RSK

Darwin Green – Soil (Subsoil and Topsoil) Strategy

Materials Suitability Technical Briefing Note – Version 3.0

(Report reference: 26716 01R (01))

13th January 2014

RSK Environment Limited was appointed by BDW Trading Limited to act as geo-environmental and geotechnical consultants for the above project. This briefing note has been prepared, at the request of the Client, to support the Darwin Green One 'Infrastructure Package' which seeks approval for a mixture of reserved matters, planning conditions and new planning applications.

The purpose of this document is to provide technical detail with respect to geo-environmental and geotechnical aspects of the proposed soil strategy. It specifically addresses the suitability for re-use of topsoil and subsoil on site.

The soil strategy is summarised in **Section 2** and detailed in the Woods Hardwick Infrastructure LLP, Subsoil and Topsoil Strategy (Ref 16483, Rev A, December 2013) included as **Appendix A**.

It should be noted that the site, Darwin Green One (DG1), refers to approximately 50.8 hectares of land currently owned by members of the North West Cambridge Consortium, and has previously been referred to as NIAB 1.

1. DARWIN GREEN ONE 'INFRASTRUCTURE PACKAGE'

The Darwin Green One 'Infrastructure Package' seeks approval for a mixture of reserved matters, planning conditions and new planning applications in order to allow works to commence on the development. This includes construction of key roads and cycle/pedestrian links, drainage swales, surface water attenuation ponds, public open space and landscaping, including a landscaped mound to the A14 to incorporate excess spoil exclusively from the DG1 development.

The 'Infrastructure' package will consist of the following submission:

- Reserved Matters submission to Cambridge City Council for the Infrastructure elements (Roads & Open Space) of Outline Planning Consent C/07/0003/OUT;
- New Full Planning Application to Cambridge City Council for a vehicular link to the City/District boundary within the existing approved outline consented site;
- New Full Planning Application to South Cambridgeshire District Council for a temporary vehicular access & turning head for a proposed secondary school site served by a new link from the Cambridge City Council Outline consented site;
- New Full Planning Application to South Cambridgeshire District Council for resurfacing and landscaping works to a length of existing Public Right of Way 135/5 on the boundary of Cambridge City Council consented site C/07/0003/OUT;

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- New Full Planning Application to South Cambridgeshire District Council for a drainage connection between the approved surface water attenuation pond in consent S/0001/07/F to an existing Award Drain AND Approval of an alternate surface water attenuation pond and its connections to the Award Drain along with necessary Haul Road access to be approved on an EITHER/OR basis in place of the existing approved pond;
- New Full Planning Application to South Cambridgeshire District Council for a landscaped mound adjacent to the A14 to be constructed exclusively from excess spoil arising from the Darwin Green One development; and
- New Full Planning Application to South Cambridgeshire District Council for provision of a Foul Pumping Station, Utility Compound and Cambridge Road Access Works.

Concurrently with the Infrastructure Package Application submissions will also be made for the discharge of conditions relating to:

- Full Planning Consent S/0001/07/F, South Cambridgeshire District Council; and
- Outline Planning Consent C/07/0003/OUT, Cambridge City Council.

2. SOIL STRATEGY

The soil (subsoil and topsoil) strategy for the infrastructure package is outlined in the Woods Hardwick Infrastructure LLP (**Appendix A**) Subsoil and Topsoil Strategy Technical Note (**Appendix B**). The purpose of this strategy is to achieve a balanced solution on the site to avoid external movements of bulk spoil and topsoil on the public highway.

The strategy consists of a:

- *Subsoil strategy:*

  In order to form the anticipated finished levels across the site based on the approved drainage model, the northern 1/3rd of the site requires raising between 0.5 and 2.0m. The 61,273m^3 of subsoil required for this will be obtained from a 'borrow' pit located in the Central Park.

  The location of the borrow pit, which will be approximately 2.4m deep, is shown in the Woods Hardwick Borrow Pit Plan (Ref: 16483/2084).

- *Topsoil strategy:*

  The strategy indicates that construction works will generate a net surplus of topsoil of approximately 140,715m^3 (87,323m^3 from DG1 and 53,392m^3 from DG2 and DG3). Subject to suitability, the surplus will be used to fill the borrow pit (61,295m^3), excavated as part of the subsoil strategy, with the balance used to create landscape mounds (79,420m^3).

  The landscape mound will be formed to a maximum height of 3.05m above ground level and with a maximum slope of 1:3 (V:H). On site vehicle movements to undertake these works will be via existing farm tracks and new haul roads.

  On site vehicle haul road routes to be agreed through Planning Conditions and the Site Wide Phasing Strategy/Construction Statements.

The strategy allows for all subsoil and topsoil generated by the development works to be re-used on the site.

3. SUITABILITY FOR RE-USE

The suitability of soil for reuse on site will be determined by its' geotechnical and environmental properties with respect to the intended end use. In order to assess soil properties RSK Environment Ltd (RSK) has undertaken the following geotechnical and geoenvironmental assessments and commissioned a soil resources survey (specifically in respect to the topsoil):

- Report for Main Site Investigation – NIAB Phase 1, Huntingdon Road, Cambridge. RSK Environment Ltd, October 2012 (Ref: 25459-01(00))
- Supplementary Investigation - NIAB1 Fields, Phase 1 Development. RSK Environment Ltd, 1st May 2013 (Ref: 25459-R02 (00)).
- Summary geo-environmental report for NIAB1 Fields, Phase 1 Development. RSK Environment Ltd, 11th October 2013 (Ref: 25459-R03 (00)).
- Soil Resources of land at Darwin Green, Cambridge. Land Research Associated, 16th October 2013 (Ref 898/1).

With respect to the soil strategy the findings of these reports are summarised in the following sections. The reports are included as **Appendix B**.

3.1 Soil properties

3.1.1 Ground model

RSK's assessment identified that the geology underlying the site comprises a variable thickness of topsoil and/or made ground overlying the River Terrace Deposits in the north/north eastern portion of the site. The Gault Clay Formation underlies these superficial deposits. Groundwater was encountered coincident with the River Terrace Gravels at a depth of between 1.3 and 3.1m below ground level (bgl).

3.1.2 Environmental/Contaminated land issues

The quantitative risk assessment (RSK, Oct 2012) compared chemical test results for the soil (topsoil and sub soils) against relevant generic assessment criteria values for the protection of human health (residential), plant growth and building materials. In the absence of any soil leachate results or groundwater results, the risk to controlled water was qualitatively assessed based on the total soil concentrations. The quantitative risk assessment identified no concentrations of any determinants to be in excess of the adopted values for the protection of human health, plant growth and building materials. In addition, the qualitative assessment identified no risk to controlled waters. The results of the ground gas monitoring recorded a negligible ground gas regime beneath the site for which no gas protection measures were considered necessary.

On this basis, the generic assessment confirmed the absence of any relevant pollutant linkages. In consultation with the regulatory authorities it was agreed that further targeted assessment works (RSK May 2013 and Oct 2013) should be undertaken to address specific points of concern. The additional investigations did not identify any significant ground contamination, though it is recommended that a watching brief be maintained during development works.

On this basis we consider that all soils (topsoil and sub soils) are, in respect to geo-environmental issues, suitable for re-use on-site for any of the proposed end uses (Section 3.2).

3.1.3 Geotechnical issues

The topsoil was encountered as a relatively organic rich cohesive soil with variable proportions of flint chalk and organic matter. The Made Ground, where present, was similar in composition to the topsoil though with infrequent inclusions of brick, clay tilling, ceramics, clinker and charcoal. The Topsoil/Made ground strata were present to depths ranging from 0.2 to 0.6m, though typically 0.3 to 0.4m bgl.

The River Terrace Deposits was found to be present across much of the site, only absent in the western fifth of the site (west of TP7, RSK Oct 2012). The River Terrace Deposits includes both cohesive and non-cohesive (granular) horizons. The cohesive portion generally comprised firm sandy gravelly clay with variable proportions of flint, chert, quartzite and chalk. The granular horizons generally comprised a combination of medium dense to dense sandy gravels and gravelly sands, with variable clay content. The cohesive portion was found to be medium to high strength with a low to medium volume change potential.

In general, the sequence of superficial deposits encountered initially comprised a cohesive portion, underlain by granular deposits and/or a sequence of interbedded granular and cohesive layers. The distribution of significant granular horizons was discontinuous across the site, albeit with a general trend of increasing thickness and distribution to the northwest.

Gault Clay was encountered directly beneath the made ground/topsoil and/or River Terrace Deposits at depths between 0.25 and 4.0m below ground level to the full depth of investigations. This stratum can generally be described as a firm to stiff over-consolidated blue/grey clay. It was found to be medium to very high strength with a predominantly high volume change potential with some localised evidence of desiccation.

Based on the laboratory testing conducted during the site investigations, the made ground, River Terrace Deposits and Gault Clay are all considered likely to be suitable as general fill for use in permanent works and are envisaged to fall within the acceptable limits for well graded granular material, uniformly graded granular material, wet cohesive material, dry cohesive material and stoney cohesive material, as detailed within Table 6/1 of the SHW Series 600 (Ref 1). Notwithstanding the above, any desiccated soils would be unacceptable as engineered fill.

3.1.4 Topsoil resource assessment

A soil resource survey (Land Research Associated, 16th October 2013) was commissioned to characterise the texture, depth, stone content and drainage characteristics of the topsoil across the site, enabling the suitability of the topsoil for re-use on-site to be established, specifically in respect to the key spaces of the proposed landscaping strategy and their associated ecological and arboricultural requirements. The report also makes recommendations for the handling, storage, replacement, need for remedial drainage and aftercare management.

The survey identified two principal types of topsoil: heavy and loamy, with the heavy soils subdivided further into calcareous and non-calcareous types. The heavy topsoil is a poorly draining material, predominantly present in the west, overlying the Gault Clay (likely parent soil). The loamy topsoil is a freely draining type largely present in the east of the site overlying the River Terrace Gravels (likely parent soil).

The report concludes that the topsoil present on site will provide suitable material for the proposed end uses as summarised in the following table.

Table 1: Topsoil Suitability

After use	Soil Type		
	Heavy calcareous	Heavy non-calcareous	Loamy
Sports pitches	Poorly suited	Poorly suited	Moderately suited
Wildflower meadow	Variably suited[1]	Variably suited[1]	Variably suited[1]
Residential gardens	Moderately suited	Moderately suited	Well suited
Green space	Well suited	Well suited	Well suited
Bund	Well suited	Well suited	Well suited
Notes: Table reproduced from LRA soil resources assessment (LRA, Oct 2013), please refer to LRA report for details			

The report concludes that all the topsoil present on site can be usefully reused as part of the proposed development and makes the following recommendations regarding the reuse of soils:

- Topsoil removed during the development should be separated according to type;
- Loamy topsoil should be preferentially used in residential gardens;
- Heavy topsoil should preferentially used in the landscape mounds/bunds;
- Where possible loamy topsoil should be used to surface the landscape mounds/bunds as it provides a preferable planting medium;
- None of the topsoil is ideally suited for sports pitches due to the present of sharp flints. Screening to remove these flints, if feasible, may render the material suitable. Heavy topsoil is not recommended for sports pitches due to its' poorly draining characteristics; and
- The nutrient status of some topsoils make it unsuitable for wildflower meadow creation. Areas of low nutrient topsoil, which will be better suited, are highlighted within the report.

The report also makes the following recommendations regarding the handling of soils:

- Areas not been built over should not be trafficked, as it will render the soil impermeable.
- Stripped topsoil should be stored in separate resource bunds no more than 3m high, kept grassed and free from construction traffic.

3.2 Soil suitability for intended re-use

The strategy calls for the reuse of soils on site in the following ways:

- Reuse of topsoil and desiccated soil (subsoil and topsoil) in the landscaping bund (maximum height 3.05m, maximum slope 1 in 3);
- Reuse of topsoil for backfilling of the borrow pit (2.5m deep); and
- Reuse of sub-soil to raise ground levels by between 0.5 and 2.0m.

3.2.1 Landscape bund

Based on the results of the Soil Resources Survey (LRA, Oct 2013) and geoenvironmental assessments (RSK, Oct 2012, May 2013 & Oct 2013) all topsoil and desiccated soils should be suitable for selective re-use to construct the landscape bund. Notwithstanding the above, the following recommendations are made to minimise likely settlements and promote uniformity:

- Topsoil used within the bund shall be selected based on suitability for use; specifically bunds should be formed using heavy topsoil and subsoil near the base and loamy topsoil towards the surface. This will allow for better drainage and provision of a suitable growing medium;
- The bund should be constructed evenly over their full width and their fullest possible extent, construction plant shall be controlled and directed uniformly over them;
- The degree of compaction should be sufficient to remove any voids and to produce a coherent mass, whilst preventing over-compaction and build up of excess pore water pressure;
- If feasible topsoil intended for use in the base of the bund may be left to settle or surcharged prior to placement in the bund; and
- Slope angles should be minimised where possible to limit issues associated with stability, erosion, drainage and future maintenance.

In addition to the above, reference should be made to the Soil Resources Survey with regard to the handling, temporary storage and use of topsoil;

3.2.2 Backfilling of borrow pit

The ‘borrow’ pit, to be located in the north half of the Central Park, is intended to be approximately 61,295m^3 and 2.4m deep. The pit is to be backfilled using surplus topsoil recovered from the site.

Shallow geology in this area consists of predominantly cohesive, and therefore relatively impermeable, River Terrace Gravel deposits and Gault Clay at shallow depths (1.3 to >4.0m bgl). Groundwater, were encountered, is present a depths varying from 2.0 to 2.6m bgl though has not been shown to form a consistent groundwater table. Due to the nature of the shallow geology groundwater in this vicinity is likely to fluctuate seasonally.

We understand that this portion of the Central Park is to be used as sports pitches. Whilst topsoil is not generally regarded as suitable for use as a general fill material, with consideration of the proposed end use, topsoil may be suitable to partially or wholly backfill the pit, assuming issues such as settlement and drainage can be appropriately managed and/or tolerated within the design. An Earthworks Specification would need to be prepared to specify testing and classification requirements for the topsoil and a subsequent method of construction and compaction to ensure the end product is suitable for its intended use. In the event that some of the material is classified as unacceptable, consideration may be given to stabilising/modifying the topsoil, to treat the material to an acceptable general fill.

It should be noted that in the event that some of the material cannot be rendered suitable for use via modification the strategy for backfilling the borrow pit will be amended appropriately.

Notwithstanding the above, it is not intended that the borrow pit will extend below the groundwater table.

As detailed above, an Earthworks Specification will need to be prepared for this element of the soil strategy to fully detail testing and classification requirements for the fill material and specify a subsequent method of construction and compaction, however, ahead of this, the following general recommendations are made:

- The formation level and proposed fill materials are potentially susceptible to rapid wetting up and softening during earthworks. Hence good earthworks practices should be adopted such as shaping and providing cross falls to all ground surfaces and the surfaces of temporary stockpiles to facilitate run-off. Reference should be made to the Soil Resources Survey with regard to the handling, temporary storage and use of topsoil;
- The filled area should be constructed evenly over the full width and fullest possible extent, construction traffic shall be controlled and directed uniformly over the area;
- Whilst the method of compaction will be prescribed within the Earthworks Specification, as a minimum, we would recommend that the degree of compaction should be sufficient to remove any voids and to produce a coherent mass, whilst preventing over-compaction and build up of excess pore water pressure; and
- Topsoil used within the fill area shall be selected based on suitability for use, specifically the filled area should be using heavy topsoil near the base and loamy topsoil towards the surface. This will allow for better drainage and provision of a suitable growing medium.

3.2.3 Reuse of sub-soil to raise ground levels

The soil strategy (**Appendix A**) includes the sub-soil recovered from the 'borrow' pit to be re-used to raise ground levels by between 0.5 and 2.0m across the east of the site. The shallow geology in the vicinity of the 'borrow' pit consists of stratified cohesive and non-cohesive River Terrace Gravels and Gault Clay. The shallow geology, in which the identified ground raising areas, consists of River Terrace Gravels. It is understood that the raise area is to be developed with houses, roads and drainage and service infrastructure.

As previously discussed, it is considered that the soil arisings from the borrow pit will be suitable as general fill for use in permanent works and are envisaged to fall within the acceptable limits for well graded granular material, uniformly graded granular material, wet cohesive material, dry cohesive material and stoney cohesive material, as detailed within Table 6/1 of the SHW Series 600 (Ref 1).

Notwithstanding the above, the testing and classification of the soil arising from the borrow pit, and its' subsequent construction and compaction should be conducted in strict accordance to an agreed Earthworks Specification.

4. CONCLUSIONS

The geotechnical/geo-environmental assessments and soil resource survey have confirmed the general suitability for re-use of the soils (topsoil and sub soil) within the soil strategy presented by Woods Hardwick, subject to the constraints and recommendations identified within this report.

Notwithstanding the above, further earthwork testing will be need to be conducted to fully assess the soils acceptability for re-use against the criteria presented within the proposed earthworks specification. The earthworks specification will need to be prepared to confirm the actual requirements for acceptability and testing of the earthworks materials. Where unacceptable materials are encountered, consideration may be given to treating the soils to an acceptable state, alternatively these soils should be segregated from the earthworks materials.

A verification report will need to be prepared to document the implementation of the earthworks strategy. Additionally a Materials Management Plan is currently being prepared by RSK in accordance with the Development Industry Code of Practice to manage the use of soils on the site going forward. The Materials Management Plan will set out the objectives relating to the use of the materials to accompany the Subsoil and Topsoil Strategy, derived using an appropriate risk assessment. It will bring together all the relevant information to demonstrate that all four key factors (protection of human health and the environment, suitability for use, certainty for use and quantity) will be met and include a tracking system and contingency arrangements.

Reference should be made to the Soil Resource Assessment (LRA, Oct 2013) and Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (Ref 2) in respect to the general practices, handling, temporary storage and use of soil during the proposed earthworks.

Author	Reviewer
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Appendices

Appendix A – Soil Strategy

Subsoil and Topsoil Strategy Technical Note Rev A - Darwin Green One, Huntingdon Road, Cambridge (16483). Wood Hardwick Infrastructure LLP, December 2013.

Appendix B – Geoenvironmental assessments

Report for Main Site Investigation – NIAB Phase 1, Huntingdon Road, Cambridge. RSK Environment Ltd, October 2012 (Ref: 25459-01(00))

Supplementary Investigation - NIAB1 Fields, Phase 1 Development. RSK Environment Ltd, 1st May 2013 (Ref: 25459-R02 (00).

Summary geo-environmental report for NIAB1 Fields, Phase 1 Development. RSK Environment Ltd, 11th October 2013 (Ref: 25459-R03 (00).

Soil Resources of land at Darwin Green, Cambridge. Land Research Associated, 16th October 2013 (Ref 898/1).

References

1. Manual of Contract Documents for Highway Works, Volume 1: Specification for Highways Works. Highways Agency, March 1998.

2. Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. DEFRA, 2009.

Appendix A – Soil Strategy

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SUBSOIL AND TOPSOIL STRATEGY TECHNICAL NOTE

(Rev A)

December 2013

PRODUCED ON BEHALF
OF BARRATT HOMES

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APPENDICES

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E. Landscape Mound Details (Drawing Number 16877/2008E)

Revision A

- Indicated in red

Issue	Revision Date	Comments	Prepared By	Approved By
1	28/10/13	First Issue		
2	29/11//13	Revision A		

1.0 INTRODUCTION

1.1 This Subsoil and Topsoil Strategy Technical Note has been prepared by Woods Hardwick Infrastructure LLP in support of a Reserved Matters Application for the primary infrastructure at the Darwin Green One development between Huntington and Histon Roads, Cambridge.

1.2 This technical note aims to assist the reader and key consultees of the planning process and to enable them to understand the background of the strategy.

1.3 The objective is to achieve a balanced solution on the site to avoid external movements of bulk spoil and topsoil on the public highway.

2.0 DEVELOPMENT PROPOSALS

2.1 The site, known previously as the NIAB 1 site, is located in the north western fringe of the City and to its north is the A14 Cambridge Northern Bypass. It comprises part of the land used by the National Institute of Agricultural Botany (NIAB) between Huntingdon Road and Histon Road. The land also includes parcels owned by the Chivers Family, Chivers Farms Ltd. and Christ's, Sydney Sussex and St. Catharine's Colleges, all of whom are party to a consortium for the purpose of this development.

2.2 The site comprises 50.8 ha, of which 48 ha falls within the administrative boundary of Cambridge City and 2.8 ha of land within South Cambridgeshire. The land within South Cambridgeshire abuts Histon Road and will be used for vehicular access and drainage facilities.

2.3 The development benefits from Outline Planning Consent ref 07/0003/OUT issued by Cambridge City Council and detailed Planning Consent ref S/001/07/F issued by South Cambridgeshire District Council.

2.4 The Cambridge City Council consent is for a Mixed Use development comprising up to 1593 Dwellings, Primary School, Community Facilities, Retail Units (use classes A1, A2, A3, A4 & A5) and associated infrastructure including vehicular, pedestrian and cycleway accesses, open space and drainage works.

2.5 This document pertains to the treatment of the subsoil and topsoil generated and required on the development.

3.0 REVIEW OF SUBSOIL QUANTITIES

3.1 A preliminary 3 dimensional ground model has been created for the DG1 site created from the existing topographical survey and the anticipated finished levels over the entire site based upon the approved drainage model.

3.2 In order to ensure that all the future parcels can drain under gravity they have been assumed to be level plateaus being extensions to the adjacent drainage model levels

3.3 The ground raising/lowering areas are indicated on drawing number 16483/2060A given in **Appendix A.**

3.4 From the plan it should be noted that the southern 2/3rds of the site are largely at existing ground level, with the northern 1/3rd requiring to be raised. The ground raising is required to provide the minimum cover to the surface water sewers and retain water within the system during extreme storm events. As the surface water discharges via flow controls to the existing Awarded Watercourse to the north there is no scope to lower the drainage to reduce the extent and quantum of fill required.

3.5 The cuttings or ground lowering areas are primarily related to the attenuation ponds, swales and ditches which transport and store surface water enroute to the outfall.

3.6 In addition to the depressions/cuttings indicated in green there will be subsoil arisings generated from the unshaded development areas where the finished levels are within 500mm of the existing levels. This spoil being generated from the drainage, road box and foundation works.

3.7 In order to allow for the construction zone a bulk earthworks model has been created allowing for a 750mm construction zone under the strategic roads, 600mm on the development parcels, and 375mm on the public open spaces.

3.8 The 750mm zone is in line with the Cambridgeshire County Council road specification, the 600mm based on previous studies with similar development characteristics, and the 375mm being the average topsoil depth across the site.

3.9 In order to allow for the topsoil removal a formation ground model was created which is the existing topographic model less 375mm being the average topsoil depth across the site.

3.10 Comparing the bulk earthworks model with the formation model the following volumes apply:- 56,141m3 Cut, 117,414m3 Fill. **Giving a net deficit of 61,273m3 of subsoil.**

4.0 ACHIEVING AN ONSITE SUBSOIL BALANCE

4.1 From the approximate quantities identified in the section above it has been established that there will be a deficit of approximately 61,273m^3.

4.2 Given that the objective of the strategy is to avoid the need for any external transport movements off the site this shortfall of subsoil will need to be sourced from within the development.

4.3 A borrow pit in the centre of Central park has been identified as a possible on site source of subsoil. The approximate location and extent of the borrow pit is given on drawing no. 16483/2084 given in **Appendix B**

4.4 The borrow pit has been located such that it does not encroach into the southern sports pitch, the swales and the northern pond such that these elements together with the footpaths within the park on the northern side can be completed prior to its backfill.

4.5 A borrow pit as indicated at this location at a depth of 2.4m, to avoid ground seepage as identified in the Geotechnical Report, will generate approximately 61,295m^3 of subsoil.

5.0 REVIEW OF SURPLUS TOPSOIL

DARWIN GREEN ONE

5.1 The volume of topsoil surplus to requirements on the DG1 development has been determined using the latest geotechnical data and the development areas indicated on the Topsoil Analysis Indicative Sub Parcel Area Plan (drawing number 10886/SK56) given in **Appendix C**.

5.2 The calculation is based upon 60% of each residential parcel being impermeable made up of roads, drives, houses, patios etc. with 40% being soft landscape.

5.3 The depth of existing topsoil in each parcel is based upon the mean depth of each trial pit log located within that parcel.

5.4 For example Parcel 2 has a gross area of 0.9ha of which 60% (0.54ha) will be developed, with the mean depth of topsoil on the parcel being 0.35m this equates to a surplus of (5400)(0.35)m^3=1890m^3.

5.5 For residential/Area 1 allowance for a 1.0ha supermarket has been made for which an impermeable figure of 100% has been applied.

5.6 For the school site it has been assumed that 50% of the site will be impermeable and for the primary roads 100% has been applied.

5.7 With regard to the public open spaces, attenuation ponds and allotments these will be topsoil neutral as any topsoil removed will be reinstated.

5.8 The following table summarises the various parcel/areas on DG1 which in total is estimated to generate approximately 90,239m^3 of surplus topsoil.

Parcel	Gross Area (ha)	Net Area (ha)	Depth of Topsoil (m)	Volume (m^{2})	Comments/Notes
1	2.3-1.0	0.78	0.32	2,496	TP 3,6,10 and 11. Mean=0.32m
2	0.9	0.54	0.35	1,890	TP 11 and 12. Mean=0.35m
3	2.0	1.20	0.53	6,300	TP 1 and 4. Mean=0.525m
4	5.6	3.36	0.34	11,424	TP 1(1),2,3(1),5. Mean=0.34m
5	0.6	0.36	0.38	1,368	TP 7 and 9. Mean=0.38m
6	5.4	3.24	0.39	12,636	TP 10,11,13,14,19,20 and 21. Mean= 0.39m
7	4.7	2.82	0.325	9,165	TP 17,39,18,23. Mean=0.325m
8	2.1	1.26	0.53	6,678	TP 24 and 27. Mean=0.53m
9	2.6	1.56	0.366	5,710	TP 26, TP 6(1) and 25. Mean=0.366m
10	1.3	0.78	0.34	2,652	TP 7(1),30,31 and 32. Mean=0.34m
11	2.3	1.38	0.33	4,554	TP 28,8(1), 29,31 and 33. Mean=0.330m
Primary Roads	4.0	4.0	0.38	15,200	Mean of above = 0.38m
Supermarket Site	1.0	1.0	0.32	3200	As Parcel 1 above. Mean = 0.32m
School Site (25)	2.	1.15	0.35	4,050	TP 2(1),7,8 and 9. Mean=0.35m
Total: 87,323m^3					

DARWIN GREEN TWO/THREE

5.9 The volume of topsoil surplus to requirements in the DG2/3 development has been determined using the latest geotechnical data and the development areas indicated on the Topsoil Analysis Indicative Sub Parcel Area Plan (drawing number 11896/SK23) given in **Appendix D**.

5.10 The average topsoil depth over the DG2/3 site is 0.315m which has been applied to all the area references.

5.11 The calculation is based upon 60% of each residential parcel being impermeable, 80% for the school areas within the development boundary and 100% for the Primary Roads.

5.12 With regard to public open spaces, attenuation ponds, school playing fields and allotments they will be topsoil neutral in terms of surplus as any topsoil removed will be reinstated.

5.13 The following table summarises the various areas for DG2/3 which in total is estimated to generate approximately 53,392m^3 of surplus topsoil.

Area Ref	Gross Area (m^2)	Net Developable (60%) (m)	Depth of topsoil (m)	Surplus Volume (m^3)
1	32,000	19,200	0.315	6,048
2	51,000	30,600	0.315	9,639
3	59,000	35,400	0.315	11,151
4	19,000	11,400	0.315	3,591
5	18,000	10,800	0.315	3,402
6	23,000	13,800	0.315	4,347
School Sites	43,000	34,400 (80%)	0.315	10,836
Primary Roads	13,900	13,900 (100%)	0.315	4,378
			Total	53,392 m^3

DARWIN GREEN OVERALL DEVELOPMENT

5.14 The total surplus topsoil generated from the Darwin Green development is therefore estimated to be in the order of (87,323 + 53,392)m^3 = 140,715m^3.

6.0 REUSE OF SURPLUS TOPSOIL

6.1 The surplus topsoil will be utilised to backfill the Central Park borrow pit (61,295m^3) with the balance being transported via the existing farm tracks and new sections of the haul road to be utilised in the formation of the A14 landscape mounds. The haul roads will include intervisible passing bays.

6.2 The surplus topsoil will be distributed as follows :- 61,295m3 to the borrow pit with the balance of 79,420m3 to the landscape mounds.

6.3 The intention is to form mound A using the surplus topsoil from DG1 only (87,323 – 61,295) = 26,028m^3. Mounds B, C and D will be formed if and when the DG2/3 arisings are generated..

6.4 Details of the 4 mounds proposed are indicated on drawing number 16877/2008E given in **Appendix E**.

6.5 Mound A will accommodate 26,028m^3 being 3.05m high as indicated on Sections A-A, B-B and F-F and will therefore be formed entirely from the surplus generated from DG1.

6.6 Mound A narrows slightly at its midpoint where an overhead pylon is located. Side slopes of 1V:3H and 1V:8H are proposed along A14 and southern boundaries respectively.

6.7 Temporary haul road crossings will be required over the Awarded Watercourses to transport the surplus topsoil to the locations proposed.

6.8 Mound C, at a height of 3.05m will accommodate 29,791m^3 being formed from the topsoil surplus generated from DG2/3. Cross sections D-D and H-H indicate slopes of 1V:3H and 1V:6H to the A14 and southern boundaries respectively.

6.9 Mound C has been adjusted in plan to avoid the iron age fort area for which a 5m proximity zone has been applied.

6.10 Mound B, the central mound at a height of 1.30m will accommodate 2,300m^3. This mound will also be formed entirely from the surplus topsoil generated from DG2/3. As indicated on sections C-C and G-G.

6.11 Mound D the western mound will use up the balance of the topsoil generated from DG2/3 (53,392 – (29,791 + 2,300) = 21,301m^3 being 1.30m high. Cross sections E-E and J-J indicate the slopes.

6.12 From the above it is clear that all the surplus topsoil generated from the Darwin Green Development can be retained on site.

7.0 SUMMARY AND CONCLUSIONS

7.1 This Technical Note establishes a good estimate of the likely subsoil and topsoil quantities created and required on the Darwin Green development.

7.2 The ground raising is required to provide the necessary cover to the drainage which cannot be lowered due to the existing ditch outfalls governed by the A14 culverts together with the need to attenuate large volumes of water below ground during extreme storm events.

7.3 Based upon the assumptions used in the Note it has been established that there will be a shortfall of approximately 61,273m^3 of subsoil on DG1. This will be sourced from a borrow located in the centre of Central Park.

7.4 The Central Park borrow pit when completed will be backfilled with surplus topsoil arisings generated exclusively from DG1.

7.5 The total volume of surplus topsoil from DG1 and DG2/3 is likely to be in the order of 140,715m^3 which can be accommodated in the DG1 borrow pit and the proposed landscape mounds along the A14 frontage. The proposed mounds avoid the iron age fort area.

7.6 With the proposed Central Park subsoil borrow pit external subsoil and topsoil haulage trips on the public highway will be kept to a minimum.

7.7 With the surplus topsoil being used to create the A14 landscape mounds there will be significant environmental enhancements particularly when the proposed A14 widening works are implemented by the Highway Agency.

7.8 With the objective of minimising external off site subsoil or topsoil vehicular trips being achieved this strategy should be fully supported by both Cambridge City and South Cambridgeshire District Councils.

APPENDIX A

Ground Raising/Lowering (Drawing Number 16483/2060A)


Woods Hardwick

Appendix B

Approximate Extent and Location of Borrow Pit (Drawing number 16483/2084)

NOTES

1. CONTRACTORS MUST CHECK ALL DIMENSIONS ON SITE. ONLY FIGURED DIMENSIONS ARE TO BE WORKED FROM. DISCREPANCIES MUST BE REPORTED [illegible] THIS DRAWING IS COPYRIGHT.
2. DRAWING TO BE READ IN CONJUNCTION WITH [illegible] STRATEGY TECHNICAL NOTE.
3. [illegible]

KEY

[illegible]

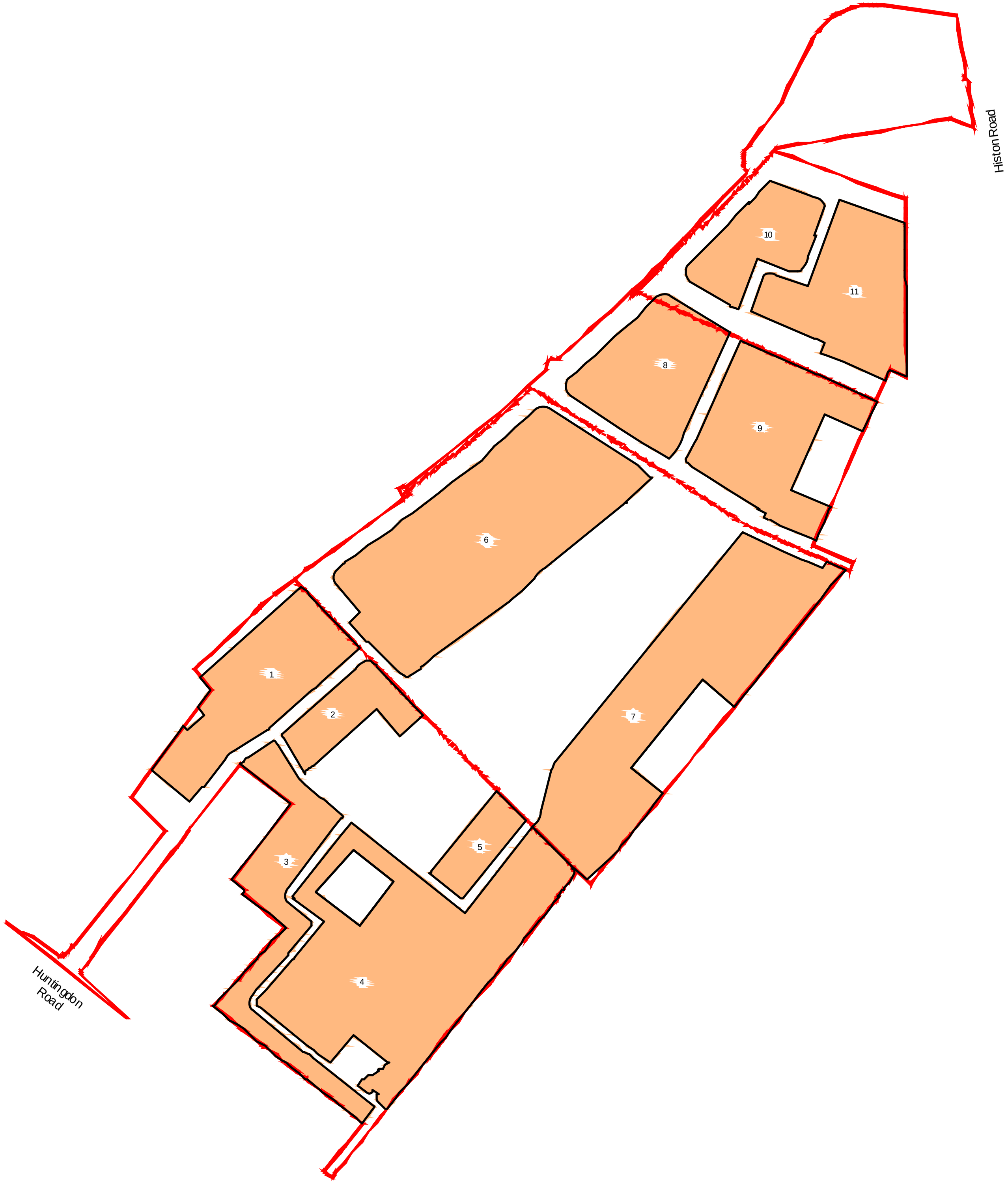
WOODS HARDWICK

DARWIN GREEN ONE
CAMBRIDGESHIRE

BORROW PIT PLAN

APPENDIX C

MRA TOPSOIL ANALYSIS – INDICATIVE SUB PARCEL AREAS PLAN (DRAWING NUMBER 10886/SK56)



Notes
Do not scale from this drawing - use figured dimensions only.
All dimensions are in millimeters unless otherwise stated.

