Worms Heath Restoration
Limpsfield Road

ENVIRONMENTAL SETTING AND SITE DESIGN
(including Conceptual Site Model)

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1 INTRODUCTION

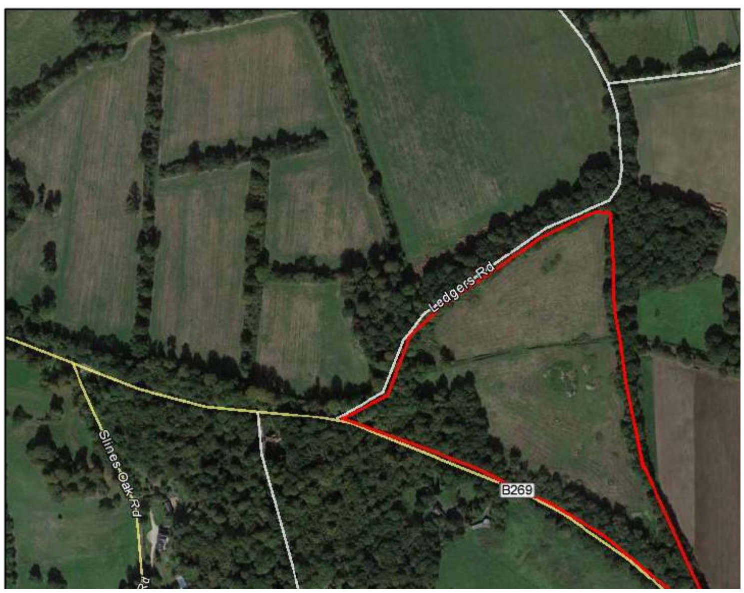
1.1 Report Context

This report has been prepared by TJS Services Ltd to accompany a Bespoke Permit Application for the importation of waste to restore the former landfill at Worms Heath, Limpsfield Road, Warlingham, Surrey CR6 9QL.

The proposed operation is for the importation of soils, largely based on Standard Rules SR2015No.39, and is a 'deposit for recovery' activity, not a 'landfill'. Accordingly, some sections of this report have been marked 'not applicable'.

1.2 Site Details

The site is located to the north of Limpsfield Road and is known as Worms Heath. It is part of a wider agricultural holding, however, the planning history for the site shows it has been used for gravel extraction since the 19th Century, before being infilled with inert waste during the 1970's. The land has since been returned to agriculture, but the poor quality of the land makes the site difficult to use and, in contrast to the surrounding agricultural land, it is now rough grassland inhabited by brambles, nettles and other weeds.



The site is approximately 9.5ha and includes 3.0ha of woodland, mainly along the southern boundary, but also along the other boundaries. The remainder of the site is an open field that gently slopes down towards the north-west. There is a public bridleway that runs east to west across the site.

The site is shown by the green boundary on the Site Plan (Ref. WH/003), provided in Appendix A.

2 SOURCE

2.1 Historical Development

The site is currently part of a wider agricultural holding, but historically, it has been used for gravel extraction, since the 19th Century. British Geological Survey (BGS) records contain historic borehole records showing the suitability of the local geology. A copy of the borehole records is provided in Appendix B.

Environment Agency (EA) records show that the site has also been used as an inert landfill between 1974 and 1979. The records clearly state that inert waste was placed at the site (not commercial, industrial, residential or other waste types). A copy of the EA map/record is provided in Appendix C.

Since the 1970's the land has been returned to agriculture, but the poor quality of the land makes the site difficult to use. Concrete, brick and other debris are common across the surface of the land, but no evidence or incidents of chemical contamination have occurred to-date.

2.2 Proposed Development

The proposed works will cap the existing unsuitable soils (and former landfill) to create an improved soil profile for productive agricultural use, in the future. The area of the proposed works is approximately 7.5ha and it is estimated that approximately 100,000m^3 of material is required.

It is envisaged that the works will be carried out under a Bespoke Permit, largely based on the Standard Rules Permit SR2015No.39. The proposed waste types (based on SR2015No.39) are listed in Table 1 below and have been previously approved in the Worm's Heath Waste Recovery Plan (WRP) (Ref: WH/001).

Table 1 – Types of Waste

Permitted waste types

Source	Sub-source	Waste code	Description	Additional restrictions
01 Waste resulting from exploration, mining, quarrying and physical and chemical treatment of minerals	01 01 wastes from mineral excavation	01 01 02	Wastes from mineral nonmetalliferous excavation	Restricted to waste overburden and interburden only.
	01 04 wastes from physical and chemical processing of non-metalliferous minerals	01 04 08	Waste gravel and crushed rocks other than those mentioned in 01 04 06	

		01 04 09	Waste sand and clays	
02 Waste from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing	02 04 wastes from sugar processing	02 04 01	Soil from cleaning and washing beet	
10 Wastes from thermal processes	10 12 wastes from manufacture of ceramic goods, bricks, tiles and construction products	10 12 08	Waste ceramics, bricks, tiles and construction products (after thermal processing)	
	10 13 waste from manufacture of cement, lime and plaster and articles and products made from them	10 13 14	Waste concrete	
17 Construction and demolition wastes	17 01 concrete, bricks, tiles and ceramics	17 01 01	Concrete	
		17 01 02	Bricks	
		17 01 03	Tiles and ceramics	
		17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	Metal from reinforced concrete must have been removed.
	17 03 bituminous mixtures	17 03 02	Bituminous mixtures other than those mentioned in 17 03 01	Road planings only.

	17 05 soil stones and dredging spoil	17 05 04	Soil and stones other than those mentioned in 17 05 03	Restricted to topsoil, peat, subsoil and stones only.
19 Wastes from waste management facilities	19 12 wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified	19 12 09	Minerals (for example sand, stones) only	Restricted to wastes from treatment of waste aggregates that are otherwise naturally occurring minerals. Does not include fines from treatment of any non-hazardous waste or gypsum from recovered plasterboard.
		19 12 12	Other wastes (including mixtures of materials) from mechanical treatment of wastes other than those mentioned in 19 12 11	Restricted to crushed bricks, tiles, concrete and ceramics only. Metal from reinforced concrete must be removed. Does not include fines from treatment of any non-hazardous waste or gypsum from recovered plasterboard.
20 Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions	20 02 garden and park wastes	20 02 02	Soil and stones	Restricted to topsoil, peat, subsoil and stones only.

The imported materials will be utilised to construct the landform shown on Drg. No. fpes 3.2, provided in Appendix D. This will involve placing the newly imported materials to form a cap over the previously placed former landfill materials. The imported material will be inert and will present a limited risk to the environment. The historically placed material (in the former landfill) is of a similar ‘inert’ nature and, historically, it has not presented any risk to the hydrogeology, surface water or the wider environment.

3 PATHWAY AND RECEPTOR

3.1 Geology

The site is located on the sands/gravels of the 'Disturbed Blackheath Beds', underlain by the 'Lewes Nodular Chalk Formation'. This is shown on the BGS map provided in Appendix E.
BGS records also contain historic borehole records demonstrating the original geology at the site. A copy of the borehole records is provided in Appendix B.

A site investigation was carried in August 2018 by Reading Agricultural Consultants (RAC). A copy of the RAC Agricultural Statement is provided in Appendix F of this ESSD.
The investigation included the excavation of trial pits across the site. The following description is extracted from the agricultural statement:

> "*The 'topsoil' material on the surface was variable in texture and structure. Some topsoils were friable, and some were poorly structured. The 'subsoil' material was mainly tipped excavated waste, including clay and chalk spoil. It should not be considered a soil material. The subsoil material was compacted and had a poor structure.*
>
> *Both the topsoil and subsoil were highly contaminated with brick, tile, glass and metal observed. Lumps of concrete up to 350mm were present.*"

The soil survey did not observe any visual or olfactory evidence that the former landfill material is not inert.

3.2 Hydrology

The hydrology of the site has been assessed by Civil Engineering Solution Ltd (CES), in August 2019. A copy of the Flood Modelling Report is provided in Appendix G of this ESSD.

The report states that the EA Flood Maps show the site located within Flood Zone 1 and hence there is a low risk of surface water flooding. The assessment models two scenarios:

> Existing: to establish the current hydraulic characteristics of the site and the wider catchment,
> Proposed: to establish hydrologic effects of the proposed surface change on the site, neighbouring properties and the catchment.

The results of the modelling show that the existing site is subject to pluvial flooding and identified three overland flow routes within the immediate proximity of the site. The hydraulic modelling also found that the proposed development has a minimal impact to maximum flood depths and a negligible increase to the overland routes. Impacts to neighbouring properties are therefore negligible.

3.3 Hydrogeology and Groundwater

The site is located on a Principal Aquifer, but is not within a Zone I or 2 Source Protection Zone. The site is within a 'Medium Risk' Groundwater Vulnerability Area.

3.4 Man-made Subsurface Pathways

None identified in the hydrology assessment.

3.5 Receptors and Compliance Points

The following potential receptors have been identified for consideration in the Risk Assessment (Ref WH/008).

3.5.1 Groundwater

Groundwater contamination could potentially occur from:

- the previously imported soils (former landfill)
- soils to be imported under the Permit

The site and the surrounding area are not a sensitive receptor and the natural geology limits groundwater migration. Based on the site setting, it is considered that there is no existing pollution linkage from the materials in the former landfill.

Any potential effect from the materials to be imported under the Bespoke Permit will be localised and these are mitigated by the management actions described in the Risk Assessment. These materials will be imported under the EPR Permit and will comply with the acceptance criteria based on the protection of human health and controlled waters, and is therefore equally protective of groundwater. The specific chemical acceptance criteria for the imported materials are stated in Appendix H.

3.5.2 Surface Water

The former landfill materials present a limited risk to the existing surface water regime. Historically, there have been no incidents of contamination from runoff, silt or leachate on or near the site. Modelling has found that the proposed development has a minimal impact on flood depths and a negligible increase to flow on the overland routes. Impacts to neighbouring properties are therefore negligible.

The proposed cap will be constructed of equally low risk 'inert' materials and will have a negligible effect on the surface water regime. These materials will be imported under the EPR Permit and will comply with the acceptance criteria based on the protection of human health and controlled waters. The specific chemical acceptance criteria for the imported materials are stated in Appendix H.

Surface water receptors are not/will not be affected.

3.5.3 Landfill Gas

Not applicable

3.5.4 Amenity (Nuisance and Health Issues)

Potential receptors of amenity source risks have been identified in the Risk Assessment, refer to Table 1 in Ref.WH/008.

4 CONCEPTUAL SITE MODEL

4.1 Summary

The Conceptual Site Model (CSM) described in the previous sections of this ESSD has identified the relevant 'Source', 'Pathways' and 'Receptors' relating to the proposed scheme at Worm's Heath.

The sources identified are the existing former landfill material and the proposed (imported) capping material. Historically, there have been no incidents of contamination from runoff, silt or leachate on or near the site, indicating that the existing materials pose little risk to the environment. The material to be imported is of a similar 'inert' nature and is of equal low risk. Consequently, there is very little risk from these two sources.

The natural geology and the surface water regime are two pathways identified in the CSM. The natural geology has the potential for groundwater migration, however, as stated above the sources provide very little risk to groundwater contamination. Additionally, the site setting (receptor) is not sensitive; the risk is therefore considered low.

Similarly, the surface water regime has been modelled and the potential impacts to neighbouring properties are negligible. The risk to neighbouring land and watercourses (receptors) is therefore low.

4.2 Conclusion

In conclusion, the risk to the receptors is low.

5 POLLUTION CONTROL MEASURES

5.1 Site Engineering

The proposed works will construct a layer of soil across the site, thereby covering the existing landfill material (Source) and minimising the infiltration (Pathway) of rainfall in to the former landfill.

5.2 Restoration

The site will be restored to a condition suitable for agricultural use

5.3 Surface Water Management

The proposed works will have a negligible effect on surface water, hence management is not required. Runoff characteristics may temporarily change during construction of the proposed works and bunds/ditches may be provided temporarily.

5.4 Post Closure Controls (Aftercare)

The site will be incorporated in to the management/use of the surrounding agricultural holding.

It is noted that the site is not a Landfill

6 MONITORING

6.1 Weather

Not applicable

6.2 Gas Monitoring Infrastructure

Not applicable

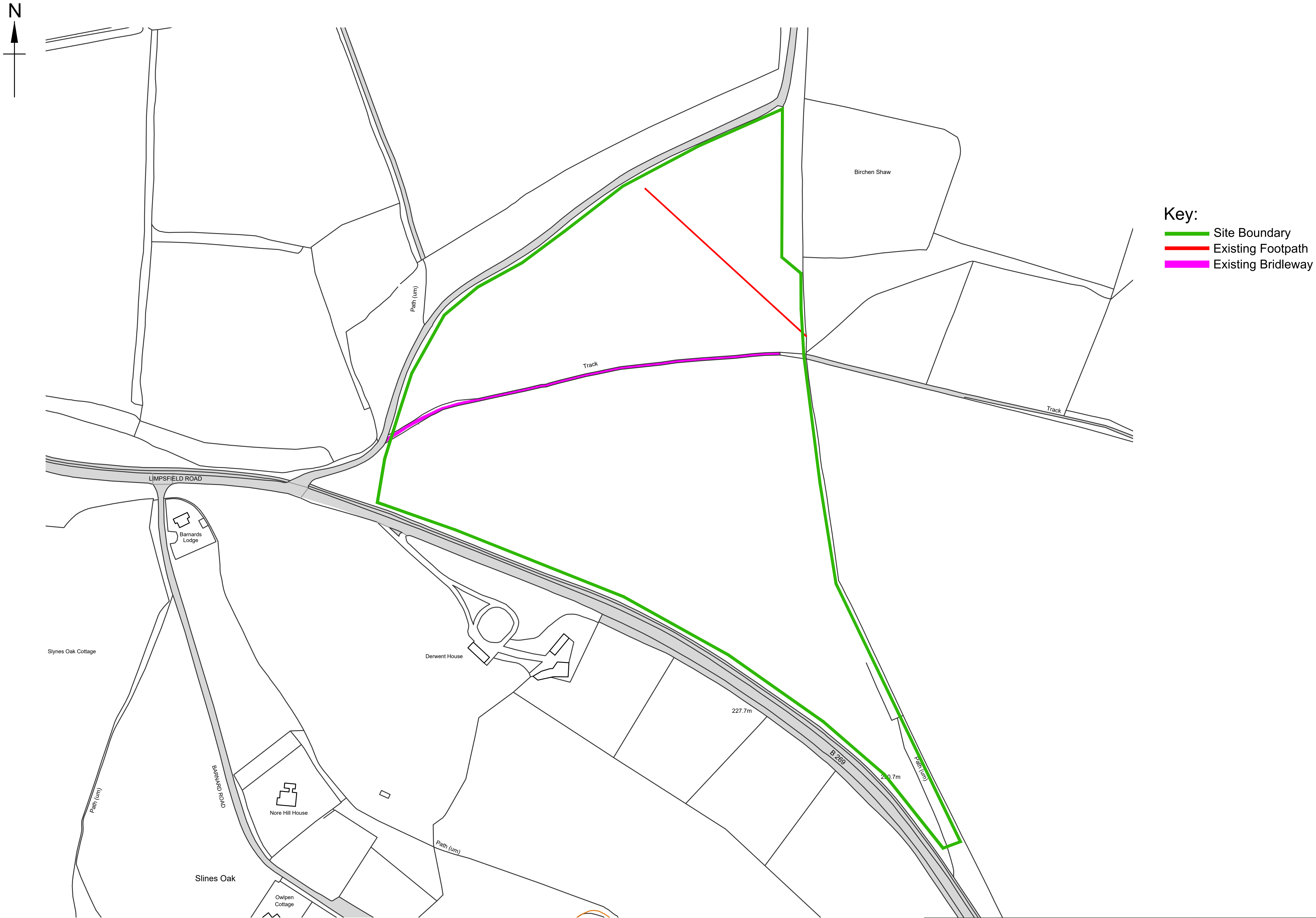
6.3 Gas Monitoring

Not applicable

7 SITE CONDITION REPORT

A Site Condition Report has been prepared separately, refer to WH/004.

