

Flood Risk Assessment and SuDS Statement

November 2024

The logo consists of a dark blue square with the white text 'EAS' inside it.

EAS

**Hillcrest and Tussocks
The Causeway
Therfield**

Hanson Services Ltd

Document History

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The content of this report is based on information available as of November 2024, the validity of the statements made may therefore vary over time as planning guidance / policies and the evidence base change.

Contents

Contents	2
1 Introduction	4
2 Policy Context	5
Introduction	5
Local Policy	6
North Herts Local Plan 2011-2031	6
North Hertfordshire District Council Strategic Flood Risk Assessment 2008 (Updated in Sep 2016)	7
Hertfordshire Interactive Flood Risk Management Viewer	7
3 LLFA Comments Response	8
Response to LLFA comments dated 05/11/2024	8
4 Existing Site Assessment	14
Site Description	14
Local Watercourses	14
Site Levels	14
Geology	14
Infiltration Tests	14
Public Sewer Mapping	15
5 Potential Sources of Flooding	16
Fluvial	16
Surface Water	16
Reservoir	16
Groundwater	16
Sewer	16
Summary	17
6 Proposed SuDS Strategy	18
Relevant SuDS Policy	18
Surface Water Drainage Parameters	18
Pre-Development Runoff Rates and Discharge Volumes - Greenfield	19
Pre-Development Runoff Rates and Discharge Volumes - Brownfield	19
Post Development Runoff Rate	20
Site Specific SuDS	20
SuDS Hierarchy	21
Proposed SuDS Strategy	21
Exceedance Events	22
Water Quality	23
Sewer Diversion	24
7 Maintenance of Development Drainage	25
8 Conclusion	29
Flood Risk	29

SuDS Strategy	29
Maintenance of the Proposed Drainage System	30
Conclusion	30
Appendices	31
Appendix: A – Location Plan	32
Appendix: B – Proposed Plans	33
Appendix: C – EA Flood Map for Planning	34
Appendix: D – Topographic Survey	35
Appendix E – Infiltration testing results	36
Appendix F - Thames Water Asset Location Plan	37
Appendix G – Surface Water Flood Mapping	38
Appendix H – Causeway Flow Calculations	39
Appendix I – Proposed SuDS Layout	40
Appendix J – Downstream Defender Specification	41
Appendix: K – Brownfield Runoff Calculations	42
Appendix: L – Standard Construction Details	43
Appendix: M – Exceedance Flow Drawing	44

1 Introduction

- 1.1 EAS has been commissioned to provide a Flood Risk Assessment and SuDS report to inform a planning application for a residential development on land at Hillcrest and Tussocks, The Causeway, Therfield, SG8 9PP (Grid Ref: TL 33591 37377) (hereafter referred to as 'the site').
- 1.2 The full planning application is for the construction of 7 residential dwellings with associated landscaping and parking.
- 1.3 This report will directly address comments received from the Lead Local Flood Authority in relation to a withdrawn application at the site (planning reference: 23/02417/FP).
- 1.4 The site location plan is included in **Appendix A** and the proposed development plans are in **Appendix B**.
- 1.5 The site is wholly located in Flood Zone 1 on the Flood Map for Planning. Flood Zone 1 is defined as having a less than a 0.1% (1 in 1,000) annual probability of river flooding. The site is located outside of all modelled surface water flood extents. This report will assess all sources of flooding and detail mitigation measures where necessary.
- 1.6 This FRA also includes a surface water drainage strategy to demonstrate compliance with national and local policy requirements.
- 1.7 The contents of this FRA are based on the advice set out in the National Planning Policy Framework (NPPF) last updated December 2023, Annex 3: Flood risk vulnerability classification, also from the NPPF and PPG 'Guidance for Flood Risk and Coastal Change', updated in August 2022.
- 1.8 This report is based on the Environment Agency flood maps, geology mapping, OS mapping, topographic survey, Strategic Flood Risk Assessment, and national & local policy.
- 1.9 This document includes the following sections:
 - Section 2 - describes the relevant policy;
 - Section 3 – Responds to LLFA comments
 - Section 4 - site description, including site levels, proximity to watercourses etc.;
 - Section 5 - outlines potential sources of flooding;
 - Section 6 – details the proposed drainage strategy;
 - Section 7 – includes suitable maintenance and management measures;
 - Section 8 – summarises and concludes the report.

2 Policy Context

Introduction

2.1 This section sets out the policy context. This report is based on the advice set out in the National Planning Policy Framework (NPPF) last updated December 2023 and the Planning Practical Guidance (PPG) updated in August 2022.

2.2 Paragraph 173 footnote 59 of the NPPF states:

“A site-specific flood risk assessment should be provided for all developments in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.”

2.3 The flood zones are defined as:

- Flood Zone 1 - less than a 0.1% (1 in 1000) annual probability of river or tidal flooding.
- Flood Zone 2 - between a 0.1% and 1% (1 in 1000 and 1 in 100) annual probability of river flooding; or between a 0.1% and 0.5% (1 in 1000 and 1 in 200) annual probability of flooding from tidal sources.
- Flood Zone 3a- This zone comprises land assessed as having a 1% (1 in 100) or greater annual probability of river flooding; and for tidal flooding at least a 0.5% (1 in 200) annual probability of flooding from tidal sources.
- Flood Zone 3b - This zone comprises land where water has to flow or be stored in times of flood. This classification is usually classified as land which had a 3.33% (1 in 30) annual probability of flooding.

2.4 Paragraph 165 discusses the suitability of development location, particularly with regards to future risks induced by climate change:

“Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere”.

2.5 Paragraphs 175 NPPF discusses the application of sustainable drainage systems:

“Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

- a. *Take account of advice from the lead local flood authority;*
- b. *Have appropriate proposed minimum operational standards;*
- c. *Have maintenance arrangements in place to ensure an acceptable standard of operation of the lifetime of the development; and*

d. Where possible, provide multifunctional benefits.”

- 2.6 The site is shown to be located within the Flood Zone 1 on the Flood Map for Planning. Flood Zone 1 is defined as having a less than 0.1% annual probability of river flooding.
- 2.7 The EA Flood Map has been enclosed in **Appendix C**.

Local Policy

North Herts Local Plan 2011-2031

- 2.8 The North Herts Local Plan was adopted in November 2022. Relevant policies are included below for reference.
- 2.9 Policy NE7: Reducing Flood Risk

Planning permission for development proposals will be granted provided that (as applicable):

- a) Development is located outside of medium and high-risk flood areas (flood zone 2 and 3) and other areas affected by other sources of flooding where possible;*
- b) Where (a) is not possible, application of the sequential and exception tests is demonstrated where development is proposed in areas of flood risk using the Strategic Flood Risk Assessment (SFRA) and Environment Agency flood maps;*
- c) A FRA has been prepared in accordance with national guidance that considers the lifetime of the development, climate change impacts and safe access and egress; North Hertfordshire Local Plan 2011-2031 159*
- d) It will be located, designed and laid out to ensure the risk of flooding is reduced whilst not increasing flood risk elsewhere;*
- e) The impact of any residual flood risk will be minimised through flood resistant, resilient design and construction;*
- f) Any flood protection and mitigation measures necessary will not cause harm to nature conservation, heritage assets, and/ or landscape and recreation and, where possible, will have a positive impact in these respects; and*
- g) Overland flow routes and functional floodplain areas are protected from all development other than that which is “water compatible” and this must be designed and constructed to remain operational and safe for users during flood events, resulting in no net loss of flood plain storage and not impeding water flows or increasing flood risk elsewhere.*

- 2.10 Policy NE8: Sustainable Drainage Systems

Planning permission for development will be granted provided that:

- a) The most appropriate sustainable drainage solution is used taking into account technical, viability and design issues to reduce the risk of surface water flooding, enhance biodiversity, water quality and provide amenity benefits;*
- b) It aims to mimic the natural drainage patterns and processes as far as possible; and*

c) *Drainage solutions follow the SuDS hierarchy.*

North Hertfordshire District Council Strategic Flood Risk Assessment 2008 (Updated in Sep 2016)

- 2.11 The North Hertfordshire SFRA was updated in 2016 as a result of improved accuracy of mapping information following the 2008 document.
- 2.12 In both the original and updated SFRA, the site has not been specifically detailed to have experienced historic fluvial flooding or sewer flooding.

Hertfordshire Interactive Flood Risk Management Viewer

- 2.13 Hertfordshire provides an interactive mapping website which displays the difference sources of flood risk across Hertfordshire County. The result of this mapping in relation to the proposed site is outlined below.
- 2.14 The interactive map can be viewed here:
<https://webmaps.hertfordshire.gov.uk/waterman/index.htm>.
- 2.15 The mapping confirms the site is located in Flood Zone 1.
- 2.16 There are no Hertfordshire County Council recorded incidents of flooding at the site. There is a recorded incident of flooding approximately 200m south of the site within Police Row however no further details have been provided.
- 2.17 There are no 'Main Rivers' or 'Ordinary Watercourses' at or within the vicinity of the site.
- 2.18 The site is not located within a 'Surface Water Management Plan Hotspot'.
- 2.19 The site remains outside the 30yr, 100yr and 1000yr modelled surface water flood extents.
- 2.20 The site is not located in an area considered to be susceptible to groundwater flooding.

3 LLFA Comments Response

Response to LLFA comments dated 05/11/2024

- 3.1 A consultation response was received from the LLFA, dated 05/11/2024. Please find below the response to these comments, with the comments shown in grey italics and EAS responses in blue text.

1. Further clarification and evidence that the drainage discharge hierarchy has been correctly followed. In light of further infiltration testing, it has been determined that discharge via infiltration will not be viable.

a. The LLFA requires the applicant to evidence that the drainage discharge hierarchy has been correctly followed, deep bore soakaways should not be used unless all the discharge methods higher up the discharge hierarchy have been sufficiently discounted.

- 3.2 The drainage discharge hierarchy is detailed in the section 6.14-6.16 of the updated FRA, where we have clarified that both shallow and deep infiltration testing show infiltration to not be suitable and there are no watercourses or surface water sewers in the area. As such, the only remaining option is to discharge to the foul water sewer. We are currently in discussions with Thames Water regarding this proposed connection.

b. The LLFA requires further infiltration testing, in the proposed locations, up to depths of 23m to be carried out and submitted (it is noted that the FRA states it will be updated once this infiltration testing is completed) to demonstrate the suitability of deep bore soakaways.

- 3.3 Further infiltration testing was undertaken and included in the updated FRA demonstrating that deep bore soakaways will not be suitable. Infiltration test results are discussed in section 4.11-4.18.

c. The LLFA requires evidence as to why deep bore soakaways have been chosen over shallow infiltration in the location of TP05.

- 3.4 Infiltration is no longer proposed as the shallow and deep infiltration testing show infiltration to not be suitable. Flows are now to discharge at a restricted rate to the foul water sewer.

2. Further clarification is required over the proposed infiltration rates.

As discussed in the updated FRA, following further infiltration testing, it has been deemed unfeasible to utilise infiltration as a discharge method. As detailed in section 6.12 “Borehole tests produced a relatively poor infiltration rate of 1.86×10^{-6} m/s. Considering the proposed site layout, there would only be space available to provide two borehole soakaways, whilst achieving required distances to the proposed dwellings. When modelled with the measured infiltration rates, this resulted in a discharge rate equivalent to 0.023l/s. As such, when tested in the drainage software Causeway Flow, it was found that it would not be possible to size on-site attenuation sufficiently large enough to support the use of borehole soakaways, nor meet half-drain times, with half-drain times of over a week.”

3. Further information relating to the permeable paving.

a. Cross sections of all permeable paving (please include the attenuation tanks for clarity)

- 3.5 A standard details drawing is provided in **Appendix L**. Subbase depths are variable from 350mm up to 600mm, with depths for each area outlined on the SuDS layout drawing in **Appendix I**.

b. Invert and cover levels of the permeable paving.

- 3.6 The permeable paving cover and invert levels are outlined on the SuDS layout drawing in **Appendix I**.

c. How the permeable paving drains. The LLFA notes the use of diffuser drains but requires clarification as why some appear to have an orifice plate, but others don't.

- 3.7 The permeable paving are to drain via diffuser units into the piped network, with orifice plates proposed where necessary to optimise subbase storage. A connection detail is shown on the standard details drawing contained in **Appendix L**.

d. Is the permeable paving a lined system.

- 3.8 The permeable paving is to be lined.

e. Where the permeable paving drains to.

- 3.9 The permeable paving is to drain into the piped network via diffuser units.

f. What volume of water will be stored within the permeable paving.

- 3.10 The combined permeable paving storage volume is 59.1m³.

g. Ensure that all areas of permeable paving are accurately accounted for within the calculations.

- 3.11 All areas of permeable paving are accounted for in calculations.

h. The LLFA notes that there is a large area on the Surface Water Drainage Strategy Drawing (DR01) (14 June.2024) that is allocated as permeable paving, however, on the Outline Landscape Proposals drawing (PR271-01) (22.10.2024) this is now proposed as macadam and asphalt surfacing. Please can the applicant provide clarification as to the final surface material as this will have an impact on the drainage strategy and layout.

- 3.12 The permeable paving surfacing can be any surfacing with suitable permeability. The surfacing is to be block paving, porous macadam and porous asphalt as detailed in the Landscape proposal.

4. Further information relating to the attenuation tanks.

a. Cross sections of all attenuation tanks (please include the permeable paving for clarity).

- 3.13 A standard details drawing is provided in **Appendix L**.

b. Invert and cover levels of the attenuation tanks.

3.14 Cover, Soffit and Invert levels are provided on the SuDS layout drawing in **Appendix I**.

c. How the attenuation tanks are connected into the drainage system – both inflow and outflow locations.

3.15 Attenuation storage tanks are to be connected via the piped network. Inlet and Outlet location are marked on the SuDS layout drawing in **Appendix I**.

d. What volume of water will be stored within the attenuation tanks.

3.16 The attenuation storage tank volume is 140.7m³.

5. Clarifications on the design of the drainage network shown on the Surface Water Drainage Strategy Drawing (DRD1).

a. How will the drainage strategy ensure that there is no increased risk of flooding off site – how will the drainage strategy keep all surface water on site. It is noted that the access road slopes down towards the main road, and while made up of permeable paving, what happens when the permeable paving is at maximum capacity, does surface water flow offsite?

3.17 Brownfield runoff rates are discussed in Section 6.7-6.8. This demonstrates that although the proposed development will increase impermeable area, the discharge rate from the site will be reduced. A summary table of discharge rates in all storm events is included below, comparing only the existing brownfield impermeable (not including greenfield runoff rates) and proposed impermeable.

	Existing Runoff (l/s)	Proposed Runoff (l/s)
1 in 1	3.9	0.6
1 in 30	11.0	0.8
1 in 100	13.9	0.9
1 in 100yr+40%CC	-	1.0

This demonstrates that the proposal will reduce the risk of flooding off-site.

In the case of an exceedance event above the 1 in 100 + 40%CC storm event, runoff will be contained by kerbs within the road area and will follow the road, discharging onto the Causeway, as per the existing situation

b. Why are there two MH1's on the drawing? The one to the north of the site, and one in a central location near the southern storage tank.

3.18 This has been rectified in the updated FRA.

c. What are the sizes of the deep bore soakaways (if chosen to be the final method of discharge).

3.19 Deep borehole soakaways are no longer included.

d. How will the drainage strategy ensure that the deep bore soakaways (if chosen to be the final method of discharge) are able to infiltrate an equal rate considering the network requires all surface water to go via the southern deep bore soakaway.

3.20 Deep borehole soakaways are no longer included.

e. What is the runoff rate for the Plots 4, 5, 6 and 7. There is no information in the calculations as to the drainage for these plots.

3.21 The primary drainage network has been modelled. Minor pipework connecting the houses into the permeable paving has not been modelled as this is an excessive amount of detail for a planning application. These pipes have been designed in accordance with building regs using 150mmdia pipes, which will be more than sufficient to manage the areas of runoff from these plots.

Plots 4, 5, 6 and 7 roof areas and urban creep has been applied directly to their respective areas of permeable paving. This is a more conservative approach, as the inspection chambers and pipes of the minor pipework will slow the arrival of surface water into the permeable paving and provide a certain volume of storage.

f. Why are only 11 manholes included within the calculations when there appear to be 18?

3.22 The primary drainage network has been modelled. Minor pipework connecting the houses into the permeable paving has not been modelled as this is an excessive amount of detail for a planning application.

g. All drainage network features must be labelled to match those within the calculations.

3.23 Minor pipework has been added to the drawing in **Appendix I**.

h. The LLFA notes that there is a large area on the Surface Water Drainage Strategy Drawing (DR01) (14.06.2024) that is allocated as permeable paving, however, on the Outline Landscape Proposals drawing (PR271-01) (22.10.2024) this is now proposed as macadam and asphalt surfacing. The applicant is required to provide clarification as to the final surface material as this will have an impact on the drainage strategy and layout.

3.24 As detailed above, the permeable paving surfacing can be any surfacing with suitable permeability. The surfacing is to be block paving, porous macadam and porous asphalt as detailed in the Landscape proposal.

6. Further information within the calculations.

a. 50% (2 year) return period.

3.25 This has been included in **Appendix H** of the updated FRA.

b. 3.33% (30 year) return period (with and without climate change allowance).

3.26 This has been included in **Appendix H** of the updated FRA.

c. Confirmation as to whether the car ports have been included within the impermeable area.

3.27 Car ports are included in the impermeable area calculation, discharging to the adjacent permeable paving using rainwater downpipes fitted with a shoe. A detail for this is included in the standard details drawing provided in **Appendix L**.

d. Use of the most conservative infiltration rate based on the infiltration testing that has been or is being undertaken. If using deep bore infiltration, testing must be carried out at the proposed depth to provide an accurate rate.

3.28 Infiltration is no longer proposed.

e. Confirmation as to whether the permeable paving is lined as this will determine whether the half drain down time requires are 24 hours or 48 hours. If the permeable paving is lined, a 48 hour half drain down time is accepted, if it is unlined, then a 24 hour half drain down time is the requirement.

3.29 The permeable paving will be lined. Half drain times for all devices remains below 24 hours.

f. All nodes are required to be included within the calculations to provide an accurate representation of any flooding or surcharging within the network i.e. if the permeable paving is at capacity, will the inflow from plots 4, 6 and 7 cause flooding?

3.30 The primary drainage network has been modelled. Minor pipework connecting the houses into the permeable paving has not been modelled as this is an excessive amount of detail for a planning application. These pipes have been designed in accordance with building regs using 150mmdia pipes, which will be more than sufficient to manage the areas of runoff from these plots.

Plots 4, 5, 6 and 7 roof areas and urban creep has been applied directly to their respective areas of permeable paving. This is a more conservative approach, as the inspection chambers and pipes of the minor pipework will slow the arrival of surface water into the permeable paving and provide a certain volume of storage.

The drainage has been designed to manage all storm events up to and including a 1 in 100 + 40%CC storm event. In an exceedance event, as Plots 4, 5, 6 and 7 will sit higher than the permeable paving they are connecting into, should an exceedance event occur, water will be drained away from the properties and back up and out of the permeable paving. Flows would be contained within the road areas and be directed towards The Causeway.

7. Further information on any exceedance flooding, flow paths and ponding areas. The applicant is required to submit a drawing which demonstrates any exceedance flooding from the drainage network. This will need to include the areas in which flood waters will be stored, the depth of any flood water and any exceedance flow arrows. This drawing will also need to include the finished floor levels and finished ground levels.

3.31 Exceedance flow routes are shown with the drainage strategy in **Appendix I** of the updated FRA. A separate drawing is also included in **Appendix M** to ensure clarity.

In an exceedance event, waters will backup through the permeable paving and run along its surface. This will then be contained within the road areas and be directed towards The Causeway.

8. Clarification of the ground floor finished floor levels showing sufficient freeboard and mitigation in relation to flood levels, maximum design water levels and proposed external ground levels. The applicant is required to submit a drawing showing the finished floor levels and the finished ground levels of the whole development. This drawing must show a sufficient level of freeboard to provide suitable mitigation. The requirements are 150mm freeboard between the floor level and any proposed external ground levels and 300mm between the finished floor level and any design water or flood level.

- 3.32 Finished Floor Levels have been provided by the architect and are included in **Appendix I**. Indicative road levels are also shown by the cover levels of the drainage strategy.

9. Information on the maintenance requirements for the deep bore soakaways (if this is chosen as the final discharge method). The LLFA notes the submission of the maintenance requirements for all other features of the drainage network. The LLFA notes there are no specific requirements outlined with the SuDS Manual for Deep Bore Soakaways, however, as it appears that the soakaways are located within the rear garden of plot 5, the applicant is required to submit information on the accessibility and arrangements for if the deep bore soakaway is to fail to ensure that there is no increased flood risk to plot 5 and the wider development.

- 3.33 Deep borehole soakaways are no longer included. Maintenance requirements for each SuDS device are provided in Section 7.

4 Existing Site Assessment

Site Description

- 4.1 EAS has been commissioned to provide a Flood Risk Assessment and SuDS report to inform a planning application for a residential development on land at Hillcrest and Tussocks, The Causeway, Therfield, SG8 9PP (Grid Ref: TL 33591 37377). The site location plan is included in **Appendix A**.
- 4.2 Proposals consist of the construction of 7 dwellings. The proposed development plans are in **Appendix B**.
- 4.3 The site currently consists of a two-storey residential dwelling and ancillary buildings with grassed areas and areas of hardstanding.
- 4.4 The site is bound to the north and west by residential dwellings. To the south the site is bound by a school with residential dwellings beyond. To the east the site is bound by undeveloped agricultural land.

Local Watercourses

- 4.5 A pond is located to the immediate south-east of the site. Whilst the topographical survey did not identify any incoming pipes or headwalls, it is assumed that the pond currently serves the existing property.
- 4.6 There are no 'Ordinary Watercourses' or 'Main Rivers' within the site or within the vicinity of the site.
- 4.7 There are no other large waterbodies e.g. reservoirs within the vicinity of the site.

Site Levels

- 4.8 The topographic survey is included in **Appendix D**. The site falls from around 167.5mAOD in the north-eastern corner to around 162.0mAOD in the south-western corner. This results in an average fall across the site of 1 in 17.
- 4.9 The dwellings are primarily proposed in areas between 167mAOD and 164mAOD.

Geology

- 4.10 With reference to the British Geological Survey, the site is located within an area with a bedrock of Lewes Nodular Chalk Formation and Seaford Chalk Formation – chalk with superficial deposits of Lowestoft Formation - Diamicton.

Infiltration Tests

- 4.11 Infiltration tests were first undertaken in April 2023 and the investigation report is enclosed in **Appendix E**. A total of 5 trial pits were dug varying in depth from 1.8m to 2.2m.

- 4.12 Topsoil was present to a maximum depth of 0.55mbgl at TP01, TP02 and TP04 and is described as being 'dark brown slightly gravelly clay with rootlets'. Made ground was present at surface level at TP03 and TP05 with the base of the made ground layer reaching a maximum depth of 1mbgl at the location of TP04. Lowestoft Formation was present at all trial pit locations and was present to a maximum depth of 2.2m below ground level at TP05. Groundwater was not encountered in all 5 trial pits.
- 4.13 Infiltration tests were conducted in line with BRE Digest 365 and for 4 out of the 5 pits, only a single test was able to be performed due to poor infiltration rates. Testing was carried out for the required 3 times at TP05.
- 4.14 TR05 was dug to a depth of 2.2m and at around 0.8m below ground level a layer of 'structureless white chalk' was discovered. TP04 also recorded the presence of 'coarse chalk' at a depth of 1m below ground level. The slowest rate recorded was 4.29×10^{-6} m/s.
- 4.15 As the majority of the trial pits failed, pursuing a shallow infiltration strategy is not considered to be viable. Nonetheless, the presence of chalk suggests a borehole strategy could be feasible.
- 4.16 Initial borehole infiltration tests undertaken on-site on 31st July 2024 failed, as they were not deep enough to fully reach the chalk layer, at 14m below ground level. As such three further falling head permeability tests were carried out with the aim of targeting the Lewes Nodular Chalk Formation and Seaford Chalk Formation. The infiltration tests were undertaken following installation of the borehole, based on a modified BRE Digest 365 (Soakaway Design, 2016) methodology. The borehole was filled with clean water and was allowed to drain on the same day. The deeper borehole infiltration test results are included in **Appendix E**.
- 4.17 The deeper borehole infiltration tests, undertaken on 30th September 2024 in the same location as the proposed boreholes, shows topsoil to a depth of 0.10m below ground level, Lowestoft Formation Clay to a depth of 14.10m bgl, with Lewes Nodular Chalk Formation and Seaford Chalk Formation beyond, consisting of White with occasional orange brown discoloured CHALK recovered as structureless low density chalk gravel in silt.
- 4.18 The testing produced a minimum relatively poor soakage rate of 1.86×10^{-6} m/s, which is slightly above the minimum rate recommended for typical infiltration devices – i.e. soakaways and permeable paving. Unfortunately, when tested as part of the SuDS design this rate was not sufficient to utilise borehole soakaways on-site. This is discussed further in Section 5.

Public Sewer Mapping

- 4.19 Thames Water sewer mapping was obtained and is enclosed in **Appendix F**.
- 4.20 There are no adopted surface water sewers within the local area.
- 4.21 A 50mmdia combined rising main is present across the northern half of the site and flows west into MH5302 (CL:165.24 IL:163.91) in the north-western corner of the site.
- 4.22 A 150mmdia foul sewer flows south within The Causeway.

5 Potential Sources of Flooding

Fluvial

- 5.1 A copy of the Environment Agency's Flood Map for Planning is enclosed in **Appendix C**. The site is shown to be wholly located in Flood Zone 1. Flood Zone 1 is defined as having a less than 0.1% annual probability of river flooding (1 in 1000).

Surface Water

- 5.2 Surface water flooding refers to flooding caused when the intensity of rainfall, particularly in urban areas, can create runoff which temporarily overwhelms the capacity of the local drainage systems or does not infiltrate into the ground. The water ponds on the ground and flows towards low-lying land. This source of flood risk is also known as 'pluvial'.
- 5.3 The EA long term risk maps (available on the GOV.UK website) show the site remains outside all modelled surface water flood extents. The low-risk scenario indicates an annual probability of surface water flooding between 1% and 0.1%, (i.e. the least frequent but worst-case scenario). In this scenario there is limited flooding within The Causeway with depths below 300mm to the south of the site access and as such access and egress will continue to be available.
- 5.4 A copy of the Long-Term Flood Map is enclosed in **Appendix G**.

Reservoir

- 5.5 The site is not located within a reservoir flood extent on the Long-Term Flood Map.

Groundwater

- 5.6 Onsite investigations did not encounter groundwater and the Hertfordshire Interactive Flood Risk Management Viewer revealed the site is not in a location where there is a susceptibility to groundwater flooding.
- 5.7 With reference to Defra's Magic Map (available at: <https://magic.defra.gov.uk/magicmap.aspx>) the site is located above a Principal Aquifer. A Principle Aquifer is defined as:
- "strategically important rock units that have high permeability and water storage capacity"*
- 5.8 The site is located in an area with medium to high groundwater vulnerability and a soluble rock risk is also present. A geotechnical engineer alongside further borehole investigations and confirmation of the chalk density will inform the parameters in which a borehole soakaway would need to be installed.
- 5.9 The sustainable drainage system will need to ensure sufficient treatment stages are present to manage pollution from runoff and to prevent the mobilisation of pollutants that could find a pathway to the groundwater.

Sewer

- 5.10 The closest manhole to the site located within The Causeway is MH5301 and this has a cover level of 163.73mAOD. Levels within the site and in the location of the proposed properties ranging from 164mAOD up to 167mAOD and therefore should a sewer flood occur, flows would remain within the carriageway and would be unable to flow into the site.
- 5.11 There is a residual risk posed by the diverted foul rising main within the site. The indicative diversionary route is via the internal access road therefore should a sewer flood occur flows may remain within the carriageway. However, all properties have a finished floor level 150mm above the surrounding ground level providing a level of protection.

Summary

- 5.12 The site is considered to be at low risk of all assessed sources of flooding and no specific mitigation measures are considered to be required.

