2	App 6/1	App 6/1				
	6	D	-	Selected uniformly graded granular material	Starter layer below pulverised fuel ash	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. Recycled aggregate	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 4	6	D	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) uniformity coefficient	See Note 5	-	10				
							(iii) plasticity index	BS 1377 : Part 2	Non-plastic					
							(iv) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(v) MCV	Clause 632	App 6/1	App 6/1				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	E	-	Selected granular material (Class 9A)	For stabilisation with cement to form capping	Any material, or combination of materials, other than unburnt colliery spoil and argillaceous rock. (Properties (i), (ii) and (iii) in next column, shall not apply to chalk.) Recycled aggregate	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Not applicable	6	E	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) mc	BS 1377 : Part 2	-	App 6/1				
							(iii) liquid limit	BS 1377 : Part 2	-	45				
							(iv) plasticity index	BS 1377 : Part 2	-	20				
							(v) organic matter	BS 1377 : Part 3	-	App 6/1				
							(vi) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	3000 mg/l as SO ₄				
							(vii) oxidisable sulfides (OS) content	TRL Report 447, Tests No.2 and 4	-	0.6% as SO ₄				
							(viii) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	1.2% as SO ₄				
							(ix) SMC of chalk	Clause 634	-	20%				

TABLE 6/1: (11/07) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	F	1	Selected granular material (fine grading)	Capping	Any material, or combination of materials, other than unburnt colliery spoil argillaceous rock and chalk. Recycled aggregate. Property (vi) in the next column shall not apply if Class A (asphalt content is 20% or less.	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 6	6	F	1
						(ii) optimum mc	BS 1377 : Part 4 (vibrating hammer method)	-	-					
						(iii) mc	BS 1377 : Part 2	Optimum mc - 2%	Optimum mc					
						(iv) Los Angeles coefficient	Clause 635	-	60					
						(v) Class A (asphalt) content	Clause 710	-	50%					
						(vi) bitumen content	BS 598 : Part 102	-	2.0%					
	6	F	2	Selected granular material (coarse grading)	Capping	Any material, or combination of materials, other than unburnt colliery spoil and argillaceous rock. (Property (i) in next column shall not apply to chalk.) Recycled aggregate. Property (vi) in the next column shall not apply if Class A (asphalt content is 20% or less.	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 6	6	F	2
						(ii) optimum mc	BS 1377 : Part 4 (vibrating hammer method)	-	-					
						(iii) mc	BS 1377 : Part 2	Optimum mc - 2%	Optimum mc					
						(iv) Los Angeles coefficient	Clause 635	-	50					
						(v) Class A (asphalt) content	Clause 710	-	50%					
						(vi) bitumen content	BS 598 : Part 102	-	2.0%					

TABLE 6/1: (11/07) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	F	3	Selected granular material	Capping	Recycled bituminous planings and granulated asphalt, but excluding materials containing tar or tar-bitumen binders. Recycled aggregate	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 6 Maximum Compacted layer thickness shall be 200 mm	6	F	3
							BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5					
						(ii) optimum mc	Clause 613	-	-					
						(iii) mc	Clause 613	Optimum mc -2%	Optimum mc					
						(iv) Class A (asphalt) content	Clause 710	50%	-					
						(v) bitumen content	BS 598 : Part 102	-	10%					
	6	F	4	Selected granular material (fine grading - imported on to the Site	Capping	Unbound mixtures complying with BS EN 13285 Any material or combination of materials - including recycled aggregate, but excluding unburnt colliery spoil, argillaceous rock and chalk. Property (x) in the next column shall not apply if the Class A (asphalt) content is 20% or less.	(i) Size designation and overall grading category	BS EN 13285 - 0/31.5 and G_E	Tab 6/5	Tab 6/5	Tab 6/4 Method 6	6	F	4
						(ii) Maximum fines and oversize categories	BS EN 13285 - UF_{15} and OC_{75}	Tab 6/5	Tab 6/5					
						(iii) Los Angeles coefficient	BS EN 13242 - LA_{60}	-	60					
						(iv) Volume stability of blast furnace slag	BS EN 13242 - free from dicalcium silicate and iron disintegration	-	-					

TABLE 6/1: (11/07) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	F	4	(contd)			(v) Volume stability of steel (BOF) and EAF) slag	BS EN 13242 - V_s	-	-				
							(vi) Other aggregate requirements	BS EN 13242 - Category M_R (no requirement)	-	-				
							(vii) Laboratory dry density and optimum water content	BS EN 13285, clause 5.3 - declared values	-	-				
							(viii) Water content	BS EN 1097-5	Optimum wc - -2%	Optimum wc				
							(ix) Class A (asphalt) content	Clause 710	-	50%				
							(x) bitumen content	BS 598 : Part 102	-	2.0%				