APPENDIX A



Title	Reference	Version
Worm's Heath, Limpsfield Road Site Plan	WH/003	A
	Scale 1:2500 @A3	**Date** Jan. 2023

APPENDIX B

TQ 3SNE

12

TERRESEARCH LIMITED

BOREHOLE NO. 1

37800
58018

Contract Name CHELSHAM — Report No. S.663/14

Client MacKay & Schnellmann Ltd., — Site Address Worms Heath

Address Geological and Mining Consultants, — Chelsham

London E.C.2.

for Hoveringham Gravels

Standing Water Level — Diameter 8" & 6"

Water Struck NONE — Method of Boring Shell and Auger

Ground Level — Start 7.5.64. Finish 9.5.64.

Remarks:

PRELIMINARY SHEET

Description of Strata	Thickness	Depth	Disturbed Samples	'U' Cores and 'N' P. Test
Compact sand and gravel	7'0"	7'0"	B1259 5'0"	
Gravel	16'0"	23'0"	J1260 8'0" B1261 10'0" J1262 13'0" B1263 15'0" J1264 18'0" B1265 20'0"	
Compact sand and gravel	15'0"	38'0"		
Claybound gravel	2'0"	40'0"	J1266 23'0" B1267 25'0" J1268 28'0" B1269 30'0" J1270 33'0" B1271 35'0" J1272 37'0" B1273 38'0"	
Brown clay & flints	10'0"	50'0"	J1274 43'0" B1275 45'0" J1276 48'0"	
Chalk	3'0"	53'0"	B1277 50'0" J1278 53'0"	
TOTALS	53'0"	53'0"		

NOTES: 1. Descriptions are given in accordance with the B.S. Civil Engineering Code of Practice C.P.2001 "Site Investigations"
2. J indicates Jar Samples.
B „ Bulk Samples.
W „ Water Samples.
U „ Undisturbed Core Samples. These are nominal 4 in. diam. and 18 in. long. Depths shown are top of sample.
N „ Number of blows per ft. penetration with Standard Penetration Tests.

TERRESEARCH LIMITED

TQ3SNE 13

37920
S8078

BOREHOLE NO. 2

Contract Name CHELSHAM
Report No. S. 663/14

Client MacKay & Schnellmann Ltd.,
Site Address Worms Heath,

Address Geological and Mining Consultants
Chelsham.

London E.C.2.

for Hoveringham Gravels

Standing Water Level
Diameter 8" & 6"

Water Struck NONE
Method of Boring Shell and Auger

Ground Level
Start 11.5.64. Finish

Remarks:

PRELIMINARY SHEET

Description of Strata	Thickness	Depth	Disturbed Samples	'U' Cores and 'N' P. Test
Top Soil	0'3"	0'3"		
Compact gravel	7'9"	8'0"	J601 2'6" B602 5'0"	
Red compact sand & gravel	22'0"	30'0"	J603 8'0" B604 10'0" J605 13'0" B606 15'0" J607 18'0" B608 20'0" J609 23'0" B610 25'0" J611 28'0" B612 30'0"	
Compact gravel	50'0"	80'0"	J613 33'0" B614 35'0" J615 38'0" B616 40'0" J617 43'0" B618 45'0" J619 48'0" B620 50'0" J621 53'0" B622 55'0" J623 58'0" B624 60'0" J625 63'0" B626 65'0" J627 68'0"	
TOTALS				Cont'd......

NOTES: 1. Descriptions are given in accordance with the B.S. Civil Engineering Code of Practice C.P.2001 "Site Investigations"
2. J indicates Jar Samples.
B „ Bulk Samples.
W „ Water Samples.
U „ Undisturbed Core Samples. These are nominal 4 in. diam. and 18 in. long. Depths shown are top of sample.
N „ Number of blows per ft. penetration with Standard Penetration Tests.

TQ35NE 14

TERRESEARCH LIMITED

37809
57921

BOREHOLE NO. 3

Contract Name Chelsham — Report No. S. 663/14

Client MacKay & Schnellmann Limited — Site Address Worms Heath

Address Geological & Mining Consultants — Chelsham

London, E.C.2.

For Hoveringham Gravels

Standing Water Level — Diameter 8" and 16"

Water Struck None — Method of Boring Shell/Auger

Ground Level — Start 22.5.64 Finish 25.5.64

Remarks:

PRELIMINARY SHEET

Description of Strata	Thickness	Depth	Disturbed Samples	'U' Cores and 'N' P. Test
Top soil	0'4"	0'4"		
Compact sand and gravel	12'8"	13'0"	J641 2'6" B642 5'0" J643 8'0" B644 10'0"	
Claybound gravel	6'0"	19'0"	J645 13'0" B646 15'0" J647 17'0"	
Brown clay and flints	4'0"	23'0"	J648 19'0" B649 20'0"	
Chalk	3'0"	26'0"	J650 23'0" B261 26'0"	
TOTALS	26'0"	26'0"		

NOTES: 1. Descriptions are given in accordance with the B.S. Civil Engineering Code of Practice C.P.2001 "Site Investigations"
2. J indicates Jar Samples.
B ,, Bulk Samples.
W ,, Water Samples.
U ,, Undisturbed Core Samples. These are nominal 4 in. diam. and 18 in. long. Depths shown are top of sample.
N ,, Number of blows per ft. penetration with Standard Penetration Tests.

TQ35NE 15

LE GRAND ADSCO

CIVIL ENGINEERING DIVISION of
LE GRAND SUTCLIFF AND GELL LIMITED

RECORD OF TEST BORING No. 4 at Chelsham. 37901
For Messrs. Mackay & Schnellmann. 57877

O/No. 3797 Boring Completed on 21.5.64. O.D. Level

Boring lined to a Depth of 65'0" Diameter 6"

BORING FOREMAN'S STRATA RECORD	THICKNESS Ft	THICKNESS Ins	DEPTH Ft	DEPTH Ins	WATER OBSERVATIONS Date	Time	W.S.	SWL
Clay and stones	64	0	64	0			Nil	
Hard stone	0	6	64	6				
TOTAL DEPTH			64	6				

SAMPLING DETAILS

Lab Location No.

Undisturbed Core Samples Taken at

Disturbed ~~XX~~ Bulk Samples Taken at 5',10',15',20',25',30',35',40',45',50',55',60',64'6".

Water Samples Taken ~~XXX~~/NO

Standard Penetration Tests Carried Out

From To Blows

From To Blows

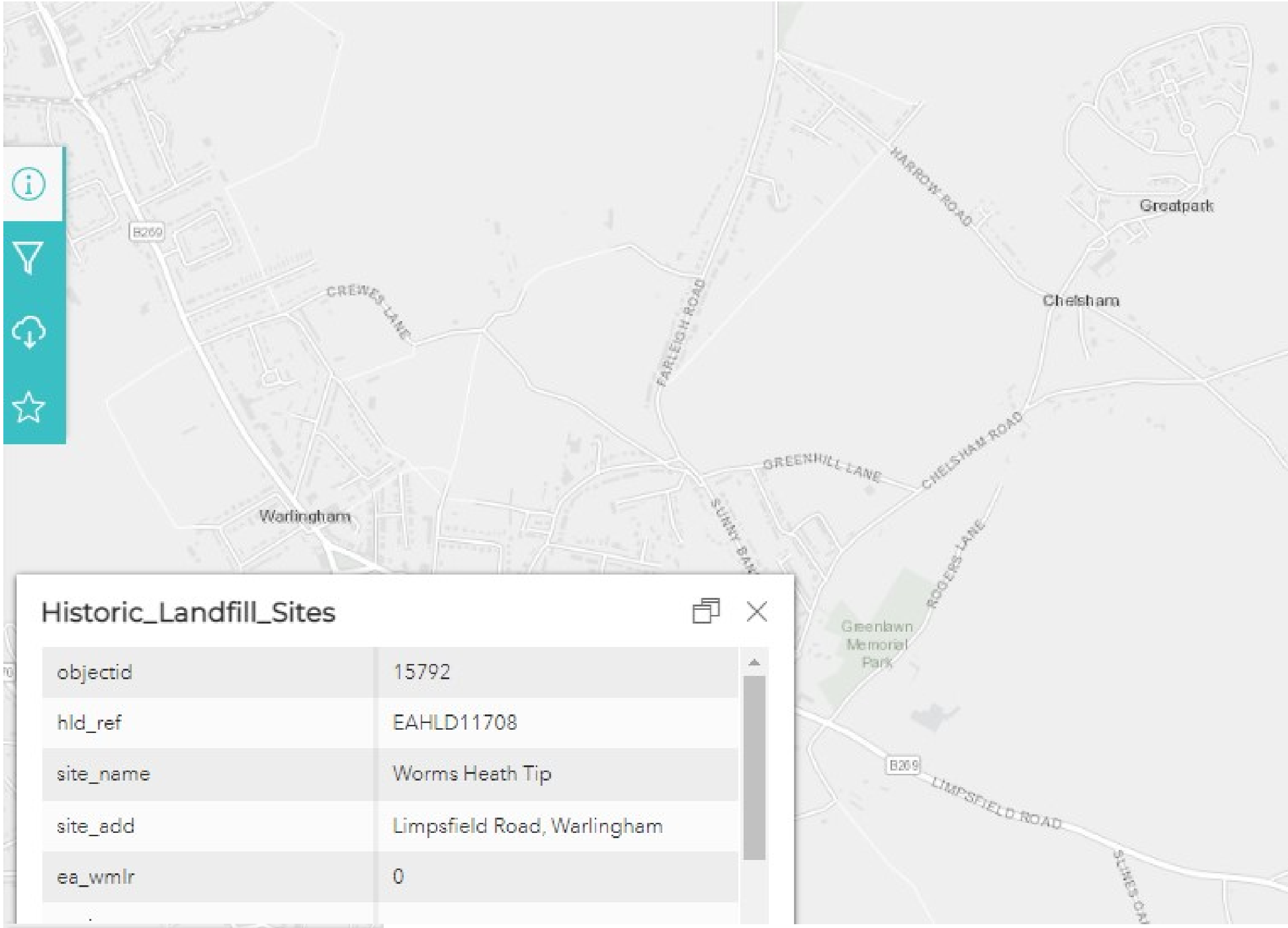
From To Blows

Boring Foreman's Remarks

Signed L. Tindall
For LE GRAND ADSCO
CIVIL ENGINEERING DIVISION OF
LE GRAND SUTCLIFF AND GELL LIMITED

JS.2692

APPENDIX C



Historic_Landfill_Sites

objectid	15792
hld_ref	EAHLD11708
site_name	Worms Heath Tip
site_add	Limpsfield Road, Warlingham
ea_wmlr	0

Historic_Landfill_Sites

licholdadd	Riverscroft, Cher Shepperton, Mid
siteopname	
siteopadd	
os_prefix	TQ
easting	537,800
northing	157,900
ea_region	TH
ea_area	South East TH
lic_issue	29 July 1977

