DRAINAGE STRATEGY REPORT

20106-ARC-XX-00-RP-D-0001-P3

PROJECT
FELIX HOTEL, WHITEHOUSE LANE, CAMBRIDGE

PROJECT NUMBER
20 106

CLIENT
CASSEL HOTELS (CAMBRIDGE) LIMITED

REPORT DATE
FEBRUARY 2021

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DOCUMENT CONTROL

PROJECT NAME	Felix Hotel, Whitehouse Lane, Cambridge
PROJECT NUMBER	20 106
CLIENT	Cassel Hotels (Cambridge) Limited

REVISION	DATE	WRITTEN BY	REVIEWED BY
P0	December 2020	LA	AC
P1	February 2021	LA	RS
P2	February 2021	LA	
P3	February 2021	LA	

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APPENDICES

Introduction

Arc Engineers Ltd have been commissioned by Cassel Hotels (Cambridge) Limited to provide a flood risk assessment and drainage strategy for both foul and surface water disposal for the proposed care home at Whitehouse Lane, Cambridge (to be referred hereafter as ‘the site’).

The project comprises the demolition of the existing hotel and the construction of an 80-bed care home. A site layout plan is included in Appendix A.

This report sets out the investigations undertaken to determine the most appropriate and suitable means of disposing of surface and foul water for the site. The report aims to follow the guidance set out in the following documents:

- National Planning Policy Framework 2019 (NPPF)
- National Planning Policy Guidance
- SuDS Manual 2015 (C753)
- South Cambridgeshire Local Plan
- Cambridgeshire Flood and Water SPD

The following data was reviewed as part of this assessment:

- Online Flood mapping
- British Geological Survey (BGS) on-line maps
- Utility drainage records for the local area.

Site Description

Existing Site

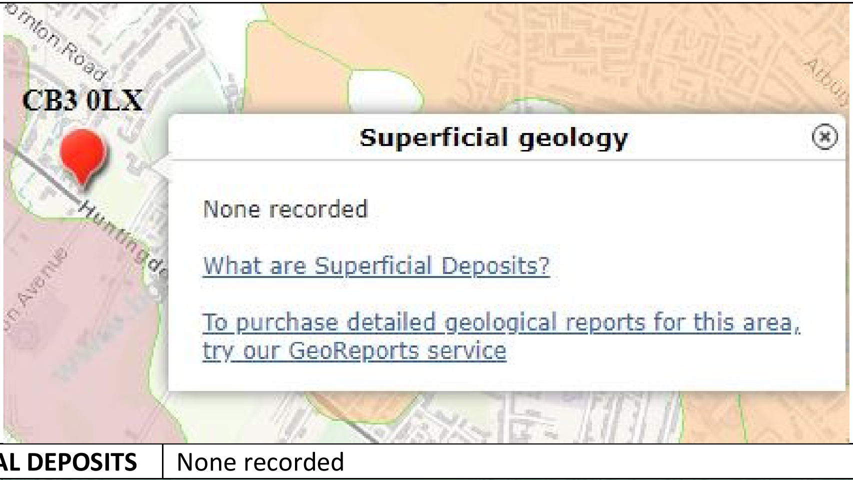
The existing site is occupied by a former hotel with associated car park hardscaping. The site extends to approximately 1.39 hectares (ha) and is centred on approximate Ordnance Survey (OS) grid reference 543140, 260564.

The site is bound to the east by Whitehouse Lane with two-storey residential houses beyond, to the west by two-storey residential houses, and to the north and south by playing fields.

Fig. 1: Existing site, Whitehouse Lane, Cambridge from OpenStreetMap.

A review of the topographic survey in Appendix B shows that the site falls from west to east. Ground levels to the west of the site are circa 22.38m above ordnance datum (mAOD) falling to circa 20.78m in the east.

Geology
(http://mapapps.bgs.ac.uk/geologyofbritain/home.html)

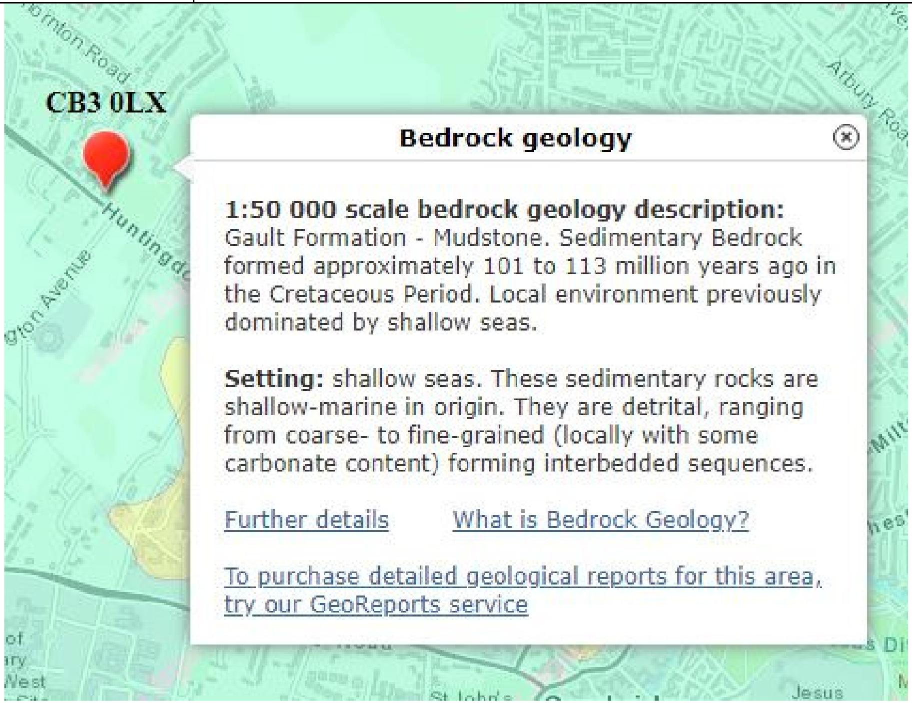


None recorded

What are Superficial Deposits?

To purchase detailed geological reports for this area, try our GeoReports service

SUPERFICIAL DEPOSITS	None recorded



1:50 000 scale bedrock geology description: Gault Formation - Mudstone. Sedimentary Bedrock formed approximately 101 to 113 million years ago in the Cretaceous Period. Local environment previously dominated by shallow seas.

Setting: shallow seas. These sedimentary rocks are shallow-marine in origin. They are detrital, ranging from coarse- to fine-grained (locally with some carbonate content) forming interbedded sequences.

Further details What is Bedrock Geology?

To purchase detailed geological reports for this area, try our GeoReports service

BEDROCK	Gault Mudstone Formation

On 30 November 2020, soakaway tests were carried out at 2 locations within the site boundary. The results show that the infiltration rate for the site ranges from 3.04 x10^{-6} to 1.69 x10^{-7} m/s which means infiltration is not feasible. The soakaway test results can be found in Appendix C.

Hydrology

Surface water features

There is a land drainage ditch approx. 270m north of the site within third party land.

Surface watercourses

Public Drain lies over 1.2km north of the site and the River Cam is 2.2km south of the site.

Site sensitivity – Hydrogeology http://magic.defra.gov.uk/MagicMap.aspx

According to the Aquifer Designation Map (Bedrock & Superficial Drift) the site is unproductive.

Groundwater Vulnerability http://magic.defra.gov.uk/MagicMap.aspx

The vulnerability of groundwater is considered to be unproductive. The site is located on the edge of an area shown as Soluble Rock Risk.

Source Protection Zone

The site is not within source protection zone.

Proposed Site

The proposal is for the demolition of the existing hotel and the construction of an 80-bed care home with associated hard and soft landscaping (see site layout plan in Appendix A).

Permeable & Impermeable Areas

Areas	Existing (ha)	% of Total Area	Proposed (ha)	% of Total Area	Difference ha (%)
Permeable	1.036	75	0.837	60	-15
Impermeable	0.354	25	0.553	40	+15
Total Area	1.39		1.39		

Flood Risk

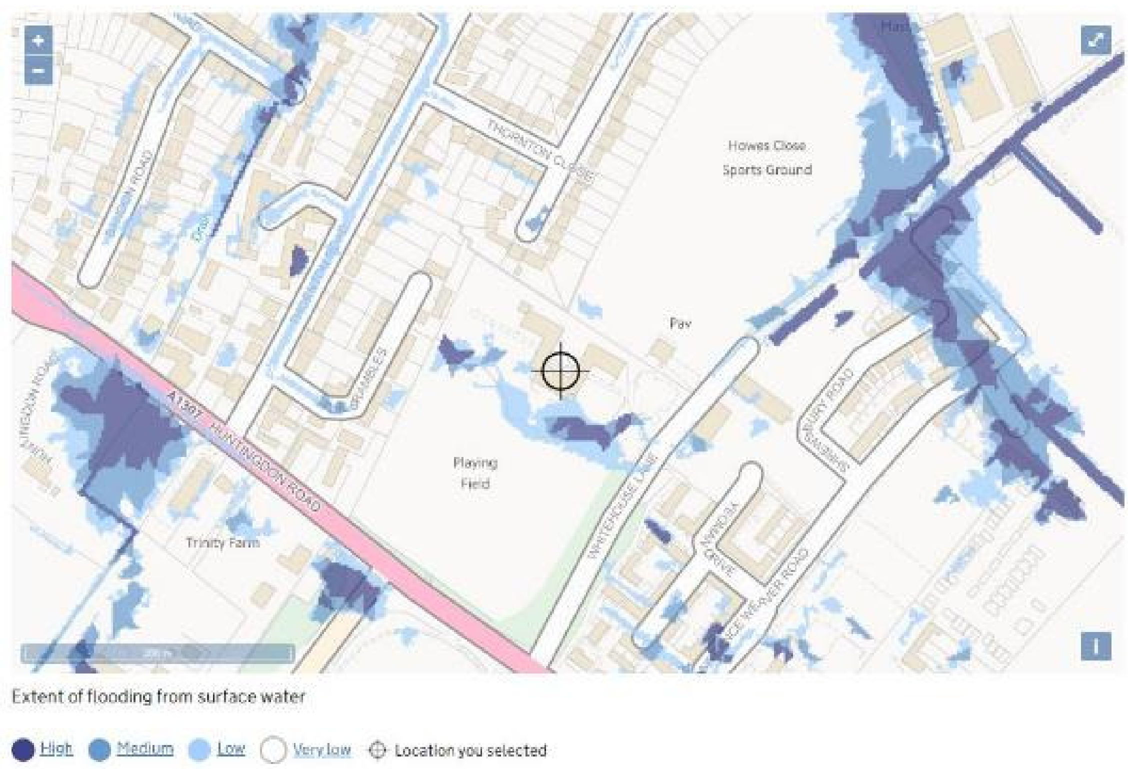
Fluvial and Tidal Flooding

The Environment Agency (EA) Flood Map indicates the development site to be located within Flood Zone 1; an area where flooding from rivers and the sea is very unlikely. There is less than 0.1% (1 in 1000) chance of flooding occurring each year. See Appendix D.

Surface Water Flooding

Ground levels on the site fall gradually from west to east.

Refer to the EA flood map below which shows the majority of the site is considered to be at very low risk from surface water flooding. There is an area along the southern boundary of the site which has a high risk of surface water flooding, there will be no development in this area so overland flow routes can be maintained.



Extent of flooding from surface water

● High ● Medium ● Low ○ Very low ⊕ Location you selected

As the site is approximately 1.39 Ha, a Flood Risk Assessment will need to be carried out.

Flood Risk Assessment

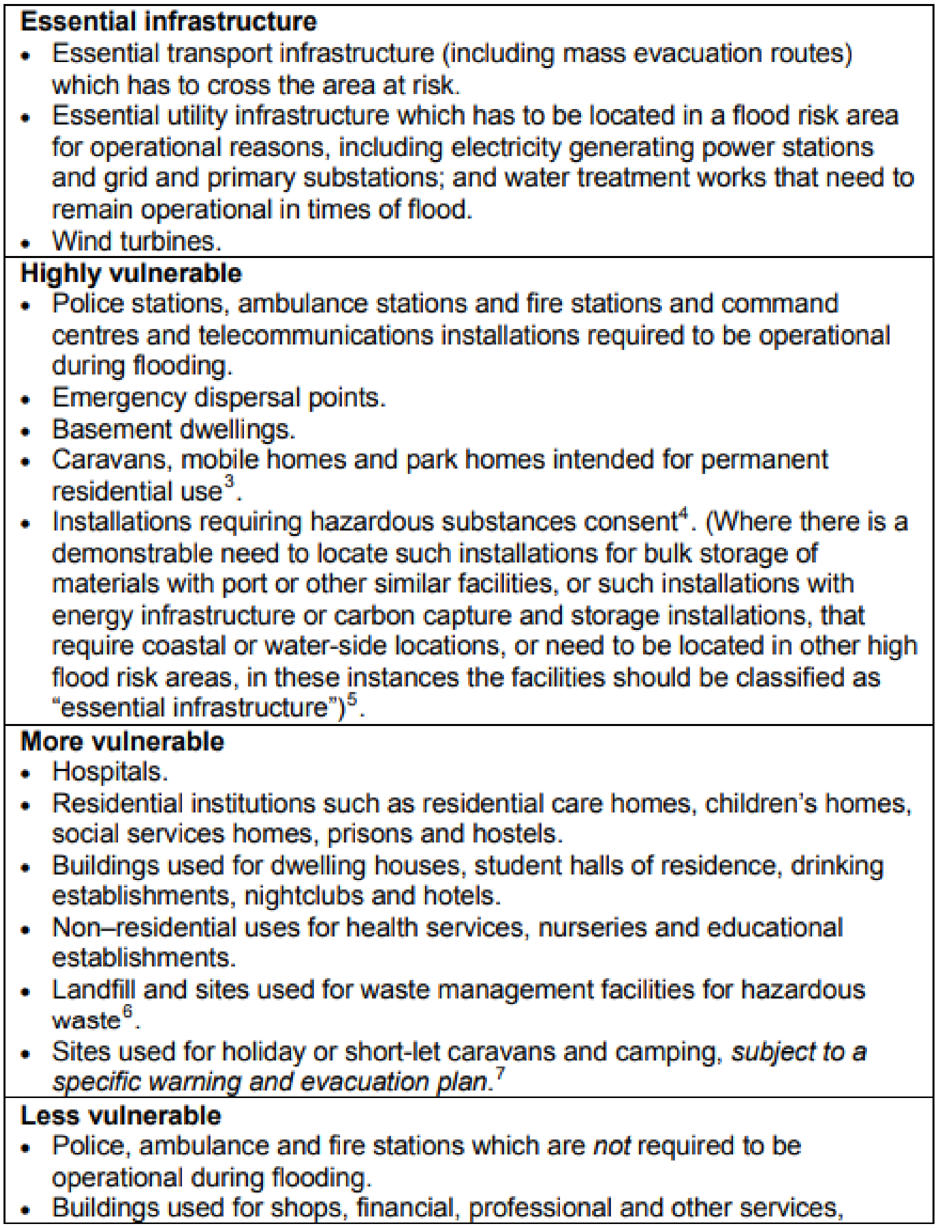
Proposed Site

The proposal is for the construction of an 80-bed care home. The site boundary covers a total area of 1.39 ha and the site layout plan is shown in Appendix A.

