Rossi Long Consulting

Flood Risk Assessment and Surface Water Drainage Strategy for:

Bicester Health and Wellbeing Hub

Graven Hill

Bicester

Oxfordshire

RLC Ref. 191607 [Rev 02]

July 2021

Prepared for

Bicester HC Development Ltd

Revision Schedule

RLC Ref. 191607

July 2021

Rev	Date	Details	Prepared by	Reviewed by
00	26 February 2021	Flood Risk Assessment & Drainage Strategy - Initial Issue	**Paul Cosford** CEng, MICE, MCIHT Technical Director	**Mike Lloyd** BEng(Hons), CEng, MIStructE Director
01	19 March 2021	Drainage strategy and calculations amended	**Paul Cosford** CEng, MICE, MCIHT Technical Director	**Mike Lloyd** BEng(Hons), CEng, MIStructE Director
02	8 July 2021	Chapter 7 and calculations updated	**Paul Cosford** CEng, MICE, MCIHT Technical Director	Mike Lloyd B.Eng (Hons), CEng MIStructE

Rossi Long Consulting Ltd
16 Meridian Way
Norwich
Norfolk
NR7 0TA

Tel. 01603 706 420

www.rossilong.co.uk

Limitations

Rossi Long Consulting Ltd has prepared this Report for the sole use of Bicester HC Projects Development Ltd ("Client") in accordance with the Agreement under which our services were performed [RLC letter dated 12 December 2019 and Apollo Capital email of 21 January 2020]. No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by Rossi Long Consulting Ltd. This Report is confidential and may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of Rossi Long Consulting Ltd.

The conclusions and recommendations contained in this Report may be based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by Rossi Long Consulting Ltd has not been independently verified by Rossi Long Consulting Ltd, unless otherwise stated in the Report.

The methodology adopted and the sources of information used by Rossi Long Consulting Ltd in providing its services are outlined in this Report. The work described in this Report was undertaken during February 2021 and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and, where appropriate, are subject to further investigations or information which may become available.

Rossi Long Consulting Ltd disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report, which may come or be brought to Rossi Long Consulting Ltd's attention after the date of the Report.

Certain statements made in the Report that are not historical facts may constitute estimates, projections or other forward-looking statements and even though they are based on reasonable assumptions as of the date of the Report, such forward-looking statements by their nature involve risks and uncertainties that could cause actual results to differ materially from the results predicted. Rossi Long Consulting Ltd specifically does not guarantee or warrant any estimate or projections contained in this Report.

Copyright

Table of Contents

1 Introduction and Client's Brief 5
2 Site Description 6
3 Planning Policy and Flood Risk 7
4 Ground Conditions 9
5 Existing Drainage 10
6 Flood Risk Sources 12
7 Proposed Surface Water Drainage 14
8 Conclusions and Recommendations 18
9 Appendices 19

Appendix A – Proposed Site Layout 20
Appendix B – Topographical Survey Drawing 21
Appendix C – Site Investigation Report Extracts 22
Appendix D – Existing Drainage Plans 23
Appendix E – Surface Water Calculations 24
Appendix F – Drainage Strategy Drawing 25
Appendix G – SuDS Management and Maintenance Plan 26

1 Introduction and Client's Brief

1.1 This Flood Risk Assessment has been prepared by Rossi Long Consulting Ltd, on behalf of Bicester HC Projects Development Ltd, to support a planning application for the construction of a new Health and Wellbeing Hub at Graven Hill, Bicester, Oxfordshire.

1.2 The development is to comprise a new Healthcare building of 3,350m² gross floor area with associated staff and visitors parking. A new entrance is to be formed on to the wider Graven Hill village infrastructure roads.

1.3 When determining planning applications, the Local Planning Authority should ensure flood risk is not increased as a result of the development. A site-specific Flood Risk Assessment is required for proposals of one hectare or greater in Flood Zone 1 and all proposals for new development in Flood Zones 2 and 3.

For major development greater than 0.5 hectares, the Lead Local Flood Authority is a statutory consultee and will comment on surface water flood risk and surface water drainage proposals.

1.4 The proposed site layout is shown on the Architect's drawing included at Appendix A.

1.5 This report is compiled with the benefit of our findings from desk study research, topographical survey, and with reference to site investigation undertaken by Geotechnical Engineering Ltd.

2 Site Description

2.1 The site is currently a vacant development plot within the Graven Hill village development adjacent to the A41. The majority of the site is open grassland, with a small area used as a site compound for construction activities on the wider Graven Hill site.

2.2 The site is located within an existing ongoing development area comprising residential housing and local amenities. The site has an area of 1.05 hectares (Ha) and is located at Ordnance Survey grid reference SP589212. A location plan is shown below:

Location Plan

2.3 Levels across the site are generally flat, with a slight fall from west to east. Levels fall from 68.0m down to 67.5m, with no discernible fall north/south. A copy of the topographical survey is included as Appendix B.

3 Planning Policy and Flood Risk

3.1 The National Planning Policy Framework (NPPF) was published by the Department for Communities and Local Government in March 2012 and updated in February 2019. NPPF requires that flood risk is taken into account in the planning process, to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. The overall aim should be to steer new development towards Flood Zone 1.

3.2 Flood Zone 1 is a low probability flood zone defined as land having a less than 1 in 1000 annual probability of river or sea flooding (shown as 'clear' on the flood map – all land outside Flood Zones 2 & 3).

Flood Zone 2 is a medium probability flood zone defined as land having between a 1 in 100 and 1 in 1000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1000 annual probability of sea flooding (land shown 'light blue' on the flood map).

Flood Zone 3a is a high probability flood zone defined as land having a 1 in 100 or greater annual probability of river flooding; or land having a 1 in 200 or greater annual probability of sea flooding (land shown 'dark blue' on the flood map).

3.3 From Environment Agency flood zone mapping it is confirmed that the site is situated in Flood Zone 1 – a copy of the map is included in section 6.1.

3.4 There are no restrictions to the type of development permitted within Flood Zone 1.

The Government's Planning Practice Guidance permits certain types of developments within the other two higher probability zones, Zone 2 (medium) and Zone 3 (high), subject to the type of development and mitigation measures being put in place.

Table 2 "Flood Risk Vulnerability Classification" of Paragraph 066 (Reference ID: 7-066-20140306) of the above guidance sets out these development types and categorises them as follows:

a) Essential Infrastructure

b) High Vulnerability

c) More Vulnerable

d) Less Vulnerable

e) Water Compatible Development

The guidance defines "hospitals and healthcare service buildings" as 'more vulnerable' development.

Table 3: Flood risk vulnerability and flood zone 'compatibility' (Paragraph 067 Reference ID: 7-066-20140306)

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	✓	x	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	x	x	x

Key: ✓ Development is appropriate x Development should not be permitted

'More vulnerable' development is appropriate in Flood Zone 1 and the Exception Test is not required.

Properly prepared assessments of flood risk will inform the decision-making process at all stages of development planning. A Strategic Flood Risk Assessment is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change, and to assess the impact that changes or development in the area will have on flood risk. It may also identify, particularly at more local levels, how to manage those changes to ensure that flood risk is not increased. A site-specific Flood Risk Assessment is carried out by, or on behalf of, a developer to assess the risk to a development site and demonstrate how flood risk from all sources of flooding to the development itself and flood risk to others will be managed now, and taking climate change into account.

3.5 For site-specific Flood Risk Assessments, the main study requirement is to identify the flood zone and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions. A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users without increasing flood risk elsewhere and, where possible, will reduce flood risk overall.

3.6 For sites in Flood Zone 1, the Flood Risk Assessment is principally required to consider the management of surface water run-off together with flood risk from sources other than rivers and the sea. Surface water arising from a developed site should, as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

4 Ground Conditions

4.1 British Geological Survey (BGS) mapping shows that the regional geology comprises a bedrock of Peterborough Member – Mudstone. No superficial deposits are indicated to overlay the Mudstone.

4.2 A site investigation has been undertaken by Geotechnical Engineering Ltd to advise on ground conditions. Exploratory boreholes and trial holes were undertaken across the Graven Hill development area, with the results confirming the BGS data and revealing clay subsoil at depths of up to 8.0m below ground level (bgl). The borehole and trial pit records most relevant to the site are included at Appendix C.

4.3 BRE 365 infiltration testing was undertaken as part of the site investigation for the wider Graven Hill development, and none of the tests returned a positive result. Due to this, the site-wide surface water drainage strategy comprises positive drainage via piped networks and watercourses, with strategic detention basins which discharge at restricted rates into an existing watercourse network which serves the area.

4.4 The infiltration test results are included in Appendix C, with those most relevant to the site being TP543 & TP548.

5 Existing Drainage

5.1 The Graven Hill development is served by a foul sewer network maintained by Anglian Water, and a private surface water system. The surface water system is designed to collect run-off from the individual development plots within Graven Hill and convey it to detention basins; from where, it is discharged at restricted rates into the local watercourse network. A plan showing the foul and surface water drainage in the vicinity of the site is included in Appendix D with an extract shown below:

Extract from Development Infrastructure As-Built Records

5.2 The above plan shows that a foul sewer is located immediately adjacent to the western boundary of the site. The manhole allocated for connection is F2402b, which has a cover level of 67.390 and an invert level of 64.899.

5.3 Rainfall run-off from the site currently drains into existing an watercourse to the west of the site. This watercourse heads northwards before linking up with a wider network of land drainage which heads towards the south west to link up with the River Ray.

5.4 The 'Greenfield' run-off rates for the site are as follows:

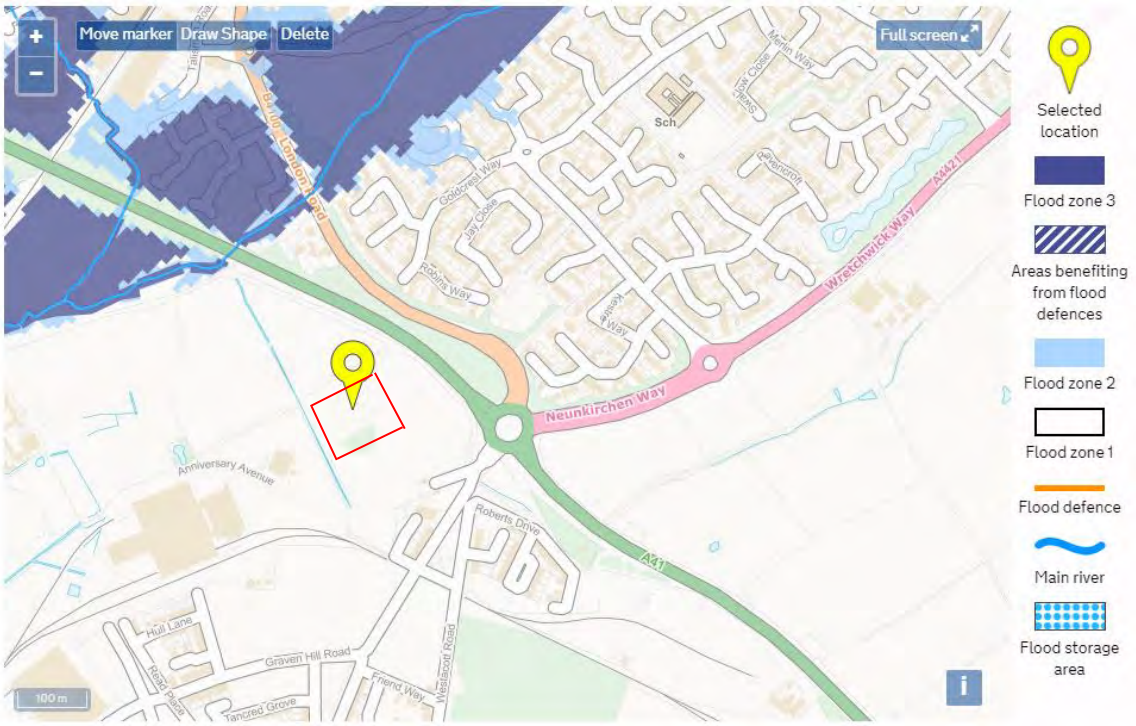
Return Period	Greenfield Run-off Rate 50ha	Site Greenfield Run-off Rate (1.05ha)
1 year	178 l/s	3.74 l/s
30 years	474.6 l/s	9.97 l/s
100 years	668.0 l/s	14.0 l/s
QBAR	209.4 l/s	4.4 l/s

The rates have been calculated using IH 124 methodology, whereby the rate is calculated for 50ha and factored down to the actual site area. A copy of the Microdrainage output from the calculation is included in Appendix E.

