Worms Heath Restoration
Limpsfield Road

Hydrogeological Risk Assessment

Contents

1 Introduction

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'.

This Hydrogeological Risk Assessment has been undertaken to identify and assess the potential risks associated with the existing site and the importation of material to undertake the proposed restoration. This has been assessed through the development of a Conceptual Site Model (CSM) in accordance with UK protocols and Environment Agency (EA) online guidance.

A 'tiered approach' has been adopted, as follows:

- Tier 1 – qualitative risk screening – identify the risks and determine whether a more detailed assessment is needed and what that would focus on (risk prioritisation)
- Tier 2 – generic quantitative risk assessment – collect more information to make an informed decision on the risk posed by the site – identify compliance points
- Tier 3 – detailed quantitative risk assessment – collect more information and formulate a plan, if there are clear source-pathway-receptor relationships.

Tiers 1 and 2 have been assessed in this Hydrogeological Risk Assessment, with a Tier 3 assessment not being deemed necessary. Mitigation measures have, however, been identified to mitigate the identified residual risks.

2 Site Details (Desk Study)

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.

Figure 1: Google Earth site boundary

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 red boundary in Figure 1 above.

3 Tier 1 - Preliminary Risk Assessment (incl. Conceptual Site Model)

3.1 Methodology

A Preliminary Risk Assessment (PRA) and Conceptual Site Model (CSM) have been prepared using the information obtained from the desk study. Possible risks associated with potential sources of contamination and sensitive receptors have been qualitatively assessed following a source-pathway receptor (Pollutant Linkage) approach.

A risk of harm may only exist where a plausible pollutant linkage is present, and where the quantity or concentration of a contaminant is sufficient so as to pose harm. Under the statutory definition, "Contamination" may only strictly exist where contaminants pose a risk of harm to a receptor. A summary of how the risks are derived and their definitions are presented in Tables 3.1 and 3.2.

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very high risk	High risk	Moderate risk	Moderate/low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low Likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

Table 3.1 Risk Ratings Matrix

Risk Rating	Definitions
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not already undertaken) and remediation are likely to be required.
High risk	Harm is likely to arise to a designated receptor from an identified hazard Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not already undertaken) is required and remediation works may be necessary in the short term and are likely over the longer term.
Moderate risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
Moderate to low risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is unlikely that any such harm would be severe, or if any harm were to occur it is probable that the harm would be relatively mild.
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very low risk	There is low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Table 3.2 Risk Rating Definitions

3.2 Summary of Plausible Sources

Possible sources of contamination identified from the desk study are summarised in Table 3.3.

Source	Description
Former Inert Landfill Material	***Historical Development*** The site is currently part of a wider agricultural holding, but planning records show that 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 the ESSD (WH/011). Planning records also show that the site has been used as a landfill in the 1970's. 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. Since the 1970's the land has been returned to agriculture, but the poor quality of the surface of the land makes the site difficult to use.
Imported soil profile	***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 100,000m3 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 will fully match the types permitted under SR2015No.39. Given that these wastes are acceptable for activities carried out under a 'standard rules' permit, it follows that they are equally acceptable for the proposed works at Worm's Heath. A full list of the waste types has previously been approved in the Worm's Heath Waste Recovery Plan (WRP) (Ref: WH/001). The imported waste materials will be inert and will present a limited risk to the environment.

Table 3.3

3.3 Summary of Plausible Pathways

The plausible pathways are summarised in Table 3.4. These pathways are based on the proposed end use as agricultural land.

Pathway	Description
Direct Contact and Inhalation	Ingestion of soil particles, inhalation of soil derived dust
Vertical & Lateral Migration	Groundwater contaminant movement vertically through leaching/gravity, more permeable bedded strata. The site is topographically sloping and therefore lateral migration and overland flow of surface water may occur.
Flooding	Discounted – the site was indicated to be located outside of any current fluvial flood plain.

Table 3.4

3.4 Summary of Plausible Receptors

Potential receptors associated with the site and its development are summarised in Table 3.5.

Receptor	Description
End Users	Landowner and farm workers. The site will be incorporated into the wider agricultural holding post restoration.
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.
Surface Water	The existing surface water regime migrates surface water to adjacent land. There are no watercourses within close proximity.

Table 3.5

3.5 Qualitative Assessment

Using the sources and receptors that have been identified above, Table 3.6 summarises the identified plausible pollution linkages and a qualitative assessment of the risks based on the desk study information.

Potential Source	Potential Receptor	Potential Pathways	Probability	Consequence	Risk and Justification
Former Inert Landfill Material	End Users	Direct contact and inhalation of dust	Unlikely	Minor	**Very Low** No potential sources which could harm human health have been identified in the former landfill. The former landfill will be fully covered by the imported soils.
	Groundwater	Vertical migration	Unlikely	Minor	**Very Low** The site overlies a Principal Aquifers. However, the desk study has not identified any significant sources of potentially mobile contamination on-site.
	Surface Water	Lateral migration	Low likelihood	Minor	**Low** The existing surface water regime migrates surface water to adjacent land. There are no watercourses within close proximity.
Imported soil profile	End Users	Direct contact and inhalation of dust	Unlikely	Minor	**Very Low** No potential sources which could harm human health have been identified in the imported soil profile.
	Groundwater	Vertical migration	Unlikely	Minor	**Very Low** The site overlies a Principal Aquifers. However, the desk study has identified that the imported material will be 'inert' and will not contain any significant sources of potentially mobile contamination.
	Surface Water	Lateral migration	Low likelihood	Minor	**Low** The proposed soil profile will continue to cause surface water to migrate on to adjacent land. There are no watercourses within close proximity.

Table 3.6

3.6 Preliminary Risk Assessment Summary

The Preliminary Risk Assessment (PRA) and Conceptual Site Model (CSM) developed from the desk study information have identified some plausible pollutant linkages that exist in relation to the construction of the proposed soil profile. The preliminary risk rating for the pollution linkages has been classified as 'low' or 'very low'.

Given that the PRA did not identify any 'moderate' or 'high' risks, there is no requirement to continue this assessment, in order to determine mitigation measures and/or a remediation strategy. However, given that the site is located on a Principal Aquifer, this Hydrogeological Risk Assessment will continue to refine the CSM and consider a Generic Quantitative Risk Assessment (GQRA).

In order to progress this assessment, further investigation of the surface water regime will be undertaken to assess the classification of the risk. Similarly, the groundwater risk classification will also be given further investigation/consideration. This will help to provide a robust risk assessment (and GQRA) for the site and, if necessary, determine mitigation measures to reduce, remove or otherwise control any risk within the site to key receptors.

4 Further Investigation

4.1 Landfill Records

Environment Agency (EA) records show that the site was 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 and accompanying record is provided in Appendix A.

4.2 Site Investigation – Encountered 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 B.

BGS records also contain historic borehole records demonstrating the original geology at the site. A copy of the borehole records is provided in Appendix C.

A site investigation was carried in August 2018 by Reading Agricultural Consultants (RAC). A copy of the RAC Agricultural Statement is provided in Appendix D.

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.

4.3 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. EA online guidance states that "*We*

normally object to a proposed landfill site within a Source Protection Zone 1" therefore, although the site is on a Principal Aquifer, it's sensitivity (i.e. Zone) is not great enough to prohibit the scheme from taking place.

The existing geology indicates that the former landfill comprises inert soils, which have a lower permeability then the surrounding natural sands/gravels. Groundwater migration through the former landfill materials is therefore limited by the nature of the material. The surrounding natural soils (from the 'Disturbed Blackheath Beds' Formation) are more permeable than the former landfill materials and have/are allowing groundwater to migrate around/below the 'mass' of former landfill material. This situation has been present for decades and there are no records (with the regulators), accounts (from the landowner) or evidence of groundwater contamination.

4.4 Surface Water 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 E of this report.

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. The report concludes that the impacts to neighbouring properties are therefore negligible.

4.5 Leachate

There have been no incidents of contamination from leachate on or near the site, indicating that the existing materials pose little risk to the environment.

4.6 Gas

None

5 Tier 2 - Generic Quantitative Risk Assessment (GQRA)

5.1 Scope and objectives

Following the Preliminary Risk Assessment (PRA) undertaken in Section 3, a GQRA has been undertaken. The objectives of this GQRA are as follows:

- use the PRA as a baseline
- develop and refine the CSM using the further information contained in Section 4
- re-assess the risks from contamination to human health and the environment.
- identify any residual risks and develop mitigation measures, if necessary.

The PRA identified two potential sources of contamination:

1. Existing Former Landfill Materials
2. Proposed imported Materials

The following sections compare each source against each of the receptors, previously identified in the PRA.

5.2 Risk Assessment of Existing Former Landfill Materials

5.2.1 Human Heath

As described in Section 4, the former landfill materials have been investigated further; EA records have confirmed that the materials placed in the landfill were inert and, the trial pits undertaken during the site investigation confirmed the expected soil types and did not observe any chemical contamination. The site has been part of the surrounding agricultural holding for several decades without causing harm to the users (humans). There is no evidence of any contamination or contaminative incidents.

The risk from the existing landfill material (source) is therefore considered to be very low and given that the proposed scheme does not involve the disturbance/excavation of this material (pathway), mitigation measures are not required.

Should there be any need to excavate/disturb the existing ground and discovery strategy will be put in place, in case any unforeseen material/contamination is encountered.

5.2.2 Groundwater

As stated above, the existing landfill materials (source) are inert and pose very limited risk to the groundwater/aquifer (receiver). Groundwater migration through the former landfill materials is limited by the nature of the material, so although the natural sandy/gravelly geology (around the landfill 'mass') create a pathway, it is limited and the risk remains very low.

5.2.3 Surface Water

Further investigation, including hydraulic modelling, has identified that the existing site is subject to pluvial flooding and has identified three overland flow routes within the immediate proximity of the site. The existing landfill material (source) and the surface water regime (pathways) have been present for decades and there are no records (with the regulators), accounts (from the landowner) or evidence of surface water contamination. The risks to neighbouring land and watercourses (receptors) are low.