Development Vulnerability

According to Table 2 in the NPFF the proposed use of the site as a residential care and dwellings comes under the classification of "More Vulnerable"

Table 2: Flood risk vulnerability classification



Essential infrastructure • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly vulnerable • Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use[3]. • Installations requiring hazardous substances consent[4]. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as "essential infrastructure")[5].
More vulnerable • Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste[6]. • Sites used for holiday or short-let caravans and camping, *subject to a specific warning and evacuation plan.*[7]
Less vulnerable • Police, ambulance and fire stations which are *not* required to be operational during flooding. • Buildings used for shops, financial, professional and other services,

Sequential Test

According to NPPF, the Sequential Test gives preference to locating new development in Flood Zone 1 (FZ1 - least risk of flooding). However, if there is no allocated land within FZ1 which meets the policy aims of the published Local Authority Local Plan or Local Development Framework then other sites in higher flood risk categories, FZ2 or FZ3 can be considered for that development.

As the proposed site lies within Flood Zone 1, the sequential test is not required as the development falls within an area with the lowest probability of flooding.

Exception Test

The site for this development, a residential care home which is classified as ‘More Vulnerable’, is located within Flood Zone 1. According to Table 3 of the NPPF, this “development is appropriate”.

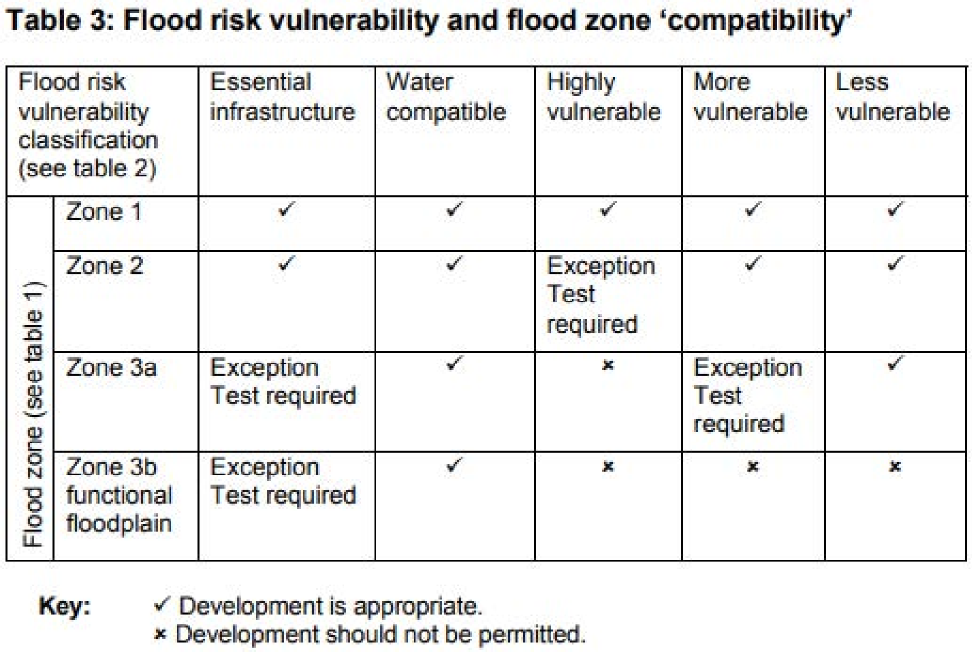


Table 3: Flood risk vulnerability and flood zone ‘compatibility’

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

Key: ✓ Development is appropriate.
× Development should not be permitted.

Surface Water Drainage Strategy

Existing Run-Off Rates

To estimate the pre-development surface water discharge into the existing drainage system a network has been simulated in Micro Drainage with a positively drained brownfield catchment area of 3382m² (0.339ha). The system is based on a single 300 dia connection to the existing surface water system. A critical 60-minute duration has been assumed to obtain the pre-development rates.

The remainder of the 1.39 ha site can be considered as greenfield and the rates for this area site have been calculated using Micro Drainage ICP SUDS method. All existing rates are shown below.

Return Period	$Q_{Brownfield}$ (l/s)	$Q_{Greenfield}$ (l/s)	Q_{Total} (l/s)
1 in 1 year	29.6	2.3	31.9
1 in 30 year	69.2	6.3	75.5
1 in 100 year	92.3	9.4	101.7

Surface water run-off from the existing site is not to attenuated nor restricted prior to discharge.

Pre-developed Greenfield Run-off Rates

The pre-developed greenfield run-off rates for this site have been calculated using Micro Drainage ICP SUDS method. The rates presented below are what would be typical of a site with an equivalent surface area which remains undeveloped / covered in grass or vegetation.

The equivalent greenfield run-off rate is tabled below:

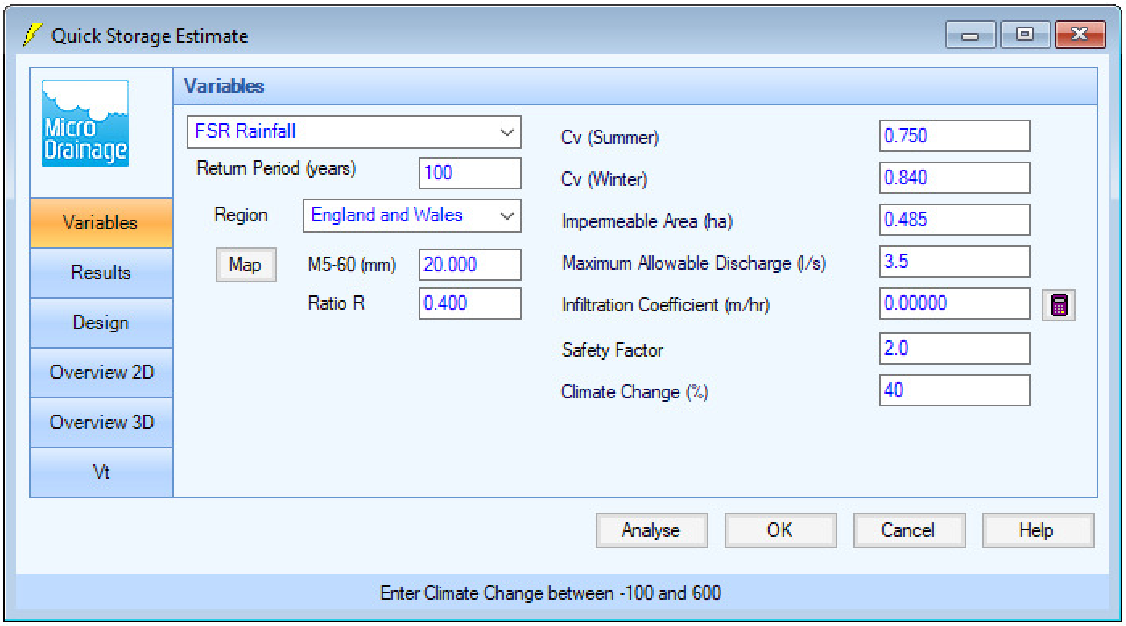
Return Period	$Q_{Greenfield}$ (l/s)
Qbar	3.5
1 in 1 year	3.0
1 in 30 year	8.4
1 in 100 year	12.4

Proposed surface water discharge rates and attenuation requirements

In accordance with Cambridgeshire County Council and South Cambridgeshire District Council requirements, the run-off from the proposed development will be restricted to pre-development Greenfield rates for the whole site. In accordance with South Cambridgeshire Local Plan policy CC/9, we have taken Qbar to size the attenuation required for this development.

The proposed development includes circa 4273m² of building and hard standing car parking that are considered to be positively drained. Where possible all patio areas will be laid to falls towards areas of soft landscaping.

A quick storage estimate for the 1 in 100 year storm event, plus 40% for climate change, using Micro Drainage, indicates that 282m³ - 383m³ of attenuation is required to limit the peak surface water discharge 3.5 l/s.



Variables

FSR Rainfall

Return Period (years) 100

Region England and Wales

M5-60 (mm) 20.000

Ratio R 0.400

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 0.485

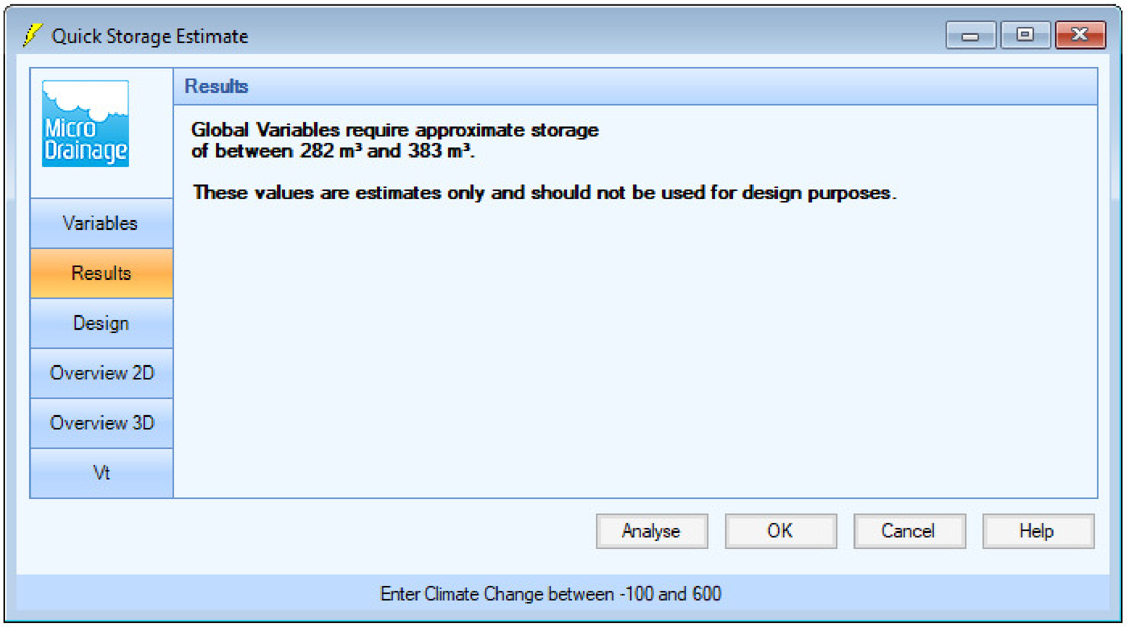
Maximum Allowable Discharge (l/s) 3.5

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 40

Enter Climate Change between -100 and 600



Results

Global Variables require approximate storage of between 282 m³ and 383 m³.

These values are estimates only and should not be used for design purposes.

Enter Climate Change between -100 and 600

Proposed surface water drainage

National Planning Policies state that "the aim should be to discharge surface runoff as high up the following hierarchy of drainage options as reasonably practicable:
1. Into the ground (infiltration)
2. To a surface water body;
3. To a surface water sewer, highway drain or another drainage system;
4. To a combined sewer."

Infiltration tests from the site show that soakaways will not be possible (see Appendix C).

There are no watercourses within the site boundary or bordering the site, therefore this option is not practicable for the discharge of surface water from the site.

The existing drainage network currently discharges into the Anglian Water surface water sewer within Whitehouse Lane and it proposed to reuse the existing connection from the site to discharge the proposed surface water runoff.

The surface water system will accommodate flows on-site up to and including the 1 in 100-year critical duration event, with an allowance for climate change. A total storage capacity of up to 400m^3 will be provided and the system will have a flow control device limiting surface water discharge to Qbar - 3.5 l/s.

Initial calculations of onsite storage and discharge rates can be found in Appendix E.

The drainage general arrangement drawing is shown in Appendix F.

SuDS Assessment

National Planning Policy Framework (the NPPF) and South Cambridgeshire Local Plan policy CC/9 state that SuDS should be incorporated in all new developments unless evidence of unsuitability is provided.

