Appendix D
Human Health Assessment Criteria

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Appendix D
Soil Guideline Values and General Assessment Criteria

D1 Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'.

D1.1 Contaminated Land Exposure Assessment Model (CLEA)

Current United Kingdom risk assessment practice is based on the Contaminated Land Exposure Assessment Model (CLEA).

The CLEA Guidance comprises the following documents:

1) EA Science Report SC050021/SR2: *Human health toxicological assessment of contaminants in soil.*
2) EA Science Report SC050021/SR3: *Updated technical background to the CLEA model.*
3) EA CLEA Bulletin (2009).
4) CLEA software version 1.04 (2009)
5) Toxicological reports and SGV technical notes.

The CLEA guidance and tools:

- *do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures.*
- *do not cover risks to the environment, such as groundwater, ecosystems or buildings.*
- *do not provide a definitive test for telling when human health risks are significant.*
- *are not a legal requirement in assessing land contamination risks. They are not part of the legal regime for Part 2A of the Environmental Protection Act 1990.*

The CLEA guidance derives soil concentrations of contaminants above which (in the opinion of the EA) there may be a concern that warrants further investigation. It does not provide a definitive test for establishing that the risk is significant.

A new statutory DEFRA guidance recently (i.e. August 2014) published some SGV/GACs with a more pragmatic (but still strongly precautionary) approach in their derivation called the Category 4 screening levels (C4SLs). These values provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land. They are intended as generic screening values, (ii) they describe a level of risk that whilst above 'minimal' is still 'low' and (iii) they provide a 'higher simple test' for deciding that land is suitable for use and definitely not contaminated. These values were derived for four generic land uses: residential, commercial, allotments, and public open space.

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D1.2 Standard Land-use Scenarios

The CLEA model uses a range of standard land-use scenarios to develop conceptual exposure models as follows:

1 Residential

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil and indoor dust ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours.
- Building type is a two-storey small terraced house.

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur.

2) Allotments

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption. Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours.
- There is no building.

3) Commercial/Industrial

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

- Critical receptor is a working female adult (aged 16 to 65 years old).
- Exposure duration is a working lifetime of 49 years.
- Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours.
- Building type is a three-storey office (pre 1970).

4) Public Open Space within Residential Area

The generic scenario refers to any grassed area 0.05 ha and that is close to Housing.

- Grassed area of up to 0.05 ha and a considerable proportion of this (up to 50%) may be bare soil
- Predominantly used by children for playing and may be used for activities such as a football kick about
- Sufficiently close proximity to home for tracking back of soil to occur, thus indoor exposure pathways apply
- older children as the critical receptor on basis that they will use site most frequently (Age class 4-9)
- ingestion rate 75 $mg.day^{-1}$

5)   Public Open Space Park

This generic scenario refers to any public park that is more than 0.5ha in area:

- Public park (>0.5 ha), predominantly grassed and may also contain children's play equipment and border areas of soil containing flowers or shrubs (75% cover)
- Female child age classes 1-6
- Soil ingestion rate of 50 mg.day^{-1}
- Occupancy period outdoors = 2 hours.day^{-1}
- Exposure frequency of 170 days.year^{-1} for age classes 2-18 and 85
- days.year^{-1} for age class 1
- Outdoor exposure pathways only (no tracking back).

D1.3 Soil Guideline Values

The EA are publishing a series of SGV reports for a selection of common contaminants relevant to the assessment of land contamination.

SGV's are generic assessment criteria based on CLEA standard land-uses and can be used to simplify the assessment of human health risks from long-term exposure to chemical contamination in soil. They do not cover short-term exposure (i.e. construction and maintenance workers), acute exposure or other risks such as fire, suffocation or explosion, as might arise from an accumulation of gases such as methane and carbon dioxide, or either odour or aesthetic issues.

SGV's represent 'trigger values', indicators that soil concentrations above the SGV level may pose a possibility of *significant harm* to human health. The converse, where soil concentrations are less that the SGV, is that the long-term human health risks are considered to be tolerable or minimal.

D1.4 Generic Assessment Criteria

If an SGV is not available for a substance identified in the soil then the range of Generic Assessment Criteria published from a collaborative research by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health will be used. For derivation of these Generic Assessment Criteria reference must be made to:

Nathanial, P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillet, A., Ogden, R., Scott, D. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition)*. **Land Quality Press**. 2009.

In the case of Lead, Category 4 screening levels (C4SLs) have replaced the AtRisk Soil SSV.

D1.5 Detailed Quantitative Risk Assessments (DQRA)

Where the adoption of an SGV/GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a DQRA may be undertaking to develop site specific values for relevant soil contaminants.

⇒ Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation.

⇒ Developing more accurate parameters using site data.