6 Proposed SuDS Strategy

Relevant SuDS Policy

- 6.1 SuDS mimic natural drainage patterns and provide a method of surface water drainage which can decrease the quantity of water discharged, and hence reduce the risk of flooding. SuDS design should meet the “four pillars” of SuDS of: water quantity, water quality, amenity and biodiversity, wherever possible.
- 6.2 The SuDS management train incorporates a hierarchy of techniques and considers all three SuDS criteria of flood reduction, pollution reduction, and landscape and wildlife benefits. In decreasing order of preference, the preferred means of disposal of surface water runoff is:
 - Discharge to ground.
 - Discharge to a surface water body.
 - Discharge to a surface water sewer.
 - Discharge to a combined sewer.
- 6.3 The philosophy of SuDS is to replicate as closely as possible the natural drainage from a site predevelopment and to treat runoff to remove pollutants, resulting in a reduced impact on the receiving watercourses. The benefits of this approach are as follows:
 - Reducing runoff rates, thus reducing the flood risk downstream;
 - Reducing pollutant concentrations, thus protecting the quality of the receiving water body;
 - Groundwater recharge;
 - Contributing to the enhanced amenity and aesthetic value of development areas; and
 - Providing habitats for wildlife in developed areas, and opportunity for biodiversity enhancement.

Surface Water Drainage Parameters

- 6.4 The following best practice design parameters have been considered:
 - The local 2070s ‘Upper End’ Climate Change allowance is 40% and has been applied to the hydraulic drainage network design.
 - The Hydraulic Model has been for a 1:2yr Storm Event, 1:30yr Storm Event, 1:30yr + 40% Climate Change Event, 1:100yr Storm Event and 1:100yr + 40% Climate Change Storm Event.
 - FEH22 rainfall data has been used.
 - The CV Value for Winter and Summer storms has been set to 1.0.

- A 5min time of entry has been used.
- 10% urban creep allowance has been applied to the roof area, totalling 60.7m².
- Half-Drain Time – In line with Hertfordshire’s LLFA Guidelines, lined devices (tanks and lined ponds, lined permeable paving) to half-drain within 48hrs (2880mins) and unlined devices are to half-drain in 24 hrs (1440 mins).
- Exceedance Routes – Exceedance routes shall be demonstrated.
- For the Pre and Post Discharge Volumes and Long-Term Storage – Non-Statutory Technical Guidance Policy S4 States: *“Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.”*
- Policy S5 States: *“Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event but should never exceed the runoff volume from the development site prior to redevelopment for that event. “*
- Policy S6 States: *“Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.”*

Pre-Development Runoff Rates and Discharge Volumes - Greenfield

6.5 The current site consists of 1 two storey General housing unit (62m²), with 2 brick outbuildings with a total area 181.1m². Brownfield runoff rates were estimated on the Causeway Flow software. The results of which are included in **Appendix H**. The proposed impermeable area of the site is 0.1785ha, the following greenfield runoff rates for a range of storm events have been scaled accordingly:

- 1 in 2 year – 4.8l/s/ha – 0.9 l/s
- 1 in 30 year – 13.1l/s/ha – 2.3 l/s
- 1 in 100 year – 17.0l/s/ha – 3.0 l/s

6.6 Greenfield runoff volumes in the 1 in 100 year, 360 minute storm scenario is 35.1m³.

Pre-Development Runoff Rates and Discharge Volumes - Brownfield

6.7 Greenfield runoff rates were estimated using the ReFH2 method on the Causeway Flow software. The results of which are included in **Appendix K**. This provides the following brownfield runoff rates for a range of storm events:

- 1 in 2 year – 3.9 l/s

- 1 in 30 year – 11.0 l/s
- 1 in 100 year – 13.9 l/s

6.8 Brownfield runoff volumes in the 1 in 100 year, 360 minute storm scenario is 16.2m³.

Post Development Runoff Rate

6.9 The proposals seek to match Greenfield Runoff Rate as closely as possible for all Storms up to and including the 1:100yr + 40% Climate Change Event. The proposed maximum outfall rates are as follows (see Causeway Flow results in **Appendix H**):

- 1 in 2 year – maximum 0.6 l/s
- 1 in 30 year – maximum 0.8 l/s
- 1 in 30 year + 40% Climate Change – maximum 0.9 l/s
- 1 in 100 year – maximum 0.9 l/s
- 1 in 100 year + 40% Climate Change – maximum 1.0 l/s

6.10 It can be seen that the greenfield rates have been improved upon.

6.11 The model results included in **Appendix H** shows that the maximum outfall volume for the proposed drainage strategy for a 1 in 100-year 360min storm is 121.6m³.

6.12 Despite not achieving the target of remaining below the pre-development runoff volume, in regard to policy S5 and S6 from the Non-Statutory Technical Guidance, since the overall runoff rate out of the system will be discharged at a rate that does not adversely affect flood risk, this is not deemed to be a significant issue.

Site Specific SuDS

6.13 The various SuDS methods have been considered in relation to site-specific constraints. Table 6.1 outlines the constraints and opportunities to each of the SuDS devices in accordance with the hierarchical approach outlined in The SUDS Manual CIRIA C753. It also indicates what could and could not be incorporated within the development, based upon site-specific criteria.

Device	Description	Constraints / Comments	Appropriate
Living roofs (source control)	Provide soft landscaping at roof level which reduces surface water runoff.	Not suitable for the pitch of residential roofs.	No
Infiltration devices & Soakaways (source control)	Store runoff and allow water to percolate into the ground via natural infiltration.	Not viable.	Yes
Pervious surfaces (source control)	Storm water is allowed to infiltrate through the surface into a storage layer, from which it can either infiltrate and/or slowly release to sewers.	Where site levels allow, lined permeable paving has been proposed.	Yes

Rainwater harvesting (source control)	Reduces the annual average rate of runoff from the Site by reusing water for non-potable uses e.g., toilet flushing, recycling processes.	Water butts are proposed to the rear of each property.	Possibly
Swales (permeable conveyance)	Broad shallow channels that convey / store runoff, and allow infiltration (ground conditions permitting).	Not proposed.	No
Filter drains & perforated pipes (permeable conveyance)	Trenches filled with granular materials (which are designed to take flows from adjacent impermeable areas) that convey runoff while allowing infiltration.	Not proposed .	No
Infiltration basins (end of pipe treatment)	Depressions in the surface designed to store runoff and allow infiltration.	Spatial constraints and poor shallow infiltration rates means this feature has not been proposed.	No
Wet ponds & constructed wetlands (end of pipe treatment)	Provide water quality treatment & temporary storage above the permanent water level.	Spatial constraints means this feature has not been proposed	No
Attenuation Underground (end of pipe treatment)	Oversized pipes or geo-cellular tanks designed to store water below ground level.	Attenuation storage tanks are proposed where necessary.	Yes
Raingardens	Rain gardens are relatively small depressions in the ground that can act as infiltration points for roof water and other 'clean' surface water.	A raingarden planter has been proposed for each property	Yes

Table 6.1 - Site-Specific Sustainable Drainage Techniques

SuDS Hierarchy

- 6.14 As noted in Section 4, there is a lack of watercourses and no adopted surface water sewers in the local area. As such shallow and borehole infiltration testing was undertaken at the site. The majority of the shallow infiltration testing failed. Borehole tests produced a relatively poor infiltration rate of 1.86×10^{-6} m/s.
- 6.15 Considering the proposed site layout, there would only be space available to provide two borehole soakaways, whilst achieving required distances to the proposed dwellings. When modelled with the measured available infiltration rates, this resulted in a discharge rate equivalent to 0.023l/s. As such, when tested in the drainage software Causeway Flow, it was found that it would not be possible to size on-site attenuation sufficiently large enough to support the use of borehole soakaways, nor meet half-drain times, with half-drain times of over a week.
- 6.16 On this basis, the only option available to outfall the runoff from the site is to the local adopted Thames Water Foul Water sewer.

Proposed SuDS Strategy

- 6.17 As outlined in Table 6.1 above, several SuDS Features shall be utilised to form the Surface Water Drainage Strategy to meet the 4 Pillars of SuDS.

- Water Quantity – Permeable Paving, Attenuation Storage Tanks, Raingarden Planters and Rainwater Harvesting Butts;
- Water Quality – Permeable Paving, Raingarden Planters and Rainwater Harvesting Butts;
- Biodiversity – Raingarden Planters.
- Amenity – Raingarden Planters.

- 6.18 The proposed strategy consists of directing roof runoff into permeable paving subbase where possible. All road areas are to be permeable paving, split into 4 sections based on the site topography. To provide further attenuation, two geo-cellular storage tanks are proposed.
- 6.19 The permeable paving is to provide 59.1m³ of storage and the attenuation tanks provide 140.7m³ of storage. This storage is sufficient to manage all storm events up to and including a 1 in 100 + 40%CC storm event. The Causeway Flow outputs are included in **Appendix H** and the proposed SuDS layout is contained in **Appendix I**.
- 6.20 A 20mm orifice is proposed to restrict the runoff from each area of permeable paving. The final outfall will be restricted via a 21mm orifice plate with a suitable filter to achieve a discharge rate of 1.0l/s in a 1 in 100 + 40%CC storm event.
- 6.21 The attenuation features within the site meet the requirements to half drain within 24hrs following a 100yr plus 40% climate change storm event. As such no additional long-term storage is required.
- 6.22 A Thames Water foul water rising main is present through the northern half of the site. As two dwellings are proposed on the route of this rising main, a diversion is proposed running to the south of plot 5 and along the road, reconnecting to the existing sewer within the road to the west of the site. A final demarcation chamber is proposed between the adopted rising main and gravity system prior to the connection to the Thames Water gravity sewer in The Causeway.
- 6.23 It is proposed to outfall SuDS system to the Thames Water foul water sewer, at the position of the proposed relocated demarcation chamber. As noted above, the proposals seek to match as closely as possible the 1:2yr Greenfield Runoff Rate, achieving a discharge rate of 1.0l/s for all Storms up to and including the 1:100yr + 40% Climate Change Event. To restrict the runoff a final control chamber with a 21mm orifice plate, with suitable filter, will be provided prior to the outfall.
- 6.24 A Thames Water pre-app is underway to confirm a discharge rate of 1l/s to the foul water sewer.

Exceedance Events

- 6.25 The proposed surface water drainage strategy is designed to accommodate a 1:100yr + 40% climate change storm event. In the unlikely scenario where a storm event exceeds in excess of a 1 in 100 + 40%CC storm event, exceedance flows shall be directed away from the residential buildings. Flows will follow the topography of the site in a south-westerly direction. The exceedance flow routes are included on a plan in **Appendix I**.

Water Quality

6.26 The drainage system has been designed in order to meet the water quality requirements set out by Table 26.2 of the CIRIA SuDS Manual C753 which sets out the specific pollution hazard indices for different surfaces.

6.27 Table 6.3 below identifies the different levels of pollution hazard indices to be mitigated.

Land Use	Hazard Level	Pollution Hazard Indices		
		Suspended Solids	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Individual property driveways and low traffic roads	Low	0.5	0.4	0.4
Pollution Mitigation Required		0.5	0.4	0.4

Table 6.3 Land Use Pollution Hazard Ratings. Extracted from the CIRIA SuDS Manual C753 Simple Index Approach Tool

SuDS Component	Pollution Mitigation Indices		
	Suspended Solids	Metals	Hydrocarbons
Permeable Paving	0.7	0.6	0.7
Downstream Defender Select – Vortex Plus	0.5	0.4	0.5

Table 6.4 Land Use Pollution Hazard Ratings. Extracted from the CIRIA SuDS Manual C753 Simple Index Approach Tool

6.28 From Table 6.3 and 6.4 above, the permeable paving and or the Downstream Defender Select, will meet the required level of pollution mitigation is provided and exceeded for removing total suspended solids, metals and hydrocarbons from the surface water runoff. A further stage of treatment is to be provided by raingarden planters.

6.29 Where flows cannot pass through the permeable paving subbase, the Downstream Defender Select (or similar approved system) is proposed to ensure suitable pollution mitigation. A Downstream Defender Select is an advanced hydrodynamic vortex separator that reliably captures and retains sediments, oil, trash and floatable from surface water runoff.

- 6.30 Hydro-International have provided a specification sheet showing that this device can achieve mitigation for TSS at 0.5; Metals at 0.4 and Hydrocarbons at 0.5. Details of the Downstream Defender Select is contained in **Appendix J** as well as advice from Hydro-International on sizing Downstream Defenders.

Sewer Diversion

- 6.31 The 50mmdia combined rising main is subject to a S185 diversion application. At the time of writing, there has been no correspondence with Thames Water regarding this. However, an indicative diversionary route has been plotted on DR01 enclosed in **Appendix I**.
- 6.32 A maintenance strip is to be provided to allow access to the diverted rising main.

7 Maintenance of Development Drainage

- 7.1 The maintenance of the SuDS/drainage infrastructure will remain the responsibility of an appointed management/maintenance company; other than individual pipework, raingarden planters and other features within private curtilage, which will be the responsibility of the house owner.
- 7.2 Regular inspections and maintenance should be carried out, particularly after periods of heavy rainfall. Maintenance tasks and frequencies for permeable paving, raingarden planters and geo-cellular storage are detailed in the CIRIA SUDS Manual (C753) and are summarised below in Tables 7.1 - 7.3 below.

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Brushing and vacuuming.	Three times per year at end of winter, mid-summer, after autumn leaf fall, or as required based on site specific observations of clogging or manufacturer's recommendations.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds.	As required.
Remedial actions	Remediate any landscaping which, through vegetation maintenance of soil slip, has been raised to within 50mm of the level of the paving.	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance of a hazard to the user.	As required
	Rehabilitation of surface and upper sub-surface.	As required (if infiltration performance is reduced as a result of significant clogging.)
Monitoring	Initial inspection	Monthly for 3 months after installation. 3 monthly, 48 hours after large storms.
	Inspect for evidence of poor operation and/or weed growth. If required, take remedial action.	Annually.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	
	Monitor inspection chambers.	Annually.

Table 7.1: Maintenance tasks for permeable paving (Source: CIRIA C753, The SUDS Manual)

Maintenance Schedule	Required Action	Typical Frequency
Regular Inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary.	Quarterly.
	Check operation of underdrains by inspection of flows after rainfall.	Annually.
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary.	Quarterly.
	Inspect inlets and outlets for blockage.	Quarterly.
Regular Maintenance	Remove litter and surface debris and weeds.	Quarterly (or more frequently for tidiness or aesthetic reasons).
	Replace any plants, to maintain planting density.	As required.
	Remove sediment, litter and debris build-up from around inlets or from forebays.	Quarterly or biannually.
Occasional Maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required.	As required.
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch.	As required.
Remedial Actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years.

Table 7.2: Maintenance tasks and frequencies for bioretention systems (raingarden planters) (The SUDS Manual C753, CIRIA)

Maintenance Schedule	Required Action	Frequency
Routine Maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation Change the filter media Remove sediment, oil, grease and floatables	Sixth Monthly As recommended by the manufacturer As necessary-indicated by a system inspections or immediately following significant spill
Remedial Actions	Replace malfunctioning parts or structures	As required
Monitoring	Inspect for evidence of poor operation Inspect filter media and establish appropriate replacement frequencies Inspect sediment accumulation rates and establish appropriate removal frequencies	Six Monthly Six Monthly Monthly during first half year of operation, then every six months

Table 7.3: Example operation and maintenance requirements for propriety treatment systems (The SUDS Manual C753, CIRIA)

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action. Remove debris from the catchment surface (where it may cause risks to performance). Remove sediment from pre-treatment structures and/or internal forebays.	Monthly for 3 months, then annually. Monthly Annually or as required.
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents.	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed. Survey inside of tank/crate system for sediment build-up and remove if necessary.	Annually Every 5 years or as required.

Table 7.4: Maintenance tasks for cellular storage tank (Source: CIRIA C753, The SUDS Manual)

- 7.3 Inspection chambers and manhole covers should be lifted each year to remove visible debris and check for blockages. It is suggested that this is undertaken every November after the heaviest leaf-fall has occurred.
- 7.4 Any control chambers/orifice plate filters should be regularly inspected (every 4 months) and cleared of silt and debris if necessary.
- 7.5 Should a blockage occur at any time, it is advised to seek professional help to jet the drainage system to clean and clear the system.
- 7.6 It is good practice to ensure that gutters and downpipes are occasionally inspected to ensure they are in good order and free of leaves & debris. Once every 6 months should be sufficient.

8 Conclusion

- 8.1 EAS has been commissioned to provide a Flood Risk Assessment and SuDS report to inform a planning application for a residential development on land at Hillcrest and Tussocks, The Causeway, Therfield, SG8 9PP (Grid Ref: TL 33591 37377).
- 8.2 Proposals consist of the construction of 7 residential dwellings with associated landscaping and parking.

Flood Risk

- 8.3 The site is located wholly in Flood Zone 1 and has not been identified to be at risk from all assessed sources. No specific mitigation measures are considered to be required.

SuDS Strategy

- 8.4 There is a lack of watercourses and no adopted surface water sewers in the local area. As such shallow and borehole infiltration testing was undertaken at the site. The majority of the shallow infiltration testing failed. Borehole tests produced a relatively poor infiltration rate of 1.86×10^{-6} m/s.
- 8.5 Considering the proposed site layout, there would only be space available to provide two borehole soakaways, whilst achieving required distances to the proposed dwellings. When the two borehole soakaways were tested in the drainage software Causeway Flow, it was found that it would not be possible to size on-site attenuation sufficiently large enough to support the use of borehole soakaways, based upon the measured available infiltration rate. On this basis, the only option available to outfall the runoff from the site is to the local adopted Thames Water Foul Water sewer.
- 8.6 The proposed SuDS strategy consists of directing roof runoff into permeable paving subbase where possible. All road areas are to be permeable paving, split into 4 sections based on the site topography. Two additional geo-cellular tanks are also proposed to meet the attenuation requirement and in addition rainwater planters and water butts, are proposed to help meet the four pillars of SuDS.
- 8.7 It is proposed to outfall SuDS system to the Thames Water foul water sewer, at the position of the proposed relocated demarcation chamber. As noted above, the proposals improve upon the Greenfield Runoff Rates, achieving a maximum discharge rate of 1.0l/s for all Storms up to and including the 1:100yr + 40% Climate Change Event. To restrict the runoff a final control chamber with a 21mm orifice plate, with suitable filter, will be provided prior to the outfall.
- 8.8 The proposed drainage strategy provides suitable pollution mitigation to exceed the requirements for the runoff from the site. Where flows cannot pass through the permeable paving subbase, a Downstream Defender Select is proposed to ensure suitable pollution mitigation.
- 8.9 A rising main sewer diversion is proposed for the foul water Thames Water sewer passing through the northern half of the site.

Maintenance of the Proposed Drainage System

- 8.10 The maintenance of the SuDS/drainage infrastructure will remain the responsibility of an appointed management/maintenance company; other than individual pipework, raingarden planters and other features within private curtilage, which will be the responsibility of the house owner.
- 8.11 Regular inspections and maintenance should be carried out, particularly after periods of heavy rainfall. Maintenance tasks and frequencies for permeable paving, raingarden planters, proprietary treatment stages, and geo-cellular storage are detailed in the CIRIA SuDS Manual (C753) and are summarised below in Section 6 of this report.

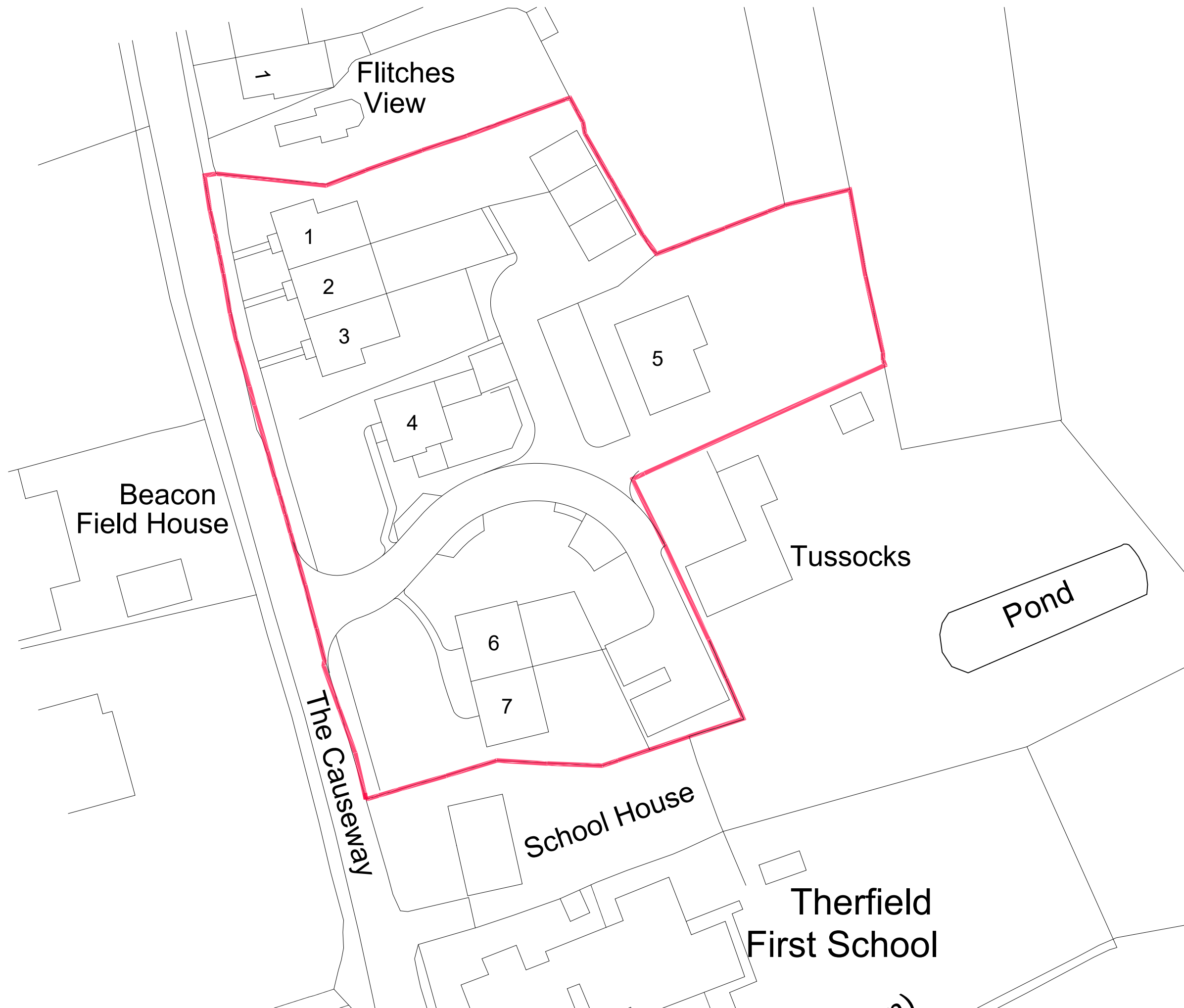
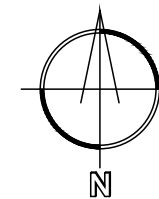
Conclusion

- 8.12 The proposed development has been demonstrated to be acceptable on flood risk and drainage grounds.

Appendices

Appendix: A – Location Plan	32
Appendix: B – Proposed Plans	33
Appendix: C – EA Flood Map for Planning	34
Appendix: D – Topographic Survey	35
Appendix E – Infiltration testing results	36
Appendix F - Thames Water Asset Location Plan	37
Appendix G – Surface Water Flood Mapping	38
Appendix H – Causeway Flow Calculations	39
Appendix I – Proposed SuDS Layout	40
Appendix J – Downstream Defender Specification	41
Appendix: K – Brownfield Runoff Calculations	42
Appendix: L – Standard Construction Details	43
Appendix: M – Exceedance Flow Drawing	44

Appendix: A – Location Plan



REV:	DATE:	DESCRIPTION:
E	18-11-24	SCHEME UPDATED
D	16-10-24	SCHEME UPDATED
C	04-06-24	SCHEME UPDATED
B	09-02-24	SCHEME UPDATED
A	29-09-23	PLOT 5 AMENDED

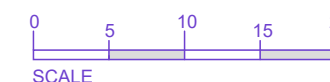
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ALL DIMENSIONS TO BE CHECKED ON SITE PRIOR TO
COMMENCEMENT OF WORK.



BLOCK PLAN

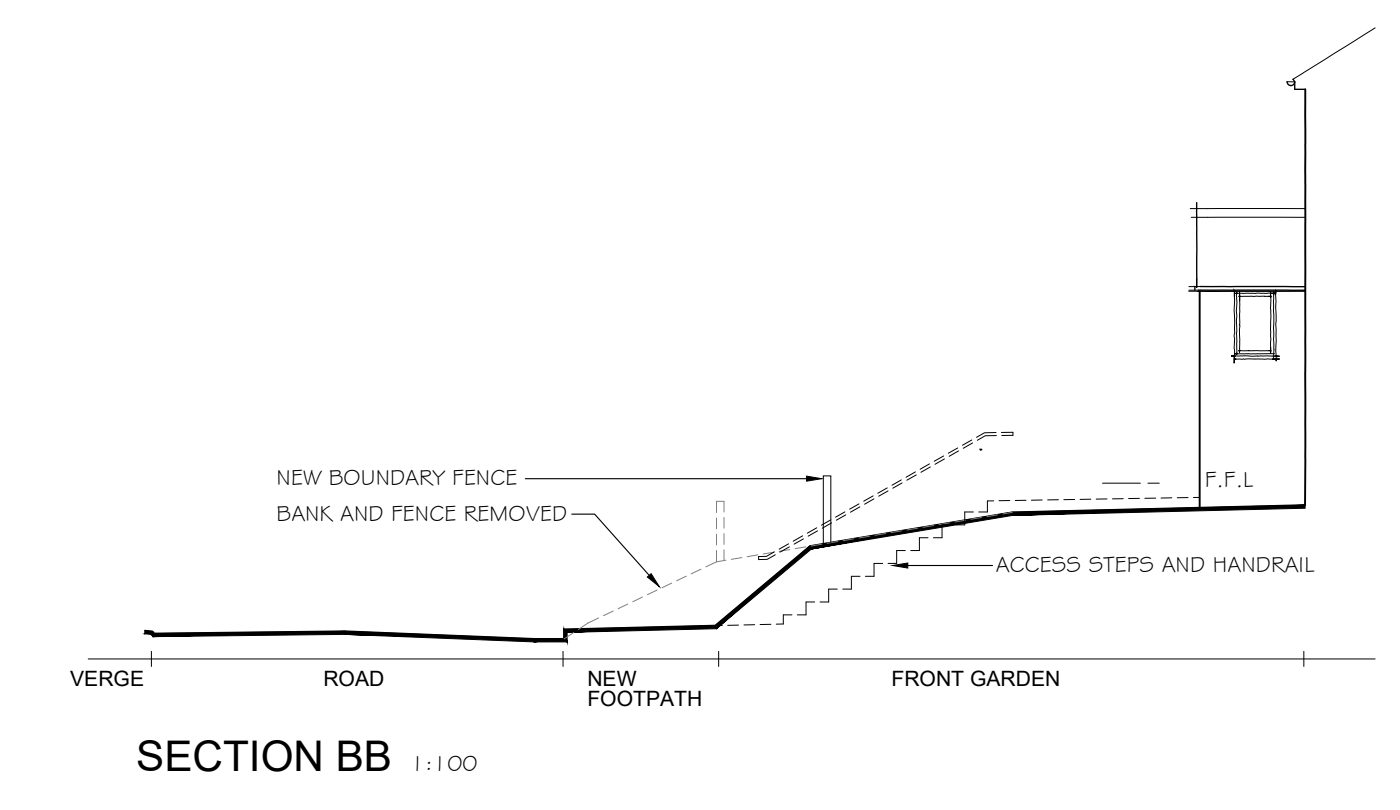
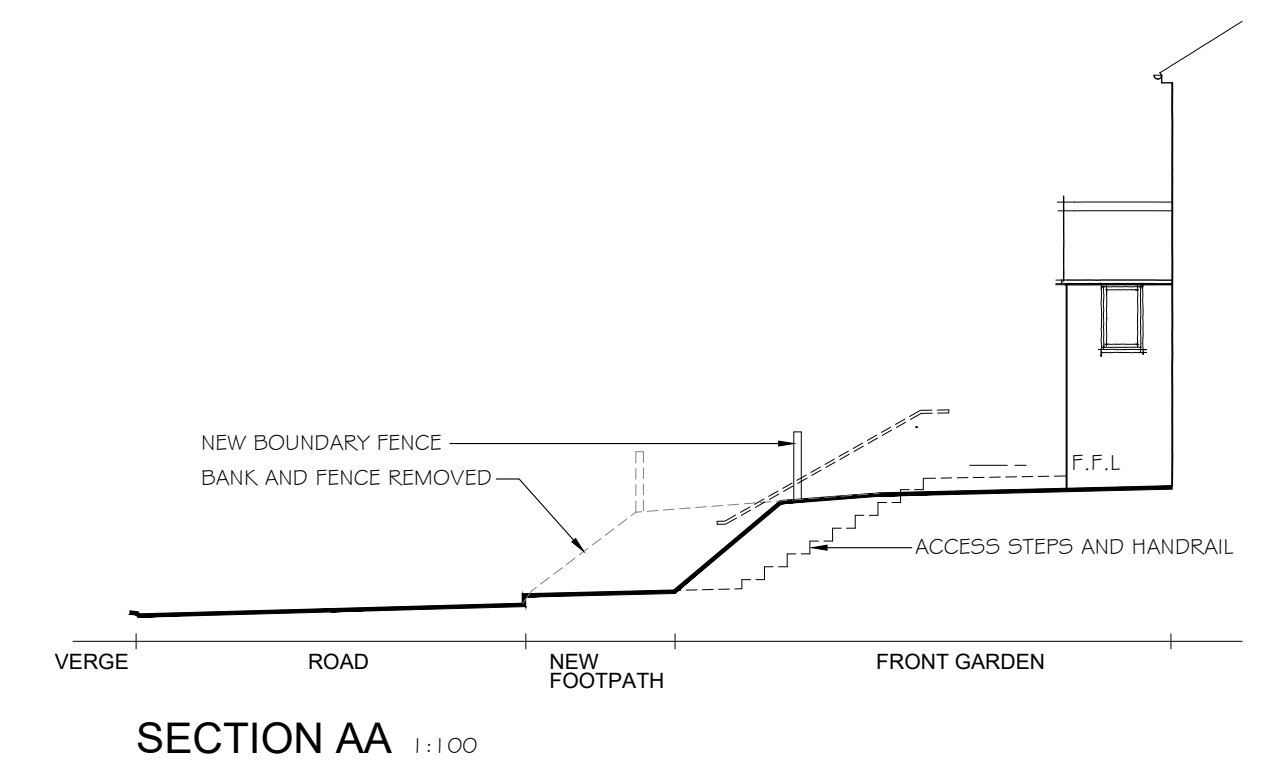
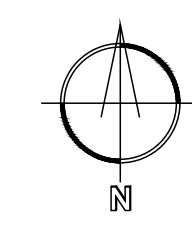
HILLCREST & TUSSOCKS
THE CAUSEWAY
THERFIELD

BLOCK PLAN 1:500
ORNANCE SURVEY LICENCE NUMBER 100053143



DATE: APR 23	SCALE @ A3: 1:500	REVISION
DRAWING NO.	478.02	E

Appendix: B – Proposed Plans



1	15-11-24	PLAN UPDATED
H	14-11-24	PLAN UPDATED
G	14-10-24	PLAN UPDATED
F	20-03-24	PLAN UPDATED
T	03-06-24	PLAN UPDATED
D	09-02-24	PLAN UPDATED
D	09-02-24	PLAN UPDATED
C	04-10-23	PLAN UPDATED
B	03-10-23	PLAN UPDATED
A	29-09-23	PLOT 5 AMENDED

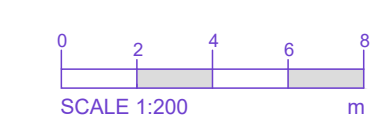
REV:	DATE:	DESCRIPTION:
DO NOT SCALE THESE DRAWINGS. USE WRITTEN DIMENSIONS ONLY. ALL DIMENSIONS TO BE CHECKED ON SITE PRIOR TO COMMENCEMENT OF WORK.		