SuDS Component	Site Suitability	Comments
Rainwater harvesting	✗	Not considered suitable due to the nature of the development and potential health concerns for residents.
Green/Blue roof	✗	Not considered viable due to plant and access.
Soakaway	✗	Ground conditions unsuitable.
Pervious pavement	✓	Potentially suitable for use in carpark areas and courtyard as supplementary attenuation.
Filter strip	?	Potentially suitable for use in the soft landscaped areas around the building and car park.
Filter trench	✗	Ground conditions unsuitable.
Infiltration trench	✗	Ground conditions unsuitable.
Swale	✗	Unsuitable due to site layout and safety concerns from varying levels with end users.
Bioretention	?	Potentially suitable for use in the soft landscaped areas around the building and car park.
Geocellular system (Attenuation Tanks)	✓	Proposed to be used to attenuate surface water run-off.
Infiltration basin	✗	Unsuitable due to ground conditions.
Detention basin	✗	Not considered suitable due to the nature of the development and health & safety concerns for residents.
Pond	✗	
Stormwater wetlands	✗	

✗ Not suitable
? Potentially suitable subject to further investigation
✓ Suitable

Based on a review of the suitability of the SUDs components, it is proposed that the Hotel Felix development incorporate the following:

- Lined permeable paving to car parking area in order to provide a level of treatment and local storage (conservatively ignored at this stage)
- Install attenuation tank below ground to provide runoff storage.
- Provide a flow control and underground storage to limit runoff from the site to acceptable limits.
- Utilise the extensive soft landscaping as filter strips and bioretention to reduce peak flows and volumes (conservatively ignored at this stage)

SuDS Maintenance

The following section describes the required maintenance for each SuDS feature in turn. The maintenance requirements listed below should be reviewed after the first 5 years, with a view to agreeing a new regime for the ongoing maintenance.

Notwithstanding the routine inspections and maintenance requirements, after severe storm events all features shall be inspected to clear debris and repair damaged structures or features. Records of the maintenance carried out shall be prepared by the owner/management company.

Geocellular system (Attenuation Tanks)

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial Actions	Repair/rehabilitate inlets, outlets, 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	Annually
	Survey inside of tank for sediment build up and remove if necessary	Every 5 years or as required

Pervious Pavement

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over the whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required- once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or 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 or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after inspection
	Inspect for evidence of poor operation and/or weed growth – if required take remedial action	Three monthly 48h after large storms in first six months
	Inspect slit accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Bioretention

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, surface debris and weeds	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants to maintain density	As required
	Remove sediment, litter and debris build-up from around inlets or 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

Flow Control Device

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Manhole: Clear out sump	Bi annual – after leaf fall and after first large storm
	Manhole: Check pivoting bypass door is operational	Annually in dry weather
Remedial Actions	Manhole: Activate pivoting bypass door to release the water. Once system is empty check and remove blockages and silt deposits	As required
	Outlet Pipe Damaged/ blocked: Repair pipe/unblock pipe Clear out all silt from catch pit	As required
Monitoring	Check manhole to ensure emptying is occurring satisfactorily	Annually – during heavy storm conditions and If water builds up in swales
	Check for blockages or pipe damage	Annually

Water Quality Management

South Cambridgeshire Local Plan 2018 Policy CC/7 states that developments need to protect and enhance water quality and that appropriate consideration is given to incorporating appropriate Sustainable Drainage Systems (SuDS) measures.

This chapter will assess water quality of surface runoff in accordance with Chapter 26 of CIRIA SuDS Manual.

Defining pollution hazards
The proposed development is a care home and using Table 26.2, residential roofs are classified as having a “Very low” hazard level. Traffic movements within the car parking areas is considered to be “Low”.

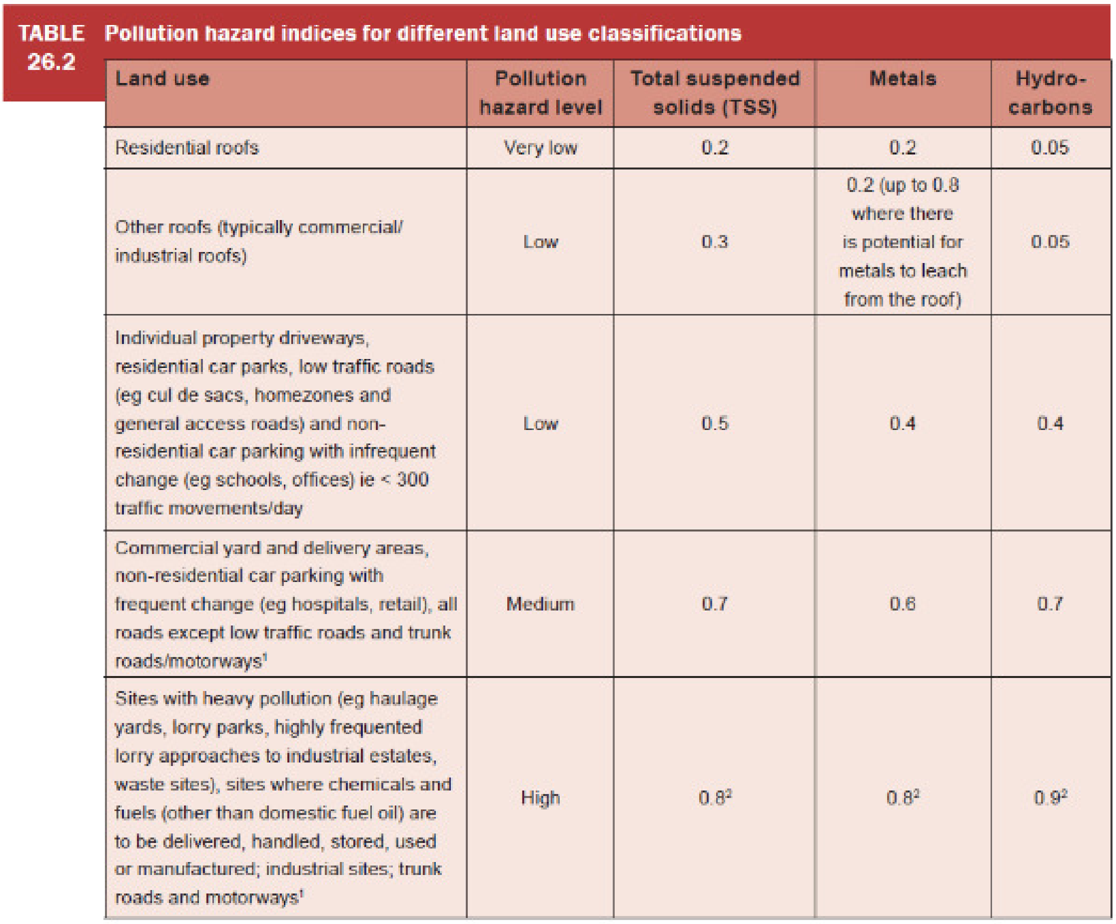


TABLE 26.2 **Pollution hazard indices for different land use classifications**

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
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Total hazard index:
Roof – 0.45
<u>Car Parks – 1.3</u>
Total – 1.75

Determining SuDS Mitigation

As per Chapter 6 of this report, SuDS components have been assessed in relation to their suitability for this site and type of development.

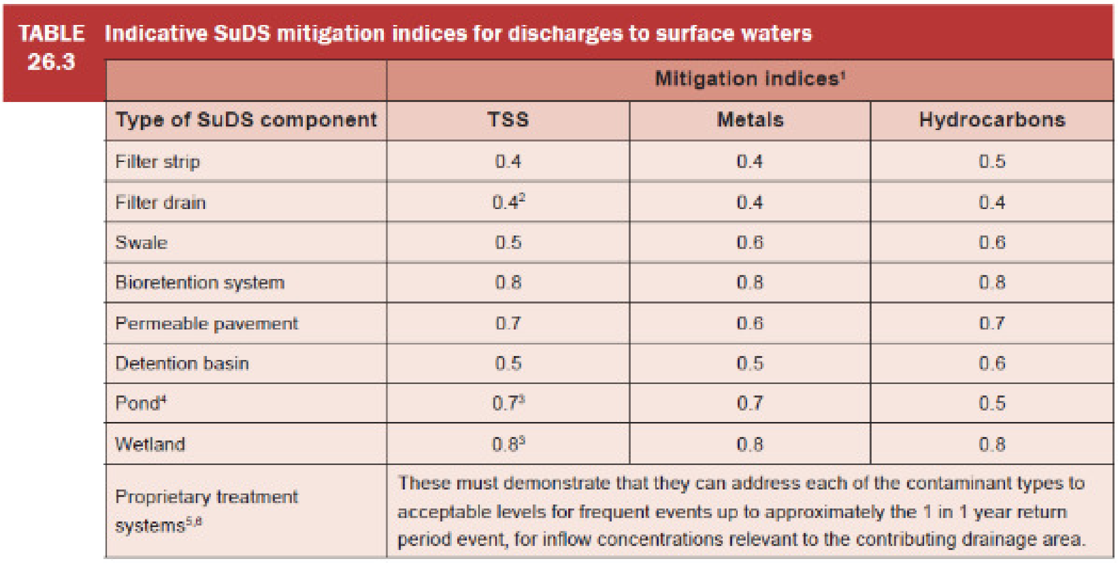


TABLE 26.3 **Indicative SuDS mitigation indices for discharges to surface waters**

	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.		

Permeable paving will be used in the car park as means of attenuation and treatment along with bioretention, which will provide a mitigation index score of 4.4 which is greater than the hazard index score of 1.75.

In addition to permeable paving, catch pits shall be installed on the surface water drainage network to provide silt traps prior to the attenuation tank.

Foul Water Drainage Strategy

Using calculations based on BS EN 752 - 4:1998, the peak foul flow rate has been based on the following assumptions:

Care Home

- 80 ensuite bedrooms in total
- 2 assisted bathrooms on the ground and first floors
- 2 washing machines in the laundry room
- 3 dishwashers (2 in the kitchen, 1 in the staff room)
- 2 sinks in the hairdressers.

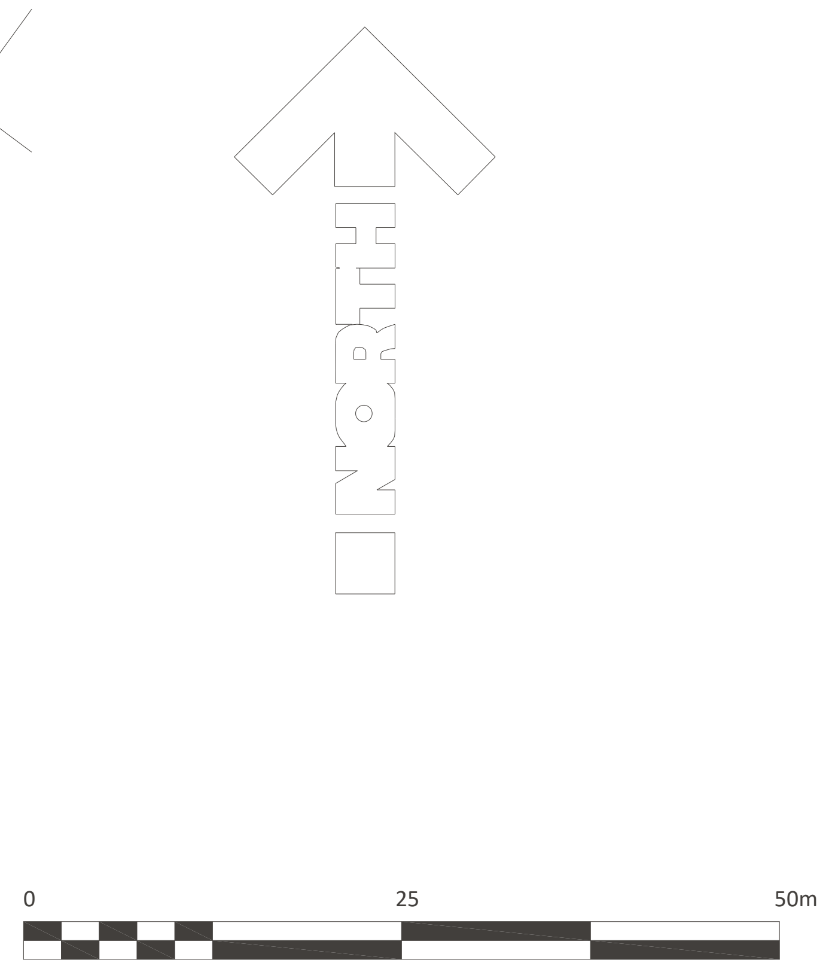
The total peak foul flow rate from the proposed buildings is estimated to be 11.4 l/s (see calculations in Appendix D).

Under the Water Industry Act (1991), developers have a right to connect foul water flows from new developments to public sewer.

The Act places a general duty on sewerage undertakers to provide the additional capacity that may be required to accommodate additional flows and loads arising from new domestic development. New public sewer connections will be subject to a Section 106 (Water Industry Act 1991) application to Anglian Water for adoption.

The foul drainage will connect to the existing foul sewer that runs south towards Huntingdon Road, through the adjacent land.