Legend			
	Darwin Green 1 Site Boundary		
1	Residential	-	23 ha
2	Residential	-	09 ha
3	Residential	-	20 ha
4	Residential	-	56 ha
5	Residential	-	06 ha
6	Residential	-	54 ha
7	Residential	-	47 ha
8	Residential	-	21 ha
9	Residential	-	26 ha
10	Residential	-	13 ha
11	Residential	-	23 ha
Total	**Residential**	-	**29.8ha**

Referenced Drawings

MRA: 1088 6SK30 0rev B

Notes:

.... 0000 00

Revision	By	Date

Mark Reeves
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5 Northfields Prospect, Putney Bridge Road, London, SW18 1PE
Tel: 0208 8740484 Fax: 0208877 1250 Email: mail@mralarchitects.co.uk

Client **Barratt Homes Eastern Counties and the North West Cambridge Consortium of Land Owners**

Project **Darwin Green 1**
Huntingdon Road Cambridge

Drwg Title **Top Soil Analysis - Indicative Sub Parcel Area**

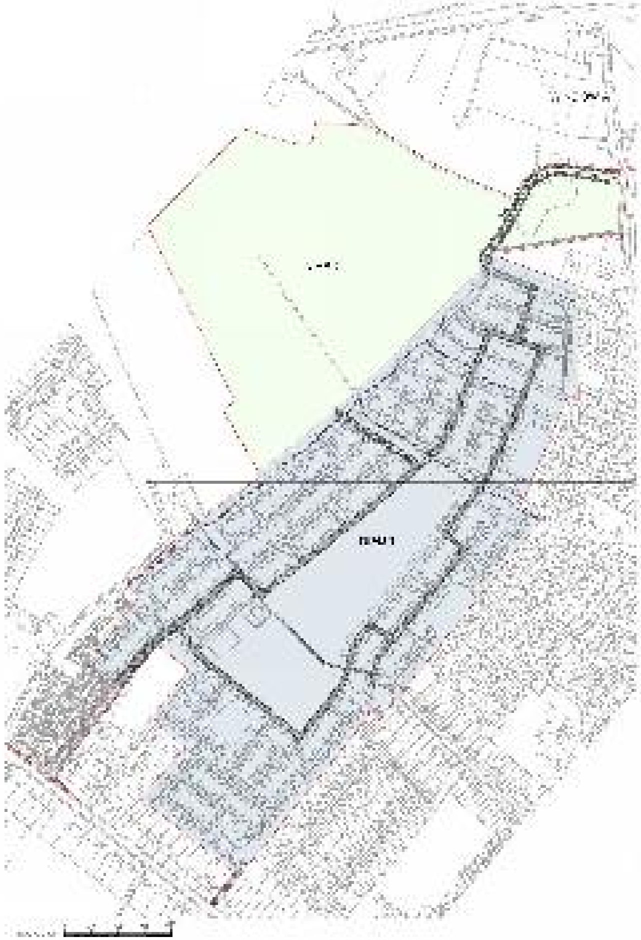
Status Preliminary Scale @A1 1:2500 Date Nov 2013

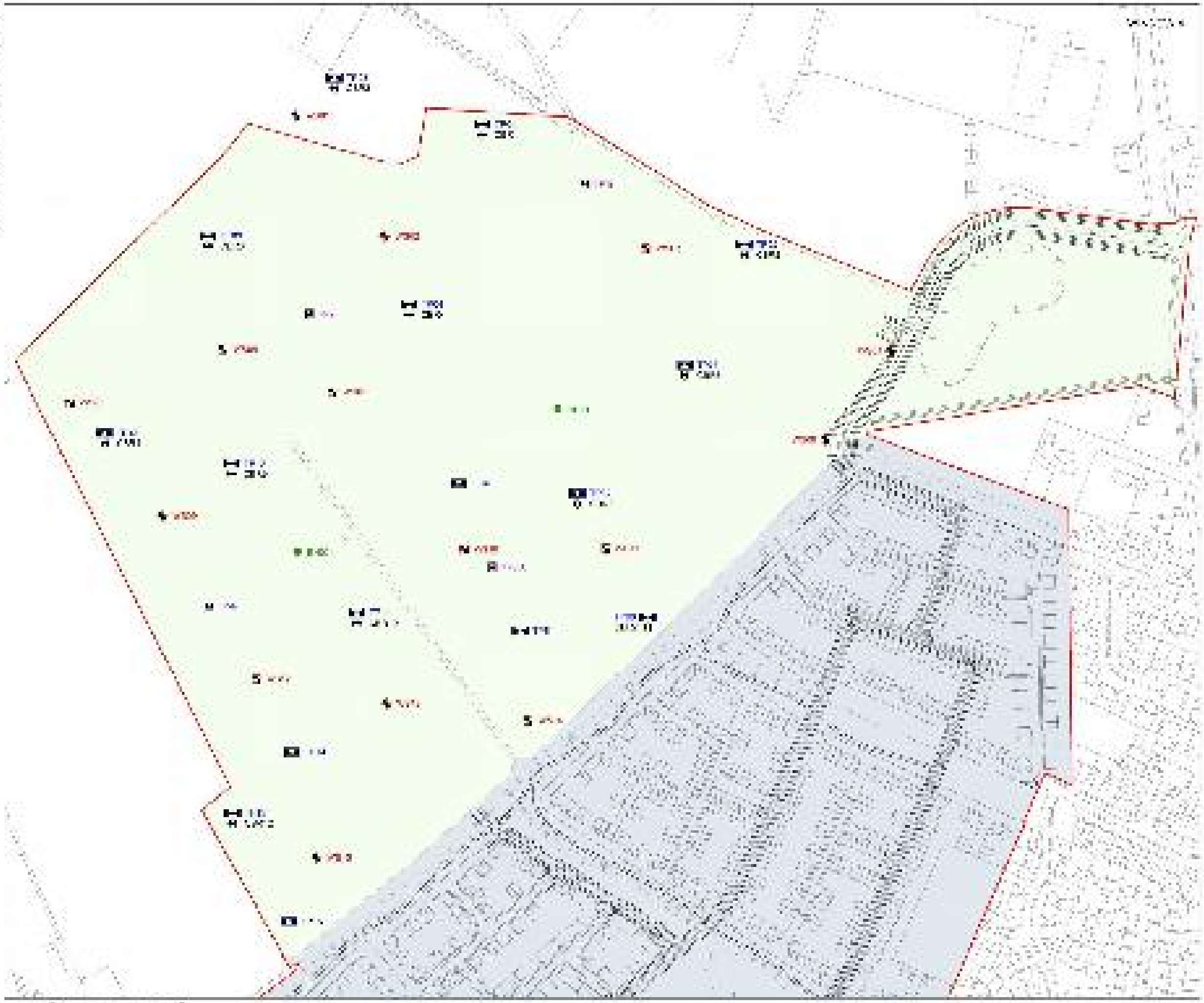
Drwg No. **10 886 - SK5**[redacted]

APPENDIX D

- MRA TOPSOIL ANALYSIS – INDICATIVE SUB PARCEL PLAN
(DRAWING NUMBER 11896/SK23)
- RSK EXPLORATORY HOLE LOCATIONS PLAN


DfE3 SITE AREA
DRAFT
Mark Reeves
Architects





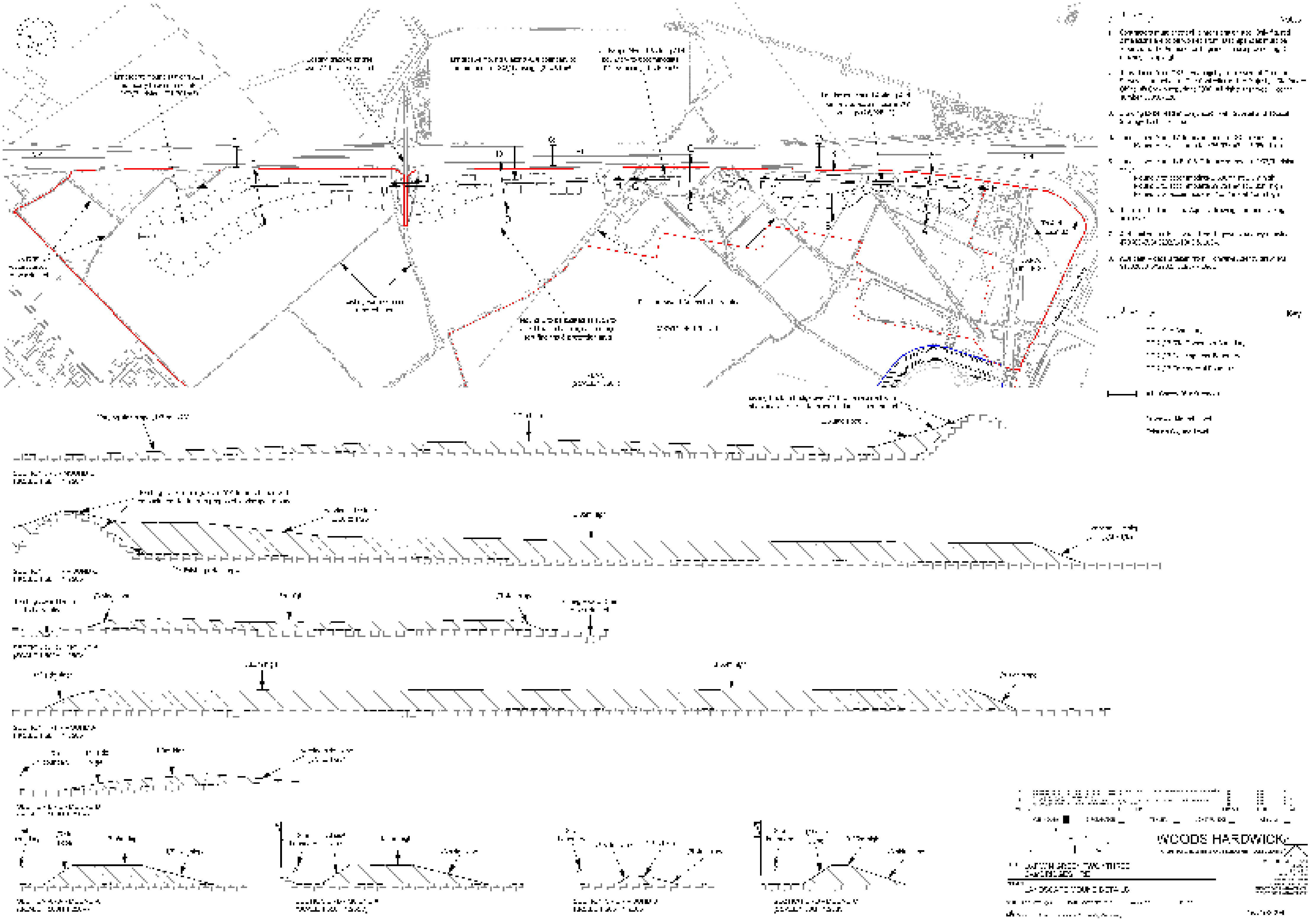
BDW TRADING

NIAB PHASE 2
HUNTINGDON ROAD
CAMBRIDGE

EXPLORATORY HOLE
LOCATION PLAN

APPENDIX E

LANDSCAPE MOUND DETAILS (DRAWING NUMBER 16877/2008E)


WOODS HARDWICK

Appendix B – Geoenvironmental assessments

SOIL RESOURCES

OF LAND AT DARWIN GREEN,

CAMBRIDGE

Report 898/2

23rd October, 2013

Land Research ASSOCIATES

SOIL RESOURCES

OF LAND AT DARWIN GREEN,

CAMBRIDGE

M W Palmer, MSc, PhD

Report 898/2

Land Research Associates Ltd
Lockington Hall,
Lockington,
Derby
DE74 2RH

23rd October, 2013

SUMMARY

This report evaluates the suitability of soil resources for the proposed after-uses at the Darwin Green 2 site. The assessment involved a semi-detailed survey of soils to a depth of 1 metre, and the sampling of topsoils within different areas of the site for nutrient analysis.

The results show the soils in the west to be principally heavy poorly draining types formed in mudstone, and in the east loamy freely draining types formed in river terrace drift. A band of heavy soils passes through the proposed development area. Soils in the southern area of the site have been extensively disturbed by previous archaeological excavations, resulting in exposure of the lower subsoil. The removed overburden is present as separate stockpiles of topsoil and upper subsoil.

Good soil resources exist on site for re-use in residential gardens, greenspace areas and the formation of the proposed landscape mound south of the A14. It is recommended that the loamy soils are reused preferentially for residential gardens The loamy soils are also moderately suited for use as sports pitches, but require treatment to remove the risk of sharp stones occurring at the surface.

Landscape mound formation where possible should make use of any residual loamy soils as a surface layer, and the heavy soils as a base and core.

The suitability of the soils for wildflower meadow creation varies according to topsoil available phosphorus concentration. It is confirmed that soils exist on site which are well suited to meadow creation. The nature of the advised seed mix also varies according to the topsoil calcium carbonate content.

1.0 Introduction

1.1 This report provides information on the soils within a 127 ha area north of Darwin Green, Cambridge. The purposes of this assessment were to map and characterise the soils which occur at the site, and to provide an evaluation of their suitability for different post-development uses within the site. The principal uses against which soil suitability is considered are:

- Parkland/woodland/green corridors/public open space
- Wildflower meadow
- School playing fields/sports pitches
- Residential gardens
- Landscape mound formation

1.2 The report is based on a soil desk study and a site survey in October 2013.

SITE ENVIRONMENT

1.3 The site is situated on level terrain at an average elevation of 15 m AOD. The majority of the site is under cultivated agriculture, comprising winter cereals at the time of survey. An area of land used as horse paddocks is located in the north east corner. Large areas of the southern section have been stripped of topsoil and upper subsoil during previous archaeological excavations, and these materials are identified as separate stockpiles (see Map 1). These areas are currently in weedy fallow. An area in the north-west is in scrubby fallow. The site also includes small areas of woodland, hard standings and buildings which were not included in the soil survey.

PUBLISHED INFORMATION

1.4 BGS 1:50,000 geological mapping records the site to be underlain by Cretaceous mudstone of the Gault Formation. In the east of the site this is recorded as overlain by river terrace sands and gravels.

1.5 A soil map[1], published at a scale of 1:63,360 records Wicken Association in the north-west, comprising calcareous soils with drainage restrictions formed in

[1] Hodge, C A H and Seale R S. *Soils of the district around Cambridge (Sheet 188). Soil Survey of England and Wales.*

Jurassic/ Cretaceous clay and thin overlying drift. The rest of the site is recorded as Milton Association, comprising loamy soils formed in river terrace or Head deposits.

2.0 Generalised Soil Types

2.1 A detailed soil resource survey was carried out in October 2013. It was based on alternate observations at intersections of an offset 100 m grid, giving a sampling density of one observation per two hectares. During the survey, soils were examined in auger borings to a maximum depth of 1 m. Generalised soil types are shown in Map 1. A log of the sampling points and a map (Map 2) showing their location is in an appendix to this report.

2.2 Once soils had been mapped, representative topsoil samples of each type were obtained from a depth of 0-15 cm, taken from different fields across the site. A total of 10 samples were collected, each comprising a minimum of 15 sub-sample points taken across each of the areas depicted on Map 1.

2.3 In the southern area, where soil had been removed to an approximate depth of 50 cm during previous archaeological excavations and stockpiled, in-situ sampling of the subsoil to 50 cm depth was conducted. This was combined with investigation of topsoil mounds, involving an assessment of the topsoil at a depth of 30 cm at the geographic centre of each stockpile. Selected topsoil stockpiles were sampled at a depth of 0-15 cm (those labelled 2, 5, 6 and 7 in Map 1).

2.4 Soil samples were submitted for laboratory chemical analysis in order to determine their post-use capability, particularly with regard to habitat creation.

2.5 The soils were found to vary between heavy soils formed in mudstone and loamy soils formed in river terrace deposits.

Heavy soils

2.6 These soils dominate in the west of the site (NIAB land) where river terrace deposits are absent or superficial. These soils are sub-divided according to the calcium carbonate status of the topsoil:

Heavy calcareous soils

2.7 Soils in the west of the site mainly comprise clay or heavy clay loam topsoil over clay subsoil. The subsoil is poorly structured and slowly permeable to shallow depth. These soils have moderately high calcium carbonate content in the topsoil which increases with depth.

<u>Heavy slightly calcareous soils</u>

2.8 These soils occur in a band running roughly south-west to north-east (see Map 1). As with the soils previously described, the lower subsoil is highly calcareous. The topsoil however, is non-calcareous or only slightly calcareous, which affects their potential after use (as described in following sections).

2.9 A representative profile at sample point 37 (see Map 2) is described below:

0-36 cm	Dark greyish brown (10YR 3/2) clay; slightly stony weakly developed coarse sub-angular blocky structure (compacted); very firm; slightly calcareous; abrupt smooth boundary to:
36-61 cm	Light brownish grey (2.5YR 6/2) clay with many distinct strong brown (7.5YR 5/6) mottles; stoneless; weakly developed coarse prismatic structure; very firm; moderately calcareous; gradual smooth boundary to:
61-100 cm+	Light brownish grey (2.5YR 6/2) clay with many distinct strong brown (7.5YR 5/6) and grey (10YR 6/1) mottles; stoneless; massive (structureless); very calcareous (containing secondary carbonates).

Loamy soils

2.10 These soils occur dominantly in the east of the site, where coarser textured river terrace deposits overlie the calcareous clay which forms the heavier soils. These soils are non-calcareous or only slightly calcareous in both the topsoil and upper subsoil. They can be subdivided into a shallow phase, where flinty very calcareous gravel forms the lower subsoil (50-100 cm) and the more commonly occurring deep phase, where the subsoil is only slightly or moderately stony.

2.11 Descriptions of a representative profile of each phase are provided below, but they are not mapped separately due to the complexity of distribution within the site.

2.12 A deep phase profile at sample point 8 (see Map 2) is described below:

0-29 cm	Dark greyish brown (10YR 3/2) medium clay loam; slightly stony; well developed medium sub-angular blocky structure; friable; non-calcareous; clear smooth boundary to:
29-48 cm	Pale brown (10YR 6/3) medium clay loam with common strong brown (7.5YR 5/8) and greyish brown (10YR 5/2) mottles; stoneless; moderately developed medium sub-angular blocky structure; non-calcareous; clear smooth boundary to:
48-71 cm	Light yellowish brown (10YR 6/4) medium clay loam with many strong brown (7.5YR 5/8) mottles; slightly stony; well developed medium sub-angular blocky structure; slightly calcareous; gradual smooth boundary to:
71-100 cm+	Light grey (10YR 7/2) medium clay loam with many strong brown (7.5YR 5/8) mottles; no hard stones (abundant weathered soft chalk); extremely calcareous.

2.13 A shallow phase profile at sample point 23 (see Map 2) is described below:

0-36 cm — Dark greyish brown (10YR 4/2) medium clay loam or sandy clay loam; slightly stony (small angular flint); well developed medium granular structure; slightly calcareous; clear smooth boundary to:

29-49 cm — Olive brown (2.5YR 4/4) sandy clay loam with faint olive yellow (2.5YR 6/6) mottles; slightly stony; moderately developed medium sub-angular blocky structure; moderately calcareous; gradual smooth boundary to:

49-80 cm+ — Light olive brown (2.5YR 5/4) slightly mottled sandy clay loam; very stony; very calcareous.

Excavated areas

2.14 The exposed lower subsoil was mainly found to comprise medium to coarse loamy material, often with high stone content. At one sample point (52, see Map 1) and in one excavation area in the west of the site (not described in sampling points) this material consisted of waterlogged grey clay.

Stockpiled topsoils

Topsoil stockpiles 1-7 were found to comprise sandy clay loam or medium clay loam material. With the exception of stockpile 5 they were all found to be non-calcareous or only slightly calcareous (Table 1). Stockpile 8 comprised heavy slightly calcareous topsoil, consistent with the underlying soil type of this area.

Stockpile ID (Map 1)	Texture	Calcium carbonate content	Stone % (>10mm)
1	Sandy clay loam	Slightly calcareous	10
2	Medium clay loam	Non calcareous	5-10
3	Medium clay loam	Slightly calcareous	5-10
4	Sandy clay loam	Non calcareous	5-10
5	Medium clay loam	Moderately calcareous	5
6	Sandy clay loam	Non calcareous	5-10
7	Sandy clay loam	Slightly calcareous	15
8	Heavy silty clay loam	Slightly calcareous	<5

3.0 Soil functional requirements

3.1 In this section soil types are considered against the after-uses described in paragraph 1.1. It is anticipated that all topsoils will be retained for reuse on site, and that in addition a small volume of subsoil will be removed during excavations on developed areas of the site, which may be usefully reused.

School playing fields/sports pitches

3.2 The most important requirements of playing fields and sports pitches are effective drainage to ensure they are playable throughout the year and minimal content of sharp stones in the surface layer in order to avoid risk of injury.

Wildflower meadows

3.3 Species-rich flower meadows generally require topsoils with low concentrations of plant available nutrients. In particular, high levels of available phosphate in the soil can lead to dominance of grasses and or agricultural weeds at the expense of less vigorous flowering plants. High nutrient levels commonly result from inputs of commercial agricultural fertiliser or organic wastes such as manure and slurry.

Residential gardens

3.4 The soils have already been demonstrated to be free from contamination and therefore chemically suitable for reuse in residential gardens. The garden use requirements for natural topsoils are generally not demanding, but coarse and medium loamy textures with low to moderate stone contents are preferable for ease of cultivation.

Parkland/woodland/green corridors/public open space

3.5 These uses are non-demanding, although high initial concentrations of available nutrients can lead to problems with growth of pernicious weeds. Uncompacted subsoil is essential for successful establishment of planted woodland.

Landscape mound formation

3.6 All soil types are suitable, other than those with very high organic matter status (not present on this site) which may lead to problems arising from decomposition leading to wastage and generation of ammonia and methane. Non-cohesive soil types (sands) may be less suitable due to the potential for erosion and mass slippage.

4.0 Soil suitability assessment

4.1 In this section the suitability of the generalised soil types for the range of after-uses outlined in section 3 is described and explained

Heavy soils

4.2 These soils have clay or heavy clay loam topsoil, which makes them difficult to handle and prone to compaction when handled or trafficked in a wet state. This makes them less than ideally suited for use in residential gardens, or for planting schemes following excavation.

4.3 The combination of the high topsoil clay content and poorly draining subsoil mean sports and playing fields located on these soils are unlikely to be playable in winter, and prone to turf damage when used in wet weather at other times of year. The topsoils also contain sharp small and medium flints which are unsuitable for sports use.

4.4 The strongly calcareous soils in are not suited to species intolerant of alkaline conditions, and if wildflower meadow is to be located in this area, a calcareous seed mix is recommended. The less calcareous soils are suitable for a neutral species mix.

4.5 These soils are best used for less demanding uses, such as use in bund formation and green spaces where the soil is not disturbed.

Loamy soils

4.6 The topsoils are medium textured and only slightly stony, which makes them a good quality soil for residential gardens.

4.7 These soils are freely draining with appropriate drainage systems installed and are therefore better suited for use as sports pitches then the heavier soils. However, the flint content of the topsoil is slightly higher, which means they are unsuitable for sports use without amendment.

4.8 The suitability for wildflower meadow is dependent on the nutrient status of the topsoil (see paragraph 4.11). All soils of this type are non-calcareous or only slightly calcareous and therefore suitable for standard neutral planting and seed mixtures.

4.9 These soils are equally well suited to the less demanding uses as the heavy soils.

4.10 Soil suitability is summarised in Table 1

Table 1: Soil suitability assessment

After-use	Soil Type		
	Heavy calcareous	Heavy non-calcareous	Loamy
Sports pitches	Poorly suited	Poorly suited	Moderately suited
Wildflower meadow	Variably suited[1]	Variably suited[1]	Variably suited[1]
Residential gardens	Moderately suited	Moderately suited	Well suited
Green space	Well suited	Well suited	Well suited
Bund	Well suited	Well suited	Well suited

[1]See comments below

Suitability for wildflower meadow

4.11 The suitability of topsoils for meadow planting varies according to management history of different areas. Topsoil analysis (see appendix) shows marked differences in available phosphorus concentrations in particular, which has been shown to have a significant effect on species distribution. Areas with a P index of 1 (samples 1, 5, 6, 7 and 10 of Map 1) are well suited, being only slightly elevated. Those in index 2 (samples 2 and 8) are moderately suited, although some difficulties with excess weed growth is anticipated. Those above index 2 (samples 3, 4 and 9) are poorly suited and their use as meadow is likely to result in an undesirable species mix with excess grass and agricultural weed growth at the expense of wildflowers.

5.0 Conclusions and recommendations

5.1 Suitable topsoil resources exist at the site to achieve the proposed after-uses, and all topsoils can be usefully re-used on site.

5.2 The soils removed from the development area should be separated according to the soil types mapped (Map 1). The loamy soils should be used preferentially in residential gardens, with the heavy soils from this area reserved for landscape mound formation.

5.3 All of the topsoils (and subsoils) on the site are suitable for mound formation. However, it is recommended that the mounds be based with the heavier soils, and any subsoil generated by excavations be placed in the core. Excess loamy topsoil removed from the development area would be a preferable planting medium for the mound surface (since it is better structured and easier to handle) and should therefore be reserved for the surface layer if possible.

5.4 None of the soils are ideally suited for sports pitches due to their content of sharp flints. It may not be feasible to screen these effectively, so import of material to form the playing surface may be necessary. The location of sports pitches on the heavier soils is not recommended due to wetness restrictions.

5.5 As the site has been under intensive arable use, nutrient status of some topsoils is too high to be well suited to wildflower meadow creation. Some areas of the site have been less intensively managed, and therefore be better suited. Details of the suitable areas are provided in Map 1.

Soil Handling

5.6 Areas not being built over (e.g. environmental buffers and landscape areas) should not be trafficked by construction vehicles as this will render the soils impermeable, preventing percolation of rainfall beyond the base of the topsoil, which will quickly become saturated.

5.7 Stripped topsoil should be stored in separate resource bunds no more than 3 m high, and kept grassed and free from construction traffic until required for re-use. The Construction Code of Practice for Sustainable Use of Soils on Construction Sites (Defra 2009) provides guidance on good practice in soil handling.

APPENDIX

MAPS, DETAILS OF OBSERVATIONS AND SOIL CHEMICAL ANALYSIS

Agricultural land quality survey of land at Darwin Green- Details of observations at each sampling point

Obs	Topsoil			Upper subsoil			Lower subsoil			Slope	Wetness	Agricultural quality	
No	Depth (cm)	Texture	Stones (%)	Depth (cm)	Texture	Mottling etc	Depth (cm)	Texture	Mottling	(°)	Class	Grade	Main limitation
1	0-34	SCL	5	34-46	SCL	0	46-62 62-82i	SCL C	*** ***	0	II		
2	0-24	MCL	<5	24-44	MCL	*	44-58 58-100i	SZL MCL	** ***	0	II		
3	0-34	SCL s st	5	34-60	SCL	*	60-81 81-100i	SCL SCL	*** ***	0	II		
4	0-30	C	5	30-80i	C	****				0	III		
5	0-37	SCL	5	37-64	SCL	***	64-84i	SC	***	0	II		
6	0-37	MCL	5	37-72	MCL	*	72-100i	SCL	**	0	II		
7	0-38	MCL s st	5	38-59	MCL	*	59-100i	SCL	**	0	II		
8	0-29	MCL	<5	29-77	MCL	**	77-100i	Chalky drift		0	II		
9	0-30	C st	5	30-40	C	**	40-80i	C	***	0	III		
10	0-30	C st	<5	30-71	C	***	71-100i	C	****	0	III		
11	0-32	C s st	5	32-57	C	***	57-82i	C	****	0	III		
12	0-30	SCL	5	30-51	SCL	*	51-80i	vs SCL	*	0	I		
13	0-37	HCL	5	37-72i	HCL	***				0	III		
14	0-34	HCL/C st	<5	34-61	C	**	61-100i	HCL	**	0	III		
15	0-30	C mst	5	30-74	C	***	74-85i	vs CS	***	0	III		
15a	0-35	MCL	5	35-57	MCL	***	57-100i	vs SL	***	0	I		
16	0-34	HCL s st	5	34-52	HCL	*	52-94 94-100i	C vs SCL	*** ****	0	III		
17	0-31	ZC vs st	<5	31-100i	ZC	****				0	III		
18	0-32	C vs st	<5	32-57	C	**	57-75i	C	***	0	III		
19	0-30	MHCL	5	30-49	HCL	*	49-85i	vs MCL	*	0	II		
20	0-38	C	<5	38-52	C	***	52-100i	C	****	0	III		
21	0-35	MCL s st	5	35-59	HCL	**	59-74 74-100i	MCL Chalky drift	***	0	II		
22	0-30	HCL vs st	5	30-74	HCL	****	74-100i	MCL	**	0	III		
23	0-38	MCL s st	5	38-54	SCL	*	54-80i	vs SCL	*	0	I		
24	0-30	ZC s/mst	<5	30-100i	ZC	****				0	III		
25	0-39	SCL	5	39-62	SCL	0	62-100i	SCL/SZL	0	0	I		
26													
27	0-30	MCL	5	30-54	MCL	0	54-100i	MCL	0	0	II		
28	0-34	MCL s st	5-10	34-47	MCL	*	47-80i	vs SCL	**	0	II		
29	0-39	MZCL s st	<5	39-68	SCL	***	68-100i	SCL	***	0	II		
30	0-38	HCL	5	38-70	MCL	0	70-85i	vs MCL	*	0	I		
31	0-35	C vs st	<5	35-50	C	***	50-100i	C	****	0	III		
32	0-38	HCL	5	38-57	C	**	57-80i	vs C	**	0	III		
33	0-37	SCL vs st	5	37-57	SCL	*	57-100i	SCL	*	0	I		
34	0-34	MCL vs st	5	34-59	MCL	*	59-100i	SCL	**	0	I		
35	0-30	C vs st	<5	30-100i	C	****				0	III		

Obs	Topsoil			Upper subsoil			Lower subsoil			Slope	Wetness	Agricultural quality	
No	Depth (cm)	Texture	Stones (%)	Depth (cm)	Texture	Mottling etc	Depth (cm)	Texture	Mottling	(°)	Class	Grade	Main limitation
36	0-32	MCL	5	32-50	MCL	**	50-66 66-85+	MCL Chalky drift	**	0	I		
37	0-32	C	5-10	32-61	C	**	61-100+	C	****	0	III		
38	0-38	MCL	<5	38-55	MCL	*	55-100+	MSL	**	0	I		
39				0-35	MCL	**	35-50+	MSL	**	0			
40	0-37	HCL	5	37-64	MCL	*	64-100+	MSZL	*	0	I		
41	0-37	MCL	5	37-60	MCL	*	60-100+	MCL	***	0	I		
42				0-35	MCL	***	35-50+	MSL	**	0			
43	0-37	SCL	20	37-57	SCL	*	57-100+	LCS	**	0	I		
44	0-36	MCL	5	36-66	MCL	*	66-100+	MCL	**	0	I		
45	0-37	MCL	5	37-72	MCL	0	72-100+	MCL	*	0	I		
46	0-36	SCL	5	36-60	SCL	0	60-80+	Chalky drift		0	I		
47	0-35	SCL	10	35-50	MSZL	*	50+	Too stony		0			
48	0-36	MCL	10	36-70+	MCL	0				0	I		
49	0-37	C	<5	37-61	C	***	61-80+	C	****	0	III		
50	0-36	SCL	10	36-61	SCL	0	61-80+	vs MSL	**	0	I		
51	0-35	MCL	5	35-64	MCL	*	64-70+	vs MCL	**	0	I		
52				0-12	MCL	**	12-50+	C	****	0			
53	0-35	HZCL	<5	35-85+	ZC	****				0	III		
54	0-30	SCL	5	30-60	MSZL	0	60-75+	vs MSL	*	0	I		
55				0-20	vs MCL	***	20+	Too stony		0			
56	0-34	HZCL	<5	34-57	ZC	***	57-80+	ZC	****	0	III		
57	0-35	HZCL mn	<5	35-60	ZC	***	60-100+	ZC	****	0	III		
58	0-36	HZCL slca	<5	36-50	ZC	***	50-82+	ZC	****	0	III		

Key to table

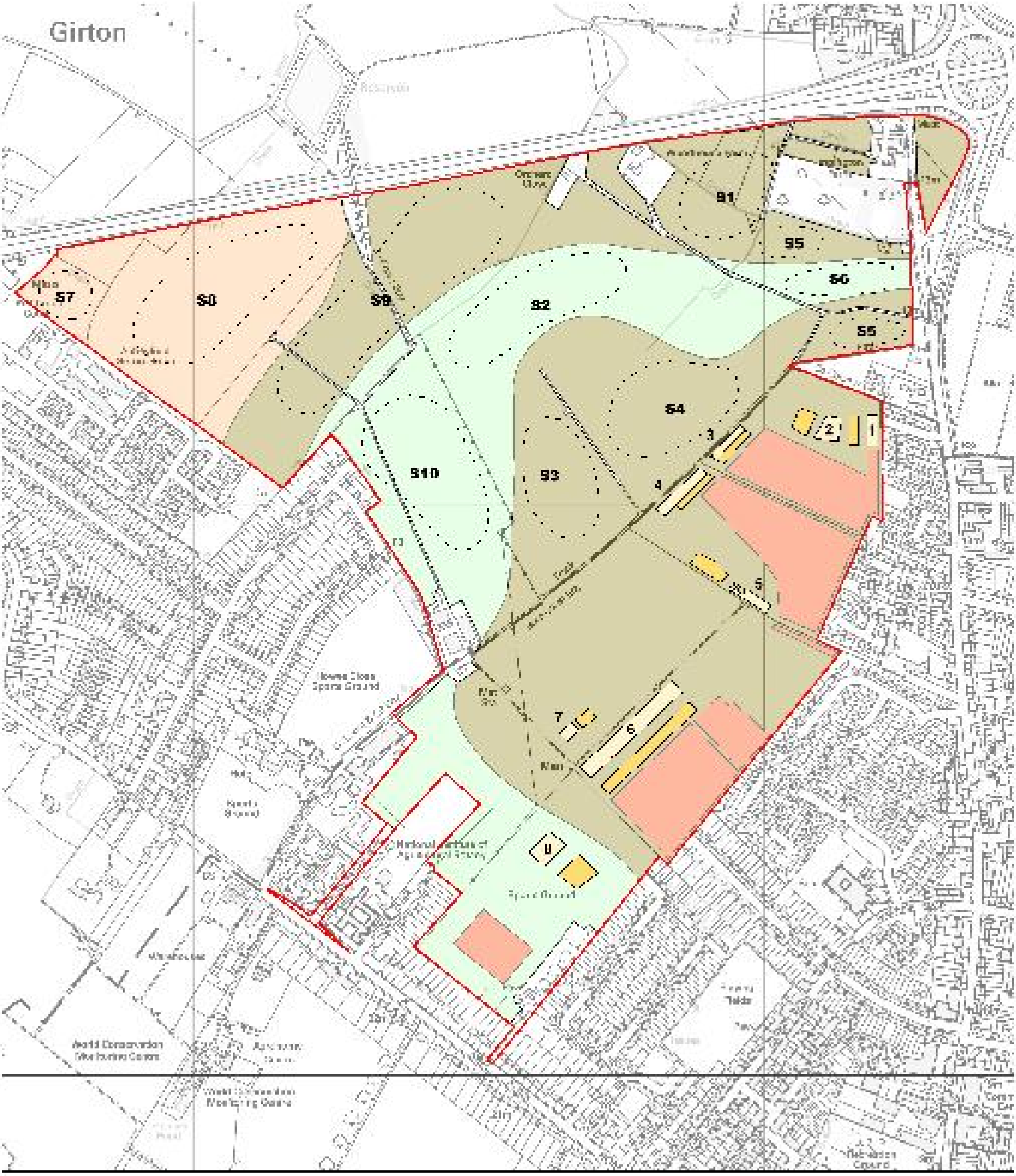
Mottling etc:
- 0 unmottled
- * few to common rusty root mottles (topsoils) or a few ochreous mottles (subsoils)
- ** common to many ochreous mottles and/or dull structure faces
- *** common to many greyish or pale mottles (gleyed horizon)
- **** dominantly grey, often with some ochreous mottles (gleyed horizon)

a depth underlined (e.g. 50) indicates the top of a slowly permeable layer
(underlined underline indicates the top of a layer borderline to slowly permeable)

Texture:
C - clay
ZC - silty clay
SC - sandy clay
CL - clay loam (H-heavy, M-medium)
ZCL - silty clay loam (H-heavy, M-medium)
SCL - sandy clay loam
SZL - sandy silt loam (F-fine, M-medium, C-coarse)
SL - sandy loam (F-fine, M-medium, C-coarse)
LS - loamy sand (F-fine, M-medium, C-coarse)
S - sand (F-fine, M-medium, C-coarse)
P - peat (H-humified, SF-semi-fibrous, F-fibrous)
LP - loamy peat; PL - peaty loam
R – consolidated bedrock

Limitations:
W – wetness/workability
D - droughtiness
De - depth
St – stoniness
Sl – slope
F – flooding
T – topography/microrelief

Texture suffixes & prefixes:
ca – calcareous (x-extremely, v-very, sl-slightly)
(ca) – marginally calcareous
mn - ferri-manganiferous concentrations
gn – greenish; yb – yellowish brown; rb – reddish brown
r – reddish; (v)st – (very) stony; sdst - sandstone
dist - disturbed soil layer; mdst – mudstone



RSK

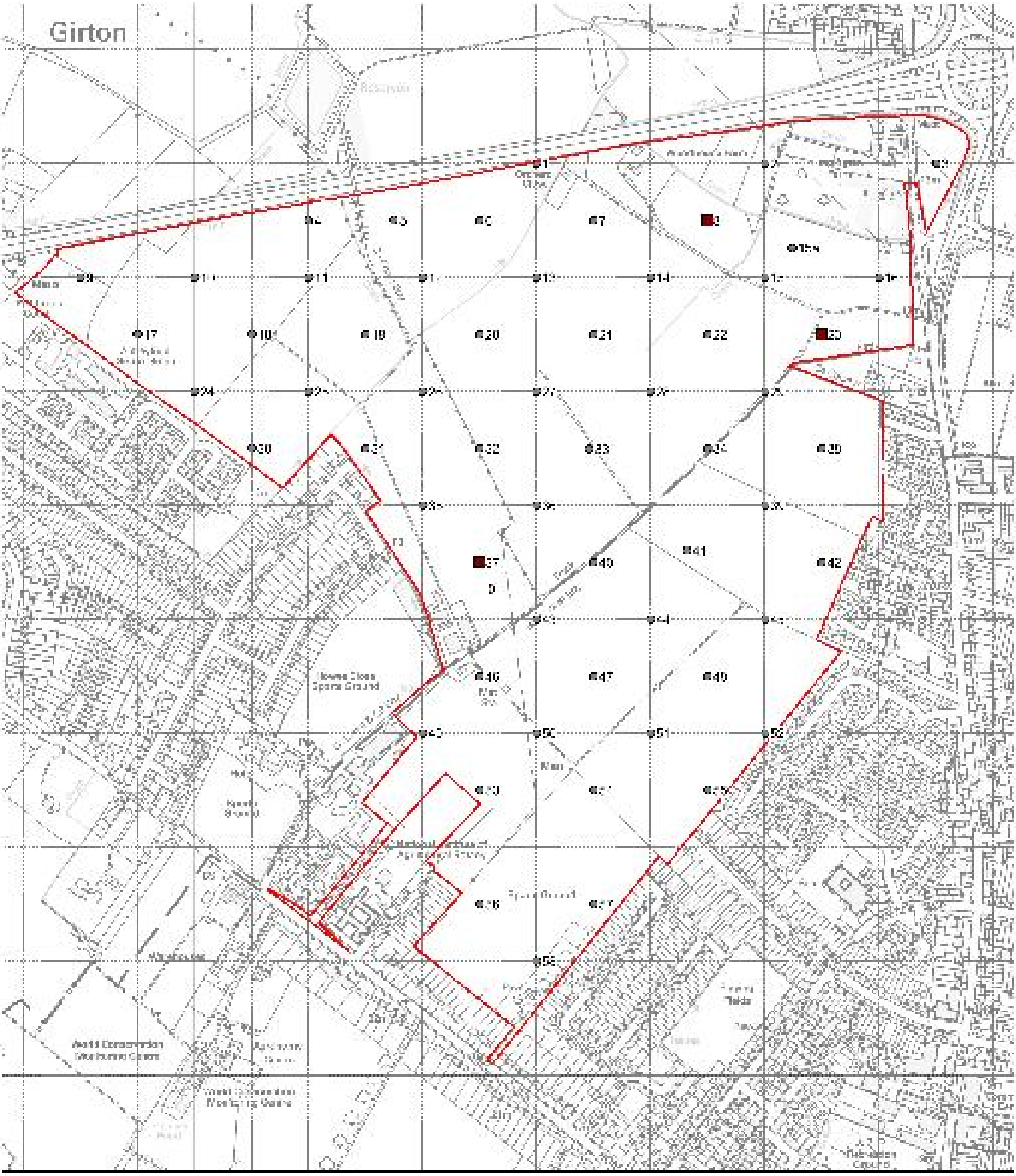
Darwin Green 2

Map 1
Generalised soil types and topsoil sample areas

KEY

- Heavy soils with strongly calcareous topsoil
- Heavy soils with slightly calcareous topsoil
- Loamy soils
- Exposed subsoil (archaeological excavation areas)
- Survey area
- Topsoil stockpiles
- Subsoil stockpiles
- S1 Sample area

Land Research Associates



Darwin Green 2

Map 2
Location of observations

KEY

Observation point

Soil description point

Survey area

ANALYTICAL REPORT

Report Number	**14855-13**	**H579**	**MR MALCOLM REEVE**
Date Received	**15-OCT-2013**		**LAND RESEARCH ASSOCIATES**
Date Reported	**18-OCT-2013**		**LOCKINGTON HALL**
Project	**SOILS**		**LOCKINGTON**
Reference	**DARWIN GREEN**		**DERBY**
Order Number			**DE74 2RH**

Client DARWIN GREEN

Laboratory Reference		**SOIL242786**	**SOIL242787**	**SOIL242788**	**SOIL242789**	**SOIL242790**	**SOIL242791**	**SOIL242792**	**SOIL242793**	**SOIL242794**	**SOIL242795**
Sample Reference		**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
Determinand	**Unit**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**	**SOIL**
pH		6.8	7.3	7.2	7.3	7.9	7.9	8.1	7.9	7.0	7.1
Available Phosphorus (Index)	mg/l	12 (1)	23 (2)	71 (5)	29 (3)	13 (1)	11 (1)	12 (1)	24 (2)	39 (3)	14 (1)
Available Potassium (Index)	mg/l	80 (1)	119 (1)	297 (3)	153 (2-)	72 (1)	63 (1)	374 (3)	332 (3)	165 (2-)	164 (2-)
Available Magnesium (Index)	mg/l	96 (2)	94 (2)	89 (2)	87 (2)	40 (1)	48 (1)	118 (3)	133 (3)	91 (2)	134 (3)
Total Nitrogen	% w/w	0.34	0.20	0.16	0.15	0.17	0.18	0.22	0.21	0.15	0.15
Organic Matter LOI	% w/w	7.4	4.6	4.0	3.8	4.1	4.2	5.7	5.6	3.8	4.1
Neutralising Value as CaCO3 eq.	% w/w	2.8	2.5	2.0	2.3	3.1	2.2	4.6	5.0	2.0	2.4
Neutralising Value as CaO eq.	% w/w	1.6	1.4	1.1	1.3	1.8	1.2	2.5	2.8	1.1	1.4

Notes

Analysis Notes
The sample submitted was of adequate size to complete all analysis requested.
The results as reported relate only to the item(s) submitted for testing.
The results are presented on a dry matter basis unless otherwise stipulated.