5.3 Risk Assessment of Proposed Imported Materials

5.3.1 Human Heath

The proposed imported materials will fully match the waste types permitted under Standard Rules Permit SR2015No.39. Given that the risk from these wastes is considered low enough to allow the 'Deposit for Recovery' activity to be carried out under 'standard rules', it follows that they are equally acceptable for the proposed soil profile at Worm's Heath. Consequently, the imported

material will be 'inert' and will not contain any significant sources of potentially mobile contamination. The risk to human health is considered to be very low.

5.3.2 Groundwater

The imported materials will be used to construct a layer of soil across the site, thereby covering the existing landfill material. This will reduce vertical migration in to the former landfill materials. Groundwater within the imported materials has 'very low' risk of contamination due to the 'inert' nature of the proposed imported materials, as described above.

5.3.3 Surface Water

The proposed soil profile will continue to cause surface water to migrate on to adjacent land. Further investigation, including hydraulic modelling, found that the proposed soil profile has a minimal impact to maximum flood depths and a negligible increase to the overland routes. The modelling report concludes that the impacts to neighbouring land and watercourses are negligible. The proposed imported materials (source) will be 'inert' and will not contain any significant sources of potentially mobile contamination (as described above). The risk to neighbouring land and watercourses (receptors) is considered to be low.

6 Summary of GQRA

The information obtained in the further investigations reinforces the fact that the 'existing landfill material' is 'inert' and there are no signs of contamination or contaminative incidents. It has been noted that the 'proposed imported materials' would be wholly acceptable under a Standard Rules Permit and are therefore of an equally 'inert' and low risk type.

Consequently, both sources are unlikely to contain significant mobile contaminants and therefore present a low risk to the receptors.

Even where plausible pathways existing, such as the surrounding natural geology (for groundwater), or the overland flow paths (for surface water) the risks from both sources remain low. This is supported by the fact that, 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. In some instances the pathway is less plausible and the risk reduces to very low.

It is noted that the site is on a Principal Aquifer, but is not within a Zone I or 2 Source Protection Zone. The proposed activity is therefore not prohibited, but the sensitivity of this key receptor has been acknowledged in this GRQA and the whole Hydrogeological Risk Assessment.

Consequently, mitigation measures have been identified to provided additional protection to the Principal Aquifer receptor in the following scenarios:

1. The 'existing former landfill materials' are disturbed or excavated and contamination is encountered.
2. The 'proposed imported materials' do not comply with the rules of the permit and exceed contamination thresholds for the proposed use.

Further detail is provided in the next section.

7 Mitigation Measures

7.1 Scope

The following mitigation measures have been identified to reduce, remove or otherwise control further risks from within the site to the key 'Principal Aquifer' receptor.

7.2 Existing Former Landfill Materials – Discovery Strategy

It has been acknowledged that whilst the acquired evidence shows that the existing former landfill materials are 'inert' there is a small possibility that the material may vary in type and that unknown (potentially contaminated) materials may be present within the landfill 'mass'. Whilst the proposed activity does not intent to disturb or excavate the existing former landfill materials, there is again a small possibility that it may disturbed/excavated, resulting in contamination being encountered.

Should this scenario occur the following discovery strategy will be implemented:

DISCOVERY STRATEGY

Whilst trial pits have been undertaken on the site, it remains possible that unexpected soil/ground may be encountered during the construction of the proposed soi profile.

Should previously undiscovered contamination or unforeseen ground conditions be encountered during construction, this must be reported to the site manager immediately in order that the relevant consultant is notified. Where deemed necessary, the consultant shall attend the site to inspect the discovery and provide recommendations on further actions required, if any. Where necessary the regulatory authority shall be informed. Post any additional investigation or laboratory testing the results and any proposed remedial measures shall be reported to the regulatory authority or other appropriate organisation for consent, before proceeding or implementing the remedial measures.

A copy of this discovery strategy will be provided on site (within the EMS) and provisions made to ensure that all site personnel are made aware of their responsibility to observe, report, and act on any potentially suspicious, abnormal unforeseen or contaminated soils/ground they may encounter.

Depending on the type, nature and extent of any such 'discovery', it may be necessary to halt works in that location until such time as the assessment has been completed. This shall be reviewed on a 'discovery' specific basis and in conjunction with regulatory consultation with the client, other technical personnel and/or regulatory/appraisal organisations.

As a general guide, where such unexpected conditions are encountered the following approach is required as a minimum:

- All discoveries are to be reported to the Site Manager immediately and works at that location are to halt until further notice;
- The Site Manager is to report any such discoveries to the Client and the Consultant;
- Following notification from the Site Manager, the Consultant shall discuss the discovery with the Local Authority and/or other relevant parties and if considered necessary, arrange to meet an Officer on site to view the discovery;
- The Consultant shall attend the site to record the location, extent and nature of the discovery and implement an appropriate sampling and analysis regime, if necessary, taking due account of the type and nature of the discovery, known and probable land uses in that area of the site;
- Where remedial action is required, regulatory consultation and approval will be sought;

- A record will be produced by the Consultant and held on site (with copies held by the Consultant, Client and Local Authority/other relevant organisation), detailing the discovery, assessment works undertaken, findings thereof, confirmation either of no action required or detailing the remedial action taken and validation thereof.

The process is shown below.

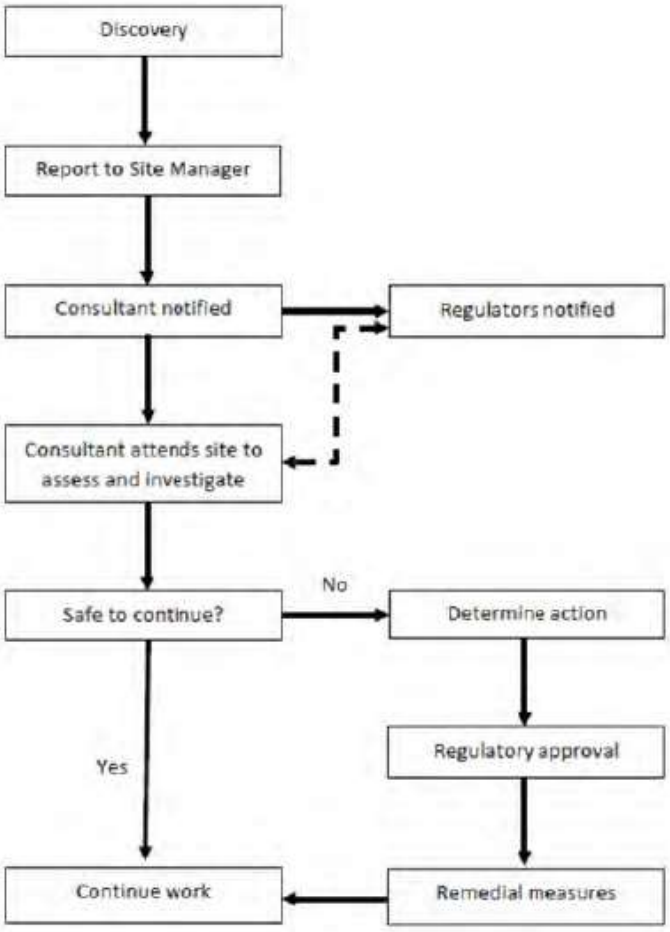


Chart 1 Discovery Strategy Process

A copy of this discovery strategy will be provided on site (within the EMS) and provisions made to ensure that all site personnel are made aware of their responsibility to observe, report, and act on any potentially suspicious, abnormal unforeseen or contaminated soils/ground they may encounter.

7.3 Proposed Imported Materials – Waste Acceptance Procedure

The proposed activity will be carried out under a Bespoke Permit, largely based on the Standard Rules Permit SR2015No.39. Only waste materials permitted under the Environmental Permit shall be imported to the site. In order to control the importation of the material and to ensure that the materials are pursuant to the rules of the Environmental Permit, the following acceptance procedure will be implemented and enforced throughout the restoration activity:

Pre-Acceptance Procedure

The imported waste materials will come from a number of source sites. All potential source sites shall be reviewed to determine whether the materials are of a type(s) permitted under the Permit and whether there is any reason to expect high levels of contaminants. Where there is no reason to suspect the source site to be contaminated, permission shall be granted for the material to be imported

Where the source site has a potential to be contaminated, site investigation information including chemical testing shall be requested. Once received, soil test results shall be checked and if deemed acceptable the source site shall be permitted to import material to the site. Where test results indicate unacceptable levels of contaminants, the source site shall be rejected and no material permitted. A record of source site data shall be maintained.

The Source Site Acceptance Procedure is shown on the flow chart on the following page.

Material Acceptance Procedure

Deliveries shall only be accepted by prior arrangement and all delivery vehicles shall report to the site manager/foreman upon arrival at the site.

All waste materials delivered to site shall be accompanied by a Controlled Waste Transfer Note. These shall be collected by site personnel upon arrival.

All materials shall be visually inspected when they arrive at the site. Unsuitable materials shall be rejected, or quarantined and promptly removed.

Use and Handling Materials

Upon arrival, waste materials shall be identified for use in the appropriate component of the works. Where practicable, materials shall be delivered directly to the appropriate area within the site.

Materials shall be incorporated in to the construction works at the earliest opportunity and in accordance with the standards and specifications stated in Section 5.2) of the Waste Recovery Plan (Ref. WH/001).

Any undesirable materials such as wood, metal and plastic shall be removed and recycled/disposed of by registered waste carriers and/or receivers. Documentation shall be retained.