APPENDIX A



SCHEDULE OF ACCOMMODATION

SITE AREA —	1.39 Ha (3.43 acres)
CARE HOME	
GROUND FLOOR	40 BEDS + SERVICE AREAS
FIRST FLOOR	40 BEDS + SPA
ROOF SPACE	SERVICE AREAS
TOTAL	80 BEDROOMS
GROSS INTERNAL FLOOR AREA	
GROUND FLOOR	2,275m²
FIRST FLOOR	2,100m²
ROOF SPACE	280m²
TOTAL GIFA:	4,655m²
SPACE PER RESIDENT	58.2m²
PARKING	31 BAYS INCL. 2 DISABLE BAYS

KEY

●	EXISTING TREES
●	PROPOSED TREES
●	EXISTING TREES WITH TPO ORDER

Rev.	Description	Author	Checked	Date
A	ISSUED FOR PLANNING APPLICATION	PK	MM	12.02.2021

CARLESS + ADAMS
www.carless-adams.co.uk
6 Progress
Business Centre,
Whittle Parkway,
Slough, SL1 6DQ
tel : 01628 665131

Client CASSEL HOTELS (CAMBRIDGE) LIMITED

Project HOTEL FELIX, CAMBRIDGE

Title SITE PLAN

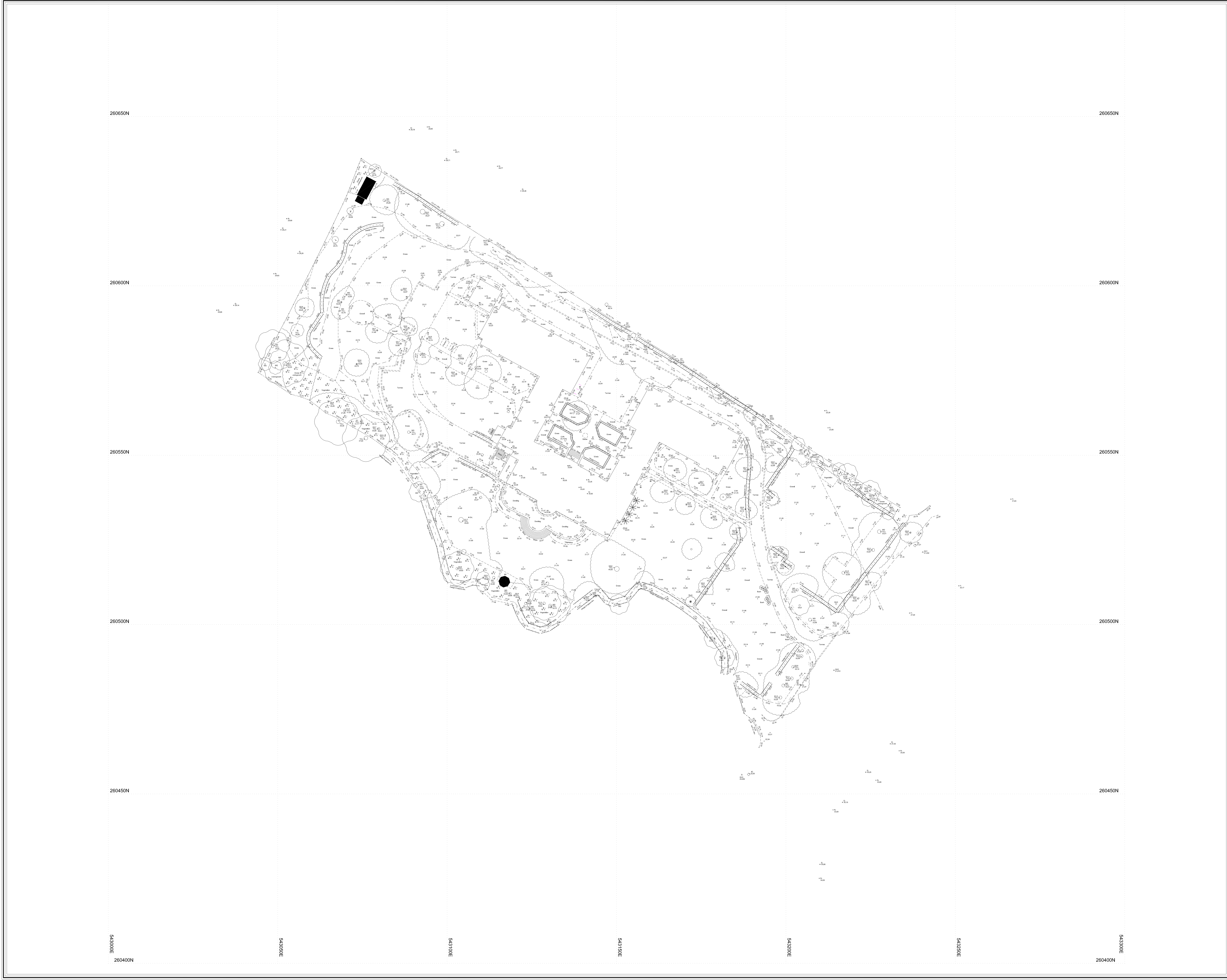
C+A no. A-846

scale	author	chk'd	date	sheet size
1:500	PK	MM	Feb. 10, 21	A1

project.	org.	zone.	level.	type.	role.	class.	num.	status.	rev.
846	C+A				A		04		A

For construction purposes dimensions shall not be scaled & figured dimensions must be verified on site before work commences.

APPENDIX B



N

Station Information:

Station	Easting (m)	Northing (m)	Level (m)
GH1	543240.372	260521.406	21.332
GH2	543214.176	260486.528	21.912
GH3	543186.968	260455.676	22.482
GH4	543191.841	260556.872	21.197
GH5	543153.871	260580.873	21.959
GH6	543105.889	260606.595	22.014
GH7	543082.200	260564.485	22.232

OS Note:

Some services may have been omitted due to parked vehicles.

Surveyed Buildings ■

This survey has been orientated to the Ordnance Survey (O.S) National Grid OSGB36(15) via Global Navigational Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN15GB & OSGM15GB transformation models.

The survey has been correlated to this point and a further one or more OSGB36 (15) points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Buildings
Wall
Kerb line
Line marking
Drop kerb
Centre line
Top of bank
Overhead Cable
Concrete edge
Tarmac edge
Grass verge
Canopy/Overhang
Verge
Bottom of bank

△ 1	Station and Name
100.000	Station Level
	Tree / Bush / Sapling
	Area of Undergrowth
	Woodland
R:	Ridge Level
E:	Eaves Level
F:	Flat Roof Level
	Gate

Fence types:

I\W	Interwoven
I\R	Iron Railings
W\M	Wire Mesh
P\R	Post & Rail
P\W	Post & Wire
C\L	Chain Link
W\P	Wooden Panels
C\B	Close Boarded
S\P	Steel Palisade

IC	Inspection chamber	Bo	Bollard
PInv	Pipe invert	IB	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Grl	Ground light
Pipe	Pipe above ground	Lbox	Letter box
MH	Manhole	Stmp	Tree Stump
WL	Water level	Sty	Stile
Fl	Flood light	IFL	Internal floor level
Lp	Lamp post	THL	Threshold level
Tp	Telegraph post	Sp	Sign post
Ep	Electricity post	TH	Trialhole
Tl	Traffic light	BH	Borehole
Bus	Bus stop	ELC	Electric
Sv	Stop valve	BT	British Telecom
St	Stop tap	C'box	Control box
Er	Earth rod	TT	Tactile
Wm	Water meter	BP	Brick paved
Gas	Gas valve	CPS	Concrete paving slabs
Av	Air valve	CVR	Cover
ICU	Unidentified inspection	R/wall	Retaining wall
Wo	Wash out	TWL	Top of Wall Level
Re	Rodding eye	TCL	Tree canopy level
BB	Belisha beacon	G:	Girth
CTV	Cable tv	MG	Multi girth
Mkr	Marker post	IC	Inspection chamber
Gmkr	Gas marker post	CL:	Cover level
So	Soffit	IL:	Invert level
Fh	Fire hydrant	UTL	Unable to lift

Rev	Date	Description	Drawn	Q. Ref.

greenhatch
group

☐ Topographical Surveys
☐ Site Engineering
☐ Utility / CCTV Surveys
☐ Measured Building Surveys
☐ 3D Laser Scanning
☐ Revit & BIM Models

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Newcastle Bus. Park
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Regents Park
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NW1 5LL
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CLIENT

Meedhurst Project Management Ltd

PROJECT

Hotel Felix
Huntingdon Road
Girton, Cambridge, CB3 0LX

TITLE

Topographical Survey

SCALE	DATE
A1@ 1: 500	03.03.20
DRAWN	QUALITY REF
JK2	GH7099

Level datum	See note
Grid orientation	See note
Job number	36289

Drawing No.	Rev.
36289_T	0

Comments
This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions should be checked on site prior to design and construction.

Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Notes:

APPENDIX C

Site
Investigations
♣
Geologists
♣
Environmental &
Geotechnical
Engineers

Solmek Ltd.
12 Yarm Road
Stockton on Tees
TS18 3NA
www.solmek.com

Tel: 01642 607083
Fax: 01642 612355
E-mail:
south@solmek.com

Cassel Hotels (Cambridge) Ltd

15th December 2020

SOAKAWAY LETTER REPORT

HOTEL FELIX, CAMBRIDGE
S201112

Authorisation

The site investigation works described in this letter report were carried out by Solmek Ltd to the instructions of Cassel Hotels (Cambridge) Ltd on a parcel of land at Hotel Felix, Huntingdon Road, Girton, Cambridge, CB3 0LX. Figure 1 attached shows the site location.

Scope of Works

Solmek visited the above site on Thursday 30th November 2020 to carry out eight machine excavated trial pits TP1 to TP8 inclusive, with shallow percolation testing in two pits (TP1 and TP8) for proposed permeable drainage design.

Please find attached a plan showing the position of the trial pit locations and the details of the percolation tests along with the trial pit logs. The testing was generally carried out in accordance with BRE Digest 365: Soakaway Design.

The trial pits were excavated to a maximum depth of 3.00mbgl using a Terex 890 excavator with a 0.60m wide bucket, the strata logged and then water was poured into TP1 and TP8 for soakaway testing.

Below gives a summary of the related infiltration rate for TP1 and TP8.

Test Number	Infiltration Rate (m/s)	Description of Base stratum	Notes
TP1	3.04×10^{-6}	Blueish grey slightly gravelly CLAY	Pocket of granular material at 1.20 – 1.80mbgl. Perched groundwater at 1.40mbgl.
TP8	1.69×10^{-7}	Blueish grey slightly gravelly CLAY	Clay found to be consistent across the site.

We would like to take this opportunity to thank you for using Solmek.

Yours sincerely
For and on behalf of Solmek Ltd

Charles Gray

C Gray
Geo-Environmental Engineer

SOLMEK

12-16 Yarm Road, Stockton on Tees, TS18 3NA
Tel: 01642 607083 Email: info@solmek.com

Figure Title
Site Location Plan
Project Number
S201112
Project Name
Felix Hotel, Cambridge
Client
Arc Engineers
Date
December 2020
DRG Number
Figure 1
Scale
1:5000 @ A4 [DO NOT SCALE]

Legend Key

🟥 Project Bounds - Project Bounds

SOLMEK

12-16 Yarm Road, Stockton on Tees, TS18 3NA
Tel: 01642 607083 Email: info@solmek.com

Figure Title	Trial Pit Location Plan
Project Number	S201112
Project Name	Felix Hotel, Cambridge
Client	Arc Engineers
Date	December 2020
DRG Number	Figure 2
Scale	1:1500 @ A4 [DO NOT SCALE]

Legend Key

○	Locations By Type - Empty
◆	Locations By Type - BH
●	Locations By Type - CP
▨	Locations By Type - TP
▭	Project Bounds - Project Bounds

SOLMEK

Solmek Ltd
12-16 Yarm Road
Stockton on Tees
TS18 3NA
Tel: 01642 607083
Email: info@solmek.com

Trial Pit Log

TrialPit No
TP1
Sheet 1 of 1

Project Name: Felix Hotel, Cambridge	Project No. S201112	Co-ords: E - N Level:		Date 30/11/2020
Plant Used: JCB 3CX		Dimensions (m): Depth 3.00	1.90 0.60	Scale 1:26
Client:				Logged CG

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.20		▩	MADE GROUND: Dark brown clayey, silty, slightly gravelly sand. Gravel is subangular, fine to coarse of brick, chalk and flint. Common roots.
	0.40 - 0.60	ES		1.20		▩	MADE GROUND: Light brown/bluish grey silty, sandy gravelly clay. Gravel is subangular, fine to coarse of brick, pottery, chalk and flint.
▼	1.20 - 1.40	ES		1.80		░	Loose yellowish brown sandy, subangular, fine to coarse GRAVEL of flint and occasional chalk.
				3.00		▤	Stiff consistency bluish grey, slightly gravelly, high strength CLAY. Gravel is subangular, fine to medium of chalk and flint.
							End of Pit at 3.000m

Remarks: 1. Groundwater encountered at 1.40m.

Stability:

Solmek Ltd
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Stockton on Tees
TS18 3NA
Tel: 01642 607083
Email: info@solmek.com

Trial Pit Log

TrialPit No
TP8
Sheet 1 of 1

Project Name: Felix Hotel, Cambridge

Project No.
S201112

Co-ords: E - N
Level:

Date
30/11/2020

Plant Used: JCB 3CX

Dimensions (m):
Depth
3.00

Scale
1:26

Client:

Logged
CG

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.20 - 0.40	ES		0.60		▨	MADE GROUND: Dark brown, clayey, silty, slightly gravelly sand. Gravel is subangular, fine to coarse of brick, chalk and flint. Common roots.
	0.80 - 1.00	ES		1.10		▨	Firm consistency light brown, slightly sandy, slightly gravelly, silty, medium strength CLAY. Gravel is subangular, fine to medium of chalk and flint. Common roots.
				3.00		▨	Stiff consistency bluish grey, slightly gravelly, high strength CLAY. Gravel is subangular, fine to medium of chalk and flint. Occasional roots.
							End of Pit at 3.000m

1
2
3
4
5

Remarks: 1. No groundwater encountered.