SITE PLAN

HILLCREST & TUSOCKS
THE CAUSEWAY
THERFIELD

SITE PLAN 1:200



DATE:	SEPT. 23	SCALE @ A1:	1:200	REVISION:	
DRAWING NO.	478.03				I

Appendix: C – EA Flood Map for Planning

Flood map for planning

Your reference
<Unspecified>

Location (easting/northing)
533590/237372

Created
17 Jun 2024 7:50

Your selected location is in flood zone 1, an area with a low probability of flooding.

You will need to do a flood risk assessment if your site is **any of the following:**

- bigger than 1 hectare (ha)
- In an area with critical drainage problems as notified by the Environment Agency
- identified as being at increased flood risk in future by the local authority's strategic flood risk assessment
- at risk from other sources of flooding (such as surface water or reservoirs) and its development would increase the vulnerability of its use (such as constructing an office on an undeveloped site or converting a shop to a dwelling)

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Flood risk data is covered by the Open Government Licence **which** sets out the terms and conditions for using government data. <https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

Use of the address and mapping data is subject to Ordnance Survey public viewing terms under Crown copyright and database rights 2022 OS 100024198. <https://flood-map-for-planning.service.gov.uk/os-terms>

Flood map for planning

Your reference
<Unspecified>

Location (easting/northing)
533590/237372

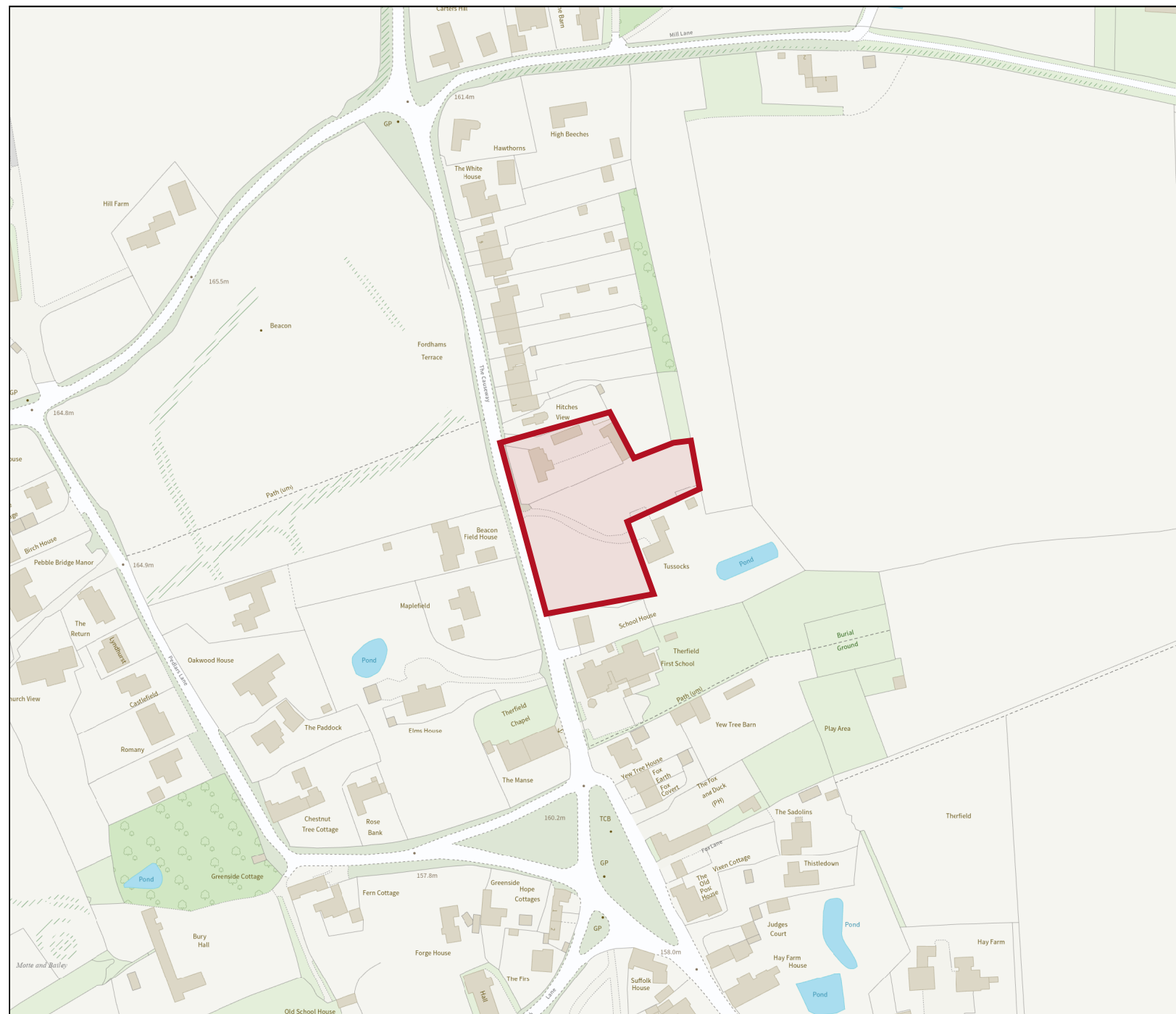
Scale
1:2500

Created
17 Jun 2024 7:50

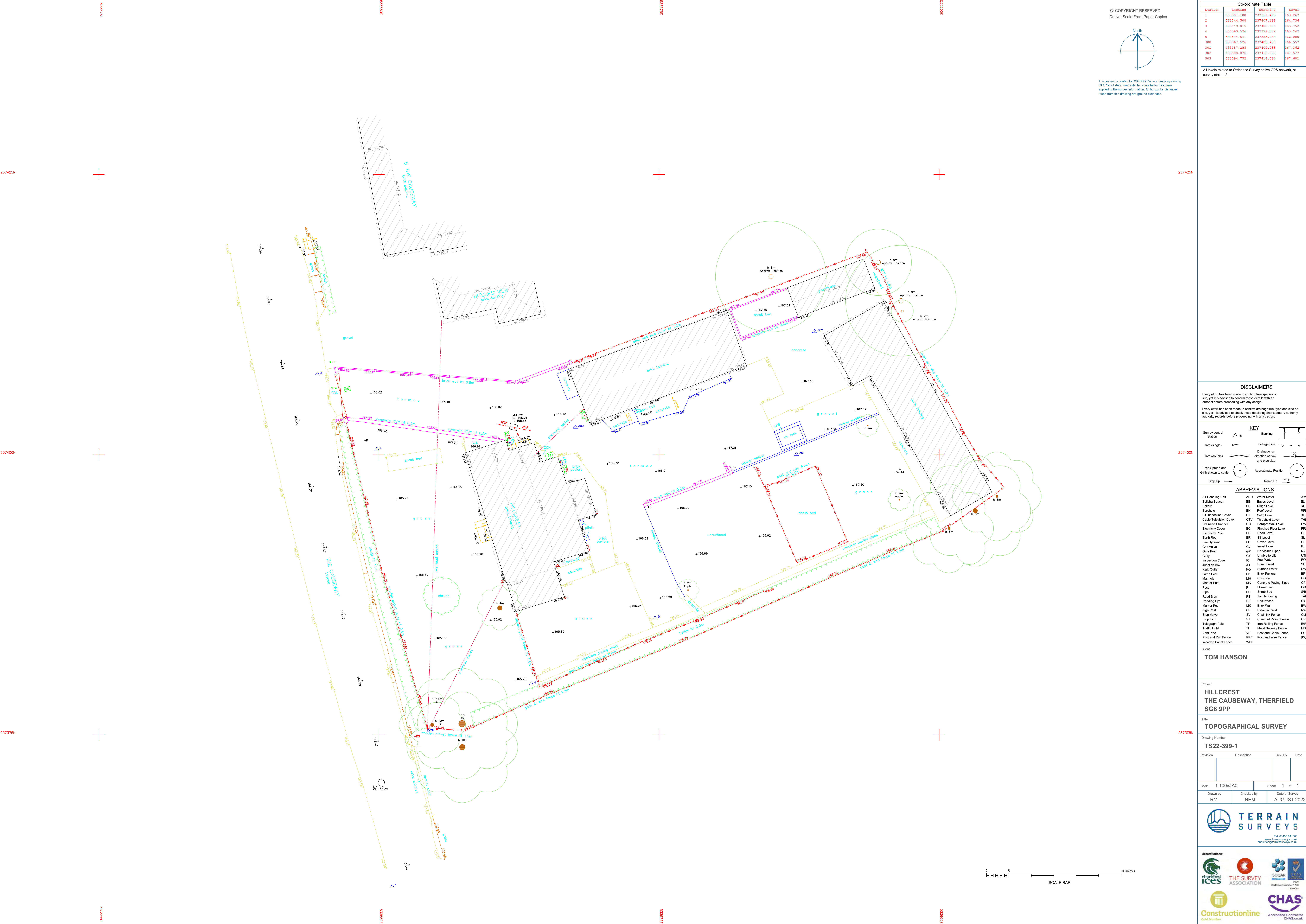
-  Selected area
-  Flood zone 3
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Water storage area

0 20 40 60m

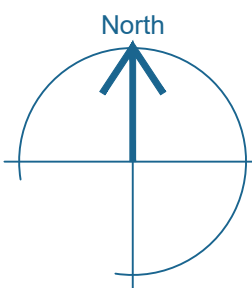
Page 2 of 2



Appendix: D – Topographic Survey



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This survey is related to OSGB36(15) coordinate system by GPS 'rapid static' methods. No scale factor has been applied to the survey information. All horizontal distances taken from this drawing are ground distances.

Co-ordinate Table			
Station	Easting	Northing	Level
1	533551.180	237361.460	163.267
2	533544.508	237407.188	164.736
3	533549.815	237400.435	165.755
4	533563.596	237379.552	165.247
5	533574.641	237385.433	166.080
300	533567.526	237402.450	166.557
301	533587.258	237400.038	167.363
302	533588.876	237410.988	167.577
303	533594.752	237414.584	167.601

All levels related to Ordnance Survey active GPS network, at survey station 2.

DISCLAIMERS

Every effort has been made to confirm tree species on site, yet it is advised to confirm these details with an arborist before proceeding with any design.

Every effort has been made to confirm drainage run, type and size on site, yet it is advised to check these details against statutory authority records before proceeding with any design.

KEY	
Survey control station	Banking
Gate (single)	Foliage Line
Gate (double)	Drainage run, direction of flow and pipe size
Tree Spread and Girth shown to scale	Approximate Position
Step Up	Ramp Up
	Ramp Down

ABBREVIATIONS

Air Handling Unit	AHU	Water Meter	WM
Beltina Beeson	BB	Even Level	EL
Bollard	BD	Ridge Level	RL
Borehole	BH	Roof Level	RFL
BT Inspection Cover	BT	Soft Level	SFL
Cable Television Cover	CTV	Threshold Level	THL
Drainage Channel	DC	Parapet Wall Level	PWL
Electricity Cover	EC	Finished Floor Level	FFL
Electricity Pole	EP	Head Level	HL
Earth Rod	ER	Sill Level	SL
Fire Hydrant	FH	Cover Level	CL
Gas Valve	GV	Invert Level	IL
Gate Post	GP	No Visible Pipes	NVP
Gully	GY	Unable to Lift	UTL
Inspection Cover	IC	Ford Water	FW
Junction Box	JB	Sump Level	SUL
Kerb Outlet	KO	Surface Water	SW
Lamp Post	LP	Brick Paviers	BP
Manhole	MH	Concrete	CON
Marker Post	MP	Concrete Paving Slabs	CPS
Post	P	Flower Bed	FIB
Pipe	PE	Shrub Bed	SIB
Road Sign	RS	Tackle Paving	TAC
Rodding Eye	RE	Unsurfaced	US
Marker Post	MK	Brick Wall	BW
Sign Post	SP	Retaining Wall	RW
Stop Valve	SV	Chamirak Fence	CLF
Stop Top	ST	Chestnut Paving Fence	CPF
Telegraph Pole	TP	Iron Railing Fence	IRF
Traffic Light	TL	Metal Security Fence	MSF
Vent Pipe	VP	Post and Chain Fence	PCF
Post and Rail Fence	PRF	Post and Wire Fence	PWF
Wooden Panel Fence	WPF		

Client

TOM HANSON

Project

HILLCREST
THE CAUSEWAY, THERFIELD
SG8 9PP

Title

TOPOGRAPHICAL SURVEY

Drawing Number

TS22-399-1

Revision	Description	Rev. By	Date
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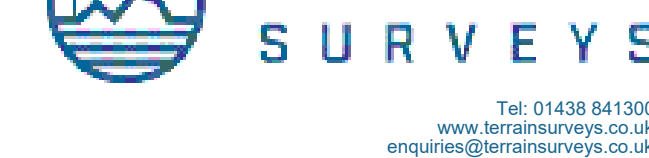
Scale 1:100@A0

Sheet 1 of 1

Drawn by RM

Checked by NEM

Date of Survey AUGUST 2022



2374450N

237400N

237350N

237300N

535000E

535000E

535000E

535000E

535000E

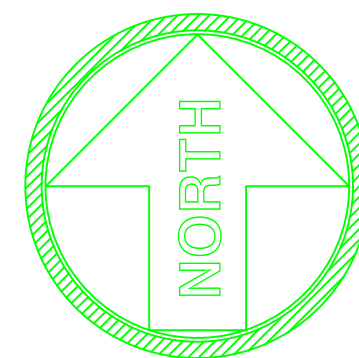
535000E

535000E

535000E

535000E

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2374450N

237400N

237350N

237300N

Co-ordinate Table			
Station	Easting	Northing	Level
1	535557.674	237355.669	162.454
2	535562.038	237358.209	163.220
3	535604.693	237365.907	165.942

GPS Note:
This survey is related to OSGB36(15) coordinate system by GPS 'rapid static' methods. No scale factor has been applied to the survey information. All horizontal distances taken from this drawing are ground distances.

Every effort has been made to confirm tree species on site, yet it is advised to confirm these details with an arborist before proceeding with any design.

Every effort has been made to confirm drainage run, type and size on site, yet it is advised to check these details against statutory authority records before proceeding with any design.

Revision	Description	Date

LEGEND

Survey control station		Building	
Banking		Fence	
Gate (single)		Contour	
Gate (double)		Wall	
Tree Spread and Girth shown to scale		Ordnance Survey	
		Value	1:5.37m

Abbreviations

Bellina Beacon	BD	Pipe	PE
Bollard	BD	Road Sign	RS
Borehole	BH	Rodding Eye	RE
British Telecom Box	BTB	Service Marker	MK
BT Inspection Cover	BT	Sign Post	SP
Concrete Paving Slabs	CPS	Sluice Valve	SV
Cable Television Cover	CTV	Stop Top	ST
Electricity Cable Pit	EC	Stop Cock	SC
Electricity Pole	EP	Telegraph Pole	TGP
Earth Rod	ER	Telephone Call Box	TL
Fire Hydrant	FH	Traffic Light	TL
Flag Staff	FS	Unsurfaced	US
Gas Valve	GV	Vent Pipe	VP
Gate Post	GP	Water Meter	WM
Gully	G	Eaves Level	EL
Inspection Cover	IC	Ridge Level	RL
Kerb Outlet	KO	Roof Level	RFL
Lamp Post	LP	Soffit Level	SFL
Manhole	MH	Threshold Level	THL
Marker Post	MK	Panoptet Wall Level	PWL
Parking Meter	PM	Finished Floor Level	FTL
Post	P		
Retaining Wall	RTW	Cover Level	CL
Barbed Wire Fence	BWF	Invert Level	IL
Close Boarded Fence	CBF	No Visible Connection	NVC
Chainlink Fence	CLF	Unable to Lift	UTL
Chestnut Paling Fence	CPT	Surface Water	SW
Post and Chain Fence	PCF	Foul Water	FW
Post and Rail Fence	PRF	Flower Bed	F/B
Post and Wire Fence	PWF	Shrub Bed	S/B
Wooden Panel Fence	WPF		



Land and Architectural Surveys

terrain Surveys Ltd
Bridge Ditches
23a High Street
Mareham
Norfolk
NR10 6JG

Tel: 01438 841330
Fax: 01438 841331
www.terrain-surveys.co.uk



Client
SIMON KINGSLEY

Project
**TUSSOCKS, THE CAUSEWAY
THERFIELD, ROYSTON
HERTS, SG8 0PP**

Title
TOPOGRAPHICAL SURVEY

Drawn by
WR

Checked by
PG

Scale
1:200@A0

Date
MAY 2018

Drawing Number
TS18-197Q\1

Revision
1

Sheet
1 of 1

All levels related to Ordnance Survey active GPS network, at survey station 2

Value 163.220m



Appendix E – Infiltration testing results

Our Ref: CW/62242/Inf
Your Ref:

21 April 2023

Hanson Services Ltd
c/o PJB Planning Ltd
2 West Street,
Ware,
Hertfordshire,
SG12 9EE

BY EMAIL ONLY TO:
peter@pjbplanning.co.uk

Dear Sirs,

**Re: Hillcrest & Tussocks, The Causeway, Therfield –
Infiltration Assessment**

As you are aware we recently attended the above site to undertake infiltration testing to inform the drainage strategy for the proposed residential redevelopment of the site. The findings of this testing are summarised in this letter and shall be read in accordance with our limitations of investigation, which are enclosed.

Site Location & Description

The site is located at Hillcrest and Tussocks, The Causeway, Therfield, Royston, Cambridgeshire, SG8 9PP. A site location plan is presented as Figure 1 and is enclosed.

At the time of investigation, the site comprised 2no. separate areas – Hillcrest & Tussocks. Hillcrest, the smaller parcel of land in the north, comprised a two-storey residential dwelling with associated garages, hardstanding, and a driveway. Tussocks, the larger parcel of land in the south, comprised a two-storey residential dwelling with garden areas, a pond, numerous mature trees, a parking area and a driveway. These areas were separated by a coniferous hedge approximately 2m in height, with access to both parcels possible from The Causeway to the immediate east.

Fieldwork

The fieldwork on which this letter is based was undertaken between 11th April & 13th April 2023 and comprised the mechanical excavation of 5no. trial pits (TP01-TP05). An exploratory hole location plan is enclosed as Figure 2 and indicates the location of the trial pits with respect to the existing site layout.

Disturbed samples were recovered from throughout the depth of each exploratory hole for record keeping purposes. The exploratory hole logs are enclosed and give descriptions and depths of the strata encountered, together with details of samples taken and other relevant information.

Cont'd.../



also at: London 020 7448 9910, Cambridge 01223 314794, Bristol 01172 020070 and
Norwich 01603 230240
Richard Jackson is a trading name of Richard Jackson Ltd. Registration No. 2744316 England.
Registered Office 847 The Crescent, Colchester, CO4 9YQ.

847 The Crescent,
Colchester, Essex CO4 9YQ

Telephone: 01206 228800
www.rj.uk.com

Where applicable, investigation techniques, sampling and logging of soils complied with the requirements of British Standard BS:5930:- 'Code of Practice for Site Investigations' (2015).

Trial Pitting

A mechanical excavator was used to form 5no. trial pits (TP01-TP05) to depths of between 1.80m below ground level (bgl) (TP02) and 2.20m bgl (TP05).

Trial pits were positioned to provide a representative coverage of the site, taking into account existing site constraints.

Infiltration Testing

Infiltration testing was undertaken in 5no. locations (TP01-TP05) in accordance with current guidance as given in BRE Digest 365 'Soakaway Design' (2016).

The trial pits were installed with a monitoring pipe and data logger, before being backfilled with gravel to maintain stability during testing. The trial pits were then filled with clean water from a water tank, with the fall in water level monitored at regular intervals.

In accordance with the requirements of BRE Digest 365, 3no. tests were undertaken in TP05. A single test was undertaken in the remaining 4no. locations (TP01-TP04) due to the observed poor infiltration.

In order to derive soil infiltration rates for TP05, the recommended calculation in BRE Digest 365 (2016) has been used. Table 1 provides a summary of the calculated infiltration rates. Full results are enclosed.

Table 1: Results of Infiltration Testing

Exploratory Hole	Infiltration Rate (m / s)		
	Test 1	Test 2	Test 3
TP05	5.64×10^6	4.29×10^6	5.65×10^6

As noted above, infiltration rates have not been determined for the encountered soils in 4no. locations (TP01-TP04) due to the insufficient infiltration observed. Table 2 provides a summary of the duration of monitoring and the observed fall in water level. Full results of the infiltration testing are enclosed.

Table 2: Summary of Infiltration Tests

Exploratory Hole	Monitoring Period Duration (mins)	Observed change in water level (m)
TP01	1,653	0.11
TP02	1,575	0.07
TP03	1,737	0.24
TP04	1,693	0.39

Ground Conditions

The British Geological Survey (BGS) 1:50,000 scale online mapping of the area indicates superficial Lowestoft Formation to exist beneath the site, underlain by a bedrock of undifferentiated Lewes Nodular and Seaford Chalk Formations.

This investigation encountered the following sequence of strata from ground level:

- Topsoil / Made Ground
- Lowestoft Formation

Groundwater was not encountered during this investigation.

Topsoil / Made Ground

Topsoil was encountered from ground level in 3no. locations (TP01, TP02 & TP04), with the thickness ranging from 0.20m bgl (TP01) to 0.55m bgl (TP02). The topsoil was typically encountered as dark brown slightly gravelly clay with rootlets.

Made Ground was encountered from ground level in 2no. locations (TP03 & TP05), and beneath topsoil in TP04. The base of the made ground ranged from 0.40m bgl (TP03 & TP05) to 1.00m bgl (TP04). The made ground was typically encountered as black or dark brown slightly gravelly clay, with gravel of clinker, brick, flint, and chalk. The made ground encountered in TP04 at 0.40m – 1.00m bgl was recorded as possible former topsoil, described as a dark brown slightly gravelly clay.

Lowestoft Formation

Soils interpreted to represent the Lowestoft Formation were encountered beneath topsoil or made ground in each of the 5no. locations (TP01-TP05), with the base of the Lowestoft Formation remaining unproven at the maximum depth of the investigation of 2.20m bgl (TP05).

The Lowestoft Formation was typically encountered as orangish brown slightly gravelly silty clay with gravel of flint, occasional flint cobbles, and iron staining, overlying a light brown slightly gravelly clay with gravel of chalk.

In TP05, underlying the typical above-described Lowestoft Formation, was a structureless chalk comprising a clayey sandy matrix, with intact clasts of weak low to medium density chalk.

The British Geological Survey (BGS) online mapping of the area identifies chalk rafts within the Lowestoft Formation indicated to be present beneath the site. The conditions encountered in TP05 are assumed to represent one of these chalk rafts. The nature of this deposit should be considered with respect to the recorded infiltration rate in this material.