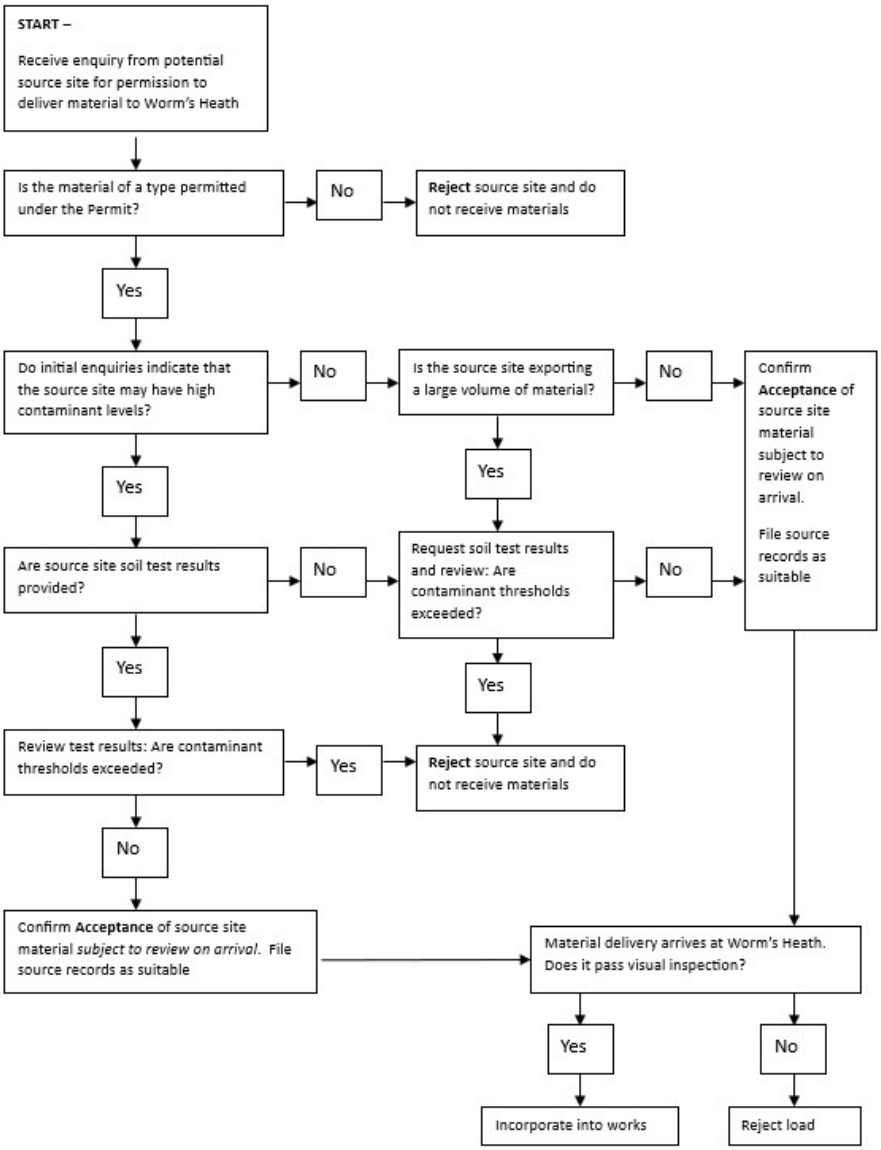


Chart 2 Acceptance Procedure

7.4 Restoration - Benefits

The following factors will also benefit the protection of the Principal Aquifer:

- 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.
- The site will be restored to a condition suitable for agricultural use and will be incorporated in to the management/use of the surrounding agricultural holding.

8 Conclusion

The Conceptual Site Model (CSM) methodology has been used to identify the relevant 'Source', 'Pathways' and 'Receptors' relating to the proposed activity at Worm's Heath. A tiered assessment has been undertaken, including both a PRA and a GQRA. The identified risks (from contamination) have been assessed as either 'low' or 'very low'.

The hydrogeology for the site has identified that the surrounding natural geology provides a plausible pathway for vertical migration of groundwater. The key receptor being the underlying Principal Aquifer. The aquifer is not within a Zone I or 2 Source Protection Zone, so the proposed activity is not prohibited, however, the sensitivity of this key receptor has been acknowledged in the CSM and the Hydrogeological Risk Assessment.

Two potential sources of contamination have been identified in the CSM; the 'existing former landfill materials' and the 'proposed imported materials'. Both sources have been assessed and are considered to be 'inert' and unlikely to contain significant mobile contaminants, therefore presenting a 'low' or 'very low' risk to the receptors. This is supported by the fact that, 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.

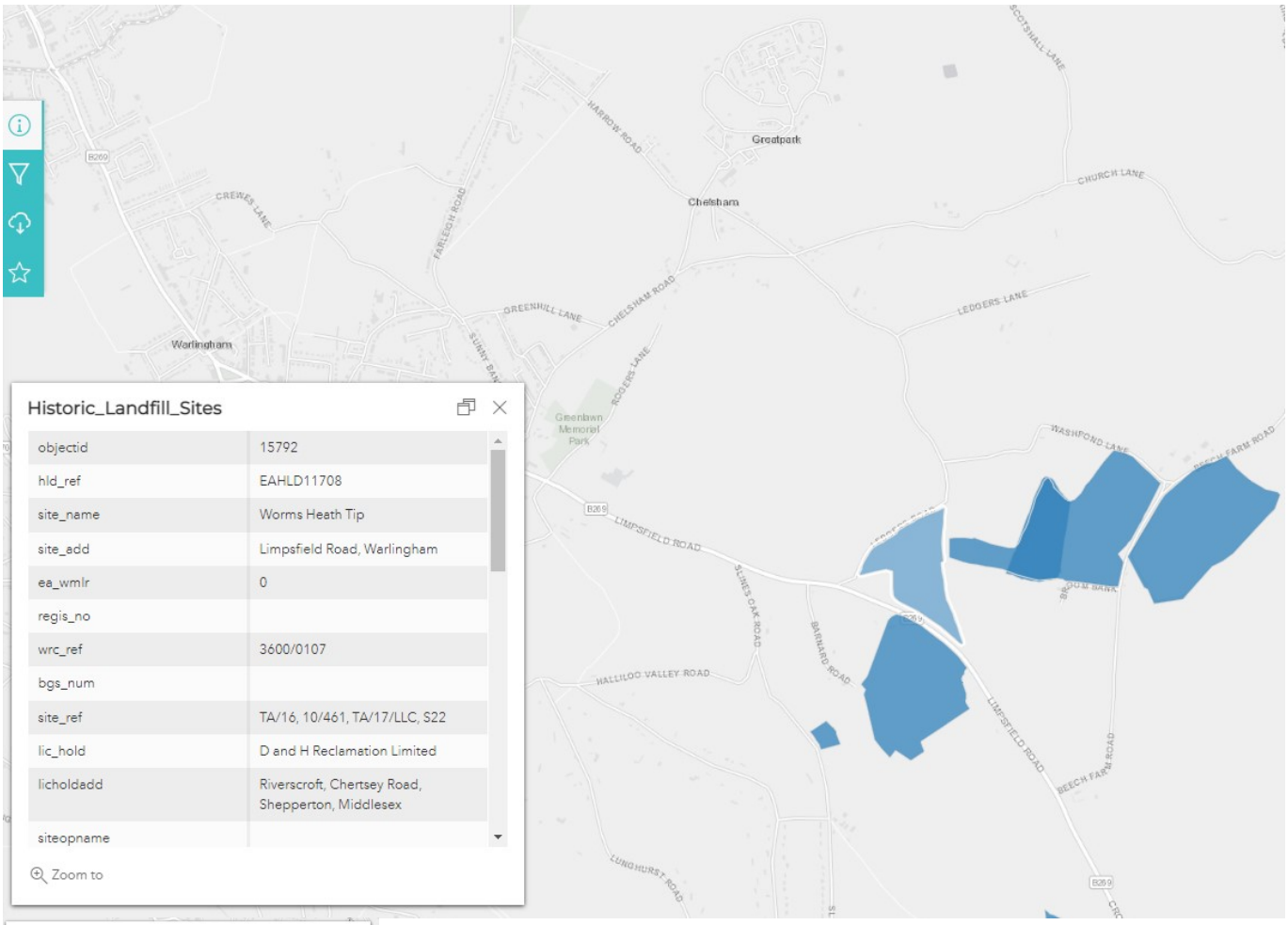
The hydrogeological risk of the proposed activity is therefore considered to be 'low'.

The sensitivity of the key 'Principal Aquifer' receptor has however been acknowledged and, consequently, mitigation measures have been identified to provided additional protection to the Principal Aquifer receptor in the following scenarios:

1. The 'existing former landfill materials' are disturbed or excavated and contamination is encountered.
2. The 'proposed imported materials' do not comply with the rules of the permit and exceed contamination thresholds for the proposed use.

These measures will ensure that the hydrological risk remains 'low'.