5.5 The Graven Hill development is served by an infrastructure drainage system, which comprises piped networks, open watercourses and a series of detention basins. One of the basins is located adjacent to the site, and an allowance for discharge from the site of 11 l/s has been made in the sitewide strategy. A copy of the Drainage Strategy drawing which includes the site prepared by Waterman is included in Appendix D.

6 Flood Risk Sources

6.1 Fluvial Flooding: The site is not at risk of flooding from rivers or tidal sources, as indicated on the flood zone mapping below:

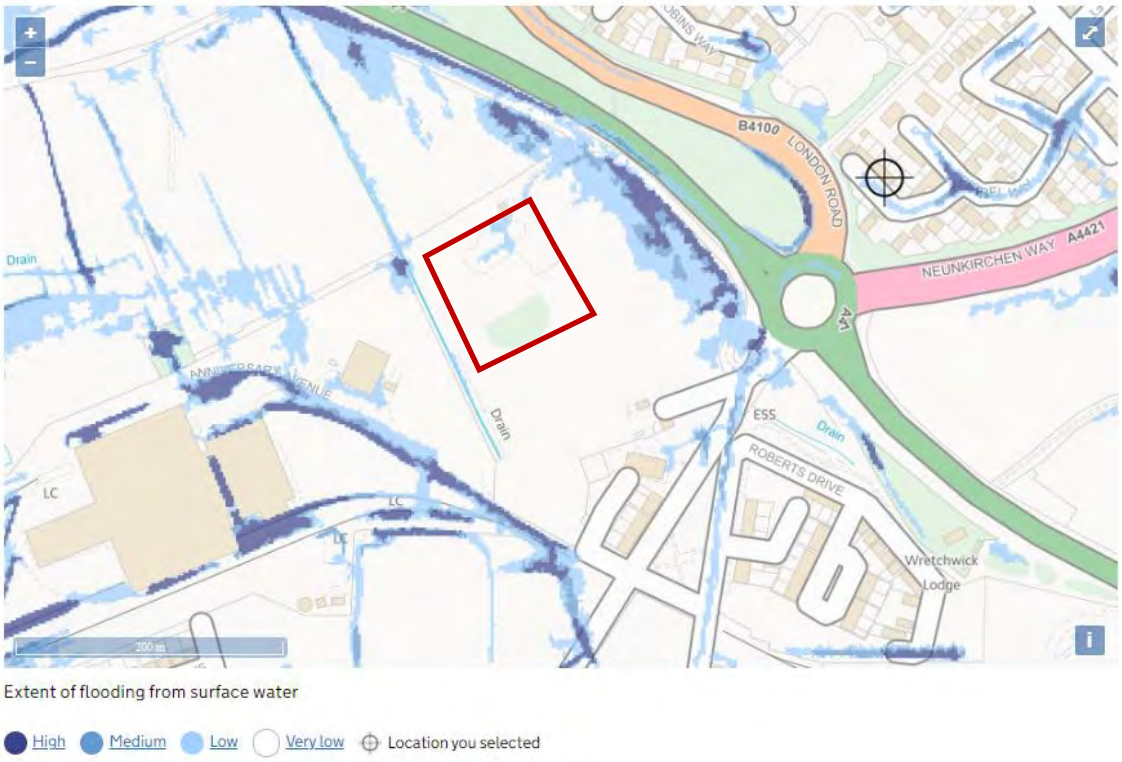


Flood Zone Map

The flood zone mapping shows that site is situated in Flood Zone 1. Flood Zone 1 is a low probability flood zone and comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (< 0.1%).

6.2 Groundwater flooding occurs when water levels in the ground rise above surface elevations. Groundwater was not encountered during site investigations and the underlying ground conditions of clay would indicate that the risk from groundwater flooding is 'low'.

6.3 Surface water flooding occurs when intense rainfall is unable to soak into the ground or enter drainage systems but lies on or flows over the ground instead. The Environment Agency publishes mapping showing the risk of flooding from surface water. An extract of this mapping is shown below and confirms that the site is generally at 'very low' risk of surface water flooding. 'Very low' risk means that each year this area has a chance of flooding of less than 0.1% (< 1 in 1000):



Extract from Surface Water Flood Map

A small area of 'low' risk flooding is indicated in the north of the site, this corresponds with the location of the existing area of hardstanding. This hardstanding will be removed prior to construction of the new development. The area of flooding is isolated and not linked to a wider issue, and is likely a result of the lack of gradient across the site.

6.4 From our review of Ordnance Survey mapping of the site and the surrounding area, our assessment is that there are no significant flood risks to the site from reservoirs, canals or other artificial sources. This is confirmed by reference to Environment Agency online mapping.

6.5 As far as we have been able to establish, there has been no history of flooding in the area of the site. All sources of flooding listed in the Government's online Planning Practice Guidance have been considered. The site is at 'low' risk of flooding from all sources.

7 Proposed Surface Water Drainage

7.1 The Building Regulations Approved Document H3 requires that rainwater from buildings and paved areas shall discharge to one of the following, listed in order of priority:

a) An adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable,

b) A watercourse; or where that is not reasonably practicable,

c) A sewer.

The Building Regulations therefore adopt a design philosophy that accords with sustainable drainage systems (SuDS).

7.2 The National Planning Policy also requires that, for planning applications relating to major development (development of 10 dwellings or more) or equivalent non-residential or mixed development, sustainable drainage systems for the management of run-off are put in place, unless demonstrated to be inappropriate. Sustainable drainage is an approach to managing surface water run-off which seeks to mimic natural drainage systems and retain water on or near the site, as opposed to traditional drainage approaches which involve piping water off-site as quickly as possible. SuDS involves a range of techniques including soakaways, infiltration trenches, permeable pavements, grassed swales, ponds and wetlands. SuDS offers significant advantages over conventional pipe drainage systems in reducing flood risk by attenuating the rate and quantity of surface water run-off from a site, promoting groundwater recharge and improving water quality and amenity.

Planning Practice Guidance considers what sort of sustainable drainage system should be considered. Generally, the aim should be to discharge surface run-off 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.

Particular types of sustainable drainage systems may not be practicable in all locations.

This hierarchy follows the same order of priority of Approved Document H3 of the Building Regulations.

7.3 Oxfordshire County Council is the Lead Local Flood Authority (LLFA) for this area and the Local Planning Authority (LPA) should consult with the LLFA on surface water drainage. CIRIA has published guidance on the use of sustainable drainage systems, which is an approach to managing surface water run-off which seeks to mimic natural drainage systems and retain water on or near the site, as opposed to traditional drainage approaches which involve piping water off-site as quickly as possible. SuDS involves a range of techniques including soakaways, infiltration trenches, permeable pavements, grassed swales, ponds and wetlands. SuDS offers significant advantages over conventional pipe drainage systems in reducing flood risk by attenuating the rate and quantity of surface water run-off from a site, promoting groundwater recharge and improving water quality and amenity.

7.4 Site investigation has been completed, and ground conditions generally comprising clay have been confirmed on the site. The findings represent the bedrock deposits recorded on BGS mapping, which also indicate no superficial deposits. Infiltration testing was undertaken in numerous locations across the Graven Hill development, with all tests returning an infiltration rate of zero – all tests failed. This confirms that a drainage solution incorporating infiltration drainage is not suitable for the site.

7.5 Surface water run-off for all external areas will therefore be collected by a drainage system prior to discharge to the adjacent watercourse at greenfield the QBAR run-off rate. The QBAR rate for the total site area of 1.04ha is 4.4 l/s, factoring this down to the total contributing area of 0.875ha generates a discharge allowance of 3.85 l/s.

7.6 Accordingly, surface water run-off from the development will be managed as follows:

- All new paved areas will comprise permeable paving systems for detention and water quality improvement purposes, with the areas connected via an underground piped network prior to discharge to the adjacent watercourse. Natural infiltration into the subsoil is not possible, therefore the permeable paving will be a Type C system with no infiltration. All permeable paving will be designed to store the 1% AEP event +40% allowance for climate change;
- Surface water run-off from roof areas will be discharge via an underground detention tank to existing watercourse to the west of the site. The tank designed to accommodate the volumes generated by all rainfall events up to and including the critical 1% AEP event +40% allowance for climate change;
- Finished floor levels will be set a minimum of 150mm above external ground levels to mitigate the risk of flooding from local sources;
- The drainage system as a whole will be designed with a restricted outflow rate to the watercourse of 3.85 l/s, with sufficient detention volume to accommodate the 1% AEP rainfall event with a 40% additional allowance for climate change, in accordance with policy.

7.7 The appropriate approach to pollution hazard assessment of the site is the Simple Index approach outlined in CIRIA Report C753. Reproduced below is Table 26.2 from the Report, which classifies sites according to their perceived Pollution Hazard.

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]

The usage of the external areas is ‘non-residential car parking with frequent change (eg hospitals, retail) which is classified as ‘Medium’ pollution hazard level. The associated Pollution Hazard Indices indices are 0.7, 0.6, 0.7.

7.8 The Pollution Mitigation indices for various SuDS features are given in Table 26.3 of CIRIA C753 as follows:

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.		

The appropriate level of treatment will be provided by the permeable paving system, as the mitigation indices are equal to the hazard indices.

7.9 A copy of surface water calculations is included in Appendix E, and a drainage strategy drawing is included in Appendix F.

7.10 Permeable paving and the detention tank will be maintained by the site operator. A preliminary copy of the SuDS Management and Maintenance Plan is included in Appendix G.

8 Conclusions and Recommendations

8.1 The proposal for the site is for the erection of a new Health and Wellbeing Hub with associated access road and car parking areas.

8.2 From examination of site levels and by reference to Environment Agency flood zone mapping, it is demonstrated that the site is situated in Flood Zone 1. This is a low probability flood zone with a less than 1 in 1000 annual probability of flooding.

8.3 The ground conditions are not suitable for infiltration; therefore, surface water management is proposed using a detention tank for roof drainage and Type C permeable paving for the new access route and parking areas, with the system attenuated to a controlled discharge rate to an adjacent existing watercourse.

8.4 The use of permeable paving will provide the appropriate level of treatment to the run-off from the parking areas, prior to discharge to the receiving watercourse.

8.5 Sustainable drainage features will be maintained by the site operator in accordance with the SuDS Management and Maintenance Plan.

9 Appendices

Appendix A – Proposed Site Layout

Proposed application
site area = 2.61 acres
(10,552 m2)

boundary line - 1m wide soft landscape strip to back of parking spaces

RPA

EP

o/h elec pole & stay

Haul road access to site from North East

boundary line - 1m wide soft landscape strip to back of parking spaces

one way

staff only OUT

one way

80 staff parking spaces

IN staff only

amulance bay

143 visitor parking spaces

one way

urgent care access fire exit

landscaped therapy gardens

bus stop drop off pick up

one way

EX MID FOUL MH

existing sewer - 6m easement, 3m each side of sewer centre line

fire exit

main public entrance

pharmacy entrance

fire exit

staff cycle store

staff entrance fire exit

landscaped courtyard garden

visitor cycle store

Proposed 3 storey building
GFA = 3350 sq m

proposed bus turning head

service access

service bay

waste access

fire exit

service access

bin store

New elec sub sta 6m x 6m

T14

extg trees T13 & T14 retained

T13

Notes:
- This drawing is copyright.
- Do not scale dimensions from this drawing.
- All discrepancies on this drawing are to be reported to the architect.
- Do not modify any element of this drawing.
- Use drawing only for purpose(s) issued.