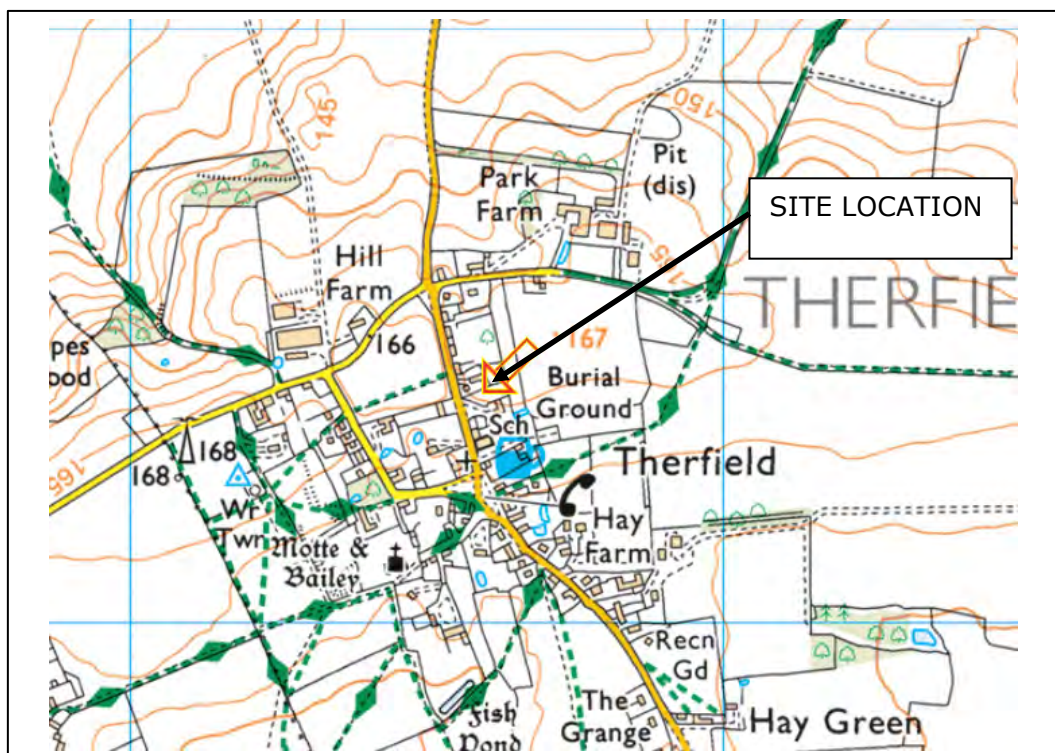
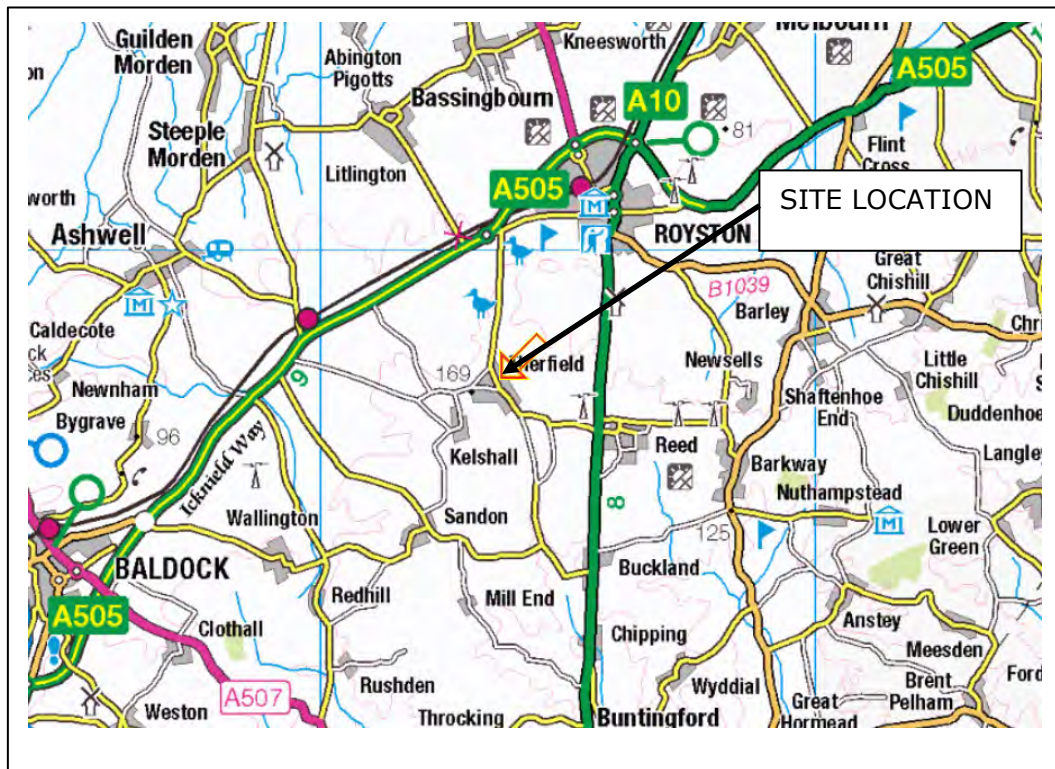
General

We trust that the above and enclosed are clear and acceptable, however, should you have any questions or queries please do not hesitate to contact us.

Yours sincerely

Camilla Watson BSc, FGS
Graduate Geotechnical Engineer
on behalf of Richard Jackson Limited

Enc Figure 1 – Site Location Plan
 Figure 2 – Exploratory Hole Location Plan
 Exploratory Hole Logs
 Soakage Tests Calculations
 Limitations of Investigation



REPRODUCED FROM ORDNANCE SURVEY MAP WITH THE PERMISSION OF THE CONTROLLER OF HIS MAJESTY'S STATIONARY OFFICE, © CROWN COPYRIGHT RICHARD JACKSON LTD – ACC No. 100002572

Richard Jackson
Engineering Consultants

Consulting Civil & Structural Engineers
847 The Crescent, Colchester, CO4 9YQ
Tel: 01206 228 800

Hillcrest & Tussocks, The Causeway,
Therfield, Royston, Cambridgeshire,
SG8 9PP

SITE LOCATION PLAN

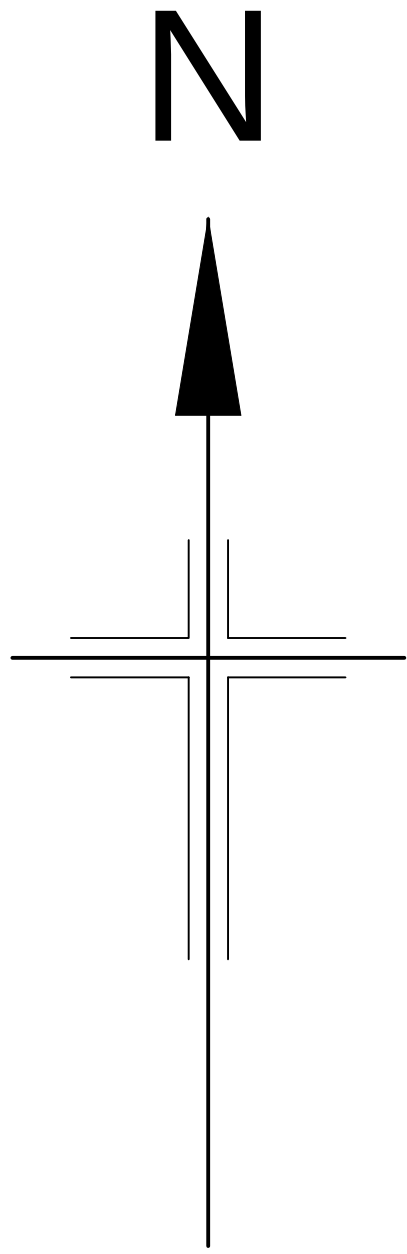
FIGURE 1

SCALE: N.T.S.

JOB NO: 62242

KEY

TRIAL PIT
LOCATIONS



REV	DATE	DESCRIPTION	DRAWN	CHKD

REVISIONS

This drawing is to be read in conjunction with all other Engineer's drawings and all other project information. Any discrepancy between the Engineer's drawings and other project information is to be reported to the Engineer immediately.



Project
**HILLCREST & TUSOCKS,
THE CAUSEWAY, THERFIELD**

Title
**EXPLORATORY HOLE
LOCATION PLAN**

Client
HANSON SERVICES LTD

Scale 1:150 @ A0	Drawn MB	Date 20/04/23
Job Manager CW	Checked CW	Approved CW

647 The Crescent, Colchester, Essex CO4 3HQ
Unit 10C/20, 10th Floor, 1 St. Katherine's Way, London, E20 0JH
5 Queens House, Mill Court, Great Shelford, Cambs CB22 5LD
The Old Church, St. Matthews Road, Norwich, Norfolk NR2 1SP
The Wheelhouse, Broomfield, Gloucestershire GL2 0JF

Tel: 0206 228805
Tel: 020 7448 9810
Tel: 0203 314764
Tel: 01603 299248
Tel: 01272 220204

Email Address: mal@rj-uk.com
Website: <http://www.rj-uk.com>

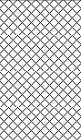
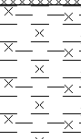
Drawing No. 62242-G-FIG02	Revision
Drawing Status ☒ INFORMATION ☐ TENDER	☐ APPROVAL ☐ CONSTRUCTION ☐ AS CONSTRUCTED
☐ COSTING	☐

Richard Jackson Engineering Consultants					847 The Crescent, Colchester, Essex, CO4 9YQ		Trial Pit No. TP01 Sheet 1 of 1					
Project Name: Hillcrest & Tussocks, The Causeway, Therfield			Project No. 62242		Co-ords: Orientation:		Date 11/04/2023					
Location: Royston, Cambridgeshire, SG8 9PP					Level (m, aOD):		Dimensions (m) 1.40		Scale 1:20			
Client: Hanson Services Ltd					Depth (m): 2.00		0.50		Logged CW			
Ground water	Samples & In Situ Testing			Level (m)	Depth (m)	Legend	Stratum Description					
	Depth	Type	Results									
					0.20		Dark brown slightly gravelly silty CLAY with rootlets. Gravel is subangular to rounded fine flint and chalk. TOPSOIL					
	0.60	D1			0.80		Dark brown slightly gravelly silty CLAY. Gravel is subangular to rounded fine to medium chalk. LOWESTOFT FORMATION					1
	1.20	D2					Light brown slightly gravelly CLAY. Gravel is subangular to rounded fine to medium chalk. LOWESTOFT FORMATION					
	1.90	D3			2.00		End of Pit at 2.000m					2
												3
												4
Groundwater: Groundwater not encountered.							Key					
Stability: Gravel filled for soakage testing.							D	Disturbed		IVN	Hand Vane	
Remarks: Soakage testing undertaken between 0.80m and 1.80m bgl.							B	Bulk		PID	PID Reading	
							ES	Environmental		PP	Pocket Penetrometer	
								Groundwater strike			Standing water level	

Richard Jackson Engineering Consultants					847 The Crescent, Colchester, Essex, CO4 9YQ		Trial Pit No. TP02 Sheet 1 of 1					
Project Name: Hillcrest & Tussocks, The Causeway, Therfield			Project No. 62242		Co-ords: Orientation:		Date 11/04/2023					
Location: Royston, Cambridgeshire, SG8 9PP					Level (m, aOD):		Dimensions (m) 1.40		Scale 1:20			
Client: Hanson Services Ltd					Depth (m): 1.80		0.50		Logged CW			
Ground water	Samples & In Situ Testing			Level (m)	Depth (m)	Legend	Stratum Description					
	Depth	Type	Results									
	0.40	D1			0.55		Dark brown slightly sandy CLAY with rootlets and occasional subangular to rounded fine flint and chalk gravel. TOPSOIL					1
	1.10	D2					Light brown slightly gravelly silty CLAY. Gravel is subangular to rounded fine to medium chalk. LOWESTOFT FORMATION					
	1.70	D3			1.80		...becoming subangular to rounded fine to coarse chalk gravel from 1.20m.					
							End of Pit at 1.800m					2
												3
												4
Groundwater: Groundwater not encountered.							Key					
Stability: Stable sidewalls.							D	Disturbed		IVN	Hand Vane	
Remarks: Soakage testing undertaken between 0.70m to 1.70m bgl.							B	Bulk		PID	PID Reading	
							ES	Environmental		PP	Pocket Penetrometer	
								Groundwater strike			Standing water level	

Richard Jackson Engineering Consultants					847 The Crescent, Colchester, Essex, CO4 9YQ		Trial Pit No. TP03 Sheet 1 of 1							
Project Name: Hillcrest & Tussocks, The Causeway, Therfield			Project No. 62242		Co-ords: Orientation:		Date 11/04/2023							
Location: Royston, Cambridgeshire, SG8 9PP					Level (m, aOD):		Dimensions (m) 1.50		Scale 1:20					
Client: Hanson Services Ltd					Depth (m): 2.00		0.50		Logged CW					
Ground water	Samples & In Situ Testing			Level (m)	Depth (m)	Legend	Stratum Description							
	Depth	Type	Results											
					0.40		Dark brown slightly gravelly CLAY with roots and rootlets. Gravel is subangular to rounded fine to medium flint, chalk, brick and clinker. MADE GROUND							
	0.80	D1					Orangish brown slightly gravelly silty CLAY with occasional subangular to rounded flint cobbles and iron staining. Gravel is subangular to rounded fine to medium flint. LOWESTOFT FORMATION					1		
	1.30	D2					...becoming mottled beige from 1.10m.							
	1.80	D3					...yellow fine to medium sand parting at 1.70m.							
					2.00		End of Pit at 2.000m					2		
												3		
												4		
Groundwater: Groundwater not encountered.							Key							
Stability: Stable sidewalls.							D B ES		Disturbed Bulk Environmental		IVN PID PP		Hand Vane PID Reading Pocket Penetrometer	
Remarks: Soakage testing undertaken between 0.80m to 1.80m bgl.									Groundwater strike				Standing water level	

Richard Jackson Engineering Consultants					847 The Crescent, Colchester, Essex, CO4 9YQ		Trial Pit No. TP04 Sheet 1 of 1							
Project Name: Hillcrest & Tussocks, The Causeway, Therfield			Project No. 62242		Co-ords: Orientation:		Date 11/04/2023							
Location: Royston, Cambridgeshire, SG8 9PP					Level (m, aOD):		Dimensions (m) 1.30		Scale 1:20					
Client: Hanson Services Ltd					Depth (m): 2.00		0.50		Logged CW					
Ground water	Samples & In Situ Testing			Level (m)	Depth (m)	Legend	Stratum Description							
	Depth	Type	Results											
	0.50	D1			0.35 0.40		Dark brown slightly gravelly CLAY with root and rootlets. TOPSOIL							
							Light brown slightly gravelly CLAY. Gravel is subangular to rounded fine to medium chalk. MADE GROUND							
	1.30	D2			1.00		Dark brown slightly gravelly CLAY. Gravel is subangular to rounded fine to medium chalk and flint. (POSSIBLE FORMER TOPSOIL) MADE GROUND							
							Light brown slightly gravelly CLAY. Gravel is subangular to rounded fine to coarse chalk. LOWESTOFT FORMATION							
	1.70	D3			2.00		End of Pit at 2.000m							
Groundwater: Groundwater not encountered.							Key							
Stability: Stable sidewalls.							D B ES		Disturbed Bulk Environmental		IVN PID PP		Hand Vane PID Reading Pocket Penetrometer	
Remarks: Soakage testing undertaken between 0.70m to 1.70m bgl.									Groundwater strike				Standing water level	

Richard Jackson Engineering Consultants					847 The Crescent, Colchester, Essex, CO4 9YQ		Trial Pit No. TP05 Sheet 1 of 1				
Project Name: Hillcrest & Tussocks, The Causeway, Therfield			Project No. 62242		Co-ords: Orientation:		Date 11/04/2023				
Location: Royston, Cambridgeshire, SG8 9PP					Level (m, aOD):		Dimensions (m) 1.50		Scale 1:20		
Client: Hanson Services Ltd					Depth (m): 2.20		0.60		Logged CW		
Ground water	Samples & In Situ Testing			Level (m)	Depth (m)	Legend	Stratum Description				
	Depth	Type	Results								
	0.70	D1			0.40		Black and dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium clinker, ash, slate and flint. MADE GROUND				
							Orangish brown silty CLAY with occasional subangular to rounded fine to medium flint gravel. LOWESTOFT FORMATION				
	1.50	D2			0.80		Structureless white CHALK recovered as intact weak low to medium density fine to medium gravel sized chalk clasts in a clayey sandy matrix with occasional iron staining. LOWESTOFT FORMATION				
						End of Pit at 2.200m					
Groundwater: Groundwater not encountered.							Key				
Stability: Stable sidewalls.							D	Disturbed	IVN	Hand Vane	
Remarks: Soakage testing undertaken between 1.10m to 2.20m bgl.							B	Bulk	PID	PID Reading	
							ES	Environmental	PP	Pocket Penetrometer	
								Groundwater strike		Standing water level	

$$\text{Soil Infiltration Rate (f)} = V_{p_{75-25}} / (a_{p_{50}} * t_{p_{75-25}})$$

Infiltration TP01 - Test 1 of 1**Date: 12/04/2023****Trial Pit Dimensions**

Length (m)	1.40
Width (m)	0.50
Depth (m)	2.00
Effective Depth (m)	1.04
tp ₇₅ (mins)	N/A
tp ₂₅ (mins)	N/A

Calculations

V_{p₇₅₋₂₅} *Insufficient*
a_{p₅₀} *infiltration for*
tp₇₅₋₂₅ *calculation*

f = n/a m/s**f = n/a m/h****Infiltration TP02 - Test 1 of 1****Date: 12/04/2023****Trial Pit Dimensions**

Length (m)	1.40
Width (m)	0.50
Depth (m)	1.80
Effective Depth (m)	0.59
tp ₇₅ (mins)	N/A
tp ₂₅ (mins)	N/A

Calculations

V_{p₇₅₋₂₅} *Insufficient*
a_{p₅₀} *infiltration for*
tp₇₅₋₂₅ *calculation*

f = n/a m/s**f = n/a m/h****Infiltration TP03 - Test 1 of 1****Date: 12/04/2023****Trial Pit Dimensions**

Length (m)	1.50
Width (m)	0.50
Depth (m)	2.00
Effective Depth (m)	1.00
tp ₇₅ (mins)	N/A
tp ₂₅ (mins)	N/A

Calculations

V_{p₇₅₋₂₅} *Insufficient*
a_{p₅₀} *infiltration for*
tp₇₅₋₂₅ *calculation*

f = n/a m/s**f = n/a m/h****Infiltration TP04 - Test 1 of 1****Date: 12/04/2023****Trial Pit Dimensions**

Length (m)	1.30
Width (m)	0.50
Depth (m)	2.00
Effective Depth (m)	0.61
tp ₇₅ (mins)	N/A
tp ₂₅ (mins)	N/A

Calculations

V_{p₇₅₋₂₅} *Insufficient*
a_{p₅₀} *infiltration for*
tp₇₅₋₂₅ *calculation*

f = n/a m/s**f = n/a m/h**

$$\text{Soil Infiltration Rate (f)} = V_{p_{75-25}} / (a_{p_{50}} * t_{p_{75-25}})$$

<u>Infiltration TP05 - Test 1 of 3</u>		
Date: 12/04/2023		
<u>Trial Pit Dimensions</u>		
Length (m)	1.50	
Width (m)	0.60	
Depth (m)	2.20	
Effective Depth (m)	1.11	
tp ₇₅ (mins)	149.5	
tp ₂₅ (mins)	12.5	
<u>Calculations</u>		
V _{p₇₅₋₂₅}	0.15	
a _{p₅₀}	3.23	
tp ₇₅₋₂₅	137	
f = 5.64E-06 m/s		
f = 2.03E-02 m/h		

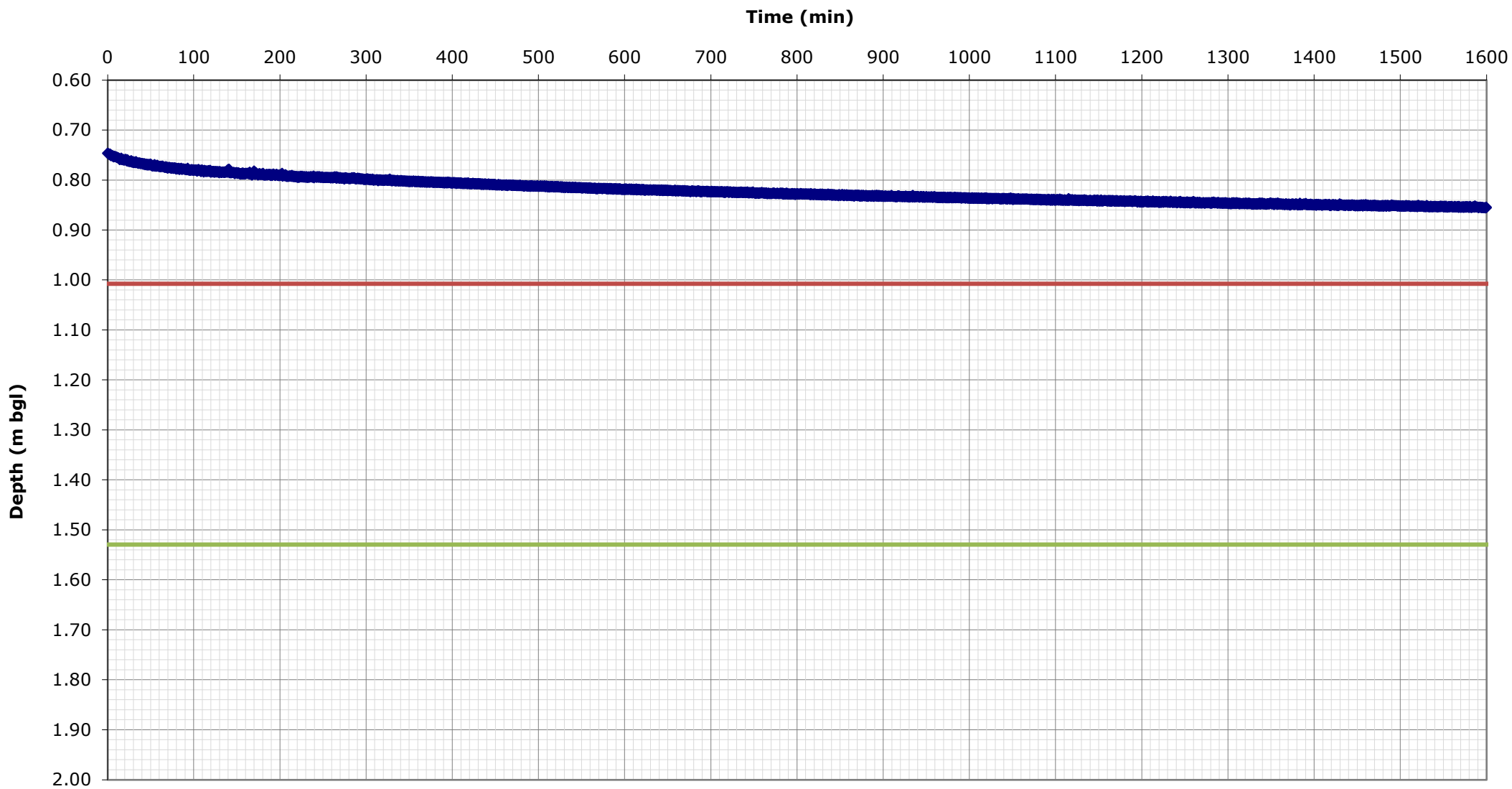
<u>Infiltration TP05 - Test 2 of 3</u>		
Date: 12/04/2023		
<u>Trial Pit Dimensions</u>		
Length (m)	1.50	
Width (m)	0.60	
Depth (m)	2.20	
Effective Depth (m)	1.07	
tp ₇₅ (mins)	200.5	
tp ₂₅ (mins)	22	
<u>Calculations</u>		
V _{p₇₅₋₂₅}	0.14	
a _{p₅₀}	3.15	
tp ₇₅₋₂₅	178.5	
f = 4.29E-06 m/s		
f = 1.54E-02 m/h		

<u>Infiltration TP05 - Test 3 of 3</u>		
Date: 13/04/2023		
<u>Trial Pit Dimensions</u>		
Length (m)	1.50	
Width (m)	0.60	
Depth (m)	2.20	
Effective Depth (m)	1.02	
tp ₇₅ (mins)	149	
tp ₂₅ (mins)	15.5	
<u>Calculations</u>		
V _{p₇₅₋₂₅}	0.14	
a _{p₅₀}	3.05	
tp ₇₅₋₂₅	133.5	
f = 5.65E-06 m/s		
f = 2.04E-02 m/h		

NB Volume adjusted by a factor of 0.3 to allow for presence of gravel in trial pit

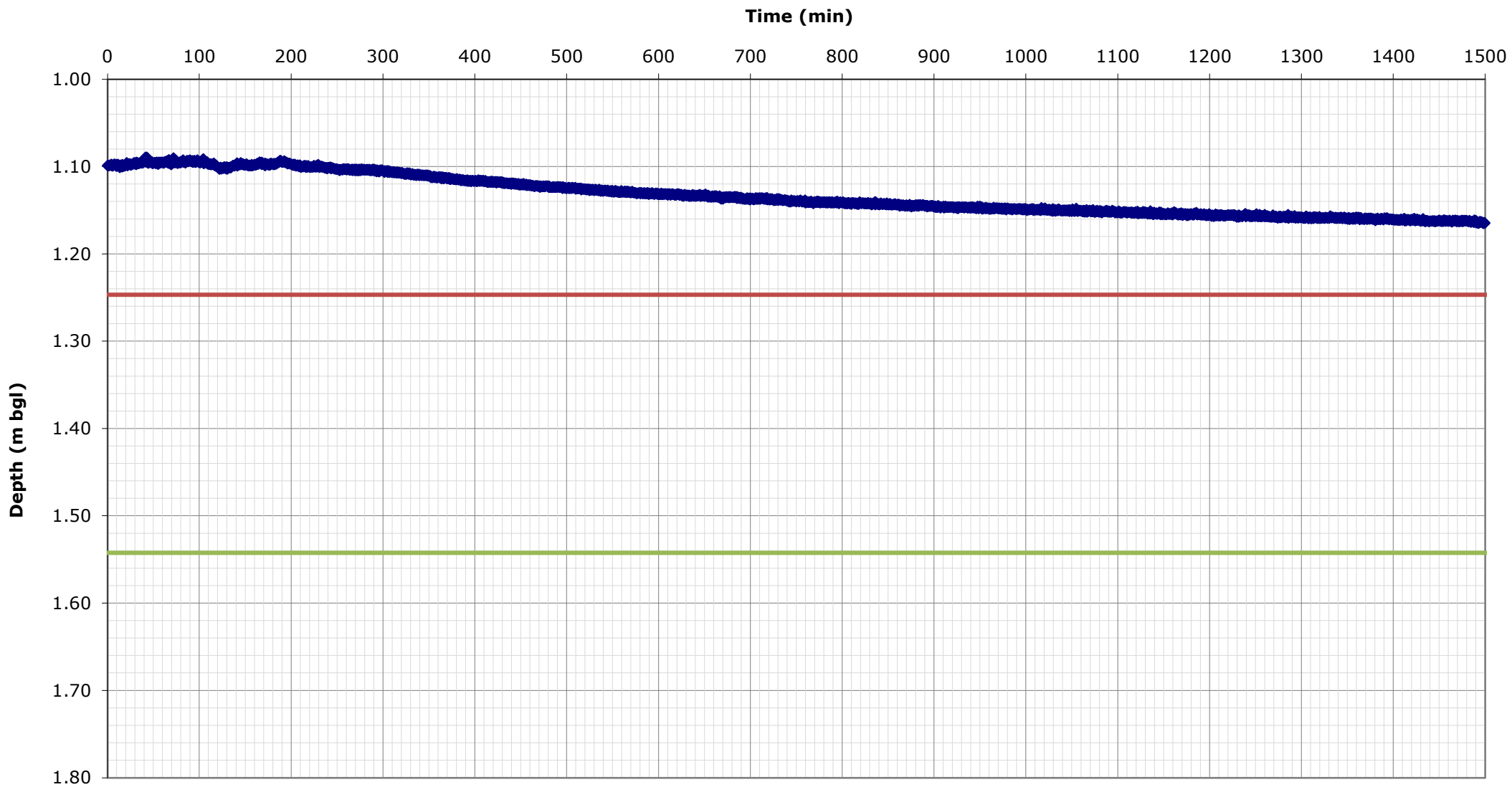
62242 - Hillcrest & Tussocks, The Causeway, Therfield - TP01 - Test 1 of 1