APPENDIX A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siteopname
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Greatpark
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Warlingham
Greenlawn Memorial Park
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GREENHILL LANE
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BEECH FARM ROAD
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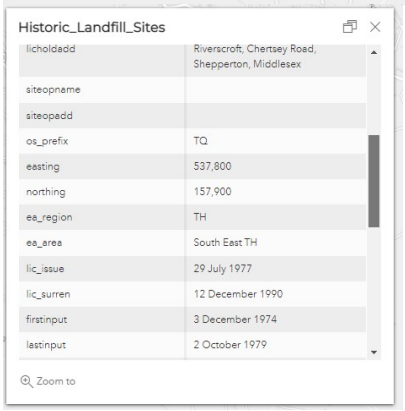
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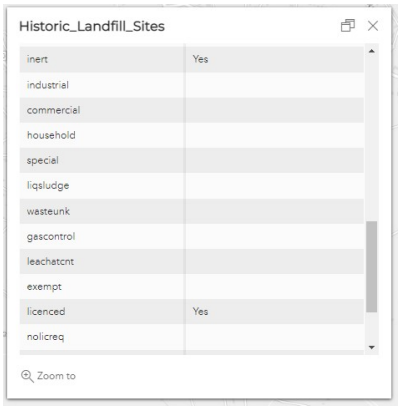
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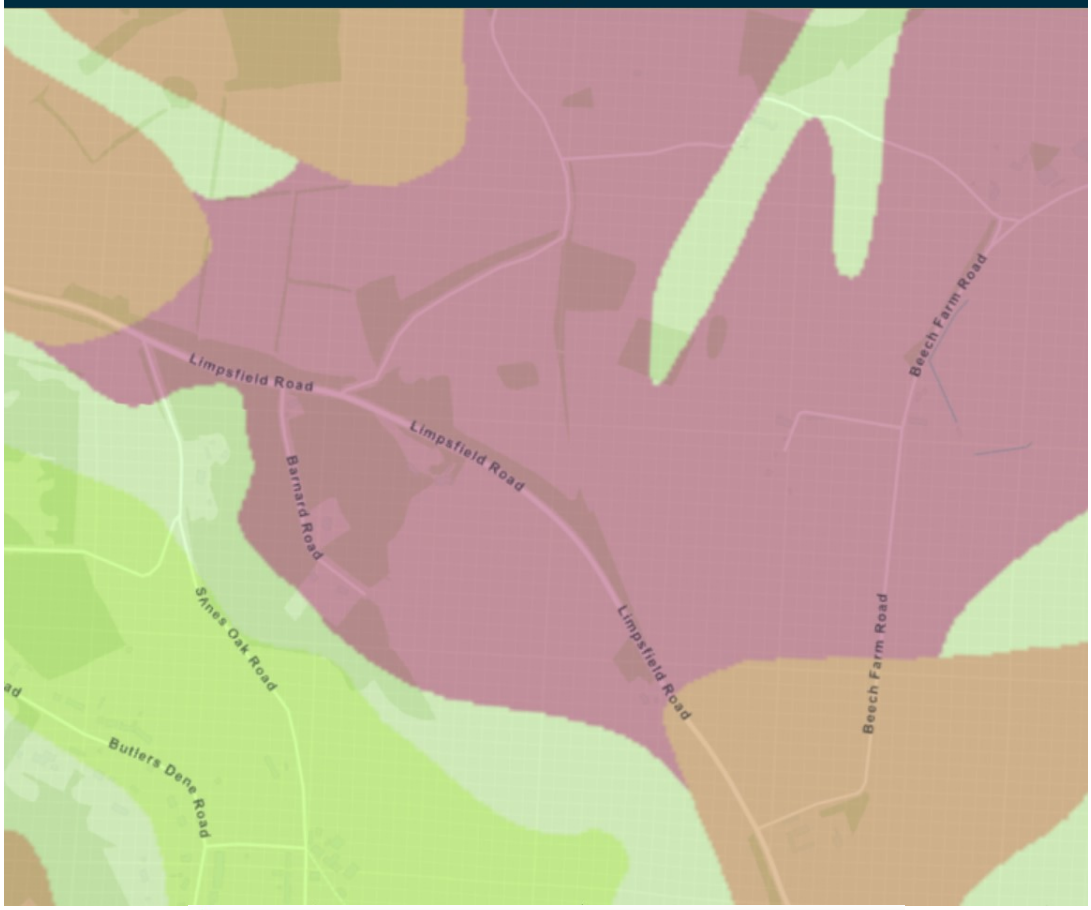
APPENDIX B

Geology Viewer



Bedrock geology

Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation - Chalk. Sedimentary bedrock formed between 93.9 and 72.1 million years ago during the Cretaceous period.

More Information

Superficial deposits

Disturbed Blackheath Beds - Sand and gravel. Sedimentary superficial deposit formed between 56 million years ago and the present between the Palaeogene and Quaternary periods.

More Information

APPENDIX C

TQ 35 NE

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 TQ 35 NE 13

BOREHOLE NO. 2

37920
58078

Contract Name CHELSHAM Report No. S. 663/14

Client MacKay & Sohnellmann 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.

APPENDIX D

READING AGRICULTURAL CONSULTANTS

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.

Pit 1

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.

[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.

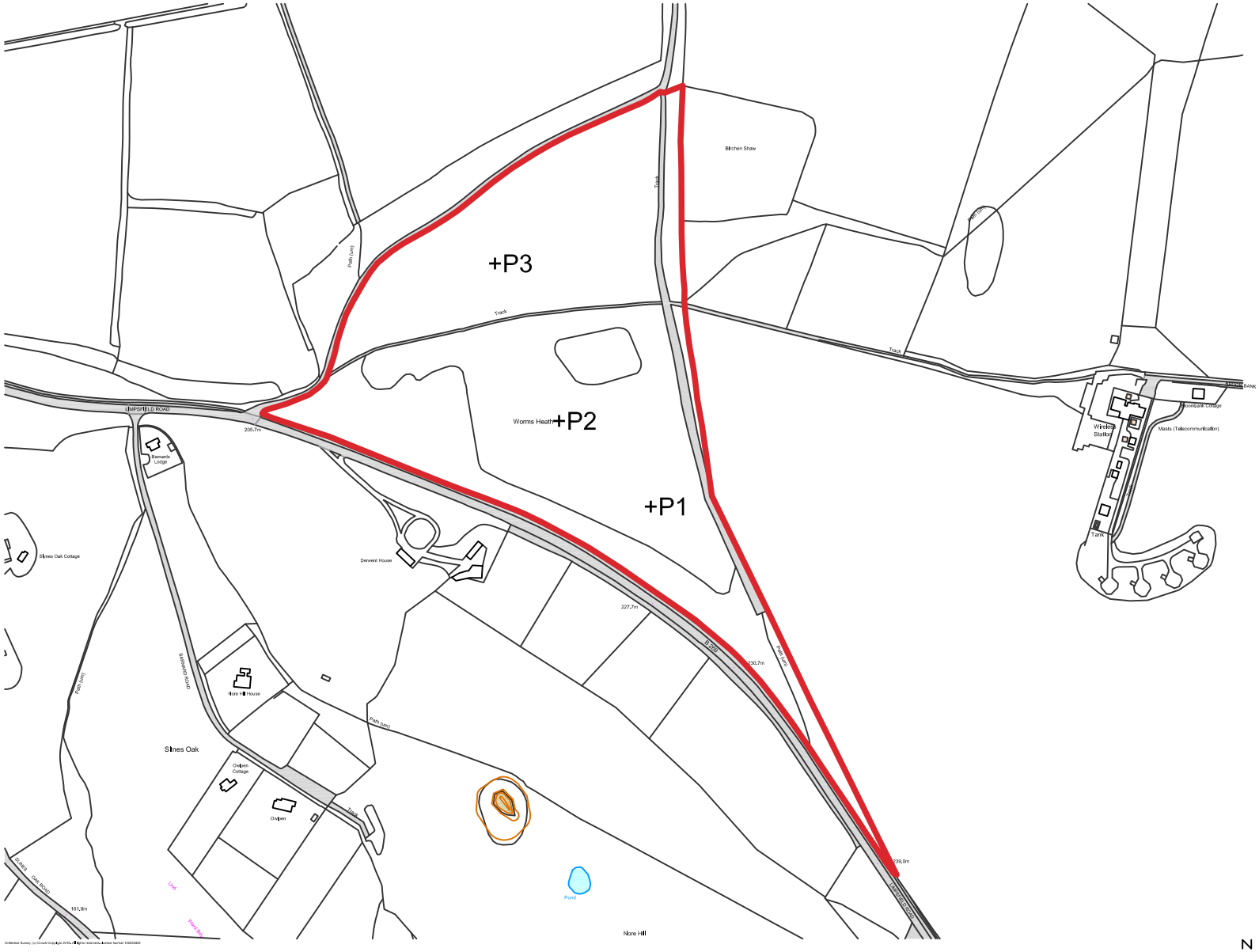
4.18 The site is not suited to intensive agriculture in its current condition because of the contamination and lack of soil material in the subsoil horizons. Debris restricts machinery to carry out field work. The site has been poorly restored.

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

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

READING AGRICULTURAL CONSULTANTS

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

Appendix 2

Appendix 3

Appendix 4

Appendix 5

APPENDIX E

CIVIL ENGINEERING SOLUTIONS LTD

CES557 LIMPSFIELD FLOOD MODELLING REPORT

REPORT

AUGUST 2019

Prepared by:
Civil Engineering Solutions Ltd
Bryn Meurig
Lombard Street
Dolgellau
Gwynedd
LL40 1DS

Tel: 01341 421 911

Email: info@ces.eu.com
Web: www.ces.eu.com

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.

Prepared By: ……. Jac Roberts Bsc
Engineer

Approved By: ……. Mark A Roberts BEng CEng FICE
Director

CONTACT DETAILS

Prepared by:

Civil Engineering Solutions Ltd
Bryn Meurig
Lombard Street
Dolgellau
Gwynedd
LL40 1DS

Tel: 01341 421 911

Email: info@ces.eu.com
Web: www.ces.eu.com

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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.

CONTENTS

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.

