SURFACE WATER & SUDS DRAINAGE STRATEGY

FOR

RESIDENTIAL REDEVELOPMENT
HOWSON TERRACE, RICHMOND HILL, RICHMOND UPON THAMES
ON BEHALF OF
HOUSING 21

SEPTEMBER 2021

[ISSUE 3]

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TRANSPORT PLANNING ~ WATER MANAGEMENT ~ CIVIL ENGINEERING

BRISTOL & SWINDON

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COLE EASDON CONSULTANTS (CEC)

DOCUMENT ISSUE RECORD

Client: Housing 21

Project: Residential Redevelopment, Howson Terrace, Richmond Hill, Richmond upon Thames

Job Number: 7488

Document Title: Surface Water & SuDS Drainage Strategy

Issuing Office: Swindon

Issue No.	1	2	3	
Date	October 2020	January 2021	September 2021	
Description / Status	Draft for Client Comment	Formal Issue	Re-issued	
Prepared	N. Parajuli MEng	N. Parajuli MEng	N. Parajuli MEng	
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Document Check	S. Seed BA (Hons)	S. Seed BA (Hons)	S. Seed BA (Hons)	

The methodology adopted and the sources of information used by Cole Easdon Consultants Limited (CEC) in providing its services are outlined within this Report. Any information provided by third parties and referred to herein has not been checked or verified by CEC, unless otherwise expressly stated within this Report. This Report was checked and approved on the date shown in the Document Issue Record and the Report (including its base information, adopted parameters and assessment methodology) is therefore valid on this date. Circumstances, regulations, assessment methodology and professional standards do change which could subsequently affect the validity of this Report.

CONTENTS

APPENDICES

1.0 INTRODUCTION

1.1 This *Surface Water & SuDS Drainage Strategy (SWDS)* has been prepared by Cole Easdon Consultants Limited (CEC) on behalf of Housing 21 to support a planning application for the proposed residential redevelopment at Howson Terrace, Richmond Hill, Richmond upon Thames.

Development Proposals

1.2 The development proposal comprises the demolition of the existing buildings and erection of a new 5 storey block accommodating 28 No. affordable apartments for the over 55s. Access to the site will be from Richmond Hill as per current arrangement. Refer to Drawing No. M8764-ASK 012 [*Proposed Site Plan*] prepared by Hunters in Appendix 2.

Need for Study

1.3 This Study discusses how surface water runoff for the development can be managed in a sustainable manner in line with the *National Planning Policy Framework (NPPF)* and its associated *Planning Practice Guidance (PPG)*, and to the requirements of the Environment Agency and Lead Local Flood Authority (London Borough of Richmond upon Thames).

Scope of Study

1.4 In Section 2.0, we describe the characteristics of the proposed development site and surrounding area. In Section 3.0, we discuss foul drainage proposals. And conclusions are presented in Section 4.0.

1.5 The following publicly available documents have also been reviewed as part of this assessment:

- *National Planning Policy Framework (February 2019);*
- *Planning Practice Guidance – Flood Risk and Coastal Change (March 2014);*
- *Flood risk assessments: climate change allowances (Update March 2020);*
- *DEFRA's Non-statutory technical standards for sustainable drainage systems (2015);*
- *CIRIA C753 The SuDS Manual (November 2015);*
- *Sewerage Sector Guidance Appendix C – Design and Construction Guidance V2;*
- *London Borough of Richmond upon Thames Strategic Flood Risk Assessment Update (March 2016);*
- *Planning Guidance Document: Delivering SuDS in Richmond (February 2015);*
- *London Borough of Richmond Local Plan (Adopted July 2018);and*

- *Surface Water Management Plan for the London Borough of Richmond upon Thames (September 2011).*

1.6 The following abbreviations are used in this report:

- AOD – Above Ordnance Datum;
- bgl – below ground level;
- EA – Environment Agency;
- LB – London Borough
- LLFA - Lead Local Flood Authority;
- LPA – Local Planning Authority
- NPPF – National Planning Policy Framework;
- PPG – Planning Practice Guidance;
- SFRA – Strategic Flood Risk Assessment; and
- SuDS – Sustainable Drainage Systems.

2.0 THE EXISTING SITE

Site Location and Topography

2.1 The application site is located in Richmond Hill, Richmond upon Thames, approx. 0.4km to the south of the town centre and 100m to the east of the River Thames. The site is located off Richmond Hill. Refer to CEC Figure 7488/500/Figure1 [*Site Location Plan*] in Appendix 1.

2.2 The site area comprises approx. 2,300m^2 (0.23 ha) of brownfield land, currently occupied by 3 blocks of flats comprising 24 No. 1-bed sheltered housing units. The site includes a crescent shaped area accessed via a driveway from Richmond Hill.

2.3 The site is located amid a predominantly residential area, and is bordered by Bromwich House to the north, residential dwellings to the west and by parkland to the east and south.

2.4 The site falls from north to south in an approx. 1 in 10 gradient. Levels remain at between c. 30.00m at Richmond Hill and 16.50mAOD at the south extent. A topographical survey [Ref: 22926] undertaken by MK Surveys was provided for this study. This survey is incorporated within CEC Plans 7488/500 [*Existing & Proposed Impermeable Area Plan*] and 7488/501 [*Proposed Drainage Strategy*] in Appendix 1.

Nearby Watercourses/Drainage Features

2.5 The River Thames is located approx. 100m to the west of the site.

Existing Drainage/Sewers

2.6 Thames Water sewer records (in Appendix 3) indicate a 225mm surface water sewer and a 225/300mm foul water sewer running beneath Richmond Hill. A 300mm surface water sewer is also located beneath Petersham Road to the west. A foul sewer is also located beneath Petersham Road which directs towards a foul trunk running parallel to the Thames. Records also show a length of a combined drain (not owned by Thames Water) located within the site.

2.7 The topographical survey included in CEC Plan 4788/500 [*Existing & Proposed Impermeable Area Plan*] (in Appendix 1) shows that there is a separate system of foul and storm water drains serving the current site. Both foul and surface water drains enter the site from the Bromwich House premises from the north, and run southerly through the site picking foul and storm flows before continuing in a westerly direction, presumably connecting to public

sewers in Petersham Road.

2.8 The existing drains serving the area beyond the site will require to be retained; redundant drainage across the development site will be removed. Refer to CEC Plan 4788/500 [*Existing & Proposed Impermeable Area Plan*] in Appendix 1.

Existing Ground Conditions

2.9 The British Geological Survey (BGS) map available online indicates the site is underlain by London Clay Formation, with no superficial deposits. Madeground associated with current buildings and hardstanding will occur to varying depth. BGS boreholes in the vicinity record madeground with blue Clay extending to a significant depth. Refer to BGS borehole records in Appendix 5.

2.10 London Clay bedrock beneath the area is classed as an 'Unproductive' strata. The site is not located within any Groundwater Source Protection Zone.

3.0 DRAINAGE PROPOSALS

3.1 This Section details how surface water flows arising from the development site will be managed in line with related national and local guidance, namely *NPPF, PPG* and *SFRA* recommendations. The proposals will consider the requirement of the Environment Agency, Thames Water and LB of Richmond upon Thames as a Lead Local Flood Authority (LLFA).

Existing Site Drainage

3.2 The development is on previously developed land, with 3 No. buildings, tarmac access paths and parking spaces. The site currently drains into a 150mm surface water drain crossing the site, which is assumed to connect into the public sewer located at Petersham Road to the west. Refer to CEC Plan 7488/500 [*Existing & Proposed Impermeable Area Plan*] in Appendix 1.

3.3 The development will result in removal of some 670m^2 of hard area (excluding access paths and parking spaces to be retained). The existing access and parking spaces included within the redline boundary will be retained. The site currently generates brownfield runoff of 6 l/s, 16 l/s and 20 l/s in the 1yr, 30yr and 100yr events respectively based on 670m^2 of hard area. Equivalent greenfield runoff from the site however is 2.7l/s in the 100yr event. Refer to calculations in Appendix 6.

Surface Water Drainage Proposal

3.4 The site, despite being located in proximity to the Thames, remains significantly elevated above the River, in Flood Zone 1 based on the Environment Agency's flood mapping. The *NPPF* identifies Flood Zone 1 as low flood risk areas with an annual probability of flooding of less than a 1 in 1000 (0.1%) from rivers or sea. The site also remains at low risk from surface water flooding. Refer to EA's flood map in Appendix 4.

3.5 Based on the NPPF/PPG, the proposed residential use, classed as 'more vulnerable' use is considered acceptable in Flood Zone 1.

3.6 The development site will comprise approx. 1,200m^2 (0.12 ha) of impermeable area, nearly double of the existing site's hard area. Notwithstanding, surface water runoff generated from the developed site will be utilising sustainable drainage measures ensuring minimal offsite discharge, as discussed below.

3.7 Drainage proposals for the site have been developed in line with national and local guidance, SuDS (Sustainable Drainage Systems) principles and Building Regulations guidelines. Opportunity for surface water runoff disposal via infiltration has been investigated before seeking to discharge into any alternative watercourses or sewers, in line with the London Plan drainage hierarchy.

3.8 The site geology, comprising London Clay, is considered unfavourable for infiltration drainage. The nearest watercourse relates to the River Thames, where the site has no direct access to the watercourse.

3.9 As such, the site will seek to discharge into the adjoining public sewer utilising existing outfalls. *London Plan Policy 5.13 Sustainable drainage* states that '*Development should utilise sustainable urban drainage systems (SuDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible.' Richmond Local Plan (Policy LP 21 Flood Risk and Sustainable Drainage) states that 'where greenfield run-off rates are not feasible, this will need to be demonstrated by the applicant, and in such instances, the minimum requirement is to achieve at least a 50% attenuation of the site's surface water runoff at peak times based on the levels existing prior to the development.'* Similar recommendations have been made with the SFRA.

3.10 Accordingly, discharge from the site will be limited to the equivalent 100yr greenfield rate from the site in line with the London and Richmond SuDS policy and SFRA recommendations. This offers significant betterment (of between 67 - 89%) over the current runoff situation. Refer to Table 3.1 below.

3.11 Surface water runoff will be treated and attenuated within a green roof and cellular tanks prior to its discharge into the existing surface water drains. Whilst green roofs will mainly contribute to slowing down runoff and water treatment, storage required to accommodate surface water runoff for up the 1 in 100-year event with 40% climate change (in line with the EA climate change allowance guidance) will be provided within cellular tanks. Discharge will be restricted to 2.7l/s in total with the use of hydrobrakes or similar vortex flow control devices. Two outfalls will be utilised to suit the site topography and layout. Refer to CEC Plan 7488/501 [*Proposed Drainage Strategy*] in Appendix 1.

3.12 Thames Water in response to a pre-development capacity enquiry have confirmed that TW

would not have any objections to the proposal, provided the flows are restricted to a total of around 2.7 l/s to TW surface water sewer network as per above. Refer to TW correspondence in Appendix 3.

3.13 Green roofs (and walls) incorporated within the design will not only contribute towards surface water runoff attenuation but also offer visual benefits, amenity space, ecological value and enhanced building performance.

3.14 A completed SuDS proforma is included in Appendix 7 of this Report to demonstrate compliance of the proposal as discussed above with the local and national SuDS policies.