D1.6 Ongoing development of CLEA based guidance

The EA is involved in a programme of publishing SGV's and related toxicity data (the TOX reports). As at July 2009 ten SGV's and matching TOX reports had been published.
Soil Assessment Criteria (SAC's) may be derived using toxicity data from the updated TOX reports, where these are published, or from the original TOX reports. SGV reports also take account of recent updates for plant uptake and other factors.

⇒ GAC's developed by CLEA guidance and given in this report will need to be assessed against updated TOX reports and SGV's when these are published.
⇒ SGV reports may give values that differ from the GAC's used in this report.
⇒ These variations may materially alter the remediation requirement for the site, requiring either an increase or decrease in the extent, type and cost of remediation.

D1.7 Phytotoxicity

CLEA guidance only addresses human health toxicity; assessment of plant toxicity (phytotoxicity) is based on threshold trigger values obtained from the following source:

- ICRCL 70/90: *Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing.*

D1.8 Statistical Tests

DEFRA R&D Publication CLR 7 (DOE 1994) addressed the statistical treatment of test results and their comparison to Soil Guideline Values.

Consideration must be given to the appropriate area of land to be considered termed the critical averaging area.

For a communal open space or commercial land-use, the critical averaging area will depend on the proposed layout. For a residential use with private gardens the averaging area is the individual plot.

It may be appropriate to compare the upper 95^{th} percentile concentration with the Soil Guideline Value, subject to applying a statistical test to establish that the range of concentrations are reasonably consistent and belonging to the same underlying distribution of data.

The DEFRA discussion paper Assessing risks from land contamination – a proportionate approach ('the way forward') (CLAN06/2006) aimed to increase understanding of the role that statistics can play in quantifying the uncertainty attached to the estimates of the mean concentration of contaminants in soil. In direct response CLAIRE/CIEH published a joint report, *Guidance in comparing soil contamination data with a critical concentration* (CLAIRE/CIEH 2008). A software implementation of the statistical techniques given in the report was published by ESI International (2008).

Treatment of Hot-Spots

⇒ A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.

⇒ Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.

D2 Soil Guideline Values and General Acceptance Criteria

Soil Guideline Values and General Acceptance Criteria used in the preparation of this report is tabulated in the following pages:

DEFRA CLEA 1.04 Soil Guideline Values (as at July 2012)
(Sandy Loam, pH 7, SOM 6%)

Contaminant	Residential (mg/kg DW)	Allotments (mg/kg DW)	Commercial (mg/kg DW)
Inorganic			
Mercury			
- Elemental	1.0	26	26
- Inorganic	170	80	3600
- Methyl	11	8	410
Nickel	130	230	1800
Selenium	350	120	13000
Organic May not be protective if SOM <6%			
Phenol	420	280	3200 (38,000*)
Benzene	0.33	0.07	95
Toluene	610	120	4400
Ethylbenzene	350	90	2800
Xylenes			
- o-xylene	250	160	2600
-m-xylene	240	180	3500
-p-xylene	230	160	3200
Dioxins			
Sum of PCDDs, PCDFs and dioxin-like PCB's.	8	8	240

* Based on a threshold protective of direct skin contact with phenol (guideline in brackets based on health affects following long term exposure provided for illustration only)

Category 4 screening levels (C4SL) ($mg.kg^{-1}$) for Metals and PAHs
(SGV or GAC shown in brackets for comparison)

Substance	Residential				Public Open Space (POS)	
Contaminant	**With home-grown produce**	**without home-grown produce**	**Allotments**	**Commercial**	**Residential**	**Park**
Arsenic	37(32)	40	49 (43)	640 (640)	79	168
Cadmium	26 (10)	149	4.9 (1.8)	410 (230)	220	880
Chromium VI	21 (4.3)[a]	21	170 (2.1)[a]	49 (35)[a]	23	250
Lead	200 (450)[b] (342)[c]	310 (450)[b](383)[c]	80 (450)[b]	2330 (750)[b](6490)[c]	630 (1590)[c]	1300 (1590)[c]
benzene	0.87 (0.33)	3.3	0.18 (0.07)	98 (95)	140	230
Benzo(a)pyrene (as a surrogate marker for genotoxic PAHs)	5 (1.0)[a]	5.3	5.7 (2.1)[a]	76 (14)[a]	10	21

Note:

[a]GAC from Nathanail *et al.*, 2009

[b] Former SGV now withdrawn

[c] Atkins AtRisk SSV Guideline Values For Lead

Published C4SL guidelines are for pH 7, SOM 6 %

LQM CIEH General Assessment Criteria (2nd edition) (mg/kg)

Contaminant	Residential	Allotment	Commercial
Metals			
Beryllium	51	55	420
Boron	291	45	192000
Chromium (III)	3000	34600	30400
Copper	2330	524	71700
Vanadium	140	150	4250
Zinc	3750	618	665000