Historic_Landfill_Sites

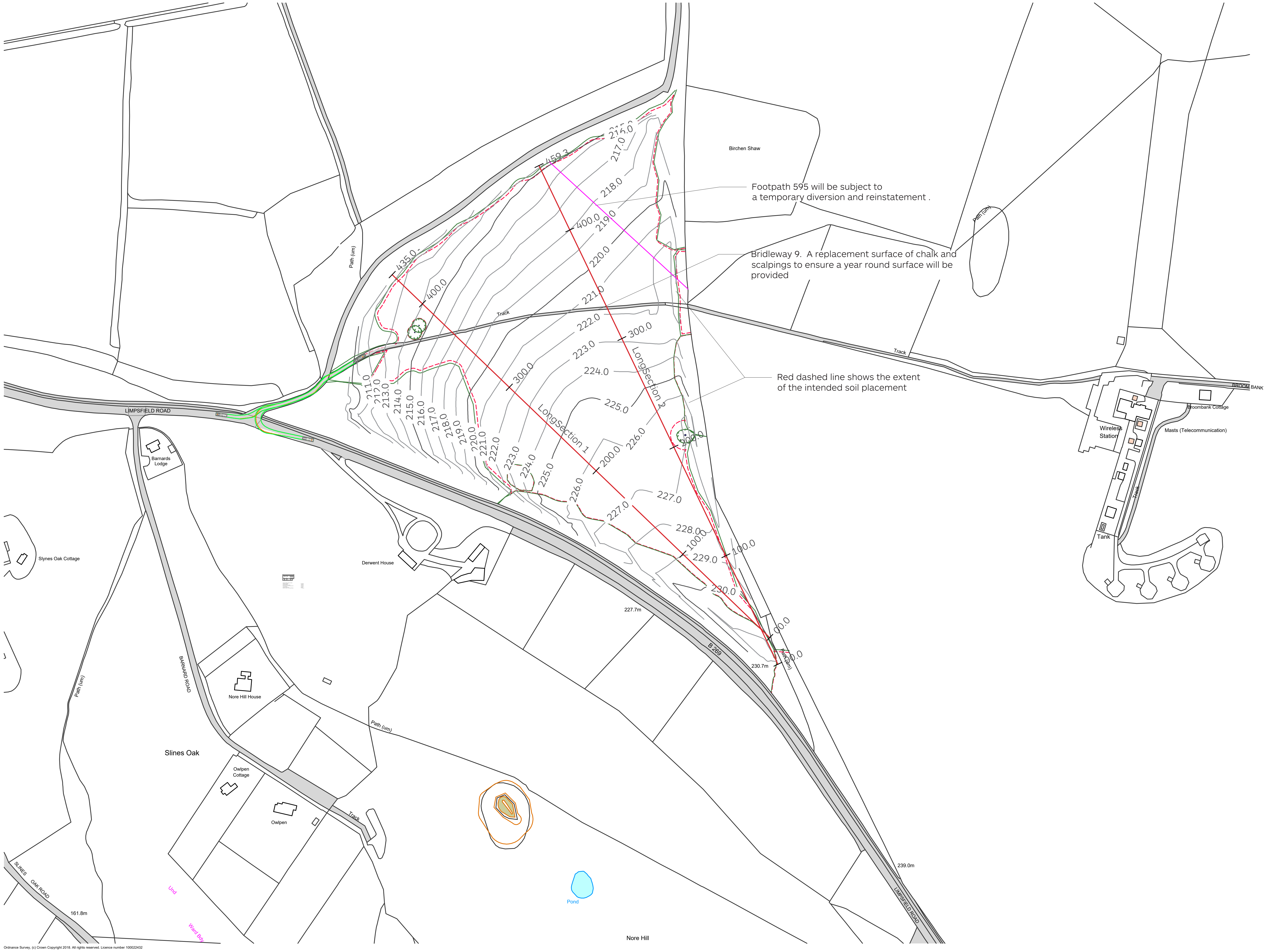
inert	Yes
industrial	
commercial	
household	
special	
liqsludge	
wasteunk	
gascontrol	
leachatcnt	

APPENDIX D

fluid planning

PO Box 1014
Horsham
RH12 9TJ

t. 01403 288383
e. info@fluidplanning.co.uk
w. fluidplanning.co.uk



1:2,500 @ A2 **December 2019** **Land north of Limpsfield Road, CR6 9QL** **fpes 3.02 Proposed levels**

APPENDIX E

Geology Viewer

Bedrock geology

Lewes Nodular Chalk Formation, Seaford Chalk Formation and I
Chalk. Sedimentary bedrock formed between 93.9 and 72.1 mill
Cretaceous period.

More Information

Superficial deposits

APPENDIX F

14th August 2018

Agricultural justification statement for the remediation of an inert landfill to agricultural use

Land at Worms Heath
Limpsfield Road
Warlingham
Surrey

Beechwood Court,
Long Toll, Woodcote,
RG8 0RR

01491 684 233
readingagricultural.co.uk

1 Introduction

1.1 Reading Agricultural Consultants Ltd (RAC) is instructed by Fluid Planning to produce an Agricultural Justification Statement for the restoration of a historical landfill, completed in line with the terms of its permission, to agricultural use at Limpsfield Road, Warlingham, Surrey. The land proposed to be restored is known as Worms Heath.

1.2 Harry Day, an Associate of RAC, inspected the site on 25th July 2018. Three pits were excavated to observe the soil profiles. The pits measured 1.5m (L) x 1m (W) x 1.2m (D).

1.3 The owner of the land, Mr Fuller, is a farmer who produces hay and haylage for the livestock and equine market and keeps a herd of longhorn cattle on nearby agricultural land. The herd comprises 37 cows and heifers with 65 young stock. The herd are extensively grazed at the start of the summer and then on the hay and haylage aftermath after cutting. The herd are out-wintered. Lucerne haylage is produced for feeding the youngstock. Worms Heath is a contiguous part of his agricultural holding and will be put into agricultural use. Mr Fuller is a tenant of Warren Barn Farm, which is about 750m south of Worms Heath. He rents adjacent land to the south and north-east of the site. If Worms Heath is restored to full agricultural use, he intends use it for the production of grass silage, hay or haylage. The useable area within the field would be approximately 6.5ha, which has the potential to produce up to 54t/ha/year of silage, or a total of about 350t per year from the field. The ultimate aim is to produce hay or haylage.

1.4 It is understood that the site has been used for gravel extraction since the 19th Century, before being filled and levelled with inert waste during the 1970s and left in a poor condition.

2 Site survey

2.1 The site extends to approximately 9.5ha, including 3.0ha of woodland. A public bridleway runs from east to west across the site. A map of the site is shown at Appendix 1.

2.2 When inspected, the site was observed to be infested with weeds, including: bramble; field bindweed; common nettle; curled dock; thistle; chickweed; and ragwort. The ragwort infestation is being managed by the landowner.

2.3 The topography of the site comprises a gentle slope running down from the south-east to the north-west.

2.4 The principal underlying geology in the area mapped by the British Geological Survey[1] is the Lewes Nodular Chalk Formation, Seaford Chalk Formation And Newhaven Chalk Formation (undifferentiated). This formation comprises Chalk.

2.5 Superficial geology of the area is mapped as Disturbed Blackheath Beds - Sand And Gravel.

2.6 The Soil Survey of England and Wales soil association mapping[2] (1:250,000 scale) shows the Hornbeam 1 association in the immediate vicinity. The association is described as deep fine and coarse loamy over clayey soils with slowly permeable subsoils and slight seasonal waterlogging. Some very flinty sandy and loamy soils. Some very acid soils with bleached subsurface horizon.

2.7 Surface soil contamination was evident at the site, including tile, brick and metal.

2.8 It is not known if there is a land drainage system at the site, but given the poor quality of the restoration this seems unlikely.

Soil survey

2.9 Three pits were excavated to observe soil profiles across the site to describe the soil profiles present. This was undertaken to establish a baseline soil description.

<u>Pit 1</u>

2.10 Pit 1 was excavated in the south of the site. A photograph of pit 1 is shown at Appendix 2. Topsoil-like material observed from 0-40cm was variable in texture, including medium clay loams and clays which were brown in colour. The structure varied from granular and friable to coarse subangular blocky, some pores were present. The structure was poor from 30-120cm. The profile was observed to be contaminated with brick, metal (including a 500mm bar), glass and other materials. The brick content was observed up to 50%. Some roots were observed to 50cm.

2.11 The material from 40-90cm was observed as mixed chalk spoil. The lower profile contained asphalt, brick and other contaminants. The consistency of the material was compacted from 30cm. The structure was poor. Few roots were penetrating the compacted material below 30cm. This material should not be considered as a subsoil but as imported excavated parent material.

2.12 Imported clay was observed from 90cm to depth. This material was firm and had a poor structure.

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[1] **British Geological Survey (2018).** *Geology of Britain viewer*, http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[2] **Soil Survey of England and Wales (1984).** *Soils of South East England* (1:250,000), Sheet 6

Pit 2

2.13 Pit 2 was excavated in the centre of the site. A photograph of the exposed soil profile is shown at Appendix 3. Topsoil material was present at 0-20cm and was variable in texture and contaminated as per pit 1. The underlying soil material was observed to be medium silty clay loam and medium clay loam.

2.14 Subsoil was observed from 30-60cm in depth as dark brown to black, with a medium sandy clay loam texture. The soil material was contaminated with brick at a rate of about 10% by volume. The consistency was recorded as very firm, with a poor subsoil structure. Roots were observed to 60cm in depth. The horizon was recorded as slowly permeable.

2.15 Chalk spoil material was observed from 60cm to depth.

Pit 3

2.16 Pit 3 was excavated in the north of the site and a photograph of the soil profile is shown at Appendix 4. Topsoil material was similar to those observed at Pit 1 and Pit 2. Contamination such as brick and large lumps of concrete <350mm were observed. A photograph of the contamination is shown at Appendix 5.

2.17 The subsoil was observed to be sandy loam, with large lumps of clay, up to 400mm in diameter. About 30% brick content was observed.

2.18 Orange sandy clay was observed from 70cm to depth, which was very firm in consistency, poor in structure and slowly permeable.

Comment on existing soil profiles

2.19 The 'topsoil' material across the site is variable in depth, texture and structure. It is not known if it is an original topsoil that was stripped and replaced, or not. The soil material appears to have some topsoil characteristics, including a darker colour and friability.

2.20 The 'subsoil' materials are considered to be waste soil material tipped at the site in an attempt to return it to agriculture. The high variability in the characteristics and distribution of the material suggests that all the material was imported.

2.21 The soil profile is shallow and in poor condition, and the landfill site was not restored to a level suitable for agricultural use.

2.22 A high level of physical contamination is present at the site, both within the topsoil and subsoil material. Due to the high level of contamination, and the nature the contaminants, field work using machinery would either be severely restricted or not possible, due to the high risk of damaging equipment. Cultivating the topsoil using discs, plough or other tillage equipment would be severely restricted due to the large lumps of concrete and metal within the topsoil. Because of this, fertiliser cannot be incorporated or placed into the soil profile. This means that crop performance would be variable. Subsoil cultivations such as using a winged subsoiler would also not be possible. Seeding operations would be restricted to broadcast seeding, as drilling would not be possible. Harvesting equipment would be at risk from damage from surface debris.

2.23 Whilst some material at the site appears to have soil-like properties, it is a variably-distributed through the profile and mixed with waste material mainly comprising low-quality chalk and clay spoil. The existing soils are not suitable for crop production. The landfilled material does not appear to have been placed as part of a planned agricultural restoration scheme, is compacted and unlikely to be underdrained. Subsoil structure is poor. It is unlikely that the imported material was handled or placed using soil handling protocols or with the aim to restore the land to agricultural use.

3 Proposed soil profile

3.1 The land is not suited to agricultural use in its current state. It is recommended that a new soil profile comparable with surrounding land and capable of sustaining agricultural production is created, with better and more versatile agricultural soils. The new profile should be formed on top of the current profile, since it would be impossible to satisfactorily strip and decontaminate the topsoil and separate it from the contaminated subsoil below.

3.2 An improved soil profile capable of sustaining plant growth, and supporting agricultural field operations such as tillage, drilling and harvesting should be produced at the site. 1,200mm of suitable imported material placed on the existing soil surface would result in a soil profile capable of supporting plant growth. The specification is shown at paragraph 0.

3.3 It is recommended that the profile is designed to reflect the nature of the soils of the locality, drain satisfactorily and fulfil services and functions association with agricultural soils. The subsoil texture should contain a sufficient quantity of clay to provide fertility and retain soil moisture.

Construction of proposed soil profile

3.4 The proposed soil profile should be placed following the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.

Soil placement

3.5 Imported subsoil and subsoil material should be imported into the site and placed using a suitable subsoil spreading technique e.g. the loose-tipping method:

a) loosening the substrate of the receiving ground;

b) loading of subsoil from stockpile;

c) backtipping subsoil onto loosened substrate;

d) levelling subsoil;

e) backtipping subsoil; and

f) spreading topsoil over subsoil using excavator working on substrate.

Subsoil specification

3.6 The imported subsoil depth across the site should be least 1,000mm to achieve a workable soil profile and surface. It is recommended that the subsoil textures are similar to the soil series in the Hornbeam 1 association. This includes: clay loam or sandy clay loam over clay (Hornbeam series); sandy loam or sandy silt loam over sandy loam or sandy silt loam, over clay (Berkhamsted series); or clay loam over clay (Marlow series).

3.7 It is important that the lower part of the profile drains sufficiently, in order to reflect the characteristics of the original site. Stony material should be used at the base of the deepest parts.

Topsoil specification

3.8 Topsoil should be placed to a depth of at least 200mm to allow for settlement.

3.9 A multipurpose topsoil should be used. If the If topsoil in adjacent land parcels are calcareous then a calcareous topsoil should be placed. The nutrient status of the topsoil should have phosphorous and potassium indices at least 2 (see British Standard BS3882-2015), with at least 3.5% organic matter.

3.10 Topsoil texture should be similar to textures of the soil series within the Hornbeam 1 soil association. This includes: clay loam of sandy clay loam (Hornbeam series); sandy loam or sandy silt loam (Berkhamsted series); or clay loam or sandy clay loam (Marlow series).

Relief of substrate and subsoil compaction

3.11 It is likely that receiving layers will be compacted by heavy machinery. Compaction in the placed subsoil should be relieved to improve soil structure and thus reduce flooding risk and increase potential for root exploitation. For areas of deep compaction, a single leg subsoiler should be used to loosen the layer.

3.12 Soil layers should be loosened when dry to reduce the risk of cutting and smearing.

Topsoil cultivation

3.13 Topsoil should be cultivated using appropriate cultivation equipment i.e. discs or harrow to break down any large, compacted lumps. The topsoil should have a fine tilth, with no aggregates >10mm.

3.14 If topsoil has been stored in stockpiles and is anaerobic and compacted, it should be cultivated twice to depth to relieve compaction and re-aerate the layer. Seeding should only take place after full re-aeration.

Topsoil inspection

3.15 Imported topsoil should be inspected and laboratory tested to ensure that it is suitable for the intended purpose, including physical, chemical and other properties. Fertiliser application recommendations should be made using the Fertiliser Manual (RB209).

4 Seed bed preparation

4.1 The surface should then be rolled with Cambridge rollers to break down any clods remaining on the surface.

4.2 The finished seed bed should be walked over and any remaining debris (tile, brick, concrete etc.) present on the surface should be removed by hand.

Stale seed bed

4.3 Weed seedlings should be allowed to germinate in the stale seed bed before being sprayed with the herbicide glyphosate. The instructions on the product label should be adhered to.

Seeding aftercare mix

4.4 When a satisfactory seed bed has been prepared in late-summer or early autumn, a seed mix containing grasses and soil-improving plants should be drilled. The field should be drilled in two directions to optimise seed distribution and reduce the risk of seedlings being outcompeted by weeds. The specific seed mix will dictate the sowing method and necessary soil conditions, which should be checked with the seed supplier. The sowed surface should be rolled in both directions with flat rolls to establish good seed-soil contact.

