GHBullard & Associates LLP
Civil and Traffic Engineering Consultants

Residential Development, Mill Lane,
Hatfield Heath, Essex.

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

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[redacted]

CONTENTS

1. INTRODUCTION

1.1. This is a flood risk assessment and drainage strategy that is being submitted to accompany an outline planning application for 12 new homes and associated infrastructure including demolition in relation to land west of Mill Lane, Hatfield Heath, Essex. Refer to Figure 1.1 for location plan.

1.2. The report is produced for the sole use by City & Country Ltd.

1.3. The report includes a thorough review of commercially available flood risk and Environment Agency (EA) data indicating potential sources of flood risk to the site.

1.4. The information provided within this report is based on the best available data currently recorded or provided by a third party. The accuracy of this report is therefore not guaranteed and does not obviate the need to make additional appropriate searches, inspections and enquiries.

1.5. The National Planning Policy Framework (NPPF, July 2021), Section 14 (Meeting the challenge of climate change, flooding and coastal change), Paragraph 159 states that:

"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."

1.6. The NPPF recommends the Environment Agency (EA) Flood Maps as a starting point for Flood Risk Assessment. An extract from the EA Flood maps is reproduced in Figure 1.1 below.

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Figure 1.1 – EA Flood Map (Rivers and Seas)

1.7. The EA have produced standing guidance for developments dependent on their size and location. As can be seen from Figure 1.1 above, the site is located in Flood Zone 1.

1.8. Industry best practice requires assessment of all flooding sources to be carried out. Despite this document having now been superseded by the NPPF, Figure 3.2 of the "PPS25: Development and Flood Risk" (PPS25) Practice Guide lists five key sources of flooding:

i. Fluvial (refer to Section 4);
ii. Tidal (refer to Section 5);
iii. Pluvial (refer to Section 6);
iv. Groundwater (refer to Section 7); and
v. Infrastructure Failure (refer to Section 8).

2. POLICY CONTEXT

2.1. The National Planning Policy Framework(NPPF) sets out the Government's planning policies for England and how these are expected to be applied. Planning law requires that applications for planning permission must be determined in accordance with the development plan, unless material considerations indicate otherwise. The NPPF must be taken into account in the preparation of local and neighbourhood plans and is a material consideration in planning decisions. In the absence of up to date policies within the Uttlesford Local Plan (adopted January 2005) in relation to flood risk and drainage the following aspects of the NPPF are particularly relevant and have been taken into account in the preparation of the planning application.

2.1.1. The purpose of the planning system is to contribute to the achievement of sustainable development – NPPF, Paragraph 7

2.1.2. At the heart of the National Planning Policy Framework is a presumption in favour of sustainable development which does not change the statutory status of the development plan as the starting point for decision making – NPPF, Paragraph 12

2.1.3. Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere – NPPF, Paragraph 155

2.1.4. The aim of the Sequential Test is to steer new development to areas with the lowest risk of flooding – NPPF, Paragraph 158

2.1.5. Following the Sequential Test, both elements of the Exception Test will have to be passed for development to be allocated or permitted – NPPF, Paragraph 161

2.1.6. The Environment Agency provide standing advice guidance.

2.2. The following local level documents are also material to the determination of the planning application and have therefore influenced its preparation.

2.2.1 Uttlesford District Council Climate Local Strategy and Action Plan 2015-18, highlights the need to account for climate change for new development.

2.2.2 Uttlesford Strategic Flood Risk Assessment, May 2016; identifies the risks in the District. An extract from the SFRA showing the flood risk for the Hatfield Heath area is shown in Appendix A and demonstrates the proposed site is at low risk of flooding.

2.2.3 Essex County Council, as lead local flood authority, document Essex Design Guide for Sustainable Drainage Systems, advises on the standards to be used at a local level.

3. EXISTING SITE INFORMATION

3.1. The site is on the north-western fringes of Hatfield Heath, along Mill Lane, as shown in Figure 1.1.

3.2. The site can be located from the following information:

- i. Postcode: CM22 7AA
- ii. NG Reference: TL518154
- iii. Elevation: 82.0 to 80.3 m AOD
- iv. The site slopes from northeast to southwest at an approximate gradient of 1 in 70

3.3. The site is a mix of buildings, areas of hardstanding and roads, woodland and grassland. See Appendix B for the topographical survey.

3.4. The site covers an area of 3.8ha. of which the buildings and access road cover an area of 1675m^2.

3.5. The nearest main river is Pincey Brook, 1.5 km to the East.

3.6. There is a watercourse that meanders through the site which is approximately 2 to 2.5 m wide and varies in depth due to siltation and lack of maintenance. The route is identified from the topographical survey shown in Appendix B and images of the watercourse condition are shown in Appendix C.

3.7. The watercourse conveys all the surface water run-off within the site. There is an inflow from the upper land, but beyond, which has a relatively small catchment.

3.8. The watercourse discharges from the site into a watercourse that runs alongside the properties, Oakfield House and The Croft which in turn outfalls to another open channel watercourse in the verge of Stortford Road. Appendix D shows images of the overgrown outfall from the site and the watercourse from the site at its inception with Stortford Road.

3.9. The BGS records describe the geology as:

- i. Superficial; Head - Gravel, Sand, Silt And Clay
- ii. Bedrock; London Clay Formation - Clay, Silt And Sand.

3.10. The BGS 1:50,000 scale drift maps (Figure 3.1 below) shows the form of the superficial deposits.

Figure 3.1 - BGS 1:50,000 Scale Drift Map

3.11. The BGS borehole record Reference: TL51NW60 located to the south of the site, show the superficial cover to be Boulder Clay.

3.12. A site investigation has been undertaken and demonstrates that soakage at shallow depth is not possible. The site investigation report is shown in Appendix E.

3.13. The existing buildings discharge to the watercourse within the site and the surface water is dissipated through the topsoil and via evapotranspiration during small storms. For the larger storms, the water is conveyed to the outlet point and discharges off the site towards Stortford Road. The watercourses are heavily silted and the outlet point is inaccessible.

3.14. The greenfield runoff from this site has been assessed using FEH data and is calculated as; Q_{bar}= 4.9l/s/ha., Q_1=4.3l/s/ha., Q_{30}=12.0l/s/ha. and Q_{100}=17.5l/s/ha., as shown in Appendix F.

4. FLUVIAL FLOODING

4.1. Fluvial flooding is the flooding associated with rivers. This can take the form of:

i. Inundation of floodplains from rivers and watercourses

ii. Inundation of areas outside the floodplain due to influence of bridges, embankments and other features that artificially raise water levels

iii. Overtopping of defences

iv. Breaching of defences

v. Blockages of culverts

vi. Blockages of flood channels or corridors

4.2. The Environment Agency (EA) have produced flood maps that show the risk of flooding from Rivers and Seas. The EA Flood Map in Figure 1.1 demonstrates the site is in Flood Zone 1. Therefore, the likelihood of flooding is less than 1% which is low risk.

5. TIDAL FLOODING

5.1. Tidal flooding is a risk of water levels from the sea or an estuary exceeding the normal tidal range. This can take the form of:

i. Overtopping of defences
ii. Breaching of defences
iii. Other flows (fluvial surface water) that could pond due to tide locking
iv. Wave action

5.2. As mentioned in 4.2, the EA Flood Map for Rivers and Seas suggests the site is in Flood Zones 1. However, the site is too far from the sea to be affected by tidal flooding.

6. PLUVIAL FLOODING

6.1. Pluvial flooding is a risk of overland flows and ponding associated with extreme rainfall events. This can take the form of:

i. Sheet run-off from adjacent land (urban or rural)
ii. Surcharged sewers

6.2. As rain falls everywhere within the United Kingdom, there will always be a residual risk of flooding from extreme rainfall events.

6.3. The EA have produced maps with risk classifications (Table 6.1) that show the risk of flooding from surface water run-off. An extract for the area is reproduced in Figure 6.1 below.

Risk Classification	Probability	
Very Low	<0.1%	(<1:1,000)
Low	1%	(1:100)
Medium	3.3%	(1:30)
High	>3.3%	(>1:30)

Table 6.1 – Surface Water Flooding Classifications

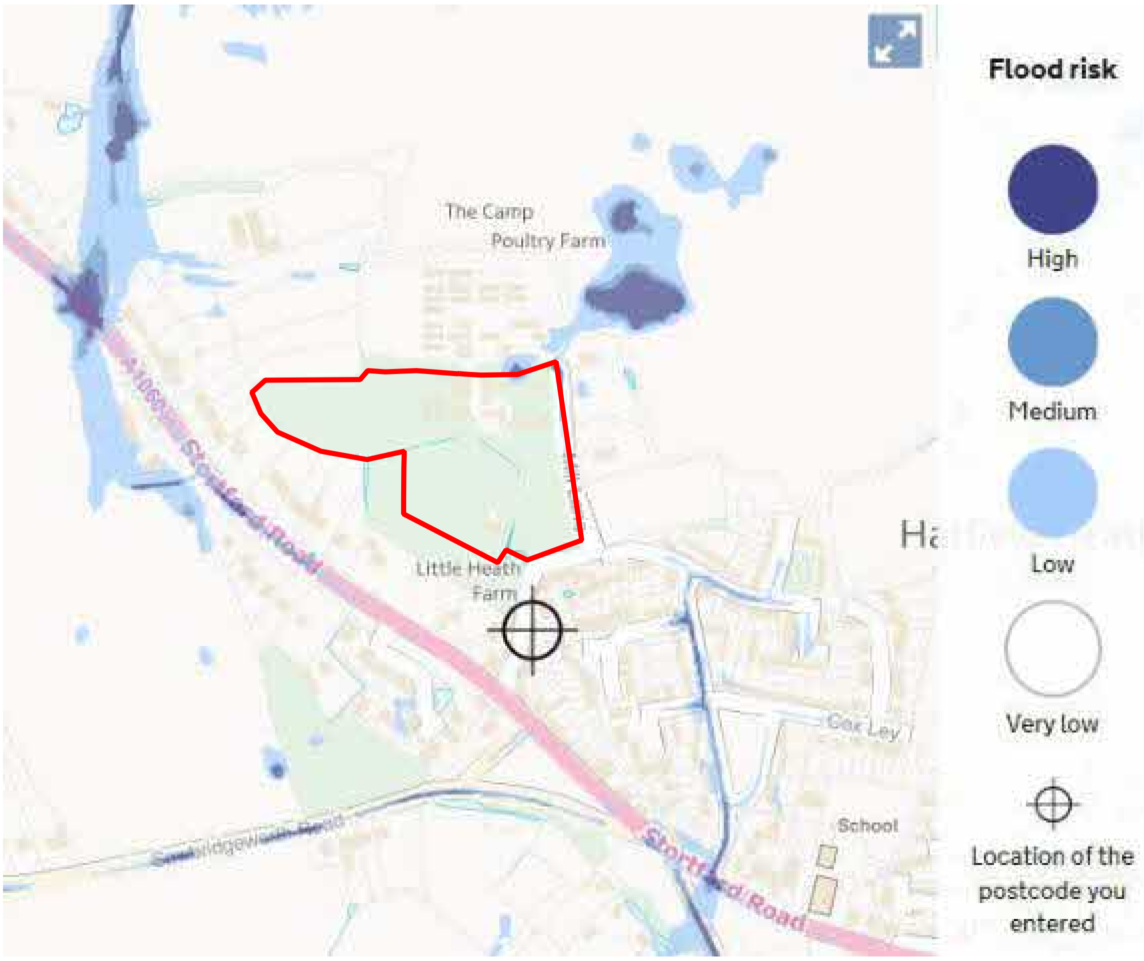


Figure 6.1 – EA Flood Map (Surface Water)

6.4. As can be seen from Figure 6.1, the data has identified a low spot which correlates with the watercourse on the site and therefore is at low risk of surface water flooding from extreme rainfall event.

7. GROUNDWATER FLOODING

7.1. Groundwater flooding is a risk of the water table rising after prolonged rainfall to emerge above ground level remote from a watercourse. It is most likely to occur in low lying areas underlain by aquifers of high vulnerability.

7.2. The Strategic Flood Risk Assessment identified that the site is at low risk of groundwater flooding.

7.3. It should be noted that the site investigation did encounter water at depths ranging between 1.0 to 2.7 m depth. This is likely to be a perched water table and created by the pocket of permeable soil within the clay.

7.4. The risk from groundwater flooding is low.

8. INFRASTRUCTURE FAILURE FLOODING

8.1. Infrastructure failure flooding is a risk of collapse, failure or surcharging of man-made structures and drainage systems. This could take the form of:

i. Reservoirs
ii. Canals
iii. Burst water mains
iv. Blocked sewers
v. Failed pumping stations

8.2. The EA have mapped failure of reservoirs and the likely flood path of their contents. There is no flood path zone near to the site.

8.3. The Strategic Flood Risk Assessment identified two incidents when flooding occurred from blocked sewer. However, these incidents were not near the site.

9. CLIMATE CHANGE

9.1. The National Planning Policy Framework (NPPF) sets out how the planning system should help to minimise vulnerability and provide resilience to the impacts of climate change.

9.2. The climate change allowances are predictions of anticipated change for:

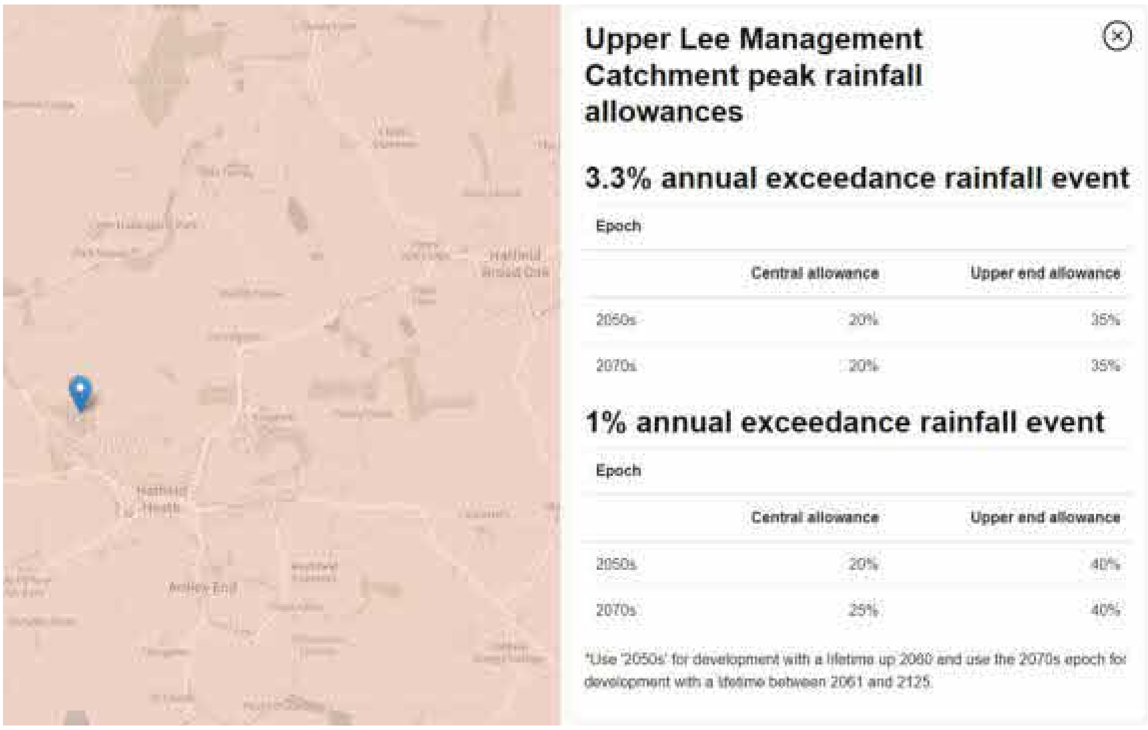
i. Peak river flow by river basin district

ii. Peak rainfall intensity

iii. Sea level rise

iv. Offshore wind speed and extreme wave height.

9.3. For the peak rainfall intensity, the design will allow for a 40% (higher central) increase, in accordance with the peak rainfall allowance for this catchment for a proposed design life of 100 years, as shown below;



Upper Lee Management Catchment peak rainfall allowances

3.3% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	20%	35%
2070s	20%	35%

1% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	20%	40%
2070s	25%	40%

*Use '2050s' for development with a lifetime up 2060 and use the 2070s epoch for development with a lifetime between 2061 and 2125.

10. PROPOSED DEVELOPMENT

10.1. The proposed development is to remove the buildings and structures which currently exist on site and erect 12 residential units and associated infrastructure across the site. The proposed layout drawing is shown in Appendix G.

10.2. The principle drainage philosophy is to replicate the existing system by utilising the existing watercourse through the site and keeping the system at or near the surface.

10.3. The watercourse will need to be cleaned and dredged to its optimum depth, with the outfall on the western boundary being the control point. The developer has the riparian right to utilise this watercourse. This will be the main conveyance mechanism and attenuation. The secondary conveyance mechanism will be dry swales to collect the road run-off and individual plot drainage. An indicative drainage layout is shown in Appendix H.

SURFACE WATER DISPOSAL

10.4. In accordance with Government and Local Plan Policies and the requirements of the Building Regulations surface water run-off from the development will be drained at source in a sustainable way by making full use of Sustainable Drainage Systems (SuDS) where possible.

10.5. The SuDS hierarchy dictates that infiltration at source is considered first. After infiltrating at source has been considered, the next stage is to deal with run-off in individual catchments, followed finally by site wide drainage solutions. Run-off from the development should not adversely impact upon drainage systems outside of the site boundary.

10.6. Detailed surface water drainage design should take into account all three key SuDS principles in equal measure:

i. Reducing peak quantity;
ii. Improving quality; and
iii. Providing amenity and biodiversity value.

10.7. Given the site characteristics and the proposed development on a brownfield site, it is proposed to replicate the existing form of drainage by discharging to the watercourse.

10.8. Infiltration is not possible on this site due to the soil conditions, as demonstrated by the soil report shown in Appendix E.

10.9. The drainage will be dealt with by providing attenuation within the existing watercourse. Due to the potential for ecological disturbance at the site, intrusive and extensive surveying of the watercourse profile was not possible at time of compiling this strategy.