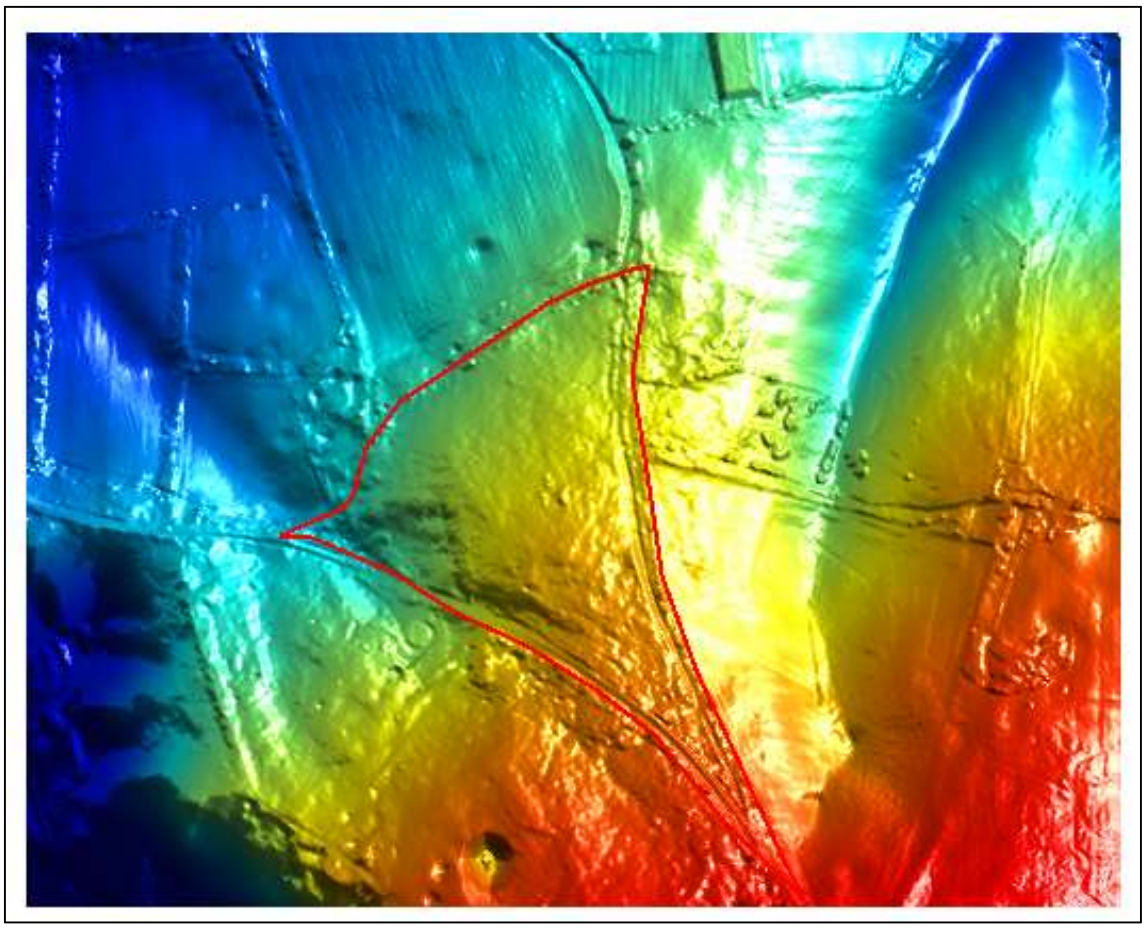

Figure 3: LiDAR coverage and Subject site boundary

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.

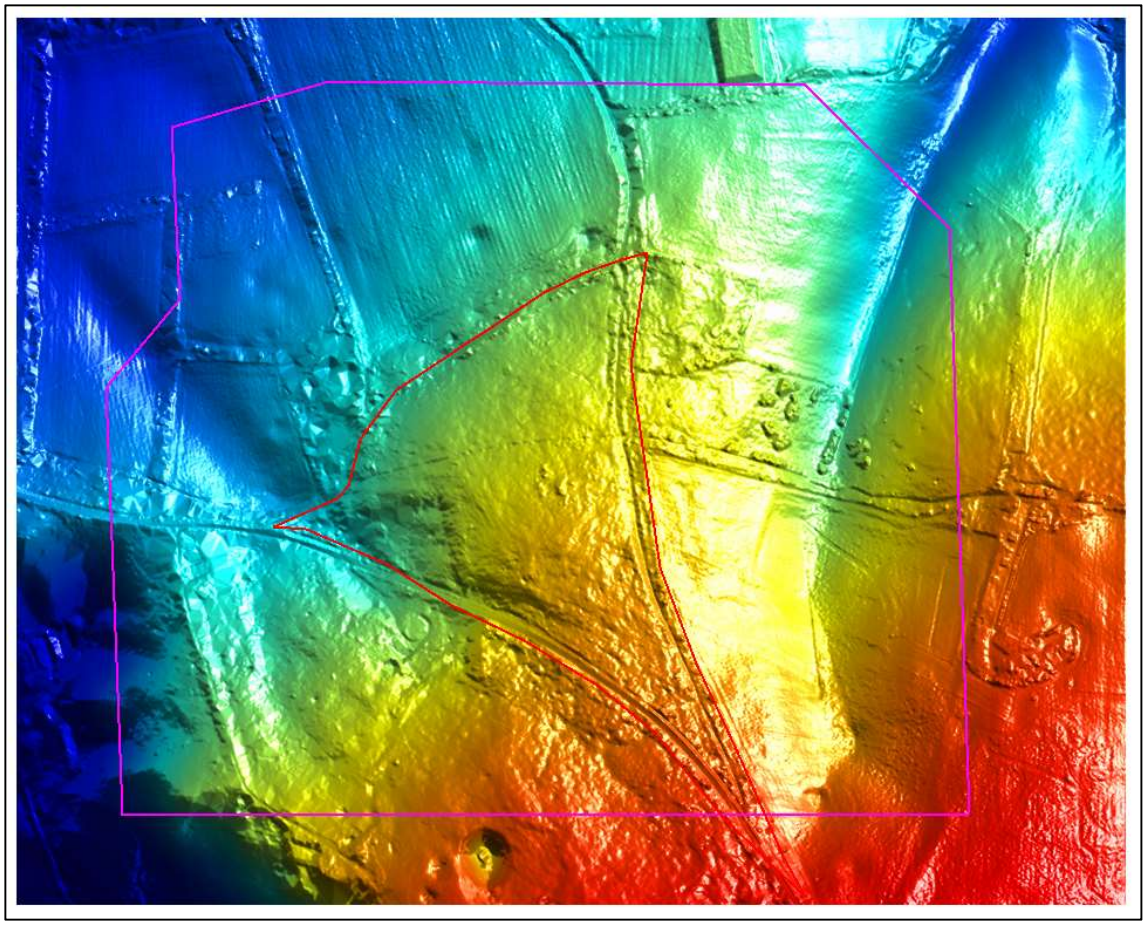

Figure 4: Catchment extents

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

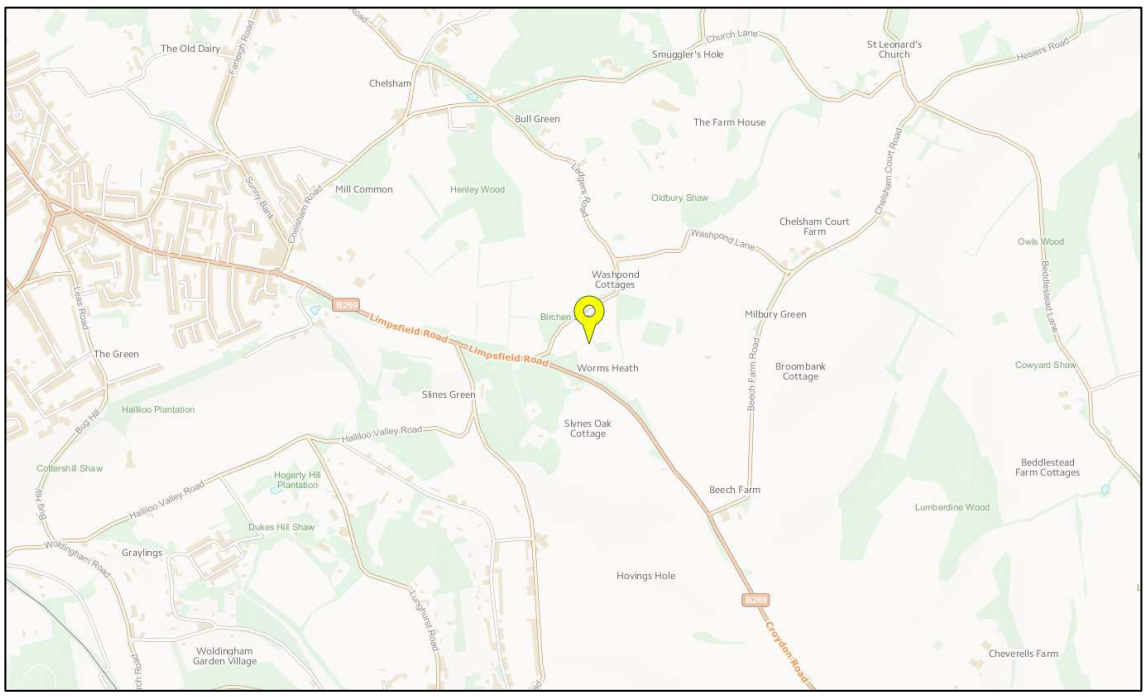

Figure 5: Environment Agency Flood Map

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

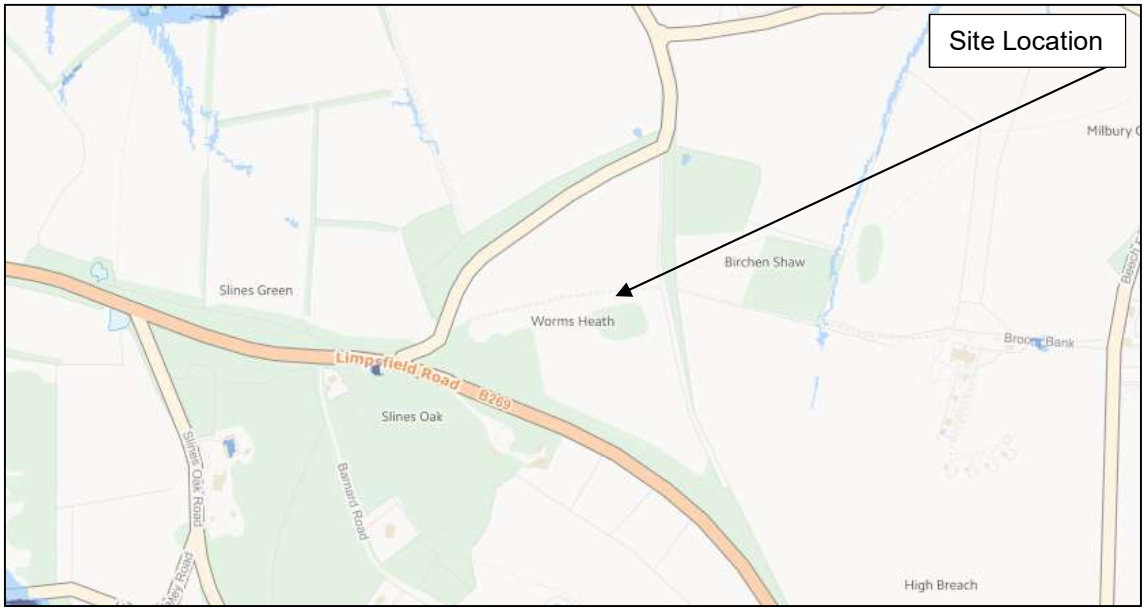

Figure 6: CES557 Limpsfield Green Surface Water Flood Map

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.