Table 3.1: Drainage Design Summary

Return Period	Existing Site		Proposed Site		Comments	Improvement over the existing situation
	Greenfield runoff Rate (l/s)	Existing discharge rate (l/s)	Discharge rate (l/s)	Required Storage (m^3)		
Qbar	0.8	-	-			
1 in 1	0.7	6	2.0 (0.9+1.1)		Unable to restrict to greenfield rate as very small flow control required.	67%
1 in 30	1.9	16	2.1 (0.9+1.2)			87.5%
1 in 100	2.7	20	2.2 (1.0+1.2)			89%
1 in 100year + 40% CC	-	-	2.7 (1.2l/s from northern area + 1.5l/s from southern area)	52 (24+28)	Discharge rate achieved with Hydrobrakes with orifice opening 49mm and 55mm	86.5%

3.15 The existing drains serving the area beyond the site will require to be retained; redundant drainage will be removed. Where existing connections are to be reused, a CCTV drainage survey will be required to confirm the condition of the outfalls.

3.16 Consequently, the new development will not increase surface water runoff and will not increase flood risk in the local area. The drainage proposals as presented above meets London Plan policy objectives in delivering multi benefits of SuDS, including water use efficiency and quality, biodiversity, amenity and recreation.

Residual Flood Risk

3.17 Should the drainage system block/fail or under extreme events of flooding which exceeds the design standard, floodwater would be directed towards the green space located around

the perimeter. This design exceedance flow routes have been indicated in CEC Plan 7488/501 [*Proposed Drainage Strategy*] in Appendix 1.

Water Quality

3.18 Runoff will be treated within green roof, with pre-treatment devices (silt chambers) prior to its discharge into the cellular tanks. As recognised within *CIRIA C753 The SuDS Manual*, green roofs help to reduce the amount of pollution delivered to the local drainage system.

Adoption/Maintenance

3.19 All drainage and SuDS components will be manged by a private management company as appointed by the developer.

3.20 The regular maintenance of the proposed SuDS devices should be carried out in line with the *CIRIA C753 The SuDS Manual* or as per manufacturer's specification, as discussed below.

Table 4.2: Maintenance Schedule for Cellular Attenuation Storage

Schedule	Maintenance Requirement	Frequency
Regular	Inspect and identify any areas that are not operating correctly	Monthly for 3 months then annually
	Remove debris from the catchment surface	Monthly
	Remove sediment from pre-treatment structures and internal forebays	Annually or as required
Remedial	Repair and rehabilitate inlets, outlets, overflows and vents	As required
Monitoring	Inspect inlets, outlets, overflows and vents to ensure they are operating as designed	Annually
	Survey inside of tank for sediment build-up and remove as necessary	Every 5 years or as required

Table 4.3: Maintenance Schedule for Green Roofs

Schedule	Maintenance Requirement	Frequency
Regular	▪ Inspect all components including vegetation, drains, roof structure and soil substrate for proper operation and structural stability ▪ Inspect inlets to ensure unrestricted runoff from the drainage layer to the roof drain system ▪ Inspect underside of roof for leakage	Annually and after severe storms
	▪ Replace dead plants as required ▪ Remove invasive or nuisance vegetation	Annually
Remedial	▪ Stabilise any evident erosion channels with soil substrate ▪ Repairs to drain inlet	As required

Table 4.4: Maintenance Schedule for Catchpits, Channel Drains and Flow Controls

Schedule	Maintenance Requirement	Frequency
Regular	▪ Inspect for accumulation of silt ▪ Inspect for debris and litter ▪ Inspect inlets and outlets for blockages	Every six months
Occasional	▪ Remove debris and litter ▪ Remove silt	As required
Remedial	Repair or replace	As required

4.0 DISCUSSION AND CONCLUSIONS

4.1 This Report discusses surface water drainage proposals in relation to the proposed residential redevelopment at Howson Terrace, Richmond Hill, Richmond upon Thames. The study considers the requirements of the Environment Agency and Lead Local Flood Authority and guidance contained within the *NPPF* and *PPG*.

4.2 The development site is located within Flood Zone 1, and is also at low risk of flooding from surface water. The *NPPF/PPG* guidance considers all types of development suitable in Flood Zone 1.

4.3 The development is on previously developed land, and will increase hard areas when compared to the existing situation. Nonetheless surface water runoff from the site will be limited to a minimal rate with the use of SuDS. The underlying geology comprising London Clay is unlikely to support infiltration drainage option.

4.4 The development site will discharge into the public sewer via the existing surface water drain located within the site at the equivalent greenfield rate of 2.7 l/s, offering a betterment of at least 67% over the existing brownfield runoff state. Runoff will be manged within green roof and cellular tank system designed for the 1:100 year + 40% event in line with the *NPPF/EA* requirements. Runoff will be treated within green roof and silt chambers prior to discharge into the public sewer via existing drainage system. Residual flood risk will be managed by directed towards green landscape area around the perimeter.

4.5 Thames Water have confirmed sufficient sewerage capacity within the adjacent TW foul sewer network to accept the proposed discharge rate of 2.7 l/s. The existing drainage system to be retained will need a CCTV drainage survey undertaken to confirm their condition for re-use.

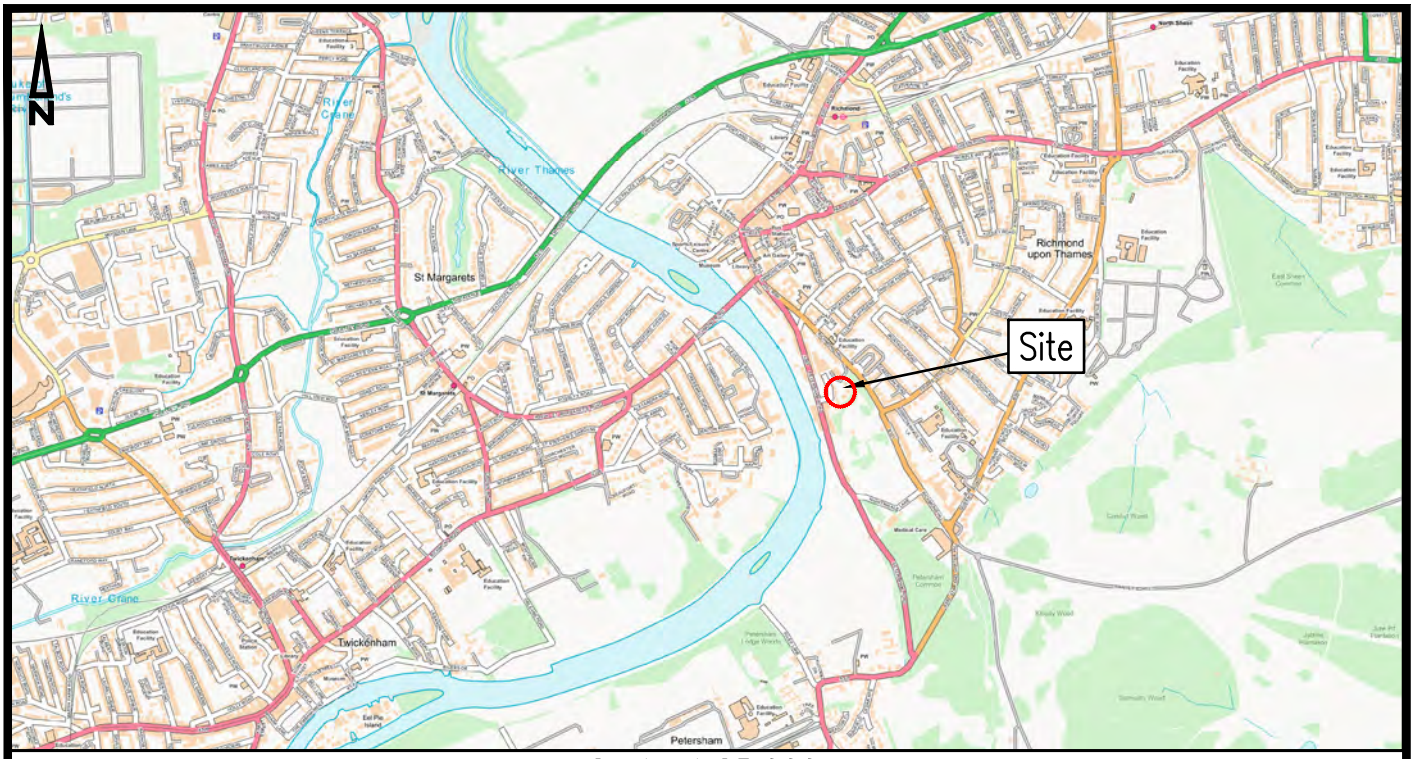
4.6 All SuDS devices will be constructed and maintained in line with *The SuDS Manual* or manufacturer's specification. All drainage and SuDS components will be maintained privately via the engagement of a private management company.

4.7 It is therefore concluded that surface water runoff can be managed sustainably within the redeveloped site in line with the local and national policies, and therefore should be considered acceptable.

Cole Easdon Consultants Limited

September 2021

Appendix 1



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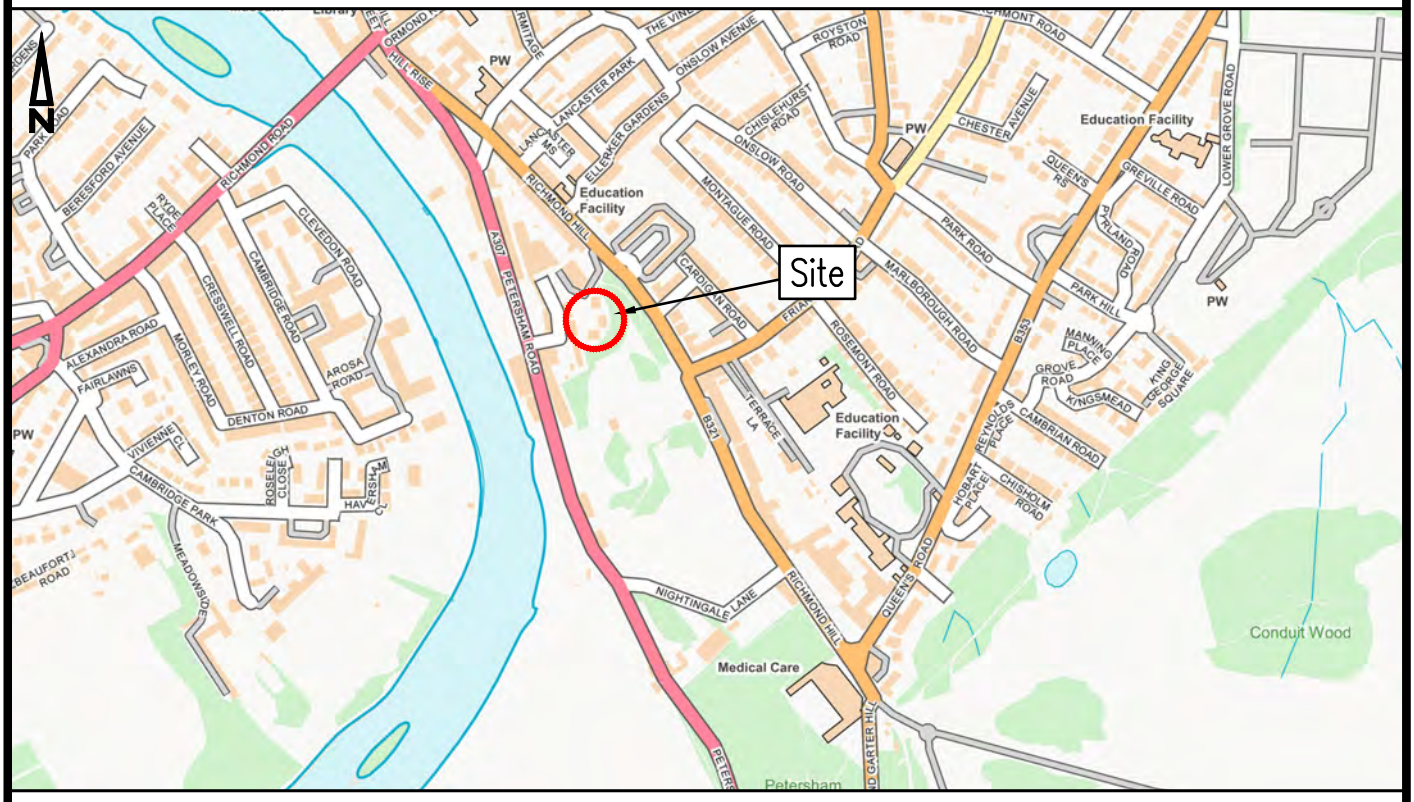

