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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.

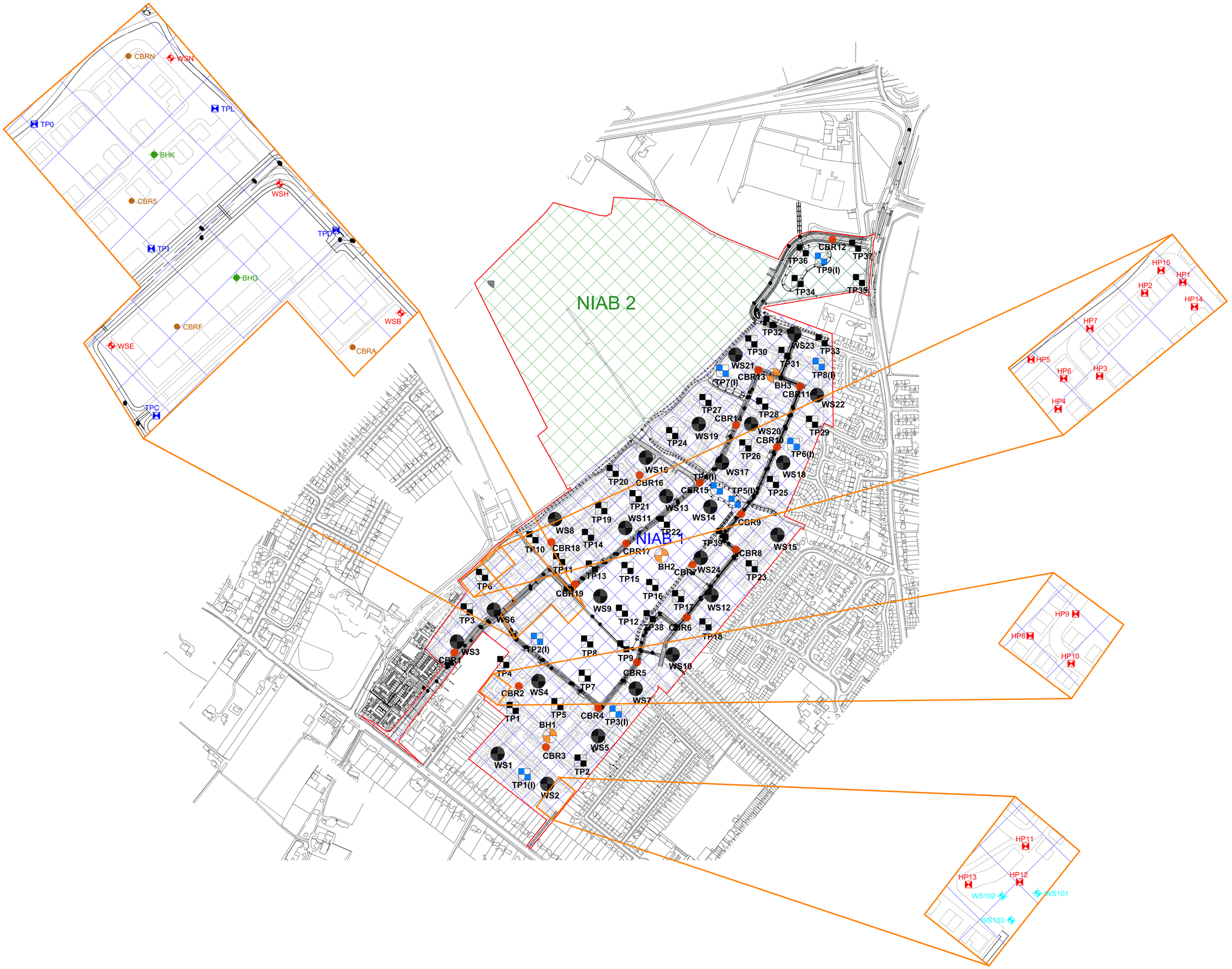
Service constraints
Figure 1 Exploratory hole location plan
Exploratory hole records
Chemical test results
RSK GAC values for residential sites with pathways for plant uptake