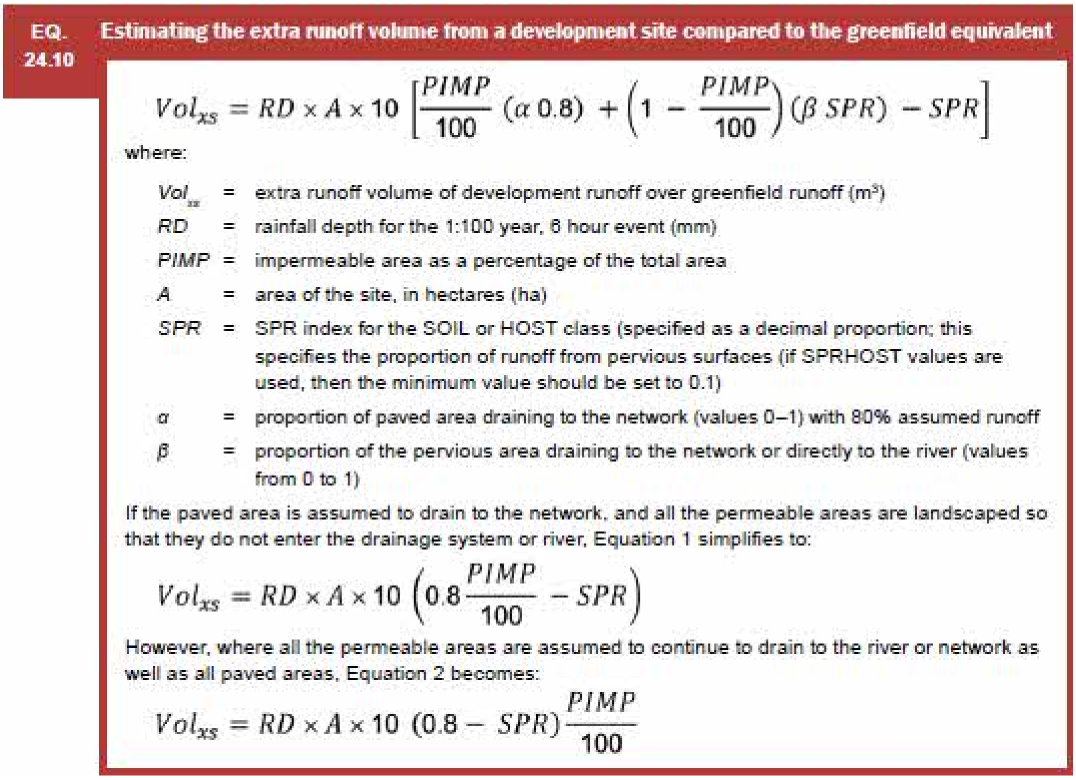
10.10. The proposed drainage system will utilise the existing features, mainly the watercourse that meanders through the site. To maintain water flow within the existing watercourse it is proposed to install a flow control device at the outlet of the watercourse from the site. The flow control will limit the additional flows created by the development to the greenfield rate.

10.11. The plots will drain to rain gardens (bio-retention mechanisms) at ground level and swales to convey the water to the main network. This provides interception storage and cleansing.

10.12. The proposed design method for the surface water run-off design is long term storage (LTS). It is recognised that this is not the most favourable method accepted by the LLFA, but it is felt this provides a better solution in utilising the existing drainage mechanisms on site, without having a dual system.

10.13. The site has existing buildings with an impermeable area of 1675m^2. This has not been included within the greenfield calculation. The proposed impermeable area is 6156m^2, with the total site area of 37700m^2.

10.14. To estimate the extra runoff volume compared to the greenfield equivalent, equation 24.10 (2) from the Ciria SuDS guidance C753 is used;



EQ. 24.10 **Estimating the extra runoff volume from a development site compared to the greenfield equivalent**

$$Vol_{xs} = RD \times A \times 10 \left[\frac{PIMP}{100}(\alpha\, 0.8) + \left(1 - \frac{PIMP}{100}\right)(\beta\, SPR) - SPR\right]$$

where:

Vol_{xs} = extra runoff volume of development runoff over greenfield runoff (m^3)

RD = rainfall depth for the 1:100 year, 6 hour event (mm)

$PIMP$ = impermeable area as a percentage of the total area

A = area of the site, in hectares (ha)

SPR = SPR index for the SOIL or HOST class (specified as a decimal proportion; this specifies the proportion of runoff from pervious surfaces (if SPRHOST values are used, then the minimum value should be set to 0.1)

α = proportion of paved area draining to the network (values 0–1) with 80% assumed runoff

β = proportion of the pervious area draining to the network or directly to the river (values from 0 to 1)

If the paved area is assumed to drain to the network, and all the permeable areas are landscaped so that they do not enter the drainage system or river, Equation 1 simplifies to:

$$Vol_{xs} = RD \times A \times 10 \left(0.8\frac{PIMP}{100} - SPR\right)$$

However, where all the permeable areas are assumed to continue to drain to the river or network as well as all paved areas, Equation 2 becomes:

$$Vol_{xs} = RD \times A \times 10\ (0.8 - SPR)\frac{PIMP}{100}$$

As the permeable area also drains to the watercourse, then equation 2 is used with the following values;

SPR=0.47, PIMP = 6156/37700 = 16%, Rainfall for the 100 year 6hour = 69.8mm, A=3.77ha.

This gives a required estimated extra run-off volume of 142m^3.

10.15. As the site has poor infiltration, the extra volume will be discharge at 2l/s/ha = 1.4l/s into the network. In order to minimise disruption to the established ecology, the watercourse will be deepened near to the outlet to accommodate the 142m^3 extra volume. This will discharge through a flow control at 2l/s/ha. The Q1 outflow will be set above the 142m^3 storage and discharge at a cumulative rate of Q1 (13.2l/s) and then Q30 (37.2l/s), with the final max discharge set at Q100+CCA (54l/s).

10.16. Info-drainage has been used to model the network and demonstrate the system does not flood and the results are shown in Appendix I. It has been demonstrated that with the addition of the 142m^3 of LTS, the existing watercourse can attenuate the run-off from this site with development. Therefore, the total overall attenuation is 432m^3.

10.17. The upstream inflow will be accepted into the system and conveyed through and will either flow out through the flow control system or in extreme conditions, overflow the flow control weir. The development will accept the inflow from the upper land and pass it on to the lower land, as it has insignificant impact on the development and will not increase flooding downstream in the design events.

10.18. A detailed design of the system is not possible at this stage, as the existing watercourse is silted and overgrown.

QUALITY

10.19. Before the water can enter the watercourse, it must be clean. This is done by passing the water through a number of treatment stages. The number of stages is dependent on the source of the water and will be in line with CIRIA guidance C753 SuDS Manual.

10.20. The types of pollution hazards that need to be treated on this site are shown in an extract from C753 document below;

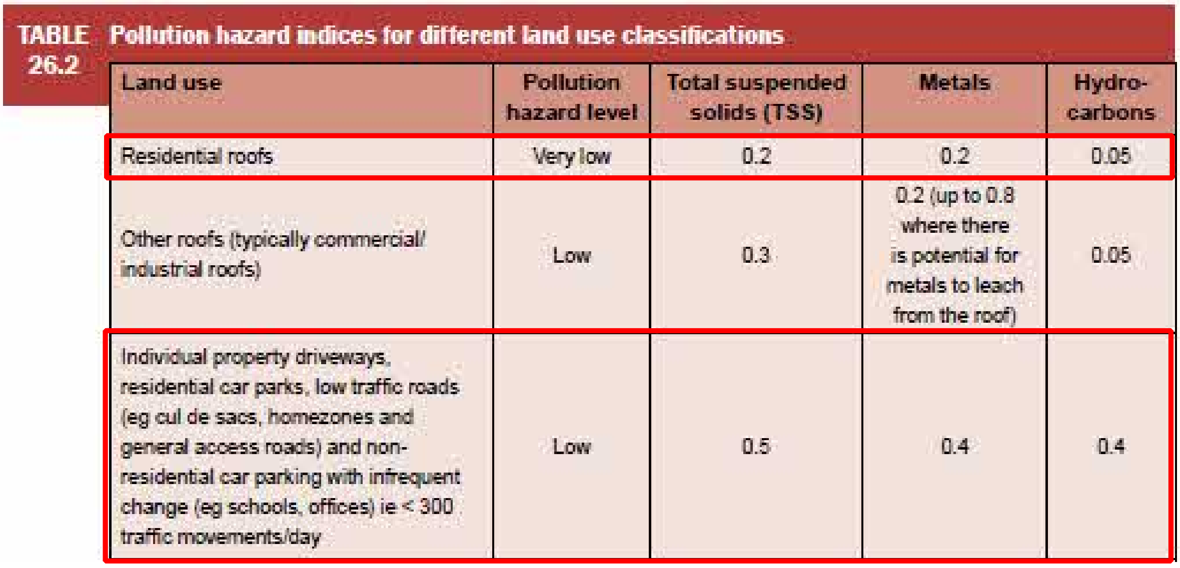


TABLE 26.2 **Pollution hazard indices for different land use classifications**

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4

10.21. In order to address these potential hazards, mitigation will be put into place in line with C753 as per the table below;

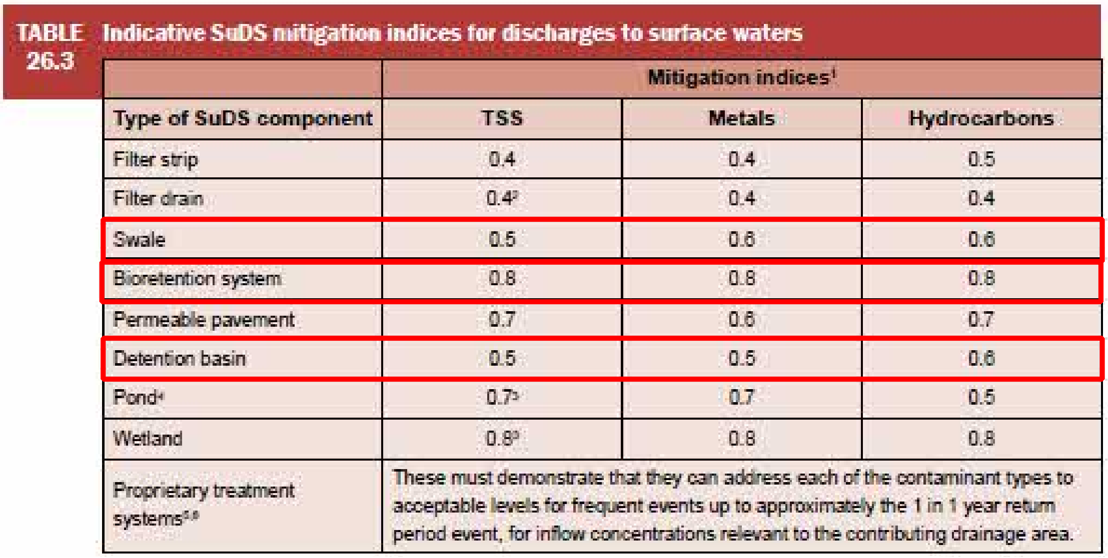


TABLE 26.3 **Indicative SuDS mitigation indices for discharges to surface waters**

	Mitigation indices[1]		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

10.22. Where space allows, a rain gardens will be installed for each individual plot, before discharging to the conveyancing swale or watercourse. Where a rain garden is not possible, then rainwater downpipe filter chambers will be installed.

10.23. The swales adjacent the roads will cleanse the carriageway run-off, before discharging to the watercourse.

10.24. From Table 26.2, the pollution hazard is low and the use of a detention basin, swale and bioretention system will mitigate for the pollutants.

ADOPTION AND MAINTENANCE

10.25. The site will remain private and therefore the responsibility of the drainage system be a management company. The management company will also be responsible for the roads and open spaces. A request to the water authority for adoption is unlikely to receive a positive response as it is deemed to be land drainage.

10.26. The SuDS mechanisms will need regular inspections and maintenance. Appendix J shows the recommended schedule of maintenance for each SuDS mechanism.

10.27. The local council could designate flood features if they so wish in accordance with Flood & Water Management Act 2010 Section 30 and Schedule 1, designation of features, to protect from future change.

EXCEEDANCE

10.28. There should be no vulnerable buildings at risk of flooding in an exceedance event (where rainfall which surpasses the design capacity).

10.29. Given the site slopes, the ground will be locally shaped to deflect overland flow away from the building. In accordance with the Building Regulations, the finished floor levels will be set a minimum 150mm above the finished ground level.

10.30. All exceedance flows will be directed towards the watercourse flowing through the site and following its path, off site, towards Stortford Road. This route is a continuation of the existing surface water exceedance flow path.

FOUL WATER DISPOSAL

10.31. Part H of the Building Regulations (2015) states that “Foul drainage should be connected to a public foul or combined sewer wherever this is reasonably practicable”.

10.32. A public sewer has been identified in Mill Lane and through payment of an infrastructure charge, connection to the Thames Water public sewer network is possible.

11. SUMMARY

11.1. It has been demonstrated that the site is within Flood Zone 1.

11.2. Table 11.1 summarises the probability of the development flooding from the five key sources as listed in PPS25.

Source	Description	Risk	
Fluvial	Rivers	Flood Zone 1	(<0.1%)
Tidal	Seas		
Pluvial	Surface Water	Low	(<1%)
Groundwater	Aquifers	Very Low	(<0.1%)
Infrastructure failure	Reservoirs Blocked Sewers	Outside maximum extent of flooding	(negligible)

Table 11.1 – Flood Risk Summary

11.3. Following the introduction of flood prevention measures, the development will be safe for its lifetime without increasing flood risk elsewhere.

11.4. Although this site is a brownfield site, the design is based on greenfield, therefore the drainage proposal meets the required standards.

11.5. Run-off from this development will be attenuated, with a controlled discharge, utilising existing watercourses.

11.6. The exceedance flow is directed away from vulnerable buildings and infrastructure and outflows along its original path.

11.7. In accordance with government policy, SuDS will be used on site, where possible, and surface water drainage of the site will be carried out in a sustainable way.

11.8. As long as the maintenance of the new drainage systems are correctly carried out, the risk of flooding and the subsequent risks from infrastructure failure or pluvial means is extremely small.

11.9. The local council could designate flood features if they so wish in accordance with Flood & Water Management Act 2010 Section 30 and Schedule 1, designation of features, to protect from future change.

11.10. The Environment Agency accepts that extreme floods will happen and it will never be possible to eliminate flood risk altogether.

11.11. It is considered that the risk of flooding to the site has been adequately considered and therefore development of the site with the proposed mitigation measures does not pose an unacceptable flood risk either to occupants of the site or to others off site.

List of Appendices

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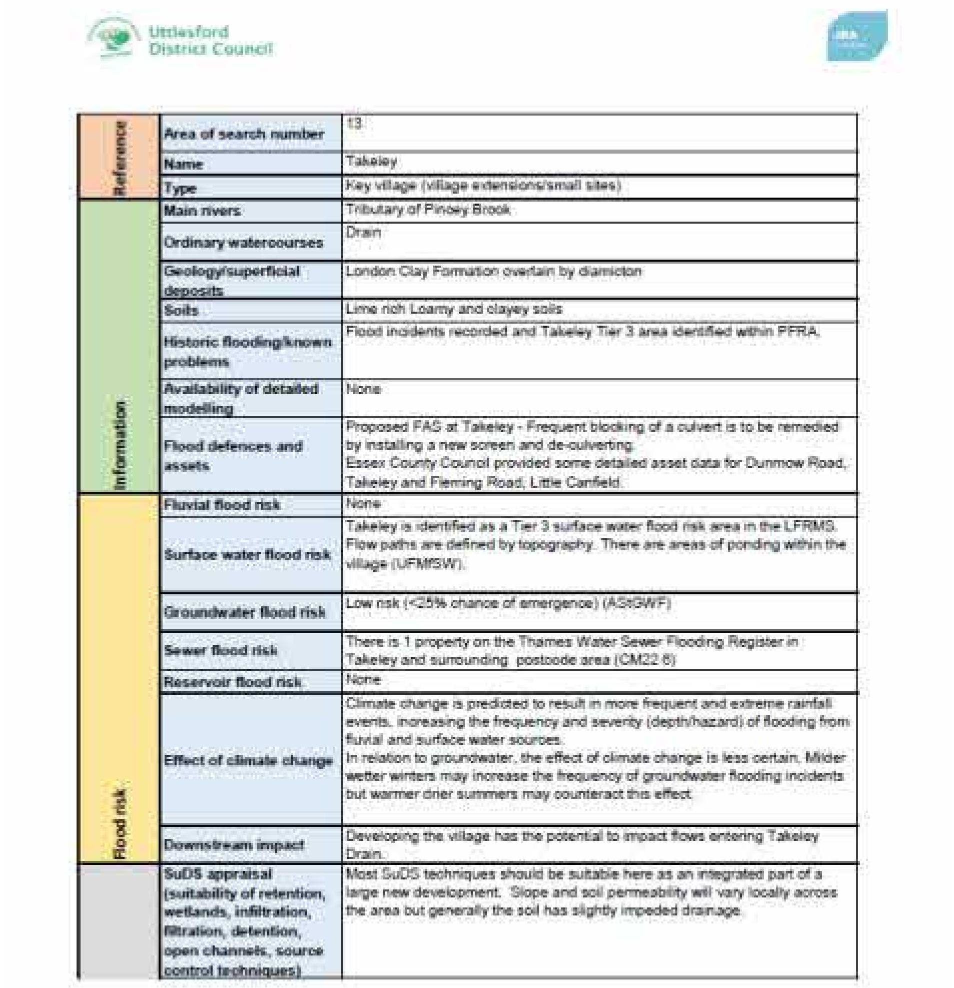
FLOOD RISK ASSESSMENT

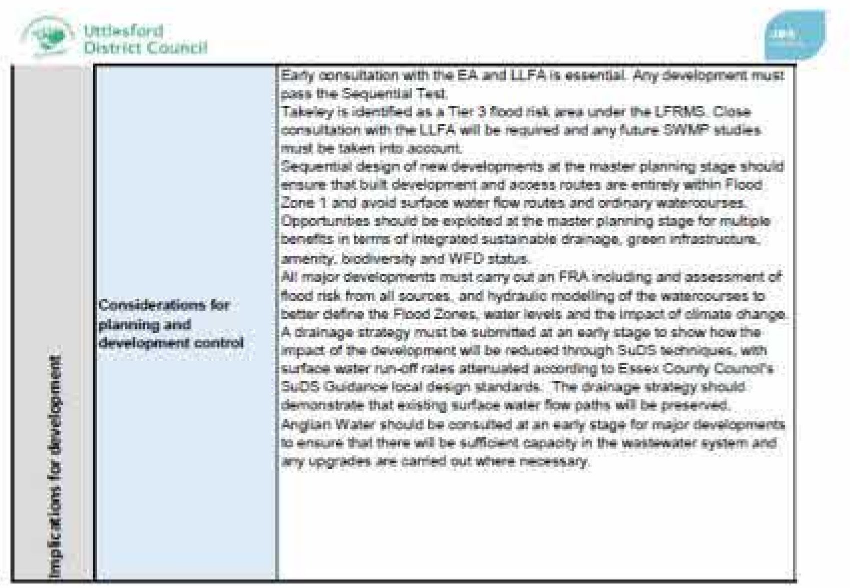
APPENDIX A

Uttlesford District Council Strategic Flood Risk Assessment Extract for Hatfield Heath



Uttlesford District Council

Reference	**Area of search number**	13
	Name	Takeley
	Type	Key village (village extensions/small sites)
Information	**Main rivers**	Tributary of Pincey Brook
	Ordinary watercourses	Drain
	Geology/superficial deposits	London Clay Formation overlain by diamicton
	Soils	Lime rich Loamy and clayey soils
	Historic flooding/known problems	Flood incidents recorded and Takeley Tier 3 area identified within PFRA.
	Availability of detailed modelling	None
	Flood defences and assets	Proposed FAS at Takeley - Frequent blocking of a culvert is to be remedied by installing a new screen and de-culverting. Essex County Council provided some detailed asset data for Dunmow Road, Takeley and Fleming Road, Little Canfield.
Flood risk	**Fluvial flood risk**	None
	Surface water flood risk	Takeley is identified as a Tier 3 surface water flood risk area in the LFRMS. Flow paths are defined by topography. There are areas of ponding within the village (UFMfSW).
	Groundwater flood risk	Low risk (<25% chance of emergence) (AStGWF)
	Sewer flood risk	There is 1 property on the Thames Water Sewer Flooding Register in Takeley and surrounding postcode area (CM22 6)
	Reservoir flood risk	None
	Effect of climate change	Climate change is predicted to result in more frequent and extreme rainfall events, increasing the frequency and severity (depth/hazard) of flooding from fluvial and surface water sources. In relation to groundwater, the effect of climate change is less certain. Milder wetter winters may increase the frequency of groundwater flooding incidents but warmer drier summers may counteract this effect.
	Downstream impact	Developing the village has the potential to impact flows entering Takeley Drain.
	SuDS appraisal (suitability of retention, wetlands, infiltration, filtration, detention, open channels, source control techniques)	Most SuDS techniques should be suitable here as an integrated part of a large new development. Slope and soil permeability will vary locally across the area but generally the soil has slightly impeded drainage.