LQM CIEH General Assessment Criteria

General Assessment Criteria For Polycyclic Aromatic Hydrocarbons (PAH's) (mg/kg)

Determinants		Residential	Allotments	Commercial
Acenapthene	1.0% SOM	210	34	85,000 (57) sol
	2.5% SOM	480	85	98,000 (141) sol
	6.0% SOM	100	200	100,000
Acenapthylene	1.0% SOM	170	28	84,000 (86) sol
	2.5% SOM	400	69	97,000 (212) sol
	6.0% SOM	850	160	100,000
Anthracene	1.0% SOM	2,300	380	530,000
	2.5% SOM	4,900	950	540,000
	6.0% SOM	9,200	2200	540,000
Benzo(a)anthracene	1.0% SOM	3.1	2.5	90
	2.5% SOM	4.7	5.5	95
	6.0% SOM	5.9	10	97
Benzo(b)flouranthene	1.0% SOM	5.6	3.5	100
	2.5% SOM	6.5	7.4	100
	6.0% SOM	7.0	13	100
Benzo(ghi)perylene	1.0% SOM	44	70	650
	2.5% SOM	46	120	660
	6.0% SOM	47	160	660
Benzo(k)flouranthene	1.0% SOM	8.5	6.8	140
	2.5% SOM	9.6	14	140
	6.0% SOM	10	23	140
Chrysene	1.0% SOM	6.0	2.6	140
	2.5% SOM	8.0	5.8	140
	6.0% SOM	9.3	12	140
Dibenzo(ah)anthracene	1.0% SOM	0.76	0.76	13
	2.5% SOM	0.86	1.5	13
	6.0% SOM	0.90	2.3	13
Flouranthene	1.0% SOM	260	52	23,000
	2.5% SOM	460	130	23,000
	6.0% SOM	670	290	23,000
Flourene	1.0% SOM	160	27	64,000 (31) sol
	2.5% SOM	380	67	69,000
	6.0% SOM	780	160	71,000
Indeno(123-cd)pyrene	1.0% SOM	3.2	1.8	60
	2.5% SOM	3.9	3.8	61
	6.0% SOM	4.2	7.1	62
Naphthalene	1.0% SOM	1.5	4.1	200 (76) sol
	2.5% SOM	3.7	9.9	480 (183) sol
	6.0% SOM	8.7	23	1100 (432) sol
Phenanthrene	1.0% SOM	92	16	22,000
	2.5% SOM	200	38	22,000
	6.0% SOM	380	90	23,000
Pyrene	1.0% SOM	560	110	54,000
	2.5% SOM	1,000	270	54,000
	6.0% SOM	1,600	620	54,000

vap – GAC presented exceeds the vapour saturation limit, which is presented in brackets.

sol – GAC presented exceeds the soil saturation limit, which is presented in brackets.

General Assessment Criteria For TPH (mg/kg)

Determinants		Residential	Allotments	Commercial
		Aliphatic		
EC 5-6	1.0% SOM	30	740	3,400 (304) [sol]
	2.5% SOM	55	1,700	6,200 (558) [sol]
	6.0% SOM	110	3,900	13,000 (1150) [sol]
EC >6-8	1.0% SOM	73	2,300	8,300 (144) [sol]
	2.5% SOM	160	5,600	18,000 (322) [sol]
	6.0% SOM	370	13,000	42,000 (736) [sol]
EC >8-10	1.0% SOM	19	320	2,100 (78) [sol]
	2.5% SOM	46	770	5,100 (118) [vap]
	6.0% SOM	110	1,700	12,000 (451) [vap]
EC >10-12	1.0% SOM	93 (48) [vap]	2,200	10,000 (48) [sol]
	2.5% SOM	230 (118) [vap]	4,400	24,000 (118) [vap]
	6.0% SOM	540 (283) [vap]	7,300	49,000 (283) [vap]
EC >12-16	1.0% SOM	740 (24) [sol]	11,000	61,000 (24) [sol]
	2.5% SOM	1,700 (59) [sol]	13,000	83,000 (59) [sol]
	6.0% SOM	3,000 (142) [sol]	13,000	91,000 (142) [sol]
EC >16-35	1.0% SOM	45,000 (8.48) [sol]	260,000	1,600,000
	2.5% SOM	64,000 (21) [sol]	270,000	1,800,000
	6.0% SOM	76,000	270,000	1,800,000
EC >35-44	1.0% SOM	45,000 (8.48) [sol]	260,000	1,600,000
	2.5% SOM	64,000 (21) [sol]	270,000	1,800,000
	6.0% SOM	76,000	270,000	1,800,000
		Aromatic		
EC 5-7	1.0% SOM	65	13	28,000 (1220) [sol]
	2.5% SOM	130	27	49,000 (2260) [sol]
	6.0% SOM	280	57	90,000 (4710) [sol]
EC >7-8	1.0% SOM	120	22	59,000 (869) [vap]
	2.5% SOM	270	51	110,000 (1920) [sol]
	6.0% SOM	611	120	190,000 (4360) [vap]
EC >8-10	1.0% SOM	27	8.6	3,700 (613) [vap]
	2.5% SOM	65	21	8,600 (1500) [vap]
	6.0% SOM	151	51	18,000 (3580) [vap]
EC >10-12	1.0% SOM	69	13	17,000 (364) [sol]
	2.5% SOM	160	31	29,000 (899) [sol]
	6.0% SOM	346	74	34,500 (2150) [sol]
EC >12-16	1.0% SOM	140	23	36,000 (169) [sol]
	2.5% SOM	480	57	37,000
	6.0% SOM	770	130	37,800
EC >16-21	1.0% SOM	250	46	28,000
	2.5% SOM	480	110	28,000
	6.0% SOM	770	260	28,000
EC >21-35	1.0% SOM	890	370	28,000
	2.5% SOM	1,100	820	28,000
	6.0% SOM	1,230	1,600	28,000
EC >35-44	1.0% SOM	890	370	28,000
	2.5% SOM	1,100	820	28,000
	6.0% SOM	1,230	1,600	28,000
		Aromatic & Aliphatic		
EC >44 - 70	1.0% SOM	1200	1200	28,000
	2.5% SOM	1300	2100	28,000
	5.0% SOM	1300	3000	28,000