Stability:

SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 1991
BRE Digest 365, Figure 2, Page 5

Client: Cassel Hotels (Cambridge) Ltd
Site: Hotel Felix, Cambridge
Job No: S201112
Pit No: TP1 **Test No:** 1

CALCULATION OF SOIL INFILTRATION RATE

Time (min)	Depth (m)
0	1.42
0.5	1.42
1	1.43
2	1.44
3	1.44
4	1.44
5	1.44
6	1.44
7	1.45
8	1.45
9	1.45
10	1.45
15	1.45
20	1.46
25	1.46
30	1.46
40	1.46
50	1.46
60	1.46
90	
120	
180	

Pit Dimensions
Length (m) = 1.90
Width (m) = 0.60
Depth (m) = 3.00

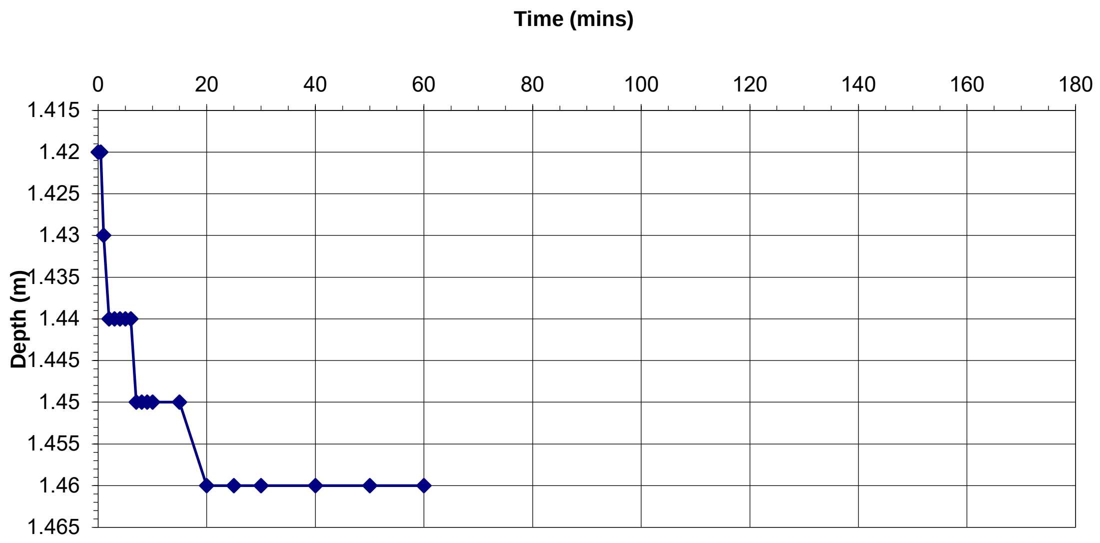
Depth at start of test (m) = 1.420
Depth at end of test (m)= 1.460
75% level (m)= 1.430
50% Effective Depth 1.560
25% level (m)= 1.450

Base area of pit (m^2) = 1.140
Vp_{75-25} (m^3) = 0.023
a_{p50} (m^2) = 8.940

From the graph:
tp 75 (min) = 1
tp 25 (min) = 15

Soil infiltration rate, f, (m/s) = **3.04E-06** **normal test**

Input by: **CG** **Date:** **30/11/2020**
Checked by: **RW** **Date:** **30/11/2020**



SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 1991
BRE Digest 365, Figure 2, Page 5

Client: Cassel Hotels (Cambridge) Ltd
Site: Hotel Felix, Cambridge
Job No: S201112
Pit No: TP8 **Test No:** 1

CALCULATION OF SOIL INFILTRATION RATE

Time (min)	Depth (m)
0	1.35
0.5	1.36
1	1.36
2	1.36
3	1.36
4	1.36
5	1.36
6	1.36
7	1.36
8	1.36
9	1.36
10	1.36
15	1.36
20	1.36
25	1.36
30	1.36
40	1.36
50	1.36
60	1.36
90	
120	
180	

Pit Dimensions

Length (m) = 1.90
Width (m) = 0.60
Depth (m) = 3.00

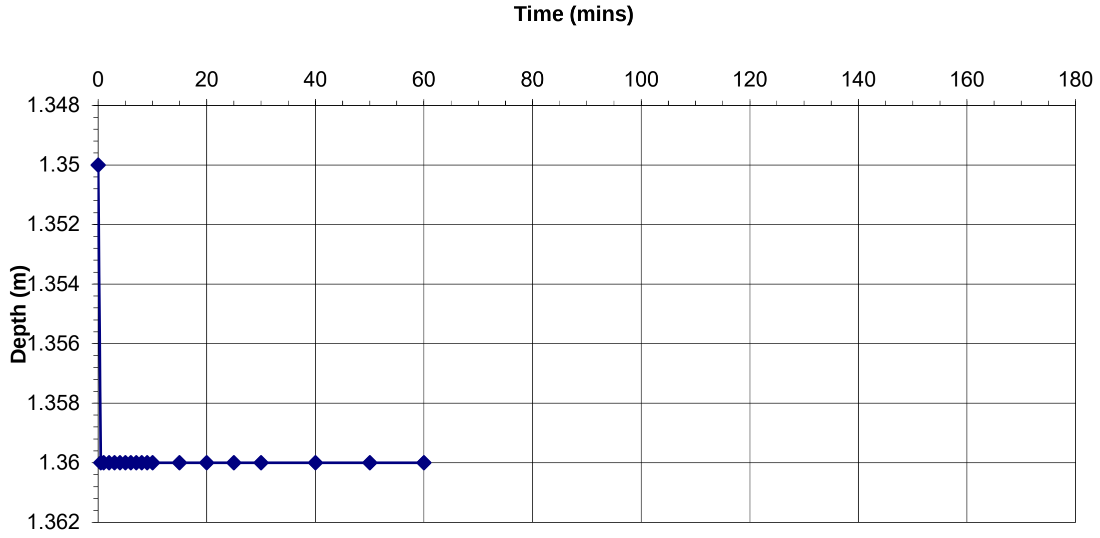
Depth at start of test (m) = 1.350
Depth at end of test (m)= 1.360
75% level (m)= 1.353
50% Effective Depth 1.645
25% level (m)= 1.358

Base area of pit (m^2) = 1.140
Vp_{75-25} (m^3) = 0.006
a_{p50} (m^2) = 9.365

From the graph:
tp 75 (min) = 0
tp 25 (min) = 60

Soil infiltration rate, f, (m/s) = **1.69E-07** **normal test**

Input by: **CG** **Date:** **30/11/2020**
Checked by: **RW** **Date:** **30/11/2020**



APPENDIX D

Environment Agency

Flood map for planning

Your reference	Location (easting/northing)	Created
Hotel Felix	**543139/260549**	**18 Aug 2020 9:51**

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

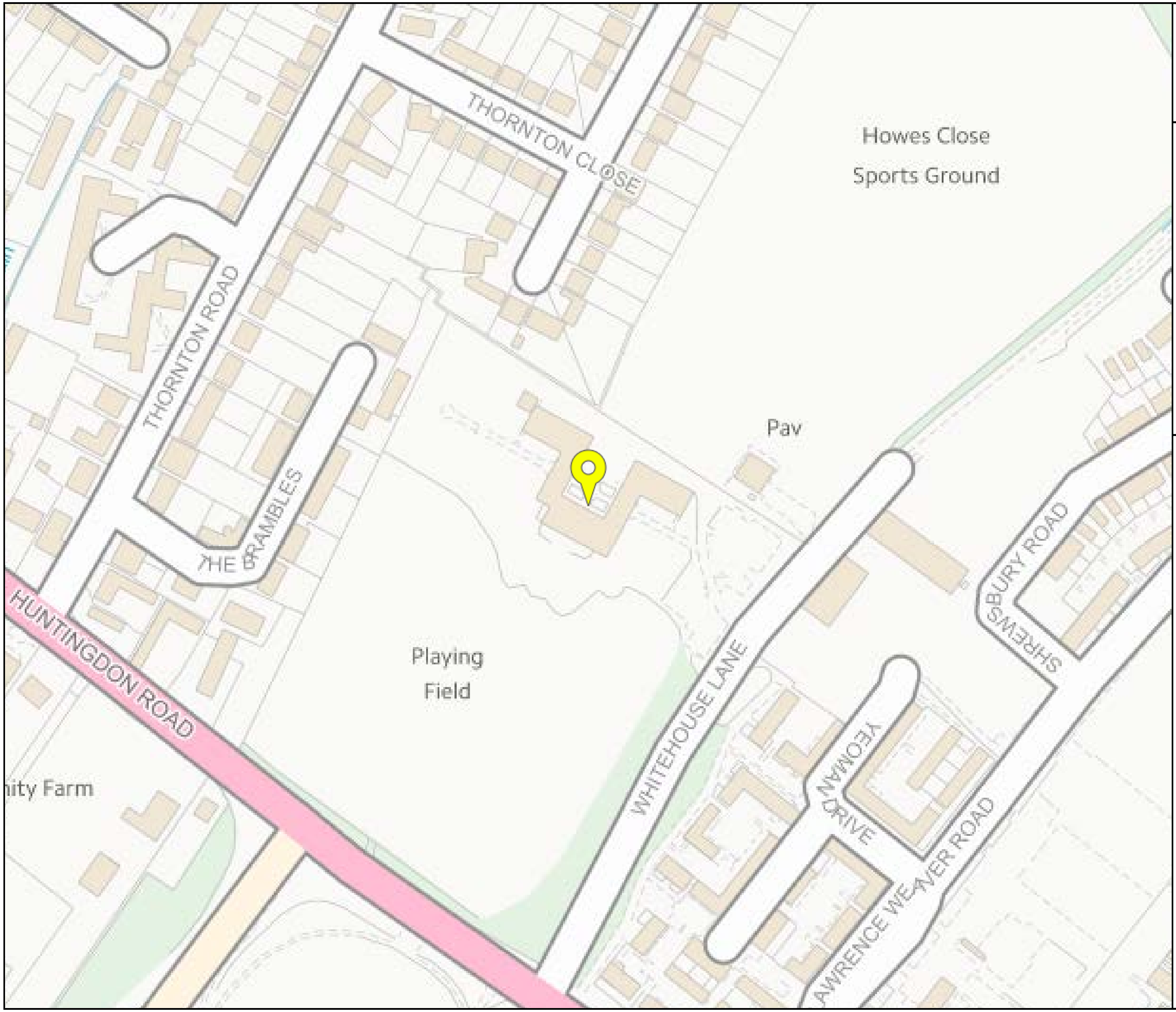
This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

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.



Environment Agency

Flood map for planning

Your reference
Hotel Felix

Location (easting/northing)
543139/260549

Scale
1:2500

Created
18 Aug 2020 9:51

📍	Selected point
🟦	Flood zone 3
▨	Flood zone 3: areas benefitting from flood defences
🟦	Flood zone 2
☐	Flood zone 1
—	Flood defence
—	Main river
⠿	Flood storage area

0 20 40 60m

APPENDIX E

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	25.000	0.125	200.0	0.339	5.00	0.0	0.600	o	300	Pipe/Conduit	🔓
1.001	5.000	0.062	80.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	🔓

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	52.98	5.38	20.600	0.339	0.0	0.0	0.0	1.11	78.3	48.6
1.001	52.77	5.42	20.475	0.339	0.0	0.0	0.0	1.75	123.9	48.6

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		22.100	20.413	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.400		

Summary Wizard of 60 minute 1 year Summer I+0% for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * $10m^3$/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 0

PN	US/MH Name	Storm Rank	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	1	5	20.738	-0.162	0.000	0.42			29.2	OK
1.001	2	5	20.622	-0.153	0.000	0.47			29.6	OK

Summary Wizard of 60 minute 30 year Summer I+0% for Storm

Simulation Criteria

```
           Areal Reduction Factor 1.000   Additional Flow - % of Total Flow 0.000
                  Hot Start (mins)     0        MADD Factor * 10m³/ha Storage 2.000
              Hot Start Level (mm)     0               Inlet Coeffiecient 0.800
  Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
    Foul Sewage per hectare (l/s) 0.000

         Number of Input Hydrographs 0 Number of Storage Structures 0
           Number of Online Controls 0 Number of Time/Area Diagrams 0
          Number of Offline Controls 0 Number of Real Time Controls 0
```

Synthetic Rainfall Details

```
           Rainfall Model             FSR      Ratio R 0.400
                   Region England and Wales Cv (Summer) 0.750
               M5-60 (mm)            20.000 Cv (Winter) 0.840

         Margin for Flood Risk Warning (mm) 300.0      DVD Status OFF
                          Analysis Timestep  Fine Inertia Status OFF
                                 DTS Status    ON


                              Profile(s) Summer and Winter
                      Duration(s) (mins)                60
                Return Period(s) (years)         1, 30, 100
                      Climate Change (%)           0, 0, 0


                      Water  Surcharged Flooded            Half Drain  Pipe
         US/MH Storm  Level    Depth    Volume Flow / Overflow  Time    Flow
   PN    Name  Rank    (m)      (m)      (m³)   Cap.   (l/s)   (mins)  (l/s)   Status

 1.000      1     3  20.901     0.001    0.000   0.99                   69.2 SURCHARGED
 1.001      2     3  20.776     0.001    0.000   1.11                   69.2 SURCHARGED
```

Summary Wizard of 60 minute 100 year Summer I+0% for Storm

Simulation Criteria

```
             Areal Reduction Factor 1.000   Additional Flow - % of Total Flow 0.000
                   Hot Start (mins)     0       MADD Factor * 10m³/ha Storage 2.000
              Hot Start Level (mm)      0              Inlet Coeffiecient 0.800
     Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
       Foul Sewage per hectare (l/s) 0.000

          Number of Input Hydrographs 0 Number of Storage Structures 0
            Number of Online Controls 0 Number of Time/Area Diagrams 0
           Number of Offline Controls 0 Number of Real Time Controls 0
```

Synthetic Rainfall Details

```
        Rainfall Model                FSR     Ratio R 0.400
                Region England and Wales Cv (Summer) 0.750
            M5-60 (mm)             20.000 Cv (Winter) 0.840

        Margin for Flood Risk Warning (mm) 300.0     DVD Status OFF
                         Analysis Timestep  Fine Inertia Status OFF
                                DTS Status    ON


                          Profile(s) Summer and Winter
                  Duration(s) (mins)                60
            Return Period(s) (years)         1, 30, 100
                  Climate Change (%)            0, 0, 0
```

```
                         Water  Surcharged Flooded                   Half Drain  Pipe
        US/MH  Storm     Level    Depth     Volume  Flow / Overflow     Time     Flow
  PN    Name   Rank       (m)      (m)      (m³)    Cap.    (l/s)      (mins)    (l/s)    Status

1.000      1      1  21.060      0.160    0.000    1.32                          92.1  SURCHARGED
1.001      2      1  20.835      0.060    0.000    1.48                          92.3  SURCHARGED
```

ARC Engineers Ltd		Page 1
3 Cadman Court Leeds LS27 0RX	Hotel Felix Cambridge Existing Greenfield Rate	
Date 22/12/2020 13:37 File	Designed by LA Checked by	
Innovyze	Source Control 2020.1	

ICP SUDS Mean Annual Flood

```
                              Input

Return Period (years)   100          Soil    0.400
            Area (ha) 1.051         Urban    0.000
            SAAR (mm)   538  Region Number Region 5

                          Results   l/s

                        QBAR Rural  2.6
                        QBAR Urban  2.6

                        Q100 years  9.4

                           Q1 year  2.3
                         Q30 years  6.3
                        Q100 years  9.4
```

ICP SUDS Mean Annual Flood

```
                              Input

Return Period (years)    100           Soil     0.400
            Area (ha)  1.390          Urban     0.000
            SAAR (mm)    538  Region Number  Region 5

                          Results    l/s

                       QBAR Rural    3.5
                       QBAR Urban    3.5

                       Q100 years   12.4

                          Q1 year    3.0
                        Q30 years    8.4
                       Q100 years   12.4
```

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 734 minutes.