Seed mix

4.5 It is recommended that the seed mix should include fodder radish and tillage radish, as the fleshy roots of the crop will help structure the soil profile penetrating up to ~50cm. The senesced roots will also add biomass to the topsoil and subsoil horizons. The crop, when incorporated will also add organic matter to the soil which will boost soil health.

4.6 The seed mix should be based on perennial ryegrass, cocksfoot, creeping bent and clover. Cocksfoot is deep-rooting and will have a beneficial effect on the soil profile, as soil pores will be penetrated. The clover content will fix nitrogen in the soil profile and will aid the establishment of the crop and reduce future nitrogen inputs.

4.7 Apart from clover, the non-grass plants will die off over winter, leaving the hardy grasses to continue to grow in spring. It is likely that it will take several years to return the field near to its original productivity.

Soil aftercare

4.8 Following the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites should minimise the risk of damage to the placed soils.

4.9 However placed soils have the potential to self-compact, which risks the development of anaerobic conditions and waterlogging which can adversely affect crops.

4.10 The land should be put into a five-year aftercare programme in the interest of a rapid and satisfactory restoration. Maintenance should be undertaken, including monitoring of soil conditions to identify areas of waterlogging and poor crop performance. Test pits and auger borings can assist in assessing these areas.

4.11 Restored land should be resurveyed after the first and third year to check progress and to determine the need for, and kind of, further remedial works. These would include the installation of underdrainage; the implementation of a progressive soil loosening programme, or addition of fertilisers, organic manures and lime. The site should then be surveyed after five years to sign-off the restoration.

4.12 Machinery access to restored land should be controlled to avoid damage to soil structure. Access should be avoided between October and April and following heavy or prolonged rain.

Conclusion

4.13 RAC has been instructed by Fluid Planning to produce an Agricultural Justification statement for the restoration of a historical landfill site to agricultural use. The site, known as Worms Heath, is off Limpsfield Road, Warlingham, Surrey. The site received inert waste in the 1970s and has subsequently been part-restored.

4.14 The landowner wishes to use the land to produce fodder and ultimately for production of hay and haylage to compliment his existing business.

4.15 A soil survey was undertaken by RAC to assess the site and to expose and describe the soil profiles at the site, and restore the site to productive agricultural condition. The site was observed as being infested with weeds and with debris on the surface.

4.16 The ‘topsoil’ material on the surface was variable in texture and structure. Some topsoils were friable, and some were poorly structured. The ‘subsoil’ material was mainly tipped excavated waste, including clay and chalk spoil. It should not be considered a soil material. The subsoil material was compacted and had a poor structure.

4.17 Both the topsoil and subsoil were highly contaminated with brick, tile, glass and metal observed. Lumps of concrete up to 350mm were present.

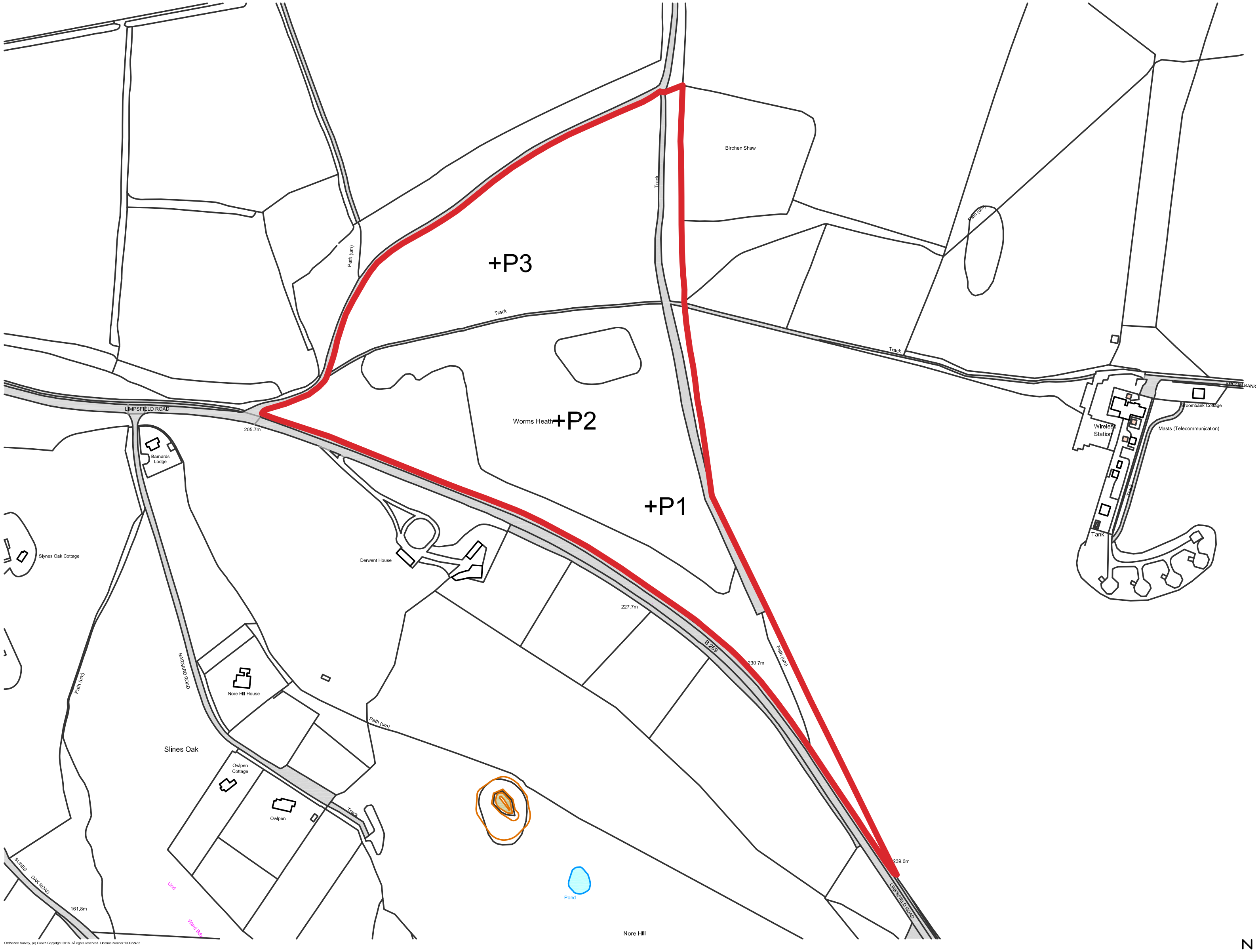
4.18 The site is not suited to intensive agriculture in its current condition because of the contamination and lack of soil material in the subsoil horizons. Debris restricts machinery to carry out field work. The site has been poorly restored.

4.19 It is recommended that subsoil and topsoil materials are imported to manufacture a soil profile which can be farmed. The soil profile should be created above the existing material, complete with artificial drainage. Soil materials should be placed to a depth of 1,200mm to create a soil profile suitable for crop production. Soil handling and related activities should be carried out in reference to the Construction Code of Practice for the Sustainable Use of Soils on Construction sites. A five-year aftercare regime should be observed.

Appendix 1

Survey area

+P1 Pit



1:5000

100m 0 100m 200m

N

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Rev.	Comment	Date

Drawing title
Observations

Contract
Fluid Planning
Land at Limpsfield Road,
Warlingham, Surrey

Reading Agricultural Consultants Ltd
Gate House
Beechwood Court
Long Toll
Woodcote
RG8 0RR
01491 684233
www.readingagricultural.co.uk

Ref.	Rev.
RAC/8132/1	
Drawn by HTD	Checked by PWD
Scales 1:5,000 @A4	Date 14/08/2018

Appendix 2

Appendix 3

Appendix 4

Appendix 5

APPENDIX G

CIVIL ENGINEERING SOLUTIONS LTD

CES557 LIMPSFIELD FLOOD MODELLING REPORT

REPORT

AUGUST 2019

Prepared by:
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REVISION HISTORY

Revision Reference	Date Issued	Amendments	Issued to
DRAFT	22/08/2019		Dan McEwan

TERMS OF REFERENCE

This report has been commissioned by AMV Haulage. Jac Roberts of Civil Engineering Solutions Ltd has undertaken the work.

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EXECUTIVE SUMMARY

Civil Engineering Solutions has been engaged to prepare flood risk modelling and SuDS drainage design associated with a proposed land reformation near Slines Oak, Limpsfield Road, Chelsham and Farleigh, Tandridge, Surrey, CR6 9QL. The flood modelling has identified the current and proposed flood risk.

This report finds that the existing site is subject to pluvial flooding. Hydraulic modelling has found that the proposed development has a minimal impact to maximum flood depths. Impacts to neighbouring properties are negligible.

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LIST OF FIGURES

APPENDICES

1 INTRODUCTION

Civil Engineering Solutions have been commissioned to prepare flood modelling outputs for a potential development site near Slines Oak, Limpsfield Road, Chelsham and Farleigh, Tandridge, Surrey, CR6 9QL. The site is centred at NGR: 537859, 157935 and measures some 9Ha. As outlined in red in Figure 1 below.

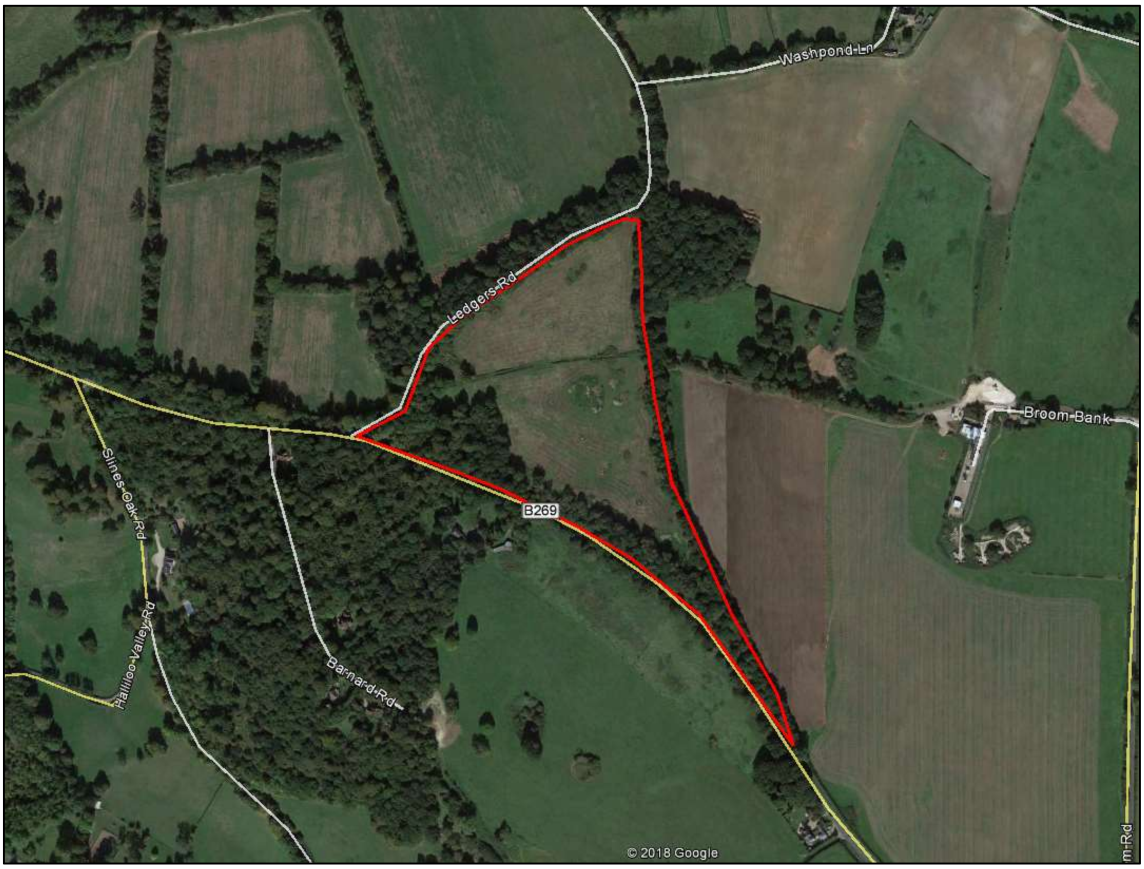

Figure 1: Google Earth site boundary

The development proposes the capping of an existing landfill site, with additional earth being placed on top. The site will be used for agricultural purposes. Proposed development plans can be found in Appendix A.

2 INFORMATION

2.1 INFORMATION PROVIDED BY THE CLIENT

On commission, CES were provided with:

Auto CAD file '0140 Land north of Limpsfield Road (CES 12.06.2019).dwg'. The file details the 'Existing' site topographic surface and the 'Proposed' site topographic surface. The CAD file also Identifies the red line boundary for the scope of works. A screenshot of the CAD file can be seen below:

Figure 2: Provided Site GA

Data obtained in support of flood modelling.

CES have obtained the following information relevant to the aims of this study:

LiDAR

The catchment area was reviewed using data downloaded from the Flood Estimation Handbook (FEH) website. This identifies that the site area is at the top of the catchment. LiDAR was purchased from 'BlueSky' on the 9th July 2019, as no freely available LiDAR was available. LiDAR file name; CM_00812745_BlueSky_LiDAR_0_5.

The file was imported into MapInfo Professional 2019 to form the baseline topography for pluvial modelling.