Document Control
This test report shall not be reproduced, except in full, without the written approval of the laboratory.

Reported by
O Davis

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Our ref: 25459-R03 (00)

11th October 2013

BDW Trading Limited
Barratt House
7 Springfield Lyons Approach
Chelmsford
Essex
CM2 5E7

For the attention of: Danny Clark

Dear Danny

RE: Summary geo-environmental report for NIAB1 Fields, Phase 1 Development

Planning reference 07/0003/OUT & S/07/0001/F

Further to recent correspondence with Cambridge City Council we are pleased to provide the results of our recent targeted phase of supplementary ground investigation at the above site within this summary letter report.

1. LIMITATIONS

The comments given in this report, and the opinions expressed, are based on the ground conditions encountered during the site work and on the results of tests made in the field. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, groundwater levels may vary from those reported due to seasonal, or other effects.

This report is subject to the RSK's service constraints attached to this letter.

The following iterative phases of ground investigation have been conducted at the site to support the planning applications 07/0003/OUT and S/07/0001/F:

- Phase 1 Environmental Risk Assessment Report reference 5593/04/CM/03-06/1213, Millard Consulting Engineers, March 2006;
- Phase 2 Environmental and Geotechnical Site Investigation Report reference 5593/14/RT/09-06/1371, Millard Consulting Engineers, September 2006;
- Main Site Investigation Report reference 25459-01(00), RSK Environment Limited, dated 25th October 2012; and
- Supplementary Investigation Report reference 25459-02R(00), RSK Environment Limited, dated 1st May 2013.

It is noted that the planning applications span the boundary between the districts administered by South Cambridgeshire District Council (SCDC) and Cambridge City Council (CCC), both authorities have therefore been consulted during the course of the project.

1.1 Phase 1 Environmental Risk Assessment Report, Millard Consulting Engineers, March 2006

The preliminary risk assessment contained within the Phase 1 Environmental Risk Assessment Report prepared by Millard Consulting Engineers identified the following risks associated with the site:

- Residential end-users – a moderate risk was identified from potentially contaminated soils (principally associated with the former above ground bulk storage of diesel and the storage and use of agrochemicals) and a low to moderate risk associated with asbestos containing materials from the former buildings;
- Construction workers – a moderate risk was identified from potentially contaminated soils and asbestos containing materials, and a low to moderate risk associated with the former above ground storage of hydrocarbons and an electricity sub-station; and
- A low risk was identified to flora and fauna, groundwater, surface water, building structures and services.

Due to the potentially complete pollutant linkages detailed above, the report recommended the completion of a preliminary Phase 2 land quality assessment to refine the initial conceptual site model.

1.2 Phase 2 Environmental and Geotechnical Site Investigation Report, Millard Consulting Engineers, September 2006

The investigation comprised the excavation of sixteen exploratory holes within the current study area. The scope of works included a programme of laboratory analyses on a limited number of soil and groundwater samples.

The investigation confirmed the ground model beneath the site to comprise a variable thickness of topsoil and/or made ground, locally overlying River Terrace Deposits. These superficial deposits were underlain by the Gault Clay Formation. A shallow groundwater table was recorded within the River Terrace Deposits (where present).

The laboratory analyses identified no significant contamination issues across the site, however, points sources of heavy metals (arsenic and cadmium) and petroleum hydrocarbons were recorded within the shallow made ground soils, the concentrations recorded exceeded the (now superseded) generic assessment criteria values adopted for the protection of human health assuming a residential land-use.

Analyses of groundwater demonstrated that the shallow groundwater within the River Terrace Deposits (which is designated as a Secondary A Aquifer) was not impacted with contamination. In addition, a single sample of groundwater recovered from an abstraction well on the NIAB premises indicated *"no measurable impact on the underlying Greensand Aquifer"*.

Notwithstanding the above, further investigation was recommended to investigate the extent of the point source of petroleum hydrocarbon contamination recorded within the soil. Additional sampling was also recommended to quantify the potential for pesticide/herbicide residues to be present within the shallow soils of previously inaccessible agricultural areas of the site.

1.3 Main Site Investigation Report, RSK Environment Limited, October 2012

The investigation used information contained within the previous phases of work to compile an initial conceptual site model (CSM). The CSM identified the following potential pollutant linkages with a risk of moderate or above:

- Risk posed to human health from contaminants contained within the shallow made ground, including herbicides and pesticides and locally hydrocarbons via direct contact, ingestion and root uptake pathways;
- Risk posed to vegetation by contaminants contained within the shallow made ground via root uptake;
- Risk posed to building materials and infrastructure, principally potable water supplies from contaminants contained within the made ground via chemical attack;
- Risk posed to human health from ground gases generated by the degradation of organic material within the made ground soils via inhalation; and
- Risk posed to the shallow aquifer from the vertical migration of herbicides and pesticides.

Intrusive investigation comprising the excavation of 86 exploratory hole locations was conducted to investigate the potential pollutant linkages identified by the CSM. The intrusive works included the installation of seven shallow ground gas and groundwater monitoring wells. Soil samples were recovered and laboratory analyses conducted to characterise the topsoil, made ground and natural strata at shallow depths (typically within the top 1m). The laboratory analyses comprised a site specific suite of contaminants, including: heavy metals, asbestos, pesticides, herbicides, polycyclic aromatic hydrocarbons and petroleum hydrocarbons.

The fieldwork typically confirmed the ground model encountered during the previous phase of investigation, comprising a variable thickness of topsoil and/or made ground overlying the River Terrace Deposits in the north/north eastern portion of the site. These superficial deposits were underlain by the Gault Clay Formation.

An initial quantitative risk assessment compared the soil results against relevant generic assessment criteria values for the protection of human health (residential), plant growth and/ or building materials. In the absence of any soil leachate results or groundwater results, the risk to controlled water was qualitatively assessed based on the total soil concentrations.

The quantitative risk assessment identified no concentrations of any determinants to be in excess of the adopted values for the protection of human health, plant growth and building materials. In addition, the qualitative assessment identified no risk to controlled waters.

The results of the ground gas monitoring recorded a negligible ground gas regime beneath the site for which no gas protection measures were considered necessary.

The report concluded that the generic assessment confirmed the absence of any relevant pollutant linkages.

Notwithstanding the above, recommendation was made for additional sampling to establish the potential risk associated with the point source of residual hydrocarbon contamination identified during the previous phase of investigation.

1.4 Regulatory Liaison, December 2012

The RSK report was submitted to SCDC and CCC for review. A joint response was received in memorandum reference wk/201258067, dated 12th December 2012. The response concluded with the following recommendations for further assessment:

- Further chemical testing for pesticides and herbicides is required across the site;
- Delineation of the contamination identified around WS6 and WS8 is required;
- A minimum of three further ground gas monitoring visits are required to adequately characterise the gassing regime on the site;

1.5 Supplementary Investigation Report, RSK Environment Limited, May 2013

Based on the comments received in May 2013, a scope of supplementary, targeted investigation and chemical analyses was subsequently proposed by RSK in January 2013, which comprised the following:

- Three additional rounds of ground gas monitoring;
- Additional investigation targeted to the location of an above ground fuel storage tank, formerly located adjacent to the farm yard, comprising the excavation of two shallow trial pits (HP1 and HP2) and testing a minimum of two soil samples for a suite of analyses including polycyclic aromatic hydrocarbons (PAH) (EPA16) and petroleum hydrocarbons (TPH-CWG);
- Additional investigation targeted to the location of a former waste storage area, comprising the excavation of five shallow trial pits (HP3 to HP7) and testing a minimum of five soil samples for a suite of analyses including PAH (EPA16), nine commonly occurring metals, a screen for asbestos containing materials (ACMs), Triazine herbicides, Phenoxy acid herbicides and petroleum hydrocarbons (TPH-total);
- Additional investigation targeted to the location of a former storage shed, comprising the excavation of three shallow trial pits (HP8 to HP10) and testing a minimum of three soil samples for a suite of analyses including PAH (EPA16), nine commonly occurring metals, a screen for asbestos containing materials (ACMs), Triazine herbicides, Phenoxy acid herbicides and petroleum hydrocarbons (TPH-total); and
- Additional investigation targeted to the location of an above ground fuel storage tank, formerly located adjacent to the sports pavilion, comprising the excavation of two shallow trial pits (HP12 and HP13) and testing a minimum of two soil samples for a suite of analyses including polycyclic aromatic hydrocarbons (PAH) (EPA16) and petroleum hydrocarbons (TPH-CWG).

The chemical test results were directly compared against the RSK Generic Assessment Criteria (GAC) values derived using CLEA version 1.06 for the protection of human health in residential sites with pathways for plant uptake.

No elevated concentrations of any determinants were identified during the comparison. Whilst no GACs were derived for the assessment of herbicides, pesticides or ACM's, no concentrations of any of these contaminants were recorded above the relevant laboratory limits of detection.

The results of the supplementary ground gas monitoring events were combined with the previous three rounds of monitoring. The Gas Screening Values calculated from the full programme of gas monitoring events confirmed a negligible gas regime for which gas protection measures are not considered necessary.

1.6 Regulatory Liaison – July 2013

The supplementary RSK report was submitted to SCDC and CCC for review. A joint response was received in memorandum reference wk/201353398, dated 29th July 2012. The response concluded that the following issues remained outstanding:

- Further investigation for TPH and pesticides is still required on site; and
- A revised report and a remediation method statement should be submitted following the completion of the additional investigation.

1.7 Supplementary Investigation, RSK Environment Limited, October 2013

Based on the comments received in July 2013, a scope of supplementary, targeted investigation and chemical analyses was subsequently agreed between RSK and CCC. The supplementary investigation is summarised in the following sections.

Two trial pits, designated HP14 to HP15, were excavated by hand within the area of the former farmer's offices and three drive-in sampler boreholes, designated WS101 and WS103, within the immediate vicinity of the former above ground fuel storage tank on 15th August 2013. The investigation and the soil descriptions were carried out in general accordance with 'BS 5930:1999. Code of Practice for Site Investigations' (BSI, 1999) and 'BS10175:2011 Investigation of Potentially Contaminated Sites – Code of Practice' (BSI, 2011). Copies of the exploratory hole records are appended to this letter for reference.

The investigation points were located by rigorous surveying techniques as shown in Figure 1, which provides a composite exploratory hole location plan, detailing all phases of investigation conducted by RSK.

The soils samples were collected in containers appropriate to the anticipated testing suite required. The containers were filled to capacity and placed in a cool box to minimise volatilisation. Samples were transported directly to RSK's testing laboratory (Envirolab) under chain of custody documentation. The samples taken from below the former farmer's offices and above ground fuel storage tank were tested for a suite of organochlorine pesticides and petroleum hydrocarbons, respectively. Copies of the chemical test results are appended to this letter for reference.

2. GROUND CONDITIONS

The supplementary, targeted investigation confirmed the shallow ground conditions at the specified locations to comprise a generally uniform veneer of made ground overlying the Gault Formation. The made ground soils typically comprised a silty sandy locally gravelly clay with rare pockets of ash and brick. No obvious signs of any significant contamination were observed during the course of the investigation. No groundwater was encountered during the course of the shallow investigation.

3. CHEMICAL TEST RESULTS AND ASSESSMENT

The chemical test results were directly compared against the RSK Generic Assessment Criteria (GAC) values derived using CLEA version 1.06 for the protection of human health in residential sites with pathways for plant uptake. The GAC values and details of their derivation are appended to this letter for reference. It is noted that due to the use of the organochloine pesticide DDT having been banned in the UK in 1984, no guideline values have recently been derived for the protection of human health. In the absence of any current available guidance from the UK or USA, reference is made to the New Dutch Intervention values and Target Values and New Zealand Soil Guideline Values of 4mg/kg (Action level) and 28mg/kg (Residential), respectively. These values are quoted in respect to the sum of all the DDT metabolites (DDE and DDD).

No elevated concentrations of any determinants were identified during the comparison.

4. CONCLUSIONS

The results of the agreed scope of supplementary targeted investigation have not identified any significant ground contamination at the targeted locations. The supplementary investigation has therefore provided a greater level of confidence that the soils across the site are suitable for use within all areas of the proposed mixed-use development.

Notwithstanding the above, a single significant concentration of petroleum hydrocarbons was recorded during the ground investigation conducted by Millard Consulting Engineers in 2006, the presence of which should not be overlooked. The further testing has demonstrated that any residual contamination associated with that previously detected must be very localised and unlikely to pose a significant contamination issue to the proposed development. However, it is obviously essential that the ground conditions with all areas of the site are suitable for their proposed use, it is therefore recommended that a watching brief be kept during the removal of the hardstanding and buildings within the immediate vicinity of the location of the former borehole designated WS8. Should any visual or olfactory evidence of any residual contamination be identified during these works, then the impacted soils should be tested to confirm suitability for use/re-use and/or disposal (as appropriate). It is noted that the point source of contamination was not recorded within any topsoil and should not therefore impact the suitability of the topsoil encountered across the site for future re-use within the development.

No further investigation or remediation is therefore recommended prior to redevelopment.

We trust the information supplied is sufficient to negate the requirement for any contaminated land conditions pertaining to the investigation of the site, should however, you have any queries or require any further information please do not hesitate to give me a call.

Yours sincerely

For RSK Environment Ltd

Duncan Sharp
Associate Director
RSK Environment - Geosciences

Encl.

Service constraints

Figure 1 Exploratory hole location plan

Exploratory hole records

Chemical test results

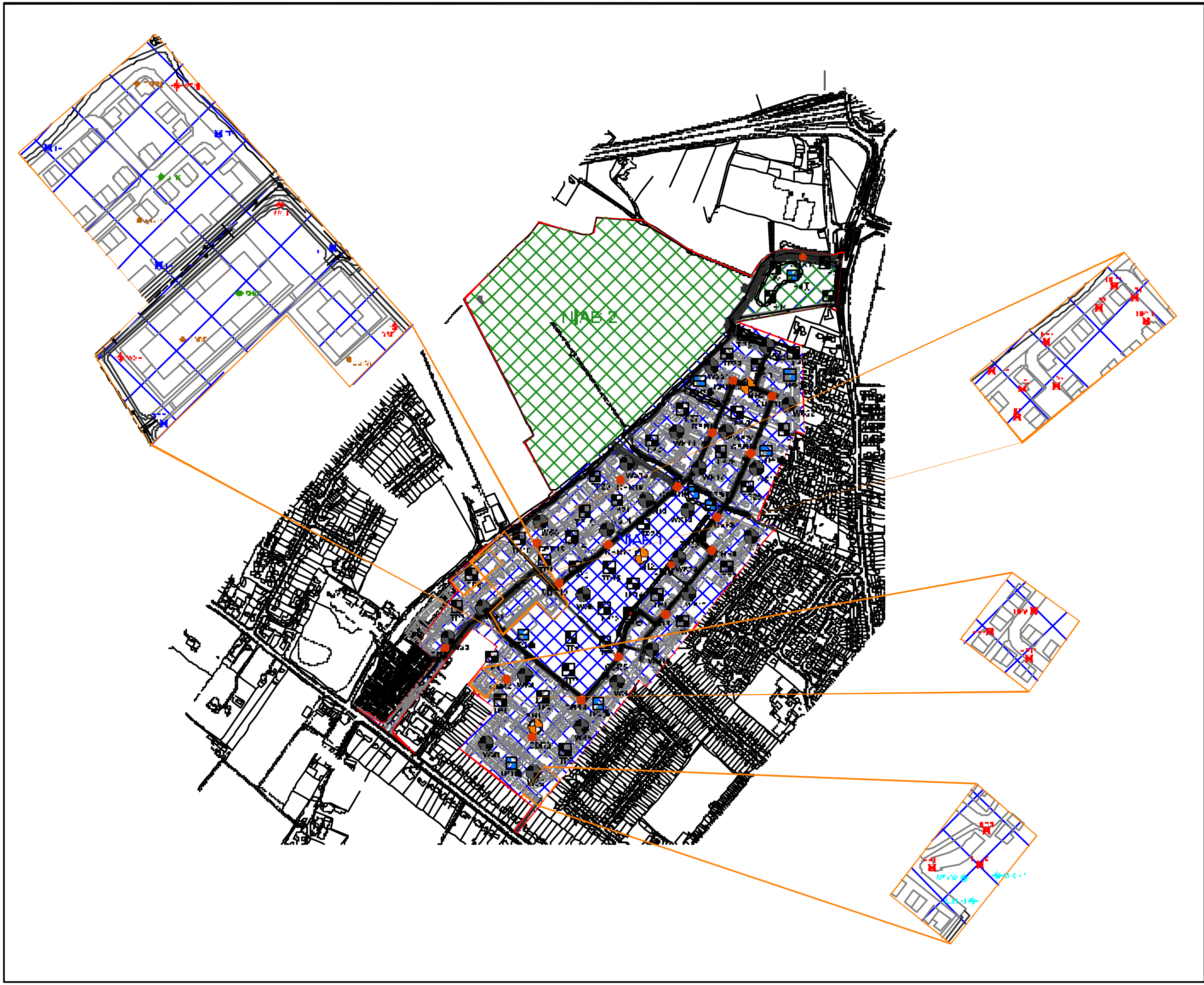
RSK GAC values for residential sites with pathways for plant uptake

Cc. Guy Kaddish - SCDC

RSK SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK for Sainsbury's Supermarket Limited (the "client") in accordance with the terms of a contract between RSK and the "client". The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.
2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date hereof, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK.. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.
8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.
9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site

FIGURES



Legend

RSK

BDW TRADING LIMITED

NIAB PHASE 1
HUNTINGDON ROAD
CAMBRIDGE

EXPLORATORY HOLE
LOCATION PLAN

EXPLORATORY HOLE LOGS

INSPECTION PIT LOG

Contract: NIAB - Phase 1	Client: BDW Trading Limited	Trial Pit: HP14

Contract Ref: 25459	Date: 15.08.13	Ground Level (m AOD): ---	National Grid Co-ordinate: ---	Sheet: 1 of 1

Samples and In-situ Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
						MADE GROUND: Firm brown slightly grey gravelly sandy CLAY with frequent fine to coarse angular to subrounded flint gravels and with occasional rootlets (1-3mm diameter) and rare ash and brick.	(0.30) 0.30	
0.50	1	DS				MADE GROUND: Firm yellowish brown slightly grey slightly sandy CLAY with occasional fine to coarse angular to subrounded flint gravels and with occasional to rare ash pockets and brick fragments.	(0.35) 0.65	
						Soft to firm brown and grey sandy CLAY with occasional fine to medium angular to subrounded flints (GAULT FORMATION).	0.70	
						Trial pit terminated at 0.70m		

Plan (Not to Scale)

??? × ???

General Remarks

1. Weather conditions: warm, overcast with occasional light showers
2. Trial pit remained dry and stable
3. Trial pit terminated at 0.70m
4. Trial pit backfilled with arisings and compacted

All dimensions in metres | Scale: 1:13

Method Used: Hand dug	Plant Used: Hand tools	Logged By: CJBall	Checked By:

INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	BDW Trading Limited	HP15

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinates:	Sheet:
25459	15.08.13	---	---	1 of 1

Samples and In-situ Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
						MADE GROUND: Firm brown slightly gravelly sandy CLAY with frequent fine to coarse angular to subrounded flint gravels and with frequent rootlets (1-3mm diameter) and rare ash and brick.	(0.25) 0.25	
0.50	1	ES				MADE GROUND: Firm yellowish brown slightly gravelly sandy CLAY with occasional fine to coarse angular to subrounded flint gravels and with occasional to rare ash pockets and brick fragments.	(0.35) 0.60	
						Soft to firm brown and grey sandy CLAY with rare fine to medium angular flints (GAULT FORMATION).	0.85	
						Trial pit terminated at 0.85m		

Plan (Not to Scale)

???

???

General Remarks

1. Weather conditions: warm, overcast with occasional light showers
2. Trial pit remained dry and stable
3. Trial pit terminated at 0.85m
4. Trial pit backfilled with arisings and compacted

All dimensions in metres | Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	CJ Ball	

AGS

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
NIAB - Phase 1	BDW Trading Limited	WS101

Contract Ref:	Start: 15.08.13 / End: 15.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	Start: 15.08.13 End: 15.08.13	---	---	1 of 1

Progress: Window Run	Samples / Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
							MADE GROUND: Brown slightly gravelly clayey SAND with occasional fine to medium angular to subrounded flints and with occasional brick fragments and with frequent grass stubble roots and rootlets (1-5mm diameter).	(0.30) 0.30	
	0.50	1	DS				MADE GROUND: Firm yellow brown slightly gravelly sandy CLAY with occasional fine to medium angular to subrounded flints and with occasional brick fragments.	(0.30) 0.60	
	1.00	2	DS				Firm brown and grey slightly sandy CLAY with frequent pockets of yellow sand. (GAULT FORMATION).	(0.90) 1.50	
	1.50	3	DS				Stiff brown and grey slightly sandy CLAY with occasional to rare pockets of yellow sand. (GAULT FORMATION).	(1.50) 3.00	
	2.00	4	DS						
	2.50	5	DS						
	3.00	6	DS				Borehole terminated at 3.0m		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. Weather conditions: warm, overcast with occasional light showers
2. Borehole remained dry and stable
3. Borehole terminated at 3.0m

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	Archway Competitor	MOS	CJBall	

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
NIAB - Phase 1	BDW Trading Limited	WS102

Contract Ref:	Start / End	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	Start: 15.08.13 End: 15.08.13	---	---	1 of 1

Progress: Window Run	Samples / Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
							MADE GROUND: Black slightly gravelly clayey SAND with frequent fine to medium angular to rounded flints and with frequent brick and ash fragments and with frequent rootlets (1-5mm diameter).	(0.30) 0.30	
	0.50	1	DS				MADE GROUND: Soft to firm yellowish brown sandy CLAY with occasional fine to medium angular to subrounded flints and with rare brick fragments.	(0.30) 0.60	
	1.00	2	DS				Firm brown and grey slightly gravelly sandy CLAY with rare fine to medium angular flints and occasional shell fragments. (GAULT FORMATION).		
	1.50	3	DS					(2.40)	
	2.00	4	DS						
	2.50	5	DS						
	3.00	6	DS					3.00	
							Borehole terminated at 3.0m		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. Weather conditions: warm, overcast with occasional light showers
2. Borehole remained dry and stable
3. Borehole terminated at 3.0m

All dimensions in metres — Scale: 1:25

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	Archway Competitor	MOS	CJBall	

AGS

WINDOW SAMPLE LOG

Contract: NIAB - Phase 1	Client: BDW Trading Limited	Window Sample: WS103

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	Start: 15.08.13 End: 15.08.13	---	---	1 of 1

Progress: Window Run	Samples / Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)
							MADE GROUND: Black slightly gravelly clayey SAND with occasional brick fragments.	0.15
							MADE GROUND: Soft to firm brown and red sandy CLAY with subangular to subrounded flints and with frequent brick fragments.	(0.45)
	0.50	1	ES					0.60
							Firm brown and grey slightly gravelly sandy CLAY with frequent fine to coarse angular to rounded flints and occasional pockets of yellow sand. (GAULT FORMATION).	0.80
	1.00	2	ES				Firm brown and grey slightly sandy CLAY with frequent pockets and lenses of fine yellow sand and occasional shell fragments. (GAULT FORMATION).	
	1.50	3	ES					
								(2.20)
	2.00	4	ES					
	2.50	5	ES					
								3.00
	3.00	6	ES				Borehole terminated at 3.0m	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. Weather conditions: warm, overcast with occasional light showers
2. Borehole remained dry and stable
3. Borehole terminated at 3.0m

All dimensions in metres | Scale: 1:25

Method Used: Tracked window sampling	Plant Used: Archway Competitor	Drilled By: MOS	Logged By: CJBall	Checked By:

APPENDIX - Results of Gas Monitoring (date 30/04/2013)

Atmospheric Pressure (mb): 1022

AP Conditions (BBC Website): Rising

Equipment Used: GA 2000 +3

Temperature: 15C

Weather Conditions: Sunny spells, dry

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH1	1.70	4.27		0	0.0	0.0	0.1	20.8	0	0	0			
				15	0.0	0.0	0.5	20.4	0	0	0			
				30	0.0	0.0	0.5	20.3	0	0	0			
				60	0.0	0.0	0.5	20.2	0	0	0			
				90	0.0	0.0	0.5	20.1	0	0	0			
				120	0.0	0.0	0.5	20.1	0	0	0			
				180	0.0	0.0	0.5	20.1	0	0	0			
				240	0.0	0.0	0.5	20.1	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH2	1.86	4.34		0	-0.1	0.0	0.0	20.4	0	0	0			
				15	-0.1	0.0	0.5	19.9	0	0	0			
				30	-0.1	0.0	0.5	19.9	0	0	0			
				60	-0.1	0.0	0.5	19.9	0	0	0			
				90	-0.1	0.0	0.5	19.9	0	0	0			
				120	-0.1	0.0	0.5	20.0	0	0	0			
				180	-0.1	0.0	0.5	20.0	0	0	0			
				240	-0.1	0.0	0.5	20.0	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH3	1.78	3.22		0	0.0	0.0	0.0	20.8	0	0	0			
				15	-0.1	0.0	0.2	20.7	0	0	0			
				30	-0.2	0.0	0.2	20.7	0	0	0			
				60	-0.2	0.0	0.2	20.7	0	0	0			
				90	-0.2	0.0	0.2	20.8	0	0	0			
				120	-0.2	0.0	0.2	20.8	0	0	0			
				180	-0.2	0.0	0.2	20.8	0	0	0			
				240	-0.2	0.0	0.2	20.8	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BHG	1.14	4.30		0	0.0	0.0	0.5	20.7	0	0	0			
				15	0.0	0.0	1.4	19.4	0	0	0			
				30	0.0	0.0	1.4	19.4	0	0	0			
				60	0.0	0.0	1.4	19.4	0	0	0			
				90	0.0	0.0	1.4	19.4	0	0	0			
				120	0.0	0.0	1.4	19.4	0	0	0			
				180	0.0	0.0	1.4	19.4	0	0	0			
				240	0.0	0.0	1.4	19.4	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BHK	1.35	4.3		0	0.01	0.0	0.0	20.9	0	0	0			
				15	0.0	0.0	0.9	20.0	0	0	0			
				30	0.0	0.0	0.9	20.0	0	0	0			
				60	0.0	0.0	0.9	20.0	0	0	0			
				90	0.0	0.0	1.0	19.9	0	0	0			
				120	0.0	0.0	1.0	19.9	0	0	0			
				180	0.0	0.0	1.0	19.9	0	0	0			
				240	0.0	0.0	1.0	19.9	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WS3	1.55	3.20		0	0.0	0.0	0.4	20.9	0	0	0			
				15	0.0	0.0	1.4	19.8	0	0	0			
				30	0.0	0.0	1.4	19.8	0	0	0			
				60	0.0	0.0	1.4	19.9	0	0	0			
				90	0.0	0.0	1.3	20.0	0	0	0			
				120	0.0	0.0	1.3	20.1	0	0	0			
				180	0.0	0.0	1.2	20.2	0	0	0			
				240	0.0	0.0	1.1	20.3	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WS17														**Could not locate position**

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WSH	1.6	2.32		0	0.0	0.0	2.0	19.5	0	0	0			
				15	0.0	0.0	2.1	19.2	0	0	0			
				30	0.0	0.0	2.1	19.2	0	0	0			
				60	0.0	0.0	2.2	19.1	0	0	0			
				90	0.0	0.0	2.3	19.1	0	0	0			
				120	0.0	0.0	2.3	19.1	0	0	0			
				180	0.0	0.0	2.2	19.1	0	0	0			
				240	0.0	0.0	2.2	19.2	0	0	0			

CHEMICAL TEST RESULTS

Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number:	13/03938	
Issue Number:	1	**Date:** 03 September, 2013

Client: RSK Environment Ltd Hemel
18 Frogmore Road
Hemel Hempstead
Hertfordshire
UK
HP3 9RT

Project Manager:	Nigel Austin / Chris Ball
Project Name:	NIAB 1
Project Ref:	25459
Order No:	Not specified
Date Samples Received:	20/08/13
Date Instructions Received:	20/08/13
Date Analysis Completed:	02/09/13

Prepared by:	**Approved by:**
Melanie Marshall Laboratory Coordinator	Liz Oliver Client Service Manager

envirolab

Envirolab Job Number: 13/03938

Client Project Name: NIAB 1

Client Project Ref: 25459

Lab Sample ID	13/03938/1	13/03938/2	13/03938/3	13/03938/4	13/03938/5	13/03938/6	13/03938/7	13/03938/8	Units	Method ref
Client Sample No										
Client Sample ID	HP14	HP15	WS1	WS1	WS2	WS2	WS3	WS3		
Depth to Top	0.50	0.50	0.50	1.50	0.50	1.50	0.50	1.50		
Depth To Bottom										
Date Sampled	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code			6BE	3	3BE	3	5	3		
OCP										
Aldrin	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
alpha-Hexachlorocyclohexane (HCH)	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
beta-Hexachlorocyclohexane (HCH)	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Chlorothalonil	<1000	<1000	-	-	-	-	-	-	µg/kg	Subcon
cis-Chlordane	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Dieldrin	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Endosulphan Sulphate	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Endosulphan I	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Endosulphan II	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Endrin	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
gamma-Hexachlorocyclohexane (HCH / Lindane)	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Heptachlor	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Heptachlor Epoxide	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Hexachlorobenzene	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Isodrin	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
o,p-DDE	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
o,p-DDT	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
o,p-Methoxychlor	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
o,p-TDE (DDD)	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
p,p-DDT	70	<50	-	-	-	-	-	-	µg/kg	Subcon
p,p-Methoxychlor	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
p,p-DDE	213	72	-	-	-	-	-	-	µg/kg	Subcon
p,p-TDE (DDD)	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Pendimethalin	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Permethrin I	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Permethrin II	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Quintozene; (PCNB)	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Tecnazene	<50	<50	-	-	-	-	-	-	µg/kg	Subcon

Envirolab Job Number: 13/03938

Client Project Name: NIAB 1

Client Project Ref: 25459

Lab Sample ID	13/03938/1	13/03938/2	13/03938/3	13/03938/4	13/03938/5	13/03938/6	13/03938/7	13/03938/8		
Client Sample No										
Client Sample ID	HP14	HP15	WS1	WS1	WS2	WS2	WS3	WS3		
Depth to Top	0.50	0.50	0.50	1.50	0.50	1.50	0.50	1.50		
Depth To Bottom										
Date Sampled	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code			6BE	3	3BE	3	5	3	Units	Method ref
Telodrin	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
trans-Chlordane	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Triadimefon	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Triallate	<50	<50	-	-	-	-	-	-	µg/kg	Subcon
Trifluralin	<50	<50	-	-	-	-	-	-	µg/kg	Subcon

Envirolab Job Number: 13/03938 | Client Project Name: NIAB 1

Client Project Ref: 25459

Lab Sample ID	13/03938/1	13/03938/2	13/03938/3	13/03938/4	13/03938/5	13/03938/6	13/03938/7	13/03938/8	Units	Method ref
Client Sample No										
Client Sample ID	HP14	HP15	WS1	WS1	WS2	WS2	WS3	WS3		
Depth to Top	0.50	0.50	0.50	1.50	0.50	1.50	0.50	1.50		
Depth To Bottom										
Date Sampled	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13	15-Aug-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code			6BE	3	3BE	3	5	3		
TPH CWG										
% Stones >10mm$_A^\#$	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	% w/w	A-T-044
Ali >C5-C6$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
Ali >C6-C8$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
Ali >C8-C10$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
Ali >C10-C12$_A^\#$	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023 s
Ali >C12-C16$_A^\#$	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023 s
Ali >C16-C21$_A^\#$	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023 s
Ali >C21-C35$_A^\#$	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	0.6	mg/kg	A-T-023 s
Total Aliphatics$_A$	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	0.6	mg/kg	A-T-022 +23s
Aro >C5-C7$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
Aro >C7-C8$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
Aro >C8-C9$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
Aro >C9-C10$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
Aro >C10-C12$_A^\#$	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023 s
Aro >C12-C16$_A^\#$	-	-	2.3	<0.1	<0.1	<0.1	0.3	<0.1	mg/kg	A-T-023 s
Aro >C16-C21$_A^\#$	-	-	44.0	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023 s
Aro >C21-C35$_A^\#$	-	-	252	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023 s
Total Aromatics$_A$	-	-	298	<0.1	<0.1	<0.1	0.3	<0.1	mg/kg	A-T-022 +23s
TPH (Ali & Aro)$_A$	-	-	298	<0.1	<0.1	<0.1	0.3	0.6	mg/kg	A-T-022 +23s
BTEX - Benzene$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
BTEX - Toluene$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
BTEX - Ethyl Benzene$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
BTEX - m & p Xylene$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
BTEX - o Xylene$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
MTBE$_A^\#$	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022 s
Mineral Oil (>C10-C35)$_A$	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	0.6	mg/kg	A-T-023 s

REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General
Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts.
Superscript "M" indicates method accredited to MCERTS.
For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations. If results are in italic font they are associated with such quality control failures and may be unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our MCERTS accreditation.

Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
Superscript # indicates method accredited to ISO 17025.
Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

RSK GAC FOR RESIDENTIAL LAND USE WITH PATHWAYS FOR PLANT UPTAKE

Generic assessment criteria for human health: residential scenario – private gardens

The human health generic assessment criteria (GAC) have been developed during a period of regulatory review and updating of the Contaminated Land Exposure Assessment (CLEA) project. Therefore, the Environment Agency (EA) is in the process of publishing updated reports relating to the CLEA project and the GAC presented in this document may change to reflect these updates. This issue was prepared following the publication of soil guideline value (SGV) reports and associated publications[(1)] for mercury, selenium, benzene, toluene, ethylbenzene and xylene in March 2009, arsenic and nickel in May 2009, cadmium and phenol in June 2009, dioxins, furans and dioxin-like polychlorinated biphenyls (PCBs) in September 2009. It was also produced following publication of GAC by LQM[(6)]. Where available, the published soil guideline values (SGV)[(1)] were used as the GAC. The GAC for lead is discussed separately below owing to it not being derived using the same approach as other compounds.

Lead GAC derivation

The Environment Agency SGV and Tox reports for lead were withdrawn in 2009. In addition, the provisional tolerable weekly intake data published in the Netherlands were withdrawn in 2010 owing to concerns that they were not suitably protective of human health. The withdrawn SGVs were based on a target blood lead concentration of 10µg/dl. In the absence of current guidelines many consultants continue to use the withdrawn SGV. However, as this is not considered sufficiently protective of human health, after attendance at the SOBRA summer workshop June 2011, RSK has revised its GAC and is currently undertaking a review of recent toxicological developments that will be used to refine this GAC further in the coming months. In the meantime, RSK has undertaken sensitivity analysis using the Society of Environmental Geochemistry and Health (SEGH) equation and the CLEA model to produce an interim GAC value. The results are summarised below:

- Using CLEA with the former provisional tolerable weekly intake (PTWI) (25 µg/kg bw), assuming 100% lead is bioavailable, produces a GAC of 212 mg/kg
- Using CLEA with the former PTWI, assuming 50% lead is bioavailable, produces a GAC of 478 mg/kg
- Using the SEGH equation amended for a blood target concentration of 5.6 µg/dl (equal to the LOAEL for IQ defects) gives a negative GAC number unless other factors such as child background blood concentration or delta are amended. Without undertaking further research into these numbers, RSK can present sensitivity analysis to demonstrate the sensitivity of these input parameters but cannot justify one parameter over another. The results are:
    - GAC between 39mg/kg and 99mg/kg if the value of delta (the slope or response of blood Pb versus soil and dust Pb relationship) only is amended from 5 to 2µg/dl/1000µg/g. The value of 2 was chosen as it is within the reasonable range quoted in the former SGV report
    - GAC between 244mg/kg and 610mg/kg if the geometric mean of blood lead concentration in young children is reduced from 3.4µg/dl to 2µg/dl. This decrease has been simulated on the basis that blood concentrations are likely to decrease over time across the UK owing to a ban on lead in petrol, lead within paint used internally and water pipe replacement. This decrease is considered reasonable as the site is a new development

so lead-based paints will not be used internally and lead water supply pipelines will be absent.

Therefore, given the results above RSK proposes to use a GAC of **300mg/kg** for a residential end use. This value is broadly in the middle of the range of sensitivity modelling results quoted above when background mean blood lead concentrations in children are reduced to reflect a new development. The value is also broadly in the middle of the range of sensitivity modelling results for a range of bioavailability of lead between 50% and 100%. This number is considered reasonably protective of human health while being practical for use.

GAC derivation for other metals and organic compounds

Model selection

Soil assessment criteria (SAC) were calculated using CLEA v1.06 and the supporting UK guidance[1–6]. Groundwater assessment criteria (GrAC) protective of human health via the inhalation pathway were derived using the RBCA 1.3b model. RSK has updated the inputs within RBCA to reflect the UK guidance[1–5]. The SAC and GrAC collectively are termed GAC.