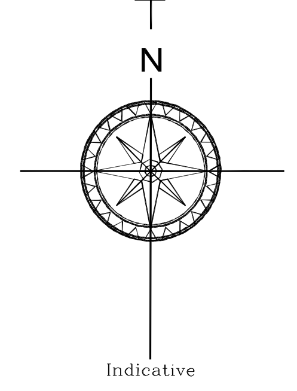
Uttlesford District Council

Implications for development	**Considerations for planning and development control**	Early consultation with the EA and LLFA is essential. Any development must pass the Sequential Test. Takeley is identified as a Tier 3 flood risk area under the LFRMS. Close consultation with the LLFA will be required and any future SWMP studies must be taken into account. Sequential design of new developments at the master planning stage should ensure that built development and access routes are entirely within Flood Zone 1 and avoid surface water flow routes and ordinary watercourses. Opportunities should be exploited at the master planning stage for multiple benefits in terms of integrated sustainable drainage, green infrastructure, amenity, biodiversity and WFD status. All major developments must carry out an FRA including and assessment of flood risk from all sources, and hydraulic modelling of the watercourses to better define the Flood Zones, water levels and the impact of climate change. A drainage strategy must be submitted at an early stage to show how the impact of the development will be reduced through SuDS techniques, with surface water run-off rates attenuated according to Essex County Council's SuDS Guidance local design standards. The drainage strategy should demonstrate that existing surface water flow paths will be preserved. Anglian Water should be consulted at an early stage for major developments to ensure that there will be sufficient capacity in the wastewater system and any upgrades are carried out where necessary.

FLOOD RISK ASSESSMENT

APPENDIX B

Site Topographical Survey



NOTE:- ALL KERB LEVELS ARE CHANNEL LEVELS

FENCE TYPES

B/W	Barbed Wire	C/P	Chestnut Paling	P/S	Palisade
C/B	Close Boarded	I/R	Iron Railing	P/W	Post & Wire
C/I	Corrugated Iron	I/W	Interwoven		
C/L	Chainlink	P/R	Post & Rail		

LEGEND

AV	Air Valve	MH	Manhole
BD	Bollard	MK	Marker
BH	Borehole	NP	Street Name Plate
CB	Cable Box	O/H	Overhead
CHY	Chimney	OSBM	Ordnance Bench Mark
CL	Cover Level	P	Post Or Pillar
CONC	Concrete	PM	Parking Meter
CTV	Cable Television	RE	Rodding Eye
DK	Drop Kerb	RS	Road Sign
DP	Down Pipe	SAP	Sapling
DR	Drain	SC	Stop Cock
ELC	Electricity	SL	Sump Level
EP	Electricity Pole	ST	Stop Tap
ER	Earth Rod	SV	Sluice Valve
FB	Flower Bed	TAR	Tarmac
FH	Fire Hydrant	TCB	Telephone Call Box
FP	Flag Pole	TL	Traffic Lights
GY	Gully	TP	Telegraph Pole
GP	Gate Post	TV	Television Box
GV	Gas Valve	UTL	Unable to lift
IC	Inspection Cover	VP	Vent Pipe
IL	Invert Level	WL	Water Level
JB	Junction Box	WM	Water Meter
KO	Kerb Outlet	WO	Wash Out
LB	Letter Box		
LP	Lamp Post		

Banking
Hedge
Tree
Bush
Gate
O/H Electric
O/H Telecom
S1
Control Station

Drawn by:- TM/MR Surveyed by:- MR Checked by:- JT

Date:	March 2016
Scale:–	1:200
Drawing Number:	ALS7335/200/03a Topo
Client:	David Sargeant
Project:	Hatfield Heath Essex

Surveyed By:–

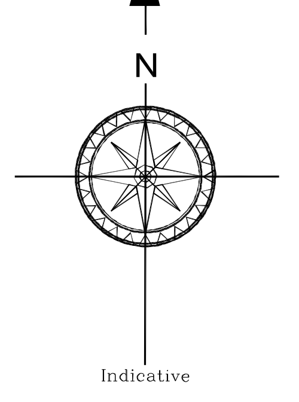
Anglia Land Surveys Ltd

EST 1976

Bowthorpe Hall,
Bowthorpe Hall Road,
Norwich, NR5 9AA

Tel:	(01603) 749600
Fax:	(01603) 734798
e-mail:	mail@als-surveys.com
Website:	www.als-surveys.com

QMS
ISO 9001
REGISTERED FIRM



NOTE:- ALL KERB LEVELS ARE CHANNEL LEVELS

FENCE TYPES

B/W	Barbed Wire	C/P	Chestnut Paling	P/S	Palisade
C/B	Close Boarded	I/R	Iron Railing	P/W	Post & Wire
C/I	Corrugated Iron	I/W	Interwoven		
C/L	Chainlink	P/R	Post & Rail		

LEGEND

AV	Air Valve	MH	Manhole
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Surveyed By:-
ALS EST 1976
Anglia Land Surveys Ltd
Bowthorpe Hall,
Bowthorpe Hall Road,
Norwich, NR5 9AA
Tel: (01603) 749600
Fax: (01603) 734798
e-mail: mail@als-surveys.com
Website: www.als-surveys.com

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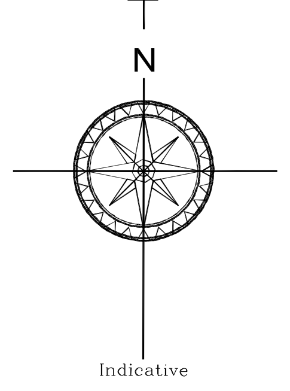

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Drawn by:- TM/MR Surveyed by:- MR Checked by:- JT

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EST 1976

Bowthorpe Hall,
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Norwich, NR5 9AA

Tel: (01603) 749600
Fax: (01603) 734798
e-mail: mail@als-surveys.com
Website: www.als-surveys.com

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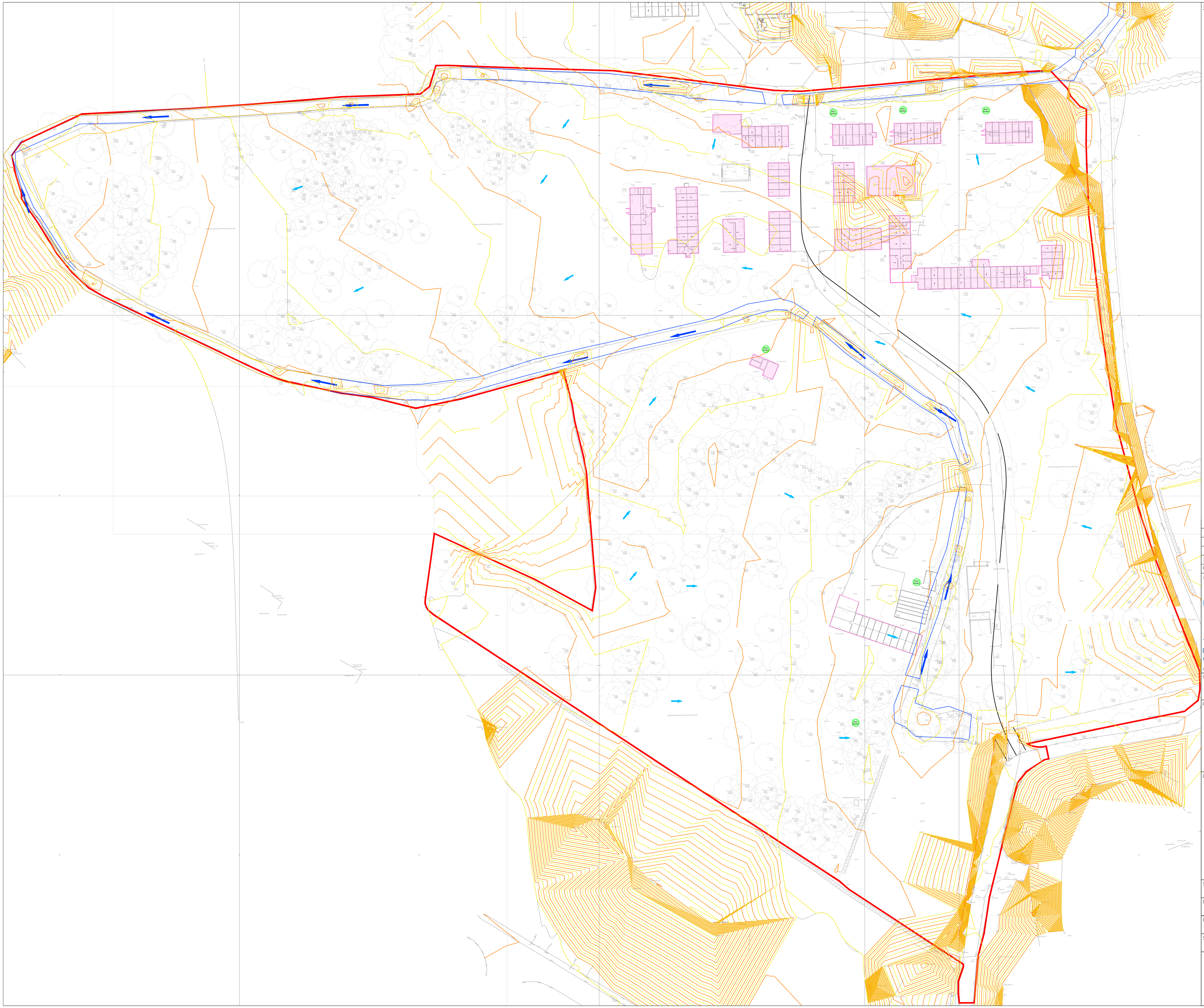


NOTES:

1. This drawing is to be read in conjunction with GHB series 321/2021 drawings and documents and any other relevant project team documents.
2. Preliminary Issue - This drawing is not to be used for construction or detailed pricing purposes. Any work undertaken before approvals are received (in writing) are at risk of abortive works.
3. This drawing has been prepared solely for the purpose of obtaining a Planning Consent based on information available and planning requirements at the date of issue only.

Legend-

▭	Site Boundary- Area:4.35ha
▨	Existing Impermeable Area: 1563m²
➡	Overland Flowpaths
═	Existing Water Course - Existing Long Term Storage: 90.92m³
▭	Primary Contours (0.5m)
▭	Secondary Contours (0.1m)

Revision	Date	Description
P1	**/**/**	Initial Issue

GHBullard & Associates LLP
Civil and Traffic Engineering Consultants

T: (01359) 235071
F: (01359) 231138
W: http://www.ghbullard.co.uk

27 Barton Road,
Thurston,
Suffolk,
IP31 3PA

Partnership No. OC383830, Registered in England and Wales

Client:
CITY and COUNTRY Ltd

Project:
LAND AT MILL LAND
AND HIGH PASTURES,
HATFIELD HEATH, ESSEX

Drawing Title:
EXISTING SITE

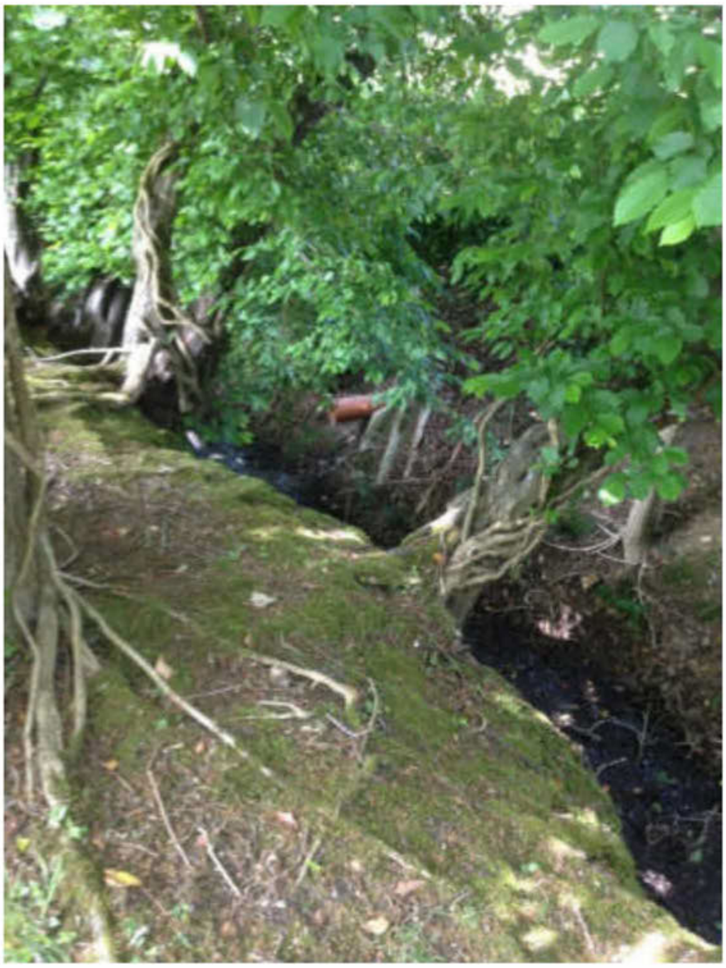
Scale: N.T.S@ A1
Date: MAY 2022
Drawn: BAF
Checked: JAH
DWG Reference: 046-2022.DWG
Status: FOR INFORMATION
Drawing Number: 046/2022/02
Revision: P1

P# = Preliminary, C# = Construction, AB# = As Built

APPENDIX C

Images of Existing Watercourse



FLOOD RISK ASSESSMENT

APPENDIX D

Images of Outfall at Stortford Road

APPENDIX E

Site Investigation Report by Roberts Hay Partnership Ltd.

BRIEF FACTUAL SITE INVESTIGATION

Site High Pastures, Stortford Road, Hatfield Heath, Essex
& Little Heath Farm, Hatfield Heath, Essex

Client City & Country Ltd
Bentfield Place
Stansted
Essex

Job number 16021
Issue date
Site Work April 2016

Signed [redacted]... Michael K Hay IEng AMIStructE
berts Hay Partnership Ltd.

Roberts Hay Partnership Ltd. St John's Innovation Centre, Cowley Road, Cambridge, CB4 0WS
T: 01223 860820 M: 07836 781377 E: rhpdesign@btconnect.com W: rhpconsult.co.uk
Registered in England and Wales Company Number 4674075

Brief

To carry out a brief site investigation, by means of machine dug trial holes, in order to determine the nature of the upper sub soils, all in relation to possible development of the sites. At the time of writing we have not seen any proposals for such development but believe that low rise residential dwelling houses are proposed.

Soakage testing is to be carried out in order to establish the viability of surface water disposal via soakaways.

We have not been asked to carry out any contamination testing or to assess the site for the possibility of chemical contamination or pollution. During our works we do visually assess for the obvious presence of signs of contamination, and will highlight any such indications if encountered, however this should not be considered as an adequate substitute for a full contamination survey that you might consider necessary.

Summary.

High Pastures. We consider that mass concrete strip foundations would be a suitable founding solution for the proposed low rise residential development. Some de-watering of foundation excavations may be required. Foundations within the influence zones of new or existing significant vegetation would need to be deepened and may require anti heave protection. However for the majority of this area of the site nominal 1.0m deep foundations would appear to be sufficient.
Ground floors should be of suspended construction.

Little Heath Farm. Existing Egg Farm.

The majority of this area of the site would appear to be suitable for nominal 1.0m deep foundations. Some de-watering of foundation excavations may be required. Where foundations are within the influence zones of new or existing significant vegetation they may need to be deepened and require anti heave protection.
De-watering of excavations may be required.
Ground floors to be of suspended construction.

Little Heath Farm. Field to the East of Mill Lane.

The extent of the fill materials encountered here should be further investigated prior to deciding on the most suitable foundation solution. However provided the depth of fill is not excessive mass concrete strip foundations would be a suitable solution.

Where foundations are within the influence zones of new or existing significant vegetation they may need to be deepened and require anti heave protection.
Some de-watering of excavations may be required.
Ground floors to be of suspended construction.

Remainder of Little Heath Farm. Due to the variability of the soil strata and the density of tree growth we consider that a pile or raft foundation would be the most appropriate founding solution for this area of the site.

Soakage Testing. Due to the subsoils encountered being predominantly clays and most of the trial excavations making water we were unable to complete the required soakage testing, however we do not consider that shallow soakaways would be an appropriate solution for the disposal of surface water.

Introduction.

This report has been prepared for the benefit of yourselves and your professional advisers; it may not be passed to any third party without the written consent of the Roberts Hay Partnership Ltd. In any case no liability will extend to any such third party for all or any part of its contents.

The comments and opinions expressed in this report are based upon the conditions encountered on site during the investigation works, any comments can only be specific to that area from which soil was extracted and must only be considered as indicative of the nature of the site as a whole. It is always possible that some special conditions prevailing on site have not been encountered and therefore have not been taken into consideration in the formulation of this report.

All ground water recordings or their absence relate only to short term observations and in particular do not allow for any seasonal variation. Any such readings may therefore not truly reflect the natural groundwater conditions.

This investigation specifically does not extend to matters of chemical contamination or pollution of the site, soils or ground water.

Site Work.

At the time of our visit the weather was overcast but dry.

The site of our investigation comprises two areas; the land behind High Pastures, Stortford Road, Hatfield Heath; and Little Heath Farm, Hatfield Heath. Both areas are bounded by residential dwellings or open farm land.

Trial pits were machine dug and during excavation the soil strata were logged, in-situ soil strength testing as appropriate was carried out, and soil samples extracted and retained for laboratory testing; all as indicated on the trial pit logs. The attached sketch plans show the trial pit locations together with other significant features.

<u>High Pastures.</u> Generally the soils encountered at a nominal founding level comprise moderatly shrinkable clays that have sufficient strength to support the anticipated loadings from low rise dwelling houses with acceptable settlement characteristics. Although any foundations within the influence zone of existing or proposed significant vegetation should be designed in accordance with the NHBC guidelines "Building Near Trees", however there is little significant vegetation and the majority of the area should be suitable for nominal 1.0m deep foundations.