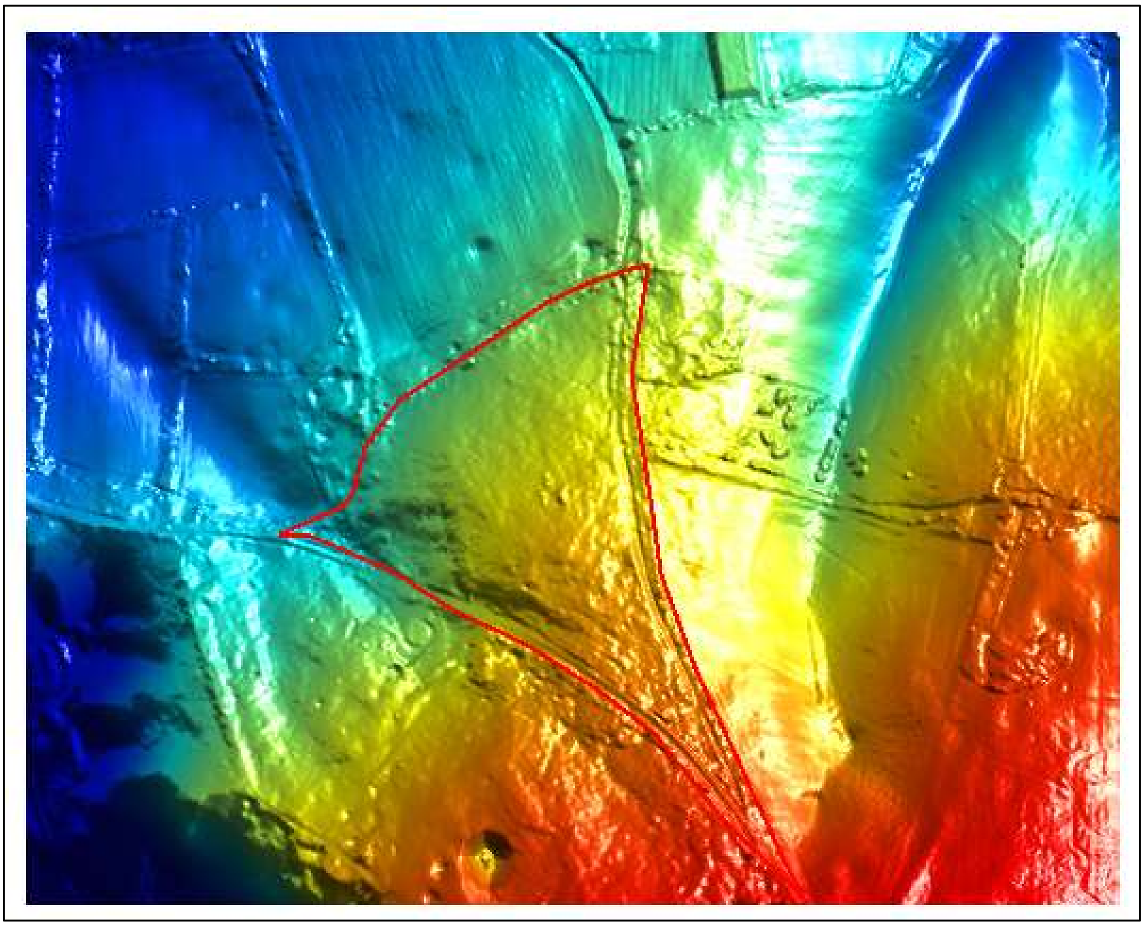

Figure 3: LiDAR coverage and Subject site boundary

FEH Rainfall Data

Rainfall information was accessed and downloaded through the FEH Website on 9th July 2019. The catchment extent was identified using the web service and descriptors saved in xml and CD3 formats. The catchment boundary was also exported as a GIS shp file and imported into MapInfo to review catchment extents against LiDAR and mapping data.

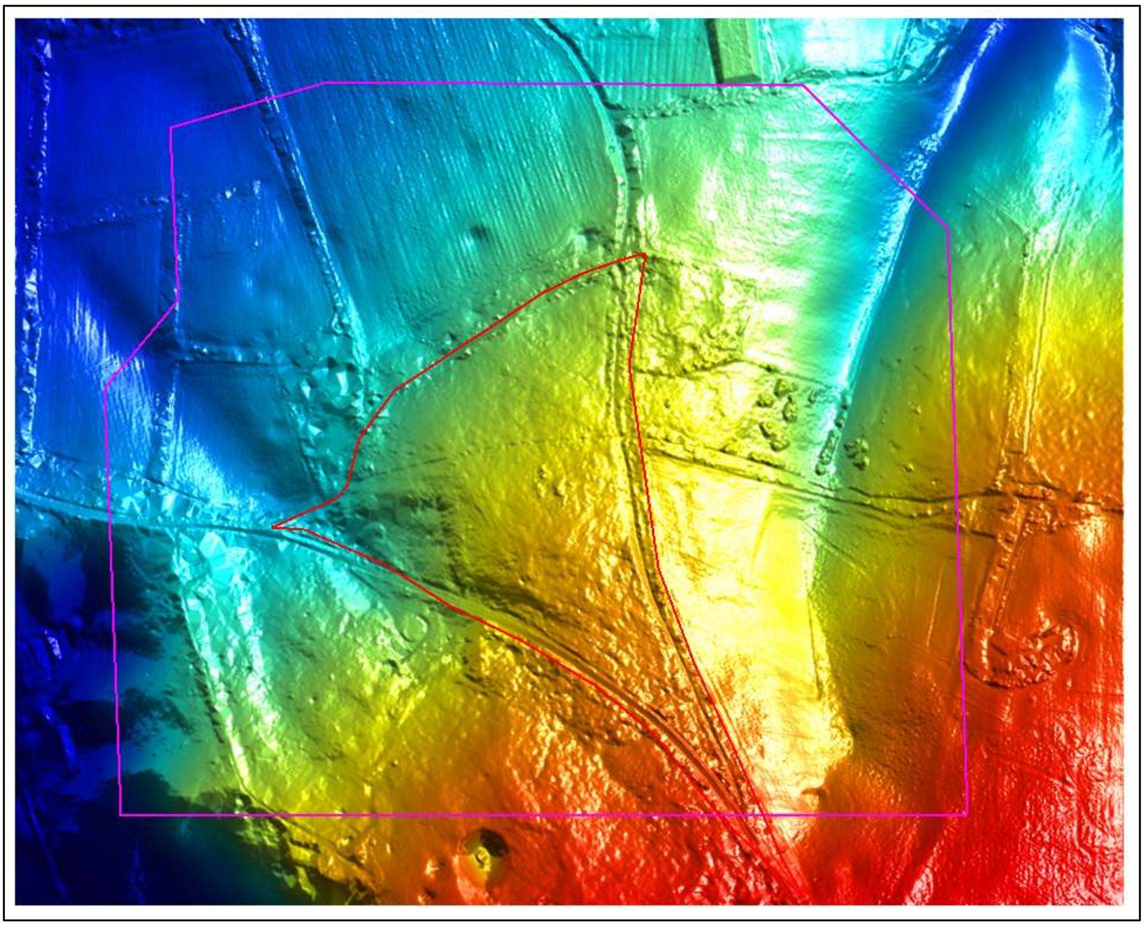

Figure 4: Catchment extents

Where the red outline illustrates the site boundary, the pink outline illustrates the modelled catchment extent.

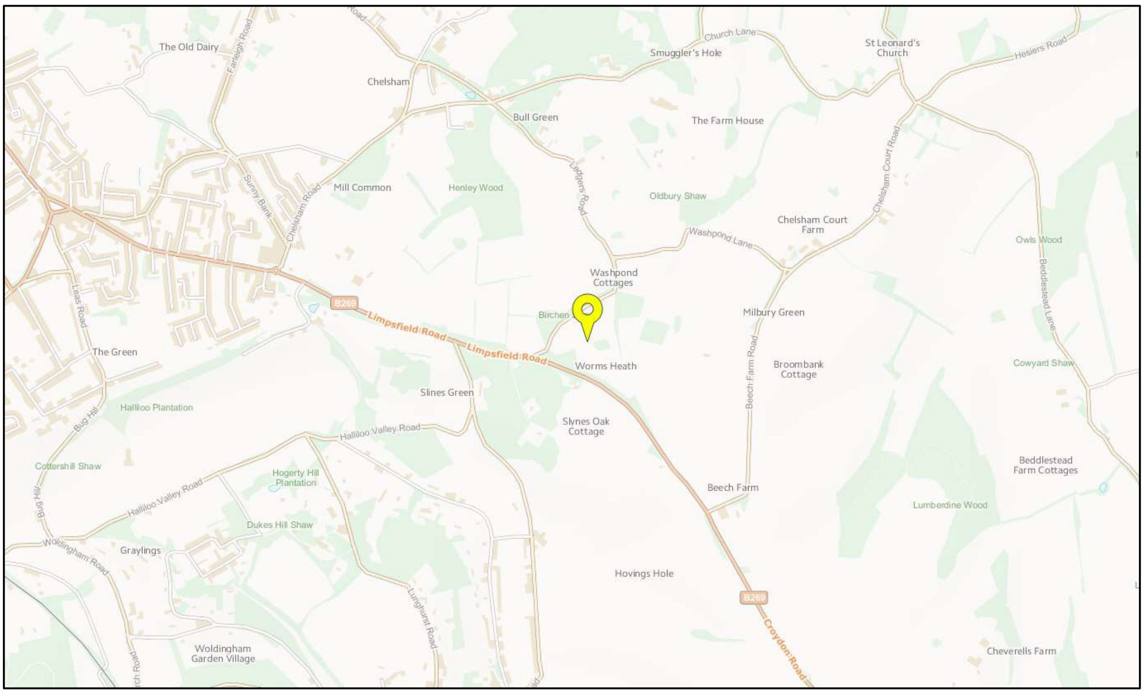

Figure 5: Environment Agency Flood Map

The Environment Agency flood map shows the site is located within Flood Zone 1.

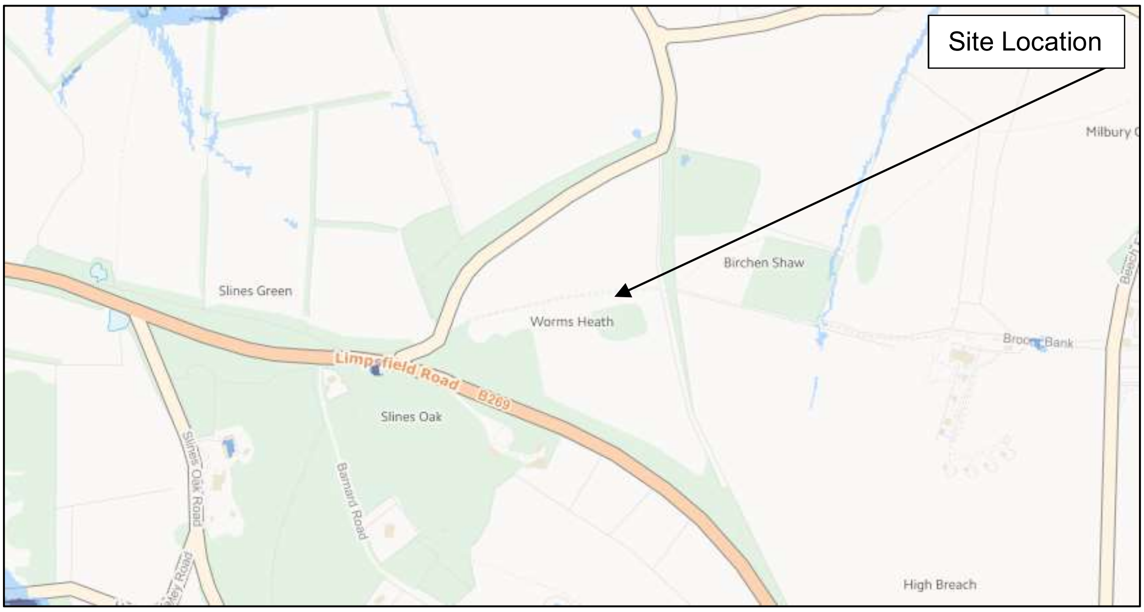

Figure 6: CES557 Limpsfield Green Surface Water Flood Map

Figure 6 above, demonstrates the site as existing has a low risk from surface water flooding as per Environment Agency Online Flood Mapping

Ordnance Survey Mastermap

Ordnance survey Mastermap data was purchased for the immediate catchment and downloaded as *.GML format. The OS Topographic Land Area table data was imported into MapInfo and the table structure edited to move the land use feature code to be the first attribute in the table. This table was then saved and exported to MID/MIF format to assist with the 2D flood modelling. This is particularly useful in defining mannings roughness and soil permeability factors for the study area based on OS land use classifications.

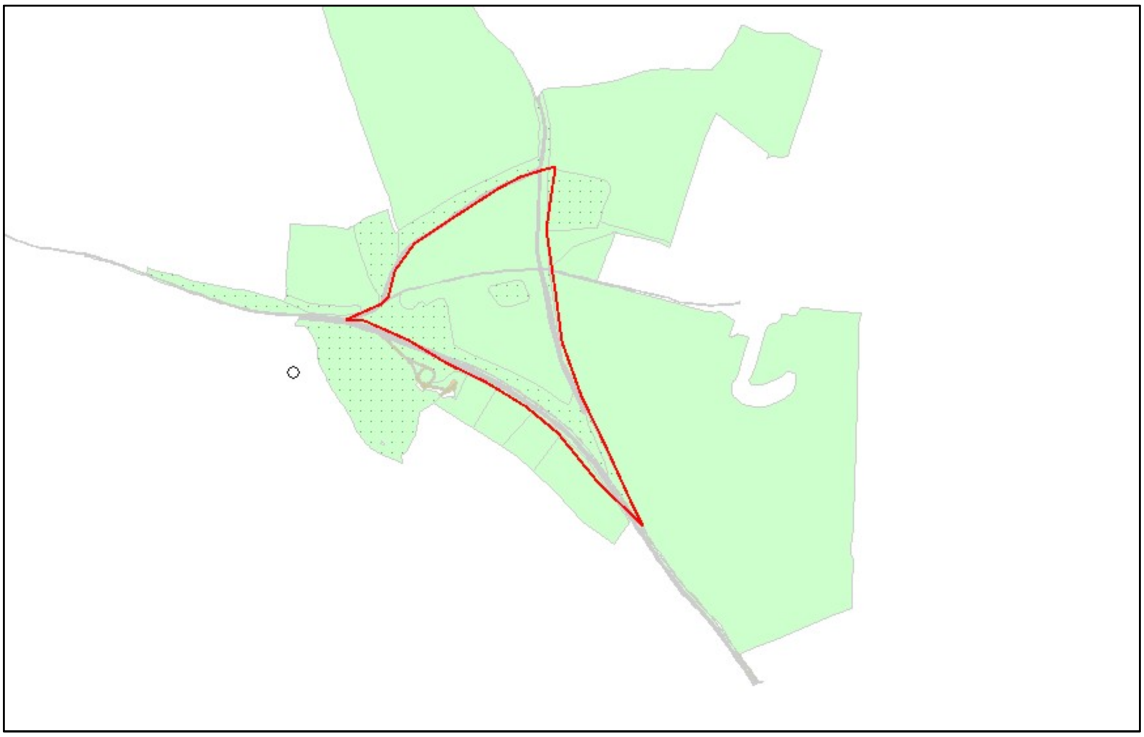

Figure 7: CES557 Limpsfield OS Mastermap Data

3 Flood Modelling

The client brief called for flood modeling outputs to be determined for the 100ycc event. A review of the published Environment Agency flood outputs for the site indicated the area is not at risk of tidal flooding.