Conceptual model

In accordance with EA Science Report SC050221/SR3[3], the residential with private garden scenario considers risks to a female child between the ages of 0 and 6 years old. In accordance with Box 3.1, SR3[3], the pathways considered for production of the SAC in the residential with gardens scenario are:

- direct soil and dust ingestion;
- consumption of home-grown produce;
- consumption of soil attached to home-grown produce;
- dermal contact with soil and indoor dust, and
- inhalation of indoor and outdoor dust and vapours.

Figure 1 is a conceptual model illustrating these linkages.

The pathway considered in production of the GrAC is the volatilisation of compounds from groundwater and subsequent vapour inhalation by residents while indoors. Figure 2 illustrates this linkage. Although the outdoor air inhalation pathway is also valid, this contributes little to the overall risks owing to the dilution in outdoor air. Within RBCA, the solubility limit of the determinant restricts the extent of volatilisation, which in turn drives the indoor air inhalation pathway. While the same restriction is not built into the CLEA model, the CLEA model output cells are flagged red where the soil saturation limit has been exceeded.

An assumption used in the CLEA model is that of simple linear partitioning of a chemical in the soil between the sorbed, dissolved and vapour phase[4]. The upper boundaries of this partitioning are represented by the aqueous solubility and pure saturated vapour concentration of the chemical. The CLEA software uses a traffic light system to identify when individual and/or combined assessment criteria exceed the lower of either the aqueous-based or the vapour based saturation limits. Where model output cells are flagged red the soil or vapour saturation limit has been exceeded and further consideration of the SAC to be used within the assessment is required. One approach that could be adopted is to use the ‘modelled’ solubility saturation limit or vapour saturation limit of the compound as the SAC. However, as stated within the CLEA handbook[(4)] this is likely to not be practical in many cases because of the very low limits and, in any case, is highly conservative. Unless free-phase product is present, concentrations of the chemical are unlikely to be present at sufficient concentration to result in an exceedance of the health criteria value (HCV).

RSK has adopted an approach for petroleum hydrocarbons in accordance with LQM/CIEH[(6)] whereby the concentration modelled for each petroleum hydrocarbon fraction has been tabulated as the SAC with the corresponding solubility or vapour saturation limit given in brackets. Therefore, when using the SAC to screen laboratory analysis the assessor should take note if a given SAC has a corresponding solubility or vapour saturation limit (in brackets), and subsequently incorporate this piece of information within the screening analytical discussion. If further assessment is required following this process then an additional approach can be utilised as detailed within Section 4.12 of the CLEA model handbook[(4)], which explains how to calculate an effective assessment criterion manually.

Input selection

Chemical data was obtained from EA Report SC050021/SR7[(5)] and the health criteria values (HCV) from the UK TOX[(1)] reports where available. For SAC for total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH), toxicological and chemical specific parameters were obtained from the LQM/CIEH report[(6)]. Similarly, toxicological and specific chemical parameters for the volatile organic compound 1,2,4-trimethylbenzene were obtained from EIC/AGS/CL:AIRE[(7)].

For total petroleum hydrocarbons (TPH), aromatic hydrocarbons C_5-C_8 were not modelled since benzene and toluene are being modelled separately. The aromatic C_8-C_9 hydrocarbon fraction comprises ethylbenzene, xylene and styrene. Since ethylbenzene and xylene are being modelled separately, the physical, chemical and toxicological data for this band has been taken from styrene.

Owing to the lack of UK-specific data, default information in the RBCA model was used to evaluate methyl tertiary butyl ether (MTBE). No published UK data was available for 1,3,5-trimethylbenzene, so information was obtained from the US EPA as in the RBCA model. RBCA uses toxicity data for the inhalation pathway in different units to the CLEA model and cannot consider separately the mean daily intake (MDI), occupancy periods or breathing rates. Therefore, the HCV in RBCA was amended to take account of:

- amendments to the MDI using Table 3.4 of SR2[(2)]
- a child weighing 13.3kg (average of 0–6 year old female in accordance with Table 4.6 of SR3[(3)]) and breathing 11.85m^3 (average daily inhalation rate for a 0–6-year old female in accordance with Table 4.14 of SR3[(3)]

1. The 50% rule (for petroleum hydrocarbons, trimethylbenzenes and MTBE)[(2)] where MDI data is not available but background exposure is considered important in the overall exposure.

Physical parameters

For the residential with private gardens scenario, the CLEA default building is a small two-storey terrace house with concrete ground-bearing slab. The house is assumed to have a $100m^2$ private garden consisting of lawn, flowerbeds and incorporating a $20m^2$ plot for growing fruit and vegetables consumed by the residents. SR3[(3)] notes this residential building type to be the most conservative in terms of protection from vapour intrusion. The building parameters are outlined in Table 5.

The parameters for a sandy loam soil type were used in line with SR3[(3)]. This includes a value of 6% for the percentage of soil organic matter (SOM) within the soil. In RSK's experience, this is rather high for many sites. To avoid undertaking site-specific risk assessments for this parameter, RSK has produced an additional set of SAC for an SOM of 1% and 2.5%. For the GrAC, the depth to groundwater was taken as 2.5m based on RSK's experience of assessing the volatilisation pathway from groundwater.

GAC

The SAC were produced using the input parameters in Tables 1 to 5 and the GrAC using input parameters in Table 6. The final selected GAC are presented by pathway in Table 7 and the combined GAC in Table 8.

Figure 1: Conceptual model for CLEA residential scenario – private gardens

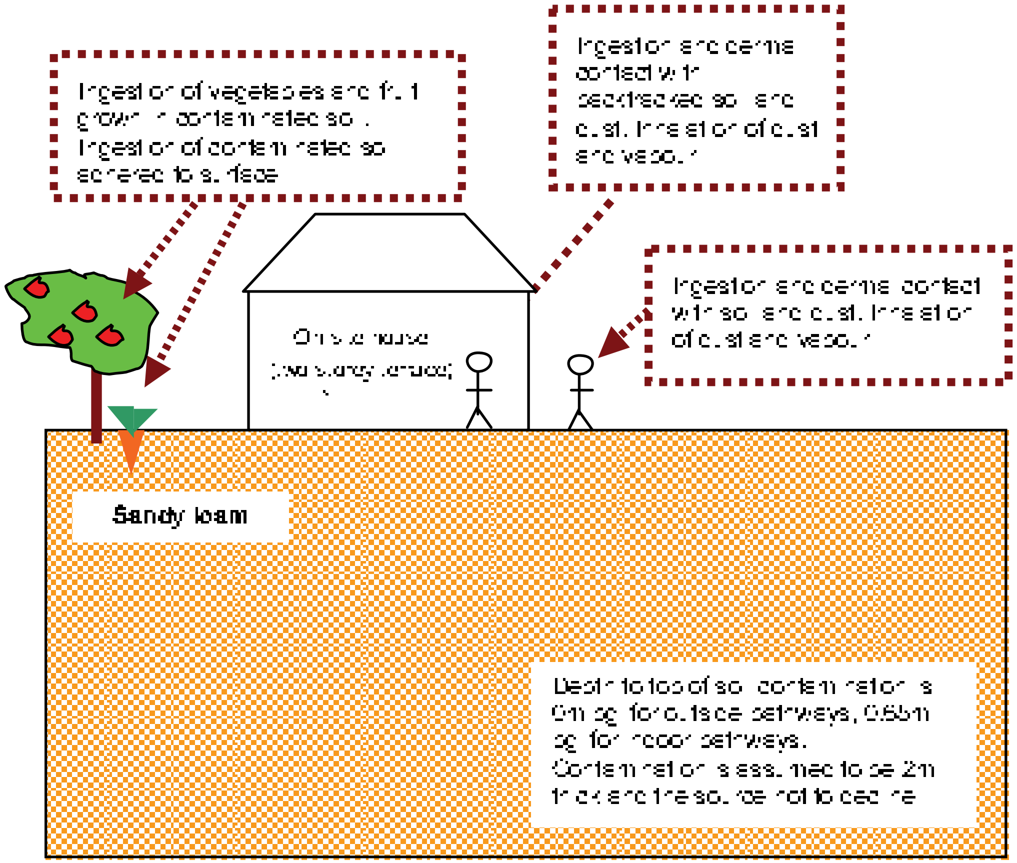


Table 1: Exposure assessment parameters for residential scenario - private gardens – inputs for CLEA model

Land use	Residential with homegrown produce	Chosen land use
Receptor	Female child age 1 to 6	Key generic assumption given in Box 3.1, report SC050021/SR3[1]
Building	Small terraced house	Key generic assumption given in Box 3.1, report SC050021/SR3. Two storey small terraced house chosen as it is the most conservative residential building type in terms of protection from vapour intrusion (Section 3.4.6, report SC050021/SR3)[1]
Soil type	Sandy Loam	Most common UK soil type (Section 4.3.1, From Table 3.1, report SC050021/SR3)[1]
Start AC (age class)	1	Range of age classes corresponding to key generic assumption that the critical receptor is a young female child aged zero to six. From Box 3.1, report SC050021/SR3[1]
End AC (age class)	6	
SOM (%)	6	Representative of sandy loam soil according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents'[4]
	1	To provide SAC for sites where SOM <6% as often observed by RSK
	2.5	
pH	7	Model default

Table 2: Residential with private gardens –home-grown produce data for CLEA model

	Consumption rate (g FW kg^{-1} BW day^{-1}) by age class						Dry weight conversion factor	Home-grown fraction (average)	Home-grown fraction (high end)	Soil loading factor	Preparation correction factor
Name	1	2	3	4	5	6	g DW g^{-1} FW	-	-	g g^{-1} DW	-
Green vegetables	7.12	6.85	6.85	6.85	3.74	3.74	0.096	0.05	0.33	1.00E-03	2.00E-01
Root vegetables	10.69	3.30	3.30	3.30	1.77	1.77	0.103	0.06	0.4	1.00E-03	1.00E+00
Tuber vegetables	16.03	5.46	5.46	5.46	3.38	3.38	0.21	0.02	0.13	1.00E-03	1.00E+00
Herbaceous fruit	1.83	3.96	3.96	3.96	1.85	1.85	0.058	0.06	0.4	1.00E-03	6.00E-01
Shrub fruit	2.23	0.54	0.54	0.54	0.16	0.16	0.166	0.09	0.6	1.00E-03	6.00E-01
Tree fruit	3.82	11.96	11.96	11.96	4.26	4.26	0.157	0.04	0.27	1.00E-03	6.00E-01
Justification	Table 4.17, SR3[(3)]						Table 6.3, SR3[(3)]	Table 4.19, SR3[(3)]		Table 6.3, SR3[(3)]	

Table 3: Residential with private gardens – land use data for CLEA model

Parameter	Unit	Age class					
		1	2	3	4	5	6
EF (soil and dust ingestion)	day yr^{-1}	180	365	365	365	365	365
EF (consumption of home-grown produce)	day yr^{-1}	180	365	365	365	365	365
EF (skin contact, indoor)	day yr^{-1}	180	365	365	365	365	365
EF (skin contact, outdoor)	day yr^{-1}	180	365	365	365	365	365
EF (inhalation of dust and vapour, indoor)	day yr^{-1}	365	365	365	365	365	365
EF (inhalation of dust and vapour, outdoor)	day yr^{-1}	365	365	365	365	365	365
Justification		Table 3.1, SR3[(3)]					
Occupancy period (indoor)	hr day^{-1}	23	23	23	23	19	19
Occupancy period (outdoor)	hr day^{-1}	1	1	1	1	1	1
Justification		Table 3.2, SR3[(3)]					
Soil to skin adherence factor (indoor)	mg cm^{-2} day^{-1}	6.00E-02	6.00E-02	6.00E-02	6.00E-02	6.00E-02	6.00E-02
Soil to skin adherence factor (outdoor)	mg cm^{-2} day^{-1}	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Justification		Table 8.1, SR3[(3)]					
Soil and dust ingestion rate	g day^{-1}	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01
Justification		Table 6.2, SR3[(3)]					

Of note, for **cadmium**, the exposure assessment for a residential land use is based on estimates representative of lifetime exposure AC1-18. This is because the TDI_{oral} and TDI_{inh} – are based on considerations of the kidney burden accumulated over 50 years. It is therefore reasonable to consider exposure not only in childhood but averaged over a longer time period. See the Environment Agency Science report: SC05002 / TOX 3 [(1)] and Science Report SC050021/Cadmium SGV [(1)] for more information.

Table 4: Residential with private gardens – receptor data for CLEA model

Parameter	Unit	Age Class						Justification
		1	2	3	4	5	6	
Body weight	kg	5.6	9.8	12.7	15.1	16.9	19.7	Table 4.6, SR3 (3)
Body height	m	0.7	0.8	0.9	0.9	1	1.1	
Inhalation rate	$m^3\ day^{-1}$	8.5	13.3	12.7	12.2	12.2	12.2	Table 4.14, SR3 (3)
Max exposed skin fraction (indoor)	$m^2\ m^{-2}$	0.32	0.33	0.32	0.35	0.35	0.33	Table 4.8, SR3 (3)
Max exposed skin fraction (outdoor)	$m^2\ m^{-2}$	0.26	0.26	0.25	0.28	0.28	0.26	

See cadmium note as per Table 3 above.

Table 5: Residential with private gardens – soil and building inputs for CLEA model

Parameter	Unit	Value	Justification
Soil properties for sandy loam			
Porosity, total	$cm^3\ cm^{-3}$	0.53	Default soil type is sandy loam, Section 4.3.1, SR3 (3) Parameters for sandy loam from Table 4.4, SR3 (3)
Porosity, air filled	$cm^3\ cm^{-3}$	0.20	
Porosity, water filled	$cm^3\ cm^{-3}$	0.33	
Residual soil water content	$cm^3\ cm^{-3}$	0.12	
Saturated hydraulic conductivity	$cm\ s^{-1}$	3.56E-03	
van Genuchten shape parameter (*m*)	-	3.20E-01	
Bulk density	$g\ cm^{-3}$	1.21	
Threshold value of wind speed at 10m	$m\ s^{-1}$	7.20	Default value taken from Section 9.2.2, SR3 (3)
Empirical function (F_x) for dust model	-	1.22	Value taken from Section 9.2.2, SR3 (3)
Ambient soil temperature	K	283	Annual average soil temperature representative of UK surface soils. Section 4.3.1, SR3 (3)
Air dispersion model			
Mean annual wind speed (10m)	$m\ s^{-1}$	5.00	Default value taken from Section 9.2.2, SR3 (3)
Air dispersion factor at height of 0.8m	$g\ m^{-2}\ s^{-1}$ per kg m^{-3}	2400	Values for a 0.01 ha site, appropriate to a residential land use in Newcastle (most representative city for UK). (from Table 9.1, SR3) (3) Assumed child of 6 is not tall enough to reach 1.6m
Air dispersion factor at height of 1.6m	$g\ m^{-2}\ s^{-1}$ per kg m^{-3}	0	
Fraction of site with hard or vegetative cover	$m^2\ m^{-2}$	0.75	Section 3.2.6, SR3 (3) based on residential land use

Parameter	Unit	Value	Justification
Building properties for small terrace house with ground-bearing floor slab			
Building footprint	m^2	28	From Table 3.3 and 4.21, SR3[3]
Living space air exchange rate	hr^{-1}	0.50	
Living space height (above ground)	m	4.8	
Living space height (below ground)	m	0.0	Assumed no basement
Pressure difference (soil to enclosed space)	Pa	3.1	From Table 3.3, SR3[3]
Foundation thickness	m	0.15	
Floor crack area	cm^2	423	
Dust loading factor	$\mu g\ m^{-3}$	50	Default value for a residential site taken from Section 9.3, SR3[3]
Vapour model			
Default soil gas ingress rate	$cm^3\ s^{-1}$	25	Generic flow rate, Section 10.3, SR3[3]
Depth to top of source (beneath building)	cm	50	Section 3.2.6, SR3 [3] states source is 50cm below building or 65cm below ground surface
Depth to top of source (no building)	cm	0	Section 10.2, SR3 [3] assumes impact from 0m to 1m for outdoor inhalation pathway
Thickness of contaminant layer	cm	200	Model default for indoor air, Section 4.9, SR4[4]
Time average period for surface emissions	years	6	Time period of a 0 to 6 year old, Box 3.5, SR3[3]
User-defined effective air permeability	cm^2	3.05E-08	Calculated for sandy loam using equations in Appendix 1, SR3[3]

Figure 2: GrAC conceptual model for RBCA residential with private gardens scenario

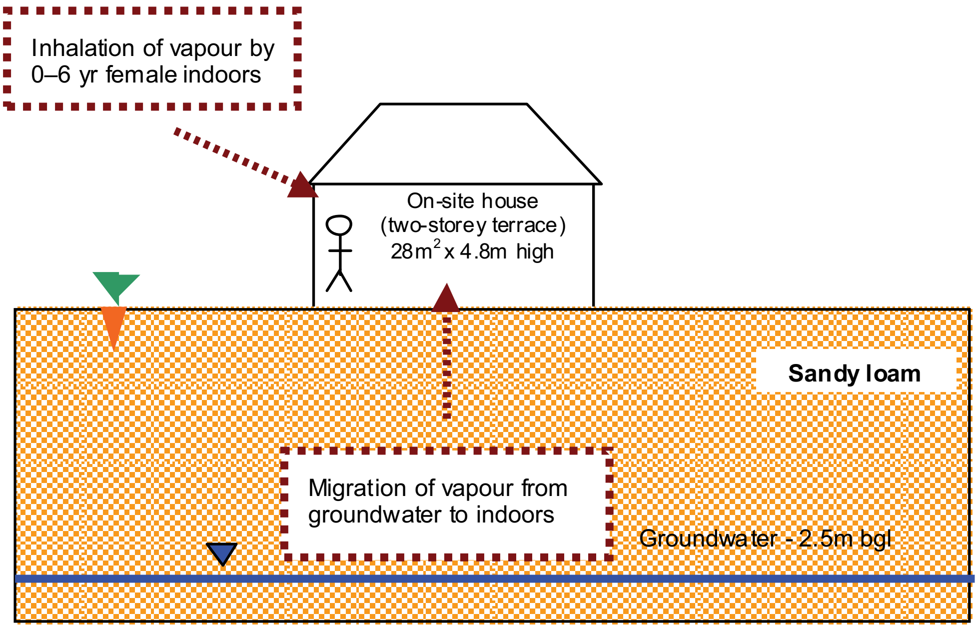


Table 6: Residential with private gardens – RBCA inputs

Parameter	Unit	Value	Justification
Receptor			
Averaging time	Years	6	From Box 3.1, SR3(3)
Receptor weight	kg	13.3	Average of CLEA 0–6 year old female data, Table 4.6, SR3(3)
Exposure duration	Years	6	From Box 3.1, report, SR3(3)
Exposure frequency	Days/yr	350	Weighted using occupancy period of 23 hours per day for 365 days of the year
Soil type – sandy loam			
Total porosity	-	0.53	CLEA value for sandy loam. Parameters for sandy loam from Table 4.4, SR3(3)
Volumetric water content	-	0.33	
Volumetric air content	-	0.20	
Dry bulk density	$g\ cm^{-3}$	1.21	
Vertical hydraulic conductivity	$cm\ s^{-1}$	3.56E-3	CLEA value for saturated conductivity of sandy loam, Table 4.4, SR3(3)
Vapour permeability	m^2	3.05E-12	Calculated for sandy loam using equations in Appendix 1, SR3(3)
Capillary zone thickness	m	0.1	Professional judgement

Parameter	Unit	Value	Justification
Fraction organic carbon	%	(i) 0.0348	Representative of sandy loam according to EA guidance note dated January 2009 entitled ‘Changes We Have Made to the CLEA Framework Documents’ [8]
		(ii) 0.0058	To provide SAC for sites where SOM < 6% as often observed by RSK
Building			
Building volume/area ratio	m	4.8	Table 3.3, SR3 [3]
Foundation area	m^2	28	
Foundation perimeter	m	22	Calculated assuming building measures 7m x 4m to give 28 m^2 foundation area
Building air exchange rate	d^{-1}	12	Table 3.3, SR3 [3]
Depth to bottom of foundation slab	m	0.15	
Foundation thickness	m	0.15	
Foundation crack fraction	-	0.0151	Calculated from floor crack area of 423 cm^2 and building footprint of 28 m^2 in Table 4.21, SR3 [3]
Volumetric water content of cracks	-	0.33	Assumed equal to underlying soil type in assumption that cracks become filled with soil over time. Parameters for sandy loam from Table 4.4, SR3 [3]
Volumetric air content of cracks	-	0.2	
Indoor/outdoor differential pressure	Pa	3.1	From Table 3.3, SR3 [3]

References

1. Environment Agency (2009), 'Science Report SC050021/benzene SGV, toluene SGV, ethylbenzene SGV, xylene SGV, mercury SGV, selenium SGV, nickel SGV, arsenic SGV, cadmium SGV, phenol SGV, dioxins, furans and dioxin like PCBs SGVs', 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', March 2009, May 2009 and September 2009.

2. Environment Agency (2009), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2*, January (Bristol: Environment Agency).

3. Environment Agency (2009), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).

4. Environment Agency (2009), Contaminated Land Exposure Assessment (CLEA) software, version 1.06.

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

6. Chartered Institute for Environmental Health and Land Quality Management (2009), 'The LQM/CIEH Generic Assessment Criteria for Human Health', second edition.

7. CL:AIRE (2009), *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).

8. Changes made to the CLEA framework documents after the three-month evaluation period in 2008, released January 2009 by the Environment Agency.

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH PRIVATE GARDENS

Table 7

Human Health Generic Assessment Criteria by Pathway for Residential Scenario - Private Gardens

Compound	Notes	GrAC (mg/l)	SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Metals														
Arsenic	(b)(c)	-	3.24E+01	8.50E+01	-	NR	3.24E+01	8.50E+01	-	NR	3.24E+01	8.50E+01	-	NR
Cadmium	(b)	-	1.12E+01	1.85E+02	1.10E+01	NR	1.12E+01	1.85E+02	1.10E+01	NR	1.12E+01	1.85E+02	1.10E+01	NR
Chromium (III) - oxide		-	1.84E+04	3.55E+03	2.98E+03	NR	1.84E+04	3.55E+03	2.98E+03	NR	1.84E+04	3.55E+03	2.98E+03	NR
Chromium (VI) - hexavalent		-	1.02E+01	4.25E+00	3.21E+00	NR	1.02E+01	4.25E+00	3.21E+00	NR	1.02E+01	4.25E+00	3.21E+00	NR
Copper		-	2.66E+03	1.04E+04	2.33E+03	NR	2.66E+03	1.04E+04	2.33E+03	NR	2.66E+03	1.04E+04	2.33E+03	NR
Lead	(a)	-	3.00E+02	-	-	NR	3.00E+02	-	-	NR	3.00E+02	-	-	NR
Elemental Mercury (Hg^0)	(b)(d)	9.40E-03	-	1.70E-01	-	4.31E+00	-	4.24E-01	-	1.07E+01	-	1.02E+00	-	2.58E+01
Inorganic Mercury (Hg^{2+})	(b)	-	1.81E+02	2.55E+03	1.69E+02	NR	1.81E+02	2.55E+03	1.69E+02	NR	1.81E+02	2.55E+03	1.69E+02	NR
Methyl Mercury (Hg^{4+})	(b)	2.00E+01	1.39E+01	1.59E+01	7.40E+00	7.33E+01	1.39E+01	3.08E+01	9.55E+00	1.42E+02	1.39E+01	6.53E+01	1.14E+01	3.04E+02
Nickel	(b)(d)	-	5.31E+02	1.27E+02	-	NR	5.31E+02	1.27E+02	-	NR	5.31E+02	1.27E+02	-	NR
Selenium	(b)(c)	-	3.50E+02	-	-	NR	3.50E+02	NR	-	NR	3.50E+02	-	-	NR
Zinc	(c)	-	3.75E+03	2.55E+07	-	NR	3.75E+03	2.55E+07	-	NR	3.75E+03	2.55E+07	-	NR
Cyanide		-	2.66E+01	3.97E+00	3.68E+00	NR	2.66E+01	3.97E+00	3.68E+00	NR	2.66E+01	3.97E+00	3.68E+00	NR
Volatile Organic Compounds														
Benzene	(b)	7.20E+00	1.12E-01	2.69E-01	7.92E-02	1.22E+03	2.28E-01	4.99E-01	1.57E-01	2.26E+03	4.89E-01	1.04E+00	3.32E-01	4.71E+03
Toluene	(b)	1.90E+03	1.47E+02	6.26E+02	1.19E+02	8.69E+02	3.35E+02	1.38E+03	2.70E+02	1.92E+03	7.59E+02	3.14E+03	6.11E+02	4.36E+03
Ethylbenzene	(b)	2.60E+02	1.06E+02	1.70E+02	6.52E+01	5.18E+02	2.51E+02	3.98E+02	1.54E+02	1.22E+03	5.70E+02	9.32E+02	3.54E+02	2.84E+03
Xylene - m	(b)	8.40E+01	2.02E+02	5.56E+01	4.36E+01	6.25E+02	4.80E+02	1.31E+02	1.03E+02	1.47E+03	1.09E+03	3.07E+02	2.40E+02	3.46E+03
Xylene - o	(b)	1.00E+02	1.85E+02	5.98E+01	4.52E+01	4.78E+02	4.38E+02	1.40E+02	1.06E+02	1.12E+03	9.96E+02	3.27E+02	2.46E+02	2.62E+03
Xylene - p	(b)	8.70E+01	1.91E+02	5.34E+01	4.17E+01	5.76E+02	4.51E+02	1.26E+02	9.82E+01	1.35E+03	1.02E+03	2.94E+02	2.28E+02	3.17E+03
Total xylene		8.40E+01	2.02E+02	5.56E+01	4.36E+01	6.25E+02	4.80E+02	1.31E+02	1.03E+02	1.47E+03	1.09E+03	3.07E+02	2.40E+02	3.46E+03
Methyl t-Butyl ether		2.20E+03	1.75E+00	1.84E+02	1.75E+00	1.66E+04	3.68E+00	2.40E+02	3.67E+00	2.16E+04	7.41E+00	3.70E+02	7.37E+00	3.34E+04
Trichloroethene		1.80E+00	2.83E+00	1.10E-01	1.06E-01	1.54E+03	6.25E+00	2.30E-01	2.22E-01	3.22E+03	1.40E+01	5.11E-01	4.93E-01	7.14E+03
Tetrachloroethene		3.60E+00	1.06E+01	1.03E+00	9.36E-01	4.24E+02	2.44E+01	2.30E+00	2.10E+00	9.51E+02	5.55E+01	5.28E+00	4.82E+00	2.18E+03
1,1,1-Trichloroethane		2.60E+01	3.20E+02	6.33E+00	6.21E+00	1.43E+03	6.97E+02	1.29E+01	1.27E+01	2.92E+03	1.55E+03	2.84E+01	2.79E+01	6.39E+03
1,1,1,2 Tetrachloroethane		1.40E+01	5.19E+00	1.08E+00	8.93E-01	2.60E+03	1.22E+01	2.50E+00	2.08E+00	6.02E+03	2.78E+01	5.83E+00	4.82E+00	1.40E+04
1,1,2,2-Tetrachloroethane		1.40E+01	2.70E+00	2.76E+00	1.37E+00	2.67E+03	5.85E+00	5.65E+00	2.87E+00	5.46E+03	1.30E+01	1.24E+01	6.34E+00	1.20E+04
Carbon Tetrachloride		5.50E-02	1.05E+00	1.81E-02	1.79E-02	1.52E+03	2.41E+00	3.97E-02	3.93E-02	3.32E+03	5.44E+00	8.99E-02	8.92E-02	7.54E+03
1,2-Dichloroethane		3.00E-01	3.06E-02	6.46E-03	5.34E-03	3.41E+03	5.53E-02	9.32E-03	7.98E-03	4.91E+03	1.05E-01	1.60E-02	1.39E-02	8.43E+03
Vinyl Chloride		1.90E-02	3.69E-03	5.43E-04	4.73E-04	1.36E+03	6.64E-03	7.02E-04	6.35E-04	1.76E+03	1.21E-02	1.07E-03	9.86E-04	2.69E+03
1,2,4-Trimethylbenzene		7.50E-02	-	3.51E-01	-	5.57E+02	-	8.55E-01	-	1.36E+03	-	2.10E+00	-	3.25E+03
1,3,5-Trimethylbenzene		4.70E-02	1.45E+01	4.60E-01	4.56E-01	9.47E+01	3.47E+01	1.10E+00	1.09E+00	2.26E+02	7.94E+01	2.59E+00	2.56E+00	5.33E+02
Semi-Volatile Organic Compounds														
Acenaphthene		3.20E+00	2.18E+02	3.46E+03	2.05E+02	5.70E+01	5.08E+02	8.54E+03	4.79E+02	1.41E+02	1.06E+03	2.03E+04	1.01E+03	3.36E+02
Acenaphthylene		4.20E+00	1.78E+02	3.27E+03	1.68E+02	8.61E+01	4.17E+02	8.03E+03	3.97E+02	2.12E+02	8.90E+02	1.91E+04	8.51E+02	5.06E+02
Anthracene		2.10E-02	2.31E+03	1.08E+05	2.26E+03	1.17E+00	5.03E+03	2.65E+05	4.93E+03	2.91E+00	9.33E+03	6.15E+05	9.19E+03	6.96E+00
Benzo(a)anthracene		3.80E-03	7.00E+00	5.55E+00	3.10E+00	1.71E+00	8.98E+00	9.83E+00	4.69E+00	4.28E+00	1.01E+01	1.41E+01	5.88E+00	1.03E+01
Benzo(b)fluoranthene		2.00E-03	8.06E+00	1.79E+01	5.56E+00	1.22E+00	9.78E+00	1.97E+01	6.53E+00	3.04E+00	1.07E+01	2.05E+01	7.02E+00	7.29E+00
Benzo(g,h,i)perylene		2.60E-04	6.68E+01	1.27E+02	4.38E+01	1.54E-02	7.04E+01	1.32E+02	4.59E+01	3.85E-02	7.19E+01	1.34E+02	4.68E+01	9.23E-02
Benzo(k)fluoranthene		8.00E-04	1.25E+01	2.66E+01	8.51E+00	6.87E-01	1.44E+01	2.83E+01	9.56E+00	1.72E+00	1.53E+01	2.91E+01	1.00E+01	4.12E+00
Chrysene		2.00E-03	8.76E+00	1.95E+01	6.00E+00	4.40E-01	1.20E+01	2.45E+01	8.04E+00	1.10E+00	1.41E+01	2.72E+01	9.27E+00	2.64E+00
Dibenzo(a,h)anthracene		6.00E-04	1.19E+00	2.13E+00	7.62E-01	3.93E-03	1.33E+00	2.42E+00	8.58E-01	9.82E-03	1.39E+00	2.56E+00	9.03E-01	2.36E-02
Fluoranthene		2.30E-01	2.59E+02	2.69E+04	2.57E+02	1.89E+01	4.67E+02	6.23E+04	4.63E+02	4.73E+01	6.78E+02	1.28E+05	6.74E+02	1.13E+02
Fluorene		1.90E+00	1.70E+02	4.35E+03	1.63E+02	3.09E+01	3.91E+02	1.07E+04	3.77E+02	7.65E+01	8.00E+02	2.54E+04	7.76E+02	1.83E+02
Indeno(1,2,3-cd)pyrene		2.00E-04	4.58E+00	1.04E+01	3.18E+00	6.13E-02	5.74E+00	1.17E+01	3.85E+00	1.53E-01	6.37E+00	1.22E+01	4.19E+00	3.68E-01
Phenanthrene		5.30E-01	9.35E+01	5.04E+03	9.18E+01	3.60E+01	2.04E+02	1.23E+04	2.01E+02	8.96E+01	3.81E+02	2.86E+04	3.76E+02	2.14E+02
Pyrene		1.30E-01	5.69E+02	6.18E+04	5.63E+02	2.20E+00	1.05E+03	1.44E+05	1.04E+03	5.49E+00	1.56E+03	2.97E+05	1.56E+03	1.32E+01
Benzo(a)pyrene		3.80E-03	1.21E+00	2.62E+00	8.26E-01	9.11E-01	1.42E+00	2.81E+00	9.43E-01	2.28E+00	1.52E+00	2.90E+00	9.98E-01	5.46E+00
Naphthalene		1.90E+01	2.68E+01	1.64E+00	1.54E+00	7.64E+01	6.36E+01	3.93E+00	3.70E+00	1.83E+02	1.43E+02	9.27E+00	8.71E+00	4.32E+02
Phenol	(b)	-	4.51E+02	3.11E+02	1.84E+02	4.16E+04	9.38E+02	4.20E+02	2.90E+02	8.15E+04	2.04E+03	5.21E+02	4.15E+02	1.74E+05

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH PRIVATE GARDENS

Table 7

Human Health Generic Assessment Criteria by Pathway for Residential Scenario - Private Gardens

Compound	Notes	GrAC (mg/l)	SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Total Petroleum Hydrocarbons														
Aliphatic hydrocarbons EC_5-EC_6		1.00E+01	4.79E+03	2.98E+01	2.97E+01	3.04E+02	1.08E+04	5.47E+01	5.46E+01	5.58E+02	2.35E+04	1.13E+02	1.13E+02	1.15E+03
Aliphatic hydrocarbons >EC_6-EC_8		5.40E+00	1.43E+04	7.27E+01	7.26E+01	1.44E+02	3.21E+04	1.62E+02	1.62E+02	3.22E+02	6.36E+04	3.72E+02	3.71E+02	7.36E+02
Aliphatic hydrocarbons >EC_8-EC_{10}		2.30E-01	1.46E+03	1.89E+01	1.88E+01	7.77E+01	2.44E+03	4.60E+01	4.58E+01	1.90E+02	3.30E+03	1.09E+02	1.08E+02	4.51E+02
Aliphatic hydrocarbons >EC_{10}-EC_{12}		3.40E-02	3.52E+03	9.34E+01	9.28E+01	4.75E+01	4.01E+03	2.32E+02	2.29E+02	1.18E+02	4.24E+03	5.57E+02	5.37E+02	2.83E+02
Aliphatic hydrocarbons >EC_{12}-EC_{16}		7.60E-04	4.37E+03	7.82E+02	7.44E+02	2.37E+01	4.40E+03	1.95E+03	1.69E+03	5.91E+01	4.41E+03	4.68E+03	3.03E+03	1.42E+00
Aliphatic hydrocarbons >EC_{16}-EC_{35}	(c)	-	4.51E+04	-	-	8.48E+00	6.38E+04	-	-	2.12E+01	7.61E+04	-	-	5.09E+01
Aliphatic hydrocarbons >EC_{35}-EC_{44}	(c)	-	4.51E+04	-	-	8.48E+00	6.38E+04	-	-	2.12E+01	7.61E+04	-	-	5.09E+01
Aromatic hydrocarbons >EC_8-EC_9 (styrene)		7.40E+00	1.66E+02	2.65E+02	1.33E+02	6.20E+02	3.92E+02	6.47E+02	3.16E+02	1.52E+03	8.50E+02	1.54E+03	7.02E+02	3.61E+03
Aromatic hydrocarbons >EC_9-EC_{10}		7.40E+00	5.55E+01	3.33E+01	2.69E+01	6.13E+02	1.31E+02	8.16E+01	6.54E+01	1.50E+03	2.84E+02	1.94E+02	1.51E+02	3.58E+02
Aromatic hydrocarbons >EC_{10}-EC_{12}		2.50E+01	7.97E+01	1.82E+02	6.91E+01	3.64E+02	1.86E+02	4.48E+02	1.62E+02	8.99E+02	3.87E+02	1.07E+03	3.46E+02	2.15E+03
Aromatic hydrocarbons >EC_{12}-EC_{16}		5.80E+00	1.40E+02	2.00E+03	1.38E+02	1.69E+02	3.13E+02	4.96E+03	3.08E+02	4.19E+02	6.01E+02	1.18E+04	5.93E+02	1.00E+03
Aromatic hydrocarbons >EC_{16}-EC_{21}	(c)	-	2.47E+02	-	-	5.37E+01	4.82E+02	-	-	1.34E+02	7.66E+02	-	-	3.21E+02
Aromatic hydrocarbons >EC_{21}-EC_{35}	(c)	-	8.88E+02	-	-	4.83E+00	1.11E+03	-	-	1.21E+01	1.22E+03	-	-	2.90E+01
Aromatic hydrocarbons >EC_{35}-EC_{44}	(c)	-	8.88E+02	-	-	4.83E+00	1.11E+03	-	-	1.21E+01	1.22E+03	-	-	2.90E+01

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.
NR - the compound is not volatile and therefore a soil saturation limit not calculated within CLEA
EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - soil assessment criteria.

The CLEA model output is colour coded depending upon whether the soil saturation limit has been exceeded.

Calculated SAC exceeds soil saturation limit and may significantly effect the interpretation of any exceedances since the contribution of the indoor and outdoor vapour pathway to total exposure is >10%. This shading has also been used for the RBCA output where the theoretical solubility limit has been exceeded. The SAC has been set as the model calculated SAC with the saturation limits shown in brackets.
Calculated SAC exceeds soil saturation limit but will not effect the SSV significantly since the contribution of the indoor and outdoor vapour pathway to total exposure is <10%.
Calculated SAC does not exceed the soil saturation limit.

For consistency where the theoretical solubility limit within RBCA has been exceeded in production of the GrAC, these cells have also been hatched red.

The SAC for organic compounds are dependant upon soil organic matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58. 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.
SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3

(a) Sensitivity analysis undertaken on SEGH equation and CLEA model, considered reasonable in absence of UK specific data
(b) GAC taken from the Environment Agency SGV reports published 2009.
(c) SAC for selenium, aliphatic and aromatic hydrocarbons >EC16 does not include inhalation pathway owing to absence of toxicity data. SAC for arsenic is only based on oral contribution (rather than combined) owing to the relative small contribution from inhalation in accordance with the SGV report. The same approach has been adopted for zinc.
(d) SAC for elemental mercury, chromium VI and nickel is based on the inhalation pathway only owing to an absence of toxicity for elemental mercury, in accordance with the SGV report for nickel and LQM report for chromium VI.