TABLE 6/1: (11/07) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	F	5	Selected granular material (coarse grading) - imported on to the Site	Capping	Unbound mixtures complying with BS EN 13285 Any material or combination of materials - including recycled aggregate, but excluding unburnt colliery spoil, argillaceous rock and chalk. Property (x) in the next column shall not apply if the Class A (asphalt) content is 20% or less.	(i) Size designation and overall grading category	BS EN 13285 - 0/80 and G_E	Tab 6/5	Tab 6/5	Tab 6/4 Method 6	6	F	5
							(ii) Maximum fines and oversize categories	BS EN 13285 - UF_{12} and OC_{75}	Tab 6/5	Tab 6/5				
							(iii) Los Angeles coefficient	BS EN 13242 - LA_{50}	-	50				
							(iv) Volume stability of blast furnace slag	BS EN 13242 - free from dicalcium silicate and iron disintegration	-	-				
							(v) Volume stability of steel (BOF) and EAF) slag	BS EN 13242 - V_5	-	-				
							(vi) Other aggregate requirements	BS EN 13242 - Category $_{NR}$ (no requirement)	-	-				
							(vii) Laboratory dry density and optimum water content	BS EN 13285, clause 5.3 - declared values	-	-				
							(viii) Water content	BS EN 1097-5	Optimum wc -- 2%	Optimum wc				
							(ix) Class A (asphalt) content	Clause 710	-	50%				
							(x) bitumen content	BS 598 : Part 102	-	2.0%				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	G	-	Selected granular material	Gabion filling	Natural gravel, crushed rock, crushed concrete or any combination thereof. None of these constituents shall include any argillaceous rock.	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	None	6	G	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) Los Angeles coefficient	Clause 635	-	50				
	6	H	-	Selected granular material	Drainage layer to reinforced soil and anchored earth structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, chalk, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. (Properties (vi), (vii), (viii), (ix), (x), (xi) and (xii) in next column only apply when metallic reinforcing or anchor elements, facing units or fastenings are used.) (Properties (ii) and (v) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	H	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) plasticity index	BS 1377 : Part 2	Non-plastic					
							(iii) Los Angeles coefficient	Clause 635	-	50				
							(iv) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(v) MCV	Clause 632	App 6/1	App 6/1				
							(vi) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3				
							(vii) chloride ion content	BS EN 1744-1	-	Tab 6/3				
							(viii) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	Tab 6/3				
							(ix) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	Tab 6/3				
							(x) resistivity	Clause 637	Tab 6/3	-				
							(xi) redox potential	Clause 638	Tab 6/3	-				
							(xii) organic content	BS 1377 : Part 3	-	Tab 6/3				
							(xiii) microbial activity index	Table 6/3	-	Tab 6/3				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	I	-	Selected well graded granular material	Fill to reinforced soil and anchored earth structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof except that chalk shall not be combined with any other constituent. None of these constituents shall include any argillaceous rock. (Properties (i), (ii) and (v) in next column shall not apply to chalk.) (Properties (viii), (ix), (x), (xi), (xii), (xiii) and (xiv) only apply when metallic reinforcing or anchor elements, facing units or fastenings are used.) Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	6	I	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) uniformity coefficient	See Note 5	10	-				
							(iii) SMC of chalk	Clause 634	-	20%				
							(iv) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(v) MCV	Clause 632	App 6/1	App 6/1				
							(vi) effective angle of friction (ϕ') and effective cohesion (c')	Clause 636	App 6/1	-				
							(vii) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
							(viii) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3				
							(ix) chloride ion content	BS EN 1744-1	-	Tab 6/3				
							(x) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	Tab 6/3				
							(xi) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	Tab 6/3				
							(xii) resistivity	Clause 637	Tab 6/3	-				
							(xiii) redox potential	Clause 638	Tab 6/3	-				
							(xiv) organic content	BS 1377 : Part 3	-	Tab 6/3				
							(xv) microbial activity index	Table 6/3	-	Tab 6/3				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	J	-	Selected uniformly graded granular material	Fill to reinforced soil and anchored earth	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof, except that chalk shall not be combined with any other constituent. None of these constituents shall include any argillaceous rock. (Properties (viii), (ix), (x), (xi), (xii), (xiii) and (xiv) in next column only apply when metallic reinforcing or anchor elements, facing units or fastenings are used.) (Properties (i), (ii) and (v) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	J	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) uniformity coefficient	See Note 5	5	10				