North Sign / Key Plan

N

The following external model files are included within this drawing:

SIGN-OFF

DATE	PRINT NAME	SIGNATURE

Rev	Date	Revision Notes	Dn	Rv
15	09/02/21	Planning application site red line boundary updated to exclude proposed new access road link to include spine road junction Application site area = 2.61 acres		
14	09/01/21	Planning application site red line boundary updated to include existing hedge retained to Northern boundary and proposed new access road link to include spine road junction		
13	08/01/21	Site plan updated, new access road updated car parking numbers updated		
12	07/12/20	Red line site boundary updated, area = 1 ha car parking provision totals 223 spaces sewer easement 6m, 3m each side		
11	04/12/20	Red line site boundary updated to avoid extg hedge to Northern boundary two existing trees to be retained proposed new elec sub station relocated proposed access & car parking updated		
10	16/09/20	Waterman's Arboricultural Constraints Plan added as overlay upon proposed site plan		
9	08/09/20	Site plan updated, new access road indicated, potential new elec sub station indicated		
8	29/04/20	Site plan updated		
7	02/04/20	Site plan updated		
6	04/03/20	Site plan updated		
5	10/01/20	Site plan updated		
4	11/12/19	Site plan updated including Concept 4 plan		
3	26/11/19	Site plan updated including turning head		
2	20/11/19	Site plan updated		
1	29/10/19	Site plan updated, future expansion indicated		

Client / Contractor

Apollo

IBI Intelligence Buildings Infrastructure www.ibigroup.com

Project
Bicester Health & Wellbeing Hub

Drawing Title
Proposed Site Plan

Job Number	Date	Scale@A1
122447	23/10/2019	1:250

Status	Purpose
-	PLANNING APPLICATION

Drawing Number	Revision
IBI-XX-XX-PL-A-200-005	15

Appendix B – Topographical Survey Drawing

Proposed application
site area = 2.61 acres
(10,552 m2)

221300N

221200N

221100N

A41

B4100 LONDON ROAD

PRIVATE ROAD

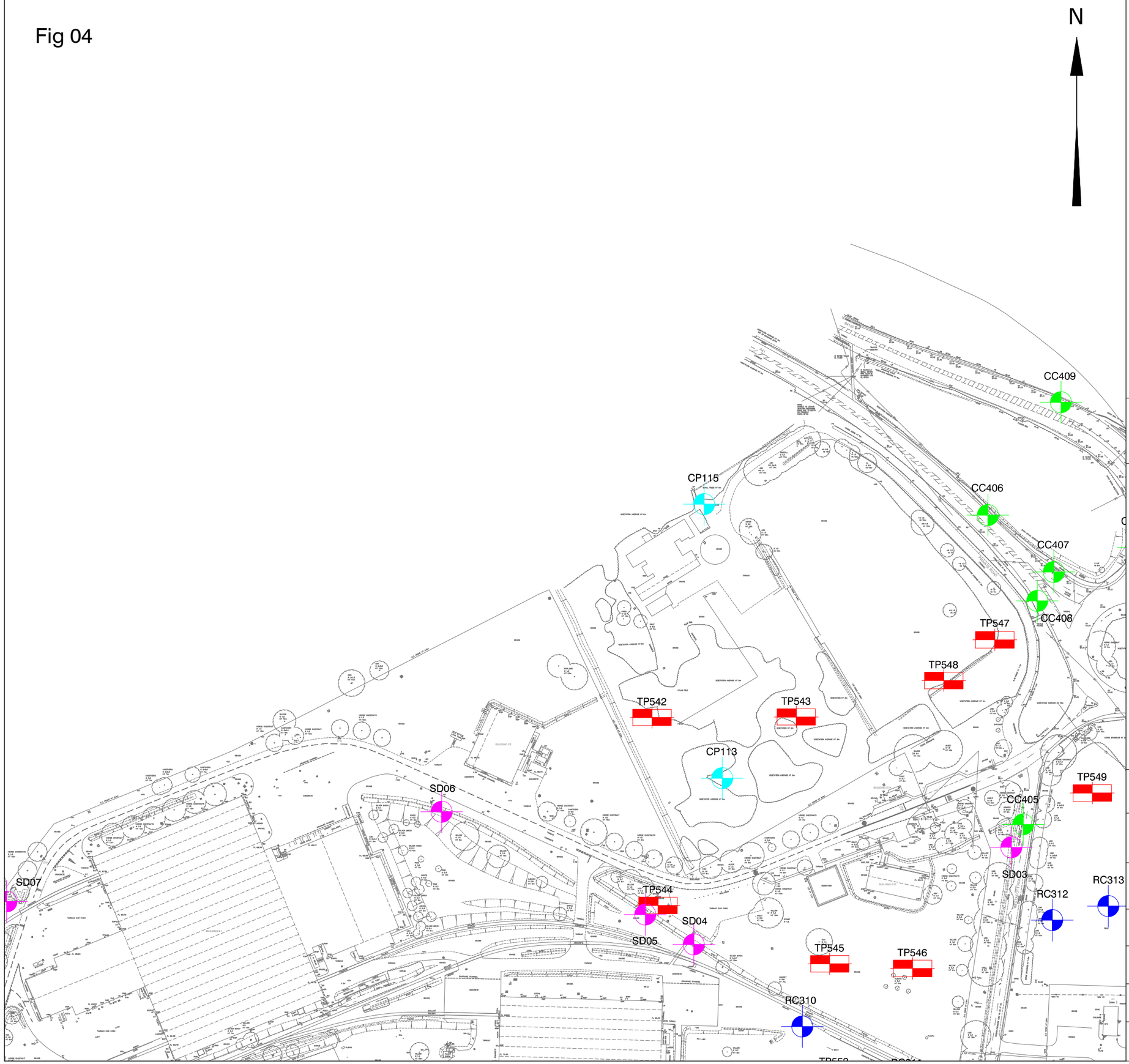
A41 AYLESBURY ROAD

A4421 NEUNKIRCHEN WAY

A4201 SEISDON WAY

Appendix C – Site Investigation Report Extracts

Fig 04



Key.

- Rotary Core Location
- Cable Percussive Location
- Concrete Core/Dynamic Sample Location
- Surface Drain Sample Location
- Plate Load Location
- Trial Pit Location
- Trial Pit (Hand Dug) Location

Notes:

Drawing supplied by client.

geotechnical

Geotechnical Engineering Ltd

Centurion House, Olympus Park, Quedgeley, Gloucester GL2 4NF
Telephone: (01452) 527743 Facsimile: (01452) 729314
E-mail: geotech@geoeng.co.uk Web: www.geoeng.co.uk

Client:	Graven Hill Village Development Company		
Consultant:	Waterman Infrastructure & Environment		
Site:	Graven Hill		
Title:	Exploratory Hole Location Plan		
Drawn By: MPE	Checked By: DO	Paper Size: A3	
Scale: 1:2000	Date: May 2015		
Contract: 30378	Figure: 04		

Geotechnical Engineering Limited

BOREHOLE LOG

CP113

CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY

SITE GRAVEN HILL NEW URBAN COMMUNITY, BICESTER — Sheet 1 of 2

Start Date 25 March 2015 — Easting 458905.2 — Scale 1 : 50

End Date 25 March 2015 — Northing 221152.0 — Ground level 68.45mOD — Depth 8.20 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range	instru -ment	description	depth (m)	reduced level (m)	legend
25/03/15 0800hrs	D*	0.25						Grass over firm brown mottled orangish brown slightly sandy silty CLAY with frequent rootlets (up to 1mm diam). (MADE GROUND)	0.25	68.20	
	1B	0.25									
	2D*	0.50						Firm brown sandy silty CLAY with frequent rootlets (up to 1mm diam).			
	3B	0.50									
	4D*	1.00							1.00	67.45	
	5B	1.00						Firm fissured orangish brown and bluish grey slightly sandy silty CLAY with frequent black fine and medium gravel sized organic fragments.			
	6D	1.20	1.25								
	7UT	1.70	2.10	1.70							
	8D	2.10	2.20						2.20	66.25	
	9D	2.20	2.65	1.70	S 10			Firm fissured brownish grey slightly sandy silty CLAY with orangish brown and yellowish brown silt on fissure surfaces and rare fine and medium gravel sized gypsum crystals.			
	10UT	2.70	3.10	1.70							
	11D	3.10	3.20						3.20	65.25	
	12D	3.20	3.65	1.70	S 12			Firm brownish grey silty CLAY with rare fine and medium gravel sized pockets of orangish brown silt and frequent coarse gravel sized gypsum crystals.			
	13UT	3.70	4.10	1.70							
	14D	4.10	4.20						4.20	64.25	
	15D	4.20	4.65	1.70	S 18			Firm becoming stiff brownish grey silty CLAY with rare fine and medium gravel sized shell fragments.			
	16UT	4.70	5.10	1.70							
	17D	5.10	5.20								
	18D	5.20	5.65	1.70	S 24						
	19D	6.20	6.25								
	20UT	6.20	6.60	1.70							
	21D	6.60	6.70								
	22D	6.70	7.15	1.70	S 39			6.70m: Very stiff with frequent fine to coarse gravel sized shell fragments.			
	23D	7.70	7.75								
25/03/15 1100hrs	24UT	7.70	8.10	1.70							
								Continued Next Page	{8.00}		

EQUIPMENT: Light cable percussive (shell and auger) rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Cable percussion (150mm) 1.20-8.20m.

CASING: 150mm diam to 1.70m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 8.00m, granular response zone 8.20-0.40m, bentonite seal 0.40-0.10m, concrete and traffic rated cover 0.10-0.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
				Groundwater not encountered.

AGS

CONTRACT	CHECKED
30378	EC

Geotechnical Engineering Limited

BOREHOLE LOG

CP113

CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY

SITE GRAVEN HILL NEW URBAN COMMUNITY, BICESTER — Sheet 2 of 2

Start Date 25 March 2015 — Easting 458905.2 — Scale 1 : 50

End Date 25 March 2015 — Northing 221152.0 — Ground level 68.45mOD — Depth 8.20 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
Dry	25D	8.10	8.20						8.10 - 8.20m: Indistinctly laminated.	8.20	60.25	
									Borehole completed at 8.20m.			
										{18.00}		

water strike (m) casing (m) rose to (m) time to rise (m) remarks

Groundwater not encountered.

AGS

CONTRACT 30378

CHECKED EC

Geotechnical Engineering Limited

TRIAL PIT LOG

TP542

CLIENT	GRAVEN HILL VILLAGE DEVELOPMENT COMPANY						
SITE	GRAVEN HILL NEW URBAN COMMUNITY, BICESTER					Sheet	1 of 1
Start Date	2 March 2015	Easting	458867.6			Scale	1 : 25
End Date	2 March 2015	Northing	221184.6	Ground level	68.00mOD	Depth	3.00 m

water record	sample/test no/type	sample/test result	sample/test depth (m)	description	depth (m)	level (m)	legend
	1D*		0.30	Very soft dark brown slightly sandy gravelly CLAY with frequent roots and rootlets (up to 8mm diam). Gravel is subrounded and subangular fine and medium quartz with a low brick cobble content. (MADE GROUND)	0.20	67.80	
	2D		0.30	Soft and firm brown and orangish brown mottled slightly sandy slightly gravelly CLAY with frequent rootlets (up to 2mm diam). Gravel is subrounded fine to coarse limestone.	0.80	67.20	
	3D*		1.00	Firm mottled light brown, orangish brown and greyish brown silty CLAY with rare rootlets (up to 2mm diam) and rare cobble sized pockets of fine and medium gravel sized angular shell fragments.			
	4B	H 87	1.00				
	5B		1.50- 1.70	1.50 - 1.70m: Lens of soft light grey very sandy CLAY.			
		H 100	2.40				
	6B		2.60	Stiff fissured dark brown silty CLAY with partially decomposed roots (up to 3mm diam). Fissures are subhorizontal very closely spaced infilled with orangish brown fine sand. 2.60 - 2.80m: Fine and medium gravel sized angular gypsum crystals.	2.60	65.40	
Dry				Trial pit completed at 3.00m.	3.00	65.00	

Notes

Trial pit excavated by JCB 3CX mechanical excavator.
Groundwater not encountered.
Trial pit sides remained stable and vertical.
Trial pit dimensions 1.80x0.65x3.00m.
On completion, the trial pit was backfilled with materials arising.