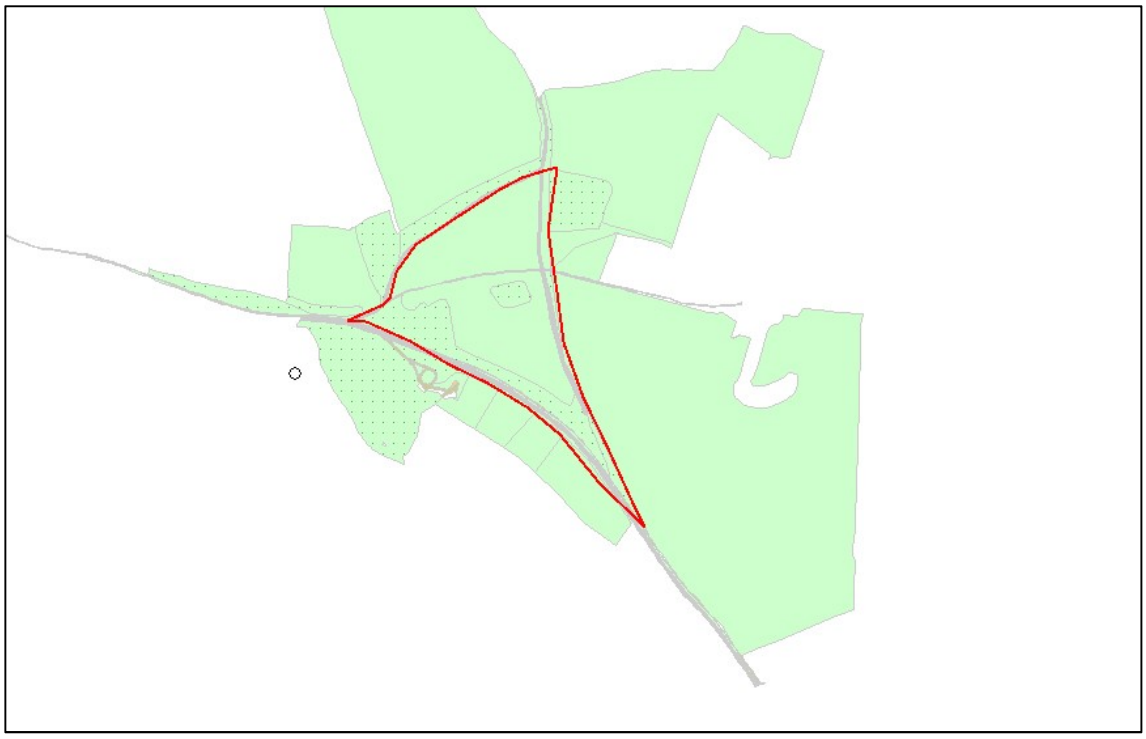

Figure 7: CES557 Limpsfield OS Mastermap Data

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.

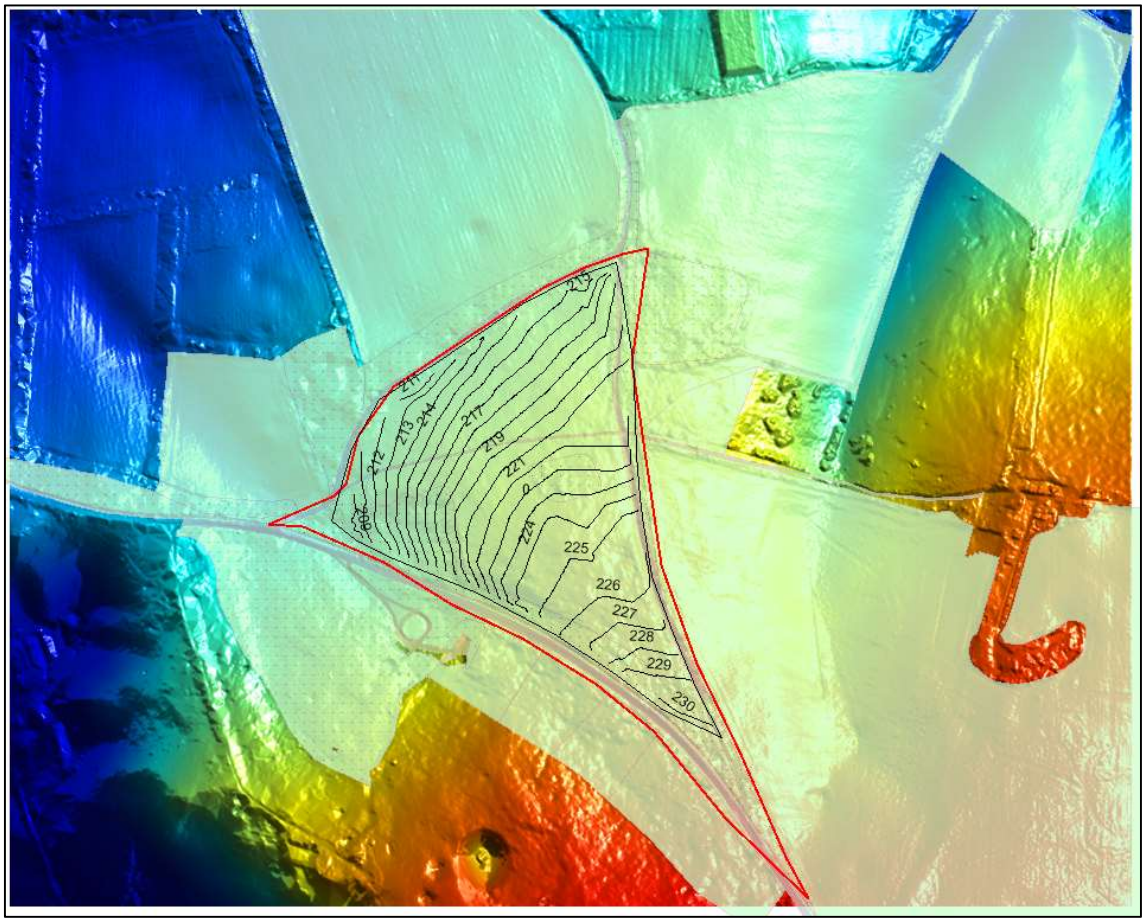

Figure 8: CES557 Limpsfield Existing Topography

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:

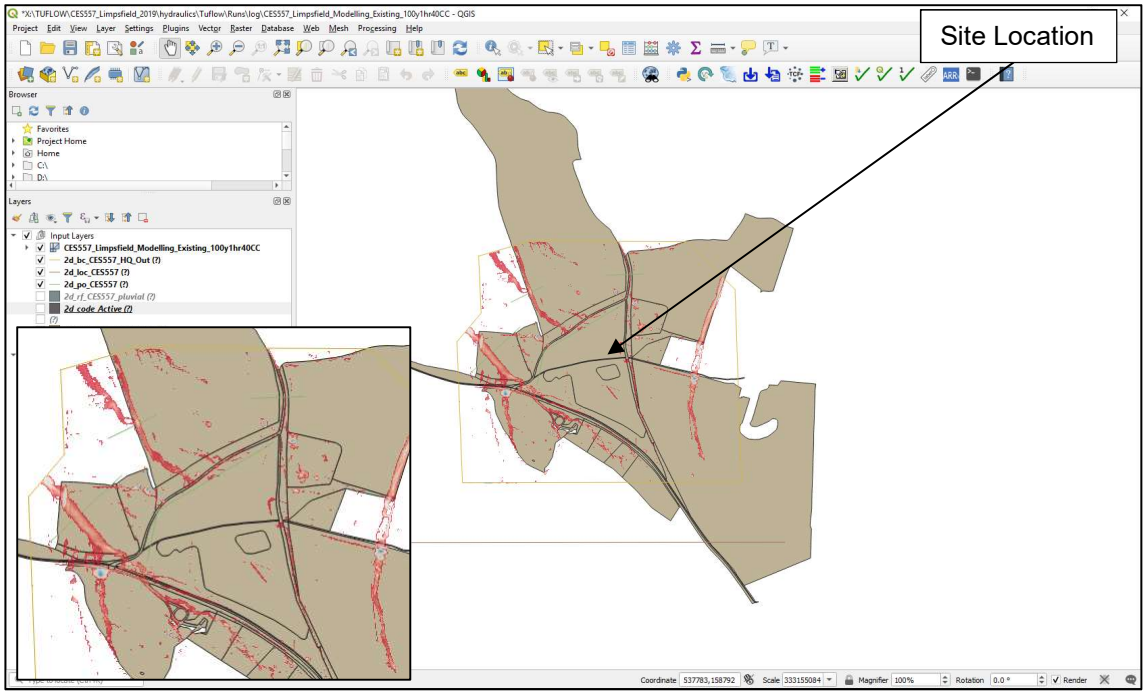

Figure 9: CES557 Limpsfield Existing 1in100yCC DMax

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.