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No.	By	Date	Revision Details

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Job Title:
Howson Terrace
Richmond Hill
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Client:
Housing 21

Drawing Status:

CONSTRUCTION AT CLIENT AND/OR CONTRACTOR RISK		
	FOR COMMENT	
	FOR PLANNING	X
	FOR TENDER	
	FOR APPROVAL	
	FOR CONSTRUCTION	
	AS BUILT	

Drawing Title:
Site Location Plan

Drawn By	Date Drawn	Scale
NP	Oct 2020	As Shown @ A4

Checked By	Drawing No.	Revision
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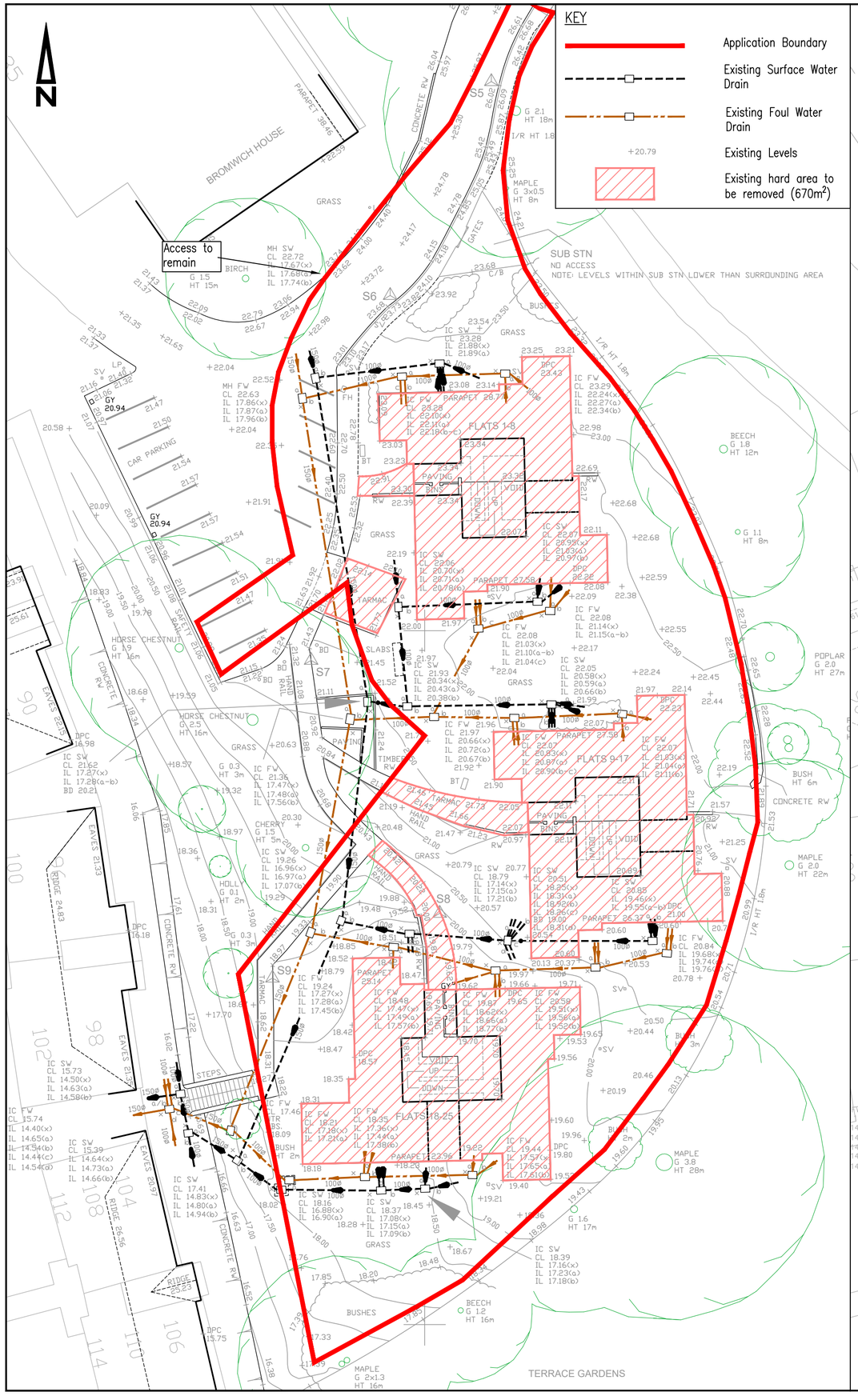

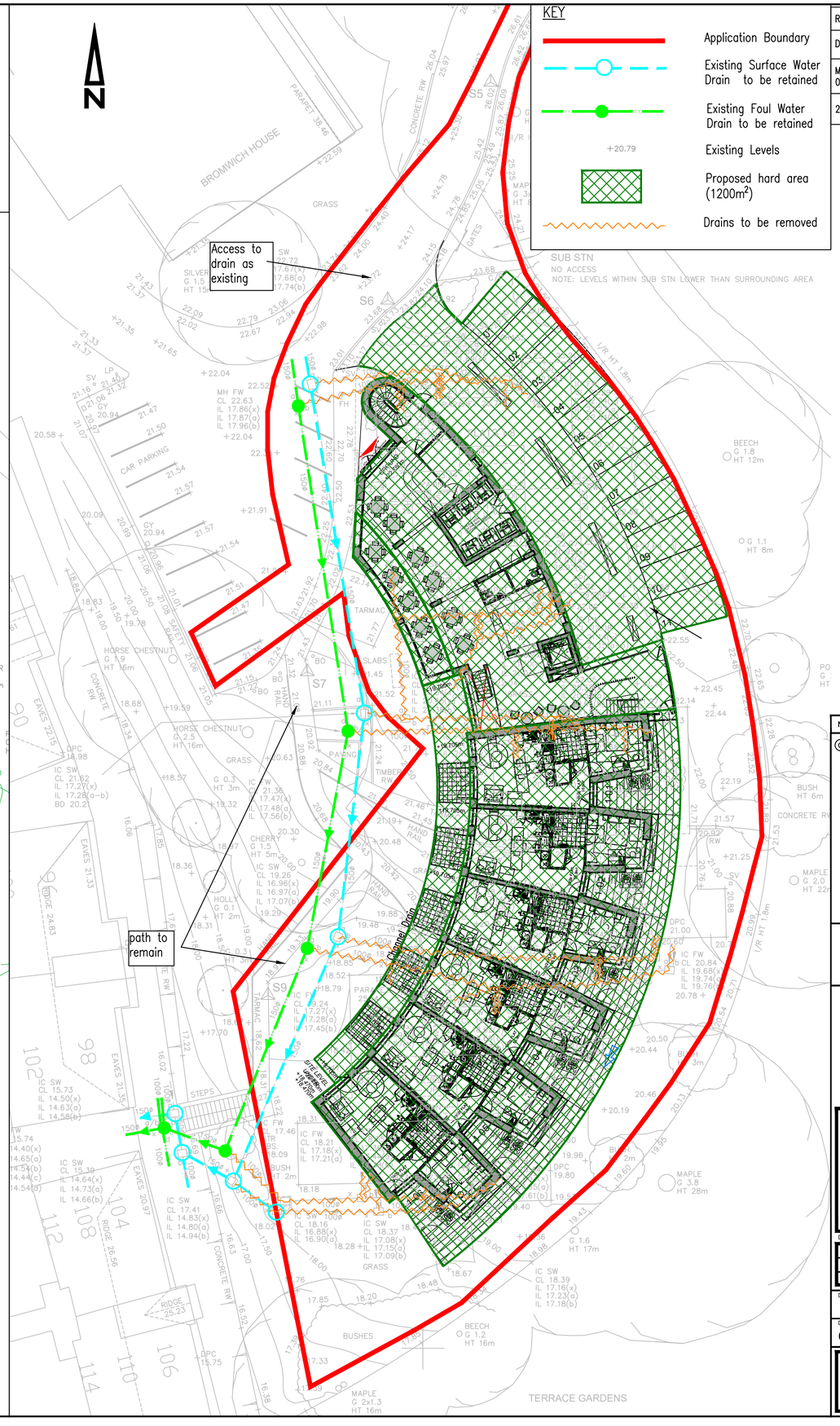

REFERENCE DRAWINGS:

Drawing No.	Drawing Title	Revision	Date	Company
M8764 ASK 007	Proposed Ground Plan	C	01.10.2020	Hunters
22926	Topographical Survey	1	Sept 2016	MK Surveys

No.	By	Date	Revision Details

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Client
Housing 21

Job Title
Howson Terrace
Richmond Hill
Richmond upon Thames

Drawing Title
Existing & Proposed Impermeable Area Plan

Drawing Status:

FOR COMMENT	FOR PLANNING	FOR TENDER	FOR APPROVAL	FOR CONSTRUCTION	AS BUILT
	X				

CONSTRUCTION AT CLIENT / CONTRACTOR RISK

Designed by:	Drawn by:	Checked by:
	NP	RB

Date	Scale
Oct 2020	1:250 (A2)

Drg. No.	Rev.
7488/500	-

REFERENCE DRAWINGS:				
Drawing No.	Drawing Title	Revision	Date	Company
M8764 ASK 007	Proposed Ground Plan	C	01.10.2020	Hunters
22926	Topographical Survey	1	Sept 2016	MK Surveys

KEY

- Application Boundary
- Existing Surface Water Drain to be retained
- Existing Foul Water Drain to be retained
- +20.79 Existing Levels
- Proposed Surface Water Drain and Manhole
- Proposed Foul Water Drain and Manhole
- Cellular Tank
- Green Roof
- Channel Drain
- Catch Pit
- Flow Control
- Flood Flow Route

Drainage Notes:

1. Surface water runoff to discharge into the existing surface water drain utilising existing connections.
2. Discharge to be limited to the equivalent 100yr greenfield rate of 2.7l/s from the site.
3. Storage to be provided for up to the 1:100 yaer within green roof and cellular tanks.
4. Foul water to discharge into the existing foul drains using existing connections.