Note: a) *SOM = Soil Organic Matter Content (%)* b)*LQM CIEH GAC not set for Allotment land-use*

ICRCL 70/90 *Restoration of metalliferous mining areas* (mg/kg)

Phytotoxicity (Harmful to Plants) Threshold Trigger Values	
Copper	250
Zinc	1000

Notes: Many cultivars and specifically grasses have a high tolerance and there will be no ill-effect at the threshold trigger values given for neutral or near neutral pH. Site observation of plant vitality may give additional guidance.

LQM CIEH General Assessment Criteria

Volatile and Semi-Volatile Organic Compounds (mg/kg)

Contaminant	Residential	Allotment	Commercial
Chloroalkanes & alkenes			
1,2 Dichloroethane			
1.0% SOM	0.0054	0.0046	0.71
2.5% SOM	0.0080	0.0083	1.00
6.0% SOM	0.014	0.016	1.80
1,1,2,2 Tetrachloroethane			
1.0% SOM	1.4	0.41	290
2.5% SOM	2.9	0.89	580
6.0% SOM	6.3	2.0	1200
1,1,1,2 Tetrachloroethane			
1.0% SOM	0.90	0.79	120
2.5% SOM	2.1	1.9	260
6.0% SOM	4.8	4.4	590
Tetrachloroethene			
1.0% SOM	0.94	1.6	130
2.5% SOM	2.1	3.7	290
6.0% SOM	4.8	8.7	660
1,1,1 Trichloroethane			
1.0% SOM	6.2	48	700
2.5% SOM	13	110	1400
6.0% SOM	28	240	3100
Tetrachloromethene			
1.0% SOM	0.018	0.16	3.0
2.5% SOM	0.039	0.37	6.6
6.0% SOM	0.089	0.85	15
Trichloroethene			
1.0% SOM	0.11	0.43	12
2.5% SOM	0.22	0.95	25
6.0% SOM	0.49	2.2	55
Trichloromethane			
1.0% SOM	0.75	0.36	110
2.5% SOM	1.3	0.70	190
6.0% SOM	2.7	1.5	370
Vinyl Chloride			
1.0% SOM	0.00047	0.00055	0.063
2.5% SOM	0.00064	0.0010	0.081
6.0% SOM	0.00099	0.0018	0.12