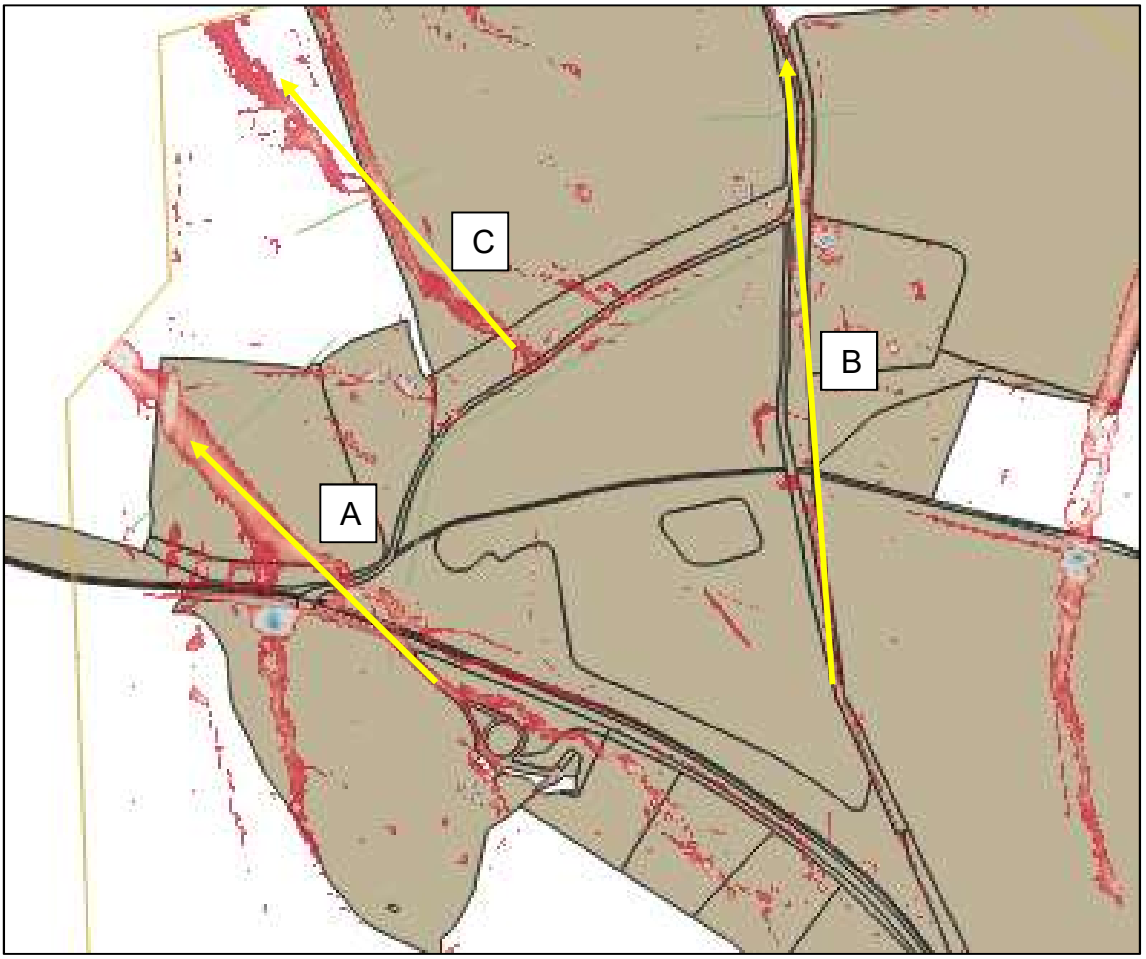

Figure 10: CES557 Limpsfield Existing Overland Flow Routes

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.

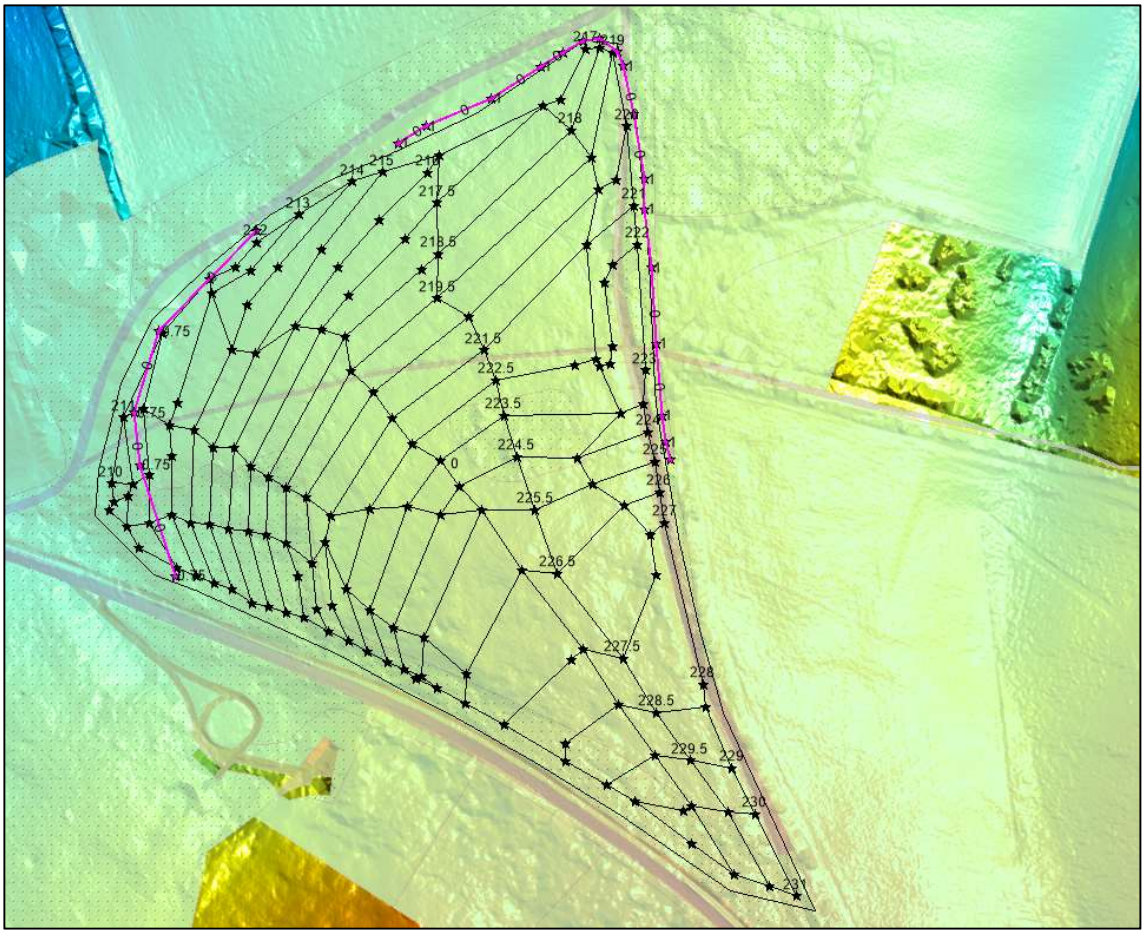

Figure 11: CES557 Limpsfield Proposed site Layout.

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.

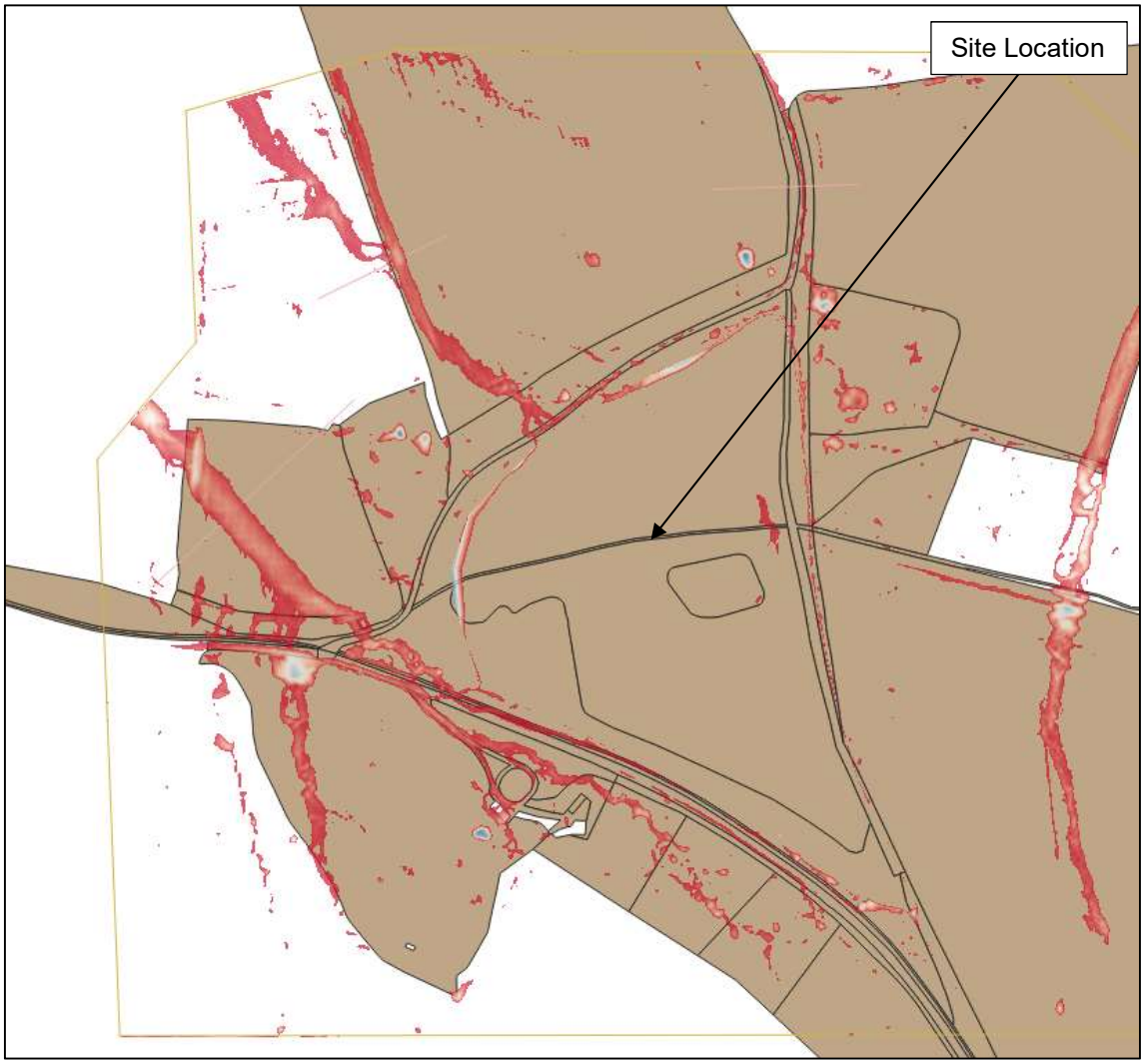

Figure 12: CES557 Limpsfield Proposed 1in100yearCC DMax

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.