25% Effective Storage Depth 75% Effective Storage Depth Measured data



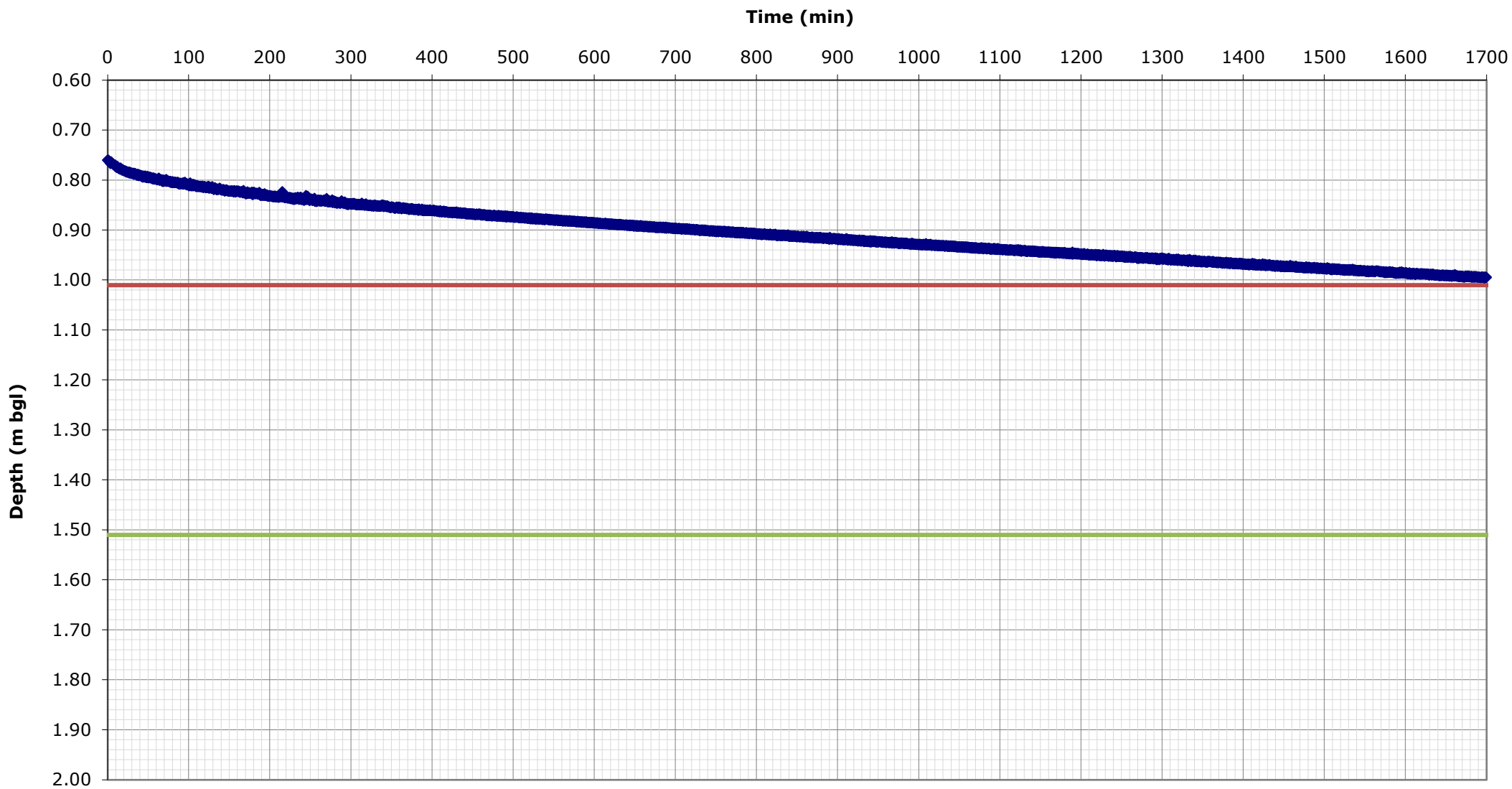
62242 - Hillcrest & Tussocks, The Causeway, Therfield - TP02 - Test 1 of 1

25% Effective Storage Depth 75% Effective Storage Depth Measured data



62242 - Hillcrest & Tussocks, The Causeway, Therfield - TP03 - Test 1 of 1

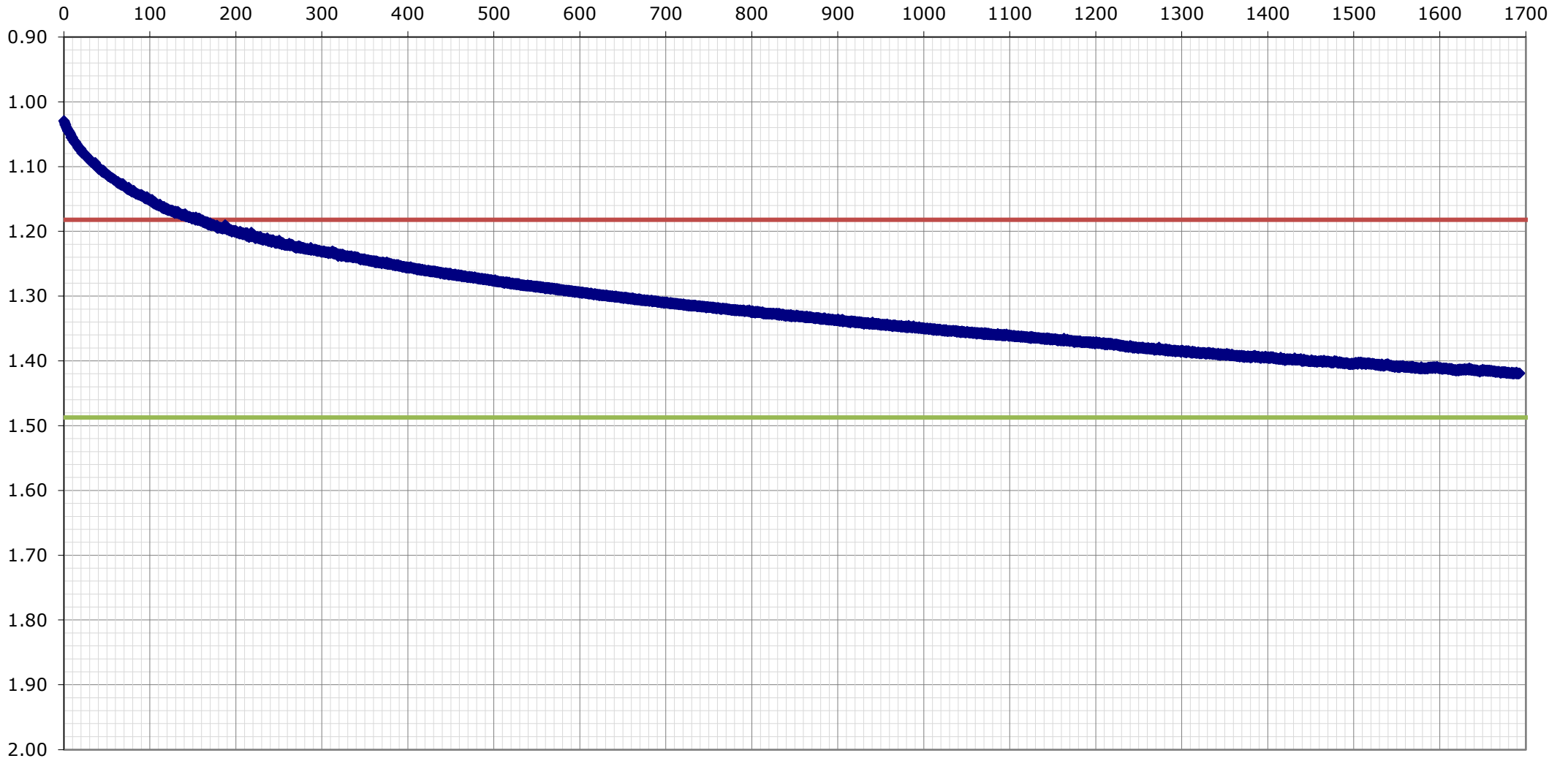
25% Effective Storage Depth 75% Effective Storage Depth Measured data



62242 - Hillcrest & Tussocks, The Causeway, Therfield - TP04 - Test 1 of 1

25% Effective Storage Depth 75% Effective Storage Depth Measured data

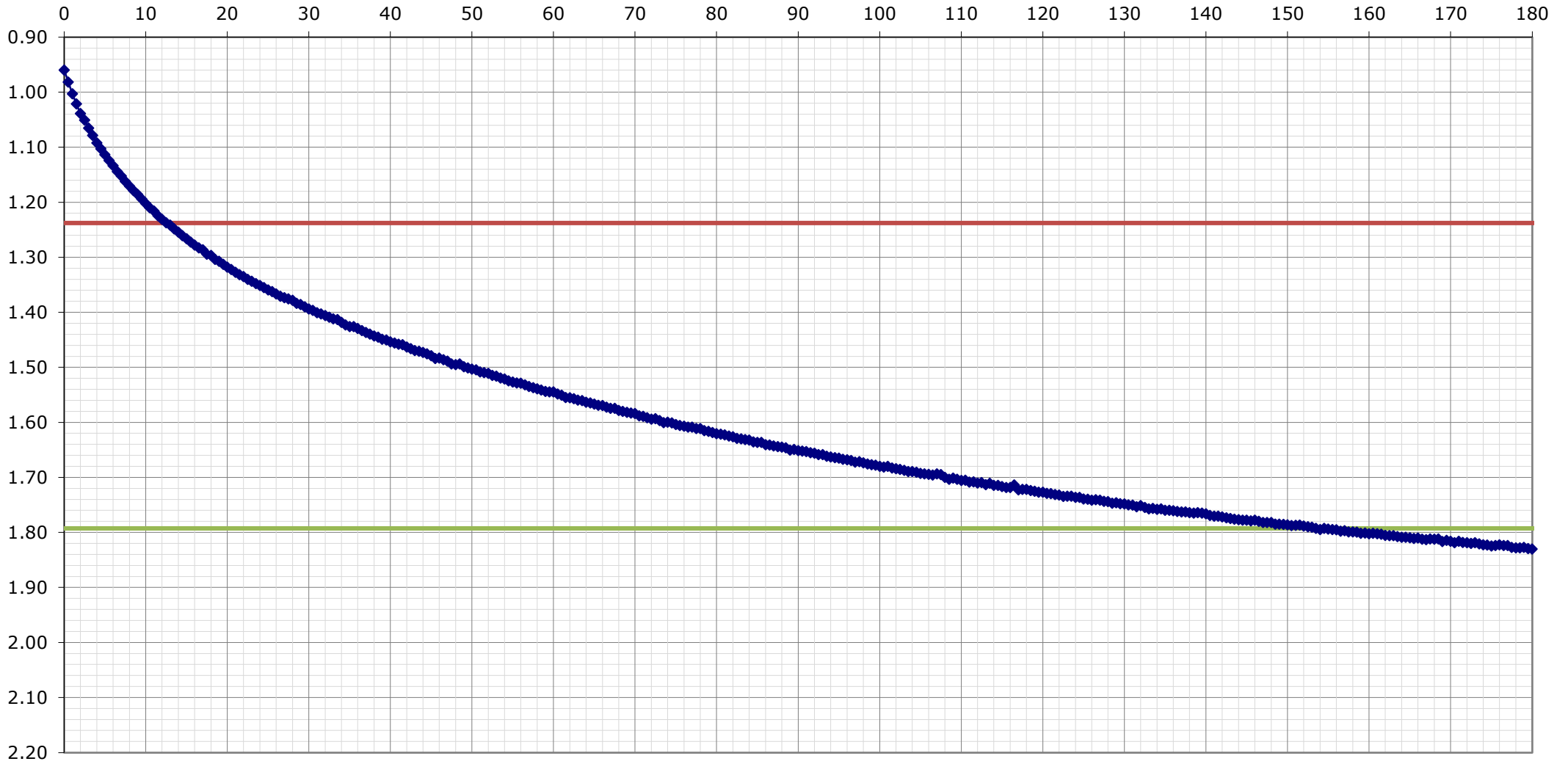
Time (min)



62242 - Hillcrest & Tussocks, The Causeway, Therfield - TP05 - Test 1 of 3

25% Effective Storage Depth 75% Effective Storage Depth Measured data

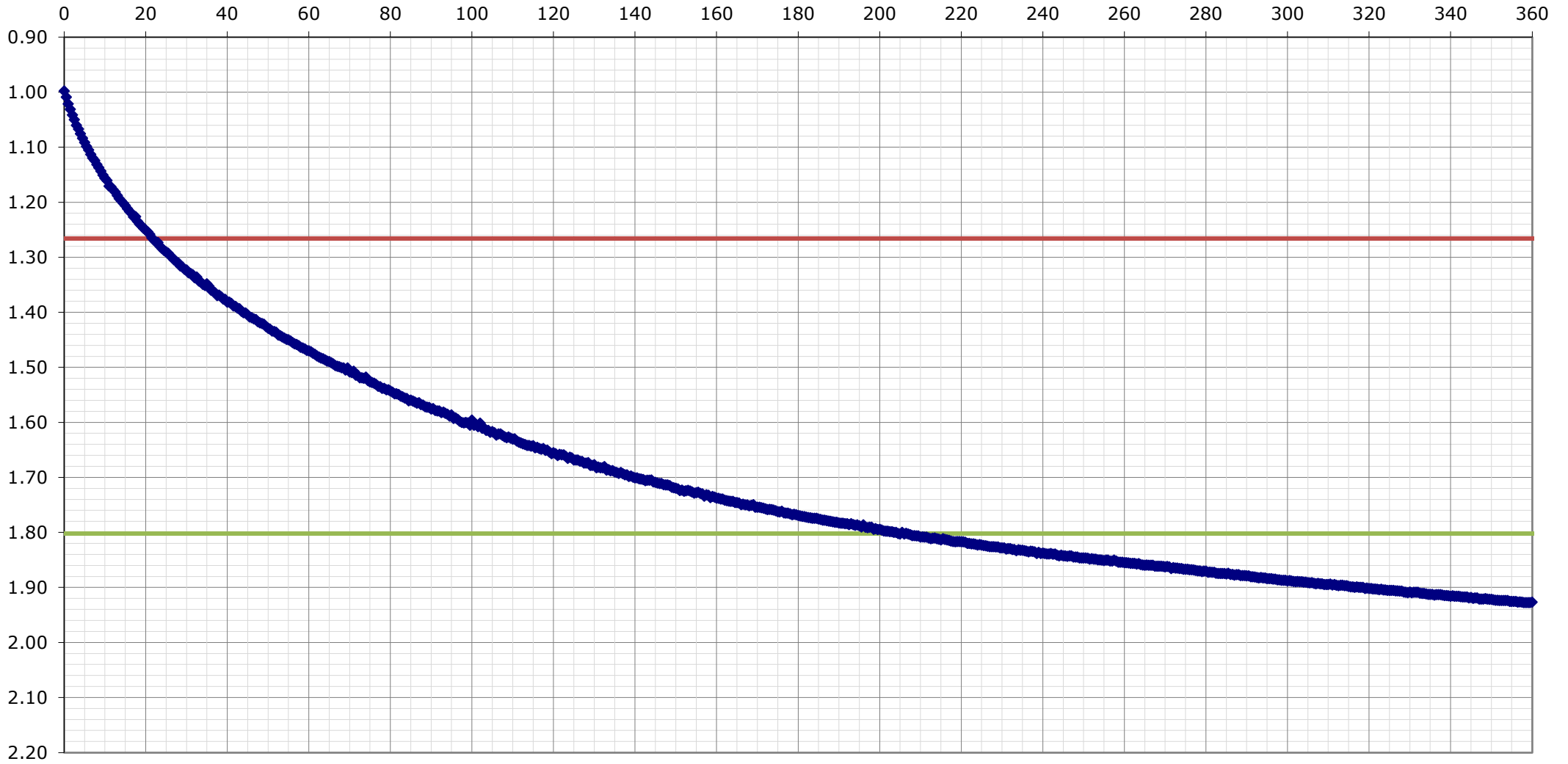
Time (min)



62242 - Hillcrest & Tussocks, The Causeway, Therfield - TP05 - Test 2 of 3

25% Effective Storage Depth 75% Effective Storage Depth Measured data

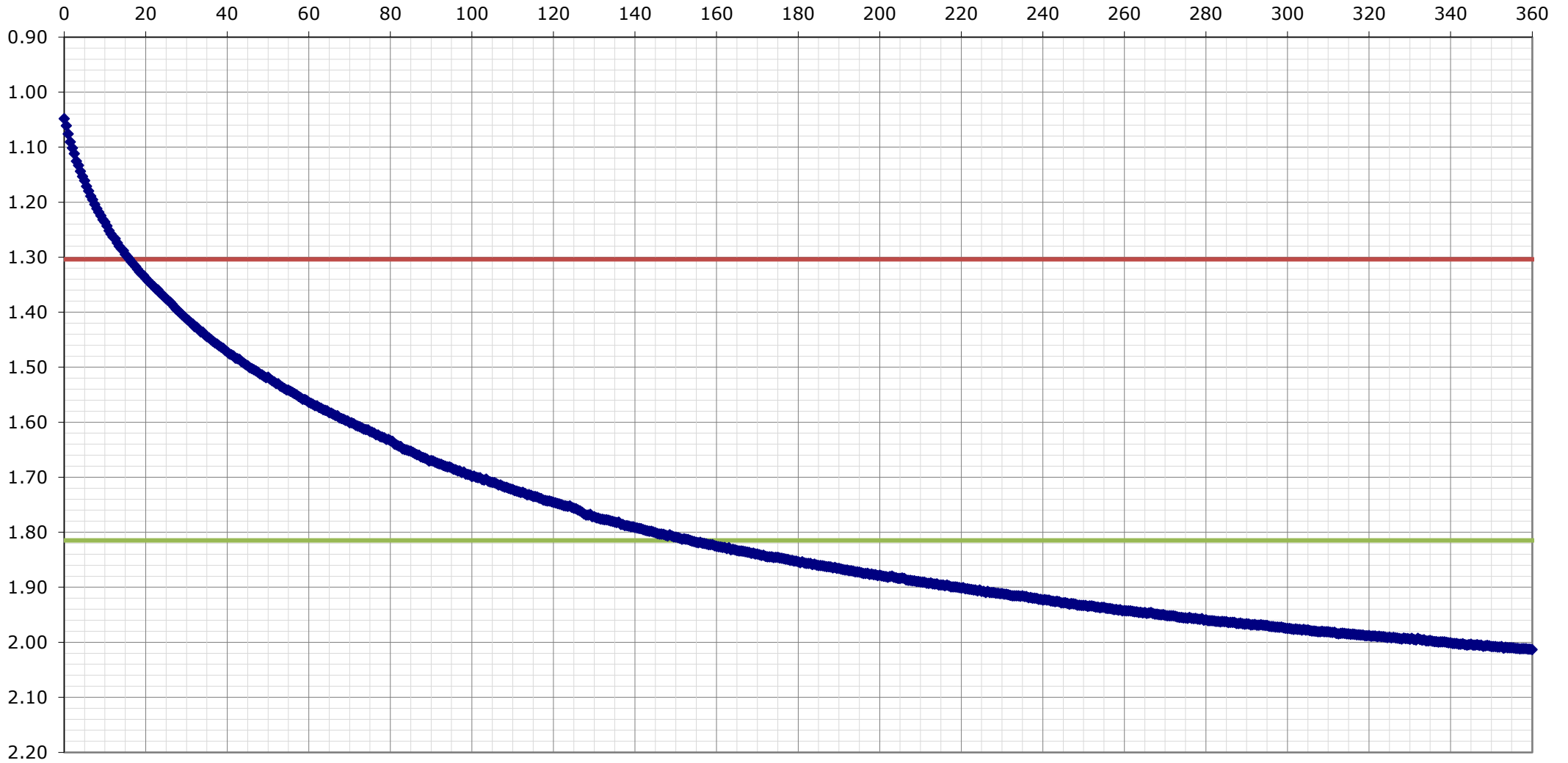
Time (min)



62242 - Hillcrest & Tussocks, The Causeway, Therfield - TP05 - Test 3 of 3

25% Effective Storage Depth 75% Effective Storage Depth Measured data

Time (min)



Limitations of Investigation

This report is based on the results of the exploratory boreholes, the laboratory testing carried out on samples recovered from those boreholes and on details of the scheme provided by the Client.

This report has been prepared for the benefit of Hanson Services Ltd and its contents should not be relied upon by others without the written authority of Richard Jackson Ltd. If any unauthorised third party makes use of this report they do so at their own risk and Richard Jackson Ltd owes them no duty of care or skill.

All information provided by others is taken as being in good faith as being accurate, but Richard Jackson Ltd cannot, and does not; accept any liability for the detailed accuracy, errors or omissions in such information.

Subsoils are by their nature hidden from view and no investigation can be exhaustive to the extent that all soil conditions are revealed. Conditions may well be present beneath the site which was not evident from the investigations carried out.

Geological data, with the exception of geological maps held by Richard Jackson Ltd, Ordnance Survey maps and aerial photographs have not been inspected, nor has any other data relating to site conditions past or present, or any information regarding underground services, other than as indicated. Groundwater levels can be subject to considerable seasonal variations, and the conditions encountered in the exploratory holes may not reflect long-term conditions.

There can be no guarantee that the samples analysed represent the highest concentrations of contamination present beneath the site. The chemical analysis results have been assessed to standards appropriate at the time of investigation.

Unless a greater period of retention of samples is agreed, it is our normal practice to discard all samples one month after submission of our final report.

30th September 2024

EAS Civil Engineering Consultants
1st Floor Millers House,
Roydon Road,
Stanstead Abbots,
SG12 8HN

Attention Of: James Cahuzac

Subject: Therfield – Falling-head infiltration testing, supplementary investigation
TRC Project No. 611601.0000.0000

Dear James,

TRC Companies Limited (TRC) was commissioned by EAS Civil Engineering Consultants (the 'Client') to carry out an investigation to appraise the ground conditions at the property located at The Causeway, Hay Green, Therfield, SG8 9PP (the 'Site').

TRC has previously undertaken a Soakage Testing Letter Report (report reference: 611601.0001.0000, 31st July 2024). The purpose of the assessment was to undertake soakage testing in the underlying unweathered chalk, that could not be undertaken during the previous phase of investigation. This letter report details of the findings of the intrusive investigation carried out at the Site by TRC.

I trust that this report is satisfactory and meets with your project requirements. Please do not hesitate to contact me if you have any questions regarding the works.

Yours sincerely,

TRC



James Gooding-Hurst CEnv
Senior Geoenvironmental Consultant

Attachments: Attachment 1 – Letter Report
Attachment 2 – Figures
Attachment 3 – Exploratory Hole Logs
Attachment 4 – Infiltration Calculations

Attachment 1

Report

1.0 Introduction

1.1 Purpose

TRC Companies Limited (TRC) was commissioned by EAS Civil Engineering Consultants (the 'Client') to undertake an intrusive ground investigation at the property located at The Causeway, Hay Green, Therfield, SG8 9PP (the 'Site'). The purpose of the assessment was to estimate the soakage rates at the Site to confirm the geological conditions and suitability for drainage via soakaway.

A Site location plan is presented as Figure 1 in Attachment 2.

1.2 Background Information

The Site comprises an approximate 0.57 ha plot of land centred on National Grid Reference 533589, 237372. It is located to the east of The Causeway, bordered by residential buildings to the north, undeveloped fields to the east, and the Therfield First School to the south.

Geological mapping shows that the majority of the Site comprises superficial deposits from the Lowestoft Formation, underlain by the bedrock deposits from the Lewes Nodular Chalk Formation and Seaford Chalk Formation. Lewes Nodular Chalk Formation and Seaford Chalk Formation is classified by the Environment Agency as Principal Aquifer and the Lowestoft Formation is designated as a Secondary (undifferentiated) Aquifer.

The ground profile from previous phase of investigation (TRC Soakage Letter Report, Dates 31st July 2024, report ref: 611601.0000.0000) is summarised in the table below:

Table 1: Summary of Ground Conditions

Strata	Description	Observed Thickness (m)	Range Depth to top of Strata (m)	Maximum recorded depth (m)
Topsoil	Dark brown matted rootlets chalk and flint gravel.	0.20 – 0.40	0.00	0.40
Lowestoft Formation	Firm brown to stiff light brownish slightly sandy slightly gravelly CLAY. Gravel consists of chalk and flint.	0.00 – 9.00	0.20 – 0.40	8.80
Lewes Nodular Chalk Formation and Seaford Chalk Formation	White clayey slightly sandy slightly gravelly SILT.	1.20 – 6.80	0.20 – 0.40	6.55

1.3 Scope of Work

TRC was engaged to perform an assessment of soakaway viability. The scope of works was defined by the Client's design engineer, namely EAS Civil Engineering Consultants. The scope comprised the following works:

- A cable percussive drilling rig was mobilised to Site;
- One location was cleared using a Cable Avoidance Tool;
- One soakaway borehole (BH101) was drilled to 20m below ground level (bgl);
- Geological logging was undertaken in the exploratory hole to record soil types;
- Installation of the borehole to facilitate falling head test; and,
- Falling-head tests were performed at the location.

1.4 Significant Assumptions

This report presents TRC's observations, findings, and conclusions as they existed on the date that this report was issued. The report is subject to modification if TRC becomes aware of additional information after the date of this report that is material to its findings and conclusions.

The reliability of information provided by others to TRC cannot be guaranteed to be accurate or complete. Performance of this report is intended to reduce, but not eliminate, uncertainty of geo-environmental and geotechnical conditions associated with the subject site; therefore, the findings and conclusions made in this report should not be construed to warrant or guarantee the subject site, or express or imply, including without limitation, warranties as to its marketability for a particular use. TRC found no reason to question the validity of information received unless explicitly noted elsewhere in this report.

1.5 User Reliance

This report was prepared for EAS Civil Engineering Consultants. Reliance on the report by any other third party is subject to requesting and fully executing a reliance letter between TRC and the third party that acknowledges the TRC Standard Terms and Conditions with the client, to the same extent as if they were the client thereunder.

TRC has been provided with information from third parties for information purposes only and without representation or warranty, express or implied as to its accuracy or completeness and without any liability on such third parties part to revise or update the information. Where reliance has been provided by third parties to potential purchasers this is noted in our report.

2.0 Factual Summary of Investigation Findings

2.1 Ground Conditions

The British Geological Survey (BGS) online GeoIndex and previous investigations indicates that the Site's geology consists of Lowestoft Formation over Lewes Nodular Chalk Formation and Seaford Chalk Formation.

Table 2 presents a summary of the ground conditions encountered by TRC at the Site, during this investigation phase. For full details of the ground descriptions the reader should refer to the exploratory log appended in Attachment 3.

Table 2: Summary of Ground Conditions

Strata	Description	Observed Thickness (m)	Depth to top of Strata (m)	Maximum recorded depth (m)
Topsoil	Dark brown sandy slightly gravelly CLAY with frequent rootlets. Gravel consists of chalk and flint.	0.10	0.00	0.10
Lowestoft Formation	Firm brown to stiff light brownish slightly sandy slightly gravelly CLAY. Gravel consists of chalk and flint.	14.00	0.10	14.10
Lewes Nodular Chalk Formation and Seaford Chalk Formation	White with occasional orange brown discolored CHALK recovered as structureless low density chalk gravel in silt.	5.90	14.10	>20.00

Topsoil

Topsoil comprised reworked dark brown gravelly CLAY with matted rootlets. Gravel consisted of chalk and flint.

Lowestoft Formation

The Lowestoft Formation was observed underlying the topsoil; this unit was generally homogeneous in nature and comprised orangish to greyish brown slightly sandy slightly gravelly CLAY. Gravel consisted of chalk and flint.

Lewes Nodular Chalk Formation and Seaford Chalk Formation

The Lewes Nodular Chalk Formation and Seaford Chalk Formation were encountered underlying the Topsoil and Lowestoft Formation. The chalk comprised white with occasional orange brown discolored CHALK recovered as structureless low density chalk gravel in silt.

2.2 Visual and Olfactory Evidence of Contamination

No visual or olfactory evidence of contamination was encountered during the ground investigation.

2.3 Laboratory Analysis

No soil samples have been taken for laboratory analysis.

3.0 Falling Head Permeability Testing

3.1 Introduction and Assessment Methodology

Three falling head permeability tests were carried out in BH101 targeting the Lewes Nodular Chalk Formation and Seaford Chalk Formation.

The infiltration tests were undertaken following installation of the borehole, based on a modified BRE Digest 365 (Soakaway Design, 2016) methodology. Installation details are shown in the borehole log in Attachment 3. The borehole was filled with clean water and was allowed to drain on the same day. The last test was not completed to 25% due to time constraints.

Given the singular location tested, the results shown in the table below should be considered indicative for the location tested only. Variation of ground permeability across the Site cannot be ruled out.

3.2 Falling Head Test Results

The falling head test results are summarised in the table below:

Table 3: Permeability Test Results

Exploratory Hole	Response Zone (m bgl)	Type of Test	Stratum	Test No	Calculated Permeability (m/s)	Comments
BH101	14.00 – 20.00	Falling Head	Lewes Nodular Chalk Formation and Seaford Chalk Formation	1	2.16×10^{-6}	Borehole was nearly emptied at finish of test.
				2	1.86×10^{-6}	Borehole was nearly emptied at finish of test.
				3	1.87×10^{-6}	Water fell to about 30% maximum water level. Calculations were based on actual fall of water level achieved. Result not compliant with BRE 365 requirement since water did not fall to 25% max water depth.

The results indicate low to medium permeability values for the Lewes Nodular Chalk Formation and Seaford Chalk Formation.

Typically, a minimum soakage rate of 1.6×10^{-6} m/sec is required for conventional soakaways to meet the BRE Digest 365 requirement for a soakaway half empty for a time period of less than 24 hours. The results indicate that the soakage rates are all slightly above the required value of 1.6×10^{-6} m/sec.

It is recommended that the test results be reviewed by an experienced drainage engineer. A safety factor may be desirable to be applied to the permeability values presented in this letter report should deep soakage drainage be adopted at the Site.