Contaminant	Residential	Allotment	Commercial
Explosives			
2,4,6 Trinitrotoluene			
1.0% SOM	1.6	0.24	1000
2.5% SOM	3.7	0.58	1000
6.0% SOM	8.0	1.4	1100
RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)			
1.0% SOM	3.5	0.52	6400
2.5% SOM	7.4	1.1	6400
6.0% SOM	16	2.5	6400
HMX (Octogen/1,3,5,7-tetrenitro-1,3,5,7-tetrazacyclo-octane)			
1.0% SOM	5.7	0.86	110,000
2.5% SOM	13	1.9	110,000
6.0% SOM	26	3.9	110,000
Atrazine			
1.0% SOM	0.24	0.037	870
2.5% SOM	0.56	0.085	880
6.0% SOM	1.3	0.20	880
Pesticides			
Aldrin			
1.0% SOM	1.7	1.3	54
2.5% SOM	2.0	2.6	54
6.0% SOM	2.1	4.0	54
Dieldrin			
1.0% SOM	0.69	0.13	90
2.5% SOM	1.4	0.32	91
6.0% SOM	2.2	0.73	92
Dichlorvos			
1.0% SOM	0.29	0.044	942
2.5% SOM	0.6	0.091	972
6.0% SOM	1.3	0.2	983
Alpha - Endosulfan			
1.0% SOM	2.9	0.47	2310 (0.003)[vap]
2.5% SOM	7.0	1.2	2990 (0.007)[vap]
6.0% SOM	16	2.7	3390
Beta - Endosulfan			
1.0% SOM	2.8	0.44	2580 (0.00007)[vap]
2.5% SOM	6.6	1.1	3160 (0.0002)[vap]
6.0% SOM	15	2.6	3480
Alpha -Hexachlorocyclohexanes			
1.0% SOM	19	3.0	14000
2.5% SOM	46	7.4	14600
6.0% SOM	100	18	14900
Beta -Hexachlorocyclohexanes			
1.0% SOM	1.7	0.26	1120
2.5% SOM	3.9	0.64	1130
6.0% SOM	8.5	1.5	1130
Gamma -Hexachlorocyclohexanes			
1.0% SOM	0.58	0.089	532
2.5% SOM	1.4	0.22	546
6.0% SOM	3.0	0.52	552

Chlorobenzenes			
Chlorobenzene			
1.0% SOM	0.33	5.9	59
2.5% SOM	0.73	14	32
6.0% SOM	59	130	310
1,2-Dichlorobenzene			
1.0% SOM	16	94	2100 (571) sol
2.5% SOM	39	230	5100 (1370) sol
6.0% SOM	91	540	12000 (3240) sol
1,3-Dichlorobenzene			
1.0% SOM	0.29	0.25	32
2.5% SOM	0.70	0.61	77
6.0% SOM	1.7	1.5	180
1,4-Dichlorobenzene			
1.0% SOM	30	15	4500 (224) vap
2.5% SOM	72	37	10000 (540) vap
6.0% SOM	167	88	22000 (1280) vap
1,2,3,-Trichlorobenzene			
1.0% SOM	1.0	4.7	110
2.5% SOM	2.6	12	270
6.0% SOM	6.1	28	620
1,2,4,-Trichlorobenzene			
1.0% SOM	1.8	31	230
2.5% SOM	4.5	75	560
6.0% SOM	11	180	1300
1,3,5,-Trichlorobenzene			
1.0% SOM	0.23	4.7	24
2.5% SOM	0.57	12	57.8
6.0% SOM	1.3	28	140
1,2,3,4,-Tetrachlorobenzene			
1.0% SOM	12	4.4	1800 (122) vap
2.5% SOM	4.5	75	3200 (304) vap
6.0% SOM	11	180	4500 (728) vap
1,2,3,5,- Tetrachlobenzene			
1.0% SOM	0.49	0.38	52 (39.4) vap
2.5% SOM	1.2	0.94	120 (98.1) vap
6.0% SOM	2.8	2.2	250 (235) vap
1,2,4, 5,- Tetrachlobenzene			
1.0% SOM	0.30	0.064	44 (19.7) sol
2.5% SOM	0.68	0.16	73 (49.1) sol
6.0% SOM	1.4	0.37	97
Pentachlrobenzene			
1.0% SOM	5.2	1.2	650 (43.0) sol
2.5% SOM	10	3.1	770 (107) sol
6.0% SOM	17	7.1	830
Hexachlorobenzene			
1.0% SOM	0.59 (0.20) vap	0.18	48 (0.20) vap
2.5% SOM	1.0 (0.50) vap	0.42	53
6.0% SOM	1.4	0.92	55
Phenols & Chlorophenols			
Chlorophenols (4 Congeners)			
1.0% SOM	0.87	0.13	3500
2.5% SOM	2.0	0.30	4000
6.0% SOM	4.4	0.70	4200
Pentachlorophenols			
1.0% SOM	0.55	0.084	1200
2.5% SOM	1.3	0.21	0.49
6.0% SOM	1200	1300	1400

Others			
Carbon Disulphide			
1.0% SOM	0.10	4.8	12
2.5% SOM	0.20	10	23
6.0% SOM	0.44	23	50
Hexachloro-1,3-Butadiene			
1.0% SOM	0.21	0.25	32
2.5% SOM	0.51	0.61	69
6.0% SOM	1.2	1.4	120

[vap] – GAC presented exceeds the vapour saturation limit, which is presented in brackets.
[sol] – GAC presented exceeds the soil saturation limit, which is presented in brackets.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

77-79 Charlotte Street

Groundwater Basement Impact Assessment

77-79 Charlotte Street
London
W1T 4PW

Site NGR: TQ 293 817

Prepared for:

Charlotte Street Property Ltd

Chord Environmental Ltd

Report no. 1132/R1

January 2015

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Groundwater Basement Impact Assessment

Site Address

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Document Control Sheet

This report has been prepared with all reasonable skill, care and diligence within the terms of the contract with Charlotte Street Property Ltd incorporating Terms of Agreed work and taking account of the manpower and resources devoted to it by agreement with the client.