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH PRIVATE GARDENS

Table 8
Human Health Generic Assessment Criteria for Residential Scenario - Private Gardens

Compound	GrAC for Groundwater (mg/l)	SAC for Soil SOM 1% (mg/kg)	SAC for Soil SOM 2.5% (mg/kg)	SAC for Soil SOM 6% (mg/kg)
Metals				
Arsenic	-	32	32	32
Cadmium	-	10	10	10
Chormium (III) - oxide	-	3,000	3,000	3,000
Chromium (VI) - hexavalent	-	4.3	4.3	4.3
Copper	-	2,300	2,300	2,300
Lead	-	300	300	300
Elemental Mercury (Hg^0)	0.009	0.17	0.42	1.0
Inorganic Mercury (Hg^{2+})	-	170	170	170
Methyl Mercury (Hg^{4+})	20	7.4	9.6	11
Nickel	-	130	130	130
Selenium	-	350	350	350
Zinc	-	3,800	3,800	3,800
Cyanide	-	3.7	3.7	3.7
Volatile Organic Compounds				
Benzene	7	0.079	0.157	0.33
Toluene	1,900	120	270	610
Ethylbenzene	260	65	154	350
Xylene - m	100	44	103	240
Xylene - o	87	45	106	250
Xylene - p	84	42	98	230
Total xylene	84	44	103	240
Methyl tertiary butyl ether (MTBE)	2,200	1.8	3.7	7.4
Trichloroethene	1.8	0.11	0.2	0.49
Tetrachloroethene	3.6	0.94	2.1	4.8
1,1,1-Trichloroethane	26	6.2	12.7	28
1,1,1,2Tetrachloroethane	14	0.89	2.1	4.8
1,1,2,2-Tetrachloroethane	14	1.4	2.87	6.3
Carbon Tetrachloride	0.055	0.018	0.039	0.089
1,2-Dichloroethane	0.30	0.0053	0.0080	0.014
Vinyl Chloride	0.019	0.00047	0.0006	0.001
1,2,4-Trimethylbenzene	0.075	0.35	0.85	2.1
1,3,5-Trimethylbenzene	0.047	0.46	1.1	2.6
Semi-Volatile Organic Compounds				
Acenaphthene	3.2	210	480	1,000
Acenaphthylene	4.2	170	400	850
Anthracene	0.021	2,300	4,900	9,200
Benzo(a)anthracene	0.0038	3.1	4.7	5.9
Benzo(b)fluoranthene	0.0020	5.6	6.5	7.0
Benzo(g,h,i)perylene	0.00026	44	46	47
Benzo(k)fluoranthene	0.00080	8.5	9.6	10
Chrysene	0.0020	6.0	8.0	9.3
Dibenzo(a,h)anthracene	0.00060	0.76	0.86	0.90
Fluoranthene	0.23	260	460	670
Fluorene	1.9	160	380	780
Indeno(1,2,3-cd)pyrene	0.0002	3.2	3.8	4.2
Phenanthrene	0.53	92	200	380
Pyrene	0.13	560	1,000	1,600
Benzo(a)pyrene	0.0038	0.83	0.94	1.0
Naphthalene	19	1.5	3.7	8.7
Phenol	-	180	290	420
Total Petroleum Hydrocarbons				
Aliphatic hydrocarbons EC_5-EC_6	10	30	55	110
Aliphatic hydrocarbons >EC_6-EC_8	5.4	73	160	370
Aliphatic hydrocarbons >EC_8-EC_{10}	0.23	19	46	110
Aliphatic hydrocarbons >EC_{10}-EC_{12}	0.034	93 (48)	230 (118)	540 (283)
Aliphatic hydrocarbons >EC_{12}-EC_{16}	0.00076	744 (24)	1,700 (59)	3,000 (142)
Aliphatic hydrocarbons >EC_{16}-EC_{35}	-	45,100 (8.48)	64,000 (21)	76,000
Aliphatic hydrocarbons >EC_{35}-EC_{44}	-	45,100 (8.48)	64,000 (21)	76,000
Aromatic hydrocarbons >EC_8-EC_9 (styrene)	7.4	130	316	700
Aromatic hydrocarbons >EC_9-EC_{10}	7.4	27	65	150
Aromatic hydrocarbons >EC_{10}-EC_{12}	25	69	160	346
Aromatic hydrocarbons >EC_{12}-EC_{16}	5.8	140	310	593
Aromatic hydrocarbons >EC_{16}-EC_{21}	-	250	480	770
Aromatic hydrocarbons >EC_{21}-EC_{35}	-	890	1,100	1,230
Aromatic hydrocarbons >EC_{35}-EC_{44}	-	890	1,100	1,230

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.

EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - soil assessment criteria.

The SAC for organic compounds are dependent on Soil Organic Matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58.
1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3.

The SAC has been set as the model calculated SAC with the saturation limit shown in brackets.
For consistency where the GrAC exceeds the solubility limit, GrAC has been set at the solubility limit. The GrAC conservative since concentrations of the chemical are very unlikely to be at sufficient concentration to result in an exceedance of the health criteria value at the point of exposure (i.e. indoor air) provided free-phase product is absent.

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Our ref: 25459-02R (00)

1st May 2013

Cambridge City Council – Environmental Services
Mandela House
4 Regent Street
Cambridge
CB2 1BY

For the attention of: Themis Kantara

Dear Themis

Supplementary Investigation NIAB 1 Fields, Phase 1 Development
Your reference wk/201258067

Background

A geo-environmental ground investigation was conducted at the above site by RSK to supplement a previous phase of investigation performed by Millard Consulting Engineers. The reports were submitted on behalf of our Client, Barratt Homes, in support of the planning application references 07/0003/OUT and S/07/0001/F.

The planning application spans the boundary between the districts administered by South Cambridgeshire District Council (SCDC) and Cambridge City Council (CCC), therefore both local authorities were consulted in respect to the information submitted and a joint response was issued on 12th December 2012.

Specifically, the response confirmed the northern portion of the site, located within the SCDC district to have been adequately investigated in respect its proposed future use. The following scope of further investigation, was however, prescribed for the remaining area of the site:

- Three additional rounds of ground gas monitoring to confidently characterise the ground gas regime beneath the site;
- Further non-targeted chemical testing for herbicides and pesticides to provide greater confidence in the initial suite of analyses; and
- Further targeted investigation of a former waste disposal area, two former above ground storage tanks and a former shed.

A scope of supplementary, targeted investigation and chemical analyses was subsequently proposed by RSK in January 2013, which comprised the following:

- Three additional rounds of ground gas monitoring;
- Additional investigation targeted to the location of an above ground fuel storage tank, formerly located adjacent to the farm yard, comprising the excavation of two shallow trial pits (HP1 and HP2) and testing a minimum of two soil samples for a suite of analyses including polycyclic aromatic hydrocarbons (PAH) (EPA16) and petroleum hydrocarbons (TPH-CWG);
- Additional investigation targeted to the location of a former waste storage area, comprising the excavation of five shallow trial pits (HP3 to HP7) and testing a minimum of five soil samples for a suite of analyses including PAH (EPA16), nine commonly occurring metals, a screen for asbestos containing materials (ACMs), Triazine herbicides, Phenoxy acid herbicides and petroleum hydrocarbons (TPH-total);
- Additional investigation targeted to the location of a former storage shed, comprising the excavation of three shallow trial pits (HP8 to HP10) and testing a minimum of three soil samples for a suite of analyses including PAH (EPA16), nine commonly occurring metals, a screen for asbestos containing materials (ACMs), Triazine herbicides, Phenoxy acid herbicides and petroleum hydrocarbons (TPH-total); and
- Additional investigation targeted to the location of an above ground fuel storage tank, formerly located adjacent to the sports pavilion, comprising the excavation of two shallow trial pits (HP12 and HP13) and testing a minimum of two soil samples for a suite of analyses including polycyclic aromatic hydrocarbons (PAH) (EPA16) and petroleum hydrocarbons (TPH-CWG).

The scope of testing for pesticides and herbicides was proposed following discussions between RSK and the National Institute of Agricultural Botany regarding the use of the plant protection products at the site. It was confirmed that plant protection products, approved for use by the Chemical Regulations Directorate, had been applied to the site in strict accordance with the Code of practice for using plant protection products. The products were stored off-site within the farmyard and mixed within a bunded chemical mixing unit with spill catchment facility. Based on this information, the risk posed by the former use of plant protection products was considered to be low.

The proposed scope of work was verbally agreed between RSK and yourself prior to its commencement.

Supplementary fieldwork

Thirteen trial pits, designated HP1 to HP13, were excavated by hand at the locations agreed for further investigation on 1st March 2013. The investigation and the soil descriptions were carried out in general accordance with 'BS 5930:1999. Code of Practice for Site Investigations' (BSI, 1999) and 'BS10175:2011 Investigation of Potentially Contaminated Sites – Code of Practice' (BSI, 2011).

The investigation points were located by rigorous surveying techniques as shown in Figure 1, the exploratory hole logs are also appended for reference.

The soils samples were collected in containers appropriate to the anticipated testing suite required. The containers were filled to capacity and placed in a cool box to minimise volatilisation. Samples were transported directly to RSK's testing laboratory (Envirolab) under chain of custody documentation. The samples were tested for the agreed suite of organic and inorganic compounds.

In addition to the above, three additional rounds of ground gas monitoring were conducted to record ground gas concentrations from the installations constructed during the previous main phase of investigation.

The results of the supplementary ground gas monitoring events and laboratory analyses are appended to this letter.

Ground conditions

The supplementary, targeted investigation confirmed the shallow ground conditions at the specified locations to comprise a generally uniform veneer of made ground overlying the Gault Formation. The made ground soils typically comprised a silty sandy locally gravelly clay with rare pockets of ash and brick. No obvious signs of any significant contamination were observed during the course of the investigation. No groundwater was encountered during the course of the shallow investigation.

Copies of the exploratory hole records are appended to this letter for reference.

Chemical test results and assessment

The chemical test results were directly compared against the RSK Generic Assessment Criteria (GAC) values derived using CLEA version 1.06 for the protection of human health in residential sites with pathways for plant uptake. The GAC values and details of their derivation are appended to this letter for reference.

No elevated concentrations of any determinants were identified during the comparison. Whilst no GACs have been derived for the assessment of herbicides, pesticides or ACM's, no concentrations of any of these contaminants were recorded above the relevant laboratory limits of detection.

Ground Gas Regime

The results of the three recent monitoring events have been combined with the previous three rounds and are appended to this letter. The minimum and maximum results are summarised in the table below.

Table 1: Summary of ground gas monitoring results

Borehole	Response zone/strata	Probable source(s) of ground gas	Number of monitoring visits	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Flow rate (l/hr)	Water level (m b TOC)	Atmospheric pressure (mbar)
BH1	GC	Shallow topsoil / made ground	6	<0.1 to 0.1	0.1 to 1.8	18.5 to 21.4	0.0	Dry to 1.70	1005 to 1022
BH2	RTD / GC	Shallow topsoil / made ground	6	<0.1	0.5 to 1.6	18.5 to 21.0	-0.4 to 0.4	0.85 to 1.86	1004 to 1022
BH3	RTD / GC	Shallow topsoil / made ground	6	-0.2 to <0.1	0.5 to 1.5	17.7 to 21.2	0.0	1.38 to 1.44	1005 to 1022
BHG	MG.TS / RTD / GC	Shallow topsoil / made ground	6	<0.1	0.0 to 1.8	19.3 to 21.5	-0.1 to 0.2	0.95 to 2.19	1005 to 1022
BHK	RTD / GF	Shallow topsoil / made ground	6	-0.1 to 0.1	0.0 to 3.5	18.0 to 21.0	-0.1 to 0.2	1.35 to 2.09	1006 to 1022
WS3	MG.TS / GF	Shallow topsoil / made ground	6	<0.1 to 0.1	0.3 to 2.2	19.3 to 21.0	0.0 to 0.9	1.55 to 2.92	1006 to 1022
WS17	MG.TS / GF	Shallow topsoil / made ground	5	<0.1	0.0 to 2.9	18.6 to 21.4	0.0 to 0.2	1.57 to 1.88	1005 to 1022
WSH	MG.TS	Shallow topsoil / made ground	6	<0.1 to 0.1	0.1 to 4.2	18.0 to 20.8	0.0 to 0.2	Dry	1005 to 1022
Note: MG.TS – Made Ground / Topsoil, RTDC – River Terrace Deposits, GC – Gault Clay									

The results of the combined data set have been assessed in accordance with the guidance provided in *CIRIA Report C665: Assessing risks posed by hazardous ground gases to buildings* (Wilson et al., 2007). In the assessment of risks posed by hazardous ground gases and selection of appropriate mitigation measures, CIRIA C665 identifies two types of development, termed Situation A (modified Wilson and Card method), appropriate to all development excluding traditional low-rise construction, and Situation B (National House-Building Council, NHBC) only appropriate to traditional low-rise construction with ventilated sub-floor voids. The site is to be redeveloped with both low-rise residential houses and commercial properties and therefore falls under Situation A and B.

The gas monitoring data has identified a maximum methane concentration of 0.1% and a maximum concentration of carbon dioxide of 4.2%. A maximum gas flow rate of 0.9l/hr has been recorded. The calculated GSV for methane is 0.0009l/hr and the GSV for carbon dioxide is 0.0378l/hr. Based on the GSVs the site has been characterised as CS1 for the area of the development defined by Situation A and as Green for the remainder of the development defined by Situation B.

The proposed mixed-use development, which fulfils the requirements of both Situation A and Situation B, has been characterised as Characteristic Situation 1 and Green, respectively. This indicates that a negligible gas regime has been identified and that gas protection measures are not considered necessary.

Conclusions

The results of the agreed scope of supplementary investigation have not identified any significant ground contamination. The supplementary investigation has therefore provided a greater level of confidence that the soils across the site are suitable for use within all areas of the proposed mixed-use development.

In addition, the supplementary rounds of ground gas monitoring, which has increased the data set for the site to the minimum prescribed by CIRIA C665, has confirmed a negligible gas regime, for which gas protection measures are not considered necessary.

In conclusion, the supplementary phase of investigation has confirmed, with an appropriate level of confidence, that the site is suitable for its proposed use. No further investigation or remediation is therefore recommended at this stage. However, should any unexpected ground conditions be revealed during redevelopment, immediate advice should be sought from the local authority and the environmental consultant.

We trust the information supplied is sufficient to recommended discharge of the contaminated land conditions pertaining to the site, should however, you have any queries or require any further information please do not hesitate to give me a call.

Yours sincerely
For RSK Environment Ltd

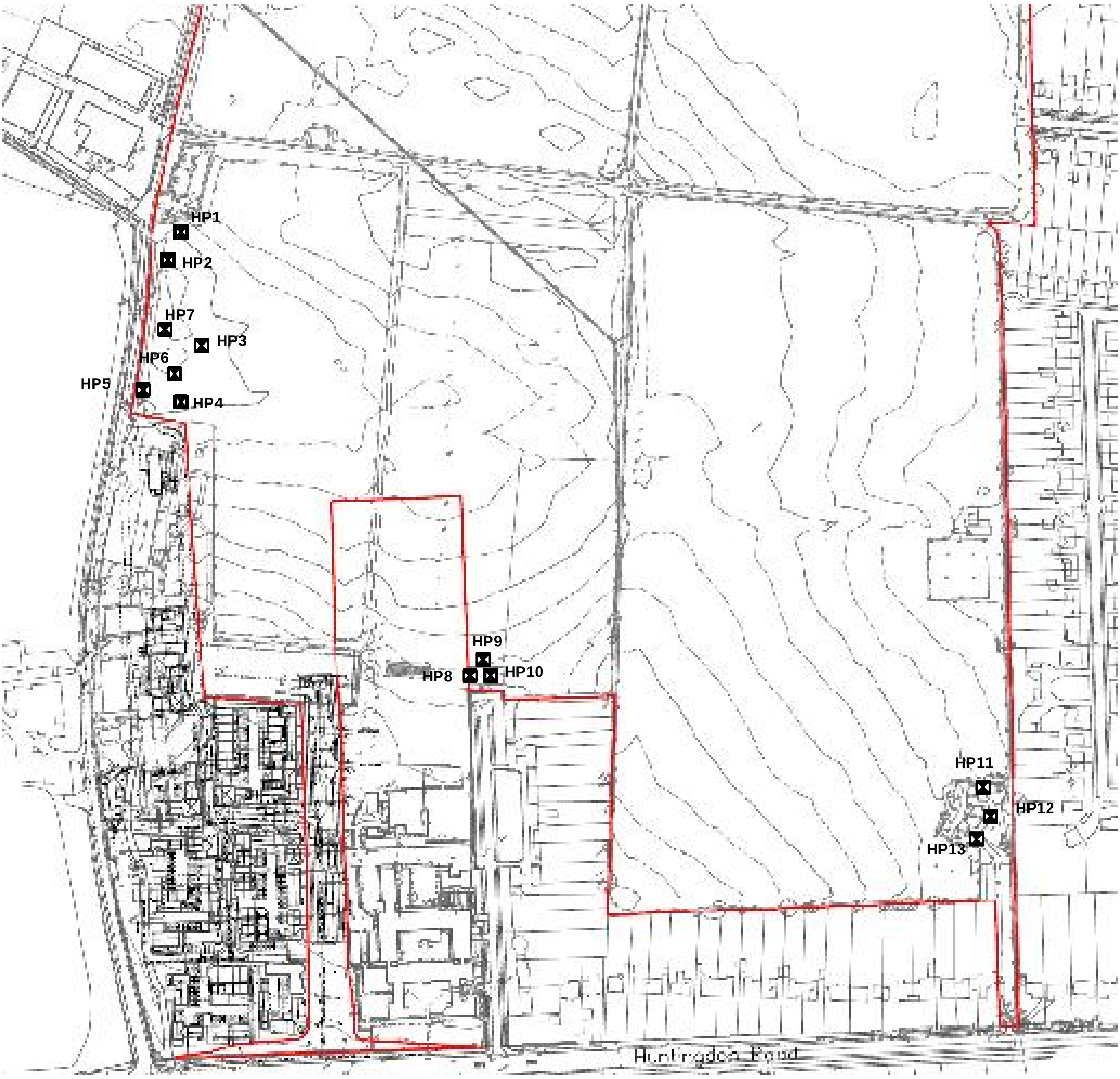
Duncan Sharp
Associate Director
RSK Environment - Geosciences

Encl.

Figure 1 Exploratory hole location plan
Exploratory hole records
Chemical test results
Ground gas monitoring records
RSK GAC values for residential sites with pathways for plant uptake

Cc. Claire Sproats - SCDC

FIGURES



RSK	Exploratory hole location plan	Client:	BDW Trading	Figure No:	Figure 1
		Site:	NIAB Phase 1	Job No:	25459-02(00)
		Scale:	NTS	Source:	Woods Hardwick

EXPLORATORY HOLE LOGS

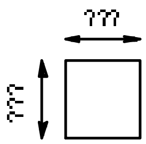
INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	**BDW Trading Limited**	**HP1**

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinates:	Sheet:
25459	01.03.13	**---**	**---**	**1** of **1**

Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
0.20	1	ES	T+J+VJ			MADE GROUND: Firm dark brown slightly gravelly sandy CLAY with occasional subangular fine to coarse flint gravels and with occasional rootlets (1-2mm diameter) and occasional to rare ash pockets. Sand is fine to medium. (MADE GROUND)	(0.30) 0.30	
0.30	2	ES	T+J+VJ			MADE GROUND: Firm yellowish brown slightly gravelly sandy CLAY with occasional subangular fine to coarse flint gravels and with occasional to rare ash pockets and brick fragments. (MADE GROUND)	(0.36) 0.66	
0.60	3	ES	T+J+VJ					
						Inspection pit terminated at 0.66m depth		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Backfilled with arisings
3. Inspection pit remained stable
4. Weather conditions: cold, overcast.

All dimensions in metres | Scale: 1:13

Method Used:	Inspection pit + Hand dug	Plant Used:	Hand tools	Logged By:	CJBall	Checked By:	

AGS

INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	**BDW Trading Limited**	**HP2**

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	01.03.13	---	---	**1** of **1**

Samples and In-situ Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)
0.20	1	ES	T+L+VL			MADE GROUND - Firm dark brown slightly gravelly sandy CLAY with occasional subangular fine to coarse flint gravels and with rootlets and rootlets (1-2mm diameter) and occasional to rare ash pockets. Sand is fine to medium. (MADE GROUND)	(0.40) 0.40
0.50	2	ES	T+L+VL			MADE GROUND - Firm yellowish brown slightly gravelly sandy CLAY with occasional subangular fine to coarse flint gravels and with rootlets and to rare ash pockets and brick fragments. (MADE GROUND)	(0.20) 0.60
						Firm yellowish brown with grey mottling slightly gravelly silty CLAY with occasional subangular fine to coarse flint gravels. Sand is fine to medium. (GAULT FORMATION).	0.61

Plan (Not to Scale)

??? × ???

General Remarks

1. No groundwater encountered
2. Backfilled with arisings
3. Inspection pit remained stable
4. Weather conditions: cold, overcast.

All dimensions in metres	Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	VMacfarlane	

AGS

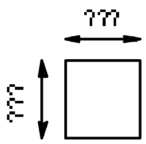
INSPECTION PIT LOG

Contract: NIAB - Phase 1	Client: BDW Trading Limited	Trial Pit: HP3

Contract Ref: 25459	Date: 01.03.13	Ground Level (m AOD): ---	National Grid Co-ordinate: ---	Sheet: 1 of 1

Samples and In-situ Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
0.20	1	ES	T+L+VL			MADE GROUND: Soft brown slightly gravelly slightly sandy CLAY with occasional subangular fine to coarse flint gravels and with roots and rootlets (1-2mm diameter).	(0.40) 0.40	
0.50	2	ES	T+L+VL			Firm yellow brown mottled grey slightly gravelly slightly sandy CLAY with occasional subangular fine to coarse flint gravels. Sand is fine to medium. (GAULT FORMATION).	(0.20) 0.60	
						Inspection pit terminated at 0.60m depth		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Backfilled with arisings
3. Inspection pit remained stable
4. Weather conditions: overcast.

All dimensions in metres | Scale: 1:13

Method Used: Hand dug	Plant Used: Hand tools	Logged By: VMacfarlane	Checked By:

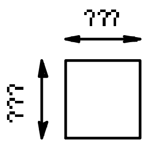
INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	BDW Trading Limited	HP4

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	01.03.13	---	---	1 of 1

Samples and In-situ Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
0.20	1	ES	T+L+VL			MADE GROUND: Firm dark brown slightly silty sandy CLAY with occasional subangular fine to medium flint gravels and with occasional rootlets (1-2mm diameter) and occasional to rare ash pockets. Sand is fine to medium.	(0.30) 0.30	
0.40	2	ES	T+L+VL			MADE GROUND: Firm yellow brown slightly silty sandy CLAY with occasional subangular fine to medium flint gravels and with occasional to rare ash.	(0.25) 0.55	
						Firm light brown mottled grey slightly silty CLAY with occasional subangular fine to coarse flint gravels. Sand is fine to medium. (GAULT FORMATION).	0.60	
						Inspection pit terminated at 0.60m depth		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Backfilled with arisings
3. Inspection pit remained stable
4. Weather conditions: dry, overcast.

All dimensions in metres | Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	CJ Ball	

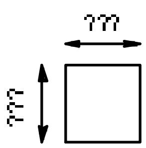
INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	BDW Trading Limited	HP5

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	01.03.13	---	---	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES	T+L+VL			MADE GROUND: soft, dark brownish grey slightly sandy CLAY with occasional subangular fine to coarse flint gravels and with roots and brick fragments. Sand is fine to medium.	(0.30) 0.30	
0.40	2	ES	T+L+VL			MADE GROUND: Firm yellowish brownish grey slightly sandy CLAY with occasional subangular fine to coarse flint gravels and with roots and occasional ash pockets and brick fragments.	(0.25) 0.55	
						Firm light brownish grey silty CLAY (GAULT FORMATION).	0.80	
						Inspection pit terminated at 0.80m depth		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Backfilled with arisings
3. Inspection pit remained stable
4. Weather conditions: dry, overcast.

All dimensions in metres | Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	VMacfarlane	

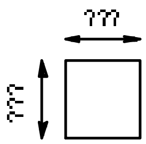
INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	BDW Trading Limited	HP6

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	01.03.13	---	---	1 of 1

Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
0.20	1	ES	T+L+VL			MADE GROUND: Firm brown slightly gravelly silty sandy CLAY with occasional subangular fine to coarse flint gravels and with rare brick fragments. Sand is fine to medium.	(0.30) 0.30	
0.40	2	ES	T+L+VL			MADE GROUND: Firm yellow brown slightly gravelly silty sandy CLAY with occasional subangular fine to coarse flint gravels and with occasional to rare ash pockets and brick fragments.	(0.20) 0.50	
						Firm light brown mottled grey slightly gravelly silty sandy CLAY with occasional subrounded to subangular fine to coarse flint gravels. Sand is fine to medium. (GAULT FORMATION).	0.80	
						Inspection pit terminated at 0.80m depth		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Backfilled with arisings
3. Inspection pit remained stable
4. Weather conditions: overcast.

All dimensions in metres | Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	VMacfarlane	

INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	BDW Trading Limited	HP7

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	01.03.13	---	---	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND: brown slightly gravelly silty CLAY with occasional subangular fine to coarse flint gravels and with occasional roots (5mm diameter) rootlets (1-2mm diameter) and occasional to rare ash pockets and brick fragments.	(0.50) 0.50	
0.20	1	ES	T+L+VL					
0.50	2	ES	T+L+VL			MADE GROUND: Firm light brown slightly gravelly silty CLAY with occasional subangular fine to coarse flint gravels and with occasional to rare ash pockets and brick fragments.	0.80	
						Firm yellowish brown mottled grey slightly gravelly silty CLAY with occasional subangular fine to coarse flint gravels. Sand is fine to medium. (GAULT FORMATION).	0.85	
						Inspection pit terminated at 0.85m depth		

Plan (Not to Scale)	General Remarks
??? × ???	1. No groundwater encountered 2. Backfilled with arisings 3. Inspection pit remained stable 4. Weather conditions: overcast.

All dimensions in metres | Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	CJBall	

AGS

INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	**BDW Trading Limited**	**HP8**

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	01.03.13	---	---	1 of 1

Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Legend
0.10	1	ES	T+J+VL			MADE GROUND: Firm greyish brown slightly silty CLAY with subangular fine to medium flint gravels and with occasional rootlets (1-2mm diameter) and occasional [illegible] ash pockets and brick fragments.	(0.30) 0.30	
0.30	2	ES	T+J+VL			MADE GROUND: Firm light brown slightly silty sandy CLAY with occasional subangular fine to coarse flint gravels. Sand is fine to medium.	0.40	
						Firm yellowish brown mottled grey slightly silty sandy CLAY with occasional subangular fine to medium flint gravels. Sand is fine to medium. (GAULT FORMATION).	(0.25) 0.65	
						Inspection pit terminated at 0.65m depth.		

Plan (Not to Scale)

??? × ???

General Remarks

1. No groundwater encountered
2. Backfilled with arisings
3. Inspection pit remained stable
4. Weather conditions: dry, overcast.

All dimensions in metres | Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	VMacfarlane	

AGS

INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	**BDW Trading Limited**	**HP9**

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinates:	Sheet:
25459	01.03.13	---	---	1 of 1

Samples and In situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES	T+J+VL			MADE GROUND: Firm dark brown slightly gravelly sandy CLAY with occasional subangular fine to coarse flint gravels and with occasional to rare ash pockets and brick fragments. Sand is fine to medium.	(0.30) 0.30	
0.40	2	ES	T+J+VL			MADE GROUND: Firm yellow brown slightly gravelly sandy CLAY with occasional subangular fine to coarse flint gravels and with occasional to rare ash pockets and brick fragments.	(0.20) 0.50	
						Firm light brown mottled grey and orange slightly gravelly sandy CLAY with occasional subangular fine to medium flint gravels. Sand is fine to medium. (GAULT FORMATION).	0.80	
						Inspection pit terminated at 0.80m depth		

Plan (Not to Scale)	General Remarks
??? × ???	1. No groundwater encountered 2. Backfilled with arisings 3. Inspection pit remained stable 4. Weather conditions: dry, overcast.
	All dimensions in metres — Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	CJBall	

INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	**BDW Trading Limited**	**HP10**

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	01.03.13	---	---	**1** of **1**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Made Ground Legend
Depth	No	Type	Results					
0.20	1	ES	T+L+VL			MADE GROUND: Firm dark brown slightly silty sandy CLAY with occasional sub angular fine to coarse flint gravels and with occasional rootlets (1-5mm diameter) and occasional to rare ash pockets and metal fragments. Sand is fine to medium.	(0.40) 0.40	
0.50	2	ES	T+L+VL			MADE GROUND: Firm yellow brown slightly silty sandy CLAY with occasional sub angular fine to coarse flint gravels and with occasional to rare ash pockets and brick fragments.	0.50	
						Firm light brown mottled grey and orange slightly silty sandy CLAY with occasional sub rounded fine to medium flint gravels. Sand is fine to medium. (GAULT FORMATION).	0.80	
						Inspection pit terminated at 0.80m depth		

Plan (Not to Scale)

???

???

General Remarks

1. No groundwater encountered
2. Backfilled with arisings
3. Inspection pit remained stable
4. Weather conditions: cold, overcast.

All dimensions in metres | Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	CJBall	

AGS

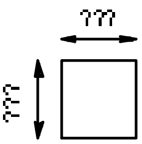
INSPECTION PIT LOG

Contract: NIAB - Phase 1	Client: BDW Trading Limited	Trial Pit: HP11

Contract Ref: 25459	Date: 01.03.13	Ground Level (m AOD): ---	National Grid Co-ordinate: ---	Sheet: 1 of 1

Samples and In-situ Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
0.20	1	ES	T+L+VL			MADE GROUND: Firm dark brownish grey slightly sandy CLAY with occasional subrounded to subangular fine to medium flint gravels and with occasional rootlets (1-2mm diameter) and occasional to rare ash pockets. Sand is fine to medium.	(0.30) 0.30	
0.50	2	ES	T+L+VL			MADE GROUND: Soft to firm brownish grey slightly sandy CLAY with occasional subangular fine to coarse flint gravels and with occasional to rare ash pockets and brick fragments.	(0.30) 0.60	
						Firm yellowish brown mottled grey slightly sandy CLAY with occasional subangular fine to coarse flint gravels. Sand is fine to medium. (GAULT FORMATION).	0.70	
						Inspection pit terminated at 0.70m depth.		

Plan (Not to Scale):



General Remarks

1. No groundwater encountered.
2. Backfilled with arisings.
3. Inspection pit remained stable.
4. Weather conditions: dry, overcast.

All dimensions in metres | Scale: 1:13

Method Used: Hand dug	Plant Used: Hand tools	Logged By: VMacfarlane	Checked By:	AGS

INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	**BDW Trading Limited**	**HP12**

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	01.03.13	---	---	**1** of **1**

Samples and In-situ Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
						MADE GROUND: Firm dark brown slightly silty sandy CLAY with occasional subangular fine to coarse flint gravels and with occasional rootlets (1-2mm diameter) and brick rubble.	(0.40)	
0.20	1	CS	T+C+VL				0.40	
						MADE GROUND: Firm yellow brown slightly silty CLAY with occasional subangular fine to medium flint gravels and with occasional to rare roots and rootlets (1-2mm)	0.50	
0.50	2	CS	T+C+VL			Soft to firm grey yellow brown silty CLAY with occasional subangular fine to medium flint gravels. (GAULT FORMATION).	0.68	
						Inspection pit terminated at 0.68m depth		

Plan (Not to Scale)

???

???

General Remarks

1. No groundwater encountered
2. Backfilled with arising
3. Inspection pit remained stable
4. Weather conditions: dry, overcast.

All dimensions in metres | Scale: 1:13

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	Hand tools	VMacfarlane	

AGS

INSPECTION PIT LOG

Contract:	Client:	Trial Pit:
NIAB - Phase 1	**BDW Trading Limited**	**HP13**

Contract Ref:	Date:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
25459	01.03.13	---	---	**1** of **1**

Samples and In-situ Tests: Depth	No	Type	Results	Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
						MADE GROUND: reworked topsoil and grass cover.	0.10	
0.20	1	ES	T4+VL			MADE GROUND: Firm dark brown very slightly sandy CLAY with occasional subrounded fine to medium flint gravels and with occasional roots (1-2mm diameter) and occasional to rare ash pockets. Sand is fine to medium.	(0.30) 0.40	
0.50	2	ES	T4+VL			MADE GROUND: Firm yellowish brown slightly gravelly slightly sandy CLAY with occasional subangular fine to coarse flint gravels, occasional to rare roots and rootlets (1-2mm diameter) with ash pockets and brick fragments.	(0.20) 0.60	
						Inspection pit terminated at 0.60m depth		

Plan (Not to Scale)

??? × ???

General Remarks

1. No groundwater encountered
2. Backfilled with arisings
3. Inspection pit remained stable
4. Weather conditions: cold, overcast.

All dimensions in metres	Scale: 1:13

Method Used:	Inspection pit + Hand dug	Plant Used:	Hand tools	Logged By:	VMacfarlane	Checked By:	

CHEMICAL TEST RESULTS

Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/01097
Issue Number: 1 **Date:** 18 March, 2013

Client: RSK Environment Ltd Hemel
18 Frogmore Road
Hemel Hempstead
Hertfordshire
UK
HP3 9RT

Project Manager: Nigel Austin / Chris Ball / Verity Macfarlane
Project Name: BDW Trading / NIAB 1, Cambridge
Project Ref: 25459
Order No: Not specified
Date Samples Received: 06/03/13
Date Instructions Received: 06/03/13
Date Analysis Completed: 18/03/13

Prepared by: **Approved by:**

Melanie Marshall
Laboratory Coordinator

Gill Scott
Laboratory Manager

Notes - Soil analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 inert stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.
Notes - General
Subscript "A" indicates analysis performed on the sample as received, "D" indicates analysis performed on the dried sample.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts. Superscript "M" indicates method accredited to MCERTS.
For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations. If results are in italic font they are associated with such quality control failures and may be unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling.
Predominant Matrix Codes - 1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our MCERTS accreditation.
Secondary Matrix Codes - A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.
IS indicates Insufficient sample for analysis. NDP indicates No Determination Possible. NAD indicates No Asbestos Detected. Superscript # indicates method accredited to ISO 17025. Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
Please contact us if you need any further information.