4.0 Conclusions

The investigation confirmed that the ground conditions at the Site reflect the information published by the British Geological Survey (BGS), comprising Lowestoft Formation over Lewes Nodular Chalk Formation and Seaford Chalk Formation at depth.

Falling head permeability tests undertaken following a modified BRE 365 methodology indicated soakage testing in the Lewes Nodular Chalk Formation and Seaford Chalk Formation may be possible for deep soakage drainage.

It is recommended that the permeability test results be reviewed by an experienced drainage engineer. A safety factor may be desirable to be applied to the permeability values presented in this letter report should soakage drainage be adopted at the Site.

Attachment 2 Figures



NOTES	COPYRIGHT NOTES			REVISIONS			Work.Life 20 Red Lion Street London WC1R 4PS		TITLE SITE LOCATION PLAN					
									TRC PROJECT NO. 611601	SCALE MAP A: 1:5,000 at A3 MAP B: 1:600 at A3				
	Aerial Imagery September 2024			P01			FIRST ISSUE		CLIENT EAS Civil Engineering Consultants		PURPOSE OF ISSUE SUITABLE FOR INFORMATION		STATUS FINAL	
				© OpenStreetMap contributors - Data is available under the Open Database License. Cartography licensed as CC BY-SA.			REV.			REVISION NOTES/COMMENTS		PROJECT Hillcrest & Tussocks, the Causeway, Therifield		DRAWING NO FIGURE 01



NOTES	COPYRIGHT NOTES Google Imagery January 2024			REVISIONS				 Work.Life 20 Red Lion Street London WC1R 4PS		TITLE EXPLORATORY HOLE LOCATION PLAN		
										TRC PROJECT NO. 611601		SCALE 1:500 at A3
				P01	FIRST ISSUE			CLIENT EAS CIVIL ENGINEERING CONSULTANTS		PURPOSE OF ISSUE SUITABLE FOR INFORMATION		STATUS FINAL
					Initials	KS	26/09/2024					
							REV.	REVISION NOTES/COMMENTS				PROJECT Hillcrest & Tussocks, the Causeway, Therifield
Initials												

Attachment 3

Exploratory Hole Logs

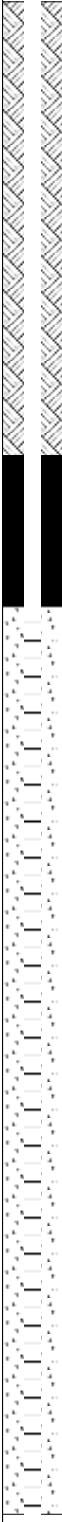
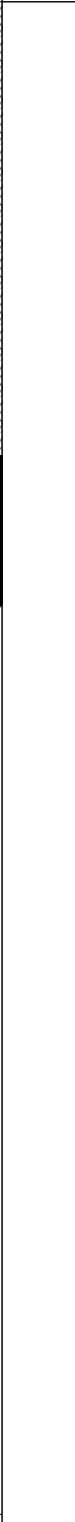
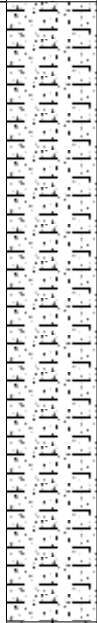
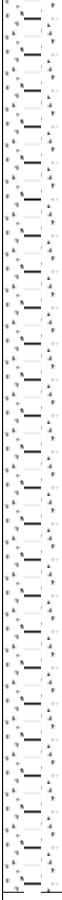
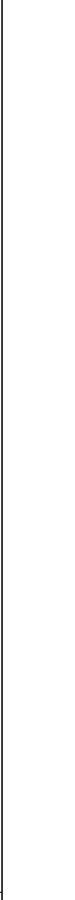
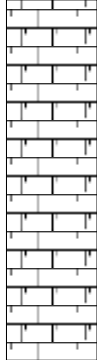


Project Name: Therfield Infiltration Testing				Client: EAS Civil Engineering Consultants				Date: 16/09/2024			
Location: The Causeway, Hay Green, Therfield, SG8 9PP				Subcontractor: Bowman Drilling Ltd				Co-ords: E533627.69 N237384.31			
Project No. : 611601.0000.0000				Crew Name: Bowman Drilling Ltd				Drilling Equipment: Dando 3000			
Borehole Number BH101		Hole Type CP		Level		Logged By James Gooding-Hurst		Scale 1:50		Page Number Sheet 1 of 2	
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					0.10			Dark brown sandy slightly gravelly CLAY with frequent rootlets throughout. Sand is fine to coarse grained. Gravel is sub-round to rounded fine and medium of chalk and flint. TOP SOIL. Firm greyish brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse grained. Gravel is angular to sub-rounded fine to coarse of chalk and flint. (LOWESTOFT FORMATION)		1	
											2
										3	
										4	
										5	
										6	
										7	
										8	
										9	
											10
Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20	200	1.50	150								
20.00	150										
Remarks											
Hand dug pit conducted to 1.20mbgl for service clearance.											
Borehole terminated at required depth.											
Borehole stable throughout											
Groundwater not encountered.											
Monitoring well installed: 0.00-14.00m plain pipe with bentonite annulus, 14.00-20.00m 50mm slotted pipe with gravel annulus.											



Percussion Drilling Log

Project Name: Therfield Infiltration Testing		Client: EAS Civil Engineering Consultants		Date: 16/09/2024	
Location: The Causeway, Hay Green, Therfield, SG8 9PP		Subcontractor: Bowman Drilling Ltd		Co-ords: E533627.69 N237384.31	
Project No. : 611601.0000.0000		Crew Name: Bowman Drilling Ltd		Drilling Equipment: Dando 3000	
Borehole Number BH101	Hole Type CP	Level	Logged By James Gooding-Hurst	Scale 1:50	Page Number Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
								Stiff brown grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse grained. Gravel is angular to sub-rounded fine to coarse of Chalk, flint. (LOWESTOFT FORMATION)	11
									12
									13
					14.10				14
								Off white with occasional orange brown discolouration CHALK recovered as structureless melange comprising 30-40% chalk gravel in silt size chalk matrix. Gravel is low density and subangular flint. (LEWES NODULAR CHALK AND SEAFORD CHALK FORMATION)	15
									16
					16.50			White with rare orange brown discolouration CHALK recovered as structureless low density chalk. (LEWES NODULAR CHALK AND SEAFORD CHALK FORMATION)	17
									18
					20.00				19
								End of Borehole at 20.000m	20

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
1.20 20.00	200 150	1.50	150								

Remarks Hand dug pit conducted to 1.20mbgl for service clearance. Borehole terminated at required depth. Borehole stable throughout Groundwater not encountered. Monitoring well installed: 0.00-14.00m plain pipe with bentonite annulus, 14.00-20.00m 50mm slotted pipe with gravel annulus.										
--	--	--	--	--	--	--	--	--	--	---

Attachment 4

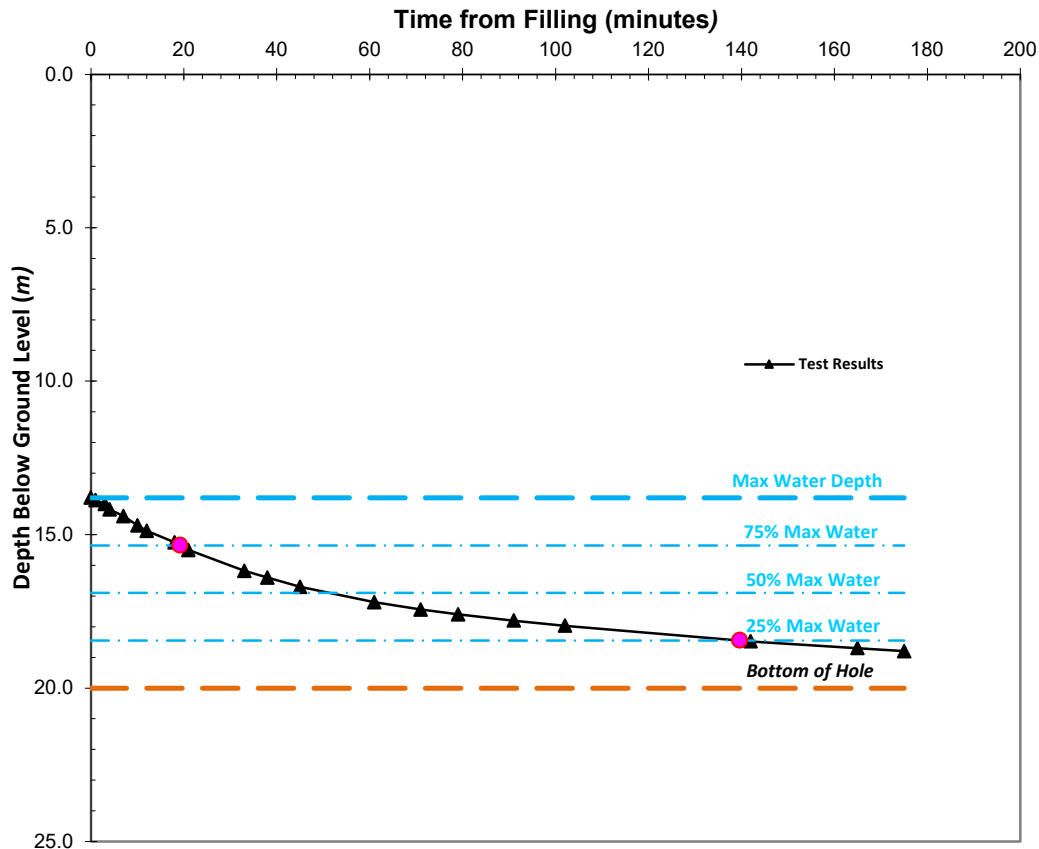
Infiltration Calculations

Preliminary Falling-Head Soakage Test



Test Hole No: BH101

Test No: Test No 1 (Initial)



Diameter of Borehole, (m)	0.15	Depth to Water at Start of Test (m)	13.80
Depth to End of Borehole Casing (m)	0.00	Max Water Dropdown during Test (m)	5.00
Depth to Borehole Base (m)	20.00	Total Soakage Test Time (min)	175.0
Depth to Top of Permeable Soils (m)	14.10	Mean Internal Discharge Area (m ²)	1.479
Depth to Groundwater Surface (m)		Discharge Rate (litre/min)	0.192
Depth to Top of Granular Fill (m)	14.00	Soakage Rate (litre/m ² /min)	0.130
Voids Assumed within Borehole (%)	42%	BRE Soil Infiltration Rate (m/sec)	2.16E-06

Comments:

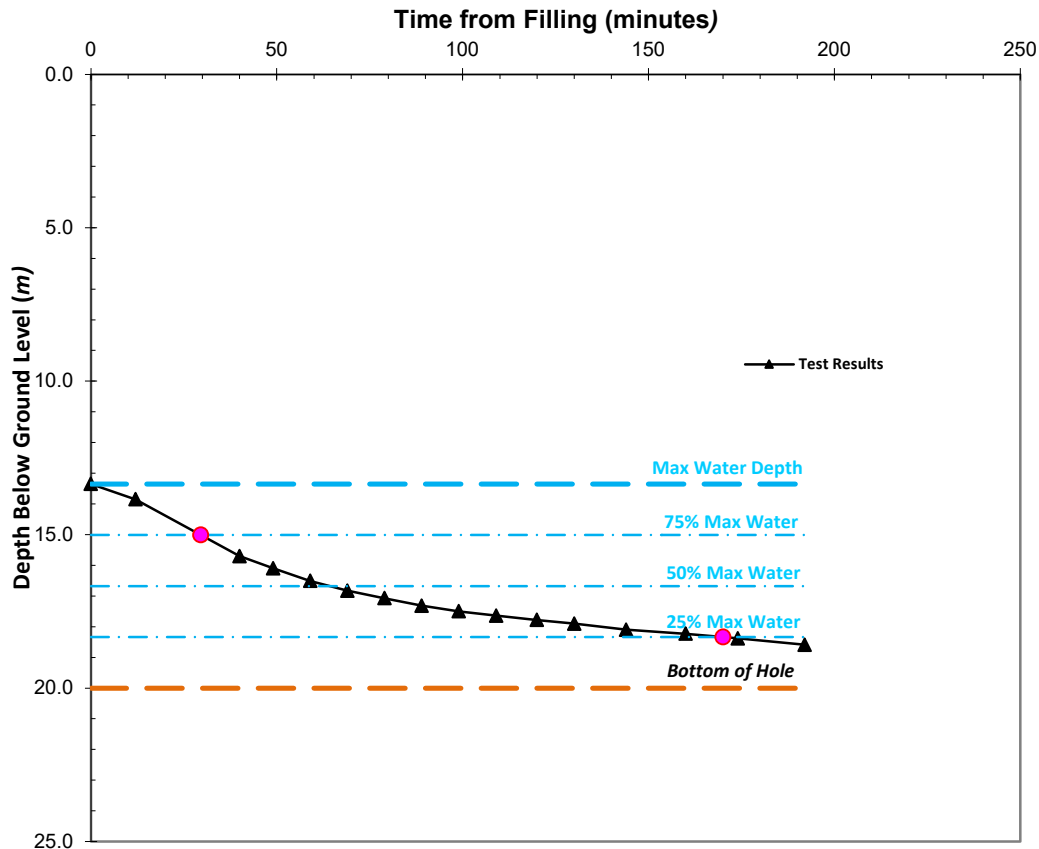
Pit was nearly emptied at finish of test.

Client: EAS Civil Engineering Consultants	Job No: 611601	Test Date: 24/Jun/2024
Project: Therfield infiltration testing	Tested By: JG	Engineer: MD Fig. S1

Preliminary Falling-Head Soakage Test



Test Hole No: BH101
Test No: Test No 2 (Repeated)



Diameter of Borehole, (m)	0.15	Depth to Water at Start of Test (m)	13.35
Depth to End of Borehole Casing (m)	0.00	Max Water Dropdown during Test (m)	5.24
Depth to Borehole Base (m)	20.00	Total Soakage Test Time (min)	192.0
Depth to Top of Permeable Soils (m)	14.10	Mean Internal Discharge Area (m ²)	1.585
Depth to Groundwater Surface (m)		Discharge Rate (litre/min)	0.177
Depth to Top of Granular Fill (m)	14.00	Soakage Rate (litre/m ² /min)	0.111
Voids Assumed within Borehole (%)	42%	BRE Soil Infiltration Rate (m/sec)	1.86E-06

Comments:

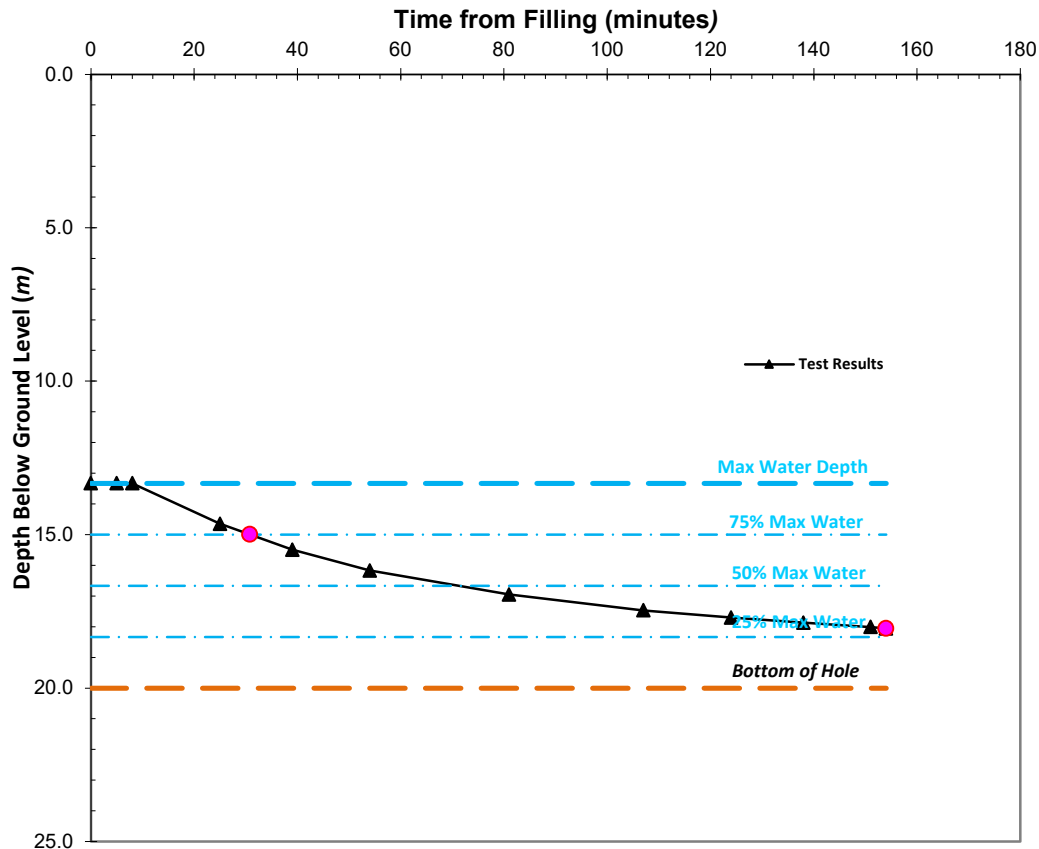
Pit was nearly emptied at finish of test.

Client: EAS Civil Engineering Consultants	Job No: 611601	Test Date: 24/Jun/2024
Project: Therfield infiltration testing	Tested By: JG	Engineer: MD Fig. S2

Preliminary Falling-Head Soakage Test



Test Hole No: BH101
Test No: Test No 3 (Repeated)



Diameter of Borehole, (m)	0.15	Depth to Water at Start of Test (m)	13.33
Depth to End of Borehole Casing (m)	0.00	Max Water Dropdown during Test (m)	4.73
Depth to Borehole Base (m)	20.00	Total Soakage Test Time (min)	154.0
Depth to Top of Permeable Soils (m)	14.10	Mean Internal Discharge Area (m ²)	1.653
Depth to Groundwater Surface (m)		Discharge Rate (litre/min)	0.185
Depth to Top of Granular Fill (m)	14.00	Soakage Rate (litre/m ² /min)	0.112
Voids Assumed within Borehole (%)	42%	BRE Soil Infiltration Rate (m/sec)	1.87E-06

Comments:

Water level fell to 50% -- 25% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

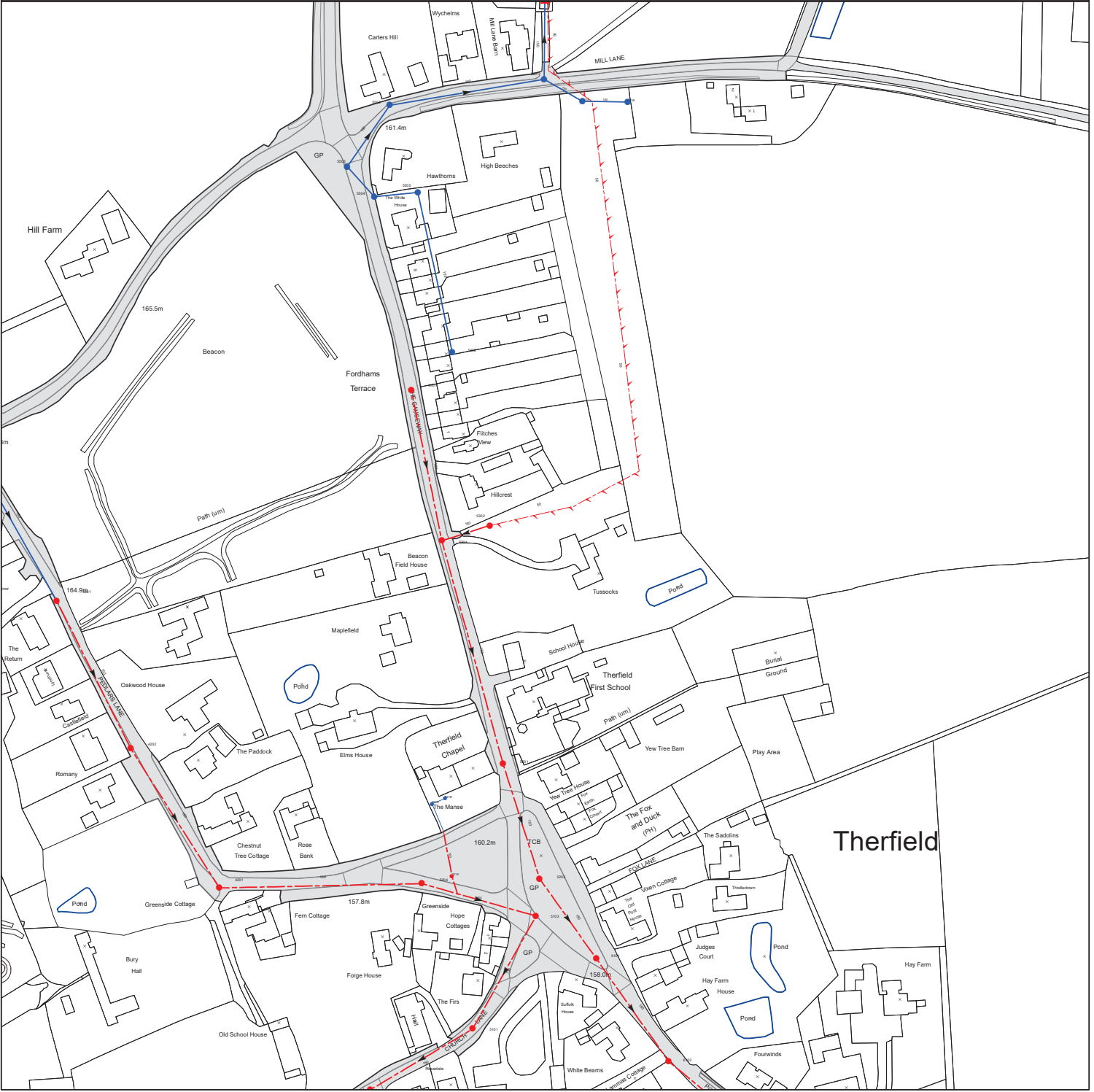
Client: EAS Civil Engineering Consultants	Job No: 611601	Test Date: 24/Jun/2024
Project: Therfield infiltration testing	Tested By: JG	Engineer: MD Fig. S3



Summary
Results of Preliminary Falling-Head Soakage Tests

Project : Therfield infiltration testing					Job No : 611601		
Client : EAS Civil Engineering Consultants					Grid Reference : E533567, N237412		
Tested By : JG				Engineer: MD		Test Date : 24/Jun/2024	
Hole No	Test No	Hole Depth (m)	Soakage Rate for Each Test (litre/m ² /min)	Soakage Rate for Each Hole (litre/m ² /min) (m/sec)		Water Level at Finish of Test	Remarks
BH101	No 1	20.00	0.130	0.111 1.86E-6		Nearly empty pit.	Depth to top of permeable soils was 14.1m.
BH101	No 2	20.00	0.111			Nearly empty pit.	
BH101	No 3	20.00	0.112			Pit was not emptied; Non compliant value was calculated.	
Mean Value of All Calculated Soakage Rates :				0.111 1.86E-6 <i>litre/m²/min m/sec</i>			

Appendix F - Thames Water Asset Location Plan



The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified before any works are undertaken. Crown copyright Reserved

Scale: 1:1789 Width: 500m Printed By: G1KANAGA Print Date: 12/09/2023 Map Centre: 533597,237369 Grid Reference: TL3337SE	Comments:
--	-------------------------

ALS/ALS Standard/2023_4883042

NB: Level quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates no Survey information is available.

REFERENCE	COVER LEVEL	INVERT LEVEL
6102		
5204	158.41	156.22
5101	157.08	155.52
5201	160.83	159.42
5202	159.69	158.11
3301	164.91	161.5
4201	158.32	156.71
5402		
5503	162.33	161.02
5502	161.87	160.35
651A		
521B		

REFERENCE	COVER LEVEL	INVERT LEVEL
5401	165.27	164.34
5301	163.73	162.3
5302	165.24	163.91
5103	158.49	155.88
6101	158.78	156.56
4202	161.36	160.07
5505	164.7	163.61
6501	161.11	159.55
5504	163.32	162.03
521A		
651B		
521C		

Appendix G – Surface Water Flood Mapping



EA Surface Water Maps

Appendix H – Causeway Flow Calculations

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	30	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	1.000	Preferred Cover Depth (m)	0.900
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.014	5.00	166.100	1200	15.108	101.807	1.050
2	0.014	5.00	165.800	1200	19.996	54.410	1.050
3			165.950	1200	18.084	79.915	1.510
4	0.031	5.00	167.200		86.521	84.591	1.000
5			167.000	1200	71.219	83.741	3.360
6	0.018	5.00	164.400		94.762	-68.850	1.050
7			165.000	1200	83.189	-19.473	1.730
8	0.042	5.00	165.700		93.101	-2.817	1.000
9			165.700		80.783	5.951	3.520
10	0.062	5.00	163.500		-15.309	-19.473	1.477
10_OUT			163.300	1200	-34.304	-10.422	1.328

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	3	17.000	0.600	165.050	164.440	0.610	27.9	150	5.15	50.0
2.000	2	3	6.200	0.600	164.750	164.440	0.310	20.0	150	5.05	50.0
1.001	3	5	16.000	0.600	164.440	163.640	0.800	20.0	150	5.27	50.0
3.000	4	5	4.000	0.600	166.200	166.000	0.200	20.0	100	5.04	50.0
1.002	5	9	32.000	0.600	163.640	162.840	0.800	40.0	150	5.60	50.0
4.000	6	7	8.000	0.600	163.350	163.270	0.080	100.0	150	5.13	50.0
4.001	7	9	30.269	0.600	163.270	162.330	0.940	32.2	150	5.42	50.0
5.000	8	9	1.500	0.600	164.700	164.625	0.075	20.0	100	5.01	50.0
1.003	9	10	37.621	0.600	162.180	162.023	0.157	240.0	300	6.22	50.0
1.004	10	10_OUT	5.118	0.600	162.023	161.972	0.051	100.0	225	6.29	50.0

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	17.000	27.9	150	Circular	166.100	165.050	0.900	165.950	164.440	1.360
2.000	6.200	20.0	150	Circular	165.800	164.750	0.900	165.950	164.440	1.360
1.001	16.000	20.0	150	Circular	165.950	164.440	1.360	167.000	163.640	3.210
3.000	4.000	20.0	100	Circular	167.200	166.200	0.900	167.000	166.000	0.900
	Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type	
	1.000	1	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable	
	2.000	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable	
	1.001	3	1200	Manhole	Adoptable	5	1200	Manhole	Adoptable	
	3.000	4		Junction		5	1200	Manhole	Adoptable	

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.002	32.000	40.0	150	Circular	167.000	163.640	3.210	165.700	162.840	2.710
4.000	8.000	100.0	150	Circular	164.400	163.350	0.900	165.000	163.270	1.580
4.001	30.269	32.2	150	Circular	165.000	163.270	1.580	165.700	162.330	3.220
5.000	1.500	20.0	100	Circular	165.700	164.700	0.900	165.700	164.625	0.975
1.003	37.621	240.0	300	Circular	165.700	162.180	3.220	163.500	162.023	1.177
1.004	5.118	100.0	225	Circular	163.500	162.023	1.252	163.300	161.972	1.103

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.002	5	1200	Manhole	Adoptable	9		Junction	
4.000	6		Junction		7	1200	Manhole	Adoptable
4.001	7	1200	Manhole	Adoptable	9		Junction	
5.000	8		Junction		9		Junction	
1.003	9		Junction		10		Junction	
1.004	10		Junction		10_OUT	1200	Manhole	Adoptable

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	2 year (l/s)	4.8
Rainfall Events	Singular	Drain Down Time (mins)	3600	30 year (l/s)	13.1
Summer CV	1.000	Additional Storage (m³/ha)	0.0	100 year (l/s)	17.0
Winter CV	1.000	Starting Level (m)		Check Discharge Volume	✓
Analysis Speed	Normal	Check Discharge Rate(s)	✓	100 year 360 minute (m³)	197

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440
----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	------

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
30	40	0	0
100	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Betterment (%)	0
Greenfield Method	ReFH2	Q 1 year (l/s)	
Region	England, Wales, NI	Q 30 year (l/s)	
Include Baseflow	x	Q 100 year (l/s)	
Positively Drained Area (ha)	1.000		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	ReFH2	Storm Duration (mins)	360
Region	England, Wales, NI	Betterment (%)	0
Include Baseflow	x	Runoff Volume (m³)	197
Positively Drained Area (ha)	1.000		