Water was encountered in TP1as a moderate inflow at some 0.9m depth and therefore some de-watering of foundation excavations may be required. Should the water inflow encountered in the trial excavations prove persistent then some de-watering of excavations may be necessary. As water inflow was slow, such de-watering should be manageable and could probably be achieved by pumping of any water ingress from a sump formed adjacent to the foundation excavations.

<u>Little Heath Farm. Existing Egg Farm.</u> Both trial pits 8 & 9 in this area encountered dense gravels at nominal foundation depths underlain by the shrinkable clays. The gravels have sufficient strength to support the anticipated loadings with acceptable settlements. However where the influence zone of existing or proposed significant vegetation exceeds the depth of the gravel layer foundations depths should be designed in accordance with the NHBC guidelines for "Building Near Trees" and may require anti-heave precautions.
Ground floors to be of suspended construction.

<u>Little Heath Farm. Field to the East of Mill Lane.</u>
The majority of this area of the site would appear to be suitable for mass concrete strip foundations. However The trial excavation encountered mixed clay and brick rubble fill down to some 1.2m depth. The extent of the fill materials should be further investigated prior to deciding on the most suitable foundation solution. Concrete strip foundations would need to be founded into virgin strata below the fill materials. Where foundations are within the influence zones of new or existing significant vegetation they may need to be deepened and require anti heave protection. Ground floors to be of suspended construction. Although the sides of the trial excavation were stable for the short time that they were exposed, the possibility of excavation collapse in the fill materials should be considered.

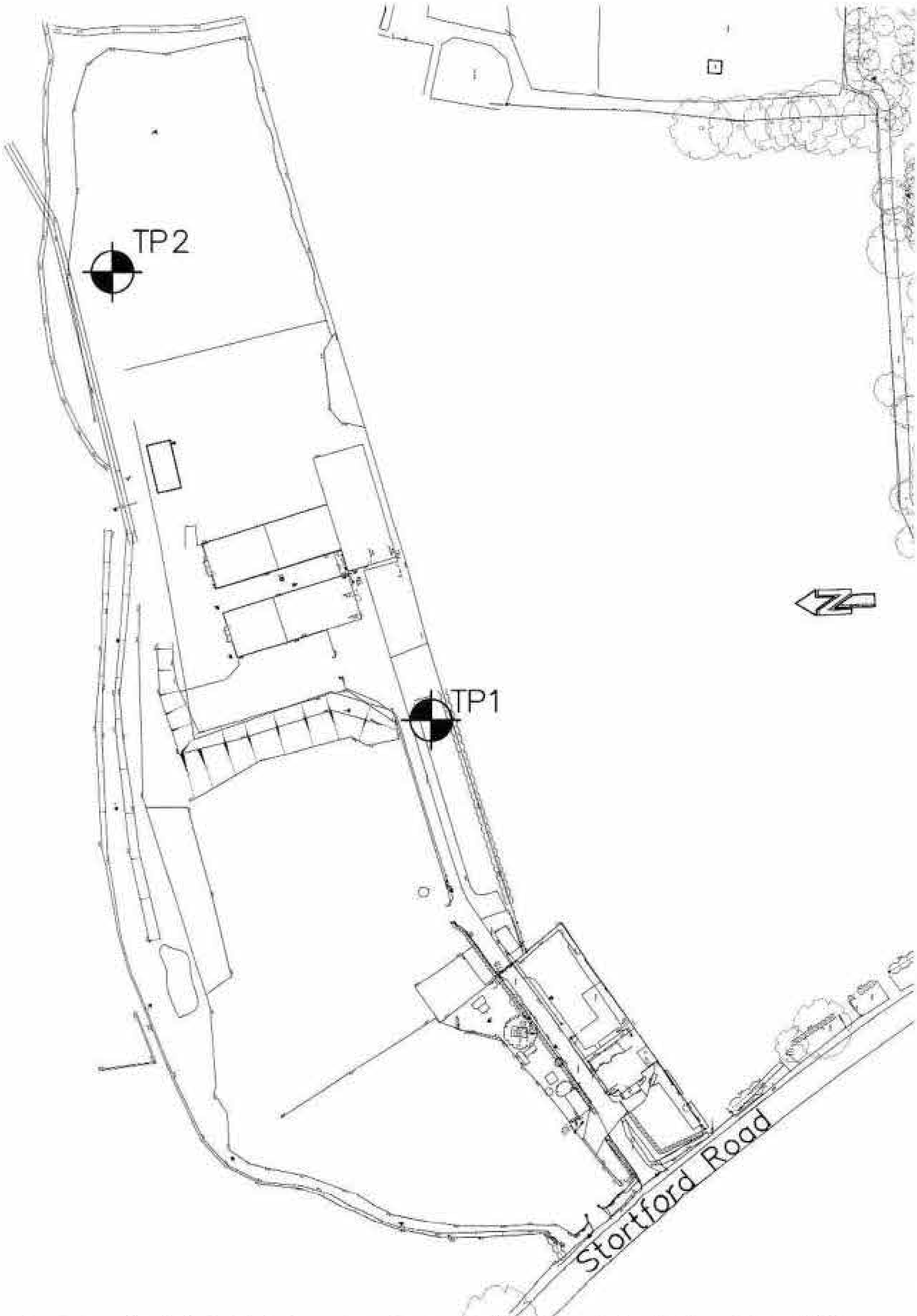
Remainder of Little Heath Farm. The remaining area of Little Heath Farm is extensively wooded with many mature and semi mature trees. There are also some water features and ditches crossing the site. The underlying soils mainly comprise of clays although there are also some areas of fill, pockets of sand and some gravels. The variability of the soil strata and the density of tree growth suggests that a pile or raft foundation would be the most appropriate founding solution. As appropriate for a piled foundation the ground floor should be of suspended construction.

Soakage testing. The majority of the subsoils encountered were the slightly silty slightly sandy clays, with poor permeability, that are typical of the local area. In most of the excavations water was encountered at variable depths, and as variable inflows. A single soakage test was carried out in TP3 at 1.3m depth where the clays where conditions were more favorable the clays containing more sand and flint gravels, however the test was abandoned after 20 minutes as the water levels were static.

Laboratory Work.

Results of laboratory analysis are attached. These show the generally silty sandy CLAYs encountered at nominal founding level to be of variable shrinkability (PI 12%-38%), that is showing a variable propensity to a change in volume following a change in their moisture content. Foundations based in these shrinkable soils within the influence zone of existing vegetation will need to be designed in accordance with NHBC Chapter 4.2 'Building Near Trees'.

Site Plan High Pasture. Not to Scale For Location Purposes Only



Site Plan Little Heath Farm. Not to Scale For Location Purposes Only

Trial Hole 1

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.40	0.40	soft to firm dark brown slightly sandy clay TOPSOIL/FILL with rare medium brick fragments rare medium to large flint gravels							
1.90	1.50	firm to stiff mid to light orange-brown slightly silty sandy CLAY with rare fine to medium flint gravels rare medium to large flint cobbles more medium gravels with depth (slight collapse)		rare fibrous	B1 B2	1.00 1.90	V MP	58 100+	mod inflow 0.90m
3.00	1.10 pen	very stiff mid grey orange-brown mottled slightly silty slightly sandy CLAY with rare to occasional fine to medium chalk gravels			B3	3.00	MP	100+	

Hole closed @ 3.00m

B	Bulk Sample
W	Water Sample
N	Standard Penetration
MP	Mackintosh Probe
D	Disturbed jar sample
U	Undisturbed sample U100
V	Shear Vane

Trial Hole 2

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.20	0.20	grass over firm dark brown / black sandy clayey TOPSOIL							
0.80	0.60	stiff mid-light brown sandy claybound Medium-large flint GRAVEL		rare upto 2mm					
		very stiff mid orange-brown grey-brown mottled slightly silty slightly sandy CLAY with rare fine chalk & flint gravels		rare fibrous	B1	1.00	MP	100+	
	2.20 pen	Rare – occasional fine-medium chalk gravels		rare fibrous					
		rare medium to large chalk & flint cobbles			B2	2	MP	100+	
		variable composition		rare fiberous					
3.00					B3	3	MP	100+	

Hole closed @ 3.00m

B	Bulk Sample
W	Water Sample
N	Standard Penetration
MP	Mackintosh Probe
D	Disturbed jar sample
U	Undisturbed sample U100
V	Shear Vane

Trial Hole 3

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.30	0.30	grass over stiff dark brown-black slightly silty slightly sandy clayey TOPSOIL		rare upto 5mm					
0.60	0.30	very stiff dark orange-brown very sandy CLAY occasional-much medium-large flint gravel		rare upto 1mm					
1.70	1.10	very stiff mid to light orange brown dark orange mottled slightly sandy CLAY with rare fine-medium flint gravels. Coarse sand veining with depth rare large flint cobbles		rare upto 2mm	B1 B2	1.00 1.7	MP MP	100+ 100+	
2.70	1.00	very stiff mid grey mid orange-brown mottled slightly sandy CLAY rare medium flint gravel & rare fine chalk gravel becoming more silty with depth. Coarse sand veining becoming more sandy with depth		rare upto 1mm	B3	2.7	MP	100+	slow inflow 2.7m
3.00	0.3	very stiff mid orange-brown damp silty sandy CLAY			B4	3.00	MP	100+	
3.30	0.3	very stiff mid grey orange-brown slightly silty sandy CLAY occasional fine-medium chalk gravels rare medium chalk cobbles							

Hole closed @ 3.30m

B	Bulk Sample
W	Water Sample
N	Standard Penetration
MP	Mackintosh Probe
D	Disturbed jar sample
U	Undisturbed sample U100
V	Shear Vane

Trial Hole 4

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.40	0.40	dense orange-brown clayey TOPSOIL FILL rare medium brick fragments		rare upto 5mm					
1.30	0.90	dense mid orange-brown orange mottled slightly silty claybound medium to large flint GRAVEL rare grey veining with depth becoming grey & more silty with depth		rare upto 1mm rare upto 1mm	B1 B2	1.00 1.30	MP MP	100+ 100+	
2.10	0.80	very stiff mid -light grey mid orange-brown mottled slightly silty sandy CLAY		rare upto 1mm	B3	2.1	MP	100+	
2.80	0.70	very stiff mid orange slightly silty sandy CLAY with rare fine-medium flint gravels grey mottling & more silty with depth							slow inflow 2.7m
3.20	0.4 pen	very dense mid orange-brown grey mottled slightly clayey silty damp SAND rare Fine-medium flint gravels			B4	3.00	MP	100+	

Hole closed @ 3.20m

B	Bulk Sample	D	Disturbed jar sample
W	Water Sample	U	Undisturbed sample U100
N	Standard Penetration	V	Shear Vane
MP	Mackintosh Probe		

Trial Hole 5

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.30	0.30	stiff dark brown sandy clayey TOPSOIL		rare upto 15mm					rapid inflow 0.3m
1.50	1.20	brick FILL		rare upto 8mm rare upto 12mm	B1	1.50	MP	28	
2.20	0.70	soft dark brown black mottled slightly sandy slightly silty CLAY with rare rotting Vegetation & leaf mould variable composition		rare upto 1mm	B2	2.2	MP	100+	
3.00	0.80	vert stiff mid-light grey dark grey mottled slightly silty sandy CLAY rare to occasional Fine-medium chalk & flint gravels rare medium-large chalk cobbles			B3	3	MP	100+	

Hole closed @ 3.00m

B	Bulk Sample	D	Disturbed jar sample
W	Water Sample	U	Undisturbed sample U100
N	Standard Penetration	V	Shear Vane
MP	Mackintosh Probe		

Trial Hole 6

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.30	0.30	grass over very stiff dark brown slightly silty sandy clayey TOPSOIL		rare upto 6mm					
0.50	0.20	very stiff dark orange-brown slightly silty sandy CLAY rare medium flint gravels							
1.20	0.70	stiff mid-light grey-brown orange mottled slightly silty slightly sandy CLAY rare to occasional fine-medium chalk & flint gravels Medium-large flint gravels with depth		rare upto 4mm rare fibrous	B1 B1	1.00 1.00	MP MP	100+ 100+	
1.80	0.60	very stiff mid orange light grey mottled slightly silty slightly sandy CLAY rare fine chalk & flint gravels. rare medium large flint cobbles			B1	1.00	MP	100+	fast seepage 1.9m
2.50	0.70	dense mid orange slightly silty very clayey coarse SAND with rare fine-medium flint gravels rare large flint cobbles			B4	2.5	MP	58	
3.00	0.50 pen	Firm-stiff mid grey orange-brown mottled slightly silty sandy CLAY rare fine-medium chalk gravels							

Hole closed @ 3.00m

B	Bulk Sample	D	Disturbed jar sample
W	Water Sample	U	Undisturbed sample U100
N	Standard Penetration	V	Shear Vane
MP	Mackintosh Probe		

Trial Hole 7

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.30	0.30	grass over stiff dark brown sandy clayey TOPSOIL		rare upto 3mm					
1.20	0.90	stiff dark brown sandy clay and brick rubble FILL variable composition			B1	1.20	MP	100+	
1.50	0.30	very dense mid-light orange-brown orange mottled slightly silty clayey sandy flint GRAVELS rare medium flint cobbles			B2	1.50	MP	100+	
3.00		very stiff light orange-brown orange mottled slightly silty sandy CLAY with occasional Fine-medium flint gravels more flint gravel with depth [slight collapse] becoming dense claybound gravels with depth variable composition			B3 B4	2 3	MP MP	100+ 100+	mod seepage 2.4m

Hole closed @ 3.00m

B	Bulk Sample
W	Water Sample
N	Standard Penetration
MP	Mackintosh Probe
D	Disturbed jar sample
U	Undisturbed sample U100
V	Shear Vane

Trial Hole 8

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.40	0.40	stiff dark brown-black clayey TOPSOIL		rare upto 10mm					
0.90	0.50	Stiff-very stiff grey-brown mottled silty CLAY occasional fine-medium flint gravels							
		very stiff light grey-brown orange-brown mottled slightly silty slightly sandy CLAY rare fine-medium chalk & flint gravels rare black partings		rare upto 2mm	B1	1.00	MP	100+	
		more chalk & flint gravels with depth		rare upto 1mm					
	2.10 pen	pocket of very dense orange-brown claybound medium-large flint gravel		rare fibrous	B2	2.00	MP	100+	
		rare large chalk & flint cobbles with depth							
		variable composition		rare inactive					
		rare very large chalk cobbles with depth							
3.00				rare inactive	B3	3.00	MP	100+	

Hole closed @ 3.00m

B	Bulk Sample
W	Water Sample
N	Standard Penetration
MP	Mackintosh Probe
D	Disturbed jar sample
U	Undisturbed sample U100
V	Shear Vane

Trial Hole 9

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.50	0.50	stiff dark brown-black sandy clayey TOPSOIL							
2.20	1.70	dense grey-brown slightly silty slightly sandy claybound fine-medium flint GRAVEL slight collapse below 1.1m orange mottling with depth rare medium flint cobbles & rare medium chalk gravels becoming more sandy with depth rare large chalk & flint cobbles with depth			B1 B2 B3	1.00 2 2.2	MP MP MP	100+ 100+ 100+	slow seepage 1.0m
2.70	0.50	very stiff mid orange-brown grey-brown mottled slightly silty sandy CLAY rare fine chalk gravels rare medium flint gravels			B4	2.7	V	58	
3.00	0.3	stiff grey-brown orange brown mottled slightly silty slightly sandy CLAY very rare fine chalk fragments.			B5	3	V	86	

Hole closed @ 3.00m

B	Bulk Sample	D	Disturbed jar sample
W	Water Sample	U	Undisturbed sample U100
N	Standard Penetration	V	Shear Vane
MP	Mackintosh Probe		

Trial Hole 10

depth below ground level (M)	thickness of strata (M)	description of strata	legend	roots	sampling				water
					ref	depth (M)	test	value	
0.20	0.20	stiff dark brown-black slightly sandy clayey TOPSOIL		upto 5mm					
0.70	0.50	Stiff-very stiff mid-dark orange-brown slightly silty slightly sandy CLAY rare medium flint gravels orange veining with depth		upto 2mm					
	2.30 pen	very stiff mid-light orange-brown grey mottled slightly silty sandy CLAY rare-occasional flint gravels		rare upto 1mm	B1	1.00	MP	100+	
		rare medium chalk gravels							
		slight collapse			B2	2	MP	100+	slow seepage 2.0m
		more chalk & flint cobbles with depth							
		variable composition		rare inactive					
		occasional vary large chalk & flint cobbles			B3	3	MP	100+	

Hole closed @ 3.00m

B	Bulk Sample
W	Water Sample
N	Standard Penetration
MP	Mackintosh Probe
D	Disturbed jar sample
U	Undisturbed sample U100
V	Shear Vane

Soakage Testing

			TEST 1		TEST 2		TEST 3	
depth below ground level (M)	description of strata	ref	elapsed time (mins)	water level below datum (mm)	elapsed time (mins)	water level below datum (mm)	elapsed time (mins)	water level below datum (mm)
	very stiff mid to light orange brown dark orange mottled slightly sandy CLAY with rare fine-medium flint gravels. Coarse sand veining with depth							
1.30	rare large flint cobbles	S1	1	12				
			2	15				
			5	15				
			10	15				
			20	15				

Test abandoned as no further fall in water level after 20 minutes

Laboratory Testing

Natural Moisture Contents & Atterburg Limits.
Clayton & Jukes Single Point Method using the Cone Penetrometer.