Envirolab Job Number: 13/01097 Client Project Name: BDW Trading / NIAB 1, Cambridge

Client Project Ref: 25459

Lab Sample ID	13/01097/1	13/01097/2	13/01097/3	13/01097/4	13/01097/5	13/01097/6	13/01097/7	13/01097/8	Units	Method ref
Client Sample No										
Client Sample ID	HP1	HP2	HP3	HP4	HP5	HP6	HP7	HP8		
Depth to Top	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10		
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5AE	5E	6AE	6AE	6AE	6AE	6AE	6E		
Asbestos in soil$_D$ #	-	-	NAD	NAD	NAD	NAD	NAD	NAD		A-T-045
Asbestos Matrix$_D$	-	-	-	-	-	-	-	-		A-T-045
Arsenic$_D$ M#	-	-	6	5	7	6	5	5	mg/kg	A-T-024
Cadmium$_D$ M#	-	-	0.9	0.8	0.8	0.8	0.9	1.0	mg/kg	A-T-024
Copper$_D$ M#	-	-	24	20	16	20	21	25	mg/kg	A-T-024
Chromium$_D$ M#	-	-	41	36	26	39	40	47	mg/kg	A-T-024
Lead$_D$ M#	-	-	50	41	32	42	46	52	mg/kg	A-T-024
Mercury$_D$	-	-	0.40	0.34	0.18	0.26	0.39	0.27	mg/kg	A-T-024
Nickel$_D$ M#	-	-	32	30	23	32	32	38	mg/kg	A-T-024
Selenium$_D$ M#	-	-	<1	<1	<1	<1	<1	<1	mg/kg	A-T-024
Zinc$_D$ M#	-	-	70	59	54	63	69	78	mg/kg	A-T-024
TPH total (C6-C40)$_A$	-	-	<10	<10	25	<10	<10	21	mg/kg	A-T-007s

Envirolab Job Number: 13/01097

Client Project Name: BDW Trading / NIAB 1, Cambridge

Client Project Ref: 25459

Lab Sample ID	13/01097/1	13/01097/2	13/01097/3	13/01097/4	13/01097/5	13/01097/6	13/01097/7	13/01097/8	Units	Method ref
Client Sample No										
Client Sample ID	HP1	HP2	HP3	HP4	HP5	HP6	HP7	HP8		
Depth to Top	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10		
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5AE	5E	6AE	6AE	6AE	6AE	6AE	6E		
Acid Herbs										
2,3,6-TBA	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
2,4-D	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
2,4-DB	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
2,4,5-T	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
2,4,5-TP; (Fenoprop); (Silvex)	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
4-CPA	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Benazolin	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Bentazone	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Bromacil	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Bromoxynil	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Clopyralid	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Dicamba	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
2,4-DP; (Dichlorprop)	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Diclofop	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Flamprop	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Flamprop-isopropyl	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Fluroxypyr	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Ioxynil	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
MCPA	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
MCPB	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
MCPP; (Mecoprop)	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
PCP; (Pentachlorophenol)	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Picloram	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon
Triclopyr	-	-	-	<0.1	-	<0.1	-	<0.1	mg/kg	Subcon

Envirolab Job Number: 13/01097 **Client Project Name: BDW Trading / NIAB 1, Cambridge**

Client Project Ref: 25459

Lab Sample ID	13/01097/1	13/01097/2	13/01097/3	13/01097/4	13/01097/5	13/01097/6	13/01097/7	13/01097/8	Units	Method ref
Client Sample No										
Client Sample ID	HP1	HP2	HP3	HP4	HP5	HP6	HP7	HP8		
Depth to Top	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10		
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5AE	5E	6AE	6AE	6AE	6AE	6AE	6E		
PAH 16										
Acenaphthene$_{A}^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Acenaphthylene$_{A}^{M\#}$	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Anthracene$_{A}^{M\#}$	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	mg/kg	A-T-019s
Benzo(a)anthracene$_{A}^{M\#}$	0.14	0.10	<0.04	0.11	<0.04	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Benzo(a)pyrene$_{A}^{M\#}$	0.22	0.18	<0.04	0.96	<0.04	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Benzo(b)fluoranthene$_{A}^{M\#}$	0.28	0.21	<0.05	0.60	<0.05	<0.05	<0.05	<0.05	mg/kg	A-T-019s
Benzo(ghi)perylene$_{A}^{M\#}$	0.19	0.13	<0.05	4.69	<0.05	<0.05	<0.05	<0.05	mg/kg	A-T-019s
Benzo(k)fluoranthene$_{A}^{M\#}$	0.15	0.12	<0.07	0.59	<0.07	<0.07	<0.07	<0.07	mg/kg	A-T-019s
Chrysene$_{A}^{M\#}$	0.20	0.13	<0.06	0.13	<0.06	<0.06	<0.06	<0.06	mg/kg	A-T-019s
Dibenzo(ah)anthracene$_{A}^{M\#}$	<0.04	<0.04	<0.04	3.89	<0.04	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Fluoranthene$_{A}^{M\#}$	0.28	0.13	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	mg/kg	A-T-019s
Fluorene$_{A}^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Indeno(123-cd)pyrene$_{A}^{M\#}$	0.15	0.12	<0.03	4.37	<0.03	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Naphthalene$_{A}^{M\#}$	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Phenanthrene$_{A}^{M\#}$	0.07	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Pyrene$_{A}^{M\#}$	0.28	0.15	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	mg/kg	A-T-019s
Total PAH$_{A}^{M\#}$	1.96	1.29	<0.08	15.4	<0.08	<0.08	<0.08	<0.08	mg/kg	A-T-019s

Envirolab Job Number: 13/01097

Client Project Name: BDW Trading / NIAB 1, Cambridge

Client Project Ref: 25459

Lab Sample ID	13/01097/1	13/01097/2	13/01097/3	13/01097/4	13/01097/5	13/01097/6	13/01097/7	13/01097/8	Units	Method ref
Client Sample No										
Client Sample ID	HP1	HP2	HP3	HP4	HP5	HP6	HP7	HP8		
Depth to Top	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10		
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5AE	5E	6AE	6AE	6AE	6AE	6AE	6E		
Triazines (x11)										
Ametryne	-	-	<0.2	-	<0.2	<0.2	<0.2	-	mg/kg	Subcon
Atraton	-	-	<0.1	-	<0.1	<0.1	<0.1	-	mg/kg	Subcon
Atrazine	-	-	<0.02	-	<0.02	<0.02	<0.02	-	mg/kg	Subcon
Cyanazine	-	-	<0.02	-	<0.02	<0.02	<0.02	-	mg/kg	Subcon
Prometon	-	-	<0.1	-	<0.1	<0.1	<0.1	-	mg/kg	Subcon
Prometryn	-	-	<0.02	-	<0.02	<0.02	<0.02	-	mg/kg	Subcon
Propazine	-	-	<0.02	-	<0.02	<0.02	<0.02	-	mg/kg	Subcon
Simazine	-	-	<0.02	-	<0.02	<0.02	<0.02	-	mg/kg	Subcon
Simetryn	-	-	<0.1	-	<0.1	<0.1	<0.1	-	mg/kg	Subcon
Terbuthylazine	-	-	<0.02	-	<0.02	<0.02	<0.02	-	mg/kg	Subcon
Terbutryn	-	-	<0.02	-	<0.02	<0.02	<0.02	-	mg/kg	Subcon

Envirolab Job Number: 13/01097

Client Project Name: BDW Trading / NIAB 1, Cambridge

Client Project Ref: 25459

Lab Sample ID	13/01097/1	13/01097/2	13/01097/3	13/01097/4	13/01097/5	13/01097/6	13/01097/7	13/01097/8	Units	Method ref
Client Sample No										
Client Sample ID	HP1	HP2	HP3	HP4	HP5	HP6	HP7	HP8		
Depth to Top	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10		
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5AE	5E	6AE	6AE	6AE	6AE	6AE	6E		
TPH CWG										
Ali >C5-C6$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
Ali >C6-C8$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
Ali >C8-C10$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
Ali >C10-C12$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-023 s
Ali >C12-C16$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-023 s
Ali >C16-C21$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-023 s
Ali >C21-C35$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-023 s
Total Aliphatics$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-022 +23s
Aro >C5-C7$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
Aro >C7-C8$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
Aro >C8-C9$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
Aro >C9-C10$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
Aro >C10-C12$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-023 s
Aro >C12-C16$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-023 s
Aro >C16-C21$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-023 s
Aro >C21-C35$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-023 s
Total Aromatics$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-022 +23s
TPH (Ali & Aro)$_A$#	<0.1	<0.1	-	-	-	-	-	-	mg/kg	A-T-022 +23s
BTEX - Benzene$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
BTEX - Toluene$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
BTEX - Ethyl Benzene$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
BTEX - m & p Xylene$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
BTEX - o Xylene$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s
MTBE$_A$#	<0.01	<0.01	-	-	-	-	-	-	mg/kg	A-T-022 s

Envirolab Job Number: 13/01097

Client Project Name: BDW Trading / NIAB 1, Cambridge

Client Project Ref: 25459

Lab Sample ID	13/01097/9	13/01097/10	13/01097/11	13/01097/12	13/01097/13				Units	Method ref
Client Sample No										
Client Sample ID	HP9	HP10	HP11	HP12	HP13					
Depth to Top	0.20	0.20	0.20	0.20	0.20					
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6AE	6E	6E	5AE	6AE					
Asbestos in soil$_D$ #	NAD	NAD	-	-	-					A-T-045
Arsenic$_D$ M#	6	7	-	-	-				mg/kg	A-T-024
Cadmium$_D$ M#	0.9	0.9	-	-	-				mg/kg	A-T-024
Copper$_D$ M#	22	25	-	-	-				mg/kg	A-T-024
Chromium$_D$ M#	37	31	-	-	-				mg/kg	A-T-024
Lead$_D$ M#	51	85	-	-	-				mg/kg	A-T-024
Mercury$_D$	0.24	0.26	-	-	-				mg/kg	A-T-024
Nickel$_D$ M#	32	28	-	-	-				mg/kg	A-T-024
Selenium$_D$ M#	<1	2	-	-	-				mg/kg	A-T-024
Zinc$_D$ M#	97	107	-	-	-				mg/kg	A-T-024
TPH total (C6-C40)$_A$	<10	45	-	-	-				mg/kg	A-T-007 s

Envirolab Job Number: 13/01097

Client Project Name: BDW Trading / NIAB 1, Cambridge

Client Project Ref: 25459

Lab Sample ID	13/01097/9	13/01097/10	13/01097/11	13/01097/12	13/01097/13				Units	Method ref
Client Sample No										
Client Sample ID	HP9	HP10	HP11	HP12	HP13					
Depth to Top	0.20	0.20	0.20	0.20	0.20					
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6AE	6E	6E	5AE	6AE					
Acid Herbs										
2,3,6-TBA	-	<0.1	-	-	-				mg/kg	Subcon
2,4-D	-	<0.1	-	-	-				mg/kg	Subcon
2,4-DB	-	<0.1	-	-	-				mg/kg	Subcon
2,4,5-T	-	<0.1	-	-	-				mg/kg	Subcon
2,4,5-TP; (Fenoprop); (Silvex)	-	<0.1	-	-	-				mg/kg	Subcon
4-CPA	-	<0.1	-	-	-				mg/kg	Subcon
Benazolin	-	<0.1	-	-	-				mg/kg	Subcon
Bentazone	-	<0.1	-	-	-				mg/kg	Subcon
Bromacil	-	<0.1	-	-	-				mg/kg	Subcon
Bromoxynil	-	<0.1	-	-	-				mg/kg	Subcon
Clopyralid	-	<0.1	-	-	-				mg/kg	Subcon
Dicamba	-	<0.1	-	-	-				mg/kg	Subcon
2,4-DP; (Dichlorprop)	-	<0.1	-	-	-				mg/kg	Subcon
Diclofop	-	<0.1	-	-	-				mg/kg	Subcon
Flamprop	-	<0.1	-	-	-				mg/kg	Subcon
Flamprop-isopropyl	-	<0.1	-	-	-				mg/kg	Subcon
Fluroxypyr	-	<0.1	-	-	-				mg/kg	Subcon
Ioxynil	-	<0.1	-	-	-				mg/kg	Subcon
MCPA	-	<0.1	-	-	-				mg/kg	Subcon
MCPB	-	<0.1	-	-	-				mg/kg	Subcon
MCPP; (Mecoprop)	-	<0.1	-	-	-				mg/kg	Subcon
PCP; (Pentachlorophenol)	-	<0.1	-	-	-				mg/kg	Subcon
Picloram	-	<0.1	-	-	-				mg/kg	Subcon
Triclopyr	-	<0.1	-	-	-				mg/kg	Subcon

Envirolab Job Number: 13/01097

Client Project Name: BDW Trading / NIAB 1, Cambridge

Client Project Ref: 25459

Lab Sample ID	13/01097/9	13/01097/10	13/01097/11	13/01097/12	13/01097/13				Units	Method ref
Client Sample No										
Client Sample ID	HP9	HP10	HP11	HP12	HP13					
Depth to Top	0.20	0.20	0.20	0.20	0.20					
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6AE	6E	6E	5AE	6AE					
PAH 16										
$Acenaphthene_A^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-019s
$Acenaphthylene_A^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-019s
$Anthracene_A^{M\#}$	<0.02	<0.02	<0.02	<0.02	0.04				mg/kg	A-T-019s
$Benzo(a)anthracene_A^{M\#}$	<0.04	<0.04	<0.04	<0.04	0.16				mg/kg	A-T-019s
$Benzo(a)pyrene_A^{M\#}$	<0.04	<0.04	<0.04	0.05	0.24				mg/kg	A-T-019s
$Benzo(b)fluoranthene_A^{M\#}$	<0.05	<0.05	<0.05	0.07	0.29				mg/kg	A-T-019s
$Benzo(ghi)perylene_A^{M\#}$	<0.05	<0.05	<0.05	<0.05	0.17				mg/kg	A-T-019s
$Benzo(k)fluoranthene_A^{M\#}$	<0.07	<0.07	<0.07	<0.07	0.14				mg/kg	A-T-019s
$Chrysene_A^{M\#}$	<0.06	<0.06	<0.06	0.09	0.26				mg/kg	A-T-019s
$Dibenzo(ah)anthracene_A^{M\#}$	<0.04	<0.04	<0.04	<0.04	<0.04				mg/kg	A-T-019s
$Fluoranthene_A^{M\#}$	<0.08	<0.08	<0.08	0.15	0.38				mg/kg	A-T-019s
$Fluorene_A^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-019s
$Indeno(123\text{-}cd)pyrene_A^{M\#}$	<0.03	<0.03	<0.03	<0.03	0.13				mg/kg	A-T-019s
$Naphthalene_A^{M\#}$	<0.03	<0.03	<0.03	<0.03	<0.03				mg/kg	A-T-019s
$Phenanthrene_A^{M\#}$	<0.03	<0.03	<0.03	0.05	0.19				mg/kg	A-T-019s
$Pyrene_A^{M\#}$	<0.07	<0.07	<0.07	0.13	0.37				mg/kg	A-T-019s
$Total\ PAH_A^{M\#}$	<0.08	<0.08	<0.08	0.55	2.38				mg/kg	A-T-019s

Envirolab Job Number: 13/01097

Client Project Name: BDW Trading / NIAB 1, Cambridge

Client Project Ref: 25459

Lab Sample ID	13/01097/9	13/01097/10	13/01097/11	13/01097/12	13/01097/13				Units	Method ref
Client Sample No										
Client Sample ID	HP9	HP10	HP11	HP12	HP13					
Depth to Top	0.20	0.20	0.20	0.20	0.20					
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6AE	6E	6E	5AE	6AE					
Triazines (x11)										
Ametryne	<0.2	-	-	-	-				mg/kg	Subcon
Atraton	<0.1	-	-	-	-				mg/kg	Subcon
Atrazine	<0.02	-	-	-	-				mg/kg	Subcon
Cyanazine	<0.02	-	-	-	-				mg/kg	Subcon
Prometon	<0.1	-	-	-	-				mg/kg	Subcon
Prometryn	<0.02	-	-	-	-				mg/kg	Subcon
Propazine	<0.02	-	-	-	-				mg/kg	Subcon
Simazine	<0.02	-	-	-	-				mg/kg	Subcon
Simetryn	<0.1	-	-	-	-				mg/kg	Subcon
Terbuthylazine	<0.02	-	-	-	-				mg/kg	Subcon
Terbutryn	<0.02	-	-	-	-				mg/kg	Subcon

Envirolab Job Number: 13/01097

Client Project Name: BDW Trading / NIAB 1, Cambridge

Client Project Ref: 25459

Lab Sample ID	13/01097/9	13/01097/10	13/01097/11	13/01097/12	13/01097/13				Units	Method ref
Client Sample No										
Client Sample ID	HP9	HP10	HP11	HP12	HP13					
Depth to Top	0.20	0.20	0.20	0.20	0.20					
Depth To Bottom										
Date Sampled	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13	01-Mar-13					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6AE	6E	6E	5AE	6AE					
TPH CWG										
Ali >C5-C6$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C6-C8$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C8-C10$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C10-C12$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Ali >C12-C16$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Ali >C16-C21$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Ali >C21-C35$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Total Aliphatics$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-022+23s
Aro >C5-C7$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C7-C8$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C8-C9$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C9-C10$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C10-C12$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Aro >C12-C16$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Aro >C16-C21$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Aro >C21-C35$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-023s
Total Aromatics$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-022+23s
TPH (Ali & Aro)$_A$#	-	-	<0.1	<0.1	<0.1				mg/kg	A-T-022+23s
BTEX - Benzene$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Toluene$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - m & p Xylene$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - o Xylene$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s
MTBE$_A$#	-	-	<0.01	<0.01	<0.01				mg/kg	A-T-022s

SUPPLEMENTARY GROUND GAS MONITORING RECORDS

IN-SITU GAS MONITORING RESULTS

(Pressures)	Previous	During	Start	End	Equipment Used & Remarks
Round 1	Constant	Constant	1013	1020	Dimeter + GA2000 + Weather: Clear & Sunny + Ground: Dry + Wind: Strong + Air Temp: 18DegC
Round 2	Rising	Rising	1003	1009	Dimeter + GA2000 + Weather: Overcast + Ground: Damp + Wind: Medium + Air Temp: 7DegC
Round 3	Falling	Falling	1005	1005	Dimeter + GFM 430 + Weather: Overcast & Sunny + Ground: Dry + Wind: Medium

Exploratory Position ID	Monitoring Round	Measured Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% v/v)	Methane (% v/v)	Oxygen (% v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH1	1	4.13	19/09/2012	1013	1013	0.0(SS)	DRY	0.6	0.1	19.3	-	0.2	0.0	0.0	
BH1	1	—	15 secs	-	-	0.0(SS)	-	0.2	0.1	19.1	-	0.2	0.0	0.0	
BH1	1	—	30 secs	-	-	0.0(SS)	-	0.6	0.1	19.1	-	0.2	0.0	0.0	
BH1	1	—	60 secs	-	-	0.0(SS)	-	0.6	0.1	19.1	-	0.0	0.0	0.0	
BH1	1	—	90 secs	-	-	0.0(SS)	-	0.6	0.1	19.4	-	0.0	0.0	0.0	
BH1	1	—	120 secs	-	-	0.0(SS)	-	0.6	0.1	19.4	-	0.0	0.0	0.0	
BH1	1	—	180 secs	-	-	0.0(SS)	-	0.6	0.1	19.4	-	0.0	0.0	0.0	
BH1	1	—	240 secs	-	-	0.0(SS)	-	0.6	0.1	19.4	-	0.0	0.0	0.0	
BH1	1	—	300 secs	-	-	0.0(SS)	-	0.6	0.1	19.4	-	0.0	0.0	0.0	
BH1	1	—	360 secs	-	-	0.0(SS)	-	0.6	0.1	19.4	-	0.0	0.0	0.0	
BH1	1	—	420 secs	-	-	0.0(SS)	-	0.6	0.1	19.4	-	0.0	0.0	0.0	
BH1	2 (2)	4.22	03/10/2012	1004	1002	0.0(SS)	DRY	0.0	0.0	20.4	-	0.0	0.0	0.0	
BH1	2 (2)	—	15 secs	-	-	0.0(SS)	-	1.1	0.0	18.5	-	0.0	0.0	0.0	
BH1	2 (2)	—	30 secs	-	-	0.0(SS)	-	1.1	0.0	18.5	-	0.0	0.0	0.0	
BH1	2 (2)	—	60 secs	-	-	0.0(SS)	-	1.1	0.0	18.5	-	0.0	0.0	0.0	
BH1	2 (2)	—	90 secs	-	-	0.0(SS)	-	1.1	0.0	18.5	-	0.0	0.0	0.0	
BH1	2 (2)	—	120 secs	-	-	0.0(SS)	-	1.1	0.0	18.5	-	0.0	0.0	0.0	
BH1	2 (2)	—	180 secs	-	-	0.0(SS)	-	1.1	0.0	18.5	-	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd 18 Frogmore Road Hemel Hempstead Hertfordshire HP3 9RT	Compiled By	Date	Checked By	Date	Contract Ref: 25459
		24/10/12			
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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Barometric Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (%v/v)	Methane (%v/v)	Oxygen (%v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH1	2 (2)	—	240 secs	-	-	0.0_{SS}	-	1.1	0.0	18.5	-	0.0	0.0	0.0	
BH1	2 (2)	—	300 secs	-	-	0.0_{SS}	-	1.1	0.0	18.5	-	0.0	0.0	0.0	
BH1	2 (2)	—	360 secs	-	-	0.0_{SS}	-	1.1	0.0	18.5	-	0.0	0.0	0.0	
BH1	2 (2)	—	420 secs	-	-	0.0_{SS}	-	1.1	0.0	18.5	-	0.0	0.0	0.0	
BH1	3 (3)	4.25	11/10/2012	1004	1003	0.0_{SS}	DRY	0.0	0.0	20.9	0.0	-	-	-	
BH1	3 (3)	—	15 secs	-	-	0.0_{SS}	-	1.7	0.0	19.9	0.0	-	-	-	
BH1	3 (3)	—	30 secs	-	-	0.0_{SS}	-	1.7	0.0	19.2	0.0	-	-	-	
BH1	3 (3)	—	60 secs	-	-	0.0_{SS}	-	1.7	0.0	19.1	0.0	-	-	-	
BH1	3 (3)	—	90 secs	-	-	0.0_{SS}	-	1.8	0.0	19.0	0.0	-	-	-	
BH1	3 (3)	—	120 secs	-	-	0.0_{SS}	-	1.8	0.0	19.0	0.0	-	-	-	
BH1	3 (3)	—	180 secs	-	-	0.0_{SS}	-	1.7	0.0	19.1	0.0	-	-	-	
BH2	1	—	19/09/2012	1013	1013	0.3_{SS}	-	0.2	0.0_I	20.1	0.0_I	0.3	0.0	0.0	
BH2	1	—	15 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.2	0.0	0.0	
BH2	1	—	30 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BH2	1	—	60 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BH2	1	—	90 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BH2	1	—	120 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BH2	1	—	180 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BH2	1	—	240 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BH2	1	—	300 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BH2	1	—	360 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BH2	1	—	420 secs	1013	1013	0.3_{SS}	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BH2	2	—	05/10/2012	1002	1002	0.4_I	-	0.0	0.0	20.8	0.0	0.0	0.0	0.0	
BH2	2	—	15 secs	1013	1013	0.0_{SS}	-	0.5	0.0	19.9	0.0	-	-	-	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd 18 Frogmore Road Hemel Hempstead Hertfordshire HP3 9RT	Compiled By	Date	Checked By	Date	Contract Ref: 25459
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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (%v/v)	Methane (%v/v)	Oxygen (%v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH2	2	—	30 secs	1018	1018	0.0SS	-	0.5	0.0	19.9	0.0	-	-	-	
BH2	2	—	60 secs	1018	1018	0.0SS	-	0.5	0.0	19.9	0.0	-	-	-	
BH2	2	—	90 secs	1018	1018	0.0SS	-	0.5	0.0	19.8	0.0	-	-	-	
BH2	2	—	120 secs	1018	1018	0.0SS	-	0.5	0.0	19.9	0.0	-	-	-	
BH2	2	—	180 secs	1018	1018	0.0SS	-	0.5	0.0	19.9	0.0	-	-	-	
BH2	2	—	240 secs	1018	1018	0.0SS	-	0.5	0.0	19.9	0.0	-	-	-	
BH2	2	—	300 secs	1018	1018	0.0SS	-	0.5	0.0	19.9	0.0	-	-	-	
BH2	2	—	360 secs	1018	1018	0.0SS	-	0.5	0.0	19.9	0.0	-	-	-	
BH2	2	—	420 secs	1018	1018	0.0SS	-	0.5	0.0	19.9	0.0	-	-	-	
BH2	3	—	11/10/2012	1006	1006	0.0P	-	0.3	0.0	20.9	0.0	-	-	-	
BH2	3	—	15 secs	1006	1006	0.0SS	-	1.7SS	0.0SS	20.5SS	0.0SS	-	-	-	
BH2	3	—	30 secs	1006	1006	0.0SS	-	1.2	0.0	20.0	0.0	-	-	-	
BH2	3	—	60 secs	1006	1006	0.0SS	-	1.2	0.0	19.5	0.0	-	-	-	
BH2	3	—	90 secs	1006	1006	0.0SS	-	1.2	-	19.4	-	-	-	-	
BH2	3	—	120 secs	1006	1006	0.0SS	-	1.2	-	19.3	-	-	-	-	
BH2	3	—	180 secs	1006	1006	0.0SS	-	1.1	-	19.3	-	-	-	-	
BH2	3	—	240 secs	1006	1006	0.0SS	-	1.1	-	19.4	-	-	-	-	
BH2	3	—	300 secs	1006	1006	0.0SS	-	1.1	-	19.4	-	-	-	-	
BH2	3	—	360 secs	1006	1006	0.0SS	-	1.1	-	19.4	-	-	-	-	
BH2	3	—	420 secs	1006	1006	0.0SS	-	1.1	-	19.4	-	-	-	-	
BH3	2 (2)	3.23	05/10/2012	-	1009	0.0SS	1.44	0.0	0.0	20.6	0.0	0.0	0.0	0.0	
BH3	2 (2)	—	15 secs	-	-	0.0SS	-	0.7	0.0	19.4	0.0	-	0.0	0.0	
BH3	2 (2)	—	30 secs	-	-	0.0SS	-	0.7	0.0	19.4	0.0	-	0.0	0.0	
BH3	2 (2)	—	60 secs	-	-	0.0SS	-	0.7	0.0	19.4	0.0	-	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT	Compiled By	Date	Checked By	Date	Contract Ref:
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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Barometric Pressure (mb)	Ambient Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% vol)	Methane (% vol)	Oxygen (% vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH3	2 (2)	—	90 secs	-	-	0.0 SS	-	0.7	0.0	19.4	0.0	-	0.0	0.0	
BH3	2 (2)	—	120 secs	-	-	0.0 SS	-	0.7	0.0	19.3	0.0	-	0.0	0.0	
BH3	2 (2)	—	180 secs	-	-	0.0 SS	-	0.7	0.0	19.4	0.0	-	0.0	0.0	
BH3	2 (2)	—	240 secs	-	-	0.0 SS	-	0.7	0.0	19.3	0.0	-	0.0	0.0	
BH3	2 (2)	—	300 secs	-	-	0.0 SS	-	0.7	0.0	19.3	0.0	-	0.0	0.0	
BH3	2 (2)	—	360 secs	-	-	0.0 SS	-	0.7	0.0	19.3	0.0	-	0.0	0.0	
BH3	2 (2)	—	420 secs	-	-	0.0 SS	-	0.7	0.0	19.3	0.0	-	0.0	0.0	
BH3	3 (3)	3.50	11/10/2012	-	1002	0.0 SS	1.52	0.0	-	20.7	-	-	0.0	-	
BH3	3 (3)	—	15 secs	-	-	0.0 SS	-	1.4	-	19.4	-	-	-	-	
BH3	3 (3)	—	30 secs	-	-	0.0 SS	-	1.5	-	18.2	-	-	-	-	
BH3	3 (3)	—	60 secs	-	-	0.0 SS	-	1.5	-	17.9	-	-	-	-	
BH3	3 (3)	—	90 secs	-	-	0.0 SS	-	1.5	-	17.9	-	-	-	-	
BH3	3 (3)	—	120 secs	-	-	0.0 SS	-	1.5	-	17.9	-	-	-	-	
BH3	3 (3)	—	180 secs	-	-	0.0 SS	-	1.5	-	17.9	-	-	-	-	
BH2	1	4.32	19/09/2012	1012	1012	-0.1 SS	2.12	0.2	0.0	20.2	0.0	0.3	0.0	0.0	
BH2	1	—	15 secs	-	-	-0.1 SS	-	0.2	0.0	20.2	0.0	0.0	0.0	0.0	
BH2	1	—	30 secs	-	-	-0.1 SS	-	0.2	0.0	20.2	0.0	0.0	0.0	0.0	
BH2	1	—	60 secs	-	-	-0.1 SS	-	0.2	0.0	20.3	0.0	0.0	0.0	0.0	
BH2	1	—	90 secs	-	-	-0.1 SS	-	0.2	0.0	20.3	0.0	0.0	0.0	0.0	
BH2	1	—	120 secs	-	-	-0.1 SS	-	0.2	0.0	20.3	0.0	0.0	0.0	0.0	
BH2	1	—	180 secs	-	-	-0.1 SS	-	0.1	0.0	20.3	0.0	0.0	0.0	0.0	
BH2	1	—	240 secs	-	-	-0.1 SS	-	0.2	0.0	20.3	0.0	0.0	0.0	0.0	
BH2	1	—	300 secs	-	-	-0.1 SS	-	0.2	0.0	20.2	0.0	0.0	0.0	0.0	
BH2	1	—	360 secs	-	-	-0.1 SS	-	0.2	0.0	20.2	0.0	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT	Compiled By	Date	Checked By	Date	Contract Ref:
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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% v/v)	Methane (% v/v)	Oxygen (% v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BHC	1	—	420 secs	-	-	-0.1 (SS)	-	0.2	0.0	20.2	0.0	0.0	0.0	0.0	
BHC	2 (2)	4.31	05/10/2012	1003	1003	0.0 (SS)	215	0.0	0.0	20.8	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	15 secs	-	-	0.0 (SS)	-	0.3	0.0	19.6	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	30 secs	-	-	0.0 (SS)	-	0.3	0.0	19.9	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	60 secs	-	-	0.0 (SS)	-	0.3	0.0	20.0	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	90 secs	-	-	0.0 (SS)	-	0.3	0.0	20.0	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	120 secs	-	-	0.0 (SS)	-	0.2	0.0	20.0	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	180 secs	-	-	0.0 (SS)	-	0.2	0.0	20.1	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	240 secs	-	-	0.0 (SS)	-	0.2	0.0	20.1	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	300 secs	-	-	0.0 (SS)	-	0.1	0.0	20.1	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	360 secs	-	-	0.0 (SS)	-	0.1	0.0	20.1	0.0	0.0	0.0	0.0	
BHC	2 (2)	—	420 secs	-	-	0.0 (SS)	-	0.1	0.0	20.2	0.0	0.0	0.0	0.0	
BHC	3 (3)	4.52	11/10/2012	1003	1003	0.0 (SS)	240	0.3	0.0	20.9	0.0	-	-	-	
BHC	3 (3)	—	15 secs	-	-	0.0 (SS)	-	1.1	0.0	20.0	0.0	-	-	-	
BHC	3 (3)	—	30 secs	-	-	0.0 (SS)	-	1.2	0.0	19.5	0.0	-	-	-	
BHC	3 (3)	—	60 secs	-	-	0.0 (SS)	-	1.2	0.0	19.4	0.0	-	-	-	
BHC	3 (3)	—	90 secs	-	-	0.0 (SS)	-	1.2	0.0	19.3	0.0	-	-	-	
BHC	3 (3)	—	120 secs	-	-	0.0 (SS)	-	1.2	0.0	19.3	0.0	-	-	-	
BHC	3 (3)	—	180 secs	-	-	0.0 (SS)	-	1.1	0.0	19.4	0.0	-	-	-	
BHC	3 (3)	—	240 secs	-	-	0.0 (SS)	-	1.1	0.0	19.4	0.0	-	-	-	
BHC	3 (3)	—	300 secs	-	-	0.0 (SS)	-	1.1	0.0	19.4	0.0	-	-	-	
BHC	3 (3)	—	360 secs	-	-	0.0 (SS)	-	1.1	0.0	19.4	0.0	-	-	-	
BHC	3 (3)	—	420 secs	-	-	0.0 (SS)	-	1.1	0.0	19.4	0.0	-	-	-	
BHK	1	4.05	10/09/2012	1013	1013	0.0 (SS)	1.97	1.3	0.1	19.8	1.0	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd 18 Frogmore Road Hemel Hempstead Hertfordshire HP3 9RT	Compiled By	Date	Checked By	Date	Contract Ref: 25459
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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Barometric Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% v/v)	Methane (% v/v)	Oxygen (% v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BHK	1	—	15 secs	-	-	0.0_{SS}	-	1.3	0.1	19.5	1.0	0.0	0.0	0.0	
BHK	1	—	30 secs	-	-	0.0_{SS}	-	1.4	0.1	19.5	1.0	0.0	0.0	0.0	
BHK	1	—	60 secs	-	-	0.0_{SS}	-	1.3	0.1	19.5	1.0	0.0	0.0	0.0	
BHK	1	—	90 secs	-	-	0.0_{SS}	-	1.3	0.1	19.5	1.0	0.0	0.0	0.0	
BHK	1	—	120 secs	-	-	0.0_{SS}	-	1.4	0.1	19.5	1.0	0.0	0.0	0.0	
BHK	1	—	180 secs	-	-	0.0_{SS}	-	1.5	0.1	19.5	1.0	0.0	0.0	0.0	
BHK	1	—	240 secs	-	-	0.0_{SS}	-	1.7	0.1	19.4	1.0	0.0	0.0	0.0	
BHK	1	—	300 secs	-	-	0.0_{SS}	-	1.2	0.1	19.3	1.0	0.0	0.0	0.0	
BHK	1	—	360 secs	-	-	0.0_{SS}	-	1.2	0.1	19.3	1.0	0.0	0.0	0.0	
BHK	1	—	420 secs	-	-	0.0_{SS}	-	1.2	0.1	19.3	1.0	0.0	0.0	0.0	
BHK	2 (2)	4.04	05/10/2012	1009	1002	0.2_{SS}	2.06	0.2	0.0	20.8	-	0.0	0.0	0.0	
BHK	2 (2)	—	15 secs	-	-	0.2_{SS}	-	0.7	0.0	19.8	-	0.0	0.0	0.0	
BHK	2 (2)	—	30 secs	-	-	0.2_{SS}	-	1.3	0.0	19.1	-	0.0	0.0	0.0	
BHK	2 (2)	—	60 secs	-	-	0.2_{SS}	-	1.3	0.0	19.1	-	0.0	0.0	0.0	
BHK	2 (2)	—	90 secs	-	-	0.2_{SS}	-	1.3	0.0	19.1	-	0.0	0.0	0.0	
BHK	2 (2)	—	120 secs	-	-	0.2_{SS}	-	1.2	0.0	19.1	-	0.0	0.0	0.0	
BHK	2 (2)	—	180 secs	-	-	0.2_{SS}	-	1.3	0.0	19.1	-	0.0	0.0	0.0	
BHK	2 (2)	—	240 secs	-	-	0.2_{SS}	-	1.2	0.0	19.1	-	0.0	0.0	0.0	
BHK	2 (2)	—	300 secs	-	-	0.2_{SS}	-	1.2	0.0	19.1	-	0.0	0.0	0.0	
BHK	2 (2)	—	360 secs	-	-	0.2_{SS}	-	1.2	0.0	19.1	-	0.0	0.0	0.0	
BHK	2 (2)	—	420 secs	-	-	0.2_{SS}	-	1.2	0.0	19.1	-	0.0	0.0	0.0	
BHK	3 (3)	4.30	11/10/2012	-	1005	-0.1_{SS}	2.32	0.1	0.0	20.7	0.0	-	-	-	
BHK	3 (3)	—	15 secs	-	-	-0.1_{SS}	-	3.2	0.0	19.2	0.0	-	-	-	
BHK	3 (3)	—	30 secs	-	-	-0.1_{SS}	-	3.3	0.0	18.4	0.0	-	-	-	
BHK	3 (3)	—	60 secs	-	-	-0.1_{SS}	-	3.3	0.0	18.2	0.0	-	-	-	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd 18 Frogmore Road Hemel Hempstead Hertfordshire HP3 9RT	Compiled By	Date 24/10/12	Checked By	Date	Contract Ref: 25459
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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Barometric Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% v/v)	Methane (% v/v)	Oxygen (% v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BHK	3 (3)	—	90 secs	-	-	-0.1ss	-	3.4	0.0	18.1	0.0	-	-	-	
BHK	3 (3)	—	120 secs	-	-	-0.1ss	-	3.4	0.0	18.1	0.0	-	-	-	
BHK	3 (3)	—	180 secs	-	-	-0.1ss	-	3.5	0.0	18.0	0.0	-	-	-	
BHK	3 (3)	—	240 secs	-	-	-0.1ss	-	3.5	0.0	18.0	0.0	-	-	-	
BHK	3 (3)	—	300 secs	-	-	-0.1ss	-	3.5	0.0	18.0	0.0	-	-	-	
WS3	1	3.21	19/09/2012	1018	1018	0.2ss	DRY	0.0	0.1	20.3	0.0	0.0	0.0	0.0	
WS3	1	—	15 secs	-	-	0.2ss	-	0.6	0.1	20.2	1.0	0.0	0.0	0.0	
WS3	1	—	30 secs	-	-	0.2ss	-	0.7	0.1	20.2	1.0	0.0	0.0	0.0	
WS3	1	—	60 secs	-	-	0.2ss	-	0.8	0.1	20.2	1.0	0.0	0.0	0.0	
WS3	1	—	90 secs	-	-	0.2ss	-	0.7	0.1	20.2	1.0	0.0	0.0	0.0	
WS3	1	—	120 secs	-	-	0.2ss	-	0.7	0.1	20.2	1.0	0.0	0.0	0.0	
WS3	1	—	180 secs	-	-	0.2ss	-	0.6	0.1	20.3	1.0	0.0	0.0	0.0	
WS3	1	—	240 secs	-	-	0.2ss	-	0.6	0.1	20.3	1.0	0.0	0.0	0.0	
WS3	1	—	300 secs	-	-	0.2ss	-	0.5	0.1	20.4	1.0	0.0	0.0	0.0	
WS3	1	—	360 secs	-	-	0.2ss	-	0.4	0.1	20.5	1.0	0.0	0.0	0.0	
WS3	1	—	420 secs	-	-	0.2ss	-	0.4	0.1	20.5	1.0	0.0	0.0	0.0	
WS3	2 (2)	3.18	05/10/2012	1004	1008	0.3ss	2.92	1.1	0.0	19.6	-	-	-	-	
WS3	2 (2)	—	15 secs	-	-	0.3ss	-	1.1	0.0	19.6	-	-	-	-	
WS3	2 (2)	—	30 secs	-	-	0.3ss	-	1.1	0.0	19.5	-	-	-	-	
WS3	2 (2)	—	60 secs	-	-	0.3ss	-	1.2	0.0	19.5	-	-	-	-	
WS3	2 (2)	—	90 secs	-	-	0.3ss	-	1.2	0.0	19.5	-	-	-	-	
WS3	2 (2)	—	120 secs	-	-	0.3ss	-	1.1	0.0	19.4	-	-	-	-	
WS3	2 (2)	—	180 secs	-	-	0.3ss	-	1.0	0.0	19.5	-	-	-	-	
WS3	2 (2)	—	240 secs	-	-	0.3ss	-	0.9	0.0	19.5	-	-	-	-	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd 18 Frogmore Road Hemel Hempstead Hertfordshire HP3 9RT	Compiled By	Date: 24/10/12	Checked By	Date	Contract Ref: 25459
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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% v/v)	Methane (% v/v)	Oxygen (% v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
WS3	2 (2)	—	300 secs	-	-	0.3 SS	-	0.9	0.0	19.6	-	-	-	-	
WS3	2 (2)	—	300 secs	-	-	0.3 SS	-	0.8	0.0	19.6	-	-	-	-	
WS3	2 (2)	—	420 secs	-	-	0.3 SS	-	0.8	0.0	19.6	-	-	-	-	
WS3	3 (3)	5.44	11/10/2012	-	1005	0.0 SS	2.87	0.3	0.0	20.7	0.0	-	-	-	
WS3	3 (3)	—	15 secs	-	-	0.0 SS	-	2.1	0.0	19.9	0.0	-	-	-	
WS3	3 (3)	—	30 secs	-	-	0.0 SS	-	2.2	0.0	19.3	0.0	-	-	-	
WS3	3 (3)	—	60 secs	-	-	0.0 SS	-	2.2	0.0	19.3	0.0	-	-	-	
WS3	3 (3)	—	90 secs	-	-	0.0 SS	-	2.2	0.0	19.3	0.0	-	-	-	
WS3	3 (3)	—	120 secs	-	-	0.0 SS	-	2.2	0.0	19.3	0.0	-	-	-	
WS3	3 (3)	—	180 secs	-	-	0.0 SS	-	2.2	0.0	19.3	0.0	-	-	-	
WS3	3 (3)	—	240 secs	-	-	0.0 SS	-	2.2	0.0	19.3	0.0	-	-	-	
WS3	3 (3)	—	300 secs	-	-	0.0 SS	-	2.2	0.0	19.3	0.0	-	-	-	
WS3	3 (3)	—	300 secs	-	-	0.0 SS	-	2.2	0.0	19.3	0.0	-	-	-	
WS3	3 (3)	—	420 secs	-	-	0.0 SS	-	2.2	0.0	19.3	0.0	-	-	-	
WS17	1	2.95	10/09/2012	1020	1020	0.1 SS	DRY	1.7	0.0	19.5	0.0	-	-	-	
WS17	1	—	15 secs	-	-	0.1 SS	-	1.7	0.0	19.5	0.0	-	-	-	
WS17	1	—	30 secs	-	-	0.1 SS	-	1.8	0.0	19.2	0.0	-	-	-	
WS17	1	—	60 secs	-	-	0.1 SS	-	2.0	0.0	19.1	0.0	-	-	-	
WS17	1	—	90 secs	-	-	0.1 SS	-	2.1	0.1	19.0	1.0	-	-	-	
WS17	1	—	120 secs	-	-	0.1 SS	-	2.4	0.1	18.8	2.0	-	-	-	
WS17	1	—	180 secs	-	-	0.1 SS	-	2.7	0.1	18.7	2.0	-	-	-	
WS17	1	—	240 secs	-	-	0.1 SS	-	2.9	0.1	18.6	2.0	-	-	-	
WS17	1	—	300 secs	-	-	0.1 SS	-	2.9	0.1	18.6	2.0	-	-	-	
WS17	1	—	300 secs	-	-	0.1 SS	-	2.9	0.1	18.6	2.0	-	-	-	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT	Compiled By	Date	Checked By	Date	Contract Ref:
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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Barometric Pressure (mb)	Annulus Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (%v/v)	Methane (%v/v)	Oxygen (%v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
WS17	1	—	420 secs	-	-	0.1ss	-	2.9	0.1	18.6	2.0	-	-	-	
WS17	2 (2)	2.95	05/10/2012	1323	1009	0.0ss	1.32	0.1	0.0	20.2	0.0	0.0	0.0	0.0	
WS17	2 (2)	—	15 secs	-	-	0.0ss	-	0.3	0.0	20.2	0.0	-	0.0	0.0	
WS17	2 (2)	—	30 secs	-	-	0.0ss	-	0.4	0.0	20.2	0.0	-	0.0	0.0	
WS17	2 (2)	—	60 secs	-	-	0.0ss	-	0.8	0.0	19.7	0.0	-	0.0	0.0	
WS17	2 (2)	—	90 secs	-	-	0.0ss	-	0.9	0.0	19.6	0.0	-	0.0	0.0	
WS17	2 (2)	—	120 secs	-	-	0.0ss	-	1.3	0.0	19.2	0.0	-	0.0	0.0	
WS17	2 (2)	—	180 secs	-	-	0.0ss	-	1.4	0.0	18.9	0.0	-	0.0	0.0	
WS17	2 (2)	—	240 secs	-	-	0.0ss	-	1.5	0.0	18.8	0.0	-	0.0	0.0	
WS17	2 (2)	—	300 secs	-	-	0.0ss	-	1.5	0.0	18.8	0.0	-	0.0	0.0	
WS17	2 (2)	—	360 secs	-	-	0.0ss	-	1.4	0.0	18.9	0.0	-	0.0	0.0	
WS17	2 (2)	—	420 secs	-	-	0.0ss	-	1.3	0.0	18.9	0.0	-	0.0	0.0	
WS17	3 (3)	2.90	11/10/2012	-	1006	0.0ss	1.26	0.2	-	21.3	-	-	-	-	
WS17	3 (3)	—	15 secs	-	-	0.0ss	-	0.6	-	20.6	-	-	-	-	
WS17	3 (3)	—	30 secs	-	-	0.0ss	-	0.6	-	20.5	-	-	-	-	
WS17	3 (3)	—	60 secs	-	-	0.0ss	-	0.7	-	20.4	-	-	-	-	
WS17	3 (3)	—	90 secs	-	-	0.0ss	-	0.9	-	20.2	-	-	-	-	
WS17	3 (3)	—	120 secs	-	-	0.0ss	-	1.1	-	20.0	-	-	-	-	
WS17	3 (3)	—	180 secs	-	-	0.0ss	-	1.4	-	19.6	-	-	-	-	
WS17	3 (3)	—	240 secs	-	-	0.0ss	-	1.5	-	19.5	-	-	-	-	
WS17	3 (3)	—	300 secs	-	-	0.0ss	-	1.7	-	19.3	-	-	-	-	
WS17	3 (3)	—	360 secs	-	-	0.0ss	-	1.7	-	19.3	-	-	-	-	
WSH	1	2.33	19/09/2012	1013	1013	0.0ss	DRY	2.7	0.1	19.1	1.0	0.7	0.0	0.0	
WSH	1	—	15 secs	-	-	0.0ss	-	2.2	0.1	19.0	1.0	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date	Contract Ref:
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AGS