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

- Site Boundary
- Trial pit by Machine Excavator
- Trial pit with infiltration test for soakaway design
- Borehole by Cable Percussive Drilling Methods
- Borehole by Drive-In Window Sampling Methods
- Insitu CBR Test Location
- Borehole by CP drilling method (Wilson & Bowden Specification)
- Trial Pit by machine excavation ( Wilson & Bowden Specification)
- Borehole by Drive-in Window Sampling Methods (Wilson & Bowden Specification)
- Insitu CBR Test Location (Wilson & Bowden Specification)
- Hand Dug Trial Pit Location
- Window Sample Location

| Rev. | Date | Amendment | Drawn | Chkd. | Appd. |
|---|---|---|---|---|---|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Client

BDW TRADING LIMITED

Project Title

NIAB PHASE 1
HUNTINGDON ROAD,
CAMBRIDGE

Drawing Title

EXPLORATORY HOLE LOCATION PLAN

| Drawn | Date | Checked | Date | Approved | Date |
|---|---|---|---|---|---|
| SAY | 03.10.13 | CJB | 03.10.13 | CJB | 03.10.13 |

| Scale | Orig Size | Dimensions |
|---|---|---|
| 1:4000 | A1 | m |

| Project No. | Drawing File |
|---|---|
| 25459-3 (00) | 25459 (R03-00).dwg |

| Drawing No. | Rev. |
|---|---|
| FIGURE 1 | P1 |

# EXPLORATORY HOLE LOGS

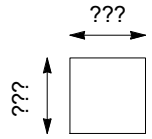
# INSPECTION PIT LOG

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

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

| Samples and In-situ Tests | | | | Water | Backfill | Description of Strata | Depth (Thickness) | Material Graphic Legend |
|---|---|---|---|---|---|---|---|---|
| Depth | No | Type | Results | | | | | |
| | | | | | | MADE GROUND: Firm brown slightly gravely 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 | |
| | | | | | | MADE GROUND: Firm yellow brown slightly silty 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 | |
| 0.50 | 1 | ES | | | | Soft to firm brown and grey sandy CLAY with occasional fine to medium angular to subrounded flints (GAULT FORMATION). | 0.73 | |
| | | | | | | Trial pit terminated at 0.73m | | |

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 0.73m
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** | **CJBall** | |

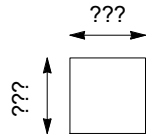
# INSPECTION PIT LOG

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

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

| Samples and In-situ Tests | | | | Water | Backfill | Description of Strata | Depth (Thickness) | Material Graphic Legend |
|---|---|---|---|---|---|---|---|---|
| Depth | No | Type | Results | | | | | |
| | | | | | | MADE GROUND: Firm brown slightly gravely 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 | |
| | | | | | | MADE GROUND: Firm yellow brown slightly silty sandy CLAY with occasional fine to coarse angular to subrounded flint gravels and with occasional to rare ash pockets and brick fragments. | (0.38) 0.63 | |
| 0.50 | 1 | ES | | | | Soft to firm brown and grey sandy CLAY with rare fine to medium angular flints (GAULT FORMATION). | 0.65 | |
| | | | | | | Trial pit terminated at 0.65m | | |

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 0.65m
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** | **CJBall** | |

# WINDOW SAMPLE LOG

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

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

| Progress | Samples / Tests | | | | Water | Backfill | Description of Strata | Depth (Thickness) | Material Graphic Legend |
|---|---|---|---|---|---|---|---|---|---|
| Window Run | Depth | No | Type | Results | | | | | |
| | | | | | | | MADE GROUND: Brown slightly gravely 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 | ES | | | | MADE GROUND: Firm yellow brown slightly gravely sandy CLAY with occasional fine to medium angular to subrounded flints and with occasional brick fragments. | (0.30) 0.60 | |
| | 1.00 | 2 | ES | | | | Firm brown and grey slightly sandy CLAY with frequent pockets of yellow sand. (GAULT FORMATION). | (0.90) 1.50 | |
| | 1.50 | 3 | ES | | | | Stiff brown and grey slightly sandy CLAY with occasional to rare pockets of yellow sand. (GAULT FORMATION). | (1.50) 3.00 | |
| | 2.00 | 4 | ES | | | | | | |
| | 2.50 | 5 | ES | | | | | | |
| | 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: | Plant Used: | Drilled By: | Logged By: | Checked By: |
|---|---|---|---|---|
| **Tracked window sampling** | **Archway Competitor** | **MOS** | **CJBall** | AGS |