Sample ref	Sample Depth	Natural Moisture Content	Liquid Limit	Plastic Limit	Retained @ 0.425mm	Retained @ 0.063mm	Passing 0.063mm	Basic Plasticity Index	**Modified Plasticity Index**	**Class.**
TP1	1.00	33%	50%	25%	11%	21%	68%	25%	**22%**	C H
	1.90	35%	44%	23%	4%	13%	83%	21%	**20%**	C I
	3.00	24%	37%	20%	5%	12%	83%	17%	**16%**	C I
TP2	1.00	20%	68%	29%	3%	15%	82%	39%	**38%**	C H
	2.00	18%	56%	24%	8%	13%	79%	32%	**29%**	C H
	3.00	18%	38%	20%	6%	14%	80%	18%	**17%**	C I
TP3	1.00	20%	35%	18%	37%	15%	27%	17%	**N/A**	C I
	1.70	21%	48%	27%	6%	29%	65%	21%	**20%**	M I
	2.70	25%	40%	23%	9%	14%	77%	17%	**15%**	C I
	3.00	20%	25%	20%	3%	36%	61%	5%	**5%**	C L
TP4	1.00	10%	49%	23%	49%	6%	45%	26%	**13%**	M I
	1.30	19%	41%	19%	1%	41%	58%	22%	**22%**	C I
	2.10	20%	42%	22%	8%	23%	69%	20%	**18%**	C I
	3.00	21%	29%	17%	2%	63%	35%	12%	**12%**	C L
TP5	1.50	65%	100%	62%	3%	7%	90%	38%	**37%**	M E
	2.20	23%	48%	29%	26%	13%	61%	19%	**14%**	M I
	3.00	21%	37%	18%	5%	14%	81%	19%	**18%**	C I
TP6	1.20	22%	52%	22%	4%	22%	74%	30%	**29%**	C H
	1.80	14%	29%	15%	34%	26%	40%	14%	**9%**	C L
	2.50	25%	47%	21%	6%	30%	64%	26%	**24%**	C I

Sample ref	Sample Depth	Natural Moisture Content	Liquid Limit	Plastic Limit	Retained @ 0.425mm	Retained @ 0.063mm	Passing 0.063mm	Basic Plasticity Index	**Modified Plasticity Index**	Class.
TP7	1.20	16%	26%	16%	41%	27%	32%	10%	**N/A**	C L
	1.50	28%	41%	24%	25%	20%	55%	17%	**13%**	M I
	2.00	24%	44%	25%	36%	24%	40%	19%	**12%**	M I
	3.00	11%	0%	0%	64%	10%	26%	0%	**N/A**	C L
TP8	1.00	26%	73%	25%	7%	12%	81%	48%	**45%**	C V
	2.00	16%	36%	19%	12%	11%	77%	17%	**15%**	C I
	3.00	16%	37%	18%	8%	13%	79%	19%	**17%**	C I
TP9	1.00	18%	0%	0%	54%	13%	33%	0%	**N/A**	C L
	2.20	27%	49%	26%	5%	18%	77%	23%	**22%**	C I
	2.70	31%	57%	28%	2%	8%	90%	29%	**28%**	C H
TP10	1.00	26%	54%	24%	15%	17%	68%	30%	**26%**	C H
	2.00	17%	35%	18%	11%	14%	75%	17%	**15%**	C I
	3.00	18%	32%	19%	5%	13%	82%	13%	**12%**	C I

FLOOD RISK ASSESSMENT

APPENDIX F

Greenfield Rate Run-off Calculation.

GHBullard & Associates LLP
Civil and Traffic Engineering Consultants

27 Barton Road,
Thurston
Suffolk,
IP31 3PA

Tel: 01359 235071
Fax: 01359 231138
Web-site:
www.ghbullard.co.uk

Project			Job ref	
Hatfield Heath			046-2022	
Design Element			Calc sheet no. ref	
Q_{bar} from FEH data				
Drawing ref	Calc by	Date	Check by	Date
	JAH	29/04/2022	JAH	29/04/2022

Ref	Calculations	Output

Input values into blue boxes only: Example (includes all drop down options)

FEH (Institute of Hydrology, 1999)
Estimation of Median Flood

Catchment area=	1	ha
SAAR	605	mm
FARL	1	
BFIHOST	0.416	

$QMED_{rural}$ Median annual flood for a rural area (m^3/s)
AREA Catchment area (km^2)
SAAR Standard average annual rainfall (1961-1990) (mm)
BFIHOST Base flow index based on soil type map

Revised Kjeldson et al (2008) Method

$$QMED = 8.3062 \cdot AREA^{0.8510} \cdot 0.1536^{\frac{1000}{SAAR}} \cdot FARL^{3.4451} \cdot 0.0460^{BFIHOST^2}$$

QM 8 0 0 1 1
QM 4.377 l/s

Qmed to Qbar conversion factor 1.12

Growth Factors		l/s/ha
Q1	0.87	4.26
Q30	2.45	12.01
Q100	3.56	17.45

Output		
Q_{med} =	4.4	l/s/ha
Q_{bar} =	4.9	l/s/ha
Q_1 =	4.3	l/s/ha
Q_{30} =	12.0	l/s/ha
Q_{100} =	17.5	l/s/ha

```
<?xml version="1.0" encoding="UTF-8" standalone="true"?>
<!--Created by FEH Web Service at 15:35:41 on Fri 29-Apr-2022-->
<FEHCDROMExportedDescriptors appVersion="2.0.0.0" version="4.0.0">
 - <PointDescriptors ngr="TL 51850 15528" y="215528" x="551850" grid="GB">
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       <bfihost19>0.416</bfihost19>
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       <saar>605</saar>
   </PointDescriptors>
 - <PointDDF2013Values>
   - <ReturnPeriods>
```

FLOOD RISK ASSESSMENT

APPENDIX G

Proposed Development Plan

Pelham Structures LIMITED
Unit 3, Brices Yard, Butts Green, Clavering, Essex CB11 4RT
Tel: 01799 551261, Fax: 01799 551284, Email: info@pelham-structures.co.uk

Project name: Little Heath, Hatfield Heath
Drawing title: Proposed Site Plan
Scale: 1:500
Date: 27.04.2022
Drawing no: 571x02 B
Paper: A1 Paper
Drawn: HLW
Dimensions are in millimeters unless otherwise stated. Do not scale from this drawing. If in doubt, ask.

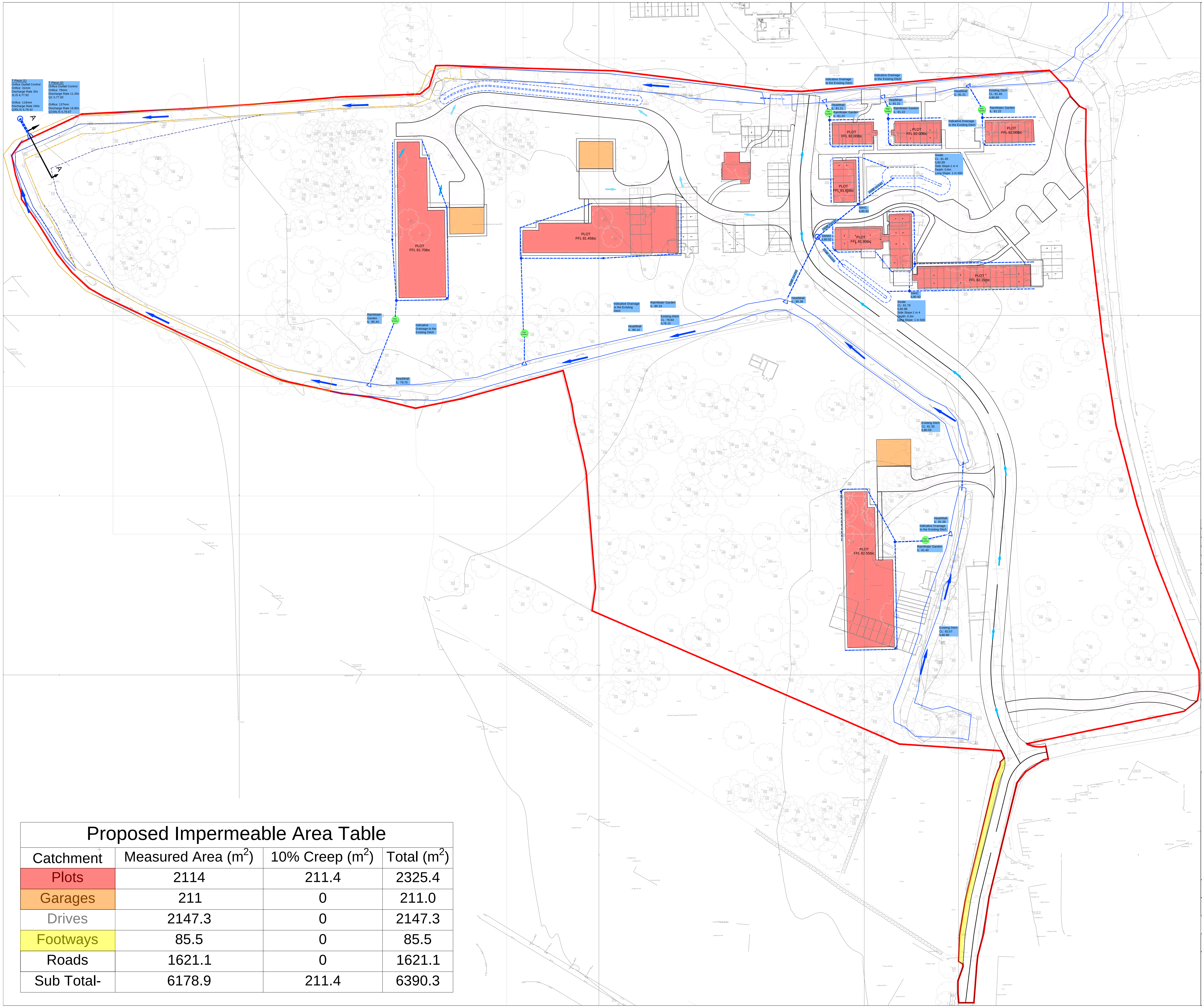
Proposed Site Plan

Little Heath, Hatfield Heath

FLOOD RISK ASSESSMENT

APPENDIX H

Indicative Drainage Layout and Typical Details



NOTES:

1. This drawing is to be read in conjunction with GHB series 046/2022 drawings and documents and any other relevant project team documents.
2. Preliminary Issue - This drawing is not to be used for construction or detailed pricing purposes. Any work undertaken before approvals are received (in writing) are at risk of abortive works.
3. This drawing has been prepared solely for the purpose of obtaining a Planning Consent based on information available and planning requirements at the date of issue only.

Legend-

🟥	Site Boundary- Area:3.77ha
➡	Proposed Flowpath
00.00	Indicative Proposed Levels
●─○	Indicative Surface Water Network
▭	Area Excavated to Provide Additional Long Term Storage: 69.785m³ Total: 160.71m³
▭	Swale
○	Flow Control- Discharge rate:
▭	Existing Water Course
▭	Extent of 1m Deepening of the Existing Ditch

Proposed Impermeable Area Table

Catchment	Measured Area (m^2)	10% Creep (m^2)	Total (m^2)
Plots	2114	211.4	2325.4
Garages	211	0	211.0
Drives	2147.3	0	2147.3
Footways	85.5	0	85.5
Roads	1621.1	0	1621.1
Sub Total-	6178.9	211.4	6390.3

Revision	Date	Description
P5	17/10/22	Changed to Suit New Architectural Layout
P4	10/10/22	Changed to Suit New Architectural Layout
P3	16/08/22	ECC Private Drainage Shown
P2	17/05/22	Comments Addressed
P1	13/05/22	Initial Issue

GHBullard & Associates LLP
Civil and Traffic Engineering Consultants

27 Barton Road,
Thurston,
Suffolk,
IP31 3PA

T: (01359) 235071
F: (01359) 231138
W: [redacted]

Partnership No. OC383830; Registered in England and Wales

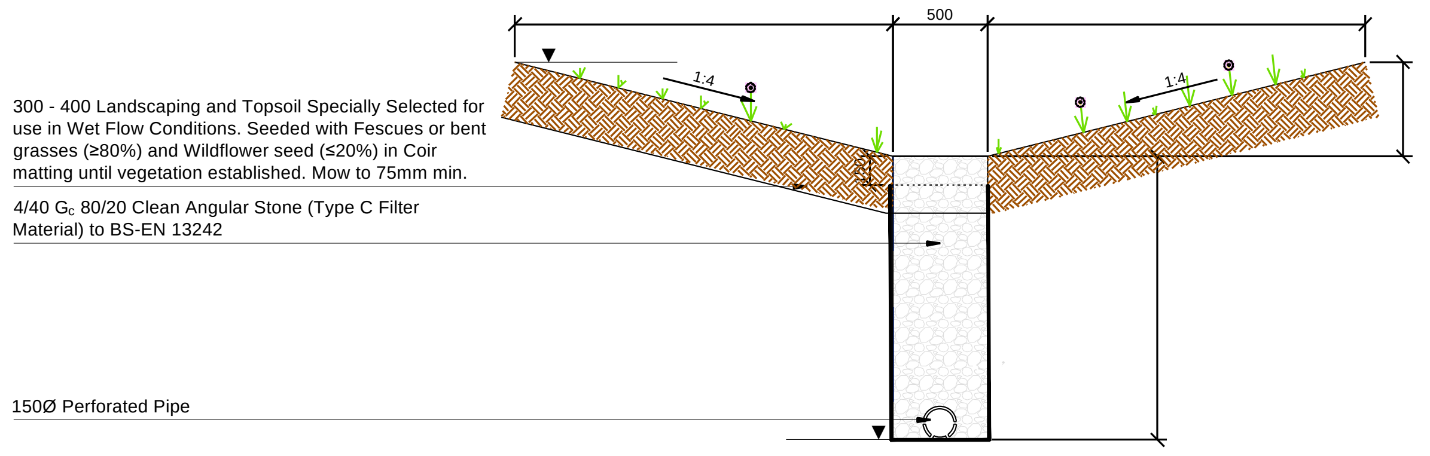
Client:
CITY and COUNTRY Ltd

Project:
LAND AT MILL LAND
AND HIGH PASTURES,
HATFIELD HEATH, ESSEX

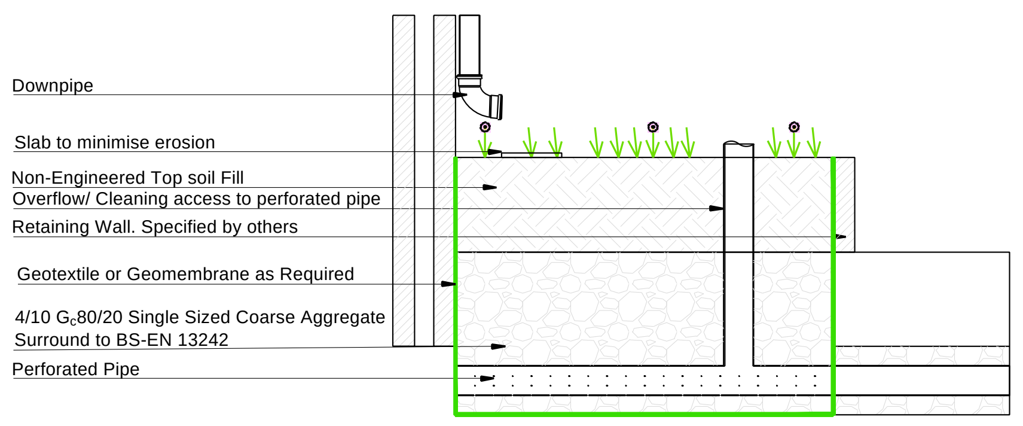
Drawing Title:
PROPOSED DRAINAGE
CONSTRICTION

Scale: 1:500 @ A1
Date: OCT 2022
Drawn: BAF
Checked: JAH
DWG Reference: 046-2022.DWG
Status: FOR INFORMATION
Drawing Number: 046/2022/03
Revision: P5

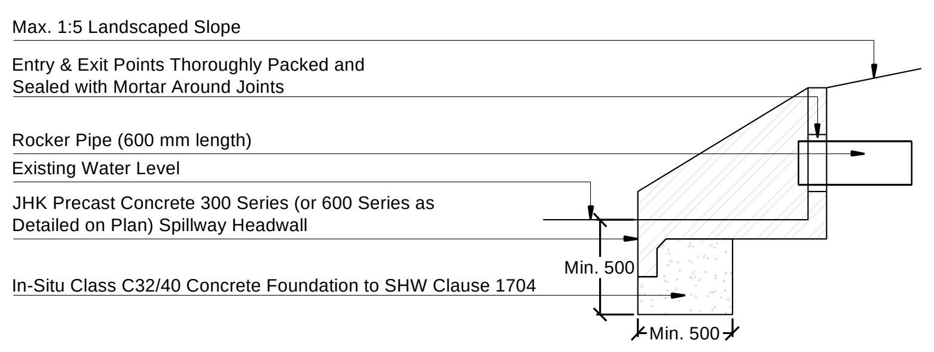
P# = Preliminary, C# = Construction, AB# = As Built