Node 10 OUT Surcharged Outfall

Overrides Design Area	x	Depression Storage Area (m ²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		
Applies to All storms					

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
0	0.225	300	0.225	600	0.225	900	0.225	1200	0.225
60	0.225	360	0.225	660	0.225	960	0.225	1260	0.225
120	0.225	420	0.225	720	0.225	1020	0.225	1320	0.225
180	0.225	480	0.225	780	0.225	1080	0.225	1380	0.225
240	0.225	540	0.225	840	0.225	1140	0.225	1440	0.225

Node 4 Online Orifice Control

Flap Valve	x	Replaces Downstream Link	✓	Diameter (m)	0.020
Downstream Link	3.000	Invert Level (m)	166.200	Discharge Coefficient	0.600

Node 8 Online Orifice Control

Flap Valve	x	Replaces Downstream Link	✓	Diameter (m)	0.020
Downstream Link	5.000	Invert Level (m)	164.700	Discharge Coefficient	0.600

Node 6 Online Orifice Control

Flap Valve	x	Replaces Downstream Link	✓	Diameter (m)	0.020
Downstream Link	4.000	Invert Level (m)	163.350	Discharge Coefficient	0.600

Node 10 Online Orifice Control

Flap Valve	x	Replaces Downstream Link	✓	Diameter (m)	0.021
Downstream Link	1.004	Invert Level (m)	162.023	Discharge Coefficient	0.600

Node 10 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	162.770	Slope (1:X)	40.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	810	Depth (m)	0.600
Safety Factor	2.0	Width (m)	6.580	Inf Depth (m)	
Porosity	0.30	Length (m)	50.000		

Node 4 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	166.570	Slope (1:X)	50.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	308	Depth (m)	0.500
Safety Factor	2.0	Width (m)	12.414	Inf Depth (m)	
Porosity	0.30	Length (m)	14.000		

Node 8 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	164.970	Slope (1:X)	50.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	468	Depth (m)	0.600
Safety Factor	2.0	Width (m)	11.680	Inf Depth (m)	
Porosity	0.30	Length (m)	24.000		

Node 6 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	163.920	Slope (1:X)	50.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	170	Depth (m)	0.350
Safety Factor	2.0	Width (m)	7.600	Inf Depth (m)	
Porosity	0.30	Length (m)	24.000		

Node 9 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	162.180
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	1440

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	126.7	0.0	1.320	126.7	0.0	1.321	0.0	0.0



Results for 2 year Critical Storm Duration. Lowest mass balance: 99.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	165.077	0.026	2.3	0.0299	0.0000	OK
15 minute summer	2	10	164.774	0.024	2.3	0.0276	0.0000	OK
15 minute summer	3	10	164.474	0.034	4.6	0.0386	0.0000	OK
180 minute summer	4	120	166.722	0.522	2.1	2.1710	0.0000	SURCHARGED
15 minute summer	5	11	163.683	0.043	5.1	0.0491	0.0000	OK
120 minute summer	6	74	164.015	0.665	1.5	0.3799	0.0000	SURCHARGED
120 minute summer	7	76	163.285	0.015	0.7	0.0173	0.0000	OK
180 minute summer	8	128	165.184	0.484	2.8	4.0370	0.0000	SURCHARGED
600 minute summer	9	570	162.497	0.317	3.7	38.1653	0.0000	SURCHARGED
600 minute summer	10	570	162.497	0.474	1.8	0.0000	0.0000	SURCHARGED
15 minute summer	10_OUT	1	162.197	0.225	0.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	3	2.3	0.899	0.067	0.0433	
15 minute summer	2	2.000	3	2.3	0.947	0.057	0.0151	
15 minute summer	3	1.001	5	4.5	1.274	0.113	0.0576	
180 minute summer	4	Orifice	5	0.6				
15 minute summer	5	1.002	9	5.1	1.208	0.180	0.1342	
120 minute summer	6	Orifice	7	0.7				
120 minute summer	7	4.001	9	0.7	0.720	0.021	0.0646	
180 minute summer	8	Orifice	9	0.6				
600 minute summer	9	1.003	10	-1.4	-0.025	-0.019	2.6492	
600 minute summer	10	Orifice	10_OUT	0.5				49.0



Results for 30 year Critical Storm Duration. Lowest mass balance: 99.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	165.095	0.044	6.5	0.0503	0.0000	OK
15 minute summer	2	10	164.791	0.041	6.5	0.0463	0.0000	OK
15 minute summer	3	10	164.499	0.059	12.9	0.0662	0.0000	OK
120 minute winter	4	114	166.869	0.669	4.4	8.3162	0.0000	SURCHARGED
15 minute summer	5	11	163.714	0.074	13.4	0.0832	0.0000	OK
120 minute summer	6	84	164.197	0.847	3.7	3.2124	0.0000	FLOOD RISK
120 minute summer	7	86	163.286	0.016	0.8	0.0184	0.0000	OK
180 minute winter	8	172	165.359	0.659	4.5	13.2684	0.0000	SURCHARGED
960 minute summer	9	975	162.877	0.697	5.1	83.8581	0.0000	SURCHARGED
960 minute summer	10	960	162.877	0.854	2.6	0.2259	0.0000	SURCHARGED
15 minute summer	10_OUT	1	162.197	0.225	0.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	3	6.5	1.208	0.191	0.0911	
15 minute summer	2	2.000	3	6.5	1.270	0.162	0.0318	
15 minute summer	3	1.001	5	12.8	1.728	0.321	0.1190	
120 minute winter	4	Orifice	5	0.7				
15 minute summer	5	1.002	9	13.4	1.569	0.474	0.2725	
120 minute summer	6	Orifice	7	0.8				
120 minute summer	7	4.001	9	0.8	0.733	0.024	0.2819	
180 minute winter	8	Orifice	9	0.7				
960 minute summer	9	1.003	10	-2.1	-0.029	-0.029	2.6492	
960 minute summer	10	Orifice	10_OUT	0.8				112.7



Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	165.103	0.053	9.1	0.0600	0.0000	OK
15 minute summer	2	10	164.800	0.050	9.1	0.0560	0.0000	OK
15 minute summer	3	10	164.511	0.071	18.1	0.0803	0.0000	OK
180 minute winter	4	172	166.963	0.762	4.6	13.1769	0.0000	FLOOD RISK
15 minute summer	5	11	163.730	0.090	18.6	0.1018	0.0000	OK
120 minute winter	6	96	164.282	0.932	3.6	5.4633	0.0000	FLOOD RISK
120 minute winter	7	96	163.287	0.017	0.8	0.0188	0.0000	OK
240 minute winter	8	232	165.452	0.752	5.1	20.3937	0.0000	FLOOD RISK
1440 minute summer	9	1440	163.142	0.962	4.9	115.7769	0.0000	SURCHARGED
1440 minute summer	10	1440	163.142	1.119	2.5	2.6522	0.0000	SURCHARGED
15 minute summer	10_OUT	1	162.197	0.225	0.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	3	9.1	1.317	0.268	0.1171	
15 minute summer	2	2.000	3	9.1	1.370	0.227	0.0412	
15 minute summer	3	1.001	5	18.0	1.876	0.450	0.1535	
180 minute winter	4	Orifice	5	0.7				
15 minute summer	5	1.002	9	18.5	1.694	0.656	0.3497	
120 minute winter	6	Orifice	7	0.8				
120 minute winter	7	4.001	9	0.8	0.735	0.025	0.2824	
240 minute winter	8	Orifice	9	0.7				
1440 minute summer	9	1.003	10	-1.9	-0.026	-0.026	2.6492	
1440 minute summer	10	Orifice	10_OUT	0.9				163.9



Results for 100 year Critical Storm Duration. Lowest mass balance: 99.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	165.101	0.051	8.3	0.0571	0.0000	OK
15 minute summer	2	10	164.797	0.047	8.3	0.0532	0.0000	OK
15 minute summer	3	10	164.507	0.067	16.5	0.0760	0.0000	OK
120 minute winter	4	118	166.928	0.728	5.5	11.3855	0.0000	FLOOD RISK
15 minute summer	5	11	163.725	0.085	17.0	0.0959	0.0000	OK
120 minute summer	6	90	164.256	0.906	4.7	4.7144	0.0000	FLOOD RISK
120 minute summer	7	90	163.287	0.016	0.8	0.0187	0.0000	OK
180 minute winter	8	176	165.421	0.721	5.6	17.8212	0.0000	FLOOD RISK
960 minute winter	9	960	163.030	0.850	4.3	102.3300	0.0000	SURCHARGED
960 minute winter	10	945	163.030	1.007	2.1	1.3059	0.0000	SURCHARGED
15 minute summer	10_OUT	1	162.197	0.225	0.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	3	8.3	1.288	0.244	0.1092	
15 minute summer	2	2.000	3	8.3	1.344	0.207	0.0383	
15 minute summer	3	1.001	5	16.4	1.837	0.410	0.1428	
120 minute winter	4	Orifice	5	0.7				
15 minute summer	5	1.002	9	16.9	1.660	0.599	0.3257	
120 minute summer	6	Orifice	7	0.8				
120 minute summer	7	4.001	9	0.8	0.731	0.025	0.2823	
180 minute winter	8	Orifice	9	0.7				
960 minute winter	9	1.003	10	-1.5	-0.022	-0.021	2.6492	
960 minute winter	10	Orifice	10_OUT	0.8				136.3

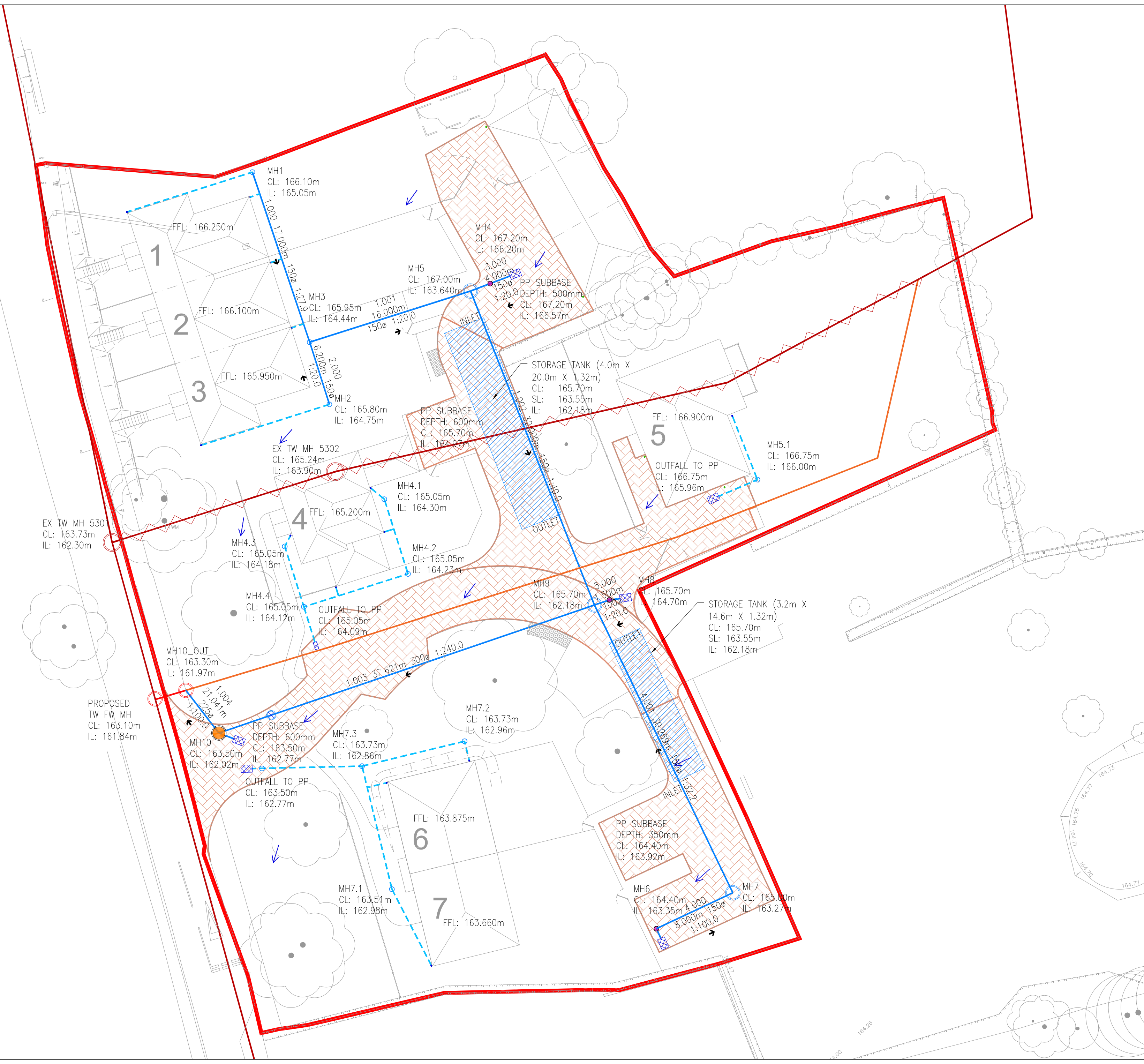
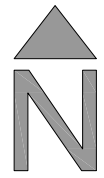


Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	165.111	0.060	11.6	0.0684	0.0000	OK
15 minute summer	2	10	164.807	0.057	11.6	0.0646	0.0000	OK
15 minute summer	3	10	164.523	0.083	23.1	0.0935	0.0000	OK
180 minute winter	4	176	167.051	0.850	5.8	17.7671	0.0000	FLOOD RISK
15 minute summer	5	11	163.747	0.107	23.6	0.1205	0.0000	OK
120 minute winter	6	102	164.351	1.001	4.5	7.7271	0.0000	FLOOD RISK
1440 minute winter	7	1410	163.349	0.079	0.6	0.0897	0.0000	OK
240 minute winter	8	232	165.534	0.834	6.4	27.2528	0.0000	FLOOD RISK
1440 minute winter	9	1410	163.349	1.169	4.2	140.7477	0.0000	SURCHARGED
1440 minute winter	10	1410	163.349	1.326	2.1	6.4045	0.0000	FLOOD RISK
15 minute summer	10_OUT	1	162.197	0.225	0.6	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	3	11.5	1.393	0.341	0.1410	
15 minute summer	2	2.000	3	11.6	1.439	0.289	0.0499	
15 minute summer	3	1.001	5	23.0	1.972	0.575	0.1860	
180 minute winter	4	Orifice	5	0.8				
15 minute summer	5	1.002	9	23.5	1.772	0.832	0.4234	
120 minute winter	6	Orifice	7	0.8				
1440 minute winter	7	4.001	9	0.6	0.495	0.019	0.4095	
240 minute winter	8	Orifice	9	0.8				
1440 minute winter	9	1.003	10	-1.4	-0.019	-0.019	2.6492	
1440 minute winter	10	Orifice	10_OUT	1.0				193.9

Appendix I – Proposed SuDS Layout



KEY

- SITE BOUNDARY (TOTAL SITE AREA 0.51ha)
- PERMEABLE PAVING
- PROPOSED GEO-CELLULAR STORAGE TANK
- SURFACE WATER PIPE NETWORK— SIZE AND GRADIENT SHOWN ON DRAWING
- 150mmØ DRAINAGE RUNS TO BE LAID AT 1:100
- SURFACE WATER MANHOLE
- PERMAVOID DIFFUSER UNIT
- RAINWATER DOWNPIPE
- RAINWATER DOWNPIPE FITTED WITH A SHOE
- ORIFICE PLATE WITH SUITABLE FILTER
- 21mm ORIFICE PLATE WITH A SUITABLE FILTER
- FLOW ARROW
- DOWNSTREAM DEFENDER
- SURFACE WATER PIPE NETWORK
- FOUL WATER SEWER DEMARCATION CHAMBER
- FOUL WATER RISING MAIN DIVERSION
- FOUL WATER SEWER DIVERSION

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS:
FOR PLANNING PURPOSES ONLY

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CLIENT:
HANSON SERVICES LTD

ARCHITECT:

PROJECT:
HILLCREST & TUSOCKS
THE CAUSEWAY, THERFIELD

TITLE:
SURFACE WATER DRAINAGE STRATEGY

SCALE: A2: 1:250	DESIGN—DRAWN: RC/JC	DATE: 18.11.2024
PROJECT No: 4405	DRAWING No: DR01—REV B	

Appendix J – Downstream Defender Specification

Downstream Defender® Select

Design Data

The Downstream Defender® Select is the **new generation of advanced hydrodynamic separator** for treatment of urban surface water runoff. Its customisable performance and extended range of chamber sizes allows engineers to tailor their drainage designs to meet specific pollutant removal standards. The Downstream Defender® Select also offers easier installation with much more flexibility of pipe sizes and connections and can accept up to three inlets.



Key Features

- » Selectable performance levels for pollutant targets and retention.
- » Extended range of chamber sizes.
- » Can accept up to three inlet pipes.
- » Can accept a range of pipe sizes.
- » No moving parts and no power requirement.
- » Available in concrete or plastic chambers.

Fig 1. Downstream Defender® Select. **Advanced Vortex** models in concrete and plastic shown with *Hydro-Logic® Smart Monitoring* and *enhanced hydrocarbon (oil) retention* options.

Targeted pollutant removal

The Downstream Defender® Select performance can be tailored to remove some or all of the following pollutants:

Sediment (Total Suspended Solids)



The Downstream Defender® Select is a highly effective sediment/TSS removal device. It can be sized in a number of ways to suit the application and level of protection required (see Table 2).

Gross Pollutants



100% removal of floatable debris, such as food wrappers, Styrofoam cups and drinks cartons.

Sediment Bound Hydrocarbons (including Polycyclic Aromatic Hydrocarbons - PAHs)



PAHs have low solubility in water and are readily adsorbed onto sediment particles. Effective removal of sediment particles will also ensure the removal of many PAHs.

Liquid Hydrocarbons (oils)



Effective spill containment device at low flow rates. Note these systems are not considered oil separators according to the BS EN 858-1 and must not be used in applications where full certification is required.

Sediment Bound Heavy Metals and Nutrients



As an efficient device for removal of fine sediment, the Downstream Defender® Select is also effective for the removal of sediment bound pollutants.

Downstream Defender® Select model options

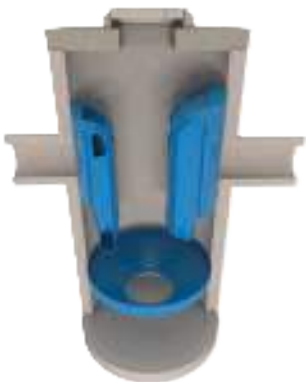
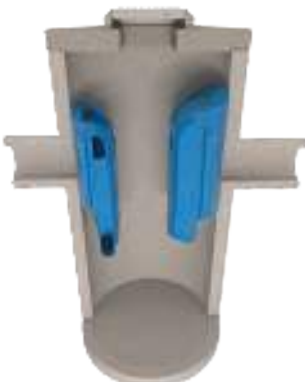
Downstream Defender® Select Model			
	Advanced Vortex	Vortex Plus	Vortex
	Our recommended model which provides sediments, litter and hydrocarbon (oil) removal with enhanced sediment retention up to four times the treatment flow rate. 	Provides sediments, litter and hydrocarbon (oil) removal, with sediments retained at up to two times the treatment flow rate. 	A simpler model providing removal of sediments, with retention up to two times the treatment flow rate. 
Key Pollutants			
Sediments	Coarse and fine	Coarse and fine	Coarse and fine
Sediment retention	Retained up to 4 x treatment flow rate	Retained up to 2 x treatment flow rate	Retained up to 2 x treatment flow rate
Litter, debris	✓	✓	✗
Liquid hydrocarbons (oils)	✓	✓	✗
Hydrocarbon (oil) retention	Option for increased retention on request	Option for increased retention on request	✗
Sediment bound metals	✓	✓	✓

Table 1 - Downstream Defender® Select pollutant removal performance

The Downstream Defender® Select may be sized for different target particle sizes and removal efficiencies – contact us for site specific design.

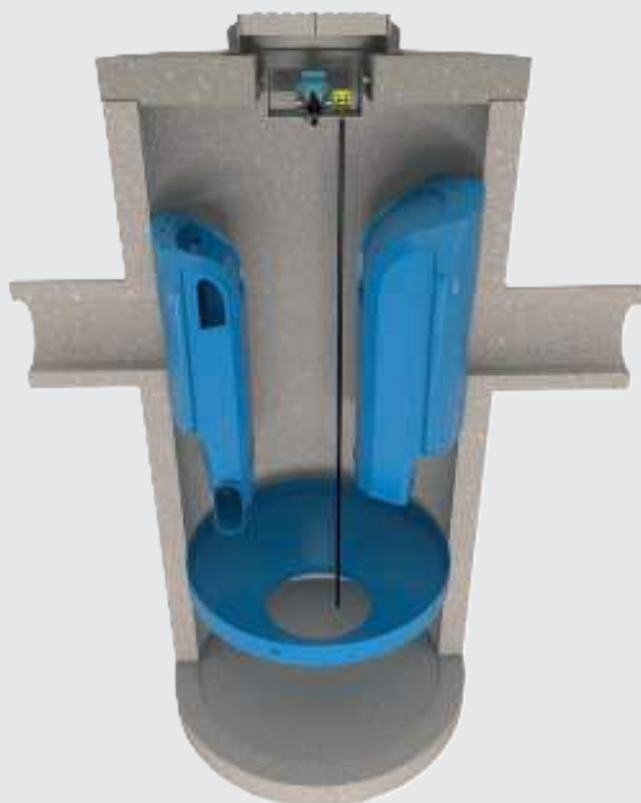
Enhancement Options

Make Maintenance Smart

To help with SuDS maintenance plans and to ensure that maintenance is cost-effective, add Hydro-Logic® Smart Maintenance to any model and get automated maintenance alerts.

Hydro-Logic® Smart Maintenance can also reduce risk and save costs by reducing the need for inspection visits for units installed alongside roads or rail tracks.

The Hydro-Logic® Flexi Logger and ATEX/IECEX sensors capture real-time data for flow levels and/or sediment build-up. Level monitoring will enable the detection of blockages relating to the unit, and sediment level monitoring can be set to a trigger point and self-report to the client's maintenance team when maintenance is due.



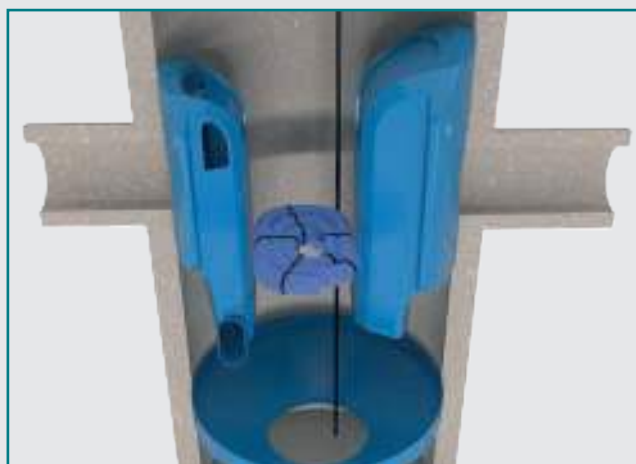
*Fig 2. Downstream Defender® Select
Hydro-Logic® Smart Maintenance.
Available for all models.*

Improve hydrocarbon retention

The option of storing hydrocarbons (oils) as solids can be added, providing increased retention, even at flow rates where the unit is bypassing.

This option is available for the [Advanced Vortex](#) and [Vortex Plus](#) models only.

Fig 3. Enhanced hydrocarbon (oil) retention option for the Downstream Defender® Select. Available for the [Advanced Vortex](#) and [Vortex Plus](#) models only.

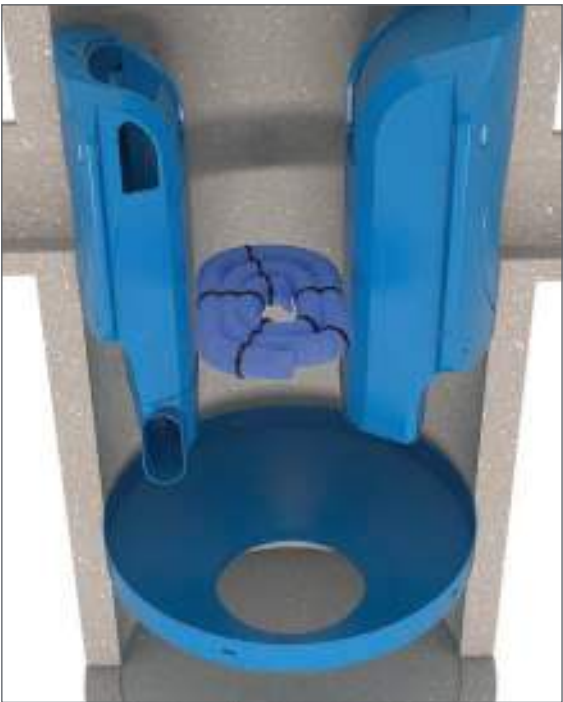


Pollutant retention

It is important to ensure that pollutants in a rainfall event are retained throughout subsequent events. The Downstream Defender® Select offers engineers the option of specifying the retention performance of sediments. The **Vortex** and **Vortex Plus** models provide sediment retention up to twice the treatment flow rate, and the **Advanced Vortex**, with its benching skirt creating a calm sediment storage zone, provides sediment retention up to four times the treatment flow rate.

An option for enhancing the retention of hydrocarbons (oils) by storing them as a solid is available, ensuring no wash out during extremely high flows. This option is only available for the **Advanced Vortex** and **Vortex Plus** models

Fig 4. Downstream Defender® Select with enhanced sediment retention and enhanced hydrocarbon (oil) retention options.



The Simple Index Approach (SIA)

The Simple Index Approach outlined in CIRIA C753 The SuDS Manual is a water quality design method for sites with a low to medium risk pollution hazard level. Sites with a high risk pollution hazard level should consider a more precautionary approach.

The approach assigns pollution hazard indices to the given land use for three pollutant groups, total suspended solids (TSS), metals and hydrocarbons. SuDS components are then selected until their combined pollution mitigation index score is greater than the pollution hazard index for each pollutant group.

Model	Downstream Defender® Select Mitigation Indices ^{(a)(b)}		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons (Oils)
Vortex	0.3	0.2	0.2
Vortex Plus	0.5	0.4	0.5
Advanced Vortex	0.5	0.4	0.5
Notes: (a) All mitigation indices supplied by Hydro International Ltd are calculated using the methods laid out in the British Water How To Guide: Applying the CIRIA SuDS Manual Simple Index Approach to Proprietary / Manufactured Stormwater Treatment Devices. The Advanced Vortex and Vortex Plus models have also been independently verified by the WRc, with the WRc Performance Declaration available on request. (b) Mitigation Indices quoted for the Downstream Defender® Select are valid when the unit is designed according to the Treatment Flow Rate (see Table 3).			

Table 2 - SuDS Mitigation Indices for Downstream Defender® Select

Sizing a Downstream Defender® Select

The Downstream Defender® can be sized for different treatment goals and objectives. For design purposes, the selected model's Treatment Flow Rate should be greater than or equal to the site's Water Quality Flow Rate.

The hydraulic capacity of the selected model should be considered with respect to the peak discharge flow rate from the site.

If there is no treatment objective, just betterment, do not use a treatment flow rate and only compare the hydraulic capacity to the peak discharge flow rate.

Model diameter (m)	Treatment flow rate ^{(a)(b)} (l/s)	Hydraulic capacity ^(c) with recommended pipe size (l/s)	Hydraulic capacity ^(d) with maximum pipe size (l/s)	Maximum catchment area m ²	Maximum headloss at treatment flow rate (mm)
1.0	21	46	70	2800	160
1.2	30	84	107	4000	170
1.5	48	144	170	6400	220
1.8	69	217	278	9200	230
2.1	94	271	355	12500	240
2.4	123	422	529	16400	250
3.0	192	652	787	25600	260

Notes:

(a) The Treatment Flow Rate is based on an annualised removal efficiency of >50% of all particles up to 1000 microns with a mass-median particle size (D50) of 63 microns and a specific gravity of 2.65. The testing was conducted in line with the British Water Code of Practice.

(b) Alternative sizing based on different sediment grades available on request.

(c) Maximum flow rate that can pass through the chamber with a maximum headloss of 500mm. Figures shown are when using the recommended pipe size in Table 5.