# WINDOW SAMPLE LOG

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

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

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

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** | **WS103** |

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

| Progress | Samples / Tests | | | | Water | Backfill | Description of Strata | Depth (Thickness) | Material Graphic Legend |
|---|---|---|---|---|---|---|---|---|---|
| Window Run | Depth | No | Type | Results | | | | | |
| | | | | | | | MADE GROUND: Black slightly gravely 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 gravely 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 | 6 | ES | | | | Borehole terminated at 3.0m | 3.00 | |

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** | |

**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

envirolab
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:**

Melanie Marshall
Laboratory Coordinator

**Approved by:**

Liz Oliver
Client Service Manager

UKAS TESTING
1247

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 | 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 | | |
| 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-022s |
| Ali >C6-C8$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| Ali >C8-C10$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| Ali >C10-C12$_A^\#$ | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | mg/kg | A-T-023s |
| Ali >C12-C16$_A^\#$ | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | mg/kg | A-T-023s |
| Ali >C16-C21$_A^\#$ | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | mg/kg | A-T-023s |
| Ali >C21-C35$_A^\#$ | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.6 | mg/kg | A-T-023s |
| 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-022s |
| Aro >C7-C8$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| Aro >C8-C9$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| Aro >C9-C10$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| Aro >C10-C12$_A^\#$ | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | mg/kg | A-T-023s |
| Aro >C12-C16$_A^\#$ | - | - | 2.3 | <0.1 | <0.1 | <0.1 | 0.3 | <0.1 | mg/kg | A-T-023s |
| Aro >C16-C21$_A^\#$ | - | - | 44.0 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | mg/kg | A-T-023s |
| Aro >C21-C35$_A^\#$ | - | - | 252 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | mg/kg | A-T-023s |
| 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-022s |
| BTEX - Toluene$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| BTEX - Ethyl Benzene$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| BTEX - m & p Xylene$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| BTEX - o Xylene$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| MTBE$_A^\#$ | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | mg/kg | A-T-022s |
| Mineral Oil (>C10-C35)$_A$ | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.6 | mg/kg | A-T-023s |

# 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.

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# 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 11.85$m^3$ (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**