FEH catchment descriptors *.xml" were imported into ReFH2 software provided by Wallingford Hydrosolutions to derive rainfall intensity profiles and depths for the one hour rainfall duration with return period of 100 years, allowing for 40% climate change.

In order to derive pluvial flood data for the proposed development site, a catchment wide, bespoke two-dimensional direct rainfall model using TUFLOW was constructed.

CES developed two model scenarios, to define the existing overland flow pathways to understand effects of the proposed residential development. The two scenarios are summerised below;

Existing: to establish the current hydraulic characteristics of the site and the wider catchment, Proposed: to establish hydrologic affects the proposed surface change would have on the site, neighboring properties and the catchment.

3.1 EXISTING

CES developed the baseline model from ‘Bluesky’ LiDAR, Ordinance Survey Mapping and exported ‘existing’ contours provided by the client.

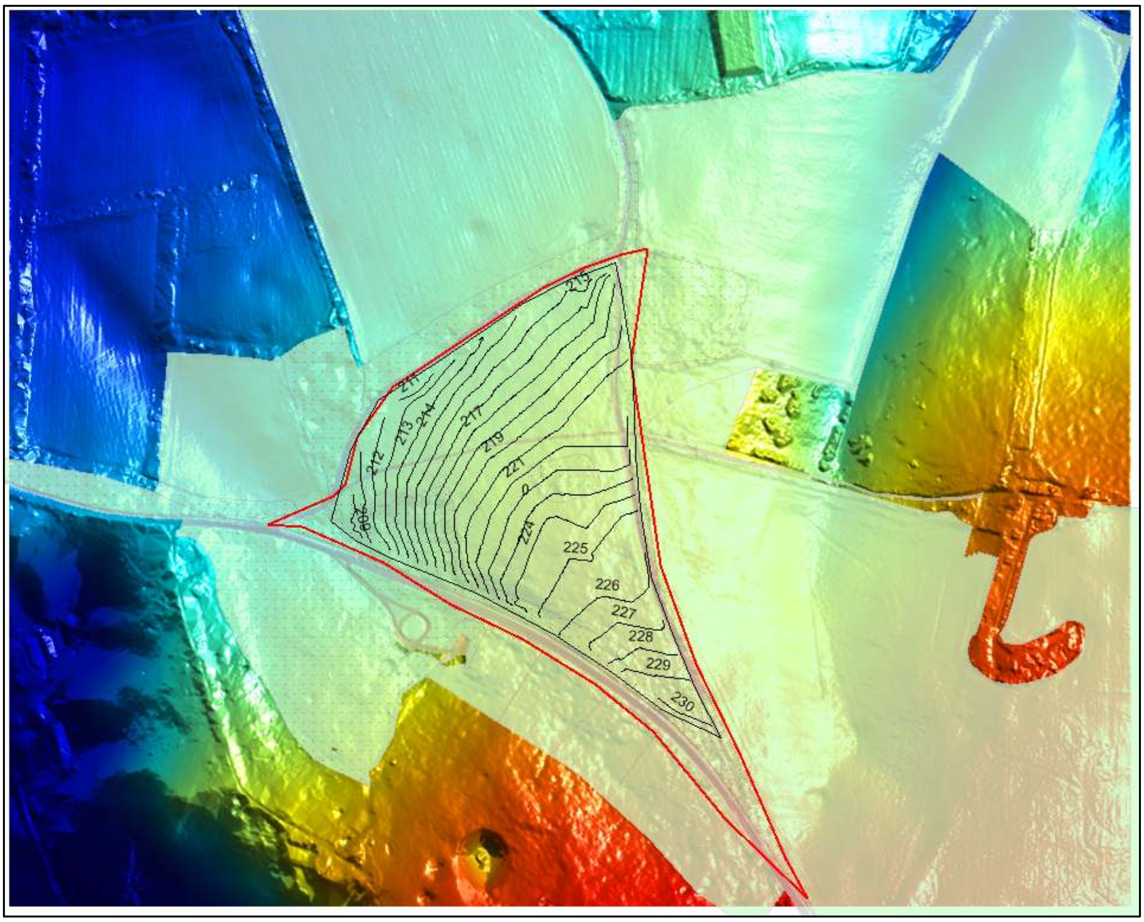

Figure 8: CES557 Limpsfield Existing Topography

The existing site ranges from 230m AOD at the south east boundary of the site, to 209m AOD at the north western site boundary.

Rainfall event simulating a one hour 100 year with 40% allowance for climate change was applied to the model to identify the overland flow pathways and maximum flood depths resulting from the synthetic storm. Figure 9 below:

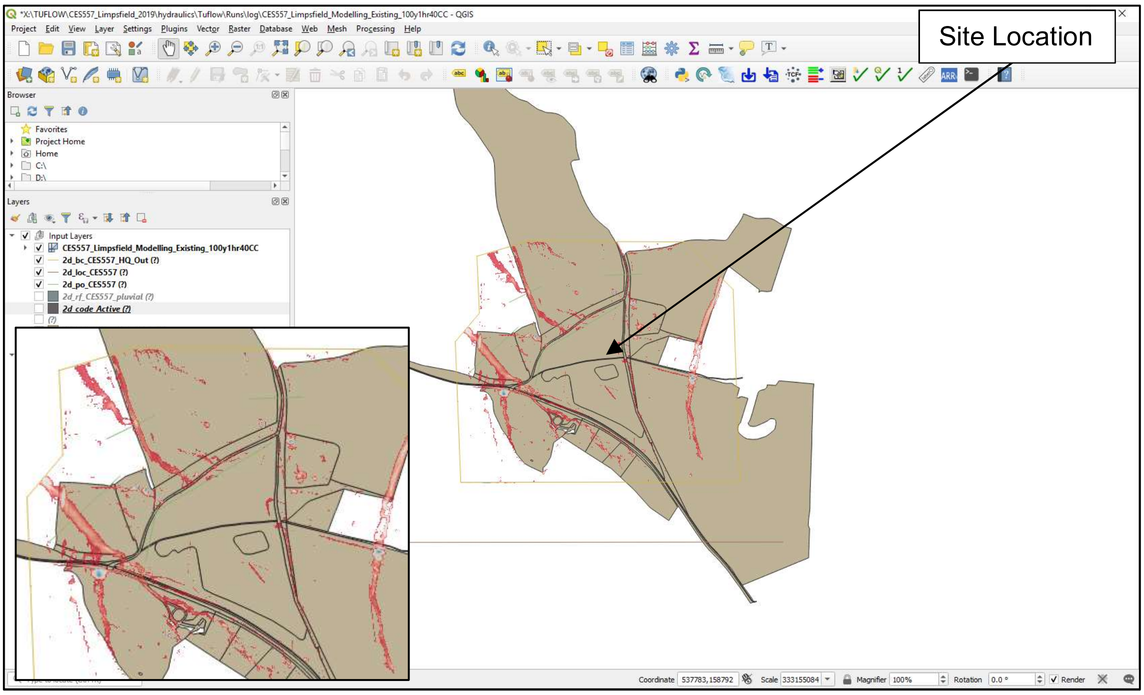

Figure 9: CES557 Limpsfield Existing 1in100yCC DMax

The baseline model's flood scope is not comparable to that illustrated by the Environment Agency Flood Maps presented in Figure 6.

The existing model shows three overland flow routes within an immediate proximity to the site. For the purposes of this report, these routes have been labelled A, B and C, as notated within Figure 10.

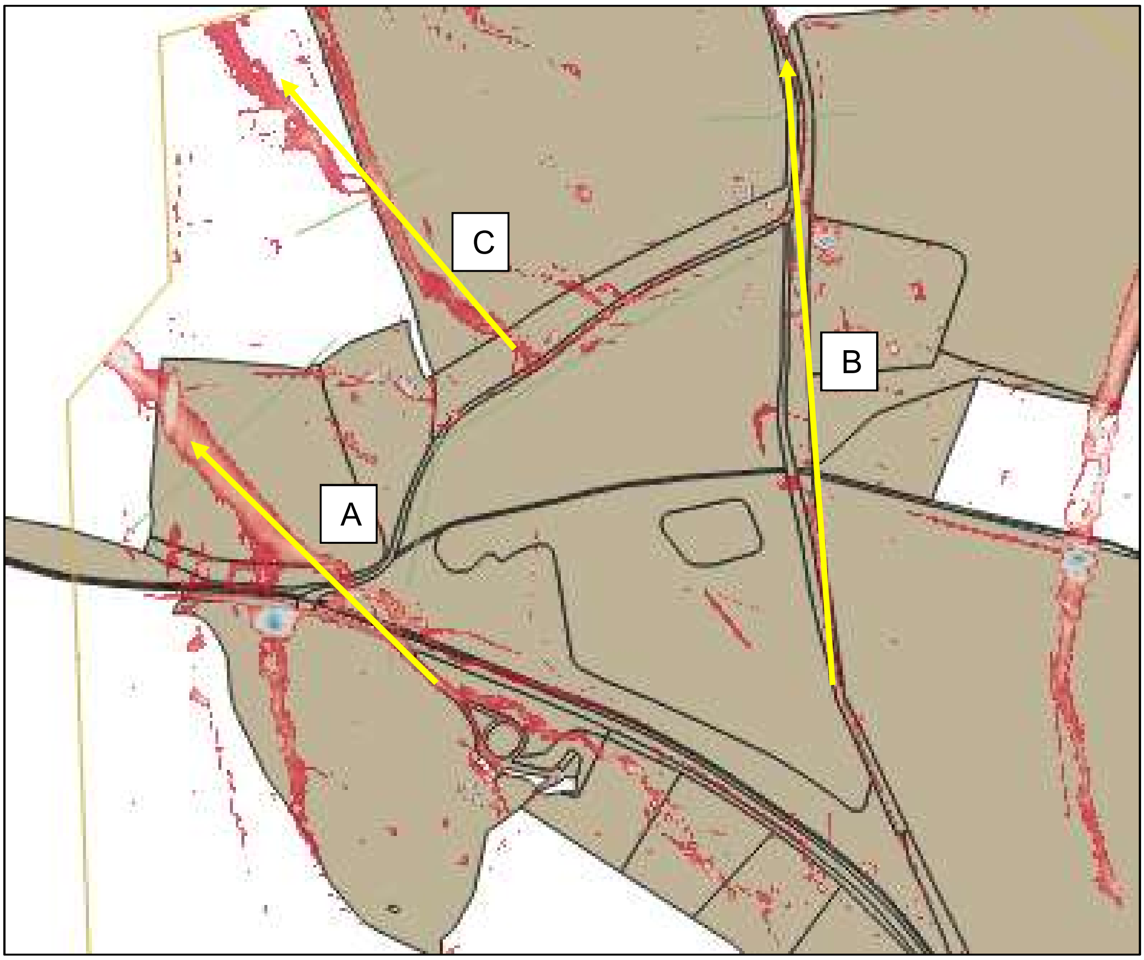

Figure 10: CES557 Limpsfield Existing Overland Flow Routes

3.2 Proposed Development

A second pluvial flood model was prepared, which included an increased site level. This model was run for the same rainfall event as the 'Existing' scenario detailed earlier. The ground model has been derived from proposed contours provided by the client.

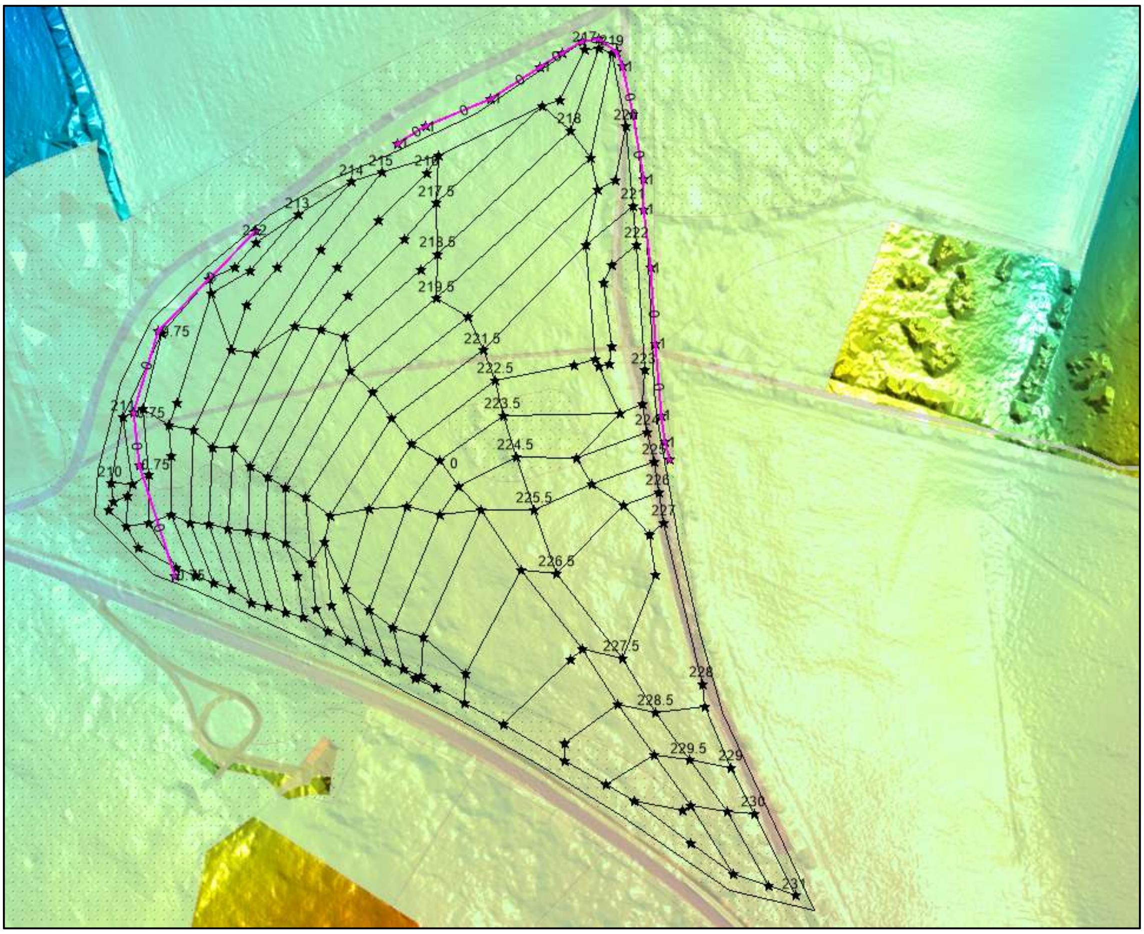

Figure 11: CES557 Limpsfield Proposed site Layout.