(d) Maximum flow rate that can pass through the chamber with a maximum headloss of 500mm. Figures shown are when using the maximum pipe size in Table 5.

Table 3 - Downstream Defender® Select design information.

Model diameter (m)	Oil Storage Capacity (l)		Minimum sediment storage capacity ^(c) (m ³)
	Minimum liquid hydrocarbon (oil) storage capacity up to Treatment Flow Rate ^(a)	Solid state storage capacity with enhanced retention option ^(b)	
1.0	256	43-70	0.31
1.2	442	43-70	0.45
1.5	849	85-140	0.71
1.8	1458	85-140	1.02
2.1	2550	128-210	1.39
2.4	3586	170-280	1.81
3.0	6811	231-350	2.83

Notes:

- (a) Liquid oil storage capacity is valid up to the Treatment Flow Rate. Oil capture and retention is only available for the **Advanced Vortex** and **Vortex Plus** models only.
- (b) Permanent oil storage capacity when using the enhanced oil retention option (available for the **Advanced Vortex** and **Vortex Plus** models only).
- (c) Additional sediment storage capacity for all Downstream Defender[®] Select models (**Advanced Vortex**, **Vortex Plus** and **Vortex**) can be provided to extend maintenance intervals if required.

Table 4 - Downstream Defender[®] Select capacities.

Design your own Downstream Defender[®] Select with our Online Design Tool



Register free and design your own Downstream Defender[®] Select and try out different performance objectives.

Project designs can be saved and submitted for a free review by our expert technical team if required. General arrangement drawings and quotes can also be requested from the tool for any saved design.

visit hydro-int.design

Pipe sizes

Downstream Defender® Select can accept a range of **inlet / outlet pipe** sizes, removing the need for complicated pipe connections or couplers. The inlet pipe size must always be equal to or smaller than the outlet pipe size.

Additional pipe sizes may be accommodated, please contact us for assistance.

Chamber size	1.0 m	1.2 m	1.5 m	1.8 m	2.1 m	2.4 m	3.0 m
Pipe sizes	150	150	300	375	375	500	600
	225 ^{a)}	225	375 ^{a)}	400	400	600 ^{a)}	675 ^{b)}
	300	300 ^{a)}	400	450 ^{a)}	450	675 ^{b)}	750 ^{a)}
		375	450	500	500 ^{a)}	750	900
				600	600		
					675 ^{b)}		

Notes:

a) The recommended pipe size for optimum performance.

b) 675 mm is only available for concrete chambers.

Table 5 - Downstream Defender® Select pipe sizes.

Setting out

The Downstream Defender® Select can accommodate a change in pipe direction to suit site specific requirements and accept up to three inlet pipes.

Pipe angles can be adjusted to suit. Minimum angle between inlets and outlet is 90°.

For ease of installation the Downstream Defender® Select can now accept a range of pipe sizes.

Head loss across the chamber is kept to a minimum (see Table 3). The inlet and outlet pipes should be sized in accordance with Table 5.

Inlet and outlet pipe connections are at the same invert level.

Additional manhole sections can be provided to extend the chamber to meet site cover and invert levels or provide additional pollutant storage where required.



Fig 5. Downstream Defender® Select Advanced Vortex with *three inlet pipes*.

Dimensions and weights for concrete chambers

Material	Chamber Diameter - Internal (mm) (C)	Chamber Diameter External (mm) (includes base slab and any extrusions)	Recommended Inlet and Outlet Internal Diameter (mm) ⁽¹⁾	Minimum Depth to Invert (mm) (A) ⁽²⁾	Total Chamber Height Including cover (mm) (B) ⁽³⁾	Maximum Component Lift Weight (kg) ⁽⁴⁾
Concrete	1050	1420	225	1550	2390	2770
Concrete	1200	1460	300	1757	2831	2320
Concrete	1500	1760	375	2050	3276	3530
Concrete	1800	2160	450	2650	4090	5250
Concrete	2100	2650	500	2857	4364	6670
Concrete	2400	2950	600	3321	5375	8600
Concrete	3000	3480	750	3518	5433	14080

Notes:

- (1) Recommended inlet and outlet internal diameter. For alternative pipe sizes to allow for easier connections, please see Table 5.
- (2) Minimum depth to invert shown. Depth to invert can be increased if required.
- (3) Minimum chamber depth shown. Additional sediment storage capacity or increased depth to invert can be provided if required. Total chamber height for concrete units **includes** the cover.
- (4) Maximum component weight is based on a single inlet and includes internal components.

Table 6 - Downstream Defender® Select dimensions and weights for concrete chambers

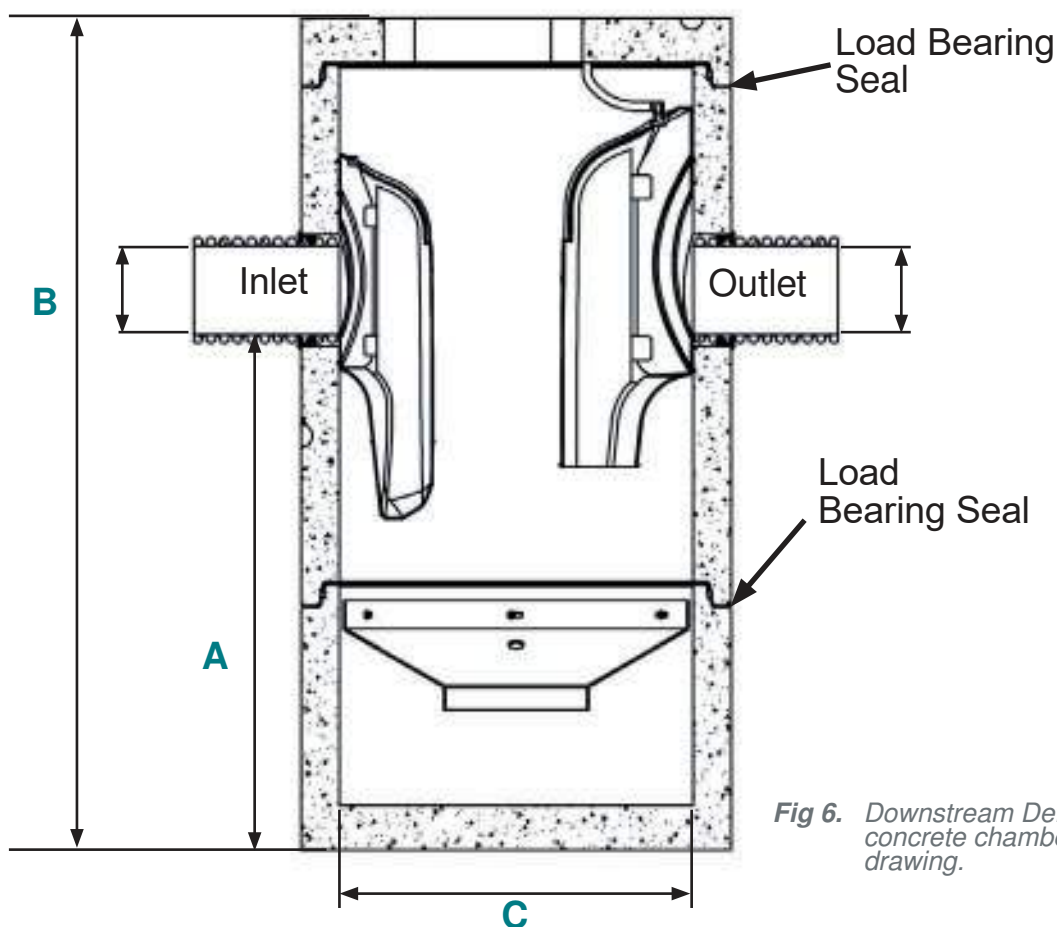


Fig 6. Downstream Defender® Select concrete chamber dimension drawing.

For General Arrangement drawings please email stormwater@hydro-int.com or submit a request at hydro-int.design

Dimensions and weights for plastic chambers

Material	Chamber Diameter - Internal (mm) (C)	Chamber Diameter External (mm) (includes base slab and any extrusions) (5)	Recommended Inlet and Outlet Internal Diameter (mm) (1)	Minimum Depth to Invert (mm) (A) (2)	Total Chamber Height Excluding Cover (mm) (B) (3)	Maximum Component Lift Weight (kg) (4)
HDPE Single Wall	1030	1282	225	1350	2012	125
HDPE Single Wall	1200	1435	300	1612	2512	170
HDPE Single Wall	1500	1735	375	1976	3012	240
HDPE Single Wall	1800	2317	450	2270	3490	410
HDPE Single Wall	2100	2630	500	2570	3920	750
HDPE Single Wall	2400	2930	600	2820	4440	950
HDPE Single Wall	3000	3530	750	3570	5270	1200

Notes:

- (1) Recommended inlet and outlet internal diameter. For alternative pipe sizes to allow for easier connections, please see Table 5.
- (2) Minimum depth to invert shown. Depth to invert can be increased if required.
- (3) Minimum chamber depth shown. Additional sediment storage capacity or increased depth to invert can be provided if required. Total chamber height for plastic units **excludes** the cover.
- (4) Maximum component weight is based on a single inlet and includes internal components.
- (5) Maximum external diameter includes lifting lugs and base slab.

Table 7 - Downstream Defender® Select dimensions and weights for plastic chambers

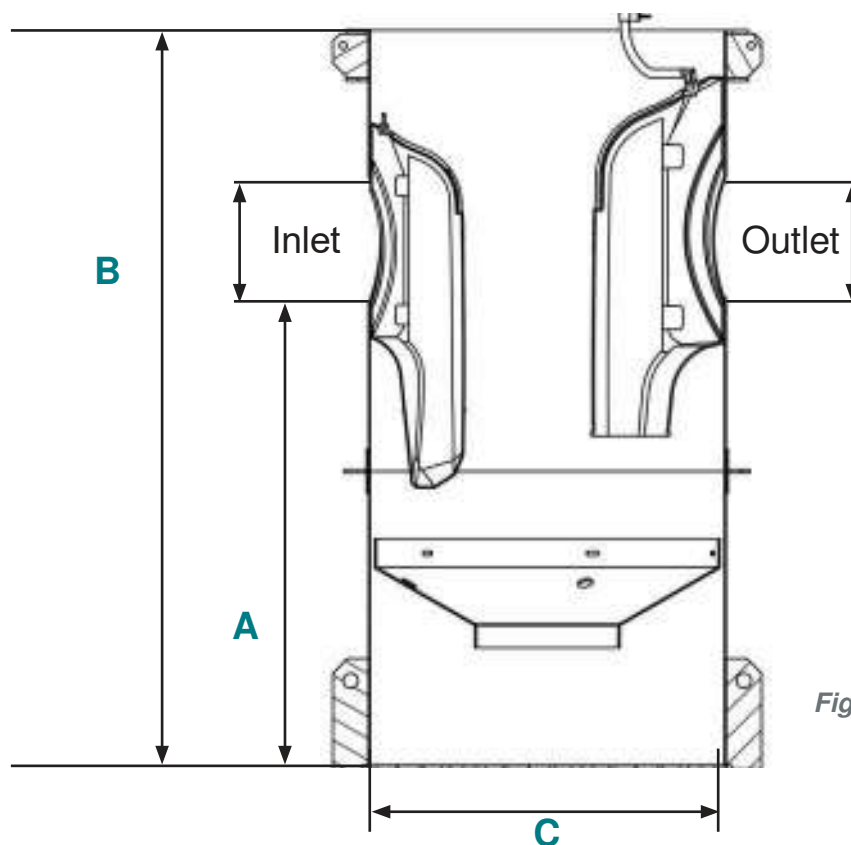


Fig 7. Downstream Defender® Select plastic chamber dimension drawing.

For General Arrangement drawings please email stormwater@hydro-int.com or submit a request at hydro-int.design

Maintenance for a Downstream Defender® Select

Periodic removal of captured pollutants is essential to the continuous, long-term functioning of your Downstream Defender® Select. The device will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the Downstream Defender® Select will no longer be able to store removed sediment and oil. Pollutant storage capacities are provided in Table 4.

If a Hydro-Logic® Smart Maintenance system is installed in the Downstream Defender® Select, when captured sediment volumes reach a predetermined level, the system will send an automated alert to request maintenance.

Maintenance events may include hydrocarbons (oils), floatables and sediment removal. These can be removed safely from the surface, no entry into the Downstream Defender® Select is required. The Hydro-Logic® Smart Maintenance system will need to be removed to allow access for the Jet Vac truck / Vacuum Tanker. This is easily done by carefully lifting the bracket holding the Hydro-Logic® Smart Maintenance package out of the unit and putting them to one side prior to inserting the Vacuum Tanker hose into the unit. The internal components of the Downstream Defender® Select do not need to be removed as the jet / vacuum hose can access the full depth of the unit through the centre of the chamber.



Determining a maintenance schedule

The frequency of clean-out is determined in the field after installation. During the first year of operation, the unit should be inspected every six months or sooner to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge Judge® can be used to determine the level of accumulated solids stored in the sump.

To enable the provision of maintenance plans for planning applications, a typical maintenance schedule for a Downstream Defender® Select would be:

Activity	Frequency
Inspection	- Regularly during first year of installation. - Every 6 months after the first year of installation
Hydrocarbons (oils) and floatables removal	- Once per year, or as needed with sediment removal. - Following a spill in the drainage area.
Sediment removal	- As and when alerted by the Hydro-Logic® Smart Maintenance system, or - At intervals as determined by the first year's inspections - Following a spill in the drainage area.
Note: For most clean-outs it is not necessary to remove the entire volume of liquid in the vessel. Only removing the first few inches of oils/floatables and the sediment storage volume is required.	

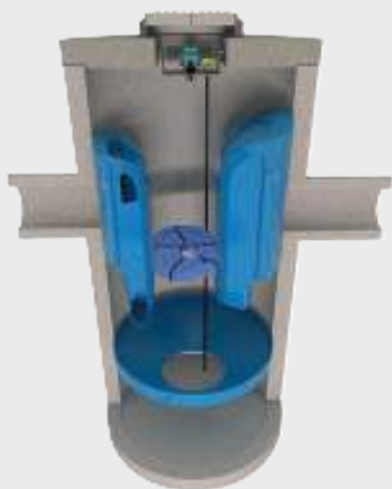
Table 8 - Typical maintenance schedule for a Downstream Defender® Select

We can provide full inspection and maintenance services for the Downstream Defender® Select, as well as for any other Sustainable Drainage Systems (SuDS) on your site - providing peace of mind and saving you time and money.

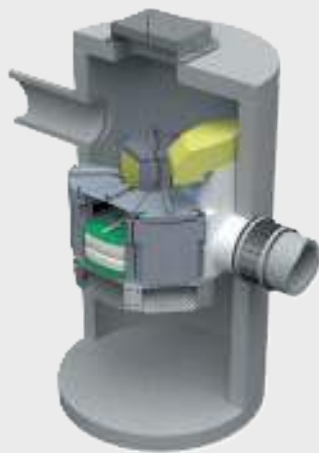
For more information, please call 01275 878371 or email sudservices@hydro-int.com

Our full range of stormwater treatment solutions

We have a range of stormwater treatment devices to treat stormwater flows of varying quality. All our solutions can work alongside, enable or enhance natural SuDS, helping to meet or improve on biodiversity and amenity targets.



Downstream Defender® Select



Up-Flo™ Filter



Hydro Biofilter™

Product		Description	Targeted pollutants						
			Sediments		Litter, debris	Liquid hydrocarbons	Sediment bound hydrocarbons, nutrients and heavy metals	Dissolved metals	Nutrients
Downstream Defender® Select	Vortex	Vortex separator	Coarse & fine	Retained up to 2 x treatment flow rate	✗	✗	✓	✗	✗
	Vortex Plus	Vortex plus separator	Coarse & fine	Retained up to 2 x treatment flow rate	✓	✓ Option for increased retention on request	✓	✗	✗
	Advanced Vortex	Advanced hydrodynamic vortex separator	Coarse & fine	Retained up to 4 x treatment flow rate	✓	✓ Option for increased retention on request	✓	✗	✗
Up-Flo™ Filter	Sand	Fluidised bed up flow filtration system with Sand media	Very fine sediment		✓	✓	✓	✗	✓
	CPZ	Fluidised bed up flow filtration system with CPZ media	Very fine sediment		✓	✓	✓	✓	✓
Hydro Biofilter™		Biofiltration system	Very fine and dissolved sediments		✓	✓	✓	✓	✓

To find out more about our range of stormwater treatment solutions visit hydro-int.com.

[Downstream Defender® Select](#)

[Up-Flo™ Filter](#)

[Hydro Biofilter™](#)

Patent: www.hydro-int.com/patents

Tel: +44 (0)1275 337937 stormwater@hydro-int.com

Hydro International
Unit 2, Rivermead Court, Kenn Business Park
Windmill Road, Kenn, Clevedon, BS21 6FT

Downstream Defender® Select Design Data E/0223

Appendix: K – Brownfield Runoff Calculations

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	30	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	1.000	Preferred Cover Depth (m)	0.900
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.006	5.00	166.400	1200	15.108	101.807	1.050
2	0.010	5.00	166.200	1200	19.996	54.410	1.050
3	0.008	5.00	166.400	1200	18.084	79.915	1.312
3_OUT			166.000	1200	-0.341	78.987	1.095

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	3	17.000	0.600	165.350	165.088	0.262	64.9	150	5.23	50.0
2.000	2	3	6.200	0.600	165.150	165.088	0.062	100.0	150	5.10	50.0
1.001	3	3_OUT	18.448	0.600	165.088	164.905	0.183	100.8	150	5.53	50.0

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	17.000	64.9	150	Circular	166.400	165.350	0.900	166.400	165.088	1.162
2.000	6.200	100.0	150	Circular	166.200	165.150	0.900	166.400	165.088	1.162
1.001	18.448	100.8	150	Circular	166.400	165.088	1.162	166.000	164.905	0.945

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	1	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
2.000	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
1.001	3	1200	Manhole	Adoptable	3_OUT	1200	Manhole	Adoptable

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	2 year (l/s)	4.8
Rainfall Events	Singular	Drain Down Time (mins)	3600	30 year (l/s)	13.1
Summer CV	1.000	Additional Storage (m³/ha)	0.0	100 year (l/s)	17.0
Winter CV	1.000	Starting Level (m)		Check Discharge Volume	✓
Analysis Speed	Normal	Check Discharge Rate(s)	✓	100 year 360 minute (m³)	197

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440
----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	------

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
100	0	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Betterment (%)	0
Greenfield Method	ReFH2	Q 1 year (l/s)	
Region	England, Wales, NI	Q 30 year (l/s)	
Include Baseflow	x	Q 100 year (l/s)	
Positively Drained Area (ha)	1.000		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	ReFH2	Storm Duration (mins)	360
Region	England, Wales, NI	Betterment (%)	0
Include Baseflow	x	Runoff Volume (m³)	197
Positively Drained Area (ha)	1.000		

Node 10 OUT Surcharged Outfall

Overrides Design Area	x	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		
Applies to All storms					

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
0	0.225	300	0.225	600	0.225	900	0.225	1200	0.225
60	0.225	360	0.225	660	0.225	960	0.225	1260	0.225
120	0.225	420	0.225	720	0.225	1020	0.225	1320	0.225
180	0.225	480	0.225	780	0.225	1080	0.225	1380	0.225
240	0.225	540	0.225	840	0.225	1140	0.225	1440	0.225

Node 10 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	0.000	Slope (1:X)	40.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.600
Safety Factor	2.0	Width (m)	6.580	Inf Depth (m)	
Porosity	0.30	Length (m)	50.000		

Node 8 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	0.000	Slope (1:X)	50.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.600
Safety Factor	2.0	Width (m)	11.680	Inf Depth (m)	
Porosity	0.30	Length (m)	24.000		

Node 6 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	0.000	Slope (1:X)	50.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.350
Safety Factor	2.0	Width (m)	7.600	Inf Depth (m)	
Porosity	0.30	Length (m)	24.000		

Node 9 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	0.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	126.7	0.0	1.320	126.7	0.0	1.321	0.0	0.0



Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	165.371	0.021	1.0	0.0242	0.0000	OK
15 minute summer	2	10	165.180	0.030	1.6	0.0344	0.0000	OK
15 minute summer	3	11	165.137	0.049	3.9	0.0551	0.0000	OK
15 minute summer	3_OUT	11	164.953	0.047	3.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	3	1.0	0.310	0.044	0.0548	
15 minute summer	2	2.000	3	1.6	0.444	0.090	0.0233	
15 minute summer	3	1.001	3_OUT	3.9	0.792	0.218	0.0898	1.7



Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	165.386	0.036	2.8	0.0406	0.0000	OK
15 minute summer	2	10	165.204	0.054	4.7	0.0608	0.0000	OK
15 minute summer	3	10	165.178	0.090	11.1	0.1016	0.0000	OK
15 minute summer	3_OUT	11	164.990	0.085	11.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	3	2.8	0.397	0.126	0.1211	
15 minute summer	2	2.000	3	4.7	0.562	0.263	0.0517	
15 minute summer	3	1.001	3_OUT	11.0	1.032	0.623	0.1968	4.8



Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

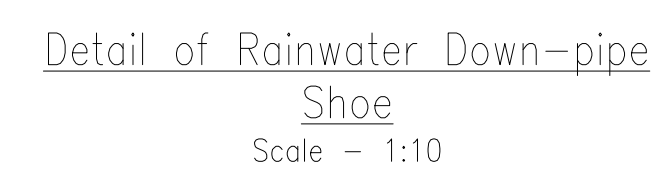
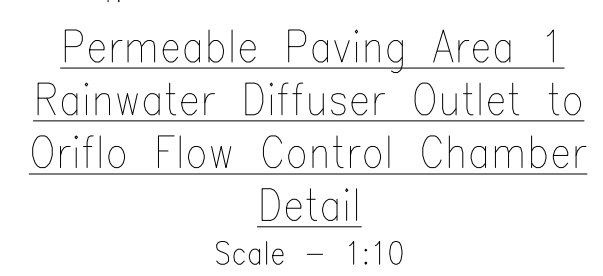
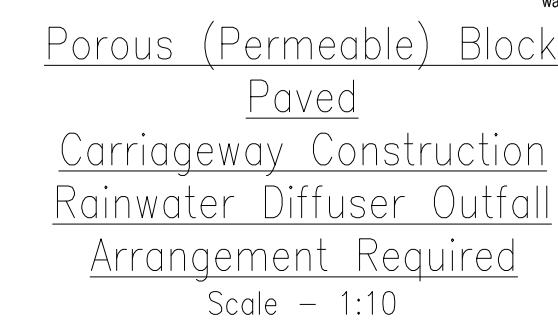
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	165.391	0.041	3.6	0.0460	0.0000	OK
15 minute summer	2	10	165.213	0.063	5.9	0.0712	0.0000	OK
15 minute summer	3	10	165.194	0.106	14.1	0.1200	0.0000	OK
15 minute summer	3_OUT	11	165.005	0.100	13.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	3	3.6	0.415	0.161	0.1461	
15 minute summer	2	2.000	3	5.9	0.581	0.330	0.0631	
15 minute summer	3	1.001	3_OUT	13.9	1.081	0.786	0.2372	6.2

Appendix: L – Standard Construction Details

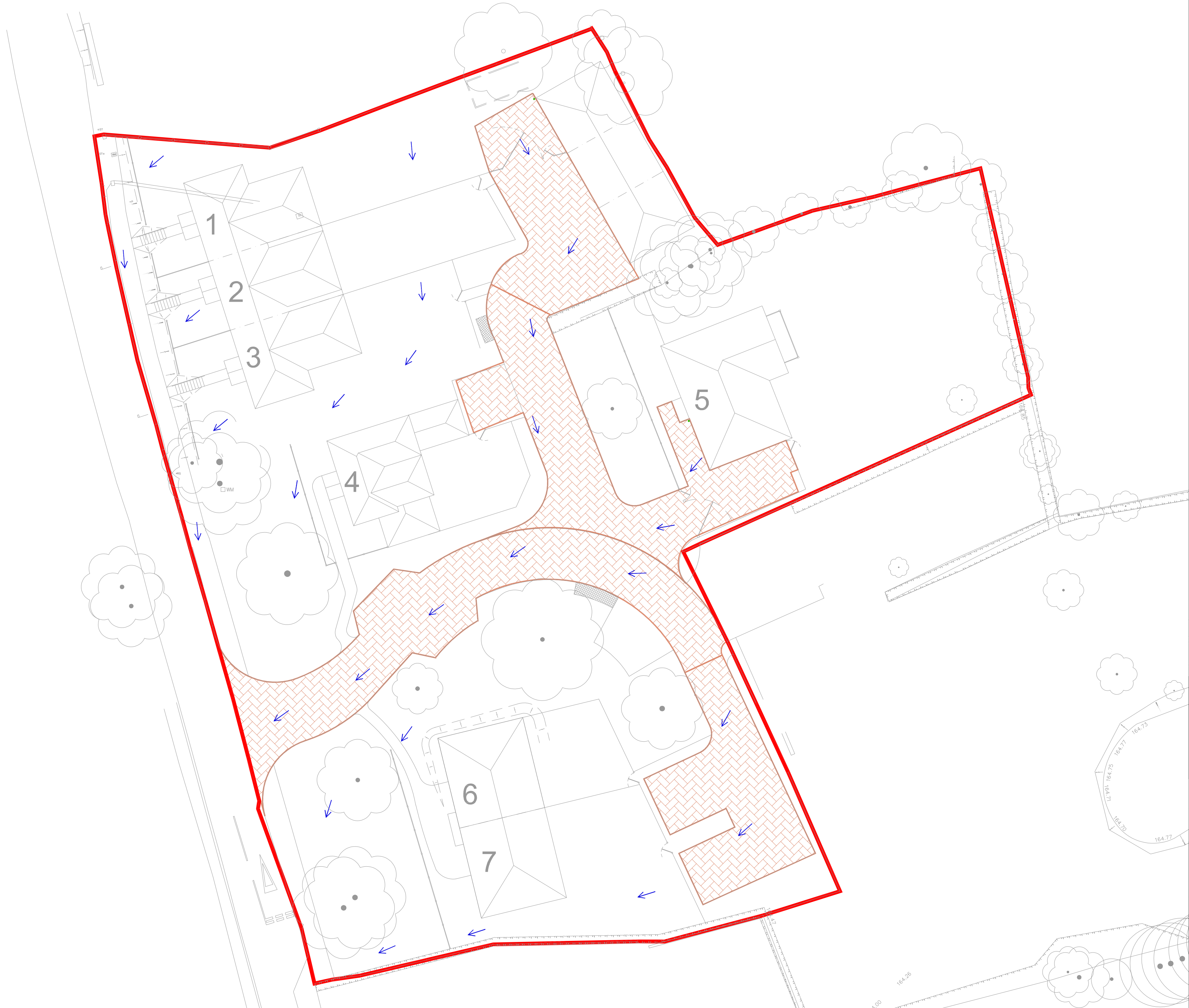
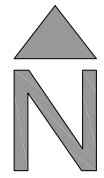


DRAINAGE TRENCH DETAIL
STANDARD CONSTRUCTION
DETAIL



-	-	-	-
PLAN	DATE	BY	DESCRIPTION
DW			JFO
DRAINING SERVICES			
FOR PLANNING			
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1st floor Miami House, Bayview Road, Hammond Square, Northmead, NSW 1510 Tel +61(0)2 8777 8177 www.easysid.co.au			
CUSTOMER	HANSON SERVICES LTD		
ARCHITECT			
PROJECT	HILLCREST & TUSSOCKS THE CAUSEWAY, THERFIELD		
TITLE	STANDARD DRAINAGE CONSTRUCTION DETAILS		
SCALE & NOS.	DESIGN ORIGIN:	DATE:	
MVS	JC	13.11.2024	
PROJECT NO.	DRAWING No.		
4405	DRO2		

Appendix: M – Exceedance Flow Drawing



KEY

-  SITE BOUNDARY (TOTAL SITE AREA 0.51ha)
-  FLOW ARROW

-	-	-	-	-	-
REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS:
FOR PLANNING PURPOSES ONLY

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Tel: 01920 871777
www.eostp.co.uk

CLIENT:
HANSON SERVICES LTD

ARCHITECT:

PROJECT:
HILLCREST & TUSOCKS
THE CAUSEWAY, THERFIELD

TITLE:
EXCEEDANCE FLOW PATHS

SCALE: A2: 1:250	DESIGN-DRAWN: RC/JC	DATE: 18.11.2024
PROJECT No: 4405	DRAWING No: DR03	