							(iii) SMC of chalk	Clause 634	-	20%				
							(iv) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(v) MCV	Clause 632	App 6/1	App 6/1				
							(vi) effective angle of friction (ϕ') and effective cohesion (c')	Clause 636	App 6/1	-				
							(vii) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
							(viii) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3				
							(ix) chloride ion content	BS EN 1744-1	-	Tab 6/3				
							(x) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	Tab 6/3				
							(xi) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos 2 and 4	-	Tab 6/3				
							(xii) resistivity	Clause 637	Tab 6/3	-				
							(xiii) redox potential	Clause 638	Tab 6/3	-				
							(xiv) organic content	BS 1377 : Part 3	-	Tab 6/3				
							(xv) microbial activity index	Table 6/3	-	Tab 6/3				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	K	-	Selected granular material	Lower bedding for corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	End product 90% of maximum dry density of BS 1377 : Part 4 (Vibrating hammer method)	6	K	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) uniformity coefficient	See Note 5	5	-				
							(iii) plasticity index	BS 1377 : Part 2	-	6				
							(iv) optimum mc	BS 1377 : Part 4 (vibrating hammer method)	-	-				
							(v) mc	BS 1377 : Part 2	Optimum mc -2%	Optimum mc +1%				
							(vi) MCV	Clause 632	App 6/1	App 6/1				
							(vii) Los Angeles coefficient	Clause 635	-	40				
							(viii) resistivity	Clause 637	2000 ohm cm	-				
							(ix) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	300 mg/l as SO ₄				
							(x) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos 2 and 4	-	0.06% as SO ₄				
							(xi) chloride ion content	BS EN 1744-1	-	0.025%				
							(xii) pH value	BS 1377 : Part 3	6	9				
							(xiii) sulfide and hydrogen sulfide	Standard textbook of qualitative inorganic analysis	-	Rapid blackening of lead acetate paper				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class			
S	F	6	L				-	Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:		6	L	-	
										Lower					Upper
S E I L L E L C T E D G R A N U L A R		6	L	-	Selected uniformly graded granular material	Upper bedding for corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	None	6	L	-
									BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
								(ii) resistivity	Clause 637	2000 ohm cm	-				
								(iii) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	300 mg/l as SO ₄				
								(iv) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.06% as SO ₄				
								(v) chloride ion content	BS EN 1744-1	-	0.025%				
								(vi) pH value	BS 1377 : Part 3	6	9				
								(vii) sulfide and hydrogen sulfide	Standard textbook of qualitative inorganic analysis	-	Rapid blackening of lead acetate paper				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	M	-	Selected granular material	Surround to corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	End product 90% of maximum dry density of BS 1377 : Part 4 (Vibrating hammer method) unless otherwise stated in App 6/1	6	M	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) uniformity coefficient	See Note 5	5	-				
							(iii) plasticity index	BS 1377 : Part 2	-	6				
							(iv) optimum mc	BS 1377 : Part 4 (vibrating hammer method)	-	-				
							(v) mc	BS 1377 : Part 2	Optimum mc -2%	Optimum mc +1%				
							(vi) MCV	Clause 632	App 6/1	App 6/1				
							(vii) Los Angeles coefficient	Clause 635	-	40				
							(viii) resistivity	Clause 637	2000 ohm cm	-				
							(ix) water soluble (WS) sulfate content	TRL Report 447 Test No. 1	-	300 mg/l as SO ₄				
							(x) oxidisable sulfides (OS) content	TRL Report 447 Tests Nos. 2 and 4	-	0.06% as SO ₄				
							(xi) chloride ion content	BS EN 1744-1	-	0.025%				
							(xii) pH value	BS 1377 : Part 3	6	9				
							(xiii) sulfide and hydrogen sulfide	Standard textbook of qualitative inorganic analysis	-	Rapid blackening of lead acetate paper				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S F E I L L E L C T E D G R A N U L A R	6	N	-	Selected well graded granular material	Fill to structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377 : Part 4 (vibrating hammer method)	6	N	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) uniformity coefficient	See Note 5	10	-				
							(iii) Los Angeles coefficient	Clause 635	-	40				
							(iv) undrained shear parameters (c and ϕ)	Clause 633	App 6/1	-				
							(v) effective angle of internal friction (ϕ') and effective cohesion (c')	Clause 636	App 6/1	-				
							(vi) permeability	Clause 640	App 6/1	-				
							(vii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(viii) MCV	Clause 632	App 6/1	App 6/1				
							(ix) slope stability test (where required in App 6/6)	Clause 610	App 6/6					