Sketch of Foundation - Not to scale. All dimensions in metres.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

AGS

CONTRACT	CHECKED
30378	EC

Geotechnical Engineering Limited

TRIAL PIT LOG

TP543

CLIENT	GRAVEN HILL VILLAGE DEVELOPMENT COMPANY						
SITE	GRAVEN HILL NEW URBAN COMMUNITY, BICESTER					Sheet	1 of 1
Start Date	2 March 2015	Easting	458944.8			Scale	1 : 25
End Date	2 March 2015	Northing	221184.9	Ground level	68.20mOD	Depth	3.00 m

water record	sample/test no/type	sample/test result	sample/test depth (m)	description	depth (m)	level (m)	legend
				Very soft dark brown slightly sandy silty CLAY with frequent roots and rootlets (up to 3mm diam).	0.15	68.05	
	1D*		0.30	Firm reddish brown mottled orangish brown silty CLAY with frequent fine rootlets (up to 2mm diam).			
	2D	H 54	0.30				
					0.80	67.40	
	3D*		1.00	Firm light brown and orangish brown locally mottled light grey slightly gravelly sandy CLAY with rare rootlets (up to 2mm diam). Gravel is subrounded medium flint.			
	4B	H 58	1.00				
	5D		1.00				
				1.60m: Light grey locally orangish brown very sandy lenses.			
					2.40	65.80	
		H 74	2.40	Stiff fissured dark brown locally light brown CLAY with frequent fine and medium gravel sized angular gypsum crystals and rare coarse gravel pockets of orangish brown silty clay.			
	6B		2.40- 2.60				
				2.90 - 3.00m: Dark bluish grey.	3.00	65.20	
Dry				Trial pit completed at 3.00m.			

Notes

Trial pit excavated by JCB 3CX mechanical excavator.
Groundwater not encountered.
Trial pit sides remained stable and vertical.
Trial pit dimensions 1.70x0.60x3.00m.
On completion, the trial pit was backfilled with materials arising.

Sketch of Foundation - Not to scale. All dimensions in metres.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

CONTRACT	CHECKED
30378	EC

Geotechnical Engineering Limited

SOAKAWAY TEST

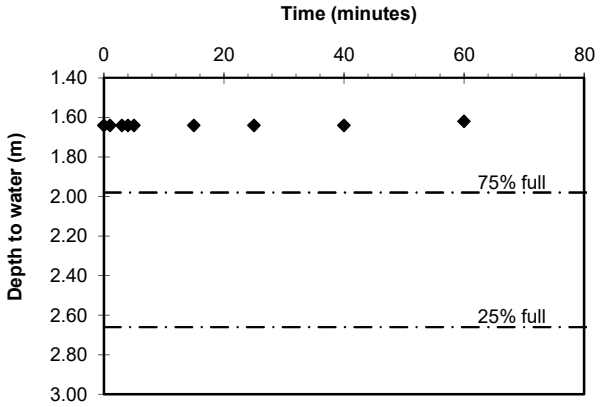
CLIENT	GRAVEN HILL VILLAGE DEVELOPMENT COMPANY		
SITE	GRAVEN HILL, BICESTER	TRIAL PIT	**TP501**
DATE	05/03/2015		

TEST 1

LENGTH	1.80	m
BREADTH	0.60	m
DEPTH	3.00	m
WATER LEVEL	Damp	
FILL LEVEL	1.64	m
v_{p75-25}	0.734	m^3
a_{p50}	4.344	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

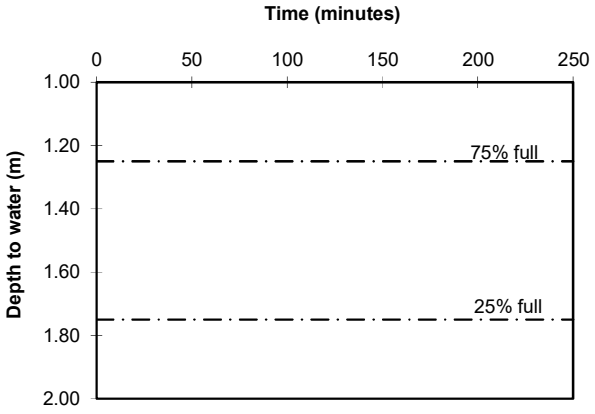
Insufficient fall in water level to calculate infiltration rate



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

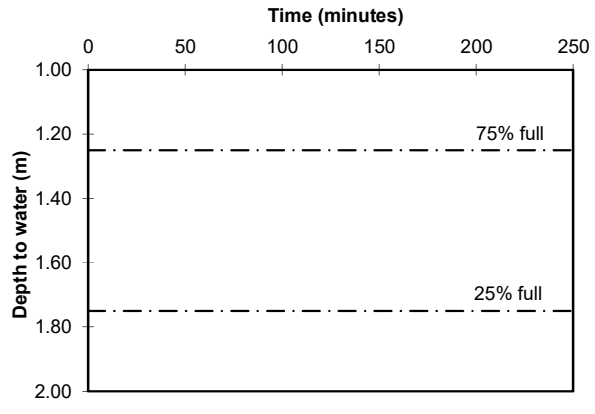
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



Remarks	Test carried out in general accordance with BRE 365 (2007).	CONTRACT	CHECKED
	Seepage of groundwater encountered at 0.80m during excavation.	**30378**	**EC**

RD / DO

08/06/09 JH

Geotechnical Engineering Limited

SOAKAWAY TEST

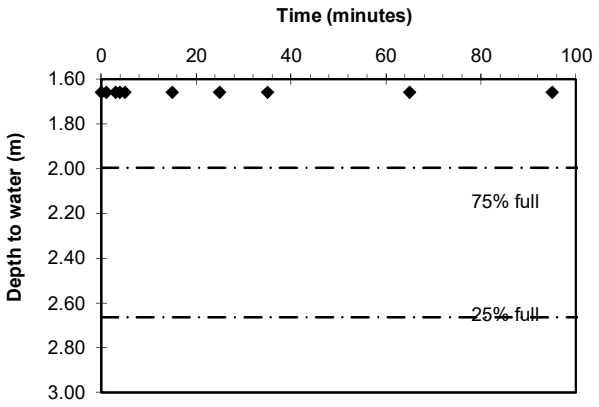
CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY
SITE GRAVEN HILL, BICESTER TRIAL PIT **TP502**
DATE 04/03/2015

TEST 1

LENGTH	1.90	m
BREADTH	0.70	m
DEPTH	3.00	m
WATER LEVEL	Dry	
FILL LEVEL	1.66	m
v_{p75-25}	0.891	m^3
a_{p50}	4.814	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

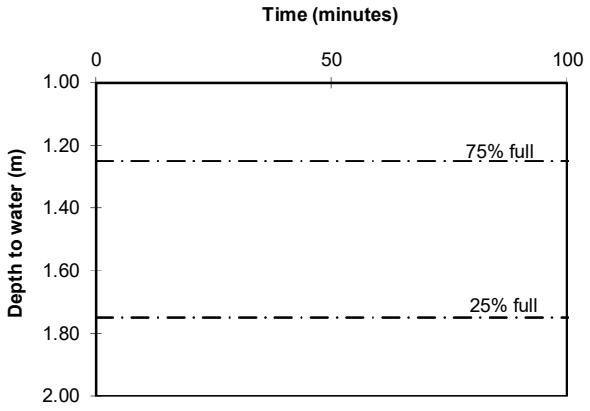
Insufficient fall in water level to calculate infiltration rate



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

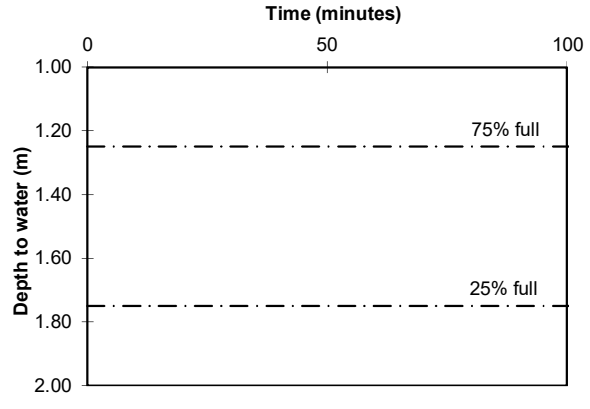
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



Remarks Test carried out in general accordance with BRE 365 (2007).

CONTRACT	CHECKED
30378	**EC**

RD / DO

08/06/09 JH

Geotechnical Engineering Limited

SOAKAWAY TEST

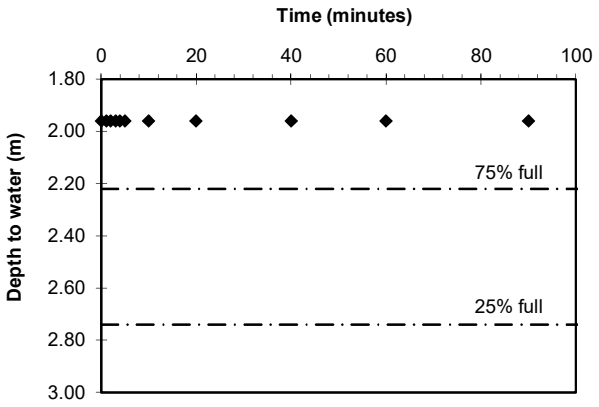
CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY
SITE GRAVEN HILL, BICESTER TRIAL PIT **TP543**
DATE 02/03/2015

TEST 1

LENGTH	1.70	m
BREADTH	0.60	m
DEPTH	3.00	m
WATER LEVEL	Dry	
FILL LEVEL	1.96	m
v_{p75-25}	0.530	m^3
a_{p50}	3.412	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

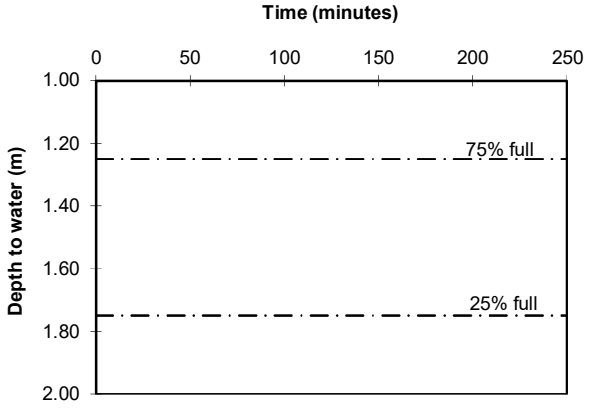
Insufficient fall in water level to calculate infiltration rate



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

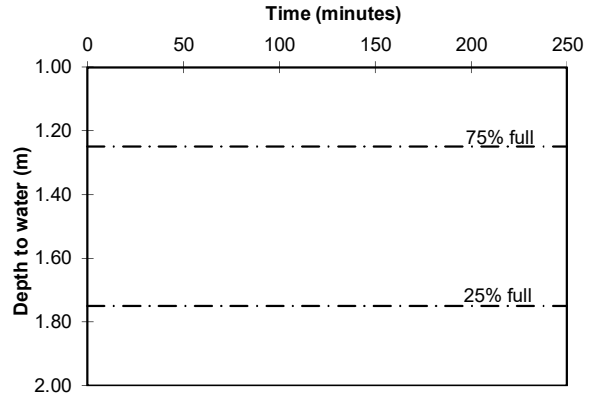
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



Remarks Test carried out in general accordance with BRE 365 (2007).