Site area	2300m²
Existing hard area to be removed	670m²
Proposed hard area	1200m²

Existing brownfield rates

1:1yr	6l/s
1:30yr	16l/s
1:100yr	20l/s

Equivalent 100yr greenfield rate	2.7l/s
Storage required at greenfield rate	52m³

Access to drain as existing

Cellular Tank (24m³)
21m²x1.2m deep
Tank Base 20.50
Top of Tank 22.50

Drainage Area 545m² (including 182m² green roof)

Flow control Discharge rate 1.2l/s

Proposed surface water connection into existing drain

proposed foul connection into existing drain

Proposed foul connection into existing drain

Proposed surface water connection into existing drain

Flow control Discharge rate 1.5l/s

Cellular Tank (28m³)
24.5m²x1.2m deep
Tank Base 16.40
Top of Tank 18.00

Drainage Area 655m² (including 340m² green roof)

No.	By	Date	Revision Details

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Job Title: Howson Terrace, Richmond Hill, Richmond upon Thames

Drawing Title: Proposed Drainage Strategy

Drawing Status:

FOR COMMENT	FOR PLANNING	FOR TENDER	FOR APPROVAL	FOR CONSTRUCTION	AS BUILT
	X				

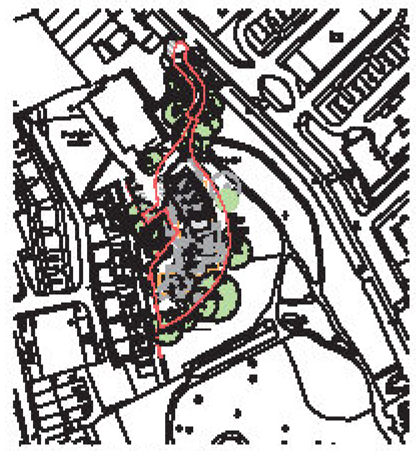
CONSTRUCTION AT CLIENT / CONTRACTOR RISK

Designed by:	Drawn by:	Checked by:
NP	NP	RB

Date: Oct 2020
Scale: 1:250 (A2)

Drg. No.: 7488/501
Rev.: -

Appendix 2



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PRELIMINARY

hunters

LOWER GROUND FLOOR PLAN
scale 1:100@A0

SITE LOCATION PLAN
scale 1:1250@A0

SITE BOUNDARY

SCHEDULE OF ACCOMMODATION

Floor	Studio 35.0m²	2Bed/3p 57.0m²	GIA
Lower Ground:	10[illegible]	–	[illegible]m²
Ground Floor:	08	–	[illegible]m²
First Floor:	07	01	[illegible]m²
Second Floor:	04	05	[illegible]m²
Third Floor:	02	01	[illegible]m²
TOTAL No Apts:	29	03	32 Apts

Parking: 11 car spaces in undercroft

Noise: [illegible] may not be a viable option due to [illegible] have a poor outlook. Potential plant areas

TOTAL GIA: 2307.8m²

SITE AREA: 3321m²

COLOUR KEY

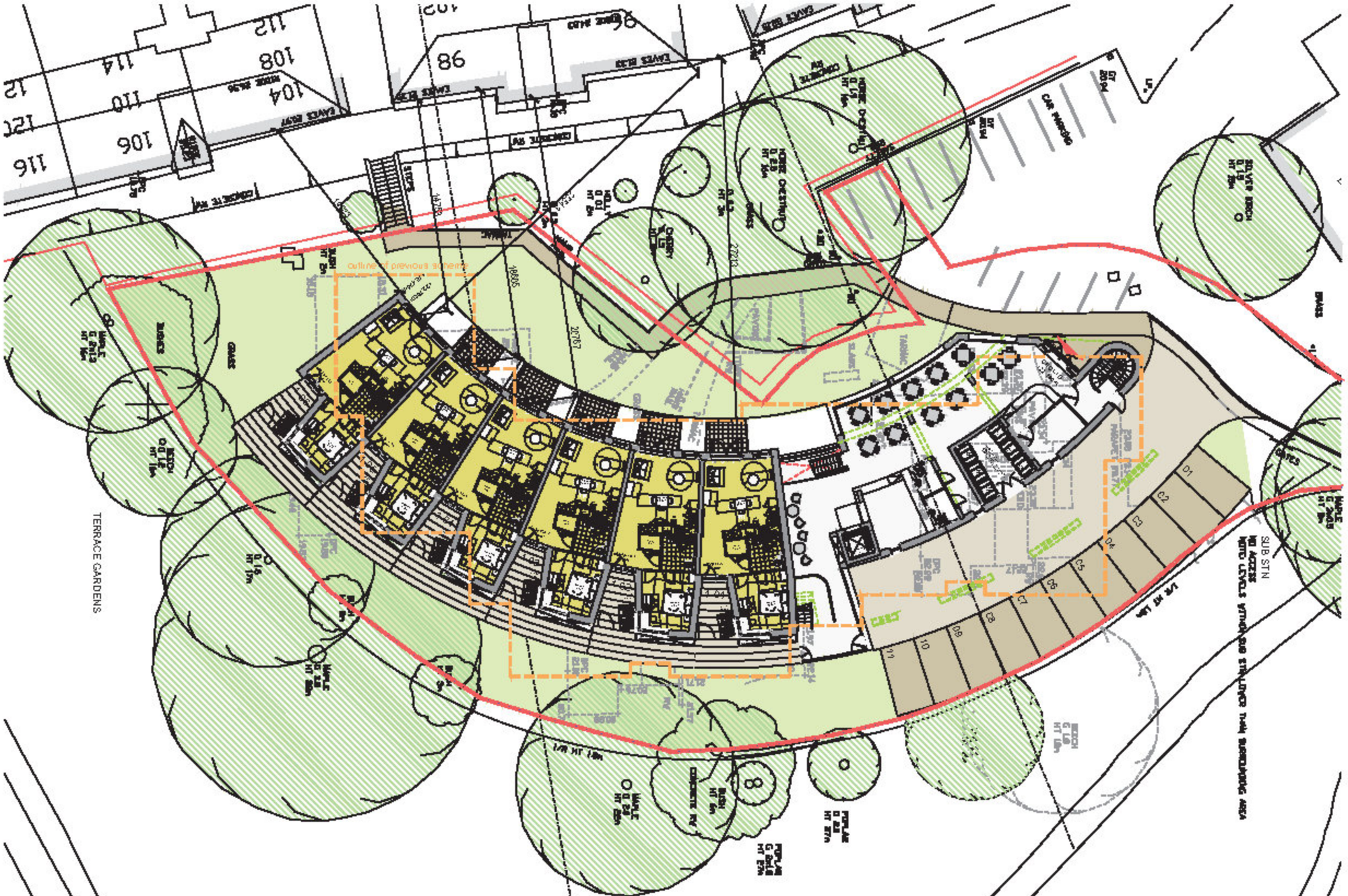
- One Bedroom Flat
- Two Bedroom Flat

Scale 1:100@A0

HOMMON TERRACE, RICHMOND

PRELIMINARY

hunters



GROUND FLOOR PLAN
scale 1:100@A0

SITE LOCATION PLAN
scale 1:1250@A0

SCHEDULE OF ACCOMMODATION			
Floor	1b2p 55.0m²	2b3p 67.5m²	GIA
Lower Ground:	06*	–	443.0m²
Ground Floor:	06	–	504.0m²
First Floor:	07	01	542.7m²
Second Floor:	04	01	346.0m²
Third Floor:	02	01	249.0m²
TOTAL No.Apts	25	03	28 Apts
Parking:	11 carspaces inundercroft		
Note:	*Unit 04 may not be a viable unit as it will have a poor outlook. Potential planning issue		
TOTAL GIA:			2167.5m²
SITE AREA:			2101m²

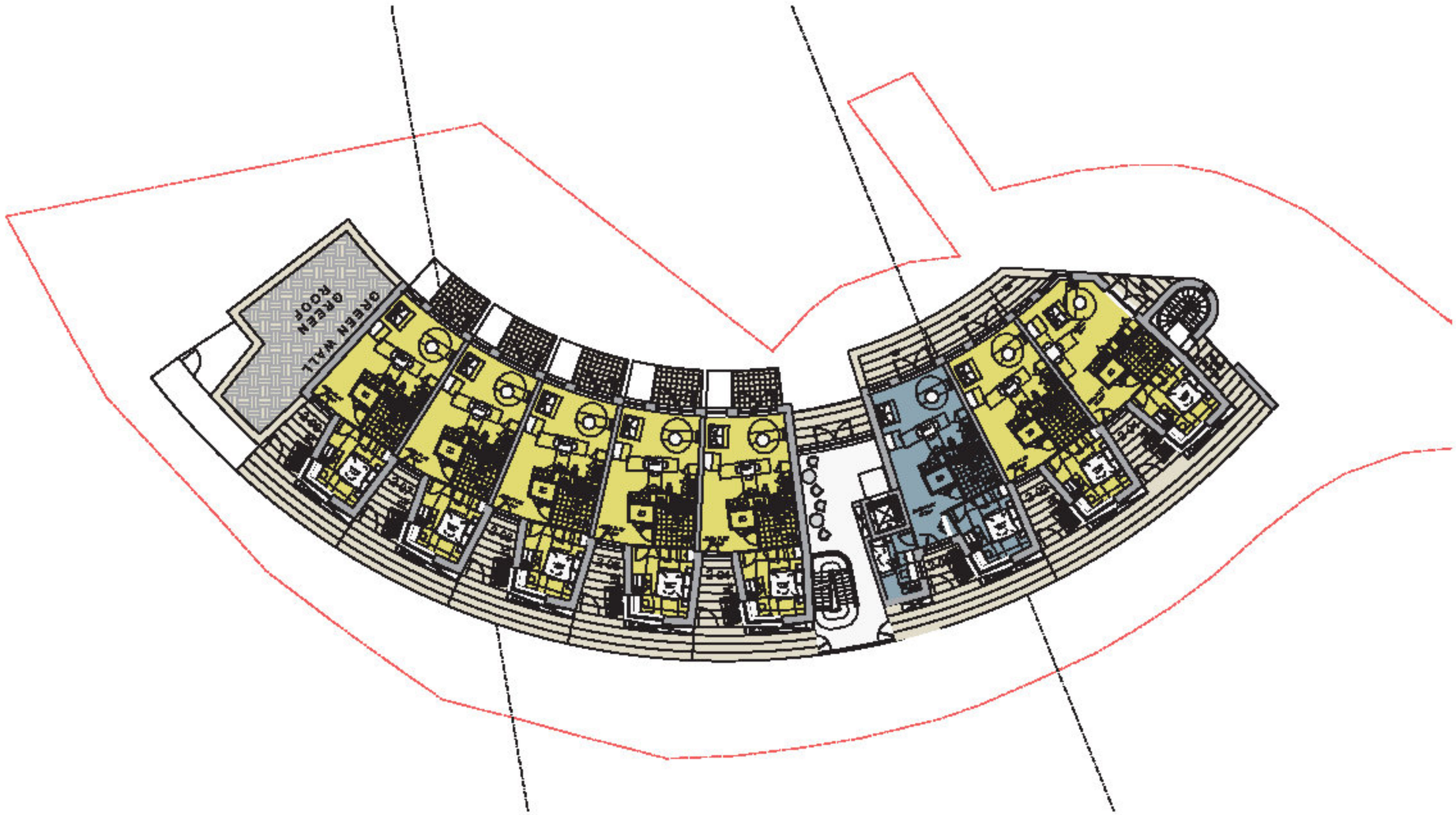
COLOUR KEY

- One Bedroom Flat
- Two Bedroom Flat

Scale 1:100@A0

HOWSON TERRACE, RICHMOND

PRELIMINARY



SITE LOCATION PLAN
scale 1:1250@A0

SCHEDULE OF ACCOMMODATION			
Floor	1Bdrm 50.0m²	2Bdrm 72.0m²	GIA
Lower Ground:	00*	–	440.0m²
Ground Floor:	05	–	554.2m²
First Floor:	07	01	648.7m²
Second Floor:	04	01	468.2m²
Third Floor:	02	01	344.6m²
TOTAL No Apts:	18	03	21 Apts
Parking:	11 car spaces in undercroft		
Notes:	*Unit 00 may not be a viable unit as it has a poor outlook. Potential plant space		
TOTAL GIA:			2987.8m²
SITE AREA:			2191m²