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	P	-	Selected granular material	Fill to structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. (Properties (i), (ii) and (ix) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377 : Part 4 (vibrating hammer method)	6	P	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) uniformity coefficient	See Note 5	5	-				
							(iii) IDD of chalk	Clause 634	-	App 6/1				
							(iv) Los Angeles coefficient	Clause 635	-	60				
							(v) undrained shear parameters (c and ϕ)	Clause 633	App 6/1	-				
							(vi) effective angle of internal friction (ϕ') and effective cohesion (c')	Clause 636	App 6/1	-				
							(vii) permeability	Clause 640	App 6/1	-				
							(viii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(ix) MCV	Clause 632	App 6/1	App 6/1				
							(x) slope stability test (where required in App 6/6)	Clause 610	App 6/6					

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	Q	-	Well graded uniformly graded or coarse granular material	Overlying fill for corrugated steel buried structures	As Class 1A, 1B or 1C granular fill materials, but not to include argillaceous rock, slag or PFA in any proportions. Recycled aggregate except recycled asphalt	As for Class 1A, 1B or 1C with the addition of the following:					6	Q	-
		(i) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	300 mg/l as SO ₄									
		(ii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.06% as SO ₄									
		(iii) chloride ion content	BS EN 1744-1	-	0.025%									
		(iv) pH value	BS 1377 : Part 3	6	9									
		(v) sulfide and hydrogen sulfide	Standard textbook of qualitative inorganic analysis	-	Rapid blackening of lead acetate paper									
	6	R	-	Selected granular material	For stabilisation with lime and cement to form capping (Class 9F)	Any material, or combination of materials, other than unburnt colliery spoil and argillaceous rock. (Properties (i), (ii) and (iii) in next column, shall not apply to chalk.)	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Not applicable	6	R	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) mc	BS 1377 : Part 2	App 6/1	-				
							(iii) liquid limit	BS 1377 : Part 2	-	45				
							(iv) plasticity index	BS 1377 : Part 2	-	20				
							(v) organic matter	BS 1377 : Part 3	-	App 6/1				
							(vi) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	3000 mg/l as SO ₄				
							(vii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.6% as SO ₄				
							(viii) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	1.2% as SO ₄				
							(ix) IDD of chalk	Clause 634	-	App 6/1				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D G R A N U L A R F I L L	6	S	-	Selected well graded granular material	Filter layer below subbase	Crushed rock or sand	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	-	6	S	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
								(ii) plasticity index	BS 1377 : Part 2	-				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S F E I L L E L C T E D C O H E S I V E	7	A	-	Selected cohesive material	Fill to structures	Any material or combination of materials, other than argillaceous rock and materials designated as Class 3 in the Contract. If chalk is used it shall form 100% of constituents. (Properties (i) and (iii) shall not apply to chalk.) (Properties (vii) and (viii) may be increased to 54% and 31% respectively for Lias Clay only and subject to the requirements of Appendix 6/6)	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	End product: 100% of maximum dry density of BS 1377 : Part 4 (2.5 kg rammer method) or a dry density corresponding to 5% air voids at field mc whichever is lower	7	A	-
							(ii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) undrained shear parameters (c and ϕ)	Clause 633	App 6/1	App 6/1				
							(v) effective angle of internal friction (ϕ') and effective cohesion (c')	Clause 636	App 6/1	App 6/1				
							(vi) IDD of chalk	Clause 634	App 6/1	App 6/1				
							(vii) liquid limit	BS 1377 : Part 2	-	45				
							(viii) plasticity index	BS 1377 : Part 2	-	25				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class			
S	F	7	B				-	Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
										Lower		Upper			
S E I L L E C T E D C O H E S I V E					Selected conditioned pulverised fuel ash cohesive material	Fill to structures and to reinforced soil	Conditioned material direct from power station dust collection system and to which a controlled quantity of water has been added	(i) mc	BS 1377 : Part 2	To enable compaction to Clause 612		End product: 95% of maximum dry density of BS 1377 : Part 4 (2.5 kg rammer method)	7	B	-
								(ii) bulk density	BS 1377 : Part 9	App 6/1	App 6/1				
								(iii) undrained shear parameters (c and ϕ)	Clause 633	App 6/1	-				
								(iv) effective angle of internal friction (ϕ') and effective cohesion (c')	Clause 636	App 6/1	-				
								(v) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
								(vi) permeability	Clause 640	App 6/1	-				
								(vii) slope stability test (where required in App 6/6)	Clause 610	App 6/6					