CONTRACT	CHECKED
30378	**EC**

RD / DO

)8/06/09 JH

Geotechnical Engineering Limited

SOAKAWAY TEST

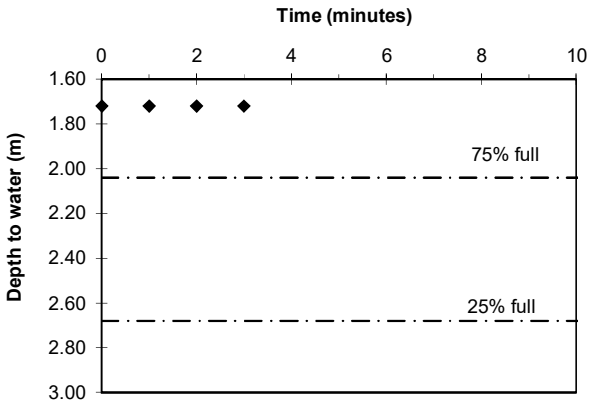
CLIENT	GRAVEN HILL VILLAGE DEVELOPMENT COMPANY		
SITE	GRAVEN HILL, BICESTER	TRIAL PIT	**TP548**
DATE	03/03/2015		

TEST 1

LENGTH	1.90	m
BREADTH	0.65	m
DEPTH	3.00	m
WATER LEVEL	Dry	
FILL LEVEL	1.72	m
v_{p75-25}	0.790	m^3
a_{p50}	4.499	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

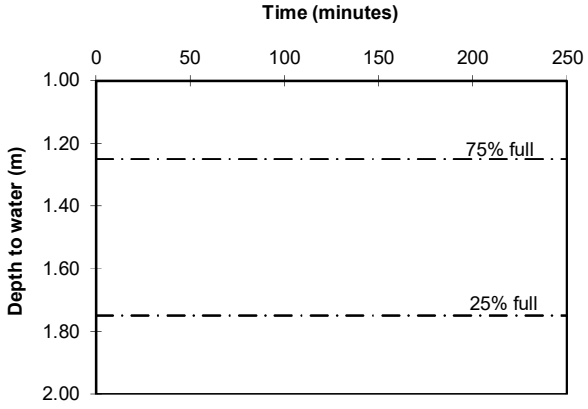
Test abandoned due to sidewall collapse



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

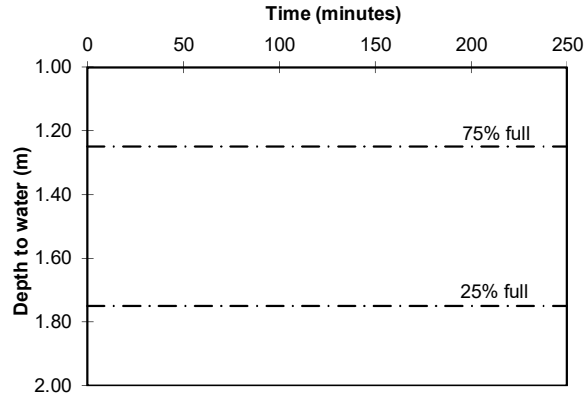
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



Remarks	Test carried out in general accordance with BRE 365 (2007).	CONTRACT	CHECKED
		30378	**EC**

RD / DO

08/06/09 JH

Geotechnical Engineering Limited

SOAKAWAY TEST

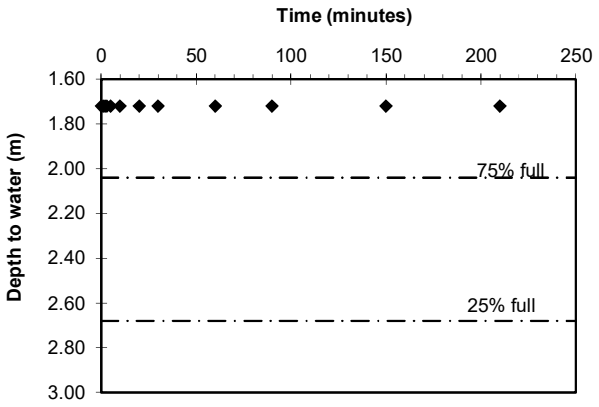
CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY
SITE GRAVEN HILL, BICESTER TRIAL PIT **TP548A**
DATE 04/03/2015

TEST 1

LENGTH	1.80	m
BREADTH	0.60	m
DEPTH	3.00	m
WATER LEVEL	Dry	
FILL LEVEL	1.72	m
v_{p75-25}	0.691	m^3
a_{p50}	4.152	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

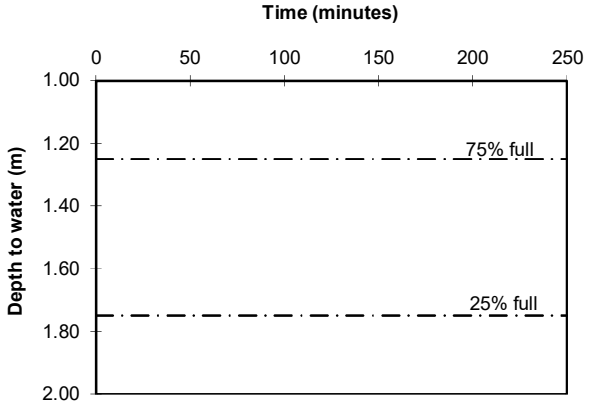
Insufficient fall in water level to calculate infiltration rate



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

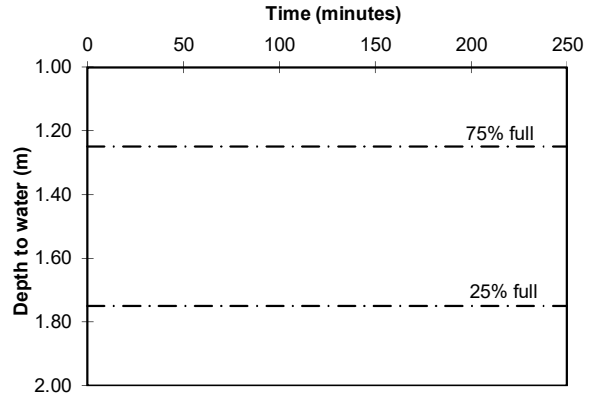
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



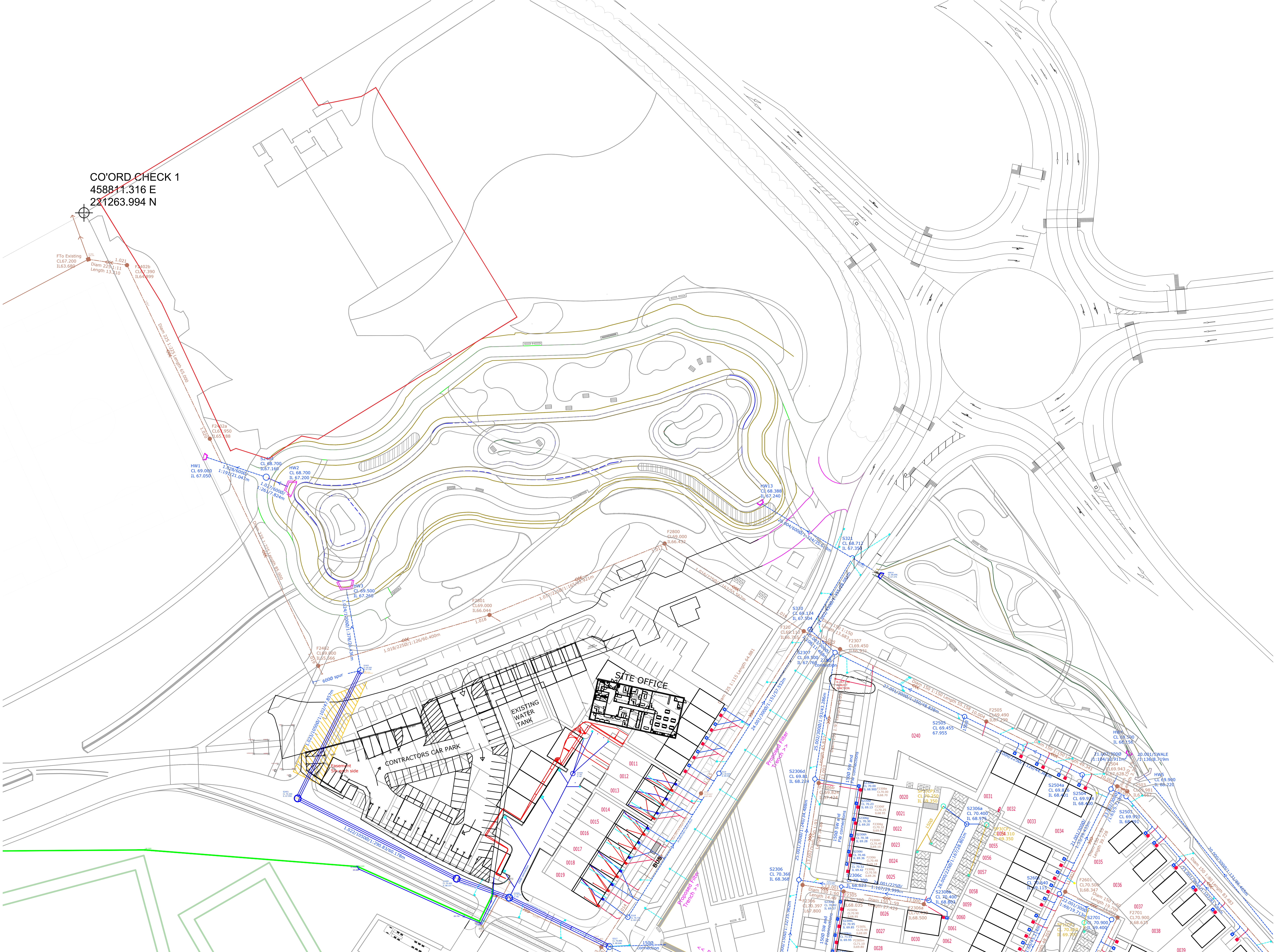
Remarks Test carried out in general accordance with BRE 365 (2007).