COLOUR KEY

- 1Dny Bedroom Flat
- Two Bedroom Flat

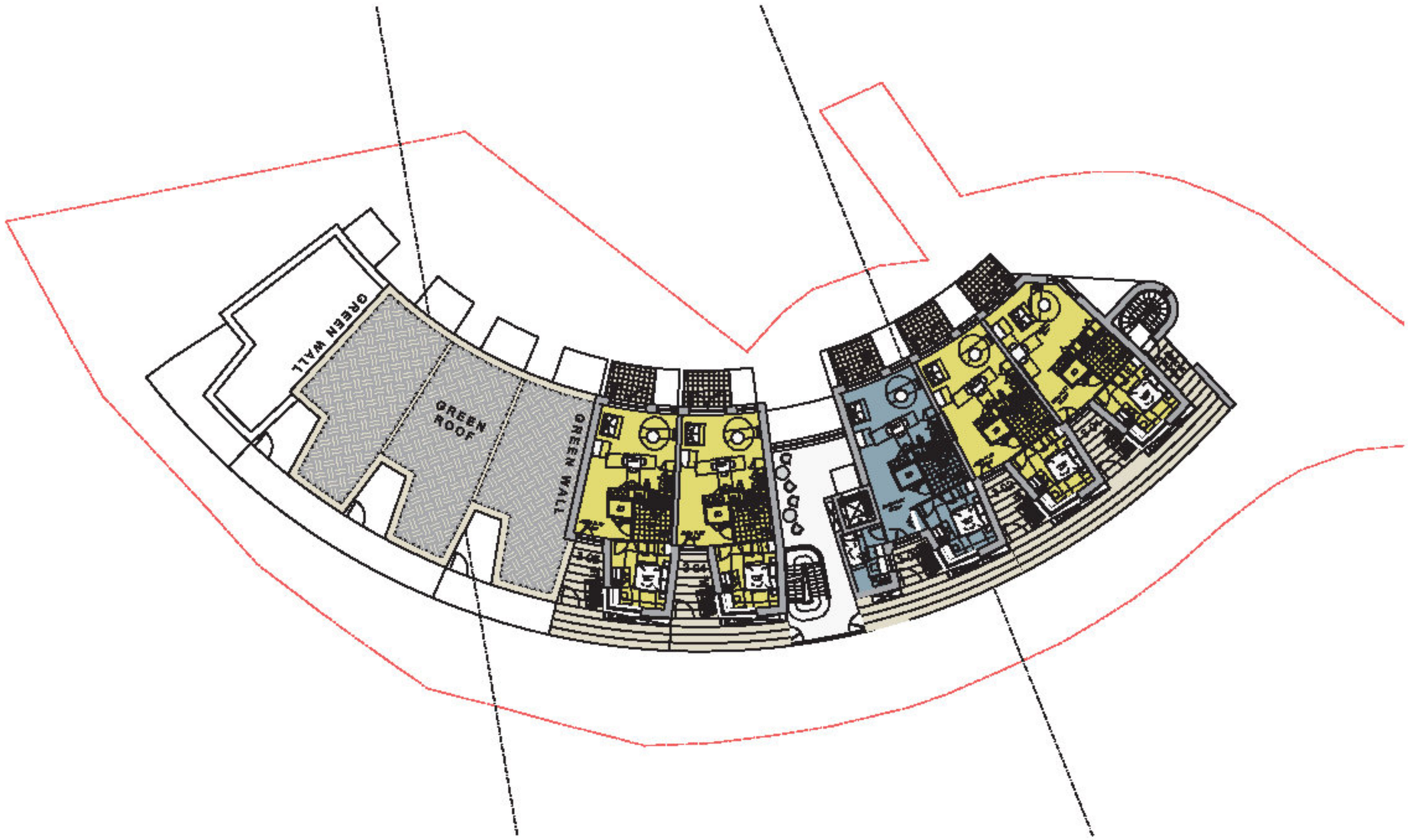
0 1m 4m 10m
Scale 1:100@A0

FIRST FLOOR PLAN
scale 1:100@A0

MONMOUTH TERRACE, RICHMOND
PROPOSED FIRST FLOOR PLAN

PRELIMINARY

hunters



SECOND FLOOR PLAN
scale 1:100@A0

SITE LOCATION PLAN
scale 1:1250@A0

SCHEDULE OF ACCOMMODATION			
Floor	1Bdle 50.0m²	2Bdle 57.5m²	GIA
Lower Ground:	00*	–	410.0m²
Ground Floor:	05	–	554.2m²
First Floor:	07	01	618.7m²
Second Floor:	04	01	468.2m²
Third Floor:	02	01	344.6m²
TOTAL No Apc:	18	03	21 Apts
Parking:	11 car spaces in undercroft		
Notes:	*Unit 0-01 may not be a viable unit as it has a poor outlook. Potential plant room		
TOTAL GIA:			2987.8m²
SITE AREA:			2191m²

COLOUR KEY

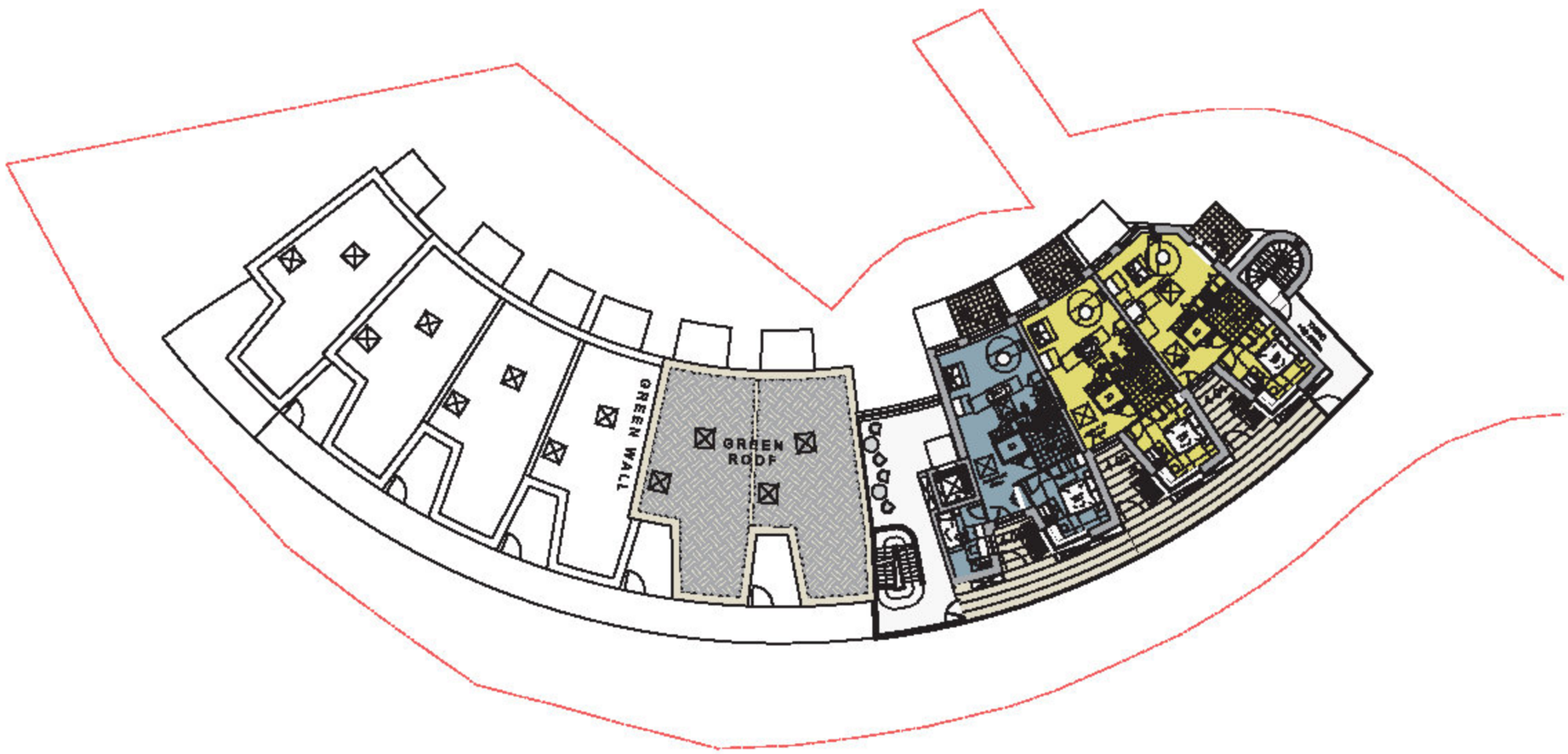
- One Bedroom Flat
- Two Bedroom Flat

0 1m 4m 10m
Scale 1:100@A0

MONSON TERRACE, RICHMOND
SECOND FLOOR PLAN

PRELIMINARY

hunters



SITE LOCATION PLAN
scale 1:1250@A0

THIRD FLOOR PLAN
scale 1:100@A0

SCHEDULE OF ACCOMMODATION			
Floor	1bdrm sq.m²	2bdrm sq.m²	GIA
Lower Ground:	00*	–	449.8m²
Ground Floor:	00	–	384.2m²
First Floor:	02	01	498.7m²
Second Floor:	04	01	555.8m²
Third Floor:	02	01	340.6m²
TOTAL No Apt:	08	03	38 Apts
Parking:	11 carspaces in undercroft		
Notes:	*Unit 0-01 may not be a useful unit as it has a poor outlook. Potential plant space		
TOTAL GIA:			2627.6m²
SITE/GIA:			2101m²

COLOUR KEY

- One Bedroom Flat
- Two Bedroom Flat

Scale 1:100@A0

HOMERTON TERRACE, RICHMOND

PRELIMINARY

hunters

SITE LOCATION PLAN
scale 1:1250@A3

SCHEDULE OF ACCOMMODATION

Floor	Studio sq.m²	2Bed/2p sq.m²	GIA
Lower Ground:	000	–	000.0m²
Ground Floor:	00	–	000.0m²
First Floor:	02	01	000.0m²
Second Floor:	04	01	000.0m²
Third Floor:	02	01	000.0m²
TOTAL No Apts:	08	03	00 Apts
Parking:	11 car spaces in enclosure (8		
Notes:	*Unit 0-01 may not be a viable unit as it has a poor outlook. Potential plant room		
TOTAL GIA:			0000.0m²
SITE AREA:			0000m²