Storm Event	**Max Level (m)**	**Max Depth (m)**	**Max Infiltration (l/s)**	**Max Control (l/s)**	**Max Σ Outflow (l/s)**	**Max Volume (m³)**	**Status**
15 min Summer	20.057	0.257	0.0	3.5	3.5	122.1	O K
30 min Summer	20.135	0.335	0.0	3.5	3.5	159.3	O K
60 min Summer	20.213	0.413	0.0	3.5	3.5	196.3	O K
120 min Summer	20.285	0.485	0.0	3.5	3.5	230.5	O K
180 min Summer	20.321	0.521	0.0	3.5	3.5	247.3	O K
240 min Summer	20.340	0.540	0.0	3.5	3.5	256.3	O K
360 min Summer	20.358	0.558	0.0	3.5	3.5	264.8	O K
480 min Summer	20.362	0.562	0.0	3.5	3.5	267.0	O K
600 min Summer	20.359	0.559	0.0	3.5	3.5	265.5	O K
720 min Summer	20.351	0.551	0.0	3.5	3.5	261.9	O K
960 min Summer	20.335	0.535	0.0	3.5	3.5	254.3	O K
1440 min Summer	20.298	0.498	0.0	3.5	3.5	236.7	O K
2160 min Summer	20.242	0.442	0.0	3.5	3.5	210.0	O K
2880 min Summer	20.191	0.391	0.0	3.5	3.5	185.8	O K
4320 min Summer	20.103	0.303	0.0	3.5	3.5	143.8	O K
5760 min Summer	20.033	0.233	0.0	3.5	3.5	110.6	O K
7200 min Summer	19.981	0.181	0.0	3.5	3.5	86.1	O K
8640 min Summer	19.944	0.144	0.0	3.4	3.4	68.5	O K
10080 min Summer	19.919	0.119	0.0	3.3	3.3	56.3	O K
15 min Winter	20.089	0.289	0.0	3.5	3.5	137.1	O K

Storm Event	**Rain (mm/hr)**	**Flooded Volume (m³)**	**Discharge Volume (m³)**	**Time-Peak (mins)**
15 min Summer	138.153	0.0	123.9	26
30 min Summer	90.705	0.0	161.8	41
60 min Summer	56.713	0.0	206.1	70
120 min Summer	34.246	0.0	248.9	128
180 min Summer	25.149	0.0	274.2	188
240 min Summer	20.078	0.0	291.9	246
360 min Summer	14.585	0.0	318.1	364
480 min Summer	11.622	0.0	337.6	482
600 min Summer	9.738	0.0	353.1	600
720 min Summer	8.424	0.0	366.1	684
960 min Summer	6.697	0.0	386.9	794
1440 min Summer	4.839	0.0	416.6	1038
2160 min Summer	3.490	0.0	456.8	1416
2880 min Summer	2.766	0.0	482.6	1816
4320 min Summer	1.989	0.0	520.8	2560
5760 min Summer	1.573	0.0	549.1	3288
7200 min Summer	1.311	0.0	571.8	3968
8640 min Summer	1.129	0.0	590.9	4664
10080 min Summer	0.994	0.0	607.3	5336
15 min Winter	138.153	0.0	138.5	26

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	20.177	0.377	0.0	3.5	3.5	179.1	O K
60 min Winter	20.265	0.465	0.0	3.5	3.5	221.0	O K
120 min Winter	20.349	0.549	0.0	3.5	3.5	260.6	O K
180 min Winter	20.389	0.589	0.0	3.5	3.5	279.9	O K
240 min Winter	20.412	0.612	0.0	3.5	3.5	290.6	O K
360 min Winter	20.435	0.635	0.0	3.5	3.5	301.5	O K
480 min Winter	20.443	0.643	0.0	3.5	3.5	305.4	O K
600 min Winter	20.443	0.643	0.0	3.5	3.5	305.2	O K
720 min Winter	20.437	0.637	0.0	3.5	3.5	302.5	O K
960 min Winter	20.417	0.617	0.0	3.5	3.5	293.0	O K
1440 min Winter	20.373	0.573	0.0	3.5	3.5	272.2	O K
2160 min Winter	20.296	0.496	0.0	3.5	3.5	235.6	O K
2880 min Winter	20.214	0.414	0.0	3.5	3.5	196.8	O K
4320 min Winter	20.080	0.280	0.0	3.5	3.5	133.1	O K
5760 min Winter	19.985	0.185	0.0	3.5	3.5	87.9	O K
7200 min Winter	19.927	0.127	0.0	3.3	3.3	60.2	O K
8640 min Winter	19.898	0.098	0.0	3.1	3.1	46.6	O K
10080 min Winter	19.886	0.086	0.0	2.8	2.8	40.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	90.705	0.0	180.6	40
60 min Winter	56.713	0.0	230.8	70
120 min Winter	34.246	0.0	278.8	126
180 min Winter	25.149	0.0	307.1	184
240 min Winter	20.078	0.0	327.0	242
360 min Winter	14.585	0.0	355.6	358
480 min Winter	11.622	0.0	377.2	472
600 min Winter	9.738	0.0	394.4	582
720 min Winter	8.424	0.0	408.7	692
960 min Winter	6.697	0.0	431.5	894
1440 min Winter	4.839	0.0	461.7	1114
2160 min Winter	3.490	0.0	511.7	1568
2880 min Winter	2.766	0.0	540.6	1968
4320 min Winter	1.989	0.0	583.5	2728
5760 min Winter	1.573	0.0	615.0	3400
7200 min Winter	1.311	0.0	640.5	4032
8640 min Winter	1.129	0.0	661.8	4584
10080 min Winter	0.994	0.0	680.2	5248

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.485

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.162	4	8	0.162	8	12	0.162

Model Details

Storage is Online Cover Level (m) 22.600

Cellular Storage Structure

Invert Level (m)	19.800	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	**Area (m^2)**	**Inf. Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Inf. Area (m^2)**
0.000	500.0	0.0	0.801	0.0	0.0
0.800	500.0	0.0			

Hydro-Brake® Optimum Outflow Control

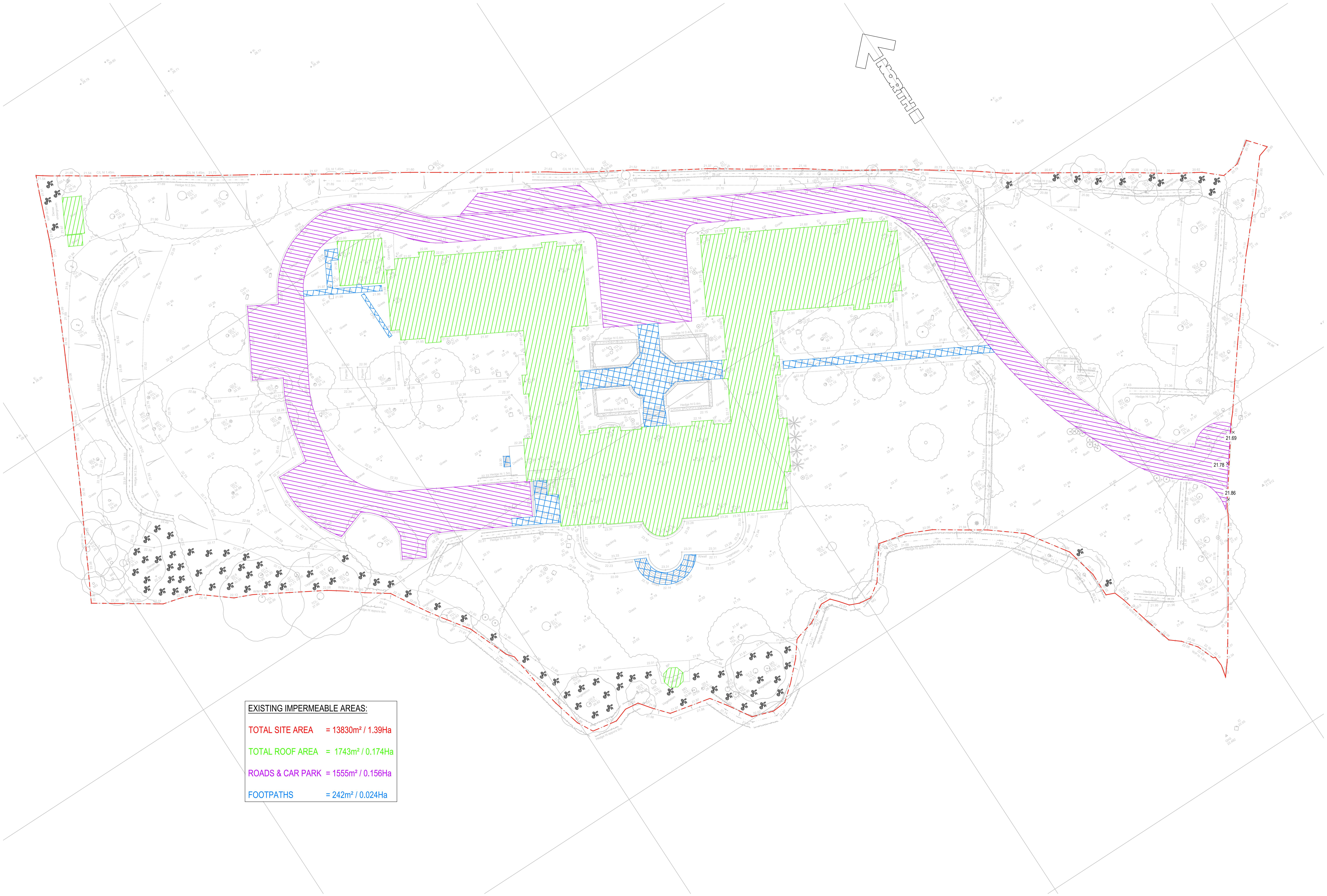
Unit Reference	MD-SHE-0092-3500-0800-3500
Design Head (m)	0.800
Design Flow (l/s)	3.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	92
Invert Level (m)	19.790
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.800	3.5
Flush-Flo™	0.238	3.5
Kick-Flo®	0.521	2.9
Mean Flow over Head Range	-	3.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	2.9	1.200	4.2	3.000	6.5	7.000	9.7
0.200	3.5	1.400	4.5	3.500	7.0	7.500	10.0
0.300	3.5	1.600	4.8	4.000	7.4	8.000	10.3
0.400	3.3	1.800	5.1	4.500	7.8	8.500	10.6
0.500	3.0	2.000	5.3	5.000	8.2	9.000	10.9
0.600	3.1	2.200	5.6	5.500	8.6	9.500	11.2
0.800	3.5	2.400	5.8	6.000	9.0		
1.000	3.9	2.600	6.0	6.500	9.3		

APPENDIX F



EXISTING IMPERMEABLE AREAS:

TOTAL SITE AREA	= 13830m² / 1.39Ha
TOTAL ROOF AREA	= 1743m² / 0.174Ha
ROADS & CAR PARK	= 1555m² / 0.156Ha
FOOTPATHS	= 242m² / 0.024Ha

DO NOT SCALE

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GENERAL NOTES

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3. This drawing is to be read in accordance with all other relevant drawings, third party drawings, specifications and supporting documentation.
4. All levels and dimensions to be checked on site by the contractor. Any discrepancies to be notified to the Engineer and further instructions obtained prior to further work being carried out.
5. All work to comply with current Local Authority design standards and DFT Manual for Streets.