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% v/v)	Methane (% v/v)	Oxygen (% v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
WSH	1	—	30 secs	-	-	0.0ss	-	3.1	0.1	18.8	1.0	0.0	0.0	0.0	
WSH	1	—	60 secs	-	-	0.0ss	-	3.4	0.1	18.8	1.0	0.0	0.0	0.0	
WSH	1	—	90 secs	-	-	0.0ss	-	3.5	0.1	18.8	1.0	0.0	0.0	0.0	
WSH	1	—	120 secs	-	-	0.0ss	-	3.6	0.1	18.7	1.0	0.0	0.0	0.0	
WSH	1	—	180 secs	-	-	0.0ss	-	3.6	0.1	18.8	1.0	0.0	0.0	0.0	
WSH	1	—	240 secs	-	-	0.0ss	-	3.5	0.1	18.9	1.0	0.0	0.0	0.0	
WSH	1	—	300 secs	-	-	0.0ss	-	3.3	0.1	18.9	1.0	0.0	0.0	0.0	
WSH	1	—	360 secs	-	-	0.0ss	-	3.3	0.1	19.0	1.0	0.0	0.0	0.0	
WSH	1	—	420 secs	-	-	0.0ss	-	3.2	0.1	19.0	1.0	0.0	0.0	0.0	
WSH	2 (2)	2.39	03/10/2012	-	1002	0.0ss	DRY	0.0	0.0	19.9	-	0.0	0.0	0.0	
WSH	2 (2)	—	15 secs	-	-	0.0ss	-	1.3	0.0	19.1	-	-	0.0	0.0	
WSH	2 (2)	—	30 secs	-	-	0.0ss	-	2.9	0.0	18.7	-	-	0.0	0.0	
WSH	2 (2)	—	60 secs	-	-	0.0ss	-	3.3	0.0	18.4	-	-	0.0	0.0	
WSH	2 (2)	—	90 secs	-	-	0.0ss	-	3.4	0.0	18.4	-	-	0.0	0.0	
WSH	2 (2)	—	120 secs	-	-	0.0ss	-	3.4	0.0	18.4	-	-	0.0	0.0	
WSH	2 (2)	—	180 secs	-	-	0.0ss	-	3.4	0.0	18.4	-	-	0.0	0.0	
WSH	2 (2)	—	240 secs	-	-	0.0ss	-	3.3	0.0	18.4	-	-	0.0	0.0	
WSH	2 (2)	—	300 secs	-	-	0.0ss	-	3.4	0.0	18.4	-	-	0.0	0.0	
WSH	2 (2)	—	360 secs	-	-	0.0ss	-	3.3	0.0	18.4	-	-	0.0	0.0	
WSH	2 (2)	—	420 secs	-	-	0.0ss	-	3.3	0.0	18.4	-	-	0.0	0.0	
WSH	3 (3)	2.70	11/10/2012	1004	1005	0.0ss	DRY	0.1	0.0	20.8	0.0	-	-	-	
WSH	3 (3)	—	15 secs	-	-	0.0ss	-	3.5	0.0	19.2	0.0	-	-	-	
WSH	3 (3)	—	30 secs	-	-	0.0ss	-	3.5	0.0	18.6	0.0	-	-	-	
WSH	3 (3)	—	60 secs	-	-	0.0ss	-	3.7	0.0	18.4	0.0	-	-	-	
WSH	3 (3)	—	90 secs	-	-	0.0ss	-	4.0	0.0	18.2	0.0	-	-	-	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date	Contract Ref:
	24/10/12			25459

Contract: NIAB - Phase 1

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Ambient Pressure (mb)	Gas Flow (l/h)	Water Depth (mbgl)	Carbon Dioxide (%v/v)	Methane (%v/v)	Oxygen (%v/v)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
WSH	3 (3)	—	120 secs	-	-	0.0_{SS}	-	4.1	0.0	18.1	0.0	-	-	-	
WSH	3 (3)	—	180 secs	-	-	0.0_{SS}	-	4.2	0.0	18.0	0.0	-	-	-	
WSH	3 (3)	—	240 secs	-	-	0.0_{SS}	-	4.2	0.0	18.0	0.0	-	-	-	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date	Contract Ref:
	24/10/12			25459

Contract: NIAB - Phase 1

APPENDIX - Results of Gas Monitoring (date 16/01/2013)

Atmospheric Pressure (mb): 1009

AP Conditions (BBC Website): Rising

Equipment Used GA2000+

Temperature: 1C

Weather Conditions: Clear, recent snow fall

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH1	0.80	4.27		0	0.0	0.0	0.1	21.4	0	0	0			
				15	0.0	0.0	0.7	21.1	0	0	0			
				30	0.0	0.0	0.7	21.0	0	0	0			
				60	0.0	0.0	0.7	21.0	0	0	0			
				90	0.0	0.0	0.7	21.0	0	0	0			
				120	0.0	0.0	0.7	21.0	0	0	0			
				180	0.0	0.0	0.7	21.0	0	0	0			
				240	0.0	0.0	0.7	21.0	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH2		4.34		0	0.0	0.0	0.1	20.7	0	0	0			
				15	0.0	0.0	0.9	19.5	0	0	0			
				30	0.0	0.0	0.9	18.0	0	0	0			
				60	0.0	0.0	0.9	18.0	0	0	0			
				90	0.0	0.0	0.9	18.2	0	0	0			
				120	0.0	0.0	0.9	18.2	0	0	0			
				180	0.0	0.0	0.9	18.2	0	0	0			
				240	0.0	0.0	0.9	18.2	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH3		3.22		0	0.0	0.0	0.1	21.2	0	0	0			
				15	0.0	0.0	1.1	20.2	0	0	0			
				30	0.0	0.0	1.1	18.9	0	0	0			
				60	0.0	0.0	1.1	17.7	0	0	0			
				90	0.0	0.0	1.1	17.7	0	0	0			
				120	0.0	0.0	1.1	17.7	0	0	0			
				180	0.0	0.0	1.1	17.7	0	0	0			
				240	0.0	0.0	1.1	17.7	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BHG	0.95	4.30		0	0.0	0.0	0.1	21.4	0	0	0			
				15	0.0	0.1	0.9	21.3	0	0	0			
				30	0.0	0.1	0.9	20.8	0	0	0			
				60	0.0	0.1	0.9	20.8	0	0	0			
				90	0.0	0.1	0.4	20.8	0	0	0			
				120	0.0	0.1	0.4	20.8	0	0	0			
				180	0.0	0.1	0.4	20.8	0	0	0			
				240	0.0	0.1	0.4	20.7	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BHK	1.96	4.3		0	0	0.0	0.1	20.7	0	0	0			
				15	-0.1	0.0	0.6	20.6	0	0	0			
				30	-0.1	0.0	0.6	17.5	0	0	0			
				60	-0.1	0.0	0.6	17.5	0	0	0			
				90	-0.1	0.0	0.6	17.5	0	0	0			
				120	-0.1	0.0	0.5	17.5	0	0	0			
				180	-0.1	0.0	0.5	17.5	0	0	0			
				240	-0.1	0.0	0.6	17.5	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WS3		3.20		0	0.0	0.0	0.1	21.0	0	0	0			
				15	0.0	0.0	2.2	20.5	0	0	0			
				30	0.0	0.0	2.2	19.4	0	0	0			
				60	0.0	0.0	2.1	18.8	0	0	0			
				90	0.0	0.0	2.1	18.8	0	0	0			
				120	0.0	0.0	2.1	18.8	0	0	0			
				180	0.0	0.0	2.1	18.8	0	0	0			
				240	0.0	0.0	2.1	18.8	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WS17	0.83	2.90		0	0.0	0.0	0.1	21.2	0	0	0			
				15	0.1	0.0	0.1	21.1	0	0	0			
				30	0.1	0.0	0.1	21.3	0	0	0			
				60	0.1	0.0	0.1	21.3	0	0	0			
				90	0.1	0.0	0.1	21.3	0	0	0			
				120	0.1	0.0	0.1	21.3	0	0	0			
				180	0.1	0.0	0.1	21.3	0	0	0			
				240	0.1	0.0	0.1	21.3	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WSH	1.30	2.32		0	0.0	0.0	0.1	21.3	0	0	0			
				15	0.0	0.0	1.2	20.5	0	0	0			
				30	0.0	0.0	1.2	20.1	0	0	0			
				60	0.0	0.0	1.2	20.0	0	0	0			
				90	0.0	0.0	1.2	20.0	0	0	0			
				120	0.0	0.0	1.2	20.0	0	0	0			
				180	0.0	0.0	1.2	20.0	0	0	0			
				240	0.0	0.0	1.2	20.0	0	0	0			

APPENDIX - Results of Gas Monitoring (date 18/04/2013)

Atmospheric Pressure (mb): 1006

AP Conditions (BBC Website): Rising

Equipment Used GA2000+

Temperature: 11C

Weather Conditions: Overcast, dry

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH1	0.89	4.27		0	0.0	0.0	0.1	21.4	0	0	0			
				15	0.0	0.0	0.2	21.2	0	0	0			
				30	0.0	0.0	0.2	21.2	0	0	0			
				60	0.0	0.0	0.2	21.2	0	0	0			
				90	0.0	0.0	0.2	21.2	0	0	0			
				120	0.0	0.0	0.2	21.2	0	0	0			
				180	0.0	0.0	0.2	21.2	0	0	0			
				240	0.0	0.0	0.2	21.2	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH2		4.34		0	0.0	0.0	0.1	20.7	0	0	0			
				15	0.0	0.0	0.7	19.5	0	0	0			
				30	0.0	0.0	0.7	19.5	0	0	0			
				60	0.0	0.0	0.7	19.5	0	0	0			
				90	0.0	0.0	0.7	19.5	0	0	0			
				120	0.0	0.0	0.7	19.5	0	0	0			
				180	0.0	0.0	0.7	19.5	0	0	0			
				240	0.0	0.0	0.7	19.5	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH3		3.22		0	0.0	0.0	0.1	21.2	0	0	0			
				15	0.0	0.0	0.5	20.1	0	0	0			
				30	0.0	0.0	0.5	19.8	0	0	0			
				60	0.0	0.0	0.5	19.8	0	0	0			
				90	0.0	0.0	0.5	19.8	0	0	0			
				120	0.0	0.0	0.5	19.8	0	0	0			
				180	0.0	0.0	0.5	19.8	0	0	0			
				240	0.0	0.0	0.5	19.8	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BHG	1.01	4.30		0	0.1	0.0	0.0	21.5	0	0	0			
				15	0.1	0.0	0.0	21.5	0	0	0			
				30	0.1	0.0	0.0	21.4	0	0	0			
				60	0.1	0.0	0.0	21.5	0	0	0			
				90	0.1	0.0	0.0	21.5	0	0	0			
				120	0.1	0.0	0.0	21.5	0	0	0			
				180	0.1	0.0	0.0	21.5	0	0	0			
				240	0.1	0.0	0.0	21.5	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BHK	1.75	4.3		0	0	0.0	0.0	20.0	0	0	0			
				15	-0.1	0.0	0.0	20.0	0	0	0			
				30	-0.1	0.0	0.0	20.9	0	0	0			
				60	-0.1	0.0	0.0	21.0	0	0	0			
				90	-0.1	0.0	0.0	21.0	0	0	0			
				120	-0.1	0.0	0.0	21.0	0	0	0			
				180	-0.1	0.0	0.0	21.0	0	0	0			
				240	-0.1	0.0	0.0	21.0	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WS3		3.20		0	0.0	0.0	0.1	21.0	0	0	0			
				15	0.0	0.0	1.2	20.5	0	0	0			
				30	0.0	0.0	1.2	19.5	0	0	0			
				60	0.0	0.0	1.2	19.5	0	0	0			
				90	0.0	0.0	1.2	19.5	0	0	0			
				120	0.0	0.0	1.2	19.5	0	0	0			
				180	0.0	0.0	1.2	19.5	0	0	0			
				240	0.0	0.0	1.2	19.5	0	0	0			

RSK

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WS17	0.83	2.90		0	0	0.0	0.1	21.2	0	0	0			
				15	0.1	0.0	0.1	21.1	0	0	0			
				30	0.1	0.0	0.1	21.3	0	0	0			
				60	0.1	0.0	0.1	21.3	0	0	0			
				90	0.1	0.0	0.1	21.3	0	0	0			
				120	0.1	0.0	0.1	21.3	0	0	0			
				180	0.1	0.0	0.1	21.3	0	0	0			
				240	0.1	0.0	0.1	21.3	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WSH	1.57	2.32		0	0.1	0.0	0.1	18.9	0	0	0			
				15	0.1	0.0	0.0	21.4	0	0	0			
				30	0.1	0.0	0.0	21.4	0	0	0			
				60	0.1	0.0	0.0	21.4	0	0	0			
				90	0.1	0.0	0.0	21.4	0	0	0			
				120	0.1	0.0	0.0	21.4	0	0	0			
				180	0.1	0.0	0.0	21.4	0	0	0			
				240	0.1	0.0	0.0	21.4	0	0	0			

APPENDIX - Results of Gas Monitoring (date 30/04/2013)

Atmospheric Pressure (mb): 1022

AP Conditions (BBC Website): Rising

Equipment Used: GA 2000 +3

Temperature: 15C

Weather Conditions: Sunny spells, dry

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH1	1.70	4.27		0	0.0	0.0	0.1	20.8	0	0	0			
				15	0.0	0.0	0.5	20.4	0	0	0			
				30	0.0	0.0	0.5	20.3	0	0	0			
				60	0.0	0.0	0.5	20.2	0	0	0			
				90	0.0	0.0	0.5	20.1	0	0	0			
				120	0.0	0.0	0.5	20.1	0	0	0			
				180	0.0	0.0	0.5	20.1	0	0	0			
				240	0.0	0.0	0.5	20.1	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH2	1.86	4.34		0	-0.1	0.0	0.0	20.4	0	0	0			
				15	-0.1	0.0	0.5	19.9	0	0	0			
				30	-0.1	0.0	0.5	19.9	0	0	0			
				60	-0.1	0.0	0.5	19.9	0	0	0			
				90	-0.1	0.0	0.5	19.9	0	0	0			
				120	-0.1	0.0	0.5	20.0	0	0	0			
				180	-0.1	0.0	0.5	20.0	0	0	0			
				240	-0.1	0.0	0.5	20.0	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BH3	1.78	3.22		0	0.0	0.0	0.0	20.8	0	0	0			
				15	-0.1	0.0	0.2	20.7	0	0	0			
				30	-0.2	0.0	0.2	20.7	0	0	0			
				60	-0.2	0.0	0.2	20.7	0	0	0			
				90	-0.2	0.0	0.2	20.8	0	0	0			
				120	-0.2	0.0	0.2	20.8	0	0	0			
				180	-0.2	0.0	0.2	20.8	0	0	0			
				240	-0.2	0.0	0.2	20.8	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BHG	1.14	4.30		0	0.0	0.0	0.5	20.7	0	0	0			
				15	0.0	0.0	1.4	19.4	0	0	0			
				30	0.0	0.0	1.4	19.4	0	0	0			
				60	0.0	0.0	1.4	19.4	0	0	0			
				90	0.0	0.0	1.4	19.4	0	0	0			
				120	0.0	0.0	1.4	19.4	0	0	0			
				180	0.0	0.0	1.4	19.4	0	0	0			
				240	0.0	0.0	1.4	19.4	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
BHK	1.35	4.3		0	0.01	0.0	0.0	20.9	0	0	0			
				15	0.0	0.0	0.9	20.0	0	0	0			
				30	0.0	0.0	0.9	20.0	0	0	0			
				60	0.0	0.0	0.9	20.0	0	0	0			
				90	0.0	0.0	1.0	19.9	0	0	0			
				120	0.0	0.0	1.0	19.9	0	0	0			
				180	0.0	0.0	1.0	19.9	0	0	0			
				240	0.0	0.0	1.0	19.9	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WS3	1.55	3.20		0	0.0	0.0	0.4	20.9	0	0	0			
				15	0.0	0.0	1.4	19.8	0	0	0			
				30	0.0	0.0	1.4	19.8	0	0	0			
				60	0.0	0.0	1.4	19.9	0	0	0			
				90	0.0	0.0	1.3	20.0	0	0	0			
				120	0.0	0.0	1.3	20.1	0	0	0			
				180	0.0	0.0	1.2	20.2	0	0	0			
				240	0.0	0.0	1.1	20.3	0	0	0			

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WS17														**Could not locate position**

Location	Depth to water (m bgl)	Depth to base of well (m bgl)	Differential Pressure (mb)	Time (secs.)	Flow (l/hr)	Methane (%/vol)	Carbon Dioxide (%/vol)	Oxygen (%/vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	PID (ppm)	Product	Observation
WSH	1.6	2.32		0	0.0	0.0	2.0	19.5	0	0	0			
				15	0.0	0.0	2.1	19.2	0	0	0			
				30	0.0	0.0	2.1	19.2	0	0	0			
				60	0.0	0.0	2.2	19.1	0	0	0			
				90	0.0	0.0	2.3	19.1	0	0	0			
				120	0.0	0.0	2.3	19.1	0	0	0			
				180	0.0	0.0	2.2	19.1	0	0	0			
				240	0.0	0.0	2.2	19.2	0	0	0			

RSK GAC FOR RESIDENTIAL LAND USE WITH PATHWAYS FOR PLANT UPTAKE

Generic assessment criteria for human health: residential scenario – private gardens

The human health generic assessment criteria (GAC) have been developed during a period of regulatory review and updating of the Contaminated Land Exposure Assessment (CLEA) project. Therefore, the Environment Agency (EA) is in the process of publishing updated reports relating to the CLEA project and the GAC presented in this document may change to reflect these updates. This issue was prepared following the publication of soil guideline value (SGV) reports and associated publications[(1)] for mercury, selenium, benzene, toluene, ethylbenzene and xylene in March 2009, arsenic and nickel in May 2009, cadmium and phenol in June 2009, dioxins, furans and dioxin-like polychlorinated biphenyls (PCBs) in September 2009. It was also produced following publication of GAC by LQM[(6)]. Where available, the published soil guideline values (SGV)[(1)] were used as the GAC. The GAC for lead is discussed separately below owing to it not being derived using the same approach as other compounds.

Lead GAC derivation

The Environment Agency SGV and Tox reports for lead were withdrawn in 2009. In addition, the provisional tolerable weekly intake data published in the Netherlands were withdrawn in 2010 owing to concerns that they were not suitably protective of human health. The withdrawn SGVs were based on a target blood lead concentration of 10µg/dl. In the absence of current guidelines many consultants continue to use the withdrawn SGV. However, as this is not considered sufficiently protective of human health, after attendance at the SOBRA summer workshop June 2011, RSK has revised its GAC and is currently undertaking a review of recent toxicological developments that will be used to refine this GAC further in the coming months. In the meantime, RSK has undertaken sensitivity analysis using the Society of Environmental Geochemistry and Health (SEGH) equation and the CLEA model to produce an interim GAC value. The results are summarised below:

- Using CLEA with the former provisional tolerable weekly intake (PTWI) (25 µg/kg bw), assuming 100% lead is bioavailable, produces a GAC of 212 mg/kg
- Using CLEA with the former PTWI, assuming 50% lead is bioavailable, produces a GAC of 478 mg/kg
- Using the SEGH equation amended for a blood target concentration of 5.6 µg/dl (equal to the LOAEL for IQ defects) gives a negative GAC number unless other factors such as child background blood concentration or delta are amended. Without undertaking further research into these numbers, RSK can present sensitivity analysis to demonstrate the sensitivity of these input parameters but cannot justify one parameter over another. The results are:
    - GAC between 39mg/kg and 99mg/kg if the value of delta (the slope or response of blood Pb versus soil and dust Pb relationship) only is amended from 5 to 2µg/dl/1000µg/g. The value of 2 was chosen as it is within the reasonable range quoted in the former SGV report
    - GAC between 244mg/kg and 610mg/kg if the geometric mean of blood lead concentration in young children is reduced from 3.4µg/dl to 2µg/dl. This decrease has been simulated on the basis that blood concentrations are likely to decrease over time across the UK owing to a ban on lead in petrol, lead within paint used internally and water pipe replacement. This decrease is considered reasonable as the site is a new development

so lead-based paints will not be used internally and lead water supply pipelines will be absent.

Therefore, given the results above RSK proposes to use a GAC of **300mg/kg** for a residential end use. This value is broadly in the middle of the range of sensitivity modelling results quoted above when background mean blood lead concentrations in children are reduced to reflect a new development. The value is also broadly in the middle of the range of sensitivity modelling results for a range of bioavailability of lead between 50% and 100%. This number is considered reasonably protective of human health while being practical for use.

GAC derivation for other metals and organic compounds

Model selection

Soil assessment criteria (SAC) were calculated using CLEA v1.06 and the supporting UK guidance[1–6]. Groundwater assessment criteria (GrAC) protective of human health via the inhalation pathway were derived using the RBCA 1.3b model. RSK has updated the inputs within RBCA to reflect the UK guidance[1–5]. The SAC and GrAC collectively are termed GAC.

Conceptual model

In accordance with EA Science Report SC050221/SR3[3], the residential with private garden scenario considers risks to a female child between the ages of 0 and 6 years old. In accordance with Box 3.1, SR3[3], the pathways considered for production of the SAC in the residential with gardens scenario are:

- direct soil and dust ingestion;
- consumption of home-grown produce;
- consumption of soil attached to home-grown produce;
- dermal contact with soil and indoor dust, and
- inhalation of indoor and outdoor dust and vapours.

Figure 1 is a conceptual model illustrating these linkages.

The pathway considered in production of the GrAC is the volatilisation of compounds from groundwater and subsequent vapour inhalation by residents while indoors. Figure 2 illustrates this linkage. Although the outdoor air inhalation pathway is also valid, this contributes little to the overall risks owing to the dilution in outdoor air. Within RBCA, the solubility limit of the determinant restricts the extent of volatilisation, which in turn drives the indoor air inhalation pathway. While the same restriction is not built into the CLEA model, the CLEA model output cells are flagged red where the soil saturation limit has been exceeded.

An assumption used in the CLEA model is that of simple linear partitioning of a chemical in the soil between the sorbed, dissolved and vapour phase[4]. The upper boundaries of this partitioning are represented by the aqueous solubility and pure saturated vapour concentration of the chemical. The CLEA software uses a traffic light system to identify when individual and/or combined assessment criteria exceed the lower of either the aqueous-based or the vapour based saturation limits. Where model output cells are flagged red the soil or vapour saturation limit has been exceeded and further consideration of the SAC to be used within the assessment is required. One approach that could be adopted is to use the 'modelled' solubility saturation limit or vapour saturation limit of the compound as the SAC. However, as stated within the CLEA handbook[4] this is likely to not be practical in many cases because of the very low limits and, in any case, is highly conservative. Unless free-phase product is present, concentrations of the chemical are unlikely to be present at sufficient concentration to result in an exceedance of the health criteria value (HCV).

RSK has adopted an approach for petroleum hydrocarbons in accordance with LQM/CIEH[6] whereby the concentration modelled for each petroleum hydrocarbon fraction has been tabulated as the SAC with the corresponding solubility or vapour saturation limit given in brackets. Therefore, when using the SAC to screen laboratory analysis the assessor should take note if a given SAC has a corresponding solubility or vapour saturation limit (in brackets), and subsequently incorporate this piece of information within the screening analytical discussion. If further assessment is required following this process then an additional approach can be utilised as detailed within Section 4.12 of the CLEA model handbook[4], which explains how to calculate an effective assessment criterion manually.

Input selection

Chemical data was obtained from EA Report SC050021/SR7[5] and the health criteria values (HCV) from the UK TOX[1] reports where available. For SAC for total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH), toxicological and chemical specific parameters were obtained from the LQM/CIEH report[6]. Similarly, toxicological and specific chemical parameters for the volatile organic compound 1,2,4-trimethylbenzene were obtained from EIC/AGS/CL:AIRE[7].

For total petroleum hydrocarbons (TPH), aromatic hydrocarbons C_5-C_8 were not modelled since benzene and toluene are being modelled separately. The aromatic C_8-C_9 hydrocarbon fraction comprises ethylbenzene, xylene and styrene. Since ethylbenzene and xylene are being modelled separately, the physical, chemical and toxicological data for this band has been taken from styrene.

Owing to the lack of UK-specific data, default information in the RBCA model was used to evaluate methyl tertiary butyl ether (MTBE). No published UK data was available for 1,3,5-trimethylbenzene, so information was obtained from the US EPA as in the RBCA model. RBCA uses toxicity data for the inhalation pathway in different units to the CLEA model and cannot consider separately the mean daily intake (MDI), occupancy periods or breathing rates. Therefore, the HCV in RBCA was amended to take account of:

- amendments to the MDI using Table 3.4 of SR2[2]
- a child weighing 13.3kg (average of 0–6 year old female in accordance with Table 4.6 of SR3[3]) and breathing 11.85m^3 (average daily inhalation rate for a 0–6-year old female in accordance with Table 4.14 of SR3[3]

1. The 50% rule (for petroleum hydrocarbons, trimethylbenzenes and MTBE)[(2)] where MDI data is not available but background exposure is considered important in the overall exposure.

Physical parameters

For the residential with private gardens scenario, the CLEA default building is a small two-storey terrace house with concrete ground-bearing slab. The house is assumed to have a $100m^2$ private garden consisting of lawn, flowerbeds and incorporating a $20m^2$ plot for growing fruit and vegetables consumed by the residents. SR3[(3)] notes this residential building type to be the most conservative in terms of protection from vapour intrusion. The building parameters are outlined in Table 5.

The parameters for a sandy loam soil type were used in line with SR3[(3)]. This includes a value of 6% for the percentage of soil organic matter (SOM) within the soil. In RSK's experience, this is rather high for many sites. To avoid undertaking site-specific risk assessments for this parameter, RSK has produced an additional set of SAC for an SOM of 1% and 2.5%. For the GrAC, the depth to groundwater was taken as 2.5m based on RSK's experience of assessing the volatilisation pathway from groundwater.

GAC

The SAC were produced using the input parameters in Tables 1 to 5 and the GrAC using input parameters in Table 6. The final selected GAC are presented by pathway in Table 7 and the combined GAC in Table 8.

Figure 1: Conceptual model for CLEA residential scenario – private gardens

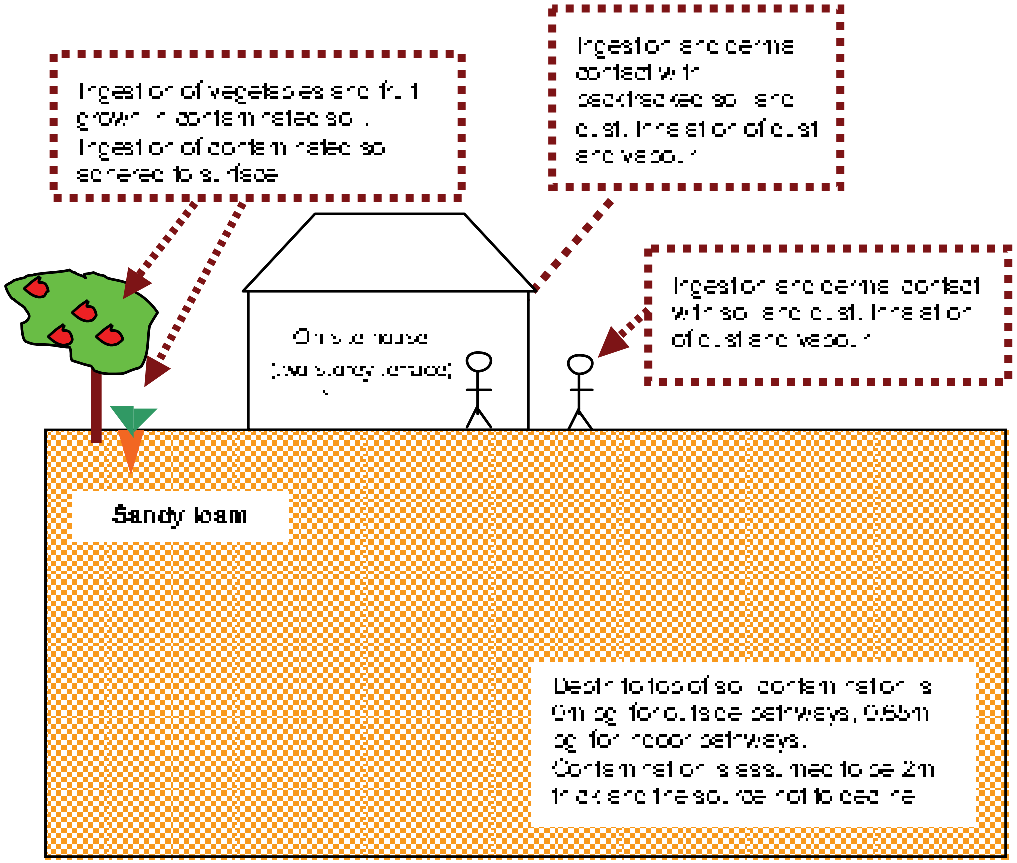

Table 1: Exposure assessment parameters for residential scenario - private gardens – inputs for CLEA model

Land use	Residential with homegrown produce	Chosen land use
Receptor	Female child age 1 to 6	Key generic assumption given in Box 3.1, report SC050021/SR3[3]
Building	Small terraced house	Key generic assumption given in Box 3.1, report SC050021/SR3. Two storey small terraced house chosen as it is the most conservative residential building type in terms of protection from vapour intrusion (Section 3.4.6, report SC050021/SR3)[3]
Soil type	Sandy Loam	Most common UK soil type (Section 4.3.1, From Table 3.1, report SC050021/SR3)[3]
Start AC (age class)	1	Range of age classes corresponding to key generic assumption that the critical receptor is a young female child aged zero to six. From Box 3.1, report SC050021/SR3[3]
End AC (age class)	6	
SOM (%)	6	Representative of sandy loam soil according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents'[4]
	1	To provide SAC for sites where SOM <6% as often observed by RSK
	2.5	
pH	7	Model default

Table 2: Residential with private gardens –home-grown produce data for CLEA model

	Consumption rate (g FW kg^{-1} BW day^{-1}) by age class						Dry weight conversion factor	Home-grown fraction (average)	Home-grown fraction (high end)	Soil loading factor	Preparation correction factor
Name	1	2	3	4	5	6	g DW g^{-1} FW	-	-	g g^{-1} DW	-
Green vegetables	7.12	6.85	6.85	6.85	3.74	3.74	0.096	0.05	0.33	1.00E-03	2.00E-01
Root vegetables	10.69	3.30	3.30	3.30	1.77	1.77	0.103	0.06	0.4	1.00E-03	1.00E+00
Tuber vegetables	16.03	5.46	5.46	5.46	3.38	3.38	0.21	0.02	0.13	1.00E-03	1.00E+00
Herbaceous fruit	1.83	3.96	3.96	3.96	1.85	1.85	0.058	0.06	0.4	1.00E-03	6.00E-01
Shrub fruit	2.23	0.54	0.54	0.54	0.16	0.16	0.166	0.09	0.6	1.00E-03	6.00E-01
Tree fruit	3.82	11.96	11.96	11.96	4.26	4.26	0.157	0.04	0.27	1.00E-03	6.00E-01
Justification	Table 4.17, SR3[(3)]						Table 6.3, SR3[(3)]	Table 4.19, SR3[(3)]		Table 6.3, SR3[(3)]	

Table 3: Residential with private gardens – land use data for CLEA model

Parameter	Unit	Age class 1	2	3	4	5	6
EF (soil and dust ingestion)	day yr^{-1}	180	365	365	365	365	365
EF (consumption of home-grown produce)	day yr^{-1}	180	365	365	365	365	365
EF (skin contact, indoor)	day yr^{-1}	180	365	365	365	365	365
EF (skin contact, outdoor)	day yr^{-1}	180	365	365	365	365	365
EF (inhalation of dust and vapour, indoor)	day yr^{-1}	365	365	365	365	365	365
EF (inhalation of dust and vapour, outdoor)	day yr^{-1}	365	365	365	365	365	365
Justification		Table 3.1, SR3[(3)]					
Occupancy period (indoor)	hr day^{-1}	23	23	23	23	19	19
Occupancy period (outdoor)	hr day^{-1}	1	1	1	1	1	1
Justification		Table 3.2, SR3[(3)]					
Soil to skin adherence factor (indoor)	mg cm^{-2} day^{-1}	6.00E-02	6.00E-02	6.00E-02	6.00E-02	6.00E-02	6.00E-02
Soil to skin adherence factor (outdoor)	mg cm^{-2} day^{-1}	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Justification		Table 8.1, SR3[(3)]					
Soil and dust ingestion rate	g day^{-1}	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01
Justification		Table 6.2, SR3[(3)]					

Of note, for **cadmium**, the exposure assessment for a residential land use is based on estimates representative of lifetime exposure AC1-18. This is because the TDI_{oral} and TDI_{inh} – are based on considerations of the kidney burden accumulated over 50 years. It is therefore reasonable to consider exposure not only in childhood but averaged over a longer time period. See the Environment Agency Science report: SC05002 / TOX 3 [(1)] and Science Report SC050021/Cadmium SGV [(1)] for more information.

Table 4: Residential with private gardens – receptor data for CLEA model

Parameter	Unit	Age Class						Justification
		1	2	3	4	5	6	
Body weight	kg	5.6	9.8	12.7	15.1	16.9	19.7	Table 4.6, SR3 (3)
Body height	m	0.7	0.8	0.9	0.9	1	1.1	
Inhalation rate	m^3 day^{-1}	8.5	13.3	12.7	12.2	12.2	12.2	Table 4.14, SR3 (3)
Max exposed skin fraction (indoor)	m^2 m^{-2}	0.32	0.33	0.32	0.35	0.35	0.33	Table 4.8, SR3 (3)
Max exposed skin fraction (outdoor)	m^2 m^{-2}	0.26	0.26	0.25	0.28	0.28	0.26	

See cadmium note as per Table 3 above.