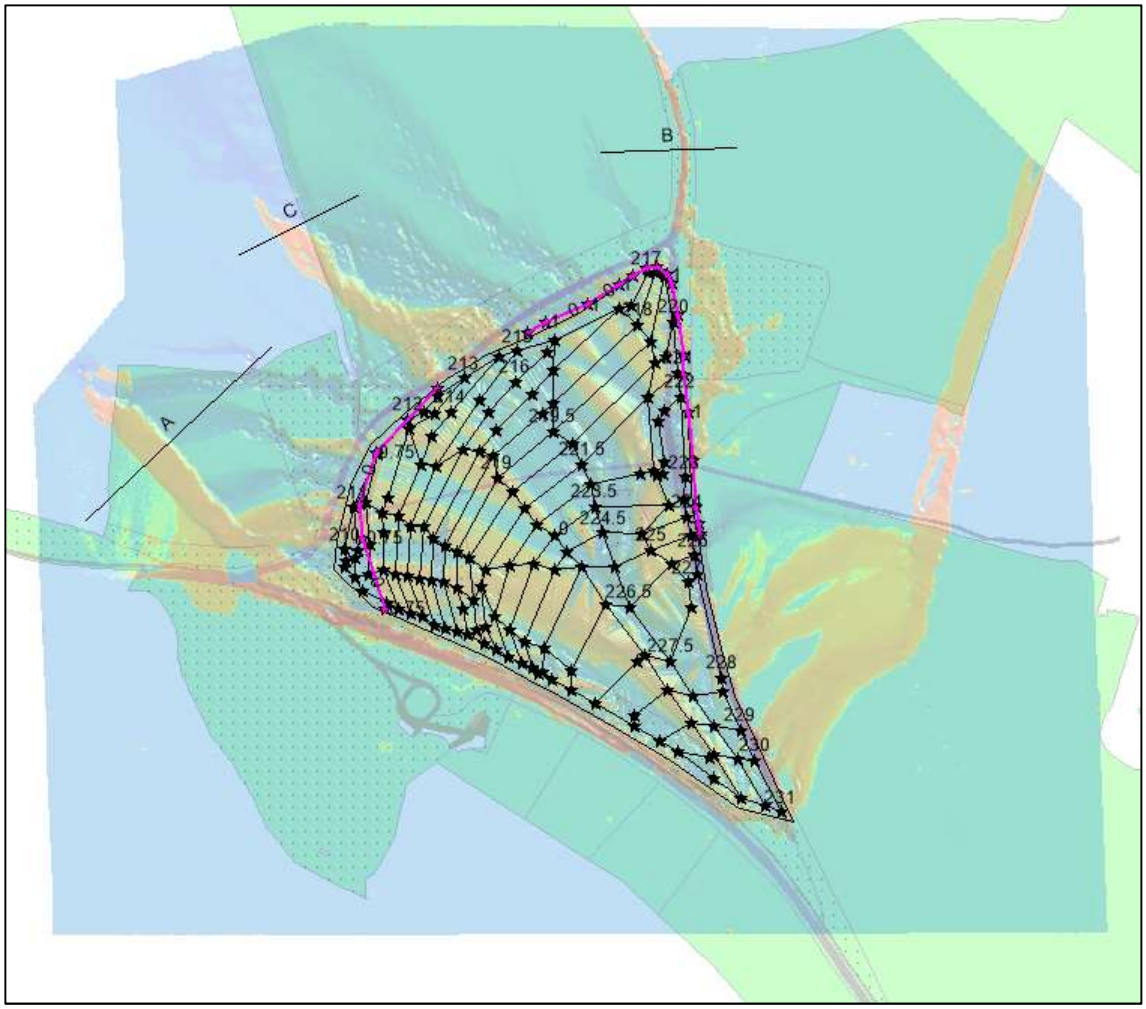

Figure 13: CES557 Limpsfield DMax Difference Model

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.

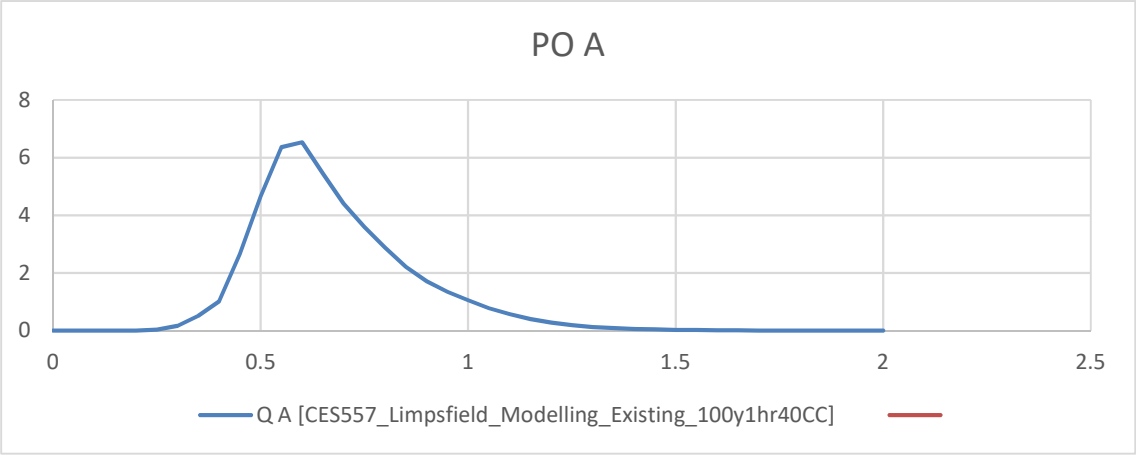

Figure 14: PO A

Of note, the X axis' units are time (hours) and the Y axis is flow in m^3/s

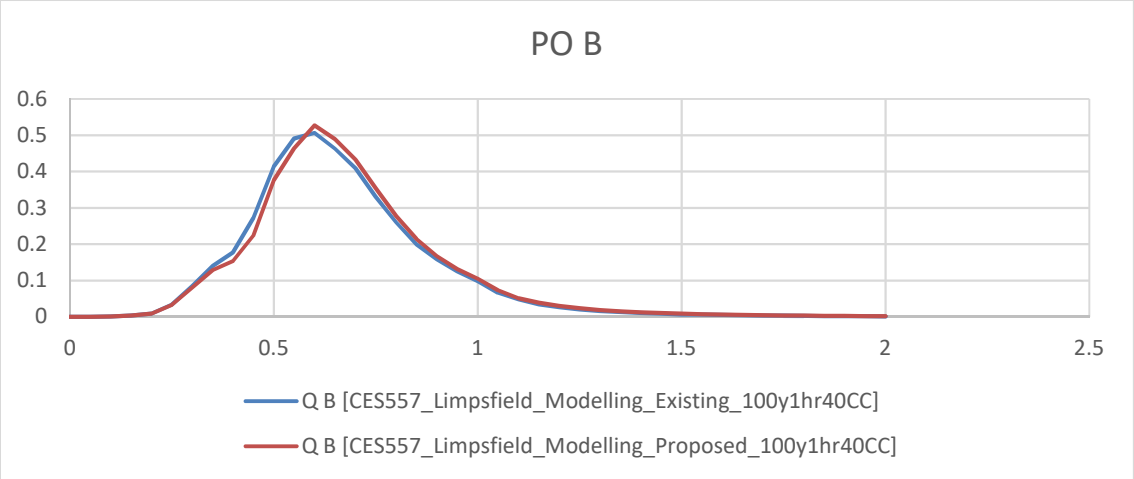

Figure 15: PO B

Of note, the X axis' units are time (hours) and the Y axis is flow in m^3/s

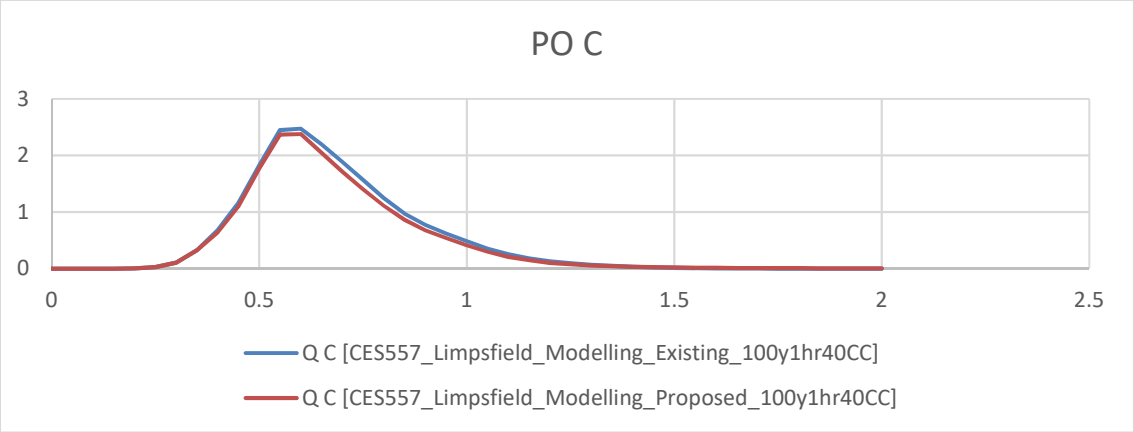

Figure 16: PO C

Of note, the X axis' units are time (hours) and the Y axis is flow in m^3/s

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

	Q Max Existing m^3/s	Q Max Proposed m^3/s	Difference m^3/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

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