CONTRACT	CHECKED
30378	**EC**

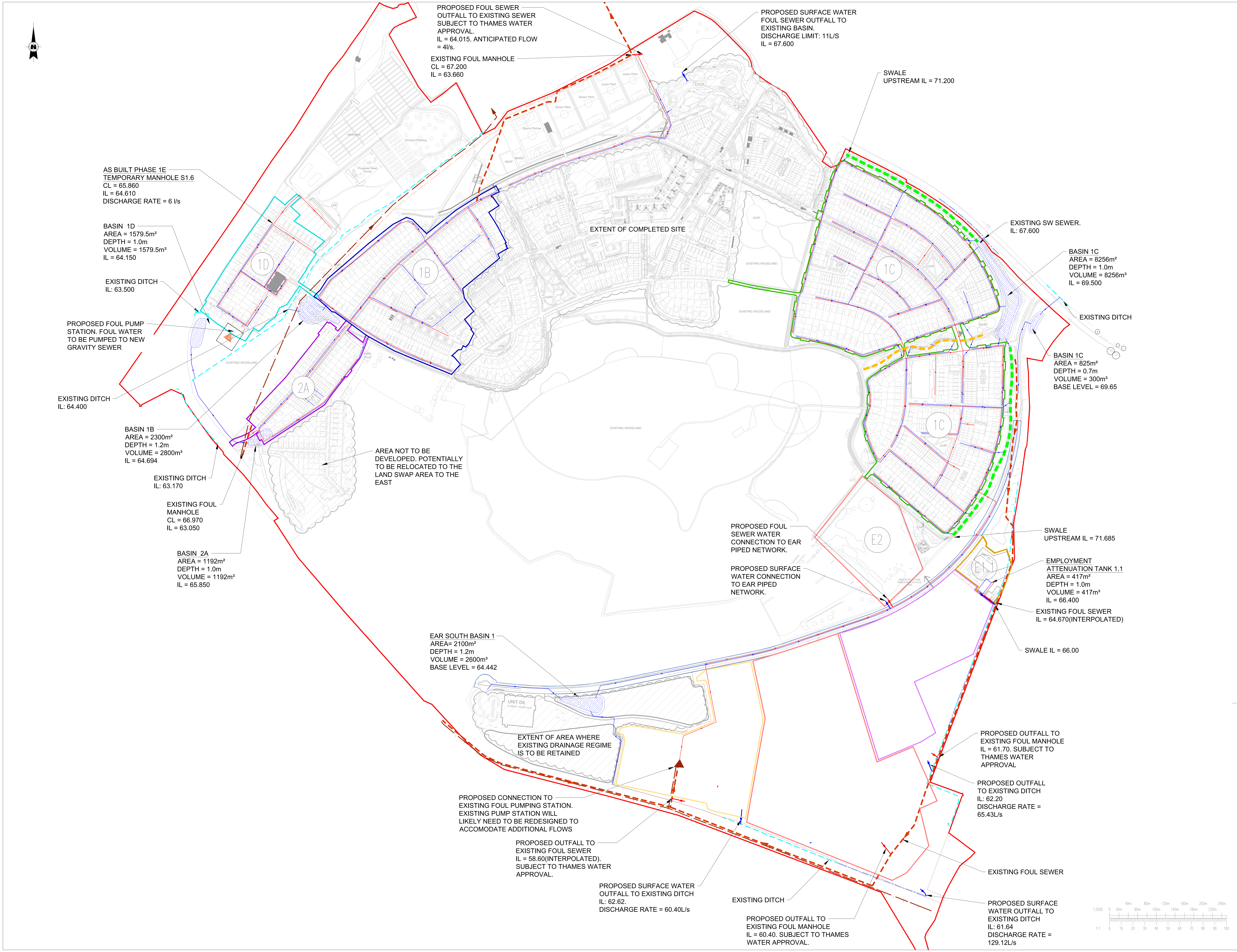
RD / DO

08/06/09 JH

Appendix D – Existing Drainage Plans



CO'ORD CHECK 1
458811.316 E
221263.994 N
SITE OFFICE
EXISTING WATER TANK
CONTRACTORS CAR PARK
HW1
CL 69.000
IL 67.050
HW2
CL 68.700
IL 67.200
HW3
CL 69.500
IL 67.260
HW13
CL 68.388
IL 67.240
S321
CL 68.712
IL 67.354
S2306
CL 70.366
IL 68.368
F2307
CL69.450
F2800
CL69.000
IL66.432
F2801
CL69.000
IL66.044
Proposed Filter Trench
BUS


PROPOSED FOUL SEWER OUTFALL TO EXISTING SEWER SUBJECT TO THAMES WATER APPROVAL. IL = 64.015. ANTICIPATED FLOW = 4l/s.
EXISTING FOUL MANHOLE CL = 67.200 IL = 63.660
PROPOSED SURFACE WATER FOUL SEWER OUTFALL TO EXISTING BASIN. DISCHARGE LIMIT: 11L/S IL = 67.600
SWALE UPSTREAM IL = 71.200
AS BUILT PHASE 1E TEMPORARY MANHOLE S1.6 CL = 65.860 IL = 64.610 DISCHARGE RATE = 6 l/s
BASIN 1D AREA = 1579.5m² DEPTH = 1.0m VOLUME = 1579.5m³ IL = 64.150
EXISTING DITCH IL: 63.500
PROPOSED FOUL PUMP STATION. FOUL WATER TO BE PUMPED TO NEW GRAVITY SEWER
EXISTING DITCH IL: 64.400
BASIN 1B AREA = 2300m² DEPTH = 1.2m VOLUME = 2800m³ IL = 64.694
EXISTING DITCH IL: 63.170
EXISTING FOUL MANHOLE CL = 66.970 IL = 63.050
BASIN 2A AREA = 1192m² DEPTH = 1.0m VOLUME = 1192m³ IL = 65.850
AREA NOT TO BE DEVELOPED. POTENTIALLY TO BE RELOCATED TO THE LAND SWAP AREA TO THE EAST
EXTENT OF COMPLETED SITE
EXISTING WOODLAND
1D
1B
2A
1C
E2
E1.1
EXISTING SW SEWER. IL: 67.600
BASIN 1C AREA = 8256m² DEPTH = 1.0m VOLUME = 8256m³ IL = 69.500
EXISTING DITCH
BASIN 1C AREA = 825m² DEPTH = 0.7m VOLUME = 300m³ BASE LEVEL = 69.65
PROPOSED FOUL SEWER WATER CONNECTION TO EAR PIPED NETWORK.
PROPOSED SURFACE WATER CONNECTION TO EAR PIPED NETWORK.
SWALE UPSTREAM IL = 71.685
EMPLOYMENT ATTENUATION TANK 1.1 AREA = 417m² DEPTH = 1.0m VOLUME = 417m³ IL = 66.400
EXISTING FOUL SEWER IL = 64.670(INTERPOLATED)
SWALE IL = 66.00
EAR SOUTH BASIN 1 AREA= 2100m² DEPTH = 1.2m VOLUME = 2600m³ BASE LEVEL = 64.442
UNIT D8
EXTENT OF AREA WHERE EXISTING DRAINAGE REGIME IS TO BE RETAINED
PROPOSED CONNECTION TO EXISTING FOUL PUMPING STATION. EXISTING PUMP STATION WILL LIKELY NEED TO BE REDESIGNED TO ACCOMODATE ADDITIONAL FLOWS
PROPOSED OUTFALL TO EXISTING FOUL SEWER IL = 58.60(INTERPOLATED). SUBJECT TO THAMES WATER APPROVAL.
PROPOSED SURFACE WATER OUTFALL TO EXISTING DITCH IL: 62.62. DISCHARGE RATE = 60.40L/s
EXISTING DITCH
PROPOSED OUTFALL TO EXISTING FOUL MANHOLE IL = 60.40. SUBJECT TO THAMES WATER APPROVAL.
PROPOSED OUTFALL TO EXISTING FOUL MANHOLE IL = 61.70. SUBJECT TO THAMES WATER APPROVAL
PROPOSED OUTFALL TO EXISTING DITCH IL: 62.20 DISCHARGE RATE = 65.43L/s
EXISTING FOUL SEWER
PROPOSED SURFACE WATER OUTFALL TO EXISTING DITCH IL: 61.64 DISCHARGE RATE = 129.12L/s
240m
220m
90
100

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
3. THE CONTRACTOR MUST ENSURE AND WILL BE HELD RESPONSIBLE FOR THE OVERALL STABILITY OF THE BUILDING/STRUCTURE/EXCAVATION AT ALL STAGES OF THE WORK.
4. ALL WORK BY THE CONTRACTOR MUST BE CARRIED OUT IN SUCH A WAY THAT ALL REQUIREMENTS UNDER THE HEALTH AND SAFETY AT WORK ACT ARE SATISFIED.
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.
6. OS DATA, TOPOGRAPHICAL SURVEY AND LIDAR DATA PROVIDED BY GLENN HOWELLS ARCHITECTS ON 3RD OCTOBER 2013
7. ADDITIONAL DRAINAGE SURVEY INFORMATION PROVIDED BY MK SURVEYS ON 18TH DECEMBER 2014
8. LAND TRANSFER AREA 1&2 BOUNDARY BASED ON GLENN HOWELLS ARCHITECTS DRAWING NO: 1982-A-L-573 REV V
9. UPGRADES REQUIRED TO THE ONSITE & OFFSITE PUBLIC SEWERS, RISING MAINS AND SEWAGE TREATMENT WORKS TO BE CONFIRMED BY THAMES WATER.
10. NORTHERN AREA MASTERPLAN PROVIDED BY GLENN HOWELLS, DRAWING NO: 1982-A-L-011-AA
11. EMPLOYMENT AREA MASTERPLAN PROVIDED BY INC DESIGN, DRAWING NO: INC-SA[20]0020 REV. P08

KEY:

LAND TRANSFER AREA 2 BOUNDARY
CATCHMENT 1B
CATCHMENT 1C
CATCHMENT 1D
CATCHMENT 2A
CATCHMENT E1
CATCHMENT E1.1
CATCHMENT E2
CATCHMENT E3
CATCHMENT EAR1
ATTENUATION BASIN
EXISTING DITCH
EXISTING SURFACE WATER SEWER
PROPOSED DITCH
PROPOSED SURFACE WATER DRAIN
PROPOSED SWALES
PROPOSED STEEP SWALES
EXISTING PUBLIC FOUL SEWER
EXISTING PUBLIC RISING MAIN
EXISTING FW PUMPING STATION
PROPOSED FOUL DRAIN
EXISTING SEWER TO BE ABANDONED
PROPOSED FW RISING MAIN
PROPOSED FW PUMPING STATION
AREA OF POTENTIAL LAND RAISING REQUIRED

Rev	Date	Description	By
A05	18.08.20	BASIN 1D&2A OUTFALL AMENDED	KP
A04	11.06.20	CATCHMENT E1.1 ADDED	KP
A03	26.05.20	STRATEGY REVIEW	CT
A02	05.03.20	MINOR AMENDMENTS TO PIONEERS SITE SURFACE WATER	KP
A01	20.02.20	PRELIMINARY ISSUE	KP

Amendments

Project
GRAVEN HILL, BICESTER

Title
OVERALL SITE DRAINAGE STRATEGY

Client
Graven Hill Village Development Company Limited

5th Floor, One Cornwall Street, Birmingham, B3 2DX
T: 0121 212 7700
mail@watermangroup.com www.watermangroup.com

Drawing Status
PRELIMINARY

Designed by KP	Checked by DB	Project No WIE11386
Drawn by KP	Date FEBRUARY 2020	
Scales @ A0 work to figured dimensions only	1:2500	Computer File No WIE11386-148-92-501-A05_1.dwg

Publisher	Zone	Category	Number	Revision
WIE	148	92	501	A05

File Path \\s-bm\WIEL\Projects\WIE11386_GH0_LTA 2\#WO148_DRAINAGE_OUTLINE_LTA2_Got PO7_CAD\92_ Drainage\

VDC, A1-Wat-S-GHVDC, R15 1106 MK Survey - Employment Area Ex Drainage, SITE WIDE OUTLINE DRAINGE STRATEGY

Appendix E – Surface Water Drainage Calculations

IH 124 Mean Annual Flood

Input

Return Period (years)	1	Soil	0.450
Area (ha)	50.000	Urban	0.000
SAAR (mm)	672	Region Number	Region 6

Results	**l/s**
QBAR Rural	209.4
QBAR Urban	209.4
Q1 year	178.0
Q1 year	178.0
Q2 years	184.5
Q5 years	268.0
Q10 years	339.2
Q20 years	419.5
Q25 years	449.8
Q30 years	474.6
Q50 years	548.7
Q100 years	668.0
Q200 years	785.3
Q250 years	823.0
Q1000 years	1080.6

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	20	Maximum Backdrop Height (m)	3.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

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	19.190	0.095	202.0	0.131	4.00	0.0	0.600	o	100	Pipe/Conduit	
2.000	5.330	0.067	80.0	0.118	4.00	0.0	0.600	o	100	Pipe/Conduit	
1.001	33.280	0.220	151.3	0.043	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	37.500	0.250	150.0	0.043	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	8.500	0.050	170.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.000	10.850	0.330	32.9	0.101	4.00	0.0	0.600	o	100	Pipe/Conduit	
4.000	8.820	0.330	26.7	0.108	4.00	0.0	0.600	o	100	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	20.00	4.60	68.040	0.131	0.0	0.0	0.0	0.54	4.2«	7.1
2.000	20.00	4.10	67.887	0.118	0.0	0.0	0.0	0.86	6.8	6.4
1.001	20.00	5.12	67.820	0.292	0.0	0.0	0.0	1.06	42.2	15.8
1.002	20.00	5.70	67.600	0.335	0.0	0.0	0.0	1.07	42.4	18.1
1.003	20.00	5.85	67.350	0.335	0.0	0.0	0.0	1.00	39.8	18.1
3.000	20.00	4.13	68.040	0.101	0.0	0.0	0.0	1.35	10.6	5.5
4.000	20.00	4.10	68.040	0.108	0.0	0.0	0.0	1.50	11.8	5.8