Table 5: Residential with private gardens – soil and building inputs for CLEA model

Parameter	Unit	Value	Justification
Soil properties for sandy loam			
Porosity, total	cm^3 cm^{-3}	0.53	Default soil type is sandy loam, Section 4.3.1, SR3 (3) Parameters for sandy loam from Table 4.4, SR3 (3)
Porosity, air filled	cm^3 cm^{-3}	0.20	
Porosity, water filled	cm^3 cm^{-3}	0.33	
Residual soil water content	cm^3 cm^{-3}	0.12	
Saturated hydraulic conductivity	$cm\ s^{-1}$	3.56E-03	
van Genuchten shape parameter (*m*)	-	3.20E-01	
Bulk density	$g\ cm^{-3}$	1.21	
Threshold value of wind speed at 10m	$m\ s^{-1}$	7.20	Default value taken from Section 9.2.2, SR3 (3)
Empirical function (F_x) for dust model	-	1.22	Value taken from Section 9.2.2, SR3 (3)
Ambient soil temperature	K	283	Annual average soil temperature representative of UK surface soils. Section 4.3.1, SR3 (3)
Air dispersion model			
Mean annual wind speed (10m)	$m\ s^{-1}$	5.00	Default value taken from Section 9.2.2, SR3 (3)
Air dispersion factor at height of 0.8m	$g\ m^{-2}\ s^{-1}$ per $kg\ m^{-3}$	2400	Values for a 0.01 ha site, appropriate to a residential land use in Newcastle (most representative city for UK). (from Table 9.1, SR3) (3) Assumed child of 6 is not tall enough to reach 1.6m
Air dispersion factor at height of 1.6m	$g\ m^{-2}\ s^{-1}$ per $kg\ m^{-3}$	0	
Fraction of site with hard or vegetative cover	m^2 m^{-2}	0.75	Section 3.2.6, SR3 (3) based on residential land use

Parameter	Unit	Value	Justification
Building properties for small terrace house with ground-bearing floor slab			
Building footprint	m^2	28	From Table 3.3 and 4.21, SR3[3]
Living space air exchange rate	hr^{-1}	0.50	
Living space height (above ground)	m	4.8	
Living space height (below ground)	m	0.0	Assumed no basement
Pressure difference (soil to enclosed space)	Pa	3.1	From Table 3.3, SR3[3]
Foundation thickness	m	0.15	
Floor crack area	cm^2	423	
Dust loading factor	$\mu g\ m^{-3}$	50	Default value for a residential site taken from Section 9.3, SR3[3]
Vapour model			
Default soil gas ingress rate	$cm^3\ s^{-1}$	25	Generic flow rate, Section 10.3, SR3[3]
Depth to top of source (beneath building)	cm	50	Section 3.2.6, SR3 [3] states source is 50cm below building or 65cm below ground surface
Depth to top of source (no building)	cm	0	Section 10.2, SR3 [3] assumes impact from 0m to 1m for outdoor inhalation pathway
Thickness of contaminant layer	cm	200	Model default for indoor air, Section 4.9, SR4[4]
Time average period for surface emissions	years	6	Time period of a 0 to 6 year old, Box 3.5, SR3[3]
User-defined effective air permeability	cm^2	3.05E-08	Calculated for sandy loam using equations in Appendix 1, SR3[3]

Figure 2: GrAC conceptual model for RBCA residential with private gardens scenario

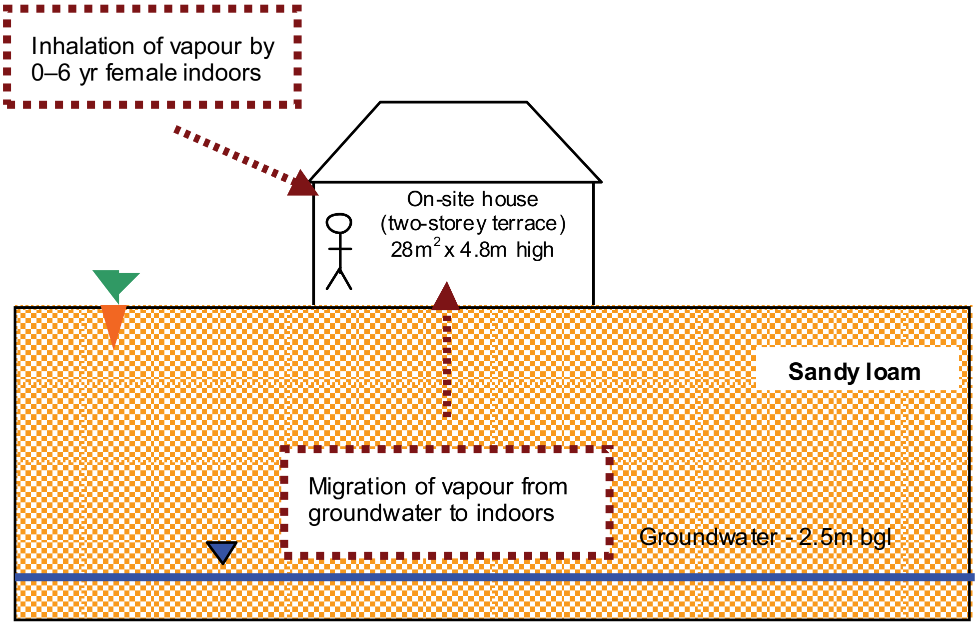

Table 6: Residential with private gardens – RBCA inputs

Parameter	Unit	Value	Justification
Receptor			
Averaging time	Years	6	From Box 3.1, SR3[(3)]
Receptor weight	kg	13.3	Average of CLEA 0–6 year old female data, Table 4.6, SR3[(3)]
Exposure duration	Years	6	From Box 3.1, report, SR3[(3)]
Exposure frequency	Days/yr	350	Weighted using occupancy period of 23 hours per day for 365 days of the year
Soil type – sandy loam			
Total porosity	-	0.53	CLEA value for sandy loam. Parameters for sandy loam from Table 4.4, SR3[(3)]
Volumetric water content	-	0.33	
Volumetric air content	-	0.20	
Dry bulk density	g cm^{-3}	1.21	
Vertical hydraulic conductivity	cm s^{-1}	3.56E-3	CLEA value for saturated conductivity of sandy loam, Table 4.4, SR3[(3)]
Vapour permeability	m^2	3.05E-12	Calculated for sandy loam using equations in Appendix 1, SR3[(3)]
Capillary zone thickness	m	0.1	Professional judgement

Parameter	Unit	Value	Justification
Fraction organic carbon	%	(i) 0.0348	Representative of sandy loam according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents' [8]
		(ii) 0.0058	To provide SAC for sites where SOM < 6% as often observed by RSK
Building			
Building volume/area ratio	m	4.8	Table 3.3, SR3 [3]
Foundation area	m^2	28	
Foundation perimeter	m	22	Calculated assuming building measures 7m x 4m to give 28 m^2 foundation area
Building air exchange rate	d^{-1}	12	Table 3.3, SR3 [3]
Depth to bottom of foundation slab	m	0.15	
Foundation thickness	m	0.15	
Foundation crack fraction	-	0.0151	Calculated from floor crack area of 423 cm^2 and building footprint of 28 m^2 in Table 4.21, SR3 [3]
Volumetric water content of cracks	-	0.33	Assumed equal to underlying soil type in assumption that cracks become filled with soil over time. Parameters for sandy loam from Table 4.4, SR3 [3]
Volumetric air content of cracks	-	0.2	
Indoor/outdoor differential pressure	Pa	3.1	From Table 3.3, SR3 [3]

References

1. Environment Agency (2009), 'Science Report SC050021/benzene SGV, toluene SGV, ethylbenzene SGV, xylene SGV, mercury SGV, selenium SGV, nickel SGV, arsenic SGV, cadmium SGV, phenol SGV, dioxins, furans and dioxin like PCBs SGVs', 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', March 2009, May 2009 and September 2009.

2. Environment Agency (2009), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2*, January (Bristol: Environment Agency).

3. Environment Agency (2009), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).

4. Environment Agency (2009), Contaminated Land Exposure Assessment (CLEA) software, version 1.06.

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

6. Chartered Institute for Environmental Health and Land Quality Management (2009), 'The LQM/CIEH Generic Assessment Criteria for Human Health', second edition.

7. CL:AIRE (2009), *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).

8. Changes made to the CLEA framework documents after the three-month evaluation period in 2008, released January 2009 by the Environment Agency.

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH PRIVATE GARDENS

Table 7

Human Health Generic Assessment Criteria by Pathway for Residential Scenario - Private Gardens

Compound	Notes	GrAC (mg/l)	SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Metals														
Arsenic	(b)(c)	-	3.24E+01	8.50E+01	-	NR	3.24E+01	8.50E+01	-	NR	3.24E+01	8.50E+01	-	NR
Cadmium	(b)	-	1.12E+01	1.85E+02	1.10E+01	NR	1.12E+01	1.85E+02	1.10E+01	NR	1.12E+01	1.85E+02	1.10E+01	NR
Chromium (III) - oxide		-	1.84E+04	3.55E+03	2.98E+03	NR	1.84E+04	3.55E+03	2.98E+03	NR	1.84E+04	3.55E+03	2.98E+03	NR
Chromium (VI) - hexavalent		-	1.02E+01	4.25E+00	3.21E+00	NR	1.02E+01	4.25E+00	3.21E+00	NR	1.02E+01	4.25E+00	3.21E+00	NR
Copper		-	2.66E+03	1.04E+04	2.33E+03	NR	2.66E+03	1.04E+04	2.33E+03	NR	2.66E+03	1.04E+04	2.33E+03	NR
Lead	(a)	-	3.00E+02	-	-	NR	3.00E+02	-	-	NR	3.00E+02	-	-	NR
Elemental Mercury (Hg^0)	(b)(d)	9.40E-03	-	1.70E-01	-	4.31E+00	-	4.24E-01	-	1.07E+01	-	1.02E+00	-	2.58E+01
Inorganic Mercury (Hg^{2+})	(b)	-	1.81E+02	2.55E+03	1.69E+02	NR	1.81E+02	2.55E+03	1.69E+02	NR	1.81E+02	2.55E+03	1.69E+02	NR
Methyl Mercury (Hg^{4+})	(b)	2.00E+01	1.39E+01	1.59E+01	7.40E+00	7.33E+01	1.39E+01	3.08E+01	9.55E+00	1.42E+02	1.39E+01	6.53E+01	1.14E+01	3.04E+02
Nickel	(b)(d)	-	5.31E+02	1.27E+02	-	NR	5.31E+02	1.27E+02	-	NR	5.31E+02	1.27E+02	-	NR
Selenium	(b)(c)	-	3.50E+02	-	-	NR	3.50E+02	NR	-	NR	3.50E+02	-	-	NR
Zinc	(c)	-	3.75E+03	2.55E+07	-	NR	3.75E+03	2.55E+07	-	NR	3.75E+03	2.55E+07	-	NR
Cyanide		-	2.66E+01	3.97E+00	3.68E+00	NR	2.66E+01	3.97E+00	3.68E+00	NR	2.66E+01	3.97E+00	3.68E+00	NR
Volatile Organic Compounds														
Benzene	(b)	7.20E+00	1.12E-01	2.69E-01	7.92E-02	1.22E+03	2.28E-01	4.99E-01	1.57E-01	2.26E+03	4.89E-01	1.04E+00	3.32E-01	4.71E+03
Toluene	(b)	1.90E+03	1.47E+02	6.26E+02	1.19E+02	8.69E+02	3.35E+02	1.38E+03	2.70E+02	1.92E+03	7.59E+02	3.14E+03	6.11E+02	4.36E+03
Ethylbenzene	(b)	2.60E+02	1.06E+02	1.70E+02	6.52E+01	5.18E+02	2.51E+02	3.98E+02	1.54E+02	1.22E+03	5.70E+02	9.32E+02	3.54E+02	2.84E+03
Xylene - m		8.40E+01	2.02E+02	5.56E+01	4.36E+01	6.25E+02	4.80E+02	1.31E+02	1.03E+02	1.47E+03	1.09E+03	3.07E+02	2.40E+02	3.46E+03
Xylene - o	(b)	1.00E+02	1.85E+02	5.98E+01	4.52E+01	4.78E+02	4.38E+02	1.40E+02	1.06E+02	1.12E+03	9.96E+02	3.27E+02	2.46E+02	2.62E+03
Xylene - p		8.70E+01	1.91E+02	5.34E+01	4.17E+01	5.76E+02	4.51E+02	1.26E+02	9.82E+01	1.35E+03	1.02E+03	2.94E+02	2.28E+02	3.17E+03
Total xylene		8.40E+01	2.02E+02	5.56E+01	4.36E+01	6.25E+02	4.80E+02	1.31E+02	1.03E+02	1.47E+03	1.09E+03	3.07E+02	2.40E+02	3.46E+03
Methyl t-Butyl ether		2.20E+03	1.75E+00	1.84E+02	1.75E+00	1.66E+04	3.68E+00	2.40E+02	3.67E+00	2.16E+04	7.41E+00	3.70E+02	7.37E+00	3.34E+04
Trichloroethene		1.80E+00	2.83E+00	1.10E-01	1.06E-01	1.54E+03	6.25E+00	2.30E-01	2.22E-01	3.22E+03	1.40E+01	5.11E-01	4.93E-01	7.14E+03
Tetrachloroethene		3.60E+00	1.06E+01	1.03E+00	9.36E-01	4.24E+02	2.44E+01	2.30E+00	2.10E+00	9.51E+02	5.55E+01	5.28E+00	4.82E+00	2.18E+03
1,1,1-Trichloroethane		2.60E+01	3.20E+02	6.33E+00	6.21E+00	1.43E+03	6.97E+02	1.29E+01	1.27E+01	2.92E+03	1.55E+03	2.84E+01	2.79E+01	6.39E+03
1,1,1,2 Tetrachloroethane		1.40E+01	5.19E+00	1.08E+00	8.93E-01	2.60E+03	1.22E+01	2.50E+00	2.08E+00	6.02E+03	2.78E+01	5.83E+00	4.82E+00	1.40E+04
1,1,2,2-Tetrachloroethane		1.40E+01	2.70E+00	2.76E+00	1.37E+00	2.67E+03	5.85E+00	5.65E+00	2.87E+00	5.46E+03	1.30E+01	1.24E+01	6.34E+00	1.20E+04
Carbon Tetrachloride		5.50E-02	1.05E+00	1.81E-02	1.79E-02	1.52E+03	2.41E+00	3.97E-02	3.93E-02	3.32E+03	5.44E+00	8.99E-02	8.92E-02	7.54E+03
1,2-Dichloroethane		3.00E-01	3.06E-02	6.46E-03	5.34E-03	3.41E+03	5.53E-02	9.32E-03	7.98E-03	4.91E+03	1.05E-01	1.60E-02	1.39E-02	8.43E+03
Vinyl Chloride		1.90E-02	3.69E-03	5.43E-04	4.73E-04	1.36E+03	6.64E-03	7.02E-04	6.35E-04	1.76E+03	1.21E-02	1.07E-03	9.86E-04	2.69E+03
1,2,4-Trimethylbenzene		7.50E-02	-	3.51E-01	-	5.57E+02	-	8.55E-01	-	1.36E+03	-	2.10E+00	-	3.25E+03
1,3,5-Trimethylbenzene		4.70E-02	1.45E+01	4.60E-01	4.56E-01	9.47E+01	3.47E+01	1.10E+00	1.09E+00	2.26E+02	7.94E+01	2.59E+00	2.56E+00	5.33E+02
Semi-Volatile Organic Compounds														
Acenaphthene		3.20E+00	2.18E+02	3.46E+03	2.05E+02	5.70E+01	5.08E+02	8.54E+03	4.79E+02	1.41E+02	1.06E+03	2.03E+04	1.01E+03	3.36E+02
Acenaphthylene		4.20E+00	1.78E+02	3.27E+03	1.68E+02	8.61E+01	4.17E+02	8.03E+03	3.97E+02	2.12E+02	8.90E+02	1.91E+04	8.51E+02	5.06E+02
Anthracene		2.10E-02	2.31E+03	1.08E+05	2.26E+03	1.17E+00	5.03E+03	2.65E+05	4.93E+03	2.91E+00	9.33E+03	6.15E+05	9.19E+03	6.96E+00
Benzo(a)anthracene		3.80E-03	7.00E+00	5.55E+00	3.10E+00	1.71E+00	8.98E+00	9.83E+00	4.69E+00	4.28E+00	1.01E+01	1.41E+01	5.88E+00	1.03E+01
Benzo(b)fluoranthene		2.00E-03	8.06E+00	1.79E+01	5.56E+00	1.22E+00	9.78E+00	1.97E+01	6.53E+00	3.04E+00	1.07E+01	2.05E+01	7.02E+00	7.29E+00
Benzo(g,h,i)perylene		2.60E-04	6.68E+01	1.27E+02	4.38E+01	1.54E-02	7.04E+01	1.32E+02	4.59E+01	3.85E-02	7.19E+01	1.34E+02	4.68E+01	9.23E-02
Benzo(k)fluoranthene		8.00E-04	1.25E+01	2.66E+01	8.51E+00	6.87E-01	1.44E+01	2.83E+01	9.56E+00	1.72E+00	1.53E+01	2.91E+01	1.00E+01	4.12E+00
Chrysene		2.00E-03	8.76E+00	1.95E+01	6.00E+00	4.40E-01	1.20E+01	2.45E+01	8.04E+00	1.10E+00	1.41E+01	2.72E+01	9.27E+00	2.64E+00
Dibenzo(a,h)anthracene		6.00E-04	1.19E+00	2.13E+00	7.62E-01	3.93E-03	1.33E+00	2.42E+00	8.58E-01	9.82E-03	1.39E+00	2.56E+00	9.03E-01	2.36E-02
Fluoranthene		2.30E-01	2.59E+02	2.69E+04	2.57E+02	1.89E+01	4.67E+02	6.23E+04	4.63E+02	4.73E+01	6.78E+02	1.28E+05	6.74E+02	1.13E+02
Fluorene		1.90E+00	1.70E+02	4.35E+03	1.63E+02	3.09E+01	3.91E+02	1.07E+04	3.77E+02	7.65E+01	8.00E+02	2.54E+04	7.76E+02	1.83E+02
Indeno(1,2,3-cd)pyrene		2.00E-04	4.58E+00	1.04E+01	3.18E+00	6.13E-02	5.74E+00	1.17E+01	3.85E+00	1.53E-01	6.37E+00	1.22E+01	4.19E+00	3.68E-01
Phenanthrene		5.30E-01	9.35E+01	5.04E+03	9.18E+01	3.60E+01	2.04E+02	1.23E+04	2.01E+02	8.96E+01	3.81E+02	2.86E+04	3.76E+02	2.14E+02
Pyrene		1.30E-01	5.69E+02	6.18E+04	5.63E+02	2.20E+00	1.05E+03	1.44E+05	1.04E+03	5.49E+00	1.56E+03	2.97E+05	1.56E+03	1.32E+01
Benzo(a)pyrene		3.80E-03	1.21E+00	2.62E+00	8.26E-01	9.11E-01	1.42E+00	2.81E+00	9.43E-01	2.28E+00	1.52E+00	2.90E+00	9.98E-01	5.46E+00
Naphthalene		1.90E+01	2.68E+01	1.64E+00	1.54E+00	7.64E+01	6.36E+01	3.93E+00	3.70E+00	1.83E+02	1.43E+02	9.27E+00	8.71E+00	4.32E+02
Phenol	(b)	-	4.51E+02	3.11E+02	1.84E+02	4.16E+04	9.38E+02	4.20E+02	2.90E+02	8.15E+04	2.04E+03	5.21E+02	4.15E+02	1.74E+05

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH PRIVATE GARDENS

Table 7

Human Health Generic Assessment Criteria by Pathway for Residential Scenario - Private Gardens

Compound	Notes	GrAC (mg/l)	SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Total Petroleum Hydrocarbons														
Aliphatic hydrocarbons EC_5-EC_6		1.00E+01	4.79E+03	2.98E+01	2.97E+01	3.04E+02	1.08E+04	5.47E+01	5.46E+01	5.58E+02	2.35E+04	1.13E+02	1.13E+02	1.15E+03
Aliphatic hydrocarbons >EC_6-EC_8		5.40E+00	1.43E+04	7.27E+01	7.26E+01	1.44E+02	3.21E+04	1.62E+02	1.62E+02	3.22E+02	6.36E+04	3.72E+02	3.71E+02	7.36E+02
Aliphatic hydrocarbons >EC_8-EC_{10}		2.30E-01	1.46E+03	1.89E+01	1.88E+01	7.77E+01	2.44E+03	4.60E+01	4.58E+01	1.90E+02	3.30E+03	1.09E+02	1.08E+02	4.51E+02
Aliphatic hydrocarbons >EC_{10}-EC_{12}		3.40E-02	3.52E+03	9.34E+01	9.28E+01	4.75E+01	4.01E+03	2.32E+02	2.29E+02	1.18E+02	4.24E+03	5.57E+02	5.37E+02	2.83E+02
Aliphatic hydrocarbons >EC_{12}-EC_{16}		7.60E-04	4.37E+03	7.82E+02	7.44E+02	2.37E+01	4.40E+03	1.95E+03	1.69E+03	5.91E+01	4.41E+03	4.68E+03	3.03E+03	1.42E+00
Aliphatic hydrocarbons >EC_{16}-EC_{35}	(c)	-	4.51E+04	-	-	8.48E+00	6.38E+04	-	-	2.12E+01	7.61E+04	-	-	5.09E+01
Aliphatic hydrocarbons >EC_{35}-EC_{44}	(c)	-	4.51E+04	-	-	8.48E+00	6.38E+04	-	-	2.12E+01	7.61E+04	-	-	5.09E+01
Aromatic hydrocarbons >EC_8-EC_9 (styrene)		7.40E+00	1.66E+02	2.65E+02	1.33E+02	6.20E+02	3.92E+02	6.47E+02	3.16E+02	1.52E+03	8.50E+02	1.54E+03	7.02E+02	3.61E+03
Aromatic hydrocarbons >EC_9-EC_{10}		7.40E+00	5.55E+01	3.33E+01	2.69E+01	6.13E+02	1.31E+02	8.16E+01	6.54E+01	1.50E+03	2.84E+02	1.94E+02	1.51E+02	3.58E+02
Aromatic hydrocarbons >EC_{10}-EC_{12}		2.50E+01	7.97E+01	1.82E+02	6.91E+01	3.64E+02	1.86E+02	4.48E+02	1.62E+02	8.99E+02	3.87E+02	1.07E+03	3.46E+02	2.15E+03
Aromatic hydrocarbons >EC_{12}-EC_{16}		5.80E+00	1.40E+02	2.00E+03	1.38E+02	1.69E+02	3.13E+02	4.96E+03	3.08E+02	4.19E+02	6.01E+02	1.18E+04	5.93E+02	1.00E+03
Aromatic hydrocarbons >EC_{16}-EC_{21}	(c)	-	2.47E+02	-	-	5.37E+01	4.82E+02	-	-	1.34E+02	7.66E+02	-	-	3.21E+02
Aromatic hydrocarbons >EC_{21}-EC_{35}	(c)	-	8.88E+02	-	-	4.83E+00	1.11E+03	-	-	1.21E+01	1.22E+03	-	-	2.90E+01
Aromatic hydrocarbons >EC_{35}-EC_{44}	(c)	-	8.88E+02	-	-	4.83E+00	1.11E+03	-	-	1.21E+01	1.22E+03	-	-	2.90E+01

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.

NR - the compound is not volatile and therefore a soil saturation limit not calculated within CLEA

EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - soil assessment criteria.

The CLEA model output is colour coded depending upon whether the soil saturation limit has been exceeded.

Calculated SAC exceeds soil saturation limit and may significantly effect the interpretation of any exceedances since the contribution of the indoor and outdoor vapour pathway to total exposure is >10%. This shading has also been used for the RBCA output where the theoretical solubility limit has been exceeded. The SAC has been set as the model calculated SAC with the saturation limits shown in brackets.

Calculated SAC exceeds soil saturation limit but will not effect the SSV significantly since the contribution of the indoor and outdoor vapour pathway to total exposure is <10%.

Calculated SAC does not exceed the soil saturation limit.

For consistency where the theoretical solubility limit within RBCA has been exceeded in production of the GrAC, these cells have also been hatched red.

The SAC for organic compounds are dependant upon soil organic matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58. 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3

(a) Sensitivity analysis undertaken on SEGH equation and CLEA model, considered reasonable in absence of UK specific data

(b) GAC taken from the Environment Agency SGV reports published 2009.

(c) SAC for selenium, aliphatic and aromatic hydrocarbons >EC16 does not include inhalation pathway owing to absence of toxicity data. SAC for arsenic is only based on oral contribution (rather than combined) owing to the relative small contribution from inhalation in accordance with the SGV report. The same approach has been adopted for zinc.

(d) SAC for elemental mercury, chromium VI and nickel is based on the inhalation pathway only owing to an absence of toxicity for elemental mercury, in accordance with the SGV report for nickel and LQM report for chromium VI.

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH PRIVATE GARDENS

Table 8
Human Health Generic Assessment Criteria for Residential Scenario - Private Gardens

Compound	GrAC for Groundwater (mg/l)	SAC for Soil SOM 1% (mg/kg)	SAC for Soil SOM 2.5% (mg/kg)	SAC for Soil SOM 6% (mg/kg)
Metals				
Arsenic	-	32	32	32
Cadmium	-	10	10	10
Chormium (III) - oxide	-	3,000	3,000	3,000
Chromium (VI) - hexavalent	-	4.3	4.3	4.3
Copper	-	2,300	2,300	2,300
Lead	-	300	300	300
Elemental Mercury (Hg^0)	0.009	0.17	0.42	1.0
Inorganic Mercury (Hg^{2+})	-	170	170	170
Methyl Mercury (Hg^{4+})	20	7.4	9.6	11
Nickel	-	130	130	130
Selenium	-	350	350	350
Zinc	-	3,800	3,800	3,800
Cyanide	-	3.7	3.7	3.7
Volatile Organic Compounds				
Benzene	7	0.079	0.157	0.33
Toluene	1,900	120	270	610
Ethylbenzene	260	65	154	350
Xylene - m	100	44	103	240
Xylene - o	87	45	106	250
Xylene - p	84	42	98	230
Total xylene	84	44	103	240
Methyl tertiary butyl ether (MTBE)	2,200	1.8	3.7	7.4
Trichloroethene	1.8	0.11	0.2	0.49
Tetrachloroethene	3.6	0.94	2.1	4.8
1,1,1-Trichloroethane	26	6.2	12.7	28
1,1,1,2Tetrachloroethane	14	0.89	2.1	4.8
1,1,2,2-Tetrachloroethane	14	1.4	2.87	6.3
Carbon Tetrachloride	0.055	0.018	0.039	0.089
1,2-Dichloroethane	0.30	0.0053	0.0080	0.014
Vinyl Chloride	0.019	0.00047	0.0006	0.001
1,2,4-Trimethylbenzene	0.075	0.35	0.85	2.1
1,3,5-Trimethylbenzene	0.047	0.46	1.1	2.6
Semi-Volatile Organic Compounds				
Acenaphthene	3.2	210	480	1,000
Acenaphthylene	4.2	170	400	850
Anthracene	0.021	2,300	4,900	9,200
Benzo(a)anthracene	0.0038	3.1	4.7	5.9
Benzo(b)fluoranthene	0.0020	5.6	6.5	7.0
Benzo(g,h,i)perylene	0.00026	44	46	47
Benzo(k)fluoranthene	0.00080	8.5	9.6	10
Chrysene	0.0020	6.0	8.0	9.3
Dibenzo(a,h)anthracene	0.00060	0.76	0.86	0.90
Fluoranthene	0.23	260	460	670
Fluorene	1.9	160	380	780
Indeno(1,2,3-cd)pyrene	0.0002	3.2	3.8	4.2
Phenanthrene	0.53	92	200	380
Pyrene	0.13	560	1,000	1,600
Benzo(a)pyrene	0.0038	0.83	0.94	1.0
Naphthalene	19	1.5	3.7	8.7
Phenol	-	180	290	420
Total Petroleum Hydrocarbons				
Aliphatic hydrocarbons EC_5-EC_6	10	30	55	110
Aliphatic hydrocarbons >EC_6-EC_8	5.4	73	160	370
Aliphatic hydrocarbons >EC_8-EC_{10}	0.23	19	46	110
Aliphatic hydrocarbons >EC_{10}-EC_{12}	0.034	93 (48)	230 (118)	540 (283)
Aliphatic hydrocarbons >EC_{12}-EC_{16}	0.00076	744 (24)	1,700 (59)	3,000 (142)
Aliphatic hydrocarbons >EC_{16}-EC_{35}	-	45,100 (8.48)	64,000 (21)	76,000
Aliphatic hydrocarbons >EC_{35}-EC_{44}	-	45,100 (8.48)	64,000 (21)	76,000
Aromatic hydrocarbons >EC_8-EC_9 (styrene)	7.4	130	316	700
Aromatic hydrocarbons >EC_9-EC_{10}	7.4	27	65	150
Aromatic hydrocarbons >EC_{10}-EC_{12}	25	69	160	346
Aromatic hydrocarbons >EC_{12}-EC_{16}	5.8	140	310	593
Aromatic hydrocarbons >EC_{16}-EC_{21}	-	250	480	770
Aromatic hydrocarbons >EC_{21}-EC_{35}	-	890	1,100	1,230
Aromatic hydrocarbons >EC_{35}-EC_{44}	-	890	1,100	1,230

Notes:

'-' Generic assessment criteria not calculated owing to low volatilty of substance and therefore no pathway, or an absence of toxicological data.

EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - sol assessment criteria.

The SAC for organic compounds are dependent on Soil Organic Matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58.
1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3.

The SAC has been set as the model calculated SAC with the saturation limit shown in brackets.
For consistency where the GrAC exceeds the solubility limit, GrAC has been set at the solubilty limit. The GrAC conservative since concentrations of the chemical are very unlikely to be at sufficient concentration to result in an exceedance of the health criteria value at the point of exposure (i.e. indoor air) provided free-phase product is absent.

BDW TRADING LIMITED

NIAB Phase 1, Huntingdon Rd, Cambridge

Report for Main Site Investigation

25459

OCTOBER 2012

RSK

RSK GENERAL NOTES

Project No.: 25459-01(00)

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1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by BDW Trading Limited to carry out a geotechnical and contaminated land assessment of a plot of land known as NIAB 1, currently owned by the National Institution of Agricultural Botany (NIAB). It is understood that current proposals include for the redevelopment of the site with a mixed-use development, specifically comprising residential, retail and school infrastructure.

This report is subject to the RSK service constraints given in Appendix A.

1.1 Background

RSK have been provided with two previous reports associated, in part, with the subject site area. The reports were both compiled by Millard Consulting Engineers in 2006 and comprise an initial stand-alone Phase 1 Environmental Risk Assessment and a subsequent follow-on Phase 2 Intrusive Environmental and Geotechnical Site Investigation. A brief summary of these reports is provided in section 2.

1.2 Objective and aims

The objective of the work is to assess the site in relation to the proposed future redevelopment. The scope of investigation and positioning of the exploratory locations was based on the drawing provided by Woods Hardwick (drawing reference 16483/1015, dated January 2011) and a scope of investigation prescribed by Wilson Bowden, specifically associated with the proposed food store and "Centre Point. It is anticipated that this main investigation will support an outline planning submission for the mixed-use redevelopment of the site.

The aims of this assessment are to:

- Enable an assessment of the site and surrounding area in terms of history and environmental setting from which a conceptual model can be collated to inform site investigation works;
- Obtain sufficient information regarding ground conditions from which risks to end-users, the environment and structures can be assessed plus geotechnical issues including the design of foundations and infrastructure; and
- Enable an initial assessment of the potential waste classification implications of soil arisings.

1.3 Scope

The scope of the investigation and layout of this report has been designed with consideration of CLR11 (Environment Agency, 2004a), BS 10175: 2011 (BSI, 2011) and PPS23 (ODPM, 2004), plus guidance on land contamination reports issued by the Environment Agency (2010a).

The project was carried out to an agreed brief as set out in RSK's proposal (ref. 25459-01T(00), dated 9 February 2012), and subsequent revisions, including the scope of works prescribed by Wilson Bowden, summarised in email dated 14 August 2012. The scope of works for the assessment included:

- An updated preliminary risk assessment (PRA) to include a review of existing reports, geological, hydrogeological and hydrological information, a commercially available environmental database, and historical plans; correspondence with regulatory authorities; and a site walkover – this information is used to develop an initial conceptual site model to consider any potentially complete pollutant linkages;
- An intrusive investigation consisting of 5 no. boreholes (2 no. associated with the Wilson Bowden Scope of works), 52 no. trial pits (4 no. associated with the Wilson Bowden scope of works), 9 no. infiltration test locations, 28 no. drive-in window sampler boreholes (4 no. associated with the Wilson Bowden scope of works) with laboratory analysis plus subsequent groundwater and gas monitoring;
- Development of a refined conceptual site model followed by generic quantitative risk assessment (GQRA) to assess complete pollutant linkages that may require mitigation measures to be implemented to facilitate redevelopment;
- Identification of outline mitigation measures for complete pollutant linkages or recommendations for further work;
- Interpretation of ground conditions and geotechnical data to provide recommendations with respect to foundations and infrastructure design; and
- A factual and interpretative report with recommendations for further works (i.e. undertake a remedial options appraisal to identify appropriate mitigation measures/produce a remedial implementation and verification plan) and/or remediation as necessary.

1.4 Existing reports

The following reports detailing previous works at the site were made available for review:

- Proposed Development Site, Huntingdon Road/Histon Road, Cambridge, Report ref: 5593/04/CM/03-06/1213, 'Phase 1 Environmental Risk Assessment', Millard Consulting Engineers, March 2006;
- Proposed Development Site, Huntingdon Road/Histon Road, Cambridge, Report ref: 5593/14/RT/09-06/1371, 'Phase 2 Intrusive Environmental and Geotechnical Site Investigation', Millard Consulting Engineers, September 2006;

These have been summarised in Section 2.

2 THE SITE

2.1 Site location and description

The site is located to the northeast of the main administration/office buildings of the National institute of Agricultural Botany (NIAB), off Huntington Road, Cambridge at National Grid reference 543818, 260766, as shown on Figure 1.

The site covers approximately 54.6 hectares and generally slopes downwards to the north/northeast with a highest elevation of 19.93m in the south east corner and the lowest at 12.03m in the north. The site land use comprises entirely of arable farmland, most recently used for agricultural research, with the exception of a disused cricket pavilion and associated storage sheds/outbuildings in the far southeast corner. The arable farmland is sectioned off into approximately eight separate fields with a further field beyond a concrete access road in the far north. The field boundaries comprise a combination of hedgerows, drainage ditches and an access road running between the central fields, providing access to the westerly NIAB farm premises. There is also a public right of way, which for most of its length, coincides with the northern site boundary and the boundary between South Cambridgeshire District and Cambridge City. Figure 3 shows the existing site layout.

The A14 is located north of the site, oriented in an east-west direction. Residential and academic land-uses occupy the area to the east of the site. The main NIAB office building is situated immediately south/southwest, between the site itself and Huntingdon Road. A mixture of residential and undeveloped/agricultural land surround the periphery of the site to both the south and west.

2.2 Proposed development

The site in question is being considered for a mixed-use redevelopment as described in section 1.The planned layout of the site is shown on Figure 2.

2.3 Key information from previous reports

Two previous investigations undertaken by Millard Consulting Engineers have been reviewed as part of the preliminary risk assessment. The following sections provide a review of pertinent information from the reports noted in section 1.4.

2.3.1 Phase 1 Environmental Risk Assessment, March 2006

This investigation comprised a phase 1 study of a wider site area than the current study, also encompassing the designated NIAB 1 site itself. The study was undertaken in connection with the intention for David Wilson Estates to apply for planning approval to redevelop the site for residential use. The site considered as part of the study included a parcel of land located between the existing main NIAB buildings and Whitehouse Lane (recently been redeveloped, in part, and currently under construction). The assessment also included correspondence with a number of consultees, including various departments of Cambridge City Council and the Environment Agency. A summary of key information extracted from the report is provided below:

- The NIAB facility has existed, in various forms, since the early 20th Century, prior to which the site was entirely occupied by open fields. The facility is used for agricultural and food research, along with general agricultural activities and has been supported by a number of buildings used as offices, laboratories, greenhouses and farm yards in the south-western portion of the site;

- Anecdotal information confirmed that a number of the buildings located on the site contained asbestos containing materials (ACM's). However, it is understood that the buildings referenced are not located in the current study area and are predominantly associated with the former NIAB laboratories, greenhouses and offices located between the existing NIAB main office and Whitehouse Lane to the south/southwest of the site;

- An above ground diesel storage tank was located on hard standing in the premises of the disused sports pavilion, adjacent to the former sports field in the southeast portion of the site;

- The site activities require the use and storage of agricultural chemicals, principally pesticides and herbicides;

- Off-site sources of contamination (referenced also as on-site sources in the report, owing to the variation in study area) were also noted, associated with the wider NIAB facility. The identified sources included the following:

  - Bulk storage of hydrocarbons in above ground storage tanks;

  - Storage and use of agricultural chemical, referenced above;

  - ACM's in the fabric of existing buildings (predominantly to the west/southwest of the current site area);

  - Gas cylinders (predominantly to the west/southwest of the current site area); and

  - Mixing of chemicals within a bunded chemical mixing point.

- An off-site historical gravel pit (worked during the early to middle part of the 20th Century) was located to the south of Huntingdon Road and has now been infilled. Adjacent to this, an area containing Roman coffins was also noted. Both are in excess of 200m from the study area. Petrol stations, nurseries and a laundry were also recorded in the vicinity of the site;

- The findings of the study identified the following risks associated with the site :

  - Residential end-users – a **moderate risk** identified from potentially contaminated soils and a moderate to low risk associated with ACM's in the buildings (it is noted that the buildings referred to are not located on the study site itself, and many no longer exist);

  - Construction workers – a **moderate risk** identified from potentially contaminated soils and ACM's (ACM's associated with buildings that are not located on the study site itself, and many no longer exist), and a moderate/low risk associated with the bulk storage of hydrocarbons and an electricity sub-station (located to the west/southwest of the existing study site);

  - A **low risk** was identified to flora and fauna, groundwater, surface water, and building structures and services.

- The phase 1 assessment undertaken Millard Consulting Engineers culminated in a number of recommendations, as follows:

  - The production of an archaeological desk study; and

  - The completion of a preliminary Phase 2 land quality assessment to refine the initial conceptual model.

2.3.2 Phase 2 Environmental and Geotechnical Site Investigation, September 2006

Millard Consulting Engineers carried out a phase 2 investigation of the study area described in section 2.3.1. The scope of work included the excavation of six cable percussive boreholes, thirteen window sampler boreholes, six mechanical trial pits, installation of seven monitoring wells and associated in-situ testing and laboratory analysis. A number of the exploratory holes were located in areas between former and existing NIAB buildings, which form the majority of the recent redevelopment area alongside Huntingdon Road. However, sixteen of the exploratory holes were located on the NIAB 1 site area, specifically BH1 to BH4, TP1, TP2, TP5, TP6, TP7, WS6, WS7 and WS CH1 to CH5. A summary of pertinent information in relation to the existing assessment of NIAB 1 is provided below:

- A variable thickness of made ground/topsoil was encountered ranging between 0.1m and 1.6m thickness, with a typical thickness of around 0.3m. The greatest thickness of made ground was encountered in CH5, where concrete and brick was encountered between 1.5m and 1.6m bgl;

- River Terrace Deposits were encountered in localised areas of the site, generally increasing in frequency and thickness to the northeast where granular deposits were encountered to the terminal depth of the exploratory hole designated CH WS1 at 4.0m bgl. Deposits of the Gault Clay Formation were encountered directly below the made ground/topsoil or River Terrace Deposits, where present;

- Significant contamination issues were not identified, albeit the presence of localised elevated concentrations of heavy metals and TPH were encountered with respect to a residential (with plant uptake) end-use. Specifically, elevated concentrations of arsenic and cadmium within the shallow made ground soils at WS6 and TPH within the shallow made ground and Gault Clay deposits in WS8 (in proximity to the former above ground fuel storage tank in proximity to the sports pavilion) were recorded;

- Topsoil across the site was generally recorded to be suitable for use, albeit with further testing required to delineate the potential sources of contamination associated with WS6 in the west of the site and WS8 in the southeast.

- Analysis of groundwater demonstrated that the underlying Secondary Aquifer associated with the granular River Terrace Deposits was not impacted with contamination. Furthermore, a single sample of groundwater recovered from an abstraction well on the NIAB premises indicated that there has been '*no measurable impact on the underlying Lower Greensand aquifer*';

- The report made the following recommendations in relation to foundations and allowable ground bearing pressures:

    - River Terrace Deposits – Loose to medium dense sands and gravels: 150kN/m^2 at a minimum foundation depth of 0.75m bgl;

    - River Terrace Deposits – soft to firm sandy clay: 100kN/m^2 at a minimum foundation depth of 0.9m bgl;

    - Gault Clay – stiff blue/grey clay: 175 kN/m^2 at a minimum foundation depth of 0.9m bgl;

    - A piled foundation solution may provide the most economical option in areas of deeper made ground, such as BH1 and CH5; and

    - Cohesive soils were identified as having medium volume change potential. Where the proposed founding stratum comprises cohesive deposits and within the zone of influence of trees, foundation depths and heave protection should be considered in accordance with NHBC Standards Chapter 4.2.

- Soakaways were only considered to be possible in the vicinity of TP5, where an infiltration rate of 1.87 x 10-5 m/s calculated;

- Standing groundwater levels were recorded between 1.64 and 2.2m bgl adjacent to the site boundaries in the central eastern and western portions of the site. Groundwater strikes were encountered in the northern portion of the site at depths ranging between 3.0 and 3.50m bgl;

- In relation to the existing study area, the following recommendations were made:

  - Further testing to investigate the extent of TPH contamination in proximity to the former AST alongside the pavilion building in the southeast of the site;

  - Additional sampling to be carried out to quantify the potential for pesticides/herbicide residues to be present within the shallow soils of agricultural areas of the site which were not previously accessible;

  - Further infiltration testing to supplement the existing data, particularly in the northern-most area of the site (referred to previously as the ‘Chivers land’;

  - Further geotechnical investigation to refine the findings of the report and to more accurately delineate the boundaries of differing soil conditions.