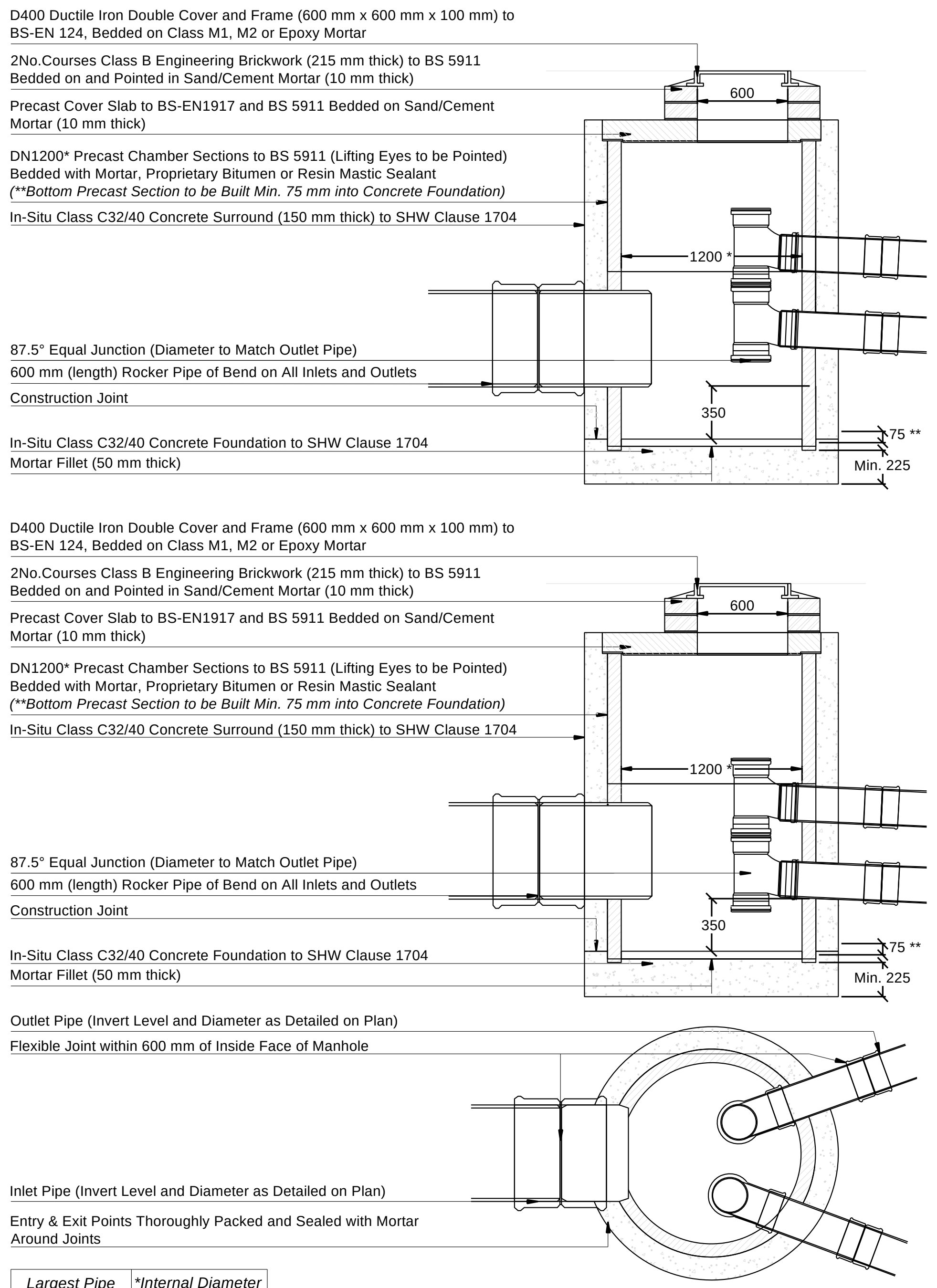
TYPICAL DRY SWALE CONSTRUCTION DETAIL



TYPICAL ABOVE GROUND RAIN GARDEN SECTION

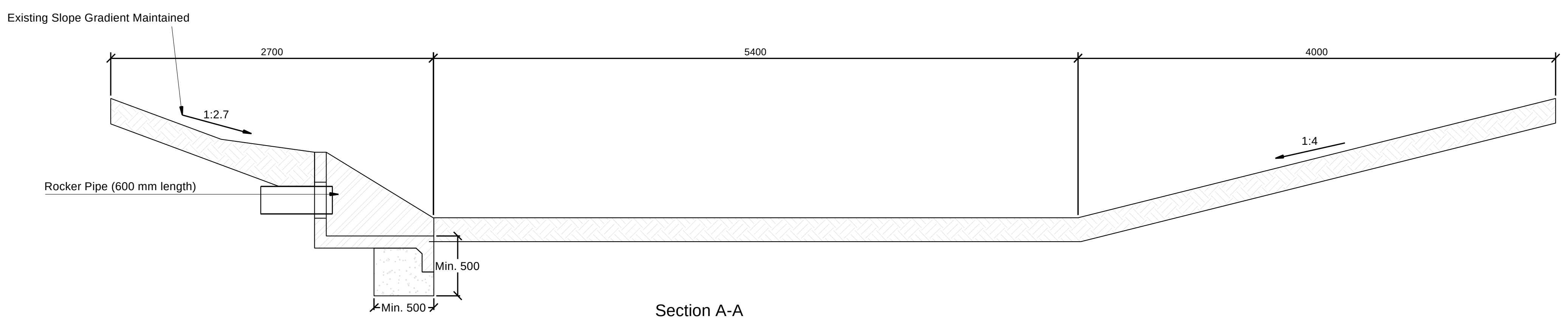


TYPICAL HEADWALL DETAIL

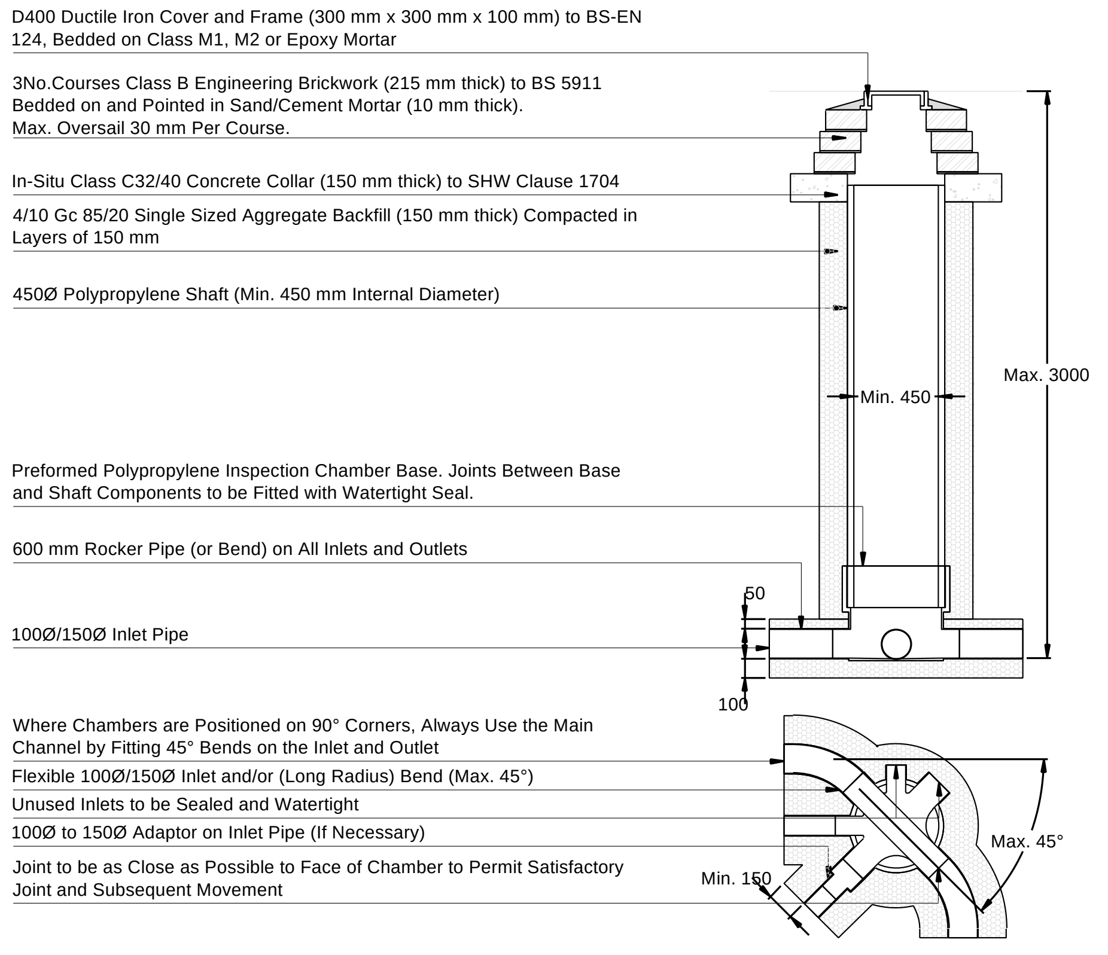


Largest Pipe Diameter	**Internal Diameter of Chamber*
<375	*1200*
375 to 700	*1500*

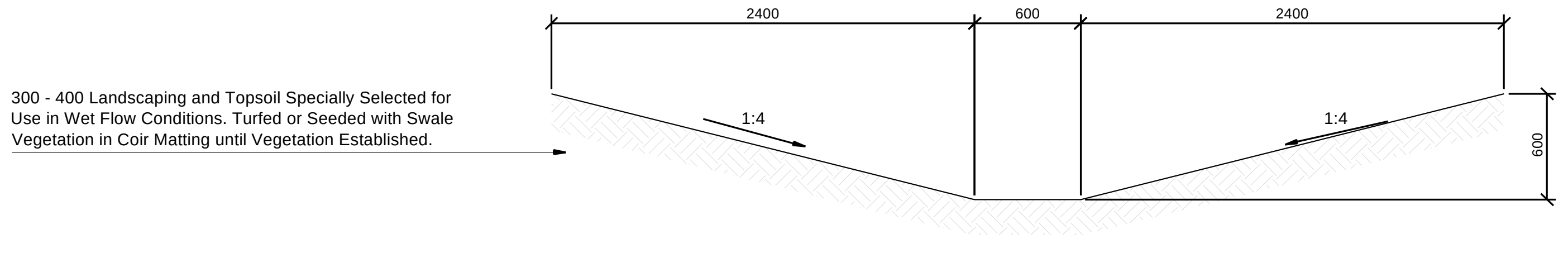
LONG TERM STORAGE FLOW CONTROL DETAIL



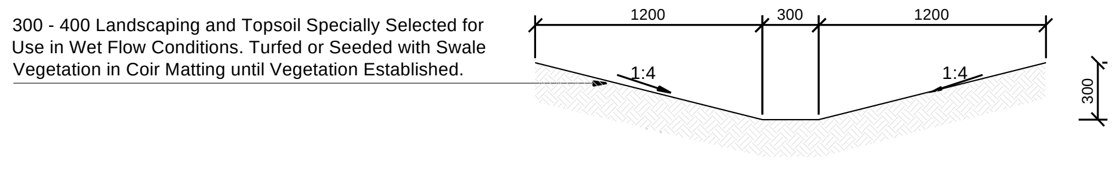
Section A-A



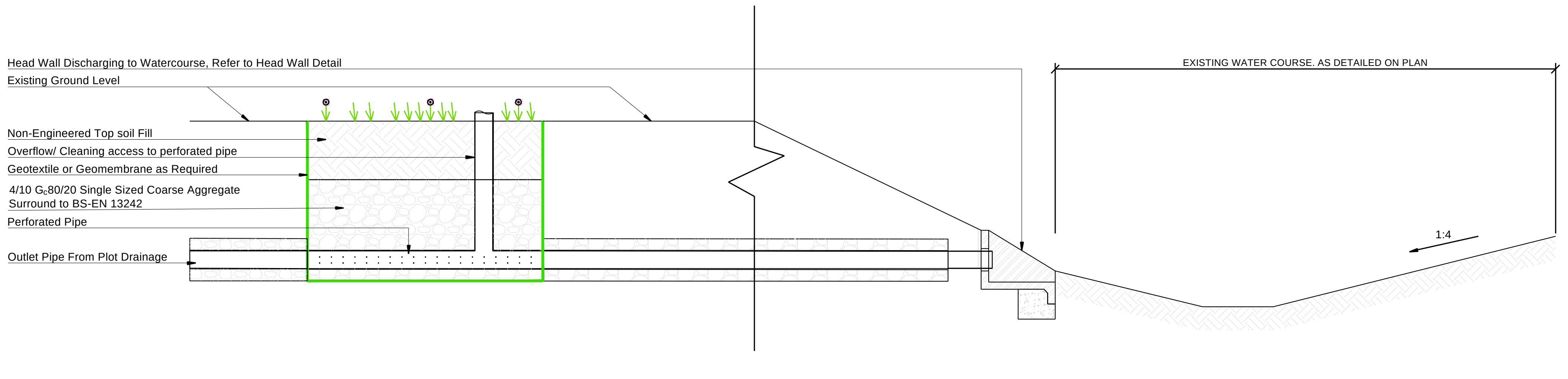
TYPICAL TYPE 3 INSPECTION CHAMBER



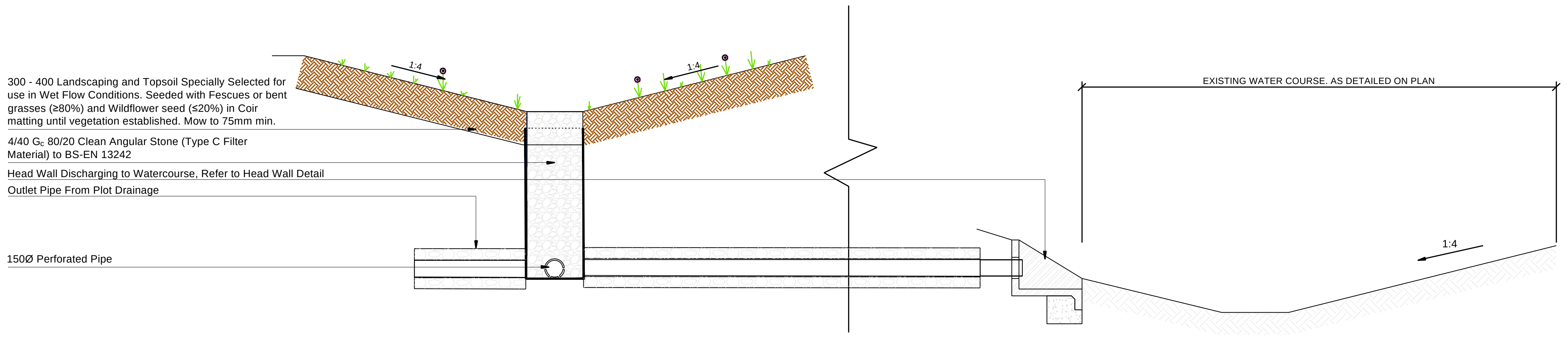
TYPICAL SWALE PROFILE



TYPICAL SWALE PROFILE



PLOT DISCHARGING INTO RAIN GARDEN INTO THE EXISTING WATER COURSE



PLOT DISCHARGING INTO A DRY SWALE INTO THE EXISTING WATER COURSE

NOTES:

1. This drawing is to be read in conjunction with GHB series 046/2022 drawings and documents and any other relevant project team documents.
2. Preliminary Issue - This drawing is not to be used for construction or detailed pricing purposes. Any work undertaken before approvals are received (in writing) are at risk of abortive works.
3. This drawing has been prepared solely for the purpose of obtaining a Planning Consent based on information available and planning requirements at the date of issue only.

Revision	Date	Description
P3	16/08/22	ECC- Private Drainage Shown
P2	19/05/22	Comments Addressed
P1	13/05/22	Initial Issue

GHBullard & Associates LLP
Civil and Traffic Engineering Consultants

T: (01359) 235071
F: (01359) 231138
W: h[redacted]

27 Barton Road,
Thurston,
Suffolk,
IP31 3PA

Partnership No. OC383830, Registered in England and Wales

Client:
CITY and COUNTRY Ltd

Project:
LAND AT MILL LAND
AND HIGH PASTURES,
HATFIELD HEATH, ESSEX

Drawing Title:
CONSTRUCTION DETAILS & SECTIONS
DRAWING

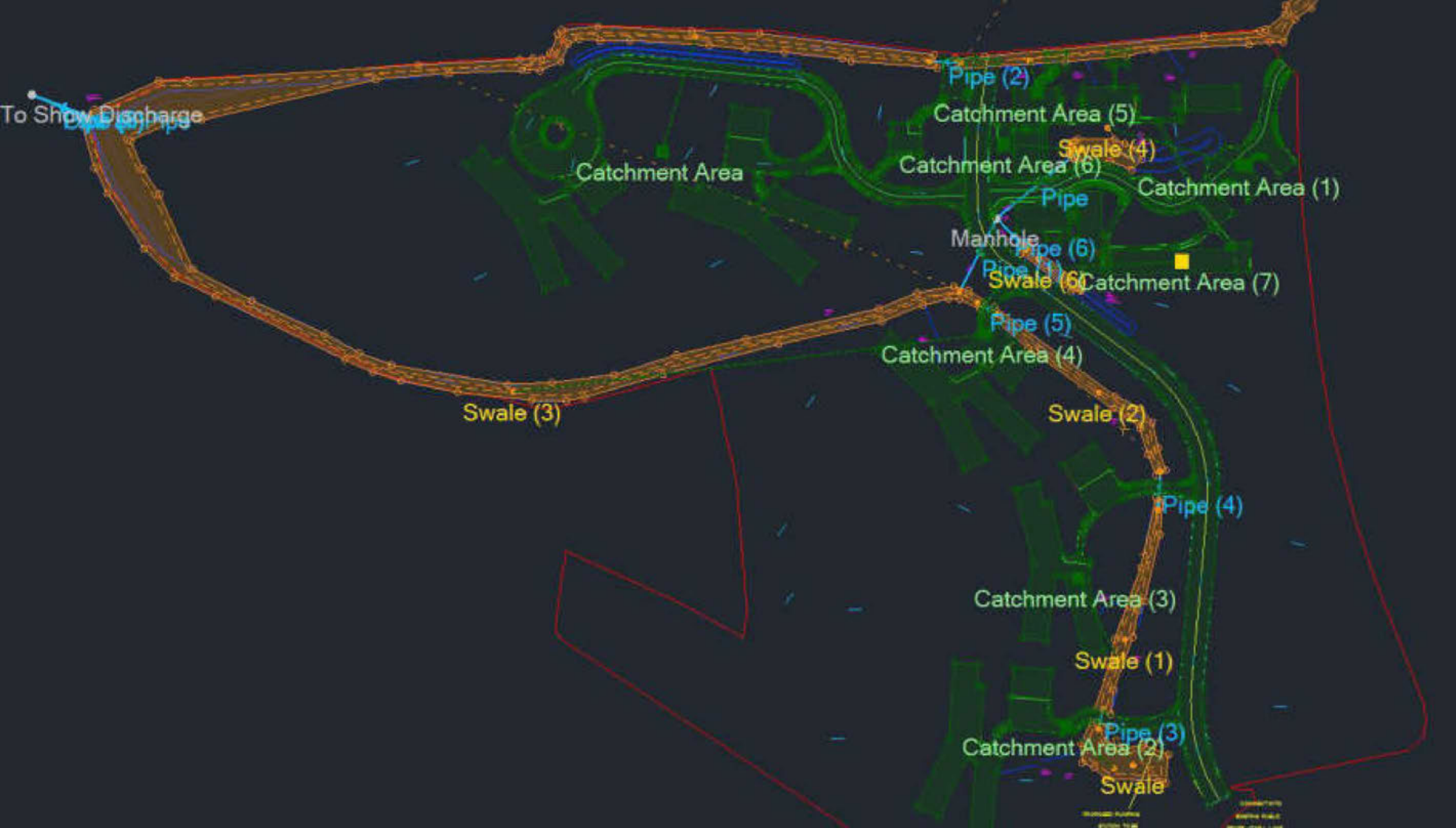
Scale: N.T.S@ A1
Date: AUG 2022
Drawn: BAF
Checked: JAH
DWG Reference: 046-2022.DWG
Status: FOR INFORMATION
Drawing Number: 046/2022/03
Revision: P3

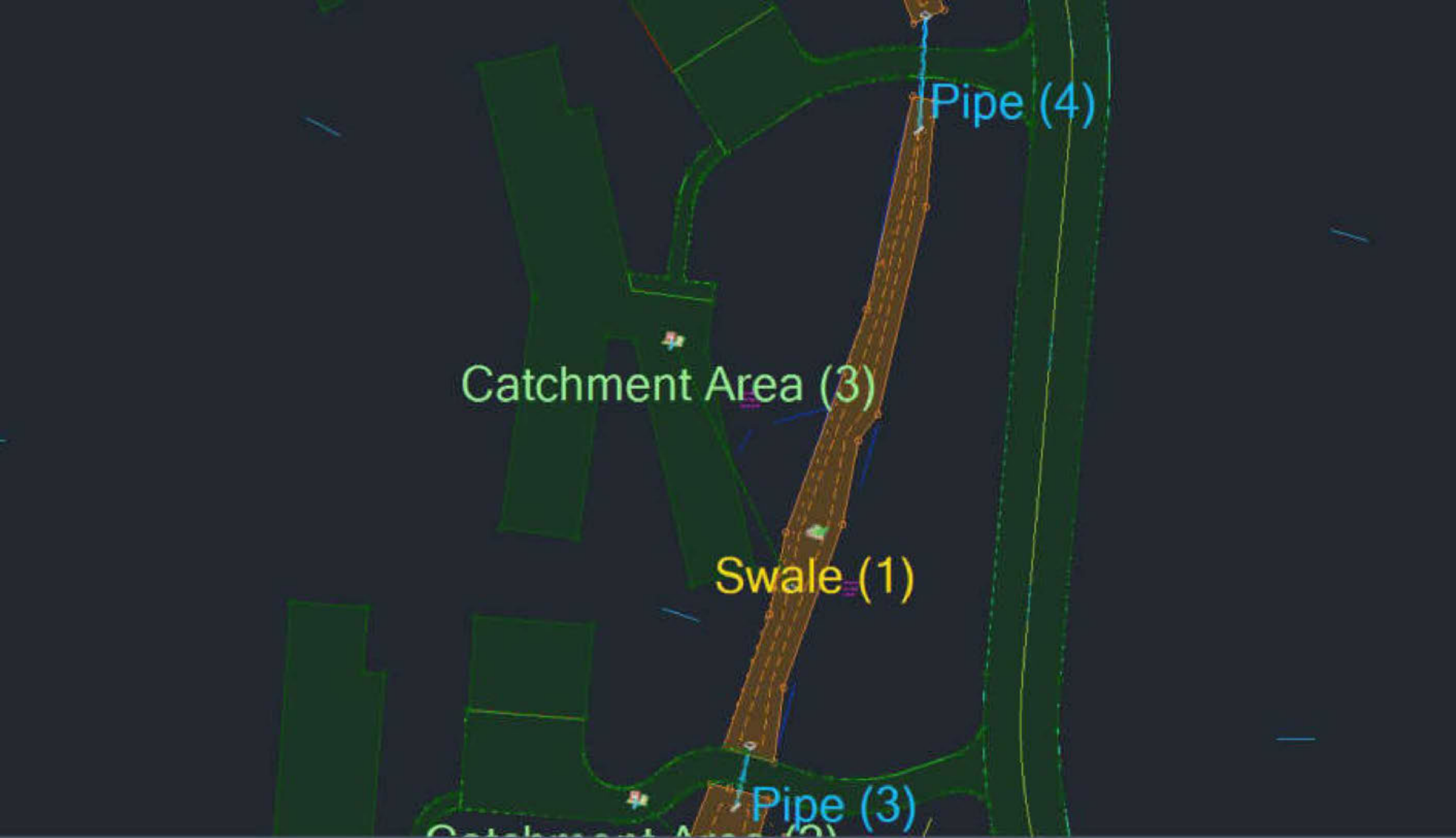
P# = Preliminary, C# = Construction, AB# = As Built