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
3.001	42.900	0.285	150.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
5.000	8.970	0.112	80.1	0.176	4.00	0.0	0.600	o	100	Pipe/Conduit	
1.004	12.650	0.070	180.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
6.000	44.900	0.300	149.7	0.042	4.00	0.0	0.600	o	225	Pipe/Conduit	
7.000	16.440	0.325	50.6	0.071	4.00	0.0	0.600	o	100	Pipe/Conduit	
6.001	54.000	0.360	150.0	0.042	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.005	12.000	0.080	150.0	0.000	0.00	0.0	0.600	o	225	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)
3.001	20.00	5.01	67.660	0.209	0.0	0.0	0.0	0.82	14.4	11.3
5.000	20.00	4.17	68.040	0.176	0.0	0.0	0.0	0.86	6.8«	9.5
1.004	20.00	6.06	67.225	0.720	0.0	0.0	0.0	0.97	38.5«	39.0
6.000	20.00	4.70	67.890	0.042	0.0	0.0	0.0	1.07	42.4	2.3
7.000	20.00	4.25	68.040	0.071	0.0	0.0	0.0	1.09	8.5	3.8
6.001	20.00	5.55	67.590	0.155	0.0	0.0	0.0	1.07	42.4	8.4
1.005	20.00	6.25	67.230	0.875	0.0	0.0	0.0	1.07	42.4«	47.4

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	100	1	68.600	68.040	0.460	Open Manhole	1200
2.000	o	100	2	68.700	67.887	0.713	Open Manhole	1200
1.001	o	225	1	68.700	67.820	0.655	Open Manhole	1200
1.002	o	225	2	68.700	67.600	0.875	Open Manhole	1200
1.003	o	225	5	68.700	67.350	1.125	Open Manhole	1200
3.000	o	100	6	68.600	68.040	0.460	Open Manhole	1200
4.000	o	100	7	68.600	68.040	0.460	Open Manhole	1200
3.001	o	150	4	68.600	67.660	0.790	Open Manhole	1200
5.000	o	100	9	68.600	68.040	0.460	Open Manhole	1200
1.004	o	225	6	68.600	67.225	1.150	Open Manhole	1200
6.000	o	225	5	68.700	67.890	0.585	Open Manhole	1200
7.000	o	100	12	68.600	68.040	0.460	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	19.190	202.0	1	68.700	67.945	0.655	Open Manhole	1200
2.000	5.330	80.0	1	68.700	67.820	0.780	Open Manhole	1200
1.001	33.280	151.3	2	68.700	67.600	0.875	Open Manhole	1200
1.002	37.500	150.0	5	68.700	67.350	1.125	Open Manhole	1200
1.003	8.500	170.0	6	68.600	67.300	1.075	Open Manhole	1200
3.000	10.850	32.9	4	68.600	67.710	0.790	Open Manhole	1200
4.000	8.820	26.7	4	68.600	67.710	0.790	Open Manhole	1200
3.001	42.900	150.5	6	68.600	67.375	1.075	Open Manhole	1200
5.000	8.970	80.1	6	68.600	67.928	0.572	Open Manhole	1200
1.004	12.650	180.7	7	68.600	67.155	1.220	Open Manhole	1200
6.000	44.900	149.7	6	68.700	67.590	0.885	Open Manhole	1200
7.000	16.440	50.6	6	68.700	67.715	0.885	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
6.001	o	225	6	68.700	67.590	0.885	Open Manhole	1200
1.005	o	225	7	68.600	67.230	1.145	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
6.001	54.000	150.0	7	68.600	67.230	1.145	Open Manhole	1200
1.005	12.000	150.0		69.000	67.150	1.625	Open Manhole	0

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)
1.005		69.000	67.150	67.550	0	0

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.005, Volume (m³): 4.1

Unit Reference	MD-SHE-0091-3900-1200-3900
Design Head (m)	1.200
Design Flow (l/s)	3.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	91
Invert Level (m)	67.230
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	3.9
Flush-Flo™	0.364	3.9
Kick-Flo®	0.747	3.1
Mean Flow over Head Range	-	3.4

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	2.8	1.200	3.9	3.000	6.0	7.000	8.9
0.200	3.7	1.400	4.2	3.500	6.4	7.500	9.2
0.300	3.9	1.600	4.5	4.000	6.8	8.000	9.5
0.400	3.9	1.800	4.7	4.500	7.2	8.500	9.8
0.500	3.8	2.000	4.9	5.000	7.6	9.000	10.0
0.600	3.7	2.200	5.2	5.500	7.9	9.500	10.3
0.800	3.2	2.400	5.4	6.000	8.3		
1.000	3.6	2.600	5.6	6.500	8.6		

Storage Structures for Storm

Porous Car Park Manhole: 1, DS/PN: 1.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	33.0
Membrane Percolation (mm/hr)	1000	Length (m)	39.6
Max Percolation (l/s)	363.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.040	Membrane Depth (mm)	0

Porous Car Park Manhole: 2, DS/PN: 2.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.7
Membrane Percolation (mm/hr)	1000	Length (m)	95.0
Max Percolation (l/s)	308.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.140	Membrane Depth (mm)	0

Porous Car Park Manhole: 6, DS/PN: 3.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	33.0
Membrane Percolation (mm/hr)	1000	Length (m)	30.7
Max Percolation (l/s)	281.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.040	Membrane Depth (mm)	0

Porous Car Park Manhole: 7, DS/PN: 4.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	30.0
Membrane Percolation (mm/hr)	1000	Length (m)	35.9
Max Percolation (l/s)	299.2	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.040	Membrane Depth (mm)	0

Porous Car Park Manhole: 9, DS/PN: 5.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	31.5
Membrane Percolation (mm/hr)	1000	Length (m)	55.7
Max Percolation (l/s)	487.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.040	Membrane Depth (mm)	0

Cellular Storage Manhole: 6, DS/PN: 1.004

Invert Level (m)	67.300	Infiltration Coefficient Side (m/hr)	0.00000
Infiltration Coefficient Base (m/hr)	0.00000	Safety Factor	2.0

Cellular Storage Manhole: 6, DS/PN: 1.004

Porosity 0.95

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	120.0	80.0	0.401	0.0	94.4
0.400	120.0	94.4			

Porous Car Park Manhole: 12, DS/PN: 7.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	16.0
Membrane Percolation (mm/hr)	1000	Length (m)	44.4
Max Percolation (l/s)	197.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.040	Membrane Depth (mm)	0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) 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	7
Number of Online Controls	1	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)	150.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	600 Winter	1	+0%	30/180 Winter				68.070
2.000	2	30 Winter	1	+0%	1/15 Winter				68.068
1.001	1	30 Winter	1	+0%	30/30 Summer				67.908
1.002	2	30 Winter	1	+0%	30/30 Summer				67.699
1.003	5	600 Winter	1	+0%	1/360 Winter				67.593
3.000	6	360 Winter	1	+0%	30/360 Winter				68.062
4.000	7	360 Winter	1	+0%	30/360 Winter				68.062
3.001	4	360 Winter	1	+0%	30/30 Summer				67.701
5.000	9	600 Winter	1	+0%	30/240 Winter				68.069
1.004	6	600 Winter	1	+0%	1/120 Winter				67.591
6.000	5	15 Winter	1	+0%	30/60 Summer				67.949
7.000	12	240 Winter	1	+0%	30/360 Winter				68.061
6.001	6	15 Winter	1	+0%	30/30 Summer				67.670
1.005	7	600 Winter	1	+0%	1/120 Winter				67.586

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.070	0.000	0.20		343	0.8	OK	
2.000	2	0.081	0.000	1.50		5	8.9	SURCHARGED	
1.001	1	-0.137	0.000	0.31			12.4	OK	
1.002	2	-0.126	0.000	0.40			15.8	OK	
1.003	5	0.018	0.000	0.11			3.3	SURCHARGED	
3.000	6	-0.078	0.000	0.11		170	1.1	OK	
4.000	7	-0.078	0.000	0.11		167	1.2	OK	
3.001	4	-0.109	0.000	0.17			2.3	OK	
5.000	9	-0.071	0.000	0.19		322	1.2	OK	
1.004	6	0.141	0.000	0.11		205	3.6	SURCHARGED	
6.000	5	-0.166	0.000	0.15			6.0	OK	
7.000	12	-0.079	0.000	0.10		133	0.8	OK	
6.001	6	-0.145	0.000	0.26			10.6	OK	
1.005	7	0.131	0.000	0.11			3.9	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) 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	7
Number of Online Controls	1	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)	150.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	600 Winter	30	+0%	30/180 Winter				68.161
2.000	2	360 Winter	30	+0%	1/15 Winter				68.168
1.001	1	120 Winter	30	+0%	30/30 Summer				68.173
1.002	2	120 Winter	30	+0%	30/30 Summer				68.174
1.003	5	120 Winter	30	+0%	1/360 Winter				68.164
3.000	6	720 Winter	30	+0%	30/360 Winter				68.150
4.000	7	720 Winter	30	+0%	30/360 Winter				68.150
3.001	4	720 Winter	30	+0%	30/30 Summer				68.148
5.000	9	600 Winter	30	+0%	30/240 Winter				68.149
1.004	6	120 Winter	30	+0%	1/120 Winter				68.159
6.000	5	120 Winter	30	+0%	30/60 Summer				68.174
7.000	12	480 Winter	30	+0%	30/360 Winter				68.145
6.001	6	120 Winter	30	+0%	30/30 Summer				68.166
1.005	7	120 Winter	30	+0%	1/120 Winter				68.155

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.021	0.000	0.45		536	1.8	SURCHARGED	
2.000	2	0.181	0.000	0.94		132	5.6	SURCHARGED	
1.001	1	0.128	0.000	0.42			16.8	SURCHARGED	
1.002	2	0.349	0.000	0.53			21.3	SURCHARGED	
1.003	5	0.589	0.000	0.62			19.4	SURCHARGED	
3.000	6	0.010	0.000	0.22		571	2.2	SURCHARGED	
4.000	7	0.010	0.000	0.22		570	2.4	SURCHARGED	
3.001	4	0.338	0.000	0.30			4.3	SURCHARGED	
5.000	9	0.009	0.000	0.44		527	2.7	SURCHARGED	
1.004	6	0.709	0.000	0.29			9.5	SURCHARGED	
6.000	5	0.059	0.000	0.11			4.6	SURCHARGED	
7.000	12	0.005	0.000	0.26		476	2.1	SURCHARGED	
6.001	6	0.351	0.000	0.28			11.2	SURCHARGED	
1.005	7	0.700	0.000	0.11			3.9	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) 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	7
Number of Online Controls	1	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)	150.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