The proposed layout shows an increase in site levels to a maximum of 331.5.

The proposed site topography affects the overland flow routes. Effectively, more water is being diverted down flow paths A and C, while a reduction in water to flow route C. To return the flow paths to existing values, some soft engineering techniques have been implemented into the proposed model.

Existing overland flow routes are to be achieved by the implementation of 0.75m and 1m tall bunds respectively. The bunds will divert flood water back to existing values, thus allowing the proposed landform to have no adverse effect on third parties.

Figure 12: CES557 Limpsfield Proposed 1in100yearCC DMax

The resulting model outputs were compared against the ‘existing’ case. The proposed DMax surface was taken away from the existing DMax surface, to create a ‘difference model’. The difference model allows for the impacts to be assessed and areas of ‘difference’ to be identified.

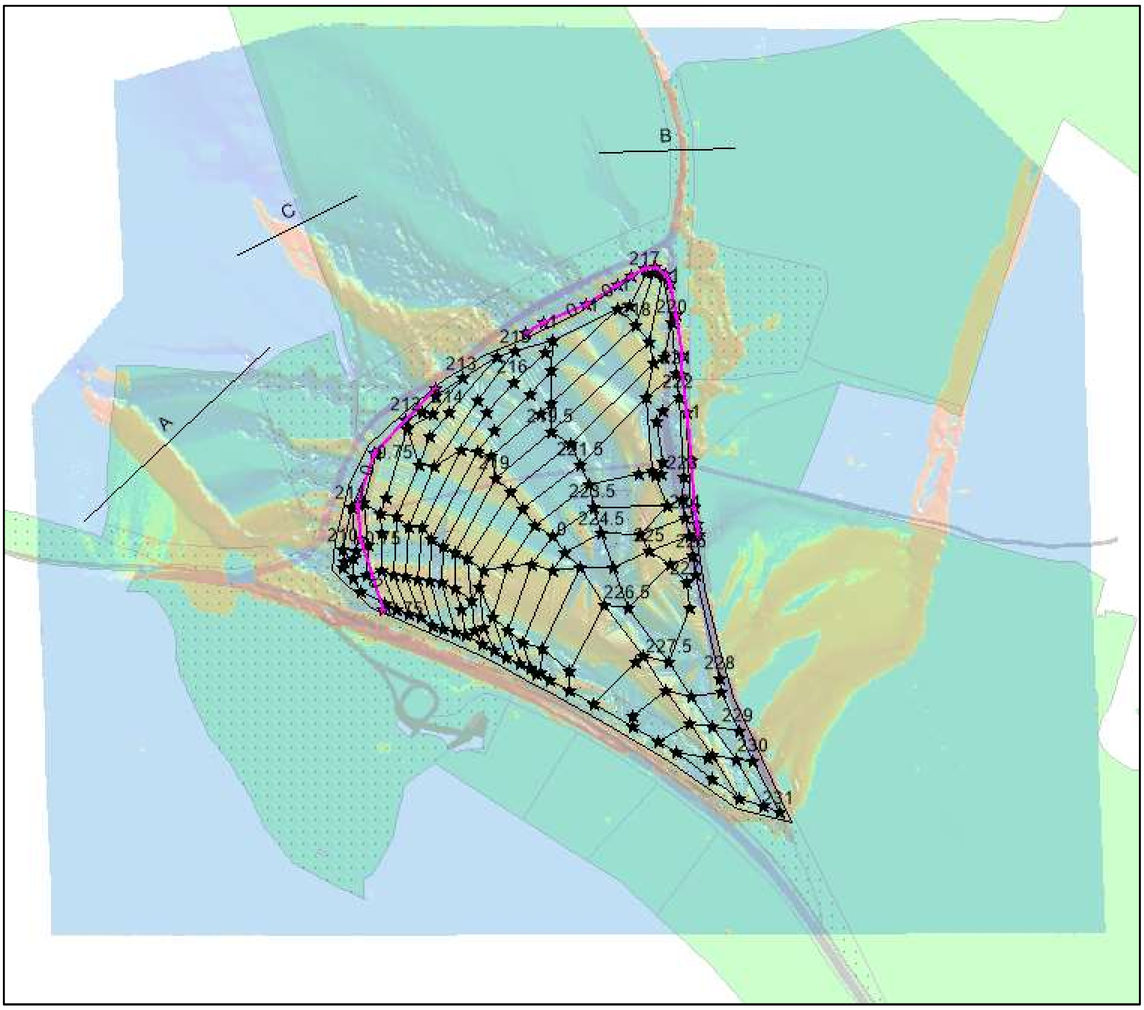

Figure 13: CES557 Limpsfield DMax Difference Model

Where the orange shaded areas identify areas of flood increase, and areas of blue shaded areas notates areas of flood decrease.

To analyse the difference model, PO Lines where positioned strategically to quantify the flow path values. The PO lines can be seen in Figure 13 above, and annotated as A, B and C.

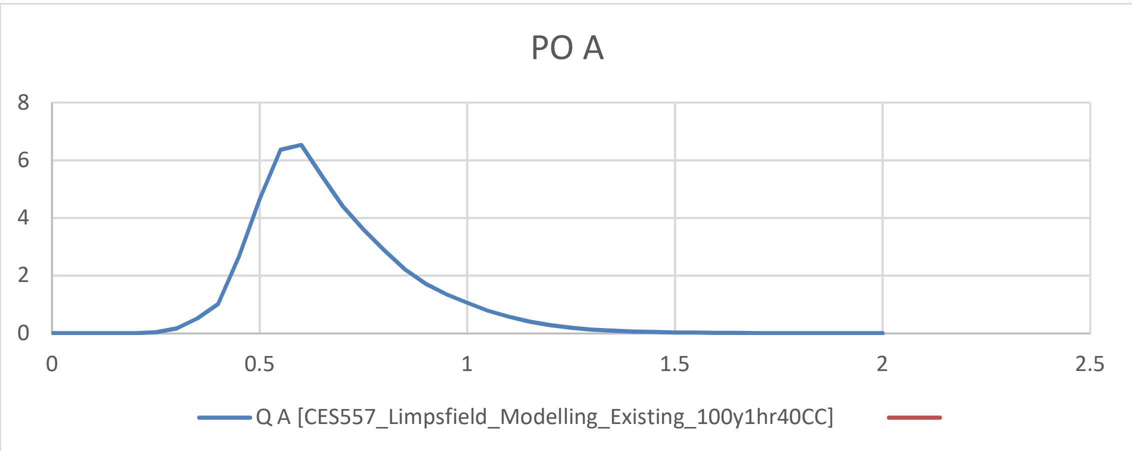

Figure 14: PO A

Of note, the X axis' units are time (hours) and the Y axis is flow in m³/s

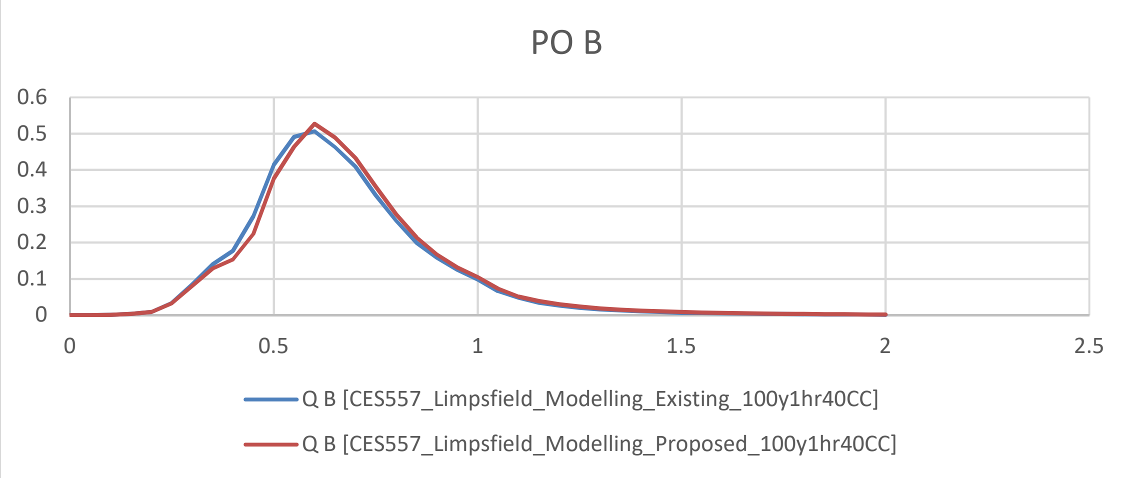

Figure 15: PO B

Of note, the X axis' units are time (hours) and the Y axis is flow in m³/s

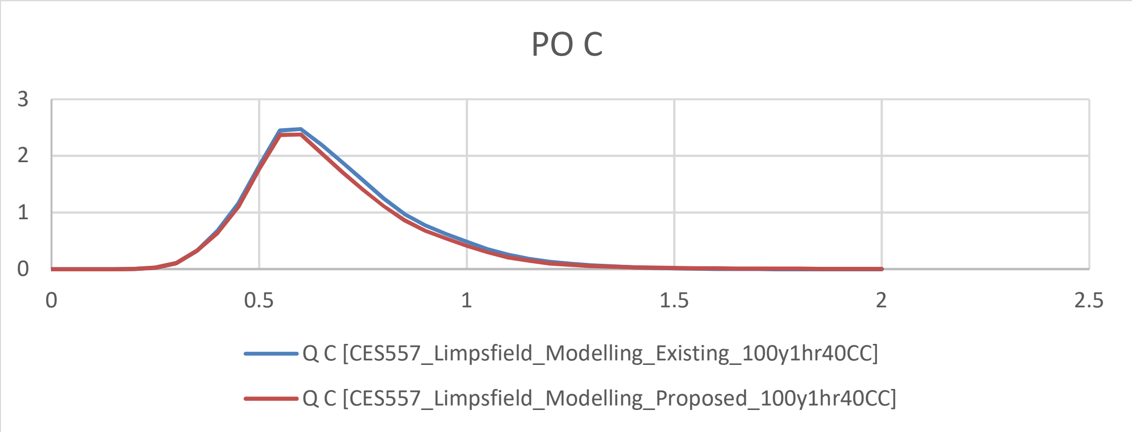

Figure 16: PO C

Of note, the X axis' units are time (hours) and the Y axis is flow in m³/s

To summarise the model results, please find the below table:

	Q Max Existing m³/s	Q Max Proposed m³/s	Difference m³/s
PO A	6.5327	6.6323	0.0996
PO B	0.5063	0.5273	0.021
PO C	2.4732	2.3787	-0.0945

The model results show that with mitigative measures, PO line A and C see an increase in overland flow, while PO line B sees a reduction. The difference in water volumes in modelling terms is insignificant and should be assessed with the perception that an increase or reduction of less than 0.01 cubic metres per second is negligible.

4 RECOMMENDATIONS

This report finds that the existing site is subject to light pluvial flooding. Hydraulic modelling has found that the proposed development has a minimal impact to runoff rates. It is recommended that an onsite soft engineering solution be incorporated into the proposed design as shown within the report, this has the potential to lower the flood depths to existing levels, or better. Impacts to neighbouring properties is negligible.

5 CONCLUSION

Detailed catchment wide two-dimensional pluvial modelling has been used to identify existing flood risk and potential adverse effects to the site and neighbouring parties. The general findings are that maximum flood volumes are shown to slightly differ, however these changes are insignificant in modelling terms, and should be assessed as so.

6 APPENDICES

APPENDIX A: PROPOSED DEVELOPMENT PLAN

Appendix A: PROPOSED DEVELOPMENT PLAN

APPENDIX H

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
Metals/metalloids																			
Arsenic		37			40			43			640			79			170		LQM (2014)
Beryllium		1.7			1.7			35			12			2.2			63		LQM (2014)
Boron		290			11000			45			240000			21000			46000		LQM (2014)
Cadmium		11			85			1.9			190			120			532		LQM (2014)
Chromium III		910			910			18000			8600			1500			33000		LQM (2014)
Chromium VI		6			6			1.8			33			7.7			220		LQM (2014)
Copper		2400			7100			520			68000			12000			44000		LQM (2014)
Lead		200			310			80			2330			630			1300		C4SL
Mercury (elemental)		1.2			1.2			21			58 (25.8)			16			30 (25.8)		LQM (2014)
Mercury (Inorganic)		40			56			19			1100			120			240		LQM (2014)
Methylmercury		11			15			6			320			40			68		LQM (2014)
Nickel		180			180			230			980			230			3400		LQM (2014)
Selenium		250			430			88			12000			1100			1800		LQM (2014)
Vanadium		410			1200			91			9000			2000			5000		LQM (2014)
Zinc		3700			40000			620			730000			81000			170000		LQM (2014)
Other																			
Total Sulphate		2,400			2,400			2,400			2,400			2,400			2,400		BRE (2005)
Water Soluble Sulphate (g/l)		0.5			0.5			0.5			0.5			0.5			0.5		BRE (2005)