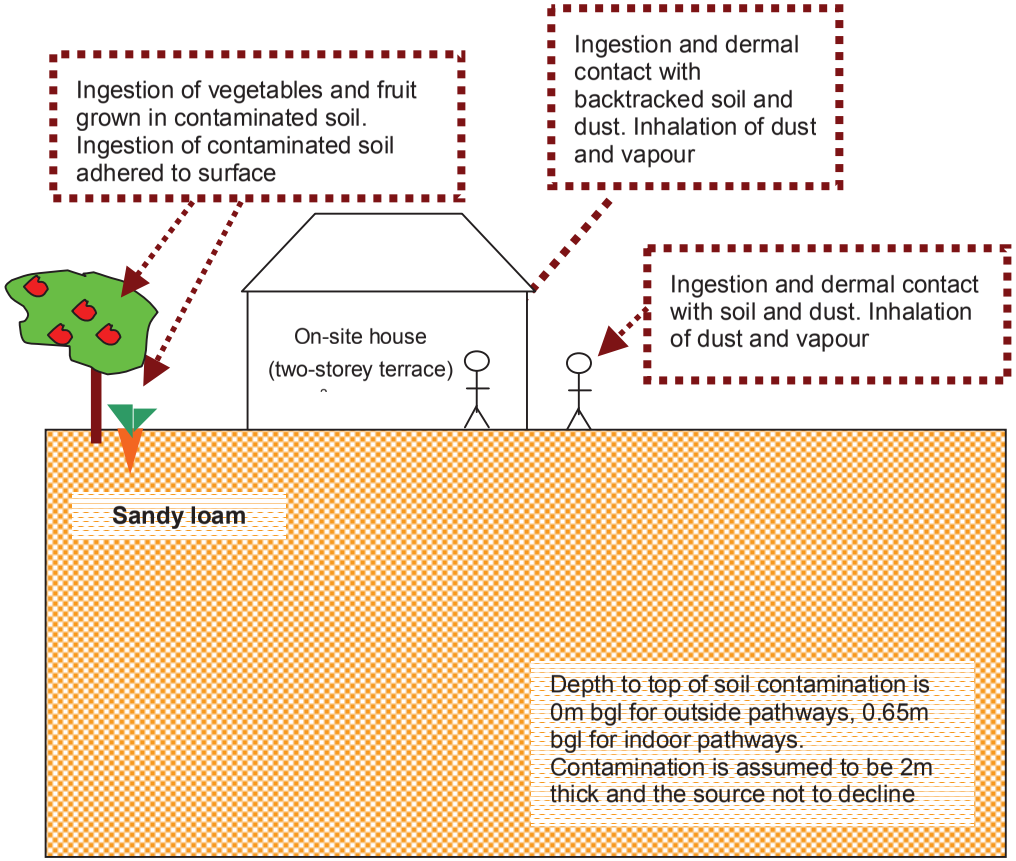


**Table 1: Exposure assessment parameters for residential scenario - private gardens – inputs for CLEA model**

| Parameter | Value | Justification |
|---|---|---|
| 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 vapor 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 loamy soil according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents'[8] |
| | 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]<br>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] |
| Air dispersion factor at height of 1.6m | g $m^{-2}$ $s^{-1}$ per kg $m^{-3}$ | 0 | Assumed child of 6 is not tall enough to reach 1.6m |
| 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**

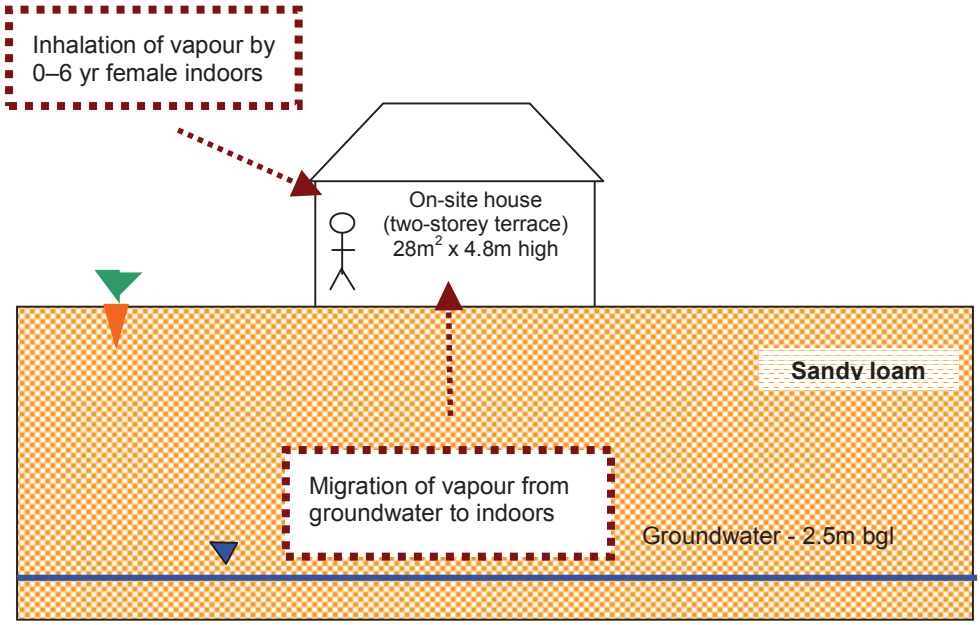


**Table 6: Residential with private gardens – RBCA inputs**

| 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 | | 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 | | 8.00E-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 |

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) Oral | Inhalation | Combined | Soil Saturation Limit (mg/kg) | SAC Appropriate to Pathway SOM 2.5% (mg/kg) Oral | Inhalation | Combined | Soil Saturation Limit (mg/kg) | SAC Appropriate to Pathway SOM 6% (mg/kg) Oral | Inhalation | Combined | Soil Saturation Limit (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 >$EC_6$-$EC_8$ | | 6.40E+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 >$EC_6$-$EC_{10}$ | 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.