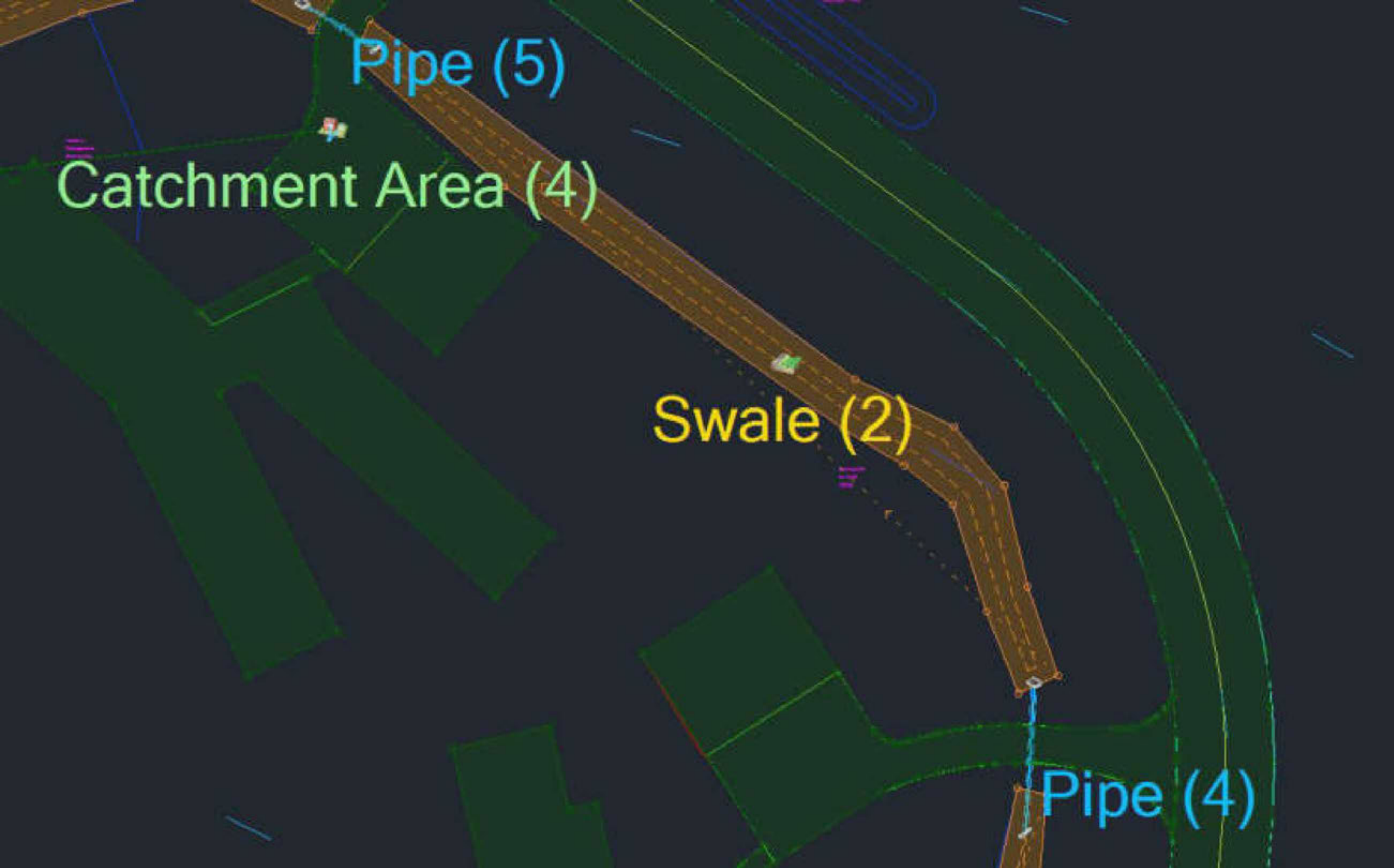
FLOOD RISK ASSESSMENT

APPENDIX H

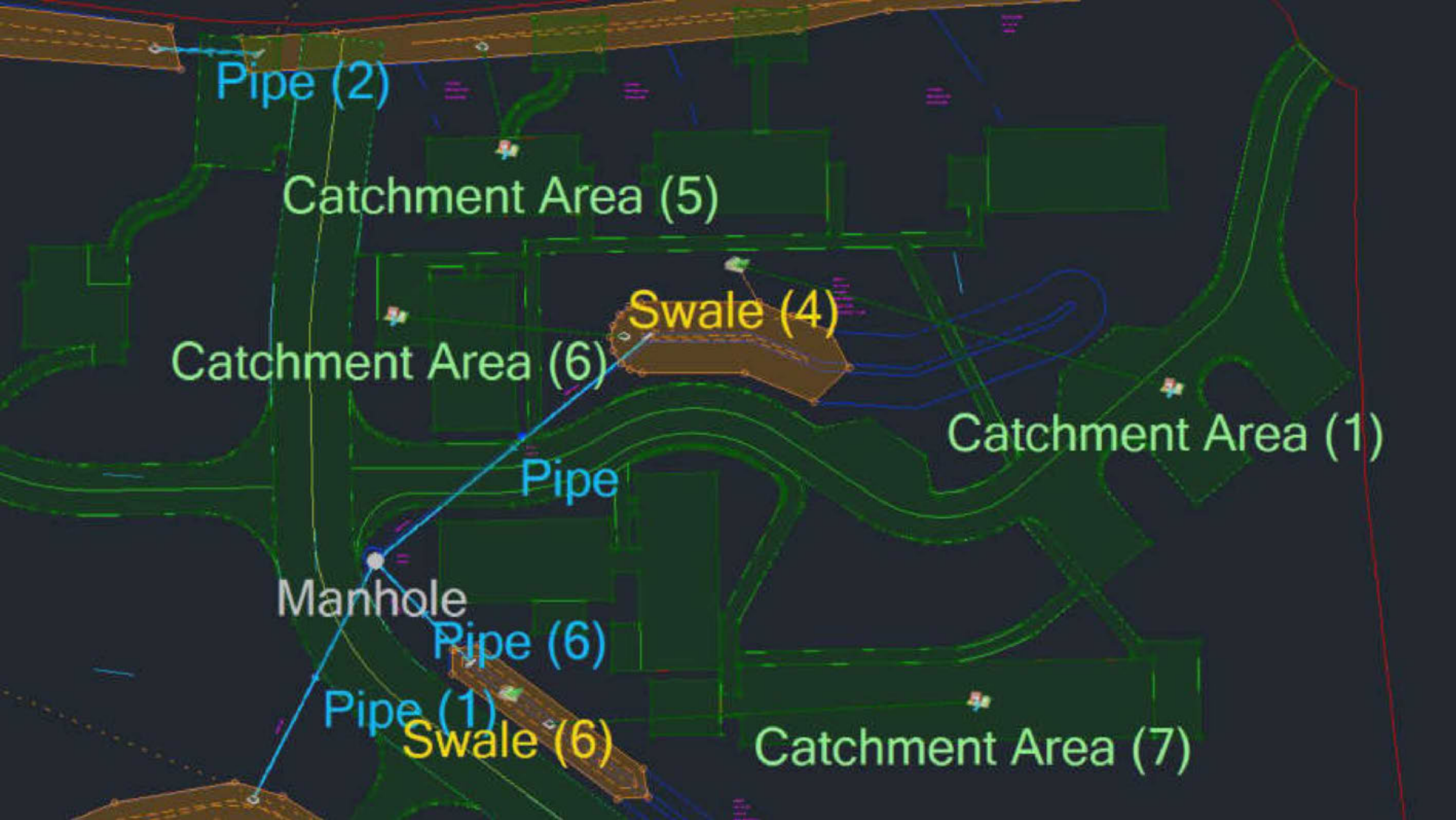
Info-Drainage Storage Calculations


To Show Discharge
Pipe (2)
Catchment Area (5)
Catchment Area
Swale (4)
Catchment Area (6)
Catchment Area (1)
Pipe
Manhole
Pipe (6)
Pipe (1)
Swale (6)
Catchment Area (7)
Pipe (5)
Catchment Area (4)
Swale (3)
Swale (2)
Pipe (4)
Catchment Area (3)
Swale (1)
Pipe (3)
Catchment Area (2)
Swale

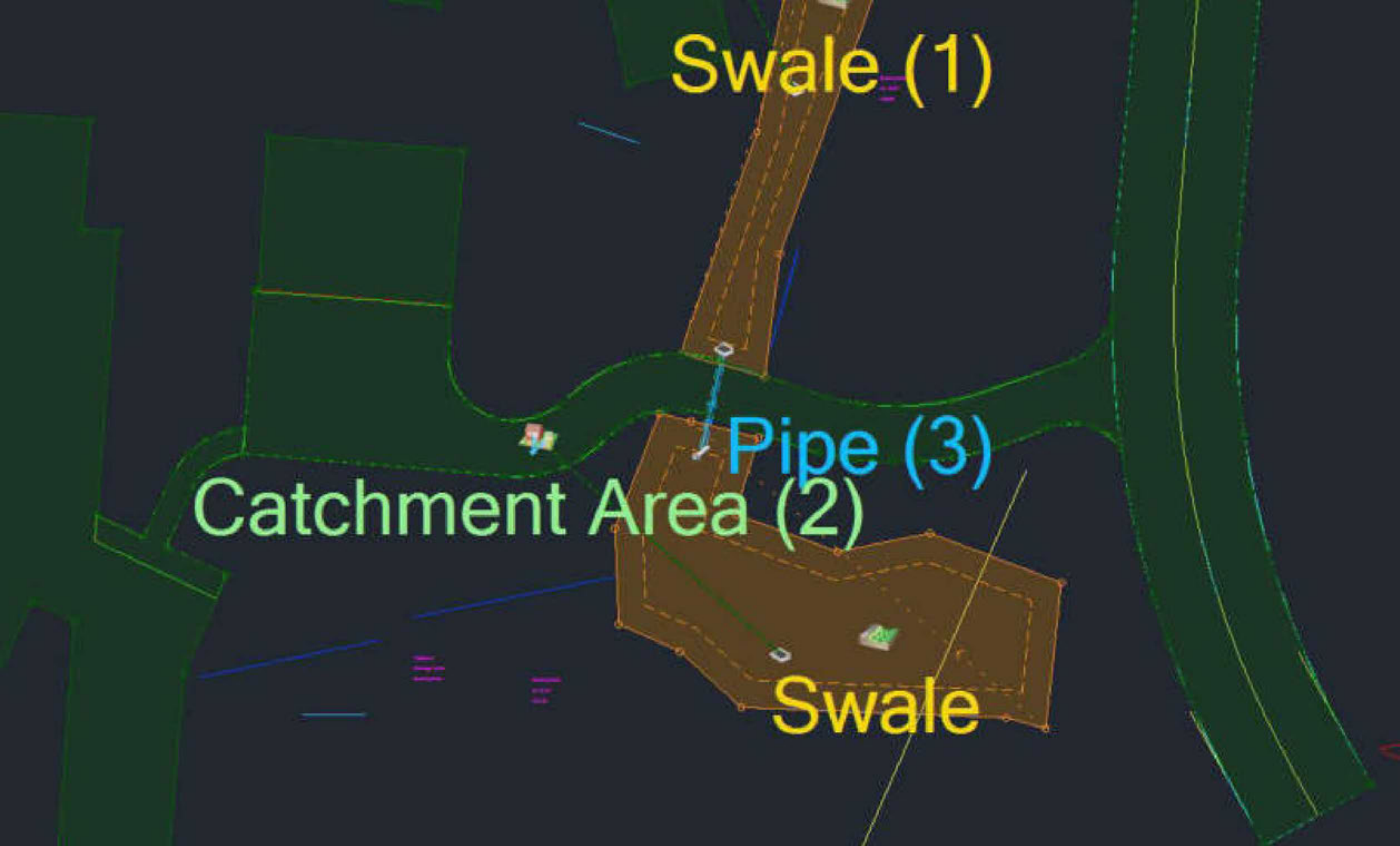

Pipe (4)
Catchment Area (3)
Swale (1)
Pipe (3)


Pipe (5)
Catchment Area (4)
Swale (2)
Pipe (4)


Discharge
Pipe
Pipe (2)
Catchment
Catchment Area
Catchment Area
Manhole
Pipe (1)
Swale
Pipe (5)
Catchment Area (4
Swale (3)


Pipe (2)
Catchment Area (5)
Swale (4)
Catchment Area (6)
Catchment Area (1)
Pipe
Manhole
Pipe (6)
Pipe (1)
Swale (6)
Catchment Area (7)


Swale (5)
Pipe (2)
Catchment Area (5)


Swale (1)
Pipe (3)
Catchment Area (2)
Swale

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Stormwater Controls Storm Phase: Phase	Company Address:		

GHBullard & Associates LLP

Swale

Type : Swale

Swale

Exceedence Level (m)	81.965
Depth (m)	0.415
Base Level (m)	81.550
Top Width (m)	7.828
Side Slope (1:x)	4.00
Base Width (m)	4.509
Freeboard (mm)	0
Length (m)	24.159
Long. Slope (1:x)	500.00
Filtration Rate (m/hr)	0.0
Friction Scheme	Manning's n
n	0.045
Total Volume (m³)	61.823

Advanced

Swale

Porosity (%)	100

Swale (1)

Type : Swale

Swale

Exceedence Level (m)	82.067
Depth (m)	1.267
Base Level (m)	80.800
Top Width (m)	3.181
Side Slope (1:x)	0.86
Base Width (m)	1.000
Freeboard (mm)	0
Length (m)	54.678
Long. Slope (1:x)	500.00
Filtration Rate (m/hr)	0.0
Friction Scheme	Manning's n
n	0.045
Total Volume (m³)	144.778

Advanced

Swale

Porosity (%)	100

Swale (2)

Type : Swale

Swale

Exceedence Level (m)	81.350
Depth (m)	0.765
Base Level (m)	80.585
Top Width (m)	3.145
Side Slope (1:x)	1.40
Base Width (m)	1.000
Freeboard (mm)	0
Length (m)	58.583
Long. Slope (1:x)	500.00
Filtration Rate (m/hr)	0.0
Friction Scheme	Manning's n
n	0.045
Total Volume (m³)	92.881

Advanced

Swale

Porosity (%)	100

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Stormwater Controls Storm Phase: Phase	Company Address:		

Swale (3)

Type : Swale

Swale

Exceedence Level (m)	78.920
Depth (m)	1.000
Base Level (m)	77.920
Top Width (m)	9.338
Side Slope (1:x)	2.70
Base Width (m)	3.938
Freeboard (mm)	0
Length (m)	228.110
Long. Slope (1:x)	500.00
Filtration Rate (m/hr)	0.0
Friction Scheme	Manning's n
n	0.045
Total Volume (m³)	1514.249

Advanced

Swale

Porosity (%)	100

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Stormwater Controls Storm Phase: Phase	Company Address:		

Swale (4)

Type : Swale

Swale

Exceedence Level (m)	81.489
Depth (m)	0.600
Base Level (m)	80.889
Top Width (m)	4.984
Side Slope (1:x)	4.00
Base Width (m)	0.184
Freeboard (mm)	0
Length (m)	18.296
Long. Slope (1:x)	500.00
Filtration Rate (m/hr)	0.0
Friction Scheme	Manning's n
n	0.045
Total Volume (m³)	28.371

Advanced

Swale

Porosity (%)	100

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Stormwater Controls Storm Phase: Phase	Company Address:		

Swale (5)

Type : Swale

Swale

Exceedence Level (m)	81.460
Depth (m)	0.570
Base Level (m)	80.890
Top Width (m)	4.754
Side Slope (1:x)	3.47
Base Width (m)	0.800
Freeboard (mm)	0
Length (m)	142.975
Long. Slope (1:x)	1000.00
Filtration Rate (m/hr)	0.0
Friction Scheme	Manning's n
n	0.045
Total Volume (m³)	226.329

Advanced

Swale

Porosity (%)	100

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Stormwater Controls Storm Phase: Phase	Company Address:		

Swale (6)

Type : Swale

Swale

Exceedence Level (m)	81.782
Depth (m)	0.300
Base Level (m)	81.482
Top Width (m)	1.288
Side Slope (1:x)	1.15
Base Width (m)	0.600
Freeboard (mm)	0
Length (m)	40.000
Long. Slope (1:x)	500.00
Filtration Rate (m/hr)	0.0
Friction Scheme	Manning's n
n	0.045
Total Volume (m³)	11.329

Advanced

Swale

Porosity (%)	100

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Connections Storm Phase: Phase	Company Address:		

Name	Length (m)	Connection Type	Slope (1:x)	Manning's n	Colebrook-White Roughness (mm)	Diameter / Base Width (mm)	Upstream Cover Level (m)	Upstream Invert Level (m)
Pipe	26.747	Pipe	141.564		0.6	150	81.521	80.889
Pipe (1)	20.360	Pipe	7.324		0.6	150	81.241	80.700
Pipe (2)	7.970	Pipe	2.683		0.6	300	82.001	80.890
Pipe (3)	5.143	Pipe	6.858		0.6	300	83.122	81.550
Pipe (4)	9.323	Pipe	43.361		0.6	300	83.351	80.800
Pipe (5)	5.383	Pipe	2.020		0.6	300	81.351	80.585
Pipe (6)	10.662	Pipe	13.626		0.6	150	82.017	81.482
OutFall Pipe	15.269	Pipe	5.229		0.6	225	79.477	77.920
Pipe (7)	15.278	Pipe	149.622		0.6	225	79.444	77.970
Pipe (8)	15.571	Pipe	90.528		0.6	225	79.309	78.220
Pipe (9)	15.504	Pipe	36.740		0.6	225	79.380	78.470