REV	DETAIL	BY	CHKD	DATE
P0	INITIAL ISSUE	AC	LA	22.12.2020

INITIAL ISSUE BASED ON ARCHITECTS DRAWING NUMBER :-

arcengineers
CONSULTING STRUCTURAL AND CIVIL ENGINEERS

3 CADMAN COURT, LEEDS, LS27 0RX
Phone: 0113 253 3904
www.arc-engineers.co.uk

CLIENT:
CASSEL HOTELS (CAMBRIDGE) LTD

PROJECT:
HOTEL FELIX
CAMBRIDGE

TITLE:
EXISTING
IMPERMEABLE AREAS

DRAWING STATUS:
PLANNING

DRAWN:	DATE:	CHECKED:	DATE:
AC	DECEMBER 2020	LA	DECEMBER 2020

CONTRACT No. 20 106

SCALE @ A1: 1:300

PROJECT No.	ORIGINATOR	ZONE	LEVEL	TYPE	DISCIPLINE	NUMBER	REVISION
20106-	ARC -	XX -	00 -	DR -	D -	0003 -	P0

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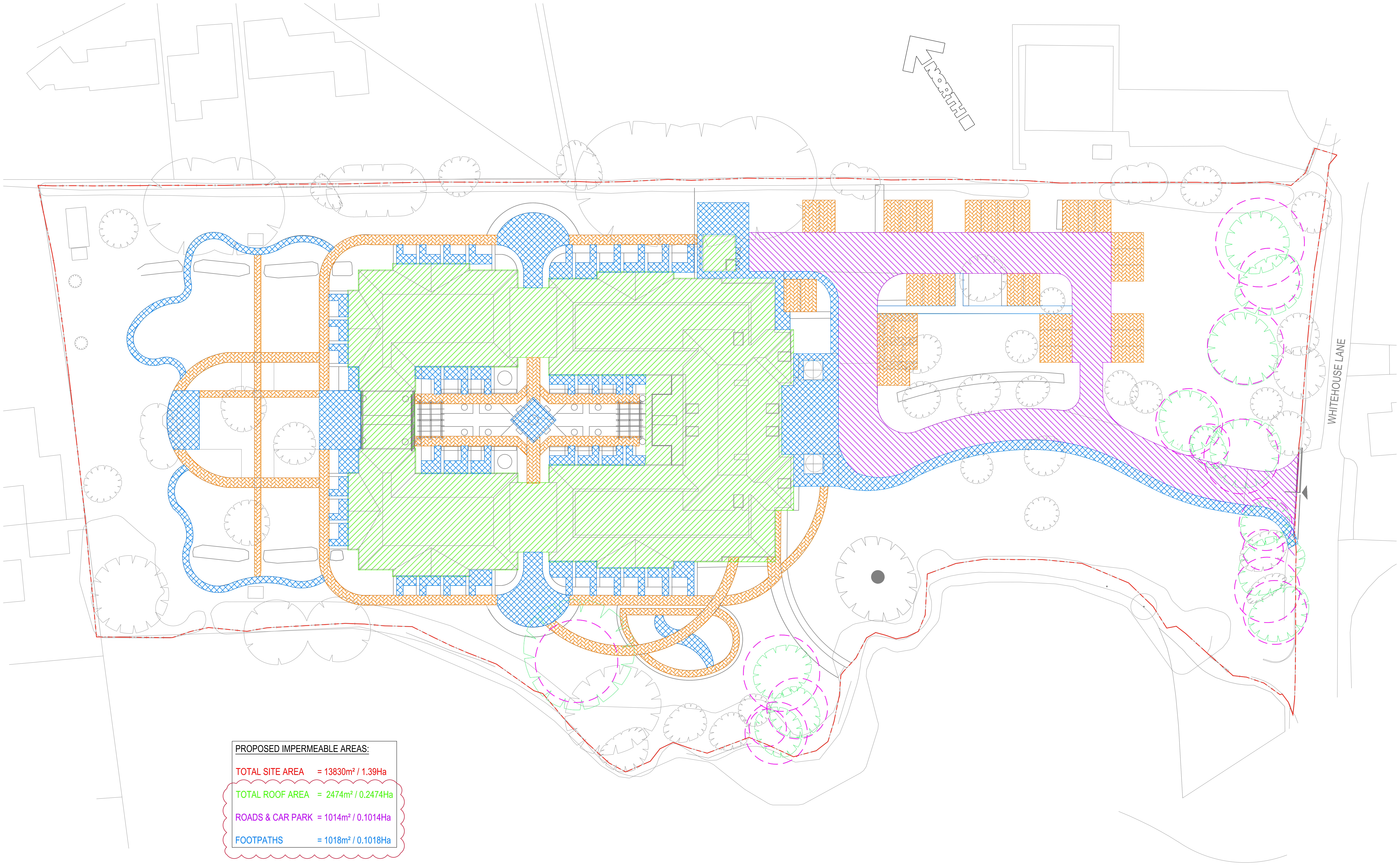

PROPOSED IMPERMEABLE AREAS:

TOTAL SITE AREA	= 13830m² / 1.39Ha
TOTAL ROOF AREA	= 2474m² / 0.2474Ha
ROADS & CAR PARK	= 1014m² / 0.1014Ha
FOOTPATHS	= 1018m² / 0.1018Ha

REV	DETAIL	BY	CHKD	DATE
P2	Paved areas updated in line with landscape plans	LA	AC	16.02.21
P1	Updated to revised site plan received 12.02.2021	AC	LA	15.02.2021
P0	INITIAL ISSUE	AC	LA	22.12.2020

INITIAL ISSUE BASED ON ARCHITECTS DRAWING NUMBER :-

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CLIENT:
CASSEL HOTELS (CAMBRIDGE) LTD

PROJECT:
HOTEL FELIX
CAMBRIDGE

TITLE:
PROPOSED
IMPERMEABLE AREAS

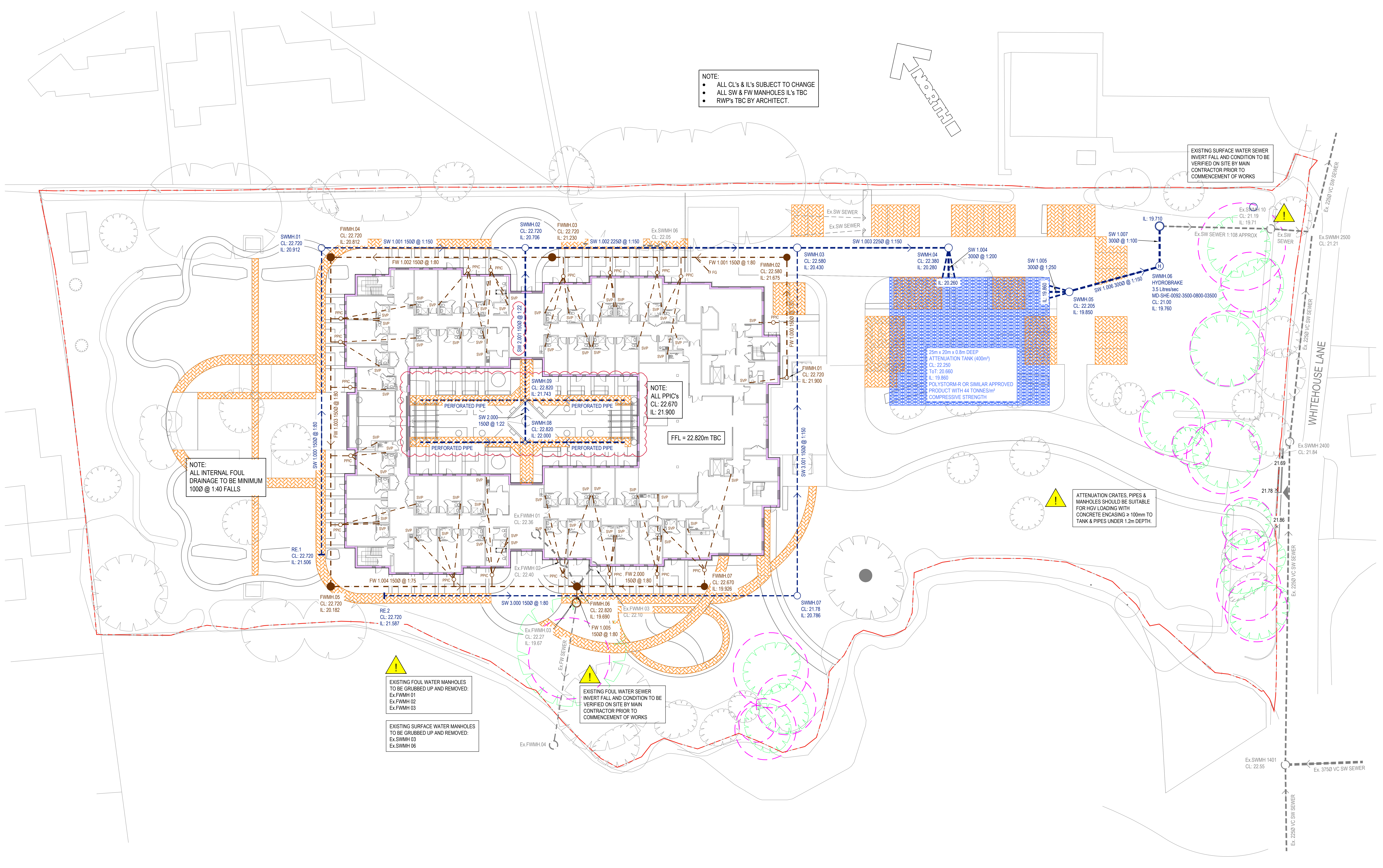
DRAWING STATUS:
PLANNING

DRAWN:	DATE:	CHECKED:	DATE:
AC	DECEMBER 2020	LA	DECEMBER 2020

CONTRACT No.: 20 106
SCALE @ A1: 1:300

PROJECT No.	ORIGINATOR	ZONE	LEVEL	TYPE	DISCIPLINE	NUMBER	REVISION
20106	ARC	XX	00	DR	D	0004	P2

20106- ARC -XX-00-DR- D - 0004 -P2



NOTE:
- ALL CL's & IL's SUBJECT TO CHANGE
- ALL SW & FW MANHOLES IL's TBC
- RWP's TBC BY ARCHITECT.

EXISTING SURFACE WATER SEWER INVERT FALL AND CONDITION TO BE VERIFIED ON SITE BY MAIN CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS

NOTE:
ALL PPIC's
CL: 22.670
IL: 21.900

NOTE:
ALL INTERNAL FOUL DRAINAGE TO BE MINIMUM 100Ø @ 1:40 FALLS

ATTENUATION CRATES, PIPES & MANHOLES SHOULD BE SUITABLE FOR HGV LOADING WITH CONCRETE ENCASING ≥ 100mm TO TANK & PIPES UNDER 1.2m DEPTH.

EXISTING FOUL WATER MANHOLES TO BE GRUBBED UP AND REMOVED:
Ex.FWMH 01
Ex.FWMH 02
Ex.FWMH 03

EXISTING SURFACE WATER MANHOLES TO BE GRUBBED UP AND REMOVED:
Ex.SWMH 03
Ex.SWMH 06

EXISTING FOUL WATER SEWER INVERT FALL AND CONDITION TO BE VERIFIED ON SITE BY MAIN CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS

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KEY:

FW 1.000 150Ø @ 1:60	FOUL WATER PIPE
SW 1.000 150Ø @ 1:60	SURFACE WATER PIPE
SWMH.09 BD	BACKDROP MANHOLE
	INDICATIVE LINE OF EXISTING FW SEWER
	INDICATIVE LINE OF EXISTING SW SEWER
	EXISTING SEWER TO BE REMOVED
SWMH.01	SURFACE WATER MANHOLE
FWMH.09 ●	FOUL WATER MANHOLE
H	HYDROBRAKE
PPIC ○	POLYPROPYLENE INSPECTION CHAMBER
◎	CONNECTION TO EXISTING FW SEWER
◎	CONNECTION TO EXISTING SW SEWER
○	EXISTING MANHOLE
RG	ROAD GULLY
RE	RODDING EYE
G	GULLY
FG	FOUL WATER GULLY
RWP ●	RAINWATER PIPE
ACO	ACO DRAINAGE CHANNEL (Built in falls)
▨	SURFACE WATER ATTENUATION POLYSTORM-R OR SIMILAR APPROVED PRODUCT WITH 44 TONNES/m² COMPRESSIVE STRENGTH
	SITE BOUNDARY
○	TREE ROOT PROTECTION ZONE
+XX.XXX	PROPOSED LEVEL
▨	DENOTES PERMEABLE PAVING

P2	Paved areas updated in line with landscape plans	LA	AC	16.02.21
P1	Updated to revised site plan received 12.02.2021	AC	LA	15.02.2021
P0	INITIAL ISSUE	AC	LA	22.12.2020
REV	DETAIL	BY	CHKD	DATE

INITIAL ISSUE BASED ON ARCHITECTS DRAWING NUMBER :-

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CLIENT:
CASSEL HOTELS (CAMBRIDGE) LTD

PROJECT:
HOTEL FELIX
CAMBRIDGE

TITLE:
DRAINAGE GA

DRAWING STATUS:
PLANNING

DRAWN:	DATE:	CHECKED:	DATE:
AC	DECEMBER 2020	LA	DECEMBER 2020

CONTRACT No.	SCALE @ A1:
20 106	1:300

PROJECT No.	ORIGINATOR	ZONE	LEVEL	TYPE	DISCIPLINE	NUMBER	REVISION
20106	ARC	XX	00	DR	D	0001	P2

APPENDIX G

Project: Hotel Felix, Whitehouse Lane, Cambridge				
Details: EXTRACTS OF BUILDING REGS				Project Number: 20106
Produced By: *LA*	Date: *Dec-20*	Checked By: *AC*	Date: *Dec-20*	Section/Page No/Revision 1 / 1

Ref. **Calculations** **Output**

RELEVANT EXTRACTS FROM APPROVED DOCUMENT H1 (as of May 2016)

Diagram 9 Discharge capacities of foul drains running 0.75 proportional depth

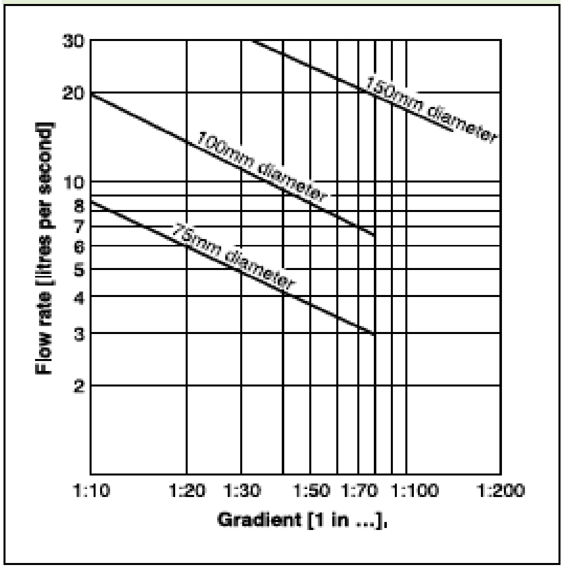


Table 6 Recommended minimum gradients for foul drains

Peak flow (litres/sec)	Pipe size (mm)	Minimum gradient (1 in ...)	Maximum capacity (litres/sec)
< 1	75 100	1:40 1:40	4.1 9.2
> 1	75 100 150	1:80 1:80* 1:150†	2.8 6.3 15.0