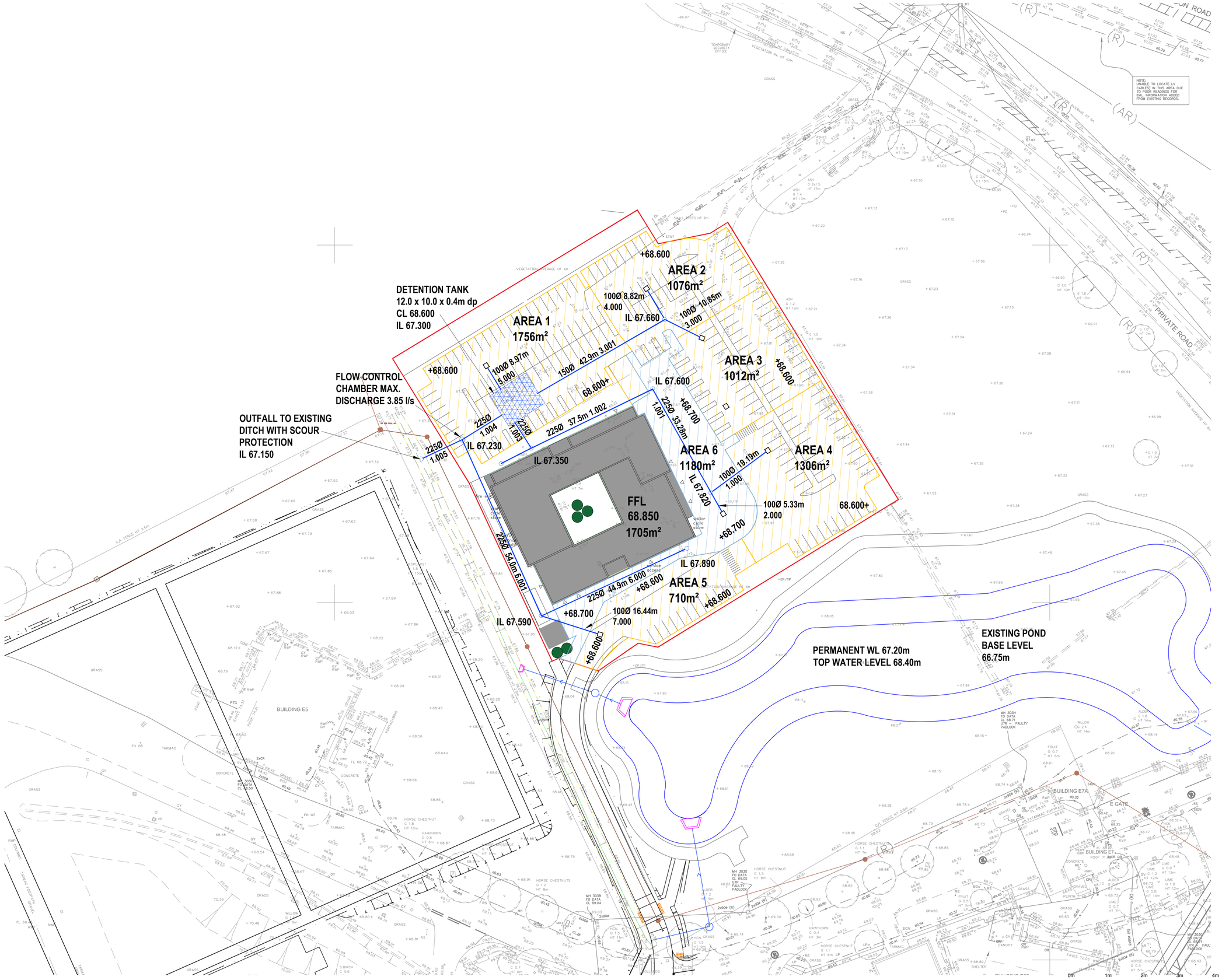
Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	960 Winter	100	+40%	30/180 Winter				68.306
2.000	2	960 Winter	100	+40%	1/15 Winter				68.303
1.001	1	60 Winter	100	+40%	30/30 Summer				68.506
1.002	2	60 Winter	100	+40%	30/30 Summer				68.517
1.003	5	60 Winter	100	+40%	1/360 Winter				68.466
3.000	6	960 Winter	100	+40%	30/360 Winter				68.298
4.000	7	960 Winter	100	+40%	30/360 Winter				68.298
3.001	4	60 Winter	100	+40%	30/30 Summer				68.303
5.000	9	960 Winter	100	+40%	30/240 Winter				68.295
1.004	6	60 Summer	100	+40%	1/120 Winter				68.460
6.000	5	60 Winter	100	+40%	30/60 Summer				68.488
7.000	12	960 Winter	100	+40%	30/360 Winter				68.291
6.001	6	60 Winter	100	+40%	30/30 Summer				68.466
1.005	7	30 Winter	100	+40%	1/120 Winter				68.500

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.166	0.000	0.44		1337	1.8	SURCHARGED	
2.000	2	0.316	0.000	0.55		807	3.3	SURCHARGED	
1.001	1	0.461	0.000	0.66			26.2	SURCHARGED	
1.002	2	0.692	0.000	0.90			36.1	SURCHARGED	
1.003	5	0.891	0.000	1.06			33.3	SURCHARGED	
3.000	6	0.158	0.000	0.21		1340	2.1	SURCHARGED	
4.000	7	0.158	0.000	0.21		1339	2.3	SURCHARGED	
3.001	4	0.493	0.000	0.87			12.3	SURCHARGED	
5.000	9	0.155	0.000	0.41		1297	2.6	SURCHARGED	
1.004	6	1.010	0.000	0.09			3.0	FLOOD RISK	
6.000	5	0.373	0.000	0.34			13.7	SURCHARGED	
7.000	12	0.151	0.000	0.19		1257	1.5	SURCHARGED	
6.001	6	0.651	0.000	0.66			27.0	SURCHARGED	
1.005	7	1.045	0.000	0.11			3.9	FLOOD RISK	

Appendix F – Drainage Strategy Drawing



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

NOTES: THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RISK REGISTER PRODUCED FOR INCLUSION IN THE HEALTH AND SAFETY PLAN. THE HAZARDS NOTED ARE IN ADDITION TO THE NORMAL HAZARDS AND RISKS FACED BY A COMPETENT CONTRACTOR WHEN DEALING WITH THE TYPE OF WORKS DETAILED ON THIS DRAWING.

CONSTRUCTION RISKS:

- WORKING ADJACENT TO WATER FEATURES.

MAINTENANCE/CLEANING/IN USE RISKS:

- NO SIGNIFICANT RISKS.

DEMOLITION RISKS:

- NO SIGNIFICANT RISKS.

NOTE:

1. DO NOT SCALE, IF IN DOUBT ASK.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT STRUCTURAL ENGINEER'S DRAWINGS AND DETAILS, THE SPECIFICATION FOR THE WORKS, THE RELEVANT ARCHITECT'S DRAWINGS AND ANY OTHER SPECIALIST'S DRAWINGS.
3. ANY DISCREPANCIES FOUND ON THIS OR ANY OTHER DRAWINGS ARE TO BE REPORTED TO AND RESOLVED BY ROSSI LONG CONSULTING BEFORE THE COMMENCEMENT OF ANY WORK RELEVANT TO THE DISCREPANCY.
4. THE PRINCIPAL CONTRACTOR IS TO PROVIDE FULLY DESIGNED PROPPING/SHORING TO FACILITATE THE WORKS. ALL PROPPING & BRACING IS TO BE ADEQUATELY FOUNDED TO ENSURE THE STABILITY/INTEGRITY OF THE EXISTING/PROPOSED STRUCTURES &/OR EARTHWORKS IS MAINTAINED. UNLESS INDICATED ON THE DRAWINGS, THE TEMPORARY WORKS ARE NOT TO IMPOSE REACTIONS ON THE PERMANENT STRUCTURE WITHOUT PRIOR WRITTEN CONSENT FROM ROSSI LONG CONSULTING.
5. THIS DOCUMENT HAS BEEN PREPARED IN ACCORDANCE WITH THE SCOPE OF ROSSI LONG CONSULTING'S APPOINTMENT WITH ITS CLIENT AND IS SUBJECT TO THE TERMS OF THAT APPOINTMENT. ROSSI LONG CONSULTING ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS CLIENT AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED. ONLY WRITTEN DIMENSIONS SHALL BE USED.

PROPOSED PERMEABLE PAVING TO VEHICULAR AREAS - 350thk SUB-BASE

PROPOSED PERMEABLE PAVING TO PEDESTRIAN AREAS - 250thk SUB-BASE

PROPOSED SURFACE WATER DRAINAGE

PRELIMINARY DRAWING:
THIS DRAWING IS FOR PRELIMINARY PURPOSES ONLY AND MUST NOT BE READ AS A CONSTRUCTION ISSUE. IT INDICATES DESIGN INTENT ONLY AND IS SUBJECT TO AMENDMENT DURING FINAL DESIGN DEVELOPMENT.

REV	DESCRIPTION	DATE	BY	AUTH
P03	REFERENCES ADDED TO SPURS, DISCHARGE RATE TO DITCH AMENDED	08.07.21	PC	-
P02	SYSTEM AMENDED TO OUTFALL TO DITCH	22.03.21	PC	-
P01	INITIAL ISSUE	25.02.21	PC	-

Rossi Long Consulting
16 Meridian Way, Norwich, Norfolk, NR7 0TA
T: 01603 706 420 www.rossilong.co.uk

CLIENT
APOLLO

PROJECT
BICESTER HEALTH AND WELLBEING HUB

TITLE
SURFACE WATER DRAINAGE STRATEGY OPTIONS

DRAWN	AUTHORISED	DATE	SCALE AT A1
PDC	-	FEB 21	1:500

SUITABILITY
S2 -INFORMATION

PROJECT NO.	DRAWING FIELDS.	DRAWING NO.	REV
191607	RLC-00-XX-DR	C-001	P03

Appendix G – SuDS Management and Maintenance Plan

Rossi Long Consulting

SuDS Management and Maintenance Plan

Bicester Healthcare Hub

Graven Hill

Bicester

Oxfordshire

RLC Ref: 191607

February 2021

Prepared for

Bicester HC Development Ltd

1.0 General Description

1.1 The development is to comprise a new Healthcare Hub building of 3,350m² gross floor area with associated staff and visitors parking. A new entrance is to be formed on to the wider Graven Hill village infrastructure roads.

1.2 The site operator will be responsible for SuDS features within the curtilage of the site. Shared facilities such as the off-site detention basin will be maintained by a Management Company for the Graven Hill development.

1.3 For the purposes of this manual, maintenance refers to:

1) Inspections required to identify performance issues and plan appropriate maintenance needs.

2) Operation and maintenance of the drainage system.

1.4 The SuDS features comprise:

1) Inlets, Outlets and Inspection Chambers

2) Pervious Block Paving

2.0 Operation and Maintenance Requirements

2.1 Detention Basin

Detention Tanks – Table 21.3 CIRIA C753

TABLE 21.3 Operation and maintenance requirements for attenuation storage 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, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

2.2 Pervious Paving – Table 20.15 CIRIA C753

TABLE 20.15 Operation and maintenance requirements for pervious pavements

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over 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 glyphospate 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 50 mm 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 installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract (many car parks or roads are swept to remove litter and for visual reasons to keep them tidy) and therefore, if litter management is already required at site, this should have marginal cost implications.

Generally, pervious pavements require less frequent gritting in winter to prevent ice formation. There is also less risk of ice formation after snow melt, as the melt water drains directly into the underlying sub-base and does not have chance to refreeze. A slight frost may occur more frequently on the surface of pervious pavements compared to adjacent impermeable surfaces, but this is only likely to last for a few hours. It does not happen in all installations and, if necessary, this can be dealt with by application of salt. It is not likely to pose a hazard to vehicle movements.

3.0 Operation and Maintenance Activities

3.1 Operation and Maintenance Activity Categories

Maintenance activities can be broadly defined as:

1) regular maintenance (including inspections);

2) occasional maintenance; and

3) remedial maintenance.

There may also be initial one-off requirements sometimes referred to as “establishment maintenance”, particularly for planting (e.g. weeding and watering). Regular maintenance consists of basic tasks carried out to a frequent and predictable schedule, including inspections / monitoring, silt or oil removal if required more frequently than once per year, vegetation management, sweeping of surfaces and litter and debris removal.

Occasional maintenance comprises tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the regular tasks (e.g. sediment removal or filter replacement). The table overleaf summarises the likely maintenance activities required for each SuDS component.

Remedial maintenance describes the intermittent tasks that may be required to rectify faults associated with the system, although the likelihood of faults can be minimised by good design, construction and regular maintenance activities. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, and so timings are difficult to predict. Remedial maintenance can comprise activities such as:

- inlet and outlet repairs;
- erosion repairs;
- infiltration surface rehabilitation;
- replacement of blocked filter materials / fabrics;
- construction stage sediment removal (although this activity should have been undertaken before the start of the maintenance contract);
- system rehabilitation immediately following a pollution event.

3.2 Operation and Maintenance Activity Schedule

Operation and maintenance activity	SuDS component			
	Inspection chambers	Conveyance pipes	Detention tanks	Pervious paving
Regular maintenance (Monthly or as Required)				
Inspection	■	■	■	■
Inspect after leaf fall in the Autumn	■	☐	■	☐
Litter and debris removal	■	■	■	■
Grass cutting	■	■		
Weed and invasive plant control	☐	☐	☐	☐
Shrub management (including pruning)	☐			
Brush regularly and remove sweepings			☐	■
Occasional maintenance (Annually)				
Sediment management	■	■	■	■
Vegetation replacement			☐	
Vacuum sweeping and brushing				
Check topsoil levels are 20mm above chambers to avoid mower damage	■			
Remove covers and inspect ensuring water is free flowing and that any inlet / outlet is unobstructed	■	☐		
Remedial maintenance (As Required)				
Jet wash and suction cleaning				☐
Structure rehabilitation / repair	☐	☐	☐	☐
Infiltration surface reconditioning				

Key
■ will be required
☐ may be required