Chord Environmental Ltd. disclaims any responsibility to the client and others in respect of any matter outside the scope of the above.

The report is confidential to Charlotte Street Property Ltd. Chord Environmental Ltd. accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known.

Prepared by:	John Evans MSc FGS CGeol	John Evans (signature)

Report no:	1132/R1	**Issue no:**	1	**Date:**	27th January 2015

Chord Environmental Ltd.

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Contents

1 Introduction

1.1 Background

Charlotte Street Property Ltd is applying for Planning Consent to redevelop the site at 77-79 Charlotte Street, Fitzrovia, London. No 77-79 Charlotte Street is a five storey building with a single basement and light-well fronting onto Charlotte Street.

It is proposed to demolish the existing property and redevelop the site with the erection of a new six storey building with a double level basement (the Site). The proposed basement would involve excavation up to approximately 5.5m below existing basement levels.

Chord Environmental has been commissioned by MLM consulting engineers on behalf of Charlotte Street Property Ltd, to prepare a groundwater Basement Impact Assessment for the proposed development.

1.2 Scope and Approach

This report reviews the proposed development at 77-79 Charlotte Street within the context of the conceptual understanding of its site setting which has been informed through both desk study and site investigation findings. The report would identify potential groundwater impacts the development may have. Appropriate mitigating measures can then be developed and adopted to avoid or minimise these affects where identified.

Site investigation works have been undertaken by Soils Ltd. The work comprised a detailed Ground Investigation[1], and this assessment should be read in conjunction with the Soils Ltd site investigation report.

This report is limited to the groundwater flow component of the Basement Impact Assessment, as specified by the London Borough of Camden Planning Guidance CPG4[2] and their Guidance for Subterranean Development[3] supporting technical document. The Author of this report is a qualified Hydrogeologist, Chartered Geologist and Fellow of the Geological Society of London, as required by the Guidance.

[1] Summary of Ground Investigation Preliminary Findings – 77-79 Charlotte Street, London W1T 4PW. Soils Ltd. January 2015.

[2] London Borough of Camden Planning Guidance CPG4 Basements and lightwells

[3] Camden Geological, Hydrogeological and Hydrological study - Guidance for Subterranean Development. Ove Arup & Partners Ltd., November 2010

1.3 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the site information obtained from the client or other third parties and the results of the work should be viewed in the context of the range of data sources consulted. No liability can be accepted for information in other data sources or conditions not revealed by the information provided. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by Chord Environmental.

2 Proposed Development

The Site (London, W1T 4PW, National Grid Reference TQ 293 817) is currently occupied by 77 and 79 Charlotte Street. The existing properties are currently used as commercial spaces. The site is bounded by Charlotte Street to the northeast and Tottenham Mews to the southwest, and the properties of No 73 and 75 Charlotte Street to the southeast and No 81 Charlotte Street to the northwest.

The proposal is to demolish the existing properties on the Site and construct a new six storey building with a double level basement. The basement formation level would be approximately 7.5m below existing ground levels, 5.5m below the existing basement level. The building footprint is proposed to remain similar to existing and the basement area would extend beneath the entire building footprint.

Contiguous pile walls would be constructed adjacent to Charlotte Street and Tottenham Mews and traditional underpinning will be undertaken beneath the party walls of 81 and 75 Charlotte Street.

3 Site Setting

The Site is located on Charlotte Street close to the junction of Tottenham Road in the Fitzrovia area of London, W1T 4PW.

3.1 Topography

The Site lies at an elevation of approximately 27m above ordnance datum (OD) on ground which falls away to less than 10m OD at the River Thames, c.1.7 km to the southwest and rises to an elevation of 134m OD on Hampstead Heath, c.5km north of the site. The ground is relatively level within and around the Site.

3.2 Hydrology and Drainage

The Site lies within the surface water catchment of the River Fleet, a tributary of the River Thames, and outside of the catchment of the Hampstead Heath chain of ponds. The Fleet is entirely covered and culverted and forms part of the surface water sewerage system, running beneath the Fitzrovia area to where it discharges into the Thames beneath Blackfriars Bridge. According to historic maps[4], a tributary of the Fleet rises c.500m to the north of the Site beneath the northern edge of Tottenham Court Road.

There are no surface water features marked on Ordnance Survey mapping (1:25,000 scale) within 1km of the Site. The site is not located within a Flood Zone as defined by the Environment Agency and Charlotte Street or adjoining roads have not been identified as at risk of surface water flooding as a result of sewer surcharging within the London Borough of Camden[5].