COLOUR KEY

- One Bedroom Flat
- Two Bedroom Flat

Scale 1:100@A3

HOMEROW TERRACE, RICHMOND
PROPOSED ROOF PLAN

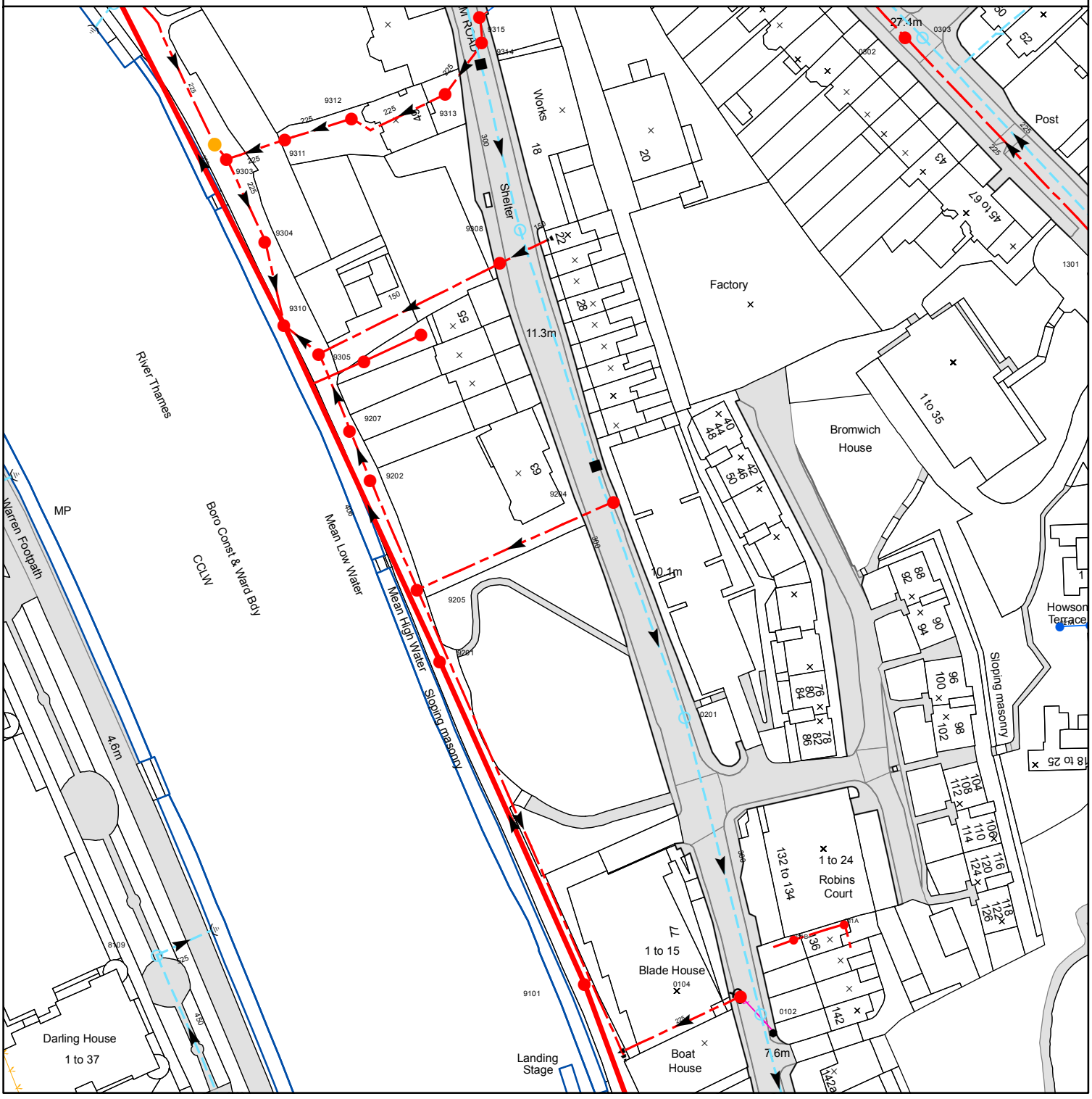
PRELIMINARY

hunters

Appendix 3

Based on the Ordnance Survey Map with the sanction of the Controller of H.M Stationary Office License Number 10019345

ALS/ALS Standard/2020_4274832



0 5 10 20 30 40 Meters

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

Scale:	1:1240
Width:	246m
Printed By:	tlove
Print Date:	19/10/2020
Map Centre:	517982,174261
Grid Reference:	TQ1774SE

Comments:

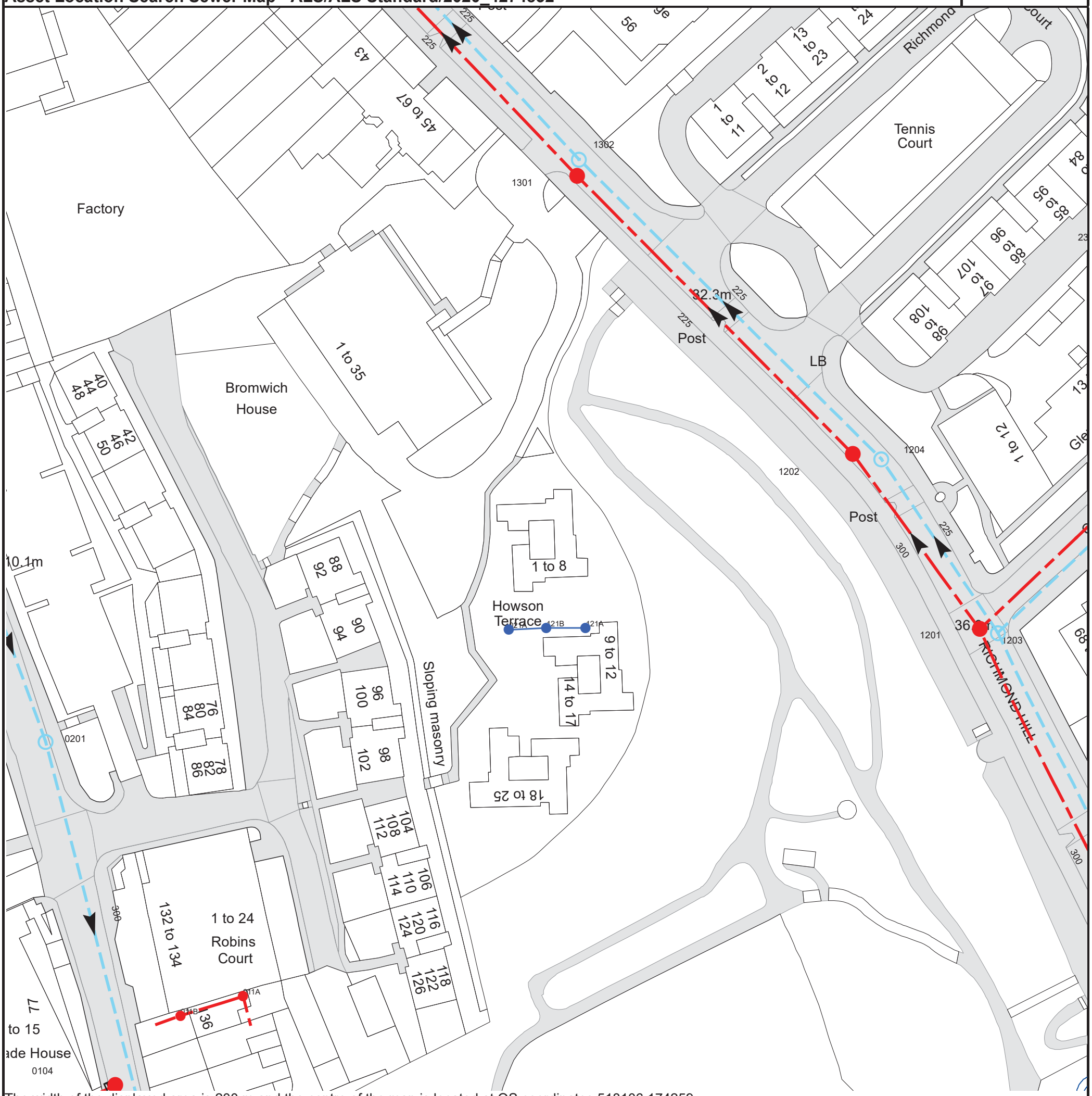
ALS/ALS Standard/2020_4274832

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

REFERENCE	COVER LEVEL	INVERT LEVEL
9207		
93ZV		
9308		
9314		
9304		
0104	7.94	5.85
9303		
9204	10.52	8.79
021A		
9312		
9310		
9305		
9202		
011A		

REFERENCE	COVER LEVEL	INVERT LEVEL
0201	9.52	5.6
0303	27.25	25.06
9311		
93ZW		
9201		-1.2
8109		2.76
9313		
0302	27.15	23.46
0102	7.92	4.41
9306		
9205		
9315		
9101		-1.09
011B		

Asset Location Search Sewer Map - ALS/ALS Standard/2020_4274832



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 518106,174259

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

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
0104	7.94	5.85
011B	n/a	n/a
011A	n/a	n/a
0201	9.52	5.6
021A	n/a	n/a
121B	n/a	n/a
121A	n/a	n/a
1204	34.35	31.61
1202	34.04	31.3
1301	30.56	27.87
1302	30.5	28.21
1203	36.07	32.88
1201	35.99	33.01

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

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

- Trunk Surface Water
- Trunk Foul
- Storm Relief
- Trunk Combined
- Vent Pipe
- Bio-solids (Sludge)
- Proposed Thames Surface Water Sewer
- Proposed Thames Water Foul Sewer
- Gallery
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Sludge Rising Main
- Proposed Thames Water Rising Main
- Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

- Air Valve
- Dam Chase
- Fitting
- Meter
- Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

- Control Valve
- Drop Pipe
- Ancillary
- Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

- Outfall
- Undefined End
- Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

- Public/Private Pumping Station
- Change of characteristic indicator (C.O.C.I.)
- Invert Level
- Summit

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Operational Site
- Chamber
- Tunnel
- Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

- Foul Sewer
- Surface Water Sewer
- Combined Sewer
- Gulley
- Culverted Watercourse
- Proposed
- Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Miss L Smith
Cole Easdon Ltd
Unit 2 York House
Edison Park, Dorcan Way
Swindon SN3 3RB

Our ref: DS6078641

0800 009 3921
Monday to Friday, 8am to 5pm

29th Oct 2020

Pre-planning enquiry: Wastewater Capacity check

Dear Miss Smith

Thank you for providing details of your development with the Pre-Planning application dated 28th Oct 20 for development @ Howson Terrace Richmond Hill TW10 6RT

Brownfield site {24 sheltered units} ,developed to {30 units } as per your above application.

We have completed the current assessment of the foul water flows & surface water discharges based on the information submitted in your application with the purpose of assessing sewerage capacity within the existing Thames Water sewer network, in liaison with TW Asset Planners.

Foul

If your proposals progress in line with the details you've provided as above, we're pleased to confirm that there will be sufficient sewerage capacity in the adjacent TW foul sewer network to serve your foul discharges from your development, provided it is by gravity.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

You'll need to keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient capacity and has to be investigated again.

Surface Water

When developing a site, policy 5.13 of the London Plan and Policy 3.4 of the Supplementary Planning Guidance (Sustainable Design And Construction) states that every attempt should be made to use flow attenuation and SuDS/Storage to reduce the surface water discharge from the site as much as possible.

In accordance with the Building Act 2000 Clause H3.3, positive connection of surface water to a public sewer will only be consented when it can be demonstrated that the hierarchy of disposal

methods have been examined and proven to be impracticable. Before we can consider your surface water needs, you'll need written approval from the lead local flood authority that you have followed the sequential approach to the disposal of surface water and considered all practical means

The disposal hierarchy being:

1. store rainwater for later use.
2. use infiltration techniques where possible.
3. attenuate rainwater in ponds or open water features for gradual release.
4. attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. discharge rainwater direct to a watercourse.;; *and if above cannot be achieved*
6. discharge rainwater to a surface water sewer/drain.
7. discharge rainwater to the combined sewer.
8. discharge rainwater to the foul sewer

Where connection to the public sewerage network is still required after examining the hierarchy {1-5} to manage surface water flows we will accept these flows at a discharge rate in line with ***CIRIA's best practice guide on SuDS or that stated within the sites planning approval.***

If the above surface water hierarchy has been followed and if the flows are restricted to a total of around 2.7 l/s to TW surface water sewer network, then TW would not have any objections to the proposal.

Please see the attached 'Planning your wastewater' leaflet for additional information. At the appropriate time, you will have to apply for a S106 connection application to DS Connection team

Source Protection Zone

Please check whether your development falls within a Source Protection Zone for groundwater abstraction. These zones may be at particular risk from polluting activities on or below the land surface. To prevent pollution, the Environment Agency and Thames Water (or other local water undertaker) will use a tiered, risk-based approach to regulate activities that may impact groundwater resources. The applicant is encouraged to read the Environment Agency's approach to groundwater protection (available at https://www.gov.uk/government/publications/ groundwater-protection-position-statements) and may wish to discuss the implications for their development with a suitably qualified environmental consultant.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

Please note that you must keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient sewerage capacity.

What happens next?

Please make sure you submit your connection application, when you are ready, giving us at least 21 days' notice of the date you wish to make your new connection/s.

If you've any further questions, please contact me.