TABLE 6/1: (05/04) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D C O H E S I V E F I L L	7	C	-	Selected wet cohesive material	Fill to reinforced soil	Any material, or combination of materials, other than unburnt colliery spoil, argillaceous rock and chalk. (Properties (viii) (ix), (x), (xi) and (xii) in next column only apply when metallic reinforcing elements, facing units or fastenings are used)	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 1	7	C	-
							(ii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) effective angle of internal friction (ϕ') and effective cohesion (c')	Clause 636	App 6/1	-				
							(v) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
							(vi) liquid limit	BS 1377 : Part 2	-	45				
							(vii) plasticity index	BS 1377 : Part 2	-	25				
							(viii) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3				
							(ix) chloride ion content	BS EN 1744-1	-	Tab 6/3				
							(x) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	Tab 6/3				
							(xi) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	Tab 6/3				
							(xii) resistivity	Clause 637	Tab 6/3	-				
							(xiii) redox potential	Clause 638	Tab 6/3	-				

TABLE 6/1: (05/04) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D C O H E S I V E F I L L	7	D	-	Selected stony cohesive material	Fill to reinforced soil	Any material, or combination of materials, other than unburnt colliery spoil, argillaceous rock and chalk. (Properties (vi), (vii), (viii), (ix), (x), (xi) and (xii) in next column only apply when metallic reinforcing elements, facing units or fastenings are used)	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	7	D	-
							(ii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) effective angle of internal friction (ϕ') and effective cohesion (c')	Clause 636	App 6/1	-				
							(v) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
							(vi) liquid limit	BS 1377 : Part 2	-	45				
							(vii) plasticity index	BS 1377 : Part 2	-	25				
							(viii) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3				
							(ix) chloride ion content	BS EN 1744-1	-	Tab 6/3				
							(x) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	Tab 6/3				
							(xi) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	Tab 6/3				
							(xii) resistivity	Clause 637	Tab 6/3	-				
							(xiii) redox potential	Clause 638	Tab 6/3	-				

TABLE 6/1: (11/03) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D C O H E S I V E	7	E	-	Selected cohesive material	For stabilisation with lime to form capping (Class 9D)	Any material, or combination of materials, other than unburnt colliery spoil	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Not applicable	7	D	-
							(ii) mc	BS 1377 : Part 2	-	App 6/1				
							(iii) MCV	Clause 632	App 6/1	-				
							(iv) plasticity index	BS 1377 : Part 2	10	-				
							(v) organic matter	BS 1377 : Part 3	-	App 6/1				
							(vi) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	App 6/1				
							(vii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	App 6/1				
							(viii) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	App 6/1				
F I L L	7	F	-	Selected silty cohesive material	For stabilisation with cement to form capping (Class 9B)	Any material, or combination of materials, other than chalk, unburnt colliery spoil and argillaceous rock	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Not applicable	7	F	-
							(ii) uniformity coefficient	See Note 5	5	-				
							(iii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iv) MCV	Clause 632	App 6/1	App 6/1				
							(v) liquid limit	BS 1377 : Part 2	-	45				
							(vi) plasticity index	BS 1377 : Part 2	-	20				
							(vii) organic matter	BS 1377 : Part 3	-	App 6/1				
							(viii) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	App 6/1				
							(ix) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	App 6/1				
							(x) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	App 6/1				

TABLE 6/1: (11/05) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D C O H E S I V E F I L L	7	G	-	Selected conditioned pulverised fuel ash cohesive material	For stabilisation with cement to form capping (Class 9C)	Conditioned material direct from power station dust collection system and to which a controlled quantity of water has been added	(i) mc	BS 1377 : Part 2	App 6/1	App 6/1	Not applicable	7	G	-
							(ii) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	3000 mg/l as SO ₄				
							(iii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.6% as SO ₄				
							(iv) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	1.2% as SO ₄				
	7	H	-	Wet, dry, stony or silty cohesive material and chalk	Overlying fill for corrugated steel buried structures	As Class 2A, 2B, 2C, 2D general cohesive fill material or Class 3 chalk fill material, except that argillaceous rock, slag, PFA or any combination thereof shall not be used	As for Class 2A, 2B, 2C, 2D or 3 with the addition of the following					7	H	-
							(i) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	300 mg/l as SO ₄				
							(ii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.06% as SO ₄				
							(iii) chloride ion content	BS EN 1744-1	-	0.025%				
							(iv) pH value	BS 1377 : Part 3	6	9				