3.3 Geology

According to the British Geological Survey (BGS) 1:50,000 scale sheet for the area (Sheet 256, North London. 2006) and the associated geological memoir, The Geology of London (BGS 2004), the Site is underlain by the sandy gravels of the Quaternary Lynch Hill Gravel deposits which are River Terrace Deposits associated with the River Thames. The Lynch Hill Gravel deposits are in turn underlain by the Eocene London Clay, generally a stiff grey clay, which outcrops c.1km to the north of the Site.

The Hackney Gravel deposits adjoin the Lynch Hill Gravel deposits to the south and lie on a lower river terrace. The Lynch Hill Gravel Formation has been mapped by the BGS as being approximately 4.5m thick beneath the Site although the thickness of River Terrace Deposits is variable.

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[4] The Lost Rivers of London: a study of their effects upon London and Londoners, and the effects of London and Londoners upon them. N. Barton. 1962.

[5] Map 22 Camden Flooding Map. North London Strategic Flood Risk Assessment. Mouchel. 2008.

The London Clay is shown to be approximately 20m in thickness, in turn underlain by c.10m of Lambeth Group sandy clays and c.10m of Thanet Sand Formation fine grained sands. The Cretaceous Upper Chalk, which underlies the Thanet Sands, is anticipated to be at a depth of c.40m beneath the Site.

Site specific geological data from the borehole drilled during the Soils Ltd site investigation[1], have established the presence of a 4.5m thickness of Made Ground beneath the existing basement level (25.17m OD). Coarse gravelly sand, likely to be the mapped Lynch Hill Gravel Formation, was proved to a depth of 6.9m (18.27m OD) where it was underlain by stiff dark grey clay to a depth of 25.0m, which correlates to the London Clay.

The Lynch Hill Gravels are likely to have been historically worked and removed to some extent in the area.

3.4 Hydrogeology

The Environment Agency classifies the Lynch Hill Gravel Member as Secondary A Aquifer, capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

The London Clay and Lambeth Group are classified as Unproductive Strata (formerly Non Aquifer), i.e. not capable of providing useable quantities of water. The Thanet Sands are classified as Secondary A Aquifer whilst the Cretaceous Chalk is classified as a Principal (formerly Major) Aquifer; however the Thanet Sands and Chalk are hydraulically confined and not generally used for drinking water supply in the central London area due to their poor water quality.

Groundwater beneath the Site is considered to be dominated by intergranular flow through the sands and gravels of the Lynch Hill Gravel Member. Historic maps indicate that a tributary of the River Fleet rose from the base of the Lynch Hill Gravel Member, flowing along the line of Euston Road.

The site investigation established groundwater at a depth of 3.95m beneath the existing basement (21.22m OD) within the Made Ground, approximately 5.95m beneath existing ground levels. Groundwater flow beneath the Site is anticipated to follow the topographic gradient toward the southeast and the River Thames.

4 Screening

The London Borough of Camden's CPG4 Guidance states that any development proposal which includes a subterranean basement should be assessed within a screening process to determine whether there is a requirement for a BIA to be undertaken.

4.1 Screening Assessment

Appendix E of the "Camden geological, hydrogeological and hydrological study" guidance document details six Basement Impact Assessment screening questions, each of which is stated and answered below:

- **Question 1a: Is the site located directly above an aquifer?**

  Yes. The Site is underlain by the Lynch Hill Gravel Member which is designated as Secondary Aquifer by the Environment Agency and considered capable of supporting local water supplies and baseflow to watercourses.

- **Question 1b: Will the proposed basement extend beneath the water table surface?**

  Yes. Based on the findings of the site investigation, the basement would extend beneath the monitored water table surface (i.e. saturated Lynch Hill Gravel Member). The proposed basement formation level (c.20m OD) would be approximately 1.22m beneath monitored groundwater levels (21.22m OD).

- **Question 2: Is the site within 100m of a watercourse, well (used/disused) or potential spring line?**

  No. There are no current, or known historic, surface water features mapped within 100m of the site.

- **Question 3: Is the site within the catchment of the pond chains on Hampstead Heath?**

  No. The Site is outside the catchment of Hampstead Heath ponds. Refer to Section 3.2.

- **Question 4: Will the proposed development result in a change in the proportion of hard surfaced / paved area?**

  No. The site is currently all hard paving and the proposed building footprint would essentially remain the same.

- **Question 5: As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to ground (e.g. via soakaways and/or SUDS)?**

  No. It is anticipated that the use of a SUDS orientated drainage scheme on this site would not be feasible due to the limited space available.

- **Question 6: Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line?**

  No. There are no local ponds or spring lines present within 100m of the Site.