Yours sincerely

Sgd: *Siva.sivarajan*

Siva Sivarajan

Developer Services- Wastewater Adoptions Engineer

Office:0203 577 7752 Mobile: 07747842608
siva.sivarajan@thameswater.co.uk

Thames Water Utilities Ltd, Clearwater Court, Vastern Road, Reading, Berkshire, RG1 8DB
Find us online at developers.thameswater.co.uk

TW Int ref : DTS 67399

Appendix 4

Environment Agency's Flood Map

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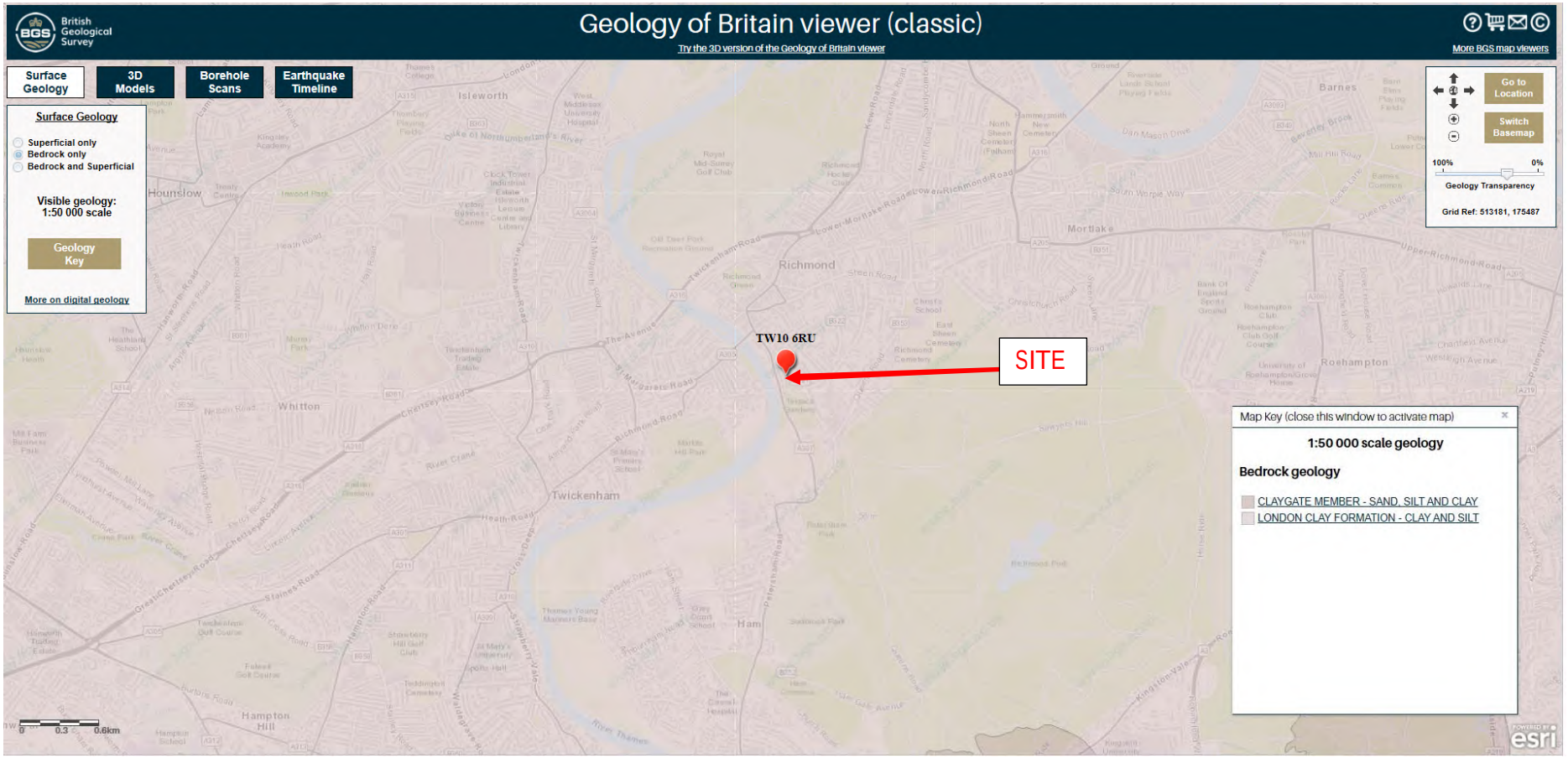
Environment Agency Surface Water Flood Map

Contains public sector information licensed under the Open Government Licence v3.0

Appendix 5

British Geological Survey – Bedrock Geology



Contains British Geological Survey materials ©NERC [2020]

British Geological Survey - Borehole Location Plan

Contains British Geological Survey materials ©NERC [2020]

British Geological Survey – Borehole Log

APPENDIX 1 SHEET 3

1312 7431
TQ17SE 163

BOREHOLE NO. 2

Ground Level 86.5 O.D. +26.37m. Diameter of Boring 8 inch

Water Struck Seepage at 76.5 O.D. 64.5 O.D. Method Shell and auger

Standing Water Level 77.0 O.D. (21/5/68) Start 13/5/68 Finish 14/5/68

REMARKS:

Description of Strata	Thickness	Depth	Reduced Level	Disturbed Samples	Undisturbed Samples and Insitu Tests
Made ground (Brown clay, gravel and brick fragments)	10'0"			J7240 2'6"	U7241 3'6"
				J7242 7'6"	U7243 8'6"
Firm brown clay	2'6"	10'0"	76.5		
		12'6"	74.0	J7244 12'6"	
					U7245 13'6"
				J7246 17'6"	U7247 18'6"
				J7248 22'6"	
					U7249 25'0"
				J7250 27'6"	
Stiff grey clay, with 1 inch sand layer at 19ft	67'6"				U7251 30'0"
				J7252 32'6"	
					U7253 35'0"
				J7254 37'6"	
					U7255 40'0"
				J7256 42'6"	U7257 43'6"
				J7258 47'6"	
					U7259 48'6"
TOTALS					

NOTES: Descriptions in accordance with C.P.2001 "Site Investigations"
J Jar Sample B Bulk Sample W Water Sample

British Geological Survey – Borehole Log

APPENDIX 1 SHEET 5

TQ175E'164

BOREHOLE NO. 3

Ground Level 72.9 OD + 22.22m Diameter of Boring 8 inch

Water Struck Seepage at 62.9 OD Method Shell and auger

Standing Water Level 68.4 OD (21/5/68) Start 15/5/68 Finish 15/5/68

REMARKS:

Description of Strata	Thickness	Depth	Reduced Level	Disturbed Samples	Undisturbed Samples and Insitu Tests
Made ground (Clay, gravel and brick fragments)	10'0"			J7273 2'6"	U7274 3'6"
				J7275 7'6"	
		10'0"	62.9		U7276 10'0"
Firm mottled grey and brown clay	5'0"			J7277 12'6"	
		15'0"	57.9		U7278 15'0"
				J7279 17'6"	U7280 18'6"
				J7281 22'6"	U7282 23'6"
Stiff to very stiff grey clay	65'0"			J7283 27'6"	U7284 28'6"
				J7285 32'6"	U7286 33'6"
				J7287 37'6"	U7288 38'6"
				J7289 42'6"	U7290 45'0"
				J7291 47'2"	U7292 48'6"
TOTALS					

NOTES: Descriptions in accordance with C.P.2001 "Site Investigations"
J – Jar Sample B – Bulk Sample W – Water Sample

Appendix 6

Determination of Peak Discharge
from Catchment

Existing Site

COLE EASDON CONSULTANTS

The Rational Formula

Q_p=CiA/0.36

Q_{1yr}	**6l/s**	Peak discharge from catchment
A	0.0670ha	Catchment area
i	31.8mm/hr	Average rainfall intensity
C	1.1mm/hr	Dimensionless coefficient

Determination of C

Value of C_V

C_V	0.84	Volumetric runoff coefficient

Value of C_R

C_R	1.3	Routing coefficient

Determination of i

Determination of M5-60 min and r

M5-60min	20mm	5 year - 60 minute rainfall depth
r	0.41	Ratio of the 5 year - 60 minute rainfall depth to the 5 year - 2 day rainfall depth
D	15min	Rainfall duration
T	1year	Return period

Determination of M5-D

Z_1	0.64	
M5-D	12.8mm	rainfall depth of 5 year return period for required duration

Determination of MT-D

Z_2	0.62	
MT-D	7.94mm	rainfall depth of the required return period

Determination of point rainfall intensities

i	31.8mm/hr

Aplication of areal reduction factor

A	0.0007km²
ARF	1
i	**31.8mm/hr**

Determination of Peak Discharge
from Catchment

Existing Site

COLE EASDON CONSULTANTS

The Rational Formula

$Q_p=CiA/0.36$

Q_{30yr}	**16l/s**	Peak discharge from catchment
A	0.0670ha	Catchment area
i	77.3mm/hr	Average rainfall intensity
C	1.1mm/hr	Dimensionless coefficient

Determination of C

Value of C_V

C_V	0.84	Volumetric runoff coefficient

Value of C_R

C_R	1.3	Routing coefficient

Determination of i

Determination of M5-60 min and r

M5-60min	20mm	5 year - 60 minute rainfall depth
r	0.41	Ratio of the 5 year - 60 minute rainfall depth to the 5 year - 2 day rainfall depth
D	15min	Rainfall duration
T	30year	Return period

Determination of M5-D

Z_1	0.64	
M5-D	12.8mm	rainfall depth of 5 year return period for required duration

Determination of MT-D

Z_2	1.51	
MT-D	19.33mm	rainfall depth of the required return period

Determination of point rainfall intensities

i	77.3mm/hr

Aplication of areal reduction factor

A	0.0007km²
ARF	1
i	**77.3mm/hr**

Determination of Peak Discharge
from Catchment

Existing Site

COLE EASDON CONSULTANTS

The Rational Formula

Q_p=CiA/0.36

Q_{100yr}	**20l/s**	Peak discharge from catchment
A	0.0670ha	Catchment area
i	99.8mm/hr	Average rainfall intensity
C	1.1mm/hr	Dimensionless coefficient

Determination of C

Value of C_V

C_V	0.84	Volumetric runoff coefficient

Value of C_R

C_R	1.3	Routing coefficient

Determination of i

Determination of M5-60 min and r

M5-60min	20mm	5 year - 60 minute rainfall depth
r	0.41	Ratio of the 5 year - 60 minute rainfall depth to the 5 year - 2 day rainfall depth
D	15min	Rainfall duration
T	100year	Return period

Determination of M5-D

Z_1	0.64	
M5-D	12.8mm	rainfall depth of 5 year return period for required duration

Determination of MT-D

Z_2	1.95	
MT-D	24.96mm	rainfall depth of the required return period

Determination of point rainfall intensities

i	99.8mm/hr

Aplication of areal reduction factor

A	0.0007km²
ARF	1
i	**99.8mm/hr**

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	0.230	Urban	0.000
SAAR (mm)	600	Region Number	Region 6

Results l/s

QBAR Rural	0.8
QBAR Urban	0.8
Q100 years	2.7
Q1 year	0.7
Q30 years	1.9
Q100 years	2.7

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	0.410	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Green Roof

Area (m^3)	182	Evaporation (mm/day)	3
Depression Storage (mm)	5	Decay Coefficient	0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.003307	32	36	0.000668	64	68	0.000135	96	100	0.000027
4	8	0.002708	36	40	0.000547	68	72	0.000110	100	104	0.000022
8	12	0.002217	40	44	0.000448	72	76	0.000090	104	108	0.000018
12	16	0.001815	44	48	0.000366	76	80	0.000074	108	112	0.000015
16	20	0.001486	48	52	0.000300	80	84	0.000061	112	116	0.000012
20	24	0.001217	52	56	0.000246	84	88	0.000050	116	120	0.000010
24	28	0.000996	56	60	0.000201	88	92	0.000041			
28	32	0.000816	60	64	0.000165	92	96	0.000033			