Notes:

* Minimum of 1 WC

† Minimum of 5 WCs

Table 10 Limits of cover for thermoplastics (nominal ring stiffness SN4) pipes in any width of trench

Nominal size	Laid in fields	Laid in light roads	Laid in main roads
100mm – 300mm	0.6m – 7m	0.9m – 7m	0.9m – 7m

Notes:

1. For drains and sewers less than 1.5m deep and there is a risk of excavation adjacent to the drain and depth, special calculation is necessary, see BS EN 1295.
2. All pipes assumed to be to in accordance with the relevant standard listed in Table 7 with nominal ring stiffness SN4; other strengths and sizes of pipe are available, consult manufacturers.
3. Bedding assumed to be Class S2 with 80% compaction and average soil conditions.
4. Alternative designs using different pipe strengths and/or bedding types may offer more appropriate or economic options using the procedures set out in BS EN 1295.
5. Minimum depth is set to 1.5m irrespective of pipe strength to cover loss of side support from parallel excavations.

arcengineers

Project:
Hotel Felix, Whitehouse Lane, Cambridge

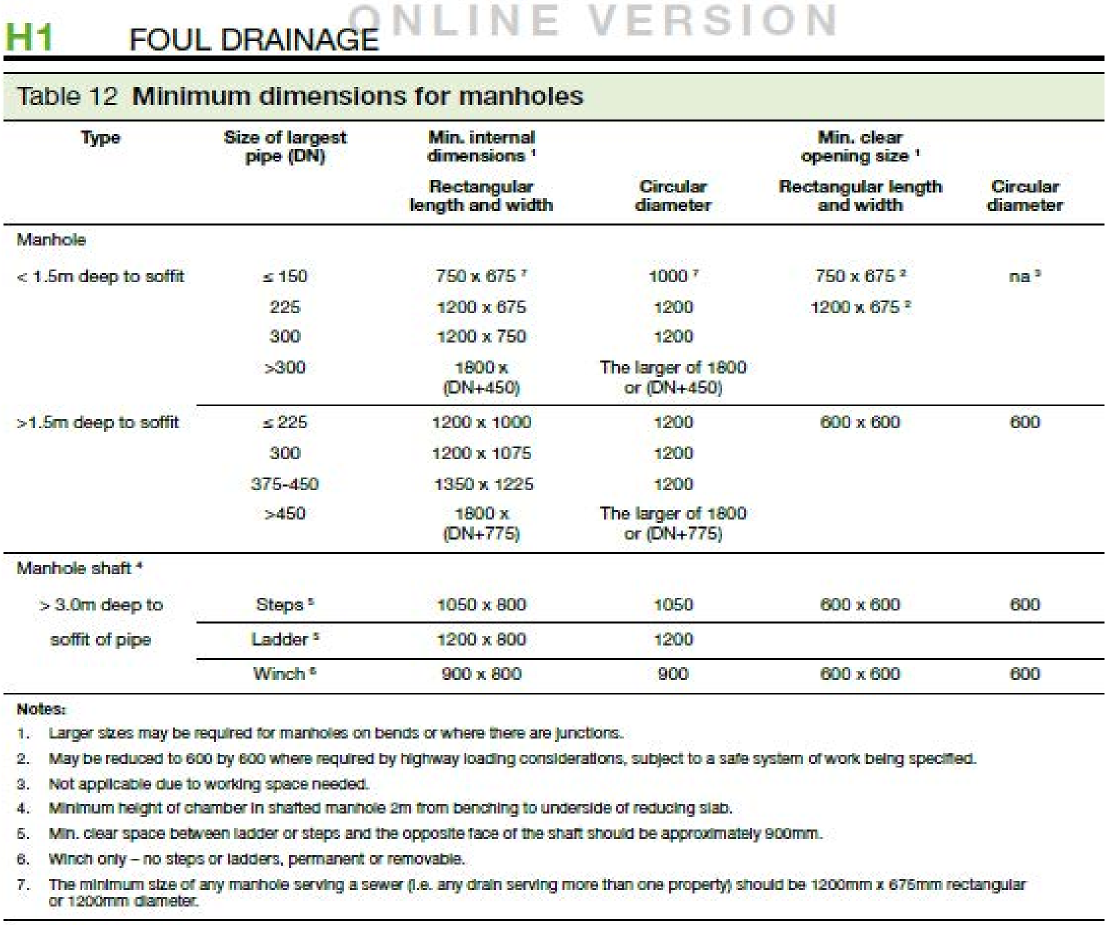
Details:
EXTRACTS OF BUILDING REGS

Project Number:
20106

Produced By:	Date:	Checked By:	Date:	Section/Page No/Revision
LA	*Dec-20*	*AC*	*Dec-20*	1 / 2

Ref.	Calculations	Output

RELEVANT EXTRACTS FROM APPROVED DOCUMENT H1 (as of May 2016)



H1 FOUL DRAINAGE

Table 12 Minimum dimensions for manholes

Type	Size of largest pipe (DN)	Min. internal dimensions [1] Rectangular length and width	Circular diameter	Min. clear opening size [1] Rectangular length and width	Circular diameter
Manhole					
< 1.5m deep to soffit	≤ 150	750 x 675 [7]	1000 [7]	750 x 675 [2]	na [3]
	225	1200 x 675	1200	1200 x 675 [2]	
	300	1200 x 750	1200		
	>300	1800 x (DN+450)	The larger of 1800 or (DN+450)		
>1.5m deep to soffit	≤ 225	1200 x 1000	1200	600 x 600	600
	300	1200 x 1075	1200		
	375-450	1350 x 1225	1200		
	>450	1800 x (DN+775)	The larger of 1800 or (DN+775)		
Manhole shaft [4]					
> 3.0m deep to soffit of pipe	Steps [5]	1050 x 800	1050	600 x 600	600
	Ladder [5]	1200 x 800	1200		
	Winch [6]	900 x 800	900	600 x 600	600

Notes:

1. Larger sizes may be required for manholes on bends or where there are junctions.
2. May be reduced to 600 by 600 where required by highway loading considerations, subject to a safe system of work being specified.
3. Not applicable due to working space needed.
4. Minimum height of chamber in shafted manhole 2m from benching to underside of reducing slab.
5. Min. clear space between ladder or steps and the opposite face of the shaft should be approximately 900mm.
6. Winch only – no steps or ladders, permanent or removable.
7. The minimum size of any manhole serving a sewer (i.e. any drain serving more than one property) should be 1200mm x 675mm rectangular or 1200mm diameter.

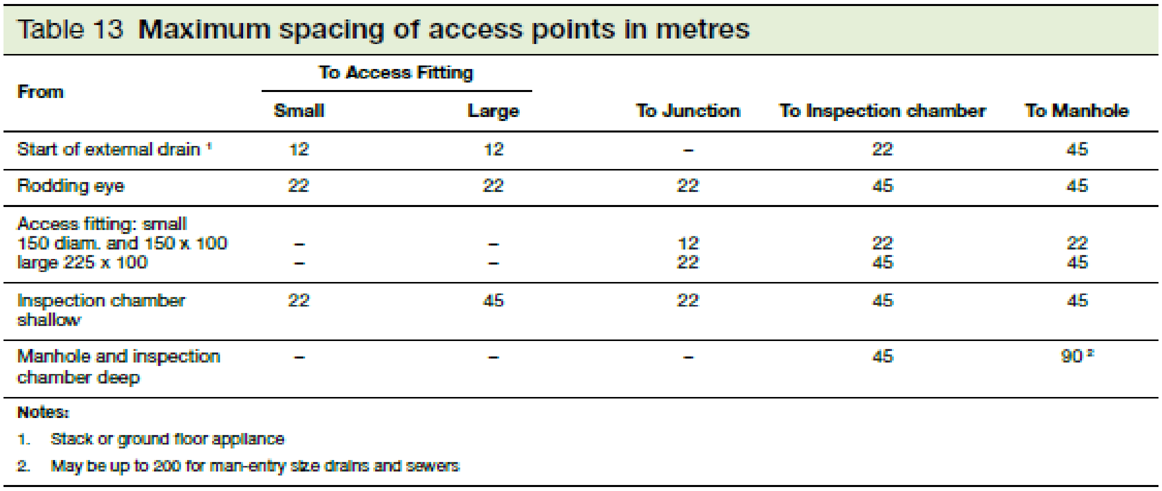


Table 13 Maximum spacing of access points in metres

From	To Access Fitting		To Junction	To Inspection chamber	To Manhole
	Small	Large			
Start of external drain [1]	12	12	–	22	45
Rodding eye	22	22	22	45	45
Access fitting: small 150 diam. and 150 x 100	–	–	12	22	22
large 225 x 100	–	–	22	45	45
Inspection chamber shallow	22	45	22	45	45
Manhole and inspection chamber deep	–	–	–	45	90 [2]

Notes:

1. Stack or ground floor appliance
2. May be up to 200 for man-entry size drains and sewers

arcengineers	Project: **Hotel Felix, Whitehouse Lane, Cambridge**
Details: **FOUL WATER FLOW RATE**	Project Number: **20106**
Produced By: ***LA***	Date: ***Dec-20***
Checked By: ***AC***	Date: ***Dec-20***
Section/Page No/Revision	**1 / 3**

Ref.	**Calculations**	**Output**

FOUL WATER DRAINAGE FLOW RATES

BASED ON BS EN 752 - 4:1998

	Type of Appliance						
Building	WC	Hand Wash Basin	Baths	Showers	Kitchen sink / sluice	Washing machine	Dish Washer
CH Ground floor	50	50	2	42	6	0	2
CH First floor	49	51	2	43	4	0	0
CH Second floor	4	4	0	4	1	2	1
Total No. Provided	**103**	**105**	**4**	**89**	**11**	**2**	**3**
Typical Discharge Unit	**1.8**	**0.3**	**0.8**	**0.4**	**0.6**	**0.8**	**0.5**
Total Discharge Unit	**185.4**	**31.5**	**3.2**	**35.6**	**6.6**	**1.6**	**1.5**

TOTAL DISCHARGE UNITS FOR ALL APPLIANCES	**265.4**
FREQUENCY FACTOR FOR BUILDING USEAGE (Tb C1)	**0.7**
TOTAL UNATTENUATED FLOW, Q =	**11.4 Litres/sec**

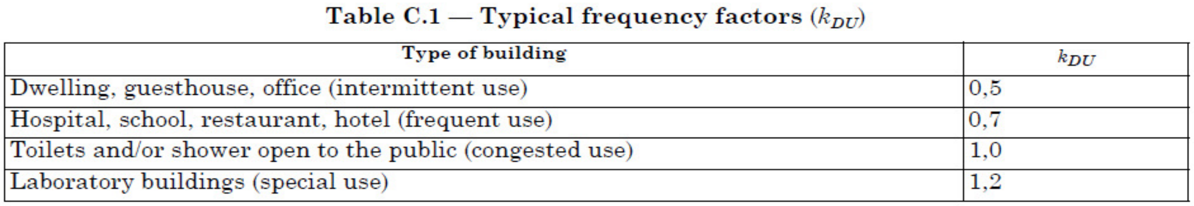


Table C.1 — Typical frequency factors (k_{DU})

Type of building	k_{DU}
Dwelling, guesthouse, office (intermittent use)	0,5
Hospital, school, restaurant, hotel (frequent use)	0,7
Toilets and/or shower open to the public (congested use)	1,0
Laboratory buildings (special use)	1,2

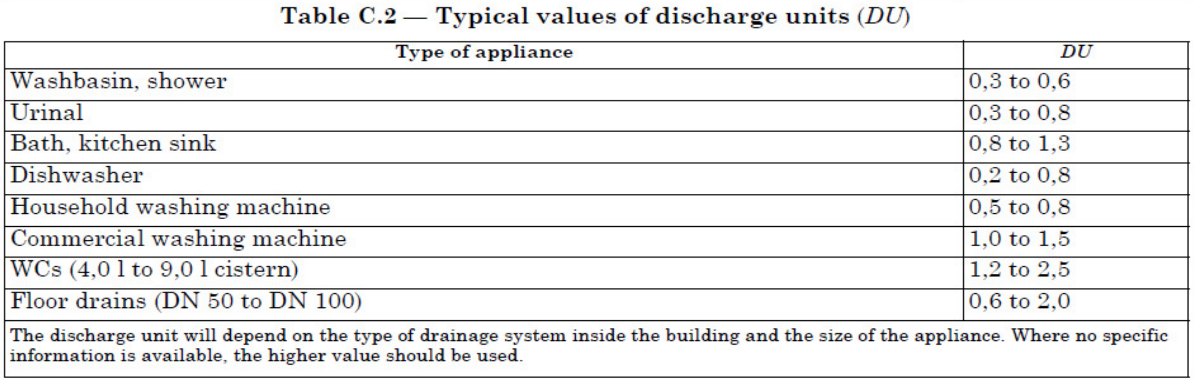


Table C.2 — Typical values of discharge units (DU)

Type of appliance	DU
Washbasin, shower	0,3 to 0,6
Urinal	0,3 to 0,8
Bath, kitchen sink	0,8 to 1,3
Dishwasher	0,2 to 0,8
Household washing machine	0,5 to 0,8
Commercial washing machine	1,0 to 1,5
WCs (4,0 l to 9,0 l cistern)	1,2 to 2,5
Floor drains (DN 50 to DN 100)	0,6 to 2,0

The discharge unit will depend on the type of drainage system inside the building and the size of the appliance. Where no specific information is available, the higher value should be used.

$$Q = k_{DU} \sqrt{\sum DU} \qquad \text{(C.1)}$$

where

Q is the wastewater design flow rate, in litres per second;

k_{DU} is a frequency factor, dimensionless;

DU is the discharge unit (a characteristic value of the rate of wastewater outflow of a sanitary appliance), dimensionless.