Name	Downstream Cover Level (m)	Downstream Invert Level (m)	Flow Restriction (L/s)
Pipe	81.241	80.700	
Pipe (1)	81.886	77.920	
Pipe (2)	82.554	77.920	
Pipe (3)	83.461	80.800	
Pipe (4)	81.871	80.585	
Pipe (5)	81.820	77.920	
Pipe (6)	81.241	80.700	
OutFall Pipe	78.922	75.000	2.0
Pipe (7)	78.922	77.868	11.0
Pipe (8)	78.922	78.048	19.6
Pipe (9)	78.922	78.048	16.7

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Inflow Summary Storm Phase: Phase	Company Address:		

Inflow Label	Connected To	Flow (L/s)	Runoff Method	Area (ha)	Percentage Impervious (%)	Urban Creep (%)	Adjusted Percentage Impervious (%)	Area Analysed (ha)
Catchment Area	Swale (3)		Time of Concentration	0.196	100	0	100	0.196
Catchment Area (1)	Swale (4)		Time of Concentration	0.069	100	0	100	0.069
Catchment Area (2)	Swale		Time of Concentration	0.016	100	0	100	0.016
Catchment Area (3)	Swale (1)		Time of Concentration	0.062	100	10	110	0.069
Catchment Area (5)	Swale (5)		Time of Concentration	0.228	100	0	100	0.228
Catchment Area (6)	Swale (4)		Time of Concentration	0.007	100	0	100	0.007
Catchment Area (7)	Swale (6)		Time of Concentration	0.041	100	10	110	0.045
TOTAL		**0.0**		**0.619**				**0.630**

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Title: Rainfall Analysis Criteria	Company Address:		

GHBullard & Associates LLP

Runoff Type	Dynamic
Output Interval (mins)	1
Time Step	Default
Urban Creep	Use Catchment Values
Junction Flood Risk Margin (mm)	300
Perform No Discharge Analysis	☐

Rainfall

FEH

Type: FEH

Site Location	GB 551850 215528 TL 51850 15528
Rainfall Version	2013
Data Type	Point
Summer	☑
Winter	☑

Return Period

Return Period (years)	Increase Rainfall (%)
2.0	0
30.0	0
100.0	40

Storm Durations

Duration (mins)	Run Time (mins)
15	30
30	60
60	120
120	240
180	360
240	480
360	720
480	960
600	1200
720	1440
960	1920
1440	2880

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Stormwater Controls Storm Phase: Phase	Company Address:		

FEH: 2 years: Increase Rainfall (%): +0: Critical Storm Per Item

Stormwater Control	Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Half Drain Down Time (mins)	Percentage Available (%)	Status
Swale	FEH: 2 years: +0 %: 30 mins: Winter	81.607	81.563	0.009	0.013	1.8	1.011	0.000	0.000	1.4	1.272	13	98	OK
Swale (1)	FEH: 2 years: +0 %: 15 mins: Winter	80.974	80.860	0.064	0.060	10.6	3.416	0.000	0.000	9.1	4.910	8	98	OK
Swale (2)	FEH: 2 years: +0 %: 30 mins: Winter	80.755	80.605	0.052	0.020	7.4	2.894	0.000	0.000	6.9	6.584	8	97	OK
Swale (3)	FEH: 2 years: +0 %: 600 mins: Winter	78.406	78.226	0.030	0.306	11.3	125.005	0.000	0.000	2.5	88.434	635	92	OK
Swale (4)	FEH: 2 years: +0 %: 15 mins: Winter	81.036	80.991	0.110	0.102	11.8	1.197	0.000	0.000	11.0	5.426	1	96	OK
Swale (5)	FEH: 2 years: +0 %: 30 mins: Winter	81.161	80.923	0.128	0.033	26.6	16.362	0.000	0.000	16.5	18.693	17	93	OK
Swale (6)	FEH: 2 years: +0 %: 15 mins: Winter	81.629	81.519	0.066	0.036	6.9	1.576	0.000	0.000	6.2	3.082	4	86	OK

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Stormwater Controls Storm Phase: Phase	Company Address:		

FEH: 30 years: Increase Rainfall (%): +0: Critical Storm Per Item

Stormwater Control	Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Half Drain Down Time (mins)	Percentage Available (%)	Status
Swale	FEH: 30 years: +0 %: 15 mins: Winter	81.616	81.572	0.018	0.022	5.6	1.913	0.000	0.000	4.4	2.244	7	97	OK
Swale (1)	FEH: 30 years: +0 %: 15 mins: Winter	81.016	80.898	0.106	0.098	24.8	6.011	0.000	0.000	21.9	12.736	4	96	OK
Swale (2)	FEH: 30 years: +0 %: 15 mins: Winter	80.799	80.618	0.097	0.033	21.9	5.459	0.000	0.000	19.0	11.060	5	94	OK
Swale (3)	FEH: 30 years: +0 %: 360 mins: Winter	78.432	78.336	0.055	0.416	31.9	216.979	0.000	0.000	5.9	155.539	529	86	OK
Swale (4)	FEH: 30 years: +0 %: 15 mins: Winter	81.113	81.109	0.187	0.220	27.5	3.737	0.000	0.000	18.2	12.661	2	87	OK
Swale (5)	FEH: 30 years: +0 %: 15 mins: Winter	81.247	80.943	0.214	0.053	82.6	32.173	0.000	0.000	43.9	28.846	13	86	OK
Swale (6)	FEH: 30 years: +0 %: 15 mins: Winter	81.671	81.540	0.108	0.058	16.2	2.710	0.000	0.000	15.0	7.327	3	76	OK

362-2021, Little Heath, Hatfield Heath:	Date: 10/10/2022		
	Designed by: BAF	Checked by: JAH	Approved By:
Report Details: Type: Stormwater Controls Storm Phase: Phase	Company Address:		

FEH: 100 years: Increase Rainfall (%): +40: Critical Storm Per Item

Stormwater Control	Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m^3)	Max. Flooded Volume (m^3)	Total Lost Volume (m^3)	Max. Outflow (L/s)	Total Discharge Volume (m^3)	Half Drain Down Time (mins)	Percentage Available (%)	Status
Swale	FEH: 100 years: +40 %: 15 mins: Winter	81.624	81.579	0.025	0.029	10.2	2.822	0.000	0.000	8.8	4.321	6	95	OK
Swale (1)	FEH: 100 years: +40 %: 15 mins: Winter	81.066	80.946	0.157	0.146	47.7	9.334	0.000	0.000	43.0	24.002	4	94	OK
Swale (2)	FEH: 100 years: +40 %: 15 mins: Winter	80.845	80.631	0.143	0.046	43.0	8.480	0.000	0.000	38.9	22.091	3	91	OK
Swale (3)	FEH: 100 years: +40 %: 360 mins: Winter	78.493	78.493	0.117	0.573	59.6	399.069	0.000	0.000	11.4	284.731	409	74	OK
Swale (4)	FEH: 100 years: +40 %: 15 mins: Winter	81.259	81.260	0.334	0.371	49.8	10.300	0.000	0.000	21.6	22.892	4	64	OK
Swale (5)	FEH: 100 years: +40 %: 15 mins: Winter	81.316	80.965	0.283	0.075	149.8	52.095	0.000	0.000	89.3	57.010	10	77	OK
Swale (6)	FEH: 100 years: +40 %: 15 mins: Winter	81.714	81.568	0.151	0.085	29.4	4.023	0.000	0.000	27.4	13.379	3	64	OK

APPENDIX J

Typical SuDS Components Maintenance schedules

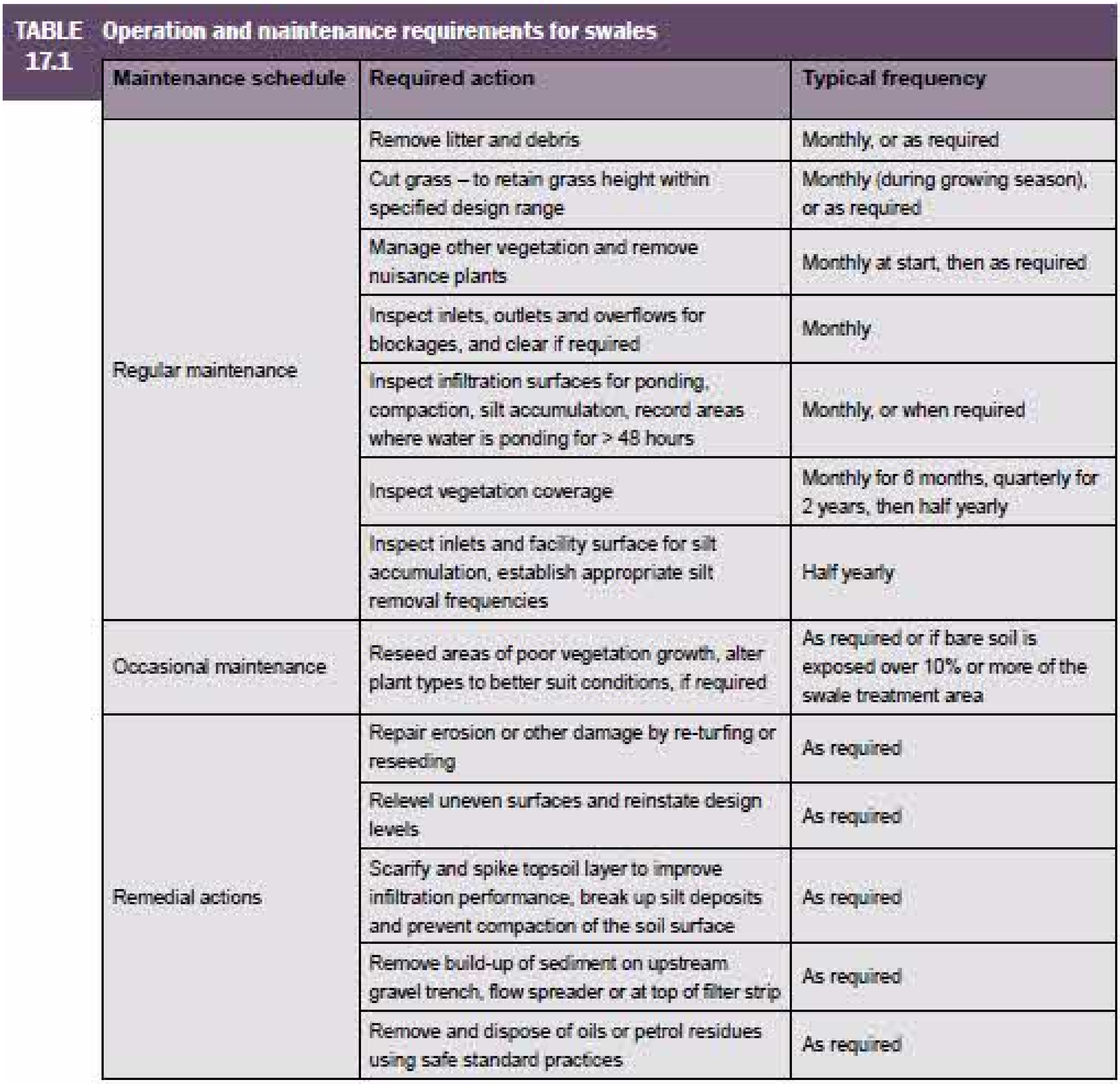


TABLE 17.1 Operation and maintenance requirements for swales

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

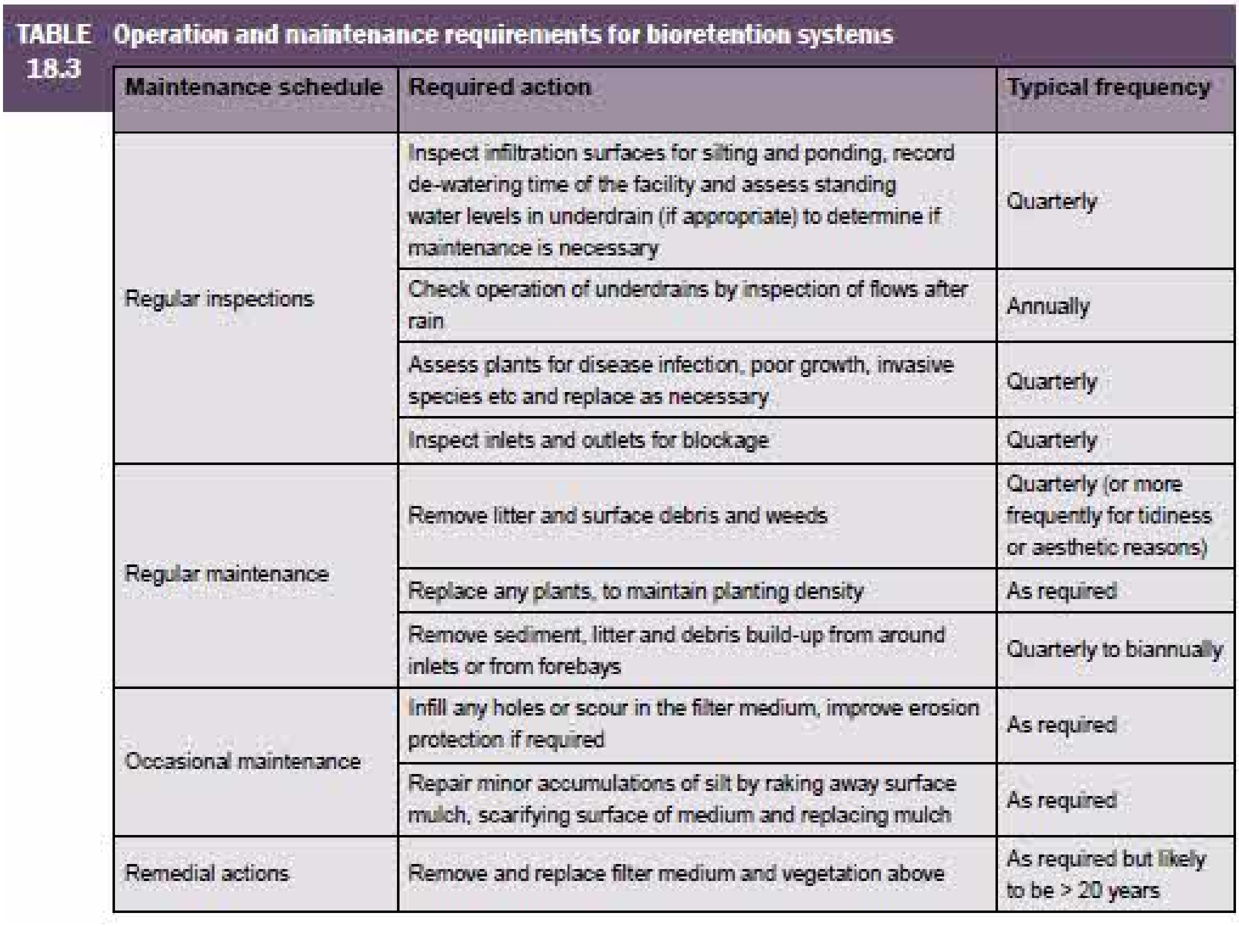


TABLE 18.3 Operation and maintenance requirements for bioretention systems

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 rain	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 to 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

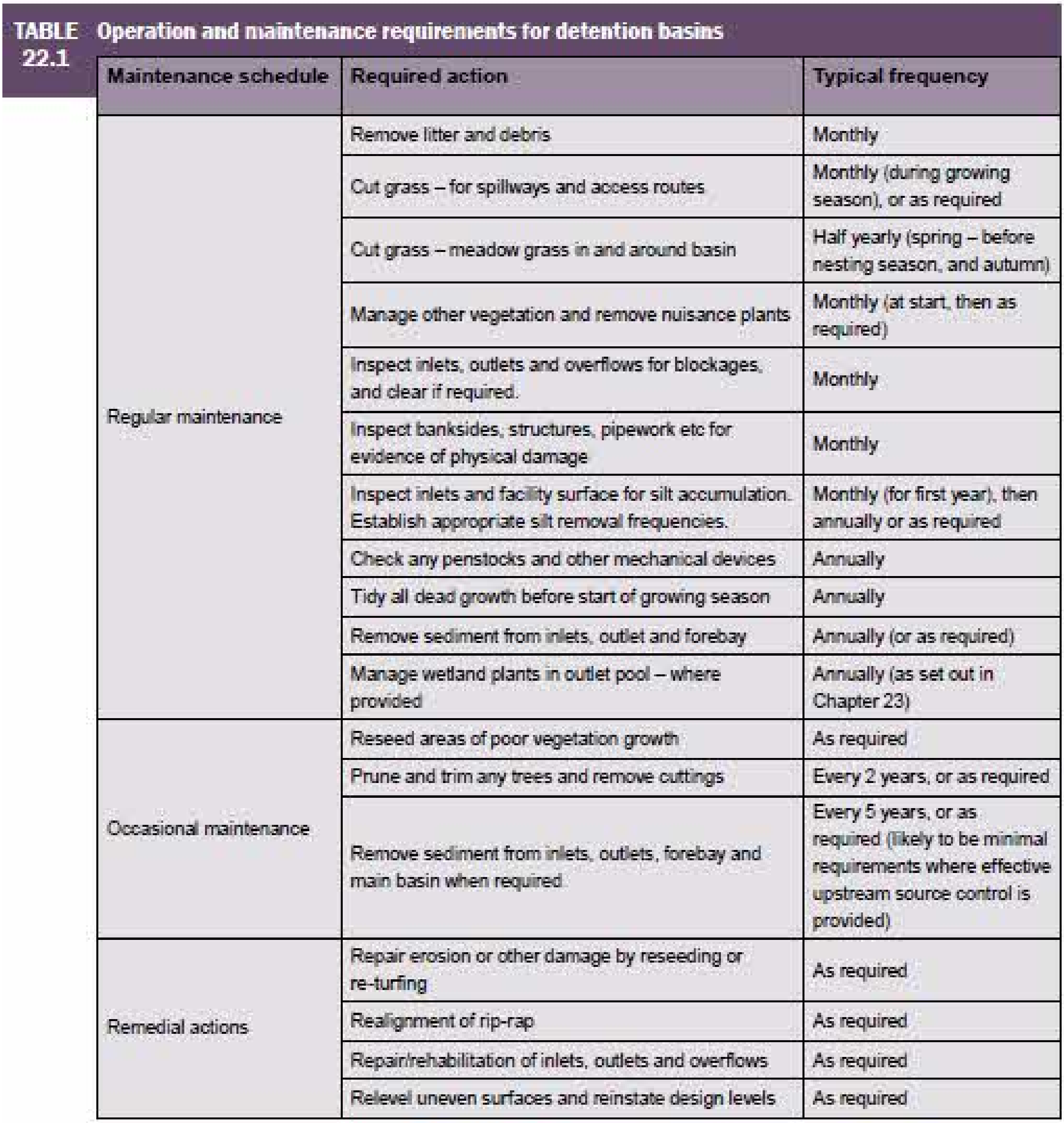


TABLE 22.1 Operation and maintenance requirements for detention basins

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23)
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required