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
PAHs																			
Acenaphthene	210	510	1100	3000 (57)	4700(141)	6000 (336)	34	85	200	84000 (57)	97000 (141)	100000	15000	15000	15000	29000	30000	30000	LQM (2014)
Acenaphthylene	170	420	920	2900 (86.1)	4600 (212)	6000 (506)	28	69	160	8300 (86.1)	97000 (212)	100000	15000	15000	15000	29000	30000	30000	LQM (2014)
Anthracene	2400	5400	11000	31000 (1.17)	35000	37000	380	950	2200	520000	540000	540000	74000	74000	74000	150000	150000	150000	LQM (2014)
Benzo(a)anthracene	7.2	11	13	11	14	15	2.9	6.5	13	170	170	180	29	29	29	49	56	62	LQM (2014)
Benzo(a)pyrene	2.2	2.7	3	3.2	3.2	3.2	0.97	2	3.5	35	35	36	5.7	5.7	5.7	11	12	13	LQM (2014)
Benzo(b)fluoranthene	2.6	3.3	3.7	3.9	4	4	0.99	2.1	3.9	44	44	45	7.1	7.1	7.1	13	15	16	LQM (2014)
Benzo(g,h,i)perylene	320	340	350	360	360	360	290	470	640	3900	4000	4000	640	640	640	1400	1500	1600	LQM (2014)
Benzo(k)fluoranthene	77	93	100	110	110	110	37	75	130	1200	1200	1200	190	190	190	370	410	440	LQM (2014)
Chrysene	15	22	27	30	31	32	4.1	9.4	19	350	350	350	57	57	57	93	110	120	LQM (2014)
Dibenz(a,h)anthracene	0.24	0.28	0.3	0.31	0.32	0.32	0.14	0.27	0.61	3.5	3.6	3.6	0.57	0.57	0.58	1.1	1.3	1.4	LQM (2014)
Fluoranthene	280	560	890	1500	1600	1600	52	130	290	23000	23000	23000	3100	3100	3100	63	6300	6400	LQM (2014)
Fluorene	170	400	860	2800 (30.9)	3800 (76.5)	4500 (183)	27	67	160	63000 (30.9)	68000	71000	9900	9900	9900	20000	20000	20000	LQM (2014)
Indeno(1,2,3-cd)pyrene	27	36	41	45	46	46	9.5	21	39	500	510	510	82	82	82	150	170	180	LQM (2014)

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SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
Naphthalene	2.3	5.6	13	2.3	5.6	13	4.1	10	24	190 (76.4)	460 (183)	1100 (432)	4900	4900	4900	1200 (76.4)	1900 (183)	3000	LQM (2014)
Phenanthrene	95	220	440	1300 (36)	1500	1500	15	38	90	22000	22000	23000	3100	3100	3100	6200	6200	6300	LQM (2014)
Pyrene	620	1200	2000	3700	3800	3800	110	270	620	54000	54000	54000	7400	7400	7400	15000	15000	15000	LQM (2014)
Coal Tar (BaP as surrogate marker)	0.79	0.98	1.1	1.2	1.2	1.2	0.32	0.67	1.2	15	15	15	2.2	2.2	2.2	4.4	4.7	4.8	LQM (2014)
BTEX and TPH																			
Benzene	0.087	0.17	0.37	0.38	0.7	1.4	0.017	0.034	0.075	27	47	90	72	72	73	90	100	110	LQM (2014)
Toluene	130	290	660	880 vap (869)	1900	3900	22	51	120	56000 vap (869)	110000 vap (1920)	180000 vap (4360)	56000	56000	56000	87000 vap (869)	95000 vap (1920)	100000 vap (4360)	LQM (2014)
Ethylbenzene	47	110	260	83	190	440	16	39	91	5700 vap (518)	13000 vap (1220)	27000 vap (2840)	24000	24000	25000	17000 vap (518)	22000 vap (1220)	27000 vap (2840)	LQM (2014)
Xylene - o	60	140	330	88	210	480	28	67	160	6600 (478)	15000 (1120)	33000 (2620)	41000	42000	43000	17000 (478)	24000 (1120)	33000 (2620)	LQM (2014)
Xylene - m	59	140	320	82	190	450	31	74	170	6200 (625)	14000 (1470)	31000 (3460)	41000	42000	43000	17000 (625)	24000 (1470)	32000 (3460)	LQM (2014)
Xylene - p	56	130	310	79	180	430	29	69	160	5900 (576)	14000 (1350)	30000 (3170)	41000	42000	43000	17000 (576)	23000 (1350)	31000 (3170)	LQM (2014)
Aliphatic EC 5-6	42	78	160	42	78	160	730	1700	3900	3200 (304)	5900 (558)	12000 (1150)	570000 (304)	590000	600000	95000 (304)	130000 (558)	180000 (1150)	LQM (2014)
Aliphatic EC >6-8	100	230	530	100	230	530	2300	5600	13000	7800 (144)	17000 (322)	40000 (736)	600000	610000	620000	150000 (144)	220000 (322)	320000 (736)	LQM (2014)

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SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
Aliphatic EC >8-10	27	65	150	27	65	150	320	770	1700	2000 (78)	4800 (190)	11000 (451)	13000	13000	13000	14000 (78)	18000 (190)	21000 (451)	LQM (2014)
Aliphatic EC >10-12	130 (48)	330 (118)	760 (283)	130 (48)	330 (118)	760 (283)	2200	4400	7300	9700 (48)	23000 (118)	47000 (283)	13000	13000	13000	21000 (48)	23000 (118)	24000 (283)	LQM (2014)
Aliphatic EC >12-16	1100 (24)	2400 (59)	4300 (142)	1100 (24)	2400 (59)	4300 (142)	11000	13000	13000	59000 (24)	82000 (59)	90000 (142)	13000	13000	13000	25000 (24)	25000 (59)	25000 (142)	LQM (2014)
Aliphatic EC >16-35	65000 (8.48)	92000 (21)	110000	65000 (8.48)	92000 (21)	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	LQM (2014)
Aliphatic EC >35-44	65000 (8.48)	92000 (21)	110000	65000 (8.48)	92000 (21)	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	LQM (2014)
Aromatic EC 5-7	70	140	300	370	690	1400	13	27	57	26000 (1220)	46000 (2260)	86000 (4710)	56000	56000	56000	76000 (1220)	84000 (2260)	92000 (4710)	LQM (2014)
Aromatic EC >7-8	130	290	660	860	1800	3900	22	51	120	56000 (869)	110000 (1920)	180000 (4360)	56000	56000	56000	87000 (869)	95000 (1920)	100000 (4360)	LQM (2014)
Aromatic EC >8-10	34	83	190	47	110	270	8.6	21	51	3500 (613)	8100 (1500)	17000 (3580)	5000	5000	5000	7200 (613)	8500 (1500)	9300 (3580)	LQM (2014)
Aromatic EC >10-12	74	180	380	250	590	1200	13	31	74	16000 (364)	28000 (899)	34000 (2150)	5000	5000	5000	9200 (364)	9700 (899)	10000	LQM (2014)
Aromatic EC >12-16	140	330	660	1800	2300 (419)	2500	23	27	130	36000 (169)	37000	38000	5100	5100	5000	10000	10000	10000	LQM (2014)
Aromatic EC >16-21	260	540	930	1900	1900	1900	46	110	260	28000	28000	28000	3800	3800	3800	7600	7700	7800	LQM (2014)
Aromatic EC >21-35	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	LQM (2014)

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SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
Aromatic EC >35-44	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	LQM (2014)
Aromatic EC >44-75	1600	1800	1900	1900	1900	1900	1200	2100	3000	28000	28000	28000	3800	3800	3800	7800	7800	7900	LQM (2014)
VOCs																			
1,2-dichloroethane (1,2-DCA)	0.0071	0.011	0.019	0.0092	0.013	0.023	0.0046	0.0083	0.016	0.67	0.97	1.7	29	29	29	21	24	28	LQM (2014)
1,1,1-trichloroethane	8.8	18	39	9	18	40	48	110	240	660	1300	3000	140000	140000	140000	57000 (1425)	76000 (2915)	100000 (6392)	LQM (2014)
1,1,2,2,tetrachloroethane	1.6	3.4	7.5	3.9	8	17	0.41	0.89	2	270	550	1100	1400	1400	1400	1800	2100	2300	LQM (2014)
tetrachloroethene	0.18	0.39	0.9	0.18	0.4	0.92	0.65	1.5	3.6	19	45	95	1400	1400	1400	810 (424)	1100 (951)	1500	LQM (2014)
tetrachloromethane (Carbon tetrachloride)	0.026	0.056	0.13	0.026	0.056	0.13	0.45	1	2.4	2.9	6.3	14	890	920	950	190	270	400	LQM (2014)
Trichloroethene	0.016	0.034	0.075	0.017	0.036	0.08	0.041	0.091	0.21	1.2	2.6	5.7	120	120	120	70	91	120	LQM (2014)
Trichloromethane (chloroform)	0.91	1.7	3.4	1.2	2.1	4.2	0.42	0.83	1.7	99	170	350	2500	2500	2500	2600	2800	3100	LQM (2014)
Chloroethene (Vinyl chloride)	0.00064	0.00087	0.0014	0.00077	0.001	0.0015	0.00055	0.001	0.0018	0.059	0.077	0.12	3.5	3.5	3.5	4.8	5	5.4	LQM (2014)
2,4,6 Trinitrotoluene (TNT)	1.6	3.7	8.1	65	66	66	0.24	0.58	1.4	1000	1000	1000	130	130	130	260	270	270	LQM (2014)

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SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
RDX	120	250	540	13000	13000	13000	17	38	85	210000	210000	210000	26000	26000	27000	49000 (18.7)	51000	53000	LQM (2014)
HMX	5.7	13	26	6700	6700	6700	0.86	1.9	3.9	110000	110000	110000	13000	13000	13000	23000 (0.35)	23000 (0.39)	24000 (0.48)	LQM (2014)
Aldrin	5.7	6.6	7.1	7.3	7.4	7.5	3.2	6.1	9.6	170	170	170	18	18	18	30	31	31	LQM (2014)
Dieldrin	0.97	2	3.5	7	7.3	7.4	0.17	0.41	0.96	170	170	170	18	18	18	30	30	31	LQM (2014)
Atrazine	3.3	7.6	17.4	610	620	620	0.5	1.2	2.7	9300	9400	9400	1200	1200	1200	2300	2400	2400	LQM (2014)
Dichlovos	0.032	0.066	0.014	6.4	6.5	6.6	0.0049	0.01	0.022	140	140	140	16	16	16	26	26	27	LQM (2014)
Alpha-Endosulfan	7.4	18	41	160 (0.003)	280 (0.007)	410 (0.016)	1.2	2.9	6.8	5600 (0.003)	7400 (0.007)	8400 (0.016)	1200	1200	1200	2400	2400	2500	LQM (2014)
alpha-Hexachlorocyclohexane	0.23	0.55	1.2	6.9	9.2	11	0.035	0.087	0.21	170	180	180	24	24	24	47	48	48	LQM (2014)
beta-hexachlorocyclohexanes	0.085	0.2	0.46	3.7	3.8	3.8	0.013	0.032	0.077	65	65	65	8.1	8.1	8.1	15	15	16	LQM (2014)
gamma-hexachlorocyclohexanes	0.06	0.14	0.33	2.9	3.3	3.5	0.0092	0.023	0.054	67	69	70	8.2	8.2	8.2	14	15	15	LQM (2014)
Chlorobenzene	0.46	1	2.4	0.46	1	2.4	5.9	14	32	56	130	290	11000	13000	14000	1300 (675)	2000 (1520)	2900	LQM (2014)
1,2-Dichlorobenzene	23	55	130	24	57	130	94	230	540	2000 (571)	4800 (1370)	11000 (3240)	90000	95000	98000	24000 (571)	36000 (1370)	51000 (3240)	LQM (2014)
1,3-Dichlorobenzene	0.4	1	2.3	0.44	1.1	2.5	0.25	0.6	1.5	30	73	170	300	300	300	390	440	470	LQM (2014)

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SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
1,4-Dichlorobenzene	61	150	350	61	150	350	15	37	88	4400 (224)	10000 (540)	25000 (1280)	17000	17000	17000	36000 (224)	36000 (540)	36000 (1280)	LQM (2014)
VOCs Continued																			
1,2,3-Trichlorobenzene	1.5	3.6	8.6	1.5	3.7	8.8	4.7	12	28	102	250	590	1800	1800	1800	770 (134)	1100 (330)	1600 (789)	LQM (2014)
1,2,4-Trichlorobenzene	2.6	6.4	15	2.6	6.4	15	55	140	320	220	530	1300	15000	17000	19000	1700 (318)	2600 (786)	4000 (1880)	LQM (2014)
1,3,5-Trichlorobenzene	0.33	0.81	1.9	0.33	0.81	1.9	4.7	12	28	23	55	130	1700	1700	1800	380 (36.7)	580 (90.8)	860 (217)	LQM (2014)
1,2,3,4-Tetrachlorobenzene	15	36	78	24	56	120	4.4	11	26	1700 (122)	3080 (304)	4400 (728)	830	830	830	1500 (122)	1600	1600	LQM (2014)
1,2,3,5-Tetrachlorobenzene	0.66	1.6	3.7	0.75	1.9	4.3	0.38	0.9	2.2	49 (39.4)	120 (98.1)	240 (235)	78	79	79	110 (39)	120	130	LQM (2014)
1,2,4,5-Tetrachlorobenzene	0.33	0.77	1.6	0.73	1.7	3.5	0.06	0.16	0.37	42 (19.7)	72 (49.1)	96	13	13	13	25	26	26	LQM (2014)
Pentachlorobenzene	5.8	12	22	19	30	38	1.2	3.1	7	640 (43)	770 (107)	830	100	100	100	190	190	190	LQM (2014)
Hexachlorobenzene	1.8 (0.2)	3.3 (0.5)	4.9	4.1 (0.2)	5.7 (0.5)	6.7 (1.2)	0.47	1.1	2.5	110 (0.2)	120	120	16	16	16	30	30	30	LQM (2014)
Phenol	280	550	1100	750	1300	2300	66	140	280	760 $_{dir}$ (31000)	1500 $_{dir}$ (35000)	3200 $_{dir}$ (37000)	760 $_{dir}$ (31000)	1500 $_{dir}$ (35000)	3200 $_{dir}$ (37000)	760 $_{dir}$ (31000)	1500 $_{dir}$ (35000)	3200 $_{dir}$ (37000)	LQM (2014)

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
Chlorophenols (excluding pentachlorophenol)	0.87 (g)	2	4.5	94	150	210	0.13 (g)	0.3	0.7	3500	4000	4300	620	620	620	1100	1100	1100	LQM (2014)
Pentachlorophenol	0.22	0.52	1.2	27 (16.4)	29	31	0.03	0.08	0.19	400	400	400	60	60	60	110	120	120	LQM (2014)
Carbon Disulphide	0.14	0.29	0.62	0.14	0.29	0.62	4.8	10	23	11	22	47	11000	11000	12000	1300	1900	2700	LQM (2014)
Hexachlorobutadiene	0.29	0.7	1.6	0.32	0.78	1.8	0.25	0.61	1.4	31	66	120	25	25	25	48	50	51	LQM (2014)

(g) derived based on 2,3,4,6-tetrachlorophenol; dir - based on a threshold protective of direct skin contact with phenol (guideline in brackets based on health effects following long term exposure provided for illustration only); (vap) calculated for vapour phase only. SOM - Soil Organic Matter; (4.5) solubility.