TABLE 6/1: (11/03) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S E L E C T E D C O H E S I V E F I L L	7	I	-	Selected cohesive material	For stabilisation with lime and cement to form capping (Class 9E)	Any material, or combination of materials, other than unburnt colliery spoil	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Not applicable	7	I	
							(ii) mc	BS 1377 : Part 2	-	App 6/1				
							(iii) MCV	Clause 632	App 6/1	-				
							(iv) plasticity index	BS 1377 : Part 2	10	-				
							(v) organic matter	BS 1377 : Part 3	-	App 6/1				
							(vi) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	App 6/1				
							(vii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	App 6/1				
							(viii) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	App 6/1				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
MF I I S L C L	8	-	-	Class 1, Class 2 or Class 3 material	Lower trench fill	Any; except there shall not be any stones or lumps of clay >40 mm nominal diameter. Recycled aggregate	(i) mc	BS 1377 : Part 2	App 6/1	App 6/1	Tab 6/4	8	-	-
							(ii) MCV	Clause 632	App 6/1	App 6/1				
S T A B I L I S E D M A T E R I A L S	9	A	-	Cement stabilised well graded granular material	Capping	Class 6E with addition of cement according to Clause 614	(i) pulverisation	BS 1924 : Part 2	60%	-	Tab 6/4 Method 6	9	A	-
							(ii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iii) mc	BS 1924 : Part 2	App 6/1	App 6/1				
	9	B	-	Cement stabilised silty cohesive material	Capping	Class 7F with addition of cement according to Clause 614	(i) pulverisation	BS 1924 : Part 2	App 6/1	-	Tab 6/4 Method 7	9	B	-
							(ii) MCV immediately before compaction	Clause 632	App 6/1	12				
							(iii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iv) mc	BS 1924 : Part 2	App 6/1	App 6/1				
	9	C	-	Cement stabilised conditioned pulverised fuel ash cohesive material	Capping	Class 7G with addition of cement according to Clause 614	(i) pulverisation	BS 1924 : Part 2	60%	-	End product 95% of maximum dry density of BS 1924 : Part 2 (2.5 kg rammer method)	9	C	-
							(ii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iii) mc	BS 1924 : Part 2	To enable compaction to Clause 612					
	9	D	-	Lime stabilised cohesive material	Capping	Class 7E with addition of lime according to Clause 615	(i) pulverisation	BS 1924 : Part 2	30%	-	Tab 6/4 Method 7	9	D	-
							(ii) MCV immediately before compaction	Clause 632	App 6/1	App 6/1				
							(iii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iv) mc	BS 1924 : Part 2	App 6/1	App 6/1				

TABLE 6/1: (11/04) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
S M T A B E I R L I A S L E S D	9	E	-	Lime and cement stabilised cohesive material	Capping	Class 7I with addition of lime and cement according to Clause 643	(i) pulverisation	BS 1924 : Part 2	30%	-	Tab 6/4 Method 7	9	E	-
							(ii) MCV immediately before completion	Clause 632	App 6/1	App 6/1				
							(iii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iv) mc	BS 1924 : Part 2	App 6/1	App 6/1				
	9	F	-	Lime and cement stabilised well graded granular material	Capping	Class 6R with addition of lime and cement according to Clause 643	(i) pulverisation	BS 1924 : Part 2	60%	-	Tab 6/4 Method 6	9	F	-
							(ii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iii) mc	BS 1924 : Part 2	App 6/1	App 6/1				

Footnotes to Table 6/1

1. App = Appendix
2. Tab = Table
3. Where in the Acceptable Limits column reference is made to App 6/1, only those properties having limits ascribed to them in Appendix 6/1 shall apply. Where Appendix 6/1 gives limits for other properties not listed in this Table such limits shall also apply.
4. (05/04) Where BS 1377 : Part 2 is specified for mc, this shall mean BS 1377 : Part 2 or BS EN 1097-5 as appropriate.
5. Uniformity coefficient is defined as the ratio of the particle diameters D_{60} to D_{10} on the particle-size distribution curve, where:
 D_{60} = particle diameter at which 60% of the soil by weight is finer
 D_{10} = particle diameter at which 10% of the soil by weight is finer
6. (11/04) The limiting values for Class U1B material are given in Appendix 6/14 and Appendix 6/15.

TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 1 to Method 6)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6		
			D	N#	D	N#	D	N#	D	N	D	N	N for D = 110 mm	N for D = 150 mm	N for D = 250 mm
Smoothed wheeled roller (or vibratory roller operating without vibration)	1	Mass per metre width of roll: over 2100 kg up to 2700 kg	125	8	125	10	125	10*	175	4	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 2700 kg up to 5400 kg	125	6	125	8	125	8*	200	4	unsuitable		16	unsuitable	unsuitable
	3	over 5400 kg	150	4	150	8	unsuitable		300	4	unsuitable		8	16	unsuitable
Grid roller	1	Mass per metre width of roll: over 2700 kg up to 5400 kg	150	10	unsuitable		150	10	250	4	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 5400 kg up to 8000 kg	150	8	125	12	unsuitable		325	4	unsuitable		20	unsuitable	unsuitable
	3	over 8000 kg	150	4	150	12	unsuitable		400	4	unsuitable		12	20	unsuitable
Deadweight tamping roller	1	Mass per metre width of roll: over 4000 kg up to 6000 kg	225	4	150	12	250	4	350	4	unsuitable		12	20	unsuitable
	2	over 6000 kg	300	5	200	12	300	3	400	4	unsuitable		8	12	20
Pneumatic-tyred roller	1	Mass per wheel: over 1000 kg up to 1500 kg	125	6	unsuitable		150	10*	240	4	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 1500 kg up to 2000 kg	150	5	unsuitable		unsuitable		300	4	unsuitable		unsuitable	unsuitable	unsuitable
	3	over 2000 kg up to 2500 kg	175	4	125	12	unsuitable		350	4	unsuitable		unsuitable	unsuitable	unsuitable
	4	over 2500 kg up to 4000 kg	225	4	125	10	unsuitable		400	4	unsuitable		unsuitable	unsuitable	unsuitable
	5	over 4000 kg up to 6000 kg	300	4	125	10	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable
	6	over 6000 kg up to 8000 kg	350	4	150	8	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable
	7	over 8000 kg up to 12000 kg	400	4	150	8	unsuitable		unsuitable		unsuitable		10	16	unsuitable
	8	over 12000 kg	450	4	175	6	unsuitable		unsuitable		unsuitable		8	12	unsuitable
Vibratory tamping roller	1	Mass per metre width of a vibrating roll: over 700 kg up to 1300 kg	100	12	100	12	150	12	100	10	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 1300 kg up to 1800 kg	125	12	125	12	175	12*	175	8	unsuitable		12	unsuitable	unsuitable
	3	over 1800 kg up to 2300 kg	150	12	150	12	200	12*	unsuitable		unsuitable		8	12	unsuitable
	4	over 2300 kg up to 2900 kg	150	9	150	9	250	12*	unsuitable		400	5	6	10	unsuitable
	5	over 2900 kg up to 3600 kg	200	9	200	9	275	12*	unsuitable		500	6	6	10	unsuitable
	6	over 3600 kg up to 4300 kg	225	9	225	9	300	12*	unsuitable		600	6	4	8	unsuitable
	7	over 4300 kg up to 5000 kg	250	9	250	9	300	9*	unsuitable		700	6	3	7	12
	8	over 5000 kg	275	9	275	9	300	7*	unsuitable		800	6	3	6	10

TABLE 6/4: Method Compaction for Earthworks Materials: plant and Methods (Method 1 to Method 6)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6		
			D	N#	D	N#	D	N#	D	N	D	N	N for D = 110 mm	N for D = 150 mm	N for D = 250 mm
Vibratory roller	1	Mass per metre width of a vibratory roll:													
	2	over 270 kg up to 450 kg	unsuitable		75	16	150	16	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	3	over 450 kg up to 700 kg	unsuitable		75	12	150	12	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	4	over 700 kg up to 1300 kg	100	12	125	10	150	6	125	10	unsuitable		16	unsuitable	unsuitable
	5	over 1300 kg up to 1800 kg	125	8	150	8	200	10*	175	4	unsuitable		6	16	unsuitable
	6	over 1800 kg up to 2300 kg	150	4	150	4	225	12*	unsuitable		unsuitable		4	6	12
	7	over 2300 kg up to 2900 kg	175	4	175	4	250	10*	unsuitable		400	5	3	5	11
	8	over 2900 kg up to 3600 kg	200	4	200	4	275	8*	unsuitable		500	5	3	5	10
	9	over 3600 kg up to 4300 kg	225	4	225	4	300	8*	unsuitable		600	5	2	4	8
	10	over 4300 kg up to 5000 kg	250	4	250	4	300	6*	unsuitable		700	5	2	4	7
		over 5000 kg	275	4	275	4	300	4*	unsuitable		800	5	2	3	6
Vibrating plate compactor	1	Mass per m ² of base plate:													
	2	over 880 kg up to 1100 kg	unsuitable		unsuitable		75	6	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	3	over 1100 kg up to 1200 kg	unsuitable		75	10	100	6	75	10	unsuitable		unsuitable	unsuitable	unsuitable
	4	over 1200 kg up to 1400 kg	unsuitable		75	6	150	6	150	8	unsuitable		unsuitable	unsuitable	unsuitable
	5	over 1400 kg up to 1800 kg	100	6	125	6	150	4	unsuitable		unsuitable		8	unsuitable	unsuitable
	6	over 1800 kg up to 2100 kg	150	6	150	5	200	4	unsuitable		unsuitable		5	8	unsuitable
		over 2100 kg	200	6	200	5	250	4	unsuitable		unsuitable		3	6	12
Vibro-tamper	1	Mass:													
	2	over 50 kg up to 65 kg	100	3	100	3	150	3	125	3	unsuitable		4	8	unsuitable
	3	over 65 kg up to 75 kg	125	3	125	3	200	3	150	3	unsuitable		3	6	12
	4	over 75 kg up to 100 kg	150	3	150	3	225	3	175	3	unsuitable		2	4	10
		over 100 kg	225	3	200	3	225	3	250	3	unsuitable		2	4	10
Power rammer	1	Mass:													
	2	100 kg up to 500 kg	150	4	150	6	unsuitable		200	4	unsuitable		5	8	unsuitable
		over 500 kg	275	8	275	12	unsuitable		400	4	unsuitable		5	8	14
Dropping-weight compactor	1	Mass of rammer over 500 kg													
	2	weight drop:													
		over 1 m up to 2 m	600	4	600	8	450	8	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
		over 2 m	600	2	600	8	unsuitable		unsuitable		unsuitable		unsuitable	unsuitable	unsuitable

TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 7)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 7	
			N for D = 150 mm	N for D = 250 mm
Smooth wheeled roller (or vibratory roller operating without vibration)	1 2 3	Mass per metre width of roll: over 2100 kg up to 2700 kg over 2700 kg up to 5400 kg over 5400 kg	unsuitable unsuitable 12	unsuitable unsuitable unsuitable
Grid roller	1 2 3	Mass per metre width of roll: over 2700 kg up to 5400 kg over 5400 kg up to 8000 kg over 8000 kg	unsuitable 16 8	unsuitable unsuitable unsuitable
Deadweight tamping roller	1 2	Mass per metre width of roll: over 4000 kg up to 6000 kg over 6000 kg	4 3	8 6
Pneumatic-tyred roller	1 2 3 4 5 6 7 8	Mass per wheel: over 1000 kg up to 1500 kg over 1500 kg up to 2000 kg over 2000 kg up to 2500 kg over 2500 kg up to 4000 kg over 4000 kg up to 6000 kg over 6000 kg up to 8000 kg over 8000 kg up to 12000 kg over 12000 kg	unsuitable 12 6 5 4 unsuitable unsuitable unsuitable	unsuitable unsuitable unsuitable unsuitable 16 8 4 4
Vibratory tamping roller	1 2 3 4 5 6 7 8	Mass per metre width of vibrating roll: over 700 kg up to 1300 kg over 1300 kg up to 1800 kg over 1800 kg up to 2300 kg over 2300 kg up to 2900 kg over 2900 kg up to 3600 kg over 3600 kg up to 4300 kg over 4300 kg up to 5000 kg over 5000 kg	unsuitable unsuitable 16 12 10 8 7 6	unsuitable unsuitable unsuitable unsuitable unsuitable 16 14 12
Vibratory roller	1 2 3 4 5 6 7 8 9 10	Mass per metre width of vibrating roll: over 270 kg up to 450 kg over 450 kg up to 700 kg over 700 kg up to 1300 kg over 1300 kg up to 1800 kg over 1800 kg up to 2300 kg over 2300 kg up to 2900 kg over 2900 kg up to 3600 kg over 3600 kg up to 4300 kg over 4300 kg up to 5000 kg over 5000 kg	unsuitable unsuitable unsuitable unsuitable 12 10 10 8 8 6	unsuitable unsuitable unsuitable unsuitable unsuitable unsuitable unsuitable unsuitable unsuitable 12
Vibratory plate compactor	1 2 3 4 5 6	Mass per m ² of base plate: over 880 kg up to 1100 kg over 1100 kg up to 1200 kg over 1200 kg up to 1400 kg over 1400 kg up to 1800 kg over 1800 kg up to 2100 kg over 2100 kg	unsuitable unsuitable unsuitable 10 8 6	unsuitable unsuitable unsuitable unsuitable unsuitable unsuitable
Vibro-tamper	1 2 3 4	Mass: over 50 kg up to 65 kg over 65 kg up to 75 kg over 75 kg up to 100 kg over 100 kg	unsuitable unsuitable unsuitable 8	unsuitable unsuitable unsuitable unsuitable
Power rammer	1 2	Mass: 100 kg up to 500 kg over 500 kg	8 6	unsuitable 10
Dropping weight compactor	1 2	Mass of rammer over 500 kg height drop: over 1 m up to 2 m over 2 m	unsuitable unsuitable	unsuitable unsuitable

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