4.2 Screening Conclusions

The screening exercise has identified the following potential issues which should be assessed:

1. The Site is underlain by the Lynch Hill Gravel Member, classified a Secondary Aquifer by the Environment Agency, capable of supporting local water supplies and baseflow to watercourses.
2. The proposed basement would extend beneath monitored winter groundwater levels beneath the Site.

5 Scoping Assessment

Scoping is the activity of defining in further detail the matters to be investigated as part of the basement impact assessment. Potential impacts should be ascertained for each of the matters of concern identified during the screening process.

The investigation of the potential impacts is undertaken through a site investigation. In this instance, a desk study and site investigation has been undertaken to establish ground conditions for geotechnical assessment purposes. The investigation included the installation of a groundwater monitoring standpipe to a depth of 7m beneath the existing basement level and approximately 9m beneath existing ground levels. This assessment relies upon the findings of the desk study and site investigation.

The following potential impacts have been identified:

Screening issue	**Potential Impact**
The Site is underlain by a Secondary Aquifer.	The proposed basement development may reduce groundwater recharge and could potentially impact on baseflow to watercourses or local private water supplies.
The proposed basement would extend beneath the water table.	The proposed basement may act as a barrier to groundwater flow causing a change in groundwater flow direction and/or levels. This could potentially impact on neighbouring properties and the baseflow to watercourses or local private water supplies.

6 Groundwater Impact Assessment

The screening process identified two potential groundwater impacts. The results of the desk study and site investigation have been used below to address these concerns and assess the likelihood of negative impacts occurring:

1. <u>Reducing recharge and groundwater flow to watercourses and groundwater supplies.</u>

Although the Lynch Hill Gravel Member is classified a Secondary Aquifer by the Environment Agency, it is not used for potable groundwater supplies in central London and there are no watercourses which are dependent on receiving baseflow from it. The River Terrace Deposits are associated with the Thames and groundwater within them discharges to it.

The site is currently covered in building footprint or hard standing and surface water drainage is directed toward the local surface water sewerage system which discharges to the Thames. The proposed basement construction would not alter this arrangement.

The proposed basement construction would therefore not result in a reduction to groundwater flow as a result of a reduction of groundwater recharge.

2. <u>Altering of the groundwater flow regime as a result of the proposed basement development.</u>

It has been established that the proposed basement is underlain by a designated Secondary Aquifer capable of supporting baseflow to watercourses and that the proposed basement would extend below currently monitored groundwater levels. The potential impact of the basement proposal is that the groundwater regime may be altered through the proposed basement acting as a barrier to groundwater flow causing groundwater levels to rise locally.

Monitored winter groundwater levels beneath the Site are recorded as being at 21.22m OD and within the Made Ground. The formation level of the basement would be 7.5m beneath current ground levels, at an elevation of 19.5m OD, and approximately 1.72m beneath monitored winter groundwater levels. The proposed basement would be completed within Made Ground and the Lynch Hill Gravel deposits, the base of which are at an elevation of 18.27m OD, approximately 1.2m beneath the basement formation level.

Groundwater movement within the Lynch Hill Gravel strata beneath the Site is controlled by intergranular flow which follows the fall of the topographic gradient toward the southeast and the River Thames. The hydraulic permeability of the gravelly sand deposits is very high. The proposed basement structure would be surrounded by these highly permeable gravelly sand deposits which would allow groundwater to flow easily around and beneath the basement structure without causing a significant change to groundwater levels.

The contiguous piled walls adjacent to Charlotte Street and Tottenham Mews would be orientated perpendicular to the direction of groundwater flow, therefore presenting the least surface area against the direction of flow. The proposed basement structure would therefore not have any significant adverse effects on the groundwater flow regime beneath the Site.

3. Cumulative Effects.

The Guidance for the assessment of basement structures states that the cumulative effects on the groundwater regime from existing neighbouring basement structures should also be assessed.

81 Charlotte Street has a basement and lightwell similar in depth to the existing basement of 77 and 79 Charlotte Street. 73-75 Charlotte Street is currently being redeveloped and includes the construction of a single level basement which is approximately 3.95m below existing ground levels. Both of these basements are over 1.5m above monitored winter groundwater levels beneath the Site and would therefore not add to any cumulative effects on the existing groundwater regime.

Based on the findings of the site investigations and the existing groundwater flow regime, it is considered highly unlikely that the proposed development would result in a significant change in groundwater flow regime beneath the site.

7 Conclusions

A groundwater basement impact assessment of the proposed development has been undertaken. The assessment has been based on information and guidance published by the London Borough of Camden[3] and on site investigation information[1].

No potential adverse impacts or effects have been identified as a result of the assessment and it is concluded that the proposed basement development is highly unlikely to result in any significant changes to the existing groundwater regime beneath, or adjacent to, the Site.