Time Area Diagram

Total Area (ha) 0.036

Time From:	(mins) To:	Area (ha)
0	4	0.036

Model Details

Storage is Online Cover Level (m) 22.500

Cellular Storage Structure

Invert Level (m) 20.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	21.0	21.0	1.200	21.0	43.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0049-1200-1200-1200
Design Head (m)	1.200
Design Flow (l/s)	1.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	49
Invert Level (m)	20.500
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	1.2	Kick-Flo®	0.438	0.8
Flush-Flo™	0.215	0.9	Mean Flow over Head Range	-	0.9

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	0.9	1.200	1.2	3.000	1.8	7.000	2.7
0.200	0.9	1.400	1.3	3.500	2.0	7.500	2.8
0.300	0.9	1.600	1.4	4.000	2.1	8.000	2.9
0.400	0.8	1.800	1.4	4.500	2.2	8.500	2.9
0.500	0.8	2.000	1.5	5.000	2.3	9.000	3.0
0.600	0.9	2.200	1.6	5.500	2.4	9.500	3.1
0.800	1.0	2.400	1.6	6.000	2.5		
1.000	1.1	2.600	1.7	6.500	2.6		

Summary of Results for 1 year Return Period

Half Drain Time : 30 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	20.585	0.085	0.0	0.8	0.8	1.7	O K
30 min Summer	20.598	0.098	0.0	0.8	0.8	2.0	O K
60 min Summer	20.605	0.105	0.0	0.9	0.9	2.1	O K
120 min Summer	20.612	0.112	0.0	0.9	0.9	2.2	O K
180 min Summer	20.611	0.111	0.0	0.9	0.9	2.2	O K
240 min Summer	20.607	0.107	0.0	0.9	0.9	2.1	O K
360 min Summer	20.596	0.096	0.0	0.8	0.8	1.9	O K
480 min Summer	20.585	0.085	0.0	0.8	0.8	1.7	O K
600 min Summer	20.576	0.076	0.0	0.8	0.8	1.5	O K
720 min Summer	20.569	0.069	0.0	0.7	0.7	1.4	O K
960 min Summer	20.559	0.059	0.0	0.7	0.7	1.2	O K
1440 min Summer	20.547	0.047	0.0	0.5	0.5	0.9	O K
2160 min Summer	20.538	0.038	0.0	0.4	0.4	0.8	O K
2880 min Summer	20.533	0.033	0.0	0.3	0.3	0.7	O K
4320 min Summer	20.528	0.028	0.0	0.2	0.2	0.6	O K
5760 min Summer	20.525	0.025	0.0	0.2	0.2	0.5	O K
7200 min Summer	20.522	0.022	0.0	0.2	0.2	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	31.246	0.0	2.2	15
30 min Summer	20.306	0.0	3.2	24
60 min Summer	12.800	0.0	4.2	42
120 min Summer	7.903	0.0	5.4	84
180 min Summer	5.931	0.0	6.2	118
240 min Summer	4.833	0.0	6.8	150
360 min Summer	3.601	0.0	7.7	214
480 min Summer	2.913	0.0	8.4	272
600 min Summer	2.471	0.0	8.9	330
720 min Summer	2.161	0.0	9.3	390
960 min Summer	1.748	0.0	10.1	508
1440 min Summer	1.296	0.0	11.2	748
2160 min Summer	0.962	0.0	12.3	1104
2880 min Summer	0.779	0.0	13.2	1468
4320 min Summer	0.577	0.0	14.3	2200
5760 min Summer	0.467	0.0	15.1	2936
7200 min Summer	0.396	0.0	15.8	3672

Summary of Results for 1 year Return Period

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
8640 min Summer	20.521	0.021	0.0	0.1	0.1	0.4	O K
10080 min Summer	20.519	0.019	0.0	0.1	0.1	0.4	O K
15 min Winter	20.596	0.096	0.0	0.8	0.8	1.9	O K
30 min Winter	20.610	0.110	0.0	0.9	0.9	2.2	O K
60 min Winter	20.625	0.125	0.0	0.9	0.9	2.5	O K
120 min Winter	20.630	0.130	0.0	0.9	0.9	2.6	O K
180 min Winter	20.623	0.123	0.0	0.9	0.9	2.5	O K
240 min Winter	20.613	0.113	0.0	0.9	0.9	2.3	O K
360 min Winter	20.591	0.091	0.0	0.8	0.8	1.8	O K
480 min Winter	20.574	0.074	0.0	0.8	0.8	1.5	O K
600 min Winter	20.565	0.065	0.0	0.7	0.7	1.3	O K
720 min Winter	20.557	0.057	0.0	0.6	0.6	1.1	O K
960 min Winter	20.548	0.048	0.0	0.5	0.5	0.9	O K
1440 min Winter	20.538	0.038	0.0	0.4	0.4	0.8	O K
2160 min Winter	20.531	0.031	0.0	0.3	0.3	0.6	O K
2880 min Winter	20.527	0.027	0.0	0.2	0.2	0.5	O K
4320 min Winter	20.523	0.023	0.0	0.2	0.2	0.5	O K
5760 min Winter	20.520	0.020	0.0	0.1	0.1	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.347	0.0	16.4	4352
10080 min Summer	0.310	0.0	16.9	5136
15 min Winter	31.246	0.0	2.6	16
30 min Winter	20.306	0.0	3.7	26
60 min Winter	12.800	0.0	4.9	58
120 min Winter	7.903	0.0	6.2	90
180 min Winter	5.931	0.0	7.1	126
240 min Winter	4.833	0.0	7.8	160
360 min Winter	3.601	0.0	8.8	222
480 min Winter	2.913	0.0	9.5	276
600 min Winter	2.471	0.0	10.1	336
720 min Winter	2.161	0.0	10.6	394
960 min Winter	1.748	0.0	11.4	510
1440 min Winter	1.296	0.0	12.7	750
2160 min Winter	0.962	0.0	14.0	1112
2880 min Winter	0.779	0.0	15.0	1476
4320 min Winter	0.577	0.0	16.4	2232
5760 min Winter	0.467	0.0	17.4	2944

Summary of Results for 1 year Return Period

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
7200 min Winter	20.519	0.019	0.0	0.1	0.1	0.4	O K
8640 min Winter	20.517	0.017	0.0	0.1	0.1	0.3	O K
10080 min Winter	20.516	0.016	0.0	0.1	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.396	0.0	18.1	3616
8640 min Winter	0.347	0.0	18.7	4296
10080 min Winter	0.310	0.0	19.3	4960

Summary of Results for 30 year Return Period

Half Drain Time : 102 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	20.738	0.238	0.0	0.9	0.9	4.7	O K
30	min Summer	20.829	0.329	0.0	0.9	0.9	6.6	O K
60	min Summer	20.914	0.414	0.0	0.9	0.9	8.3	O K
120	min Summer	20.962	0.462	0.0	0.9	0.9	9.2	O K
180	min Summer	20.954	0.454	0.0	0.9	0.9	9.1	O K
240	min Summer	20.939	0.439	0.0	0.9	0.9	8.8	O K
360	min Summer	20.899	0.399	0.0	0.9	0.9	8.0	O K
480	min Summer	20.856	0.356	0.0	0.9	0.9	7.1	O K
600	min Summer	20.815	0.315	0.0	0.9	0.9	6.3	O K
720	min Summer	20.777	0.277	0.0	0.9	0.9	5.5	O K
960	min Summer	20.711	0.211	0.0	0.9	0.9	4.2	O K
1440	min Summer	20.629	0.129	0.0	0.9	0.9	2.6	O K
2160	min Summer	20.575	0.075	0.0	0.8	0.8	1.5	O K
2880	min Summer	20.559	0.059	0.0	0.7	0.7	1.2	O K
4320	min Summer	20.544	0.044	0.0	0.5	0.5	0.9	O K
5760	min Summer	20.537	0.037	0.0	0.4	0.4	0.7	O K
7200	min Summer	20.533	0.033	0.0	0.3	0.3	0.6	O K

	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15	min Summer	76.671	0.0	6.8	25
30	min Summer	49.712	0.0	9.1	39
60	min Summer	30.811	0.0	11.5	64
120	min Summer	18.537	0.0	14.1	120
180	min Summer	13.628	0.0	15.6	154
240	min Summer	10.910	0.0	16.7	186
360	min Summer	7.952	0.0	18.3	246
480	min Summer	6.352	0.0	19.5	308
600	min Summer	5.333	0.0	20.5	372
720	min Summer	4.621	0.0	21.3	434
960	min Summer	3.685	0.0	22.7	550
1440	min Summer	2.675	0.0	24.6	780
2160	min Summer	1.940	0.0	26.6	1112
2880	min Summer	1.543	0.0	28.1	1472
4320	min Summer	1.117	0.0	30.1	2200
5760	min Summer	0.887	0.0	31.5	2936
7200	min Summer	0.742	0.0	32.6	3672

Summary of Results for 30 year Return Period

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
8640 min Summer	20.530	0.030	0.0	0.3	0.3	0.6	O K
10080 min Summer	20.528	0.028	0.0	0.2	0.2	0.5	O K
15 min Winter	20.778	0.278	0.0	0.9	0.9	5.5	O K
30 min Winter	20.883	0.383	0.0	0.9	0.9	7.6	O K
60 min Winter	20.983	0.483	0.0	0.9	0.9	9.6	O K
120 min Winter	21.039	0.539	0.0	0.9	0.9	10.7	O K
180 min Winter	21.029	0.529	0.0	0.9	0.9	10.6	O K
240 min Winter	21.007	0.507	0.0	0.9	0.9	10.1	O K
360 min Winter	20.952	0.452	0.0	0.9	0.9	9.0	O K
480 min Winter	20.878	0.378	0.0	0.9	0.9	7.5	O K
600 min Winter	20.811	0.311	0.0	0.9	0.9	6.2	O K
720 min Winter	20.752	0.252	0.0	0.9	0.9	5.0	O K
960 min Winter	20.664	0.164	0.0	0.9	0.9	3.3	O K
1440 min Winter	20.581	0.081	0.0	0.8	0.8	1.6	O K
2160 min Winter	20.554	0.054	0.0	0.6	0.6	1.1	O K
2880 min Winter	20.544	0.044	0.0	0.5	0.5	0.9	O K
4320 min Winter	20.535	0.035	0.0	0.4	0.4	0.7	O K
5760 min Winter	20.530	0.030	0.0	0.3	0.3	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.641	0.0	33.3	4376
10080 min Summer	0.567	0.0	34.0	5040
15 min Winter	76.671	0.0	7.8	27
30 min Winter	49.712	0.0	10.3	42
60 min Winter	30.811	0.0	13.0	66
120 min Winter	18.537	0.0	15.9	118
180 min Winter	13.628	0.0	17.6	168
240 min Winter	10.910	0.0	18.8	194
360 min Winter	7.952	0.0	20.6	270
480 min Winter	6.352	0.0	22.0	334
600 min Winter	5.333	0.0	23.1	396
720 min Winter	4.621	0.0	24.0	456
960 min Winter	3.685	0.0	25.5	568
1440 min Winter	2.675	0.0	27.8	778
2160 min Winter	1.940	0.0	30.1	1120
2880 min Winter	1.543	0.0	31.7	1468
4320 min Winter	1.117	0.0	34.1	2200
5760 min Winter	0.887	0.0	35.7	2848

Summary of Results for 30 year Return Period

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
7200 min Winter	20.527	0.027	0.0	0.2	0.2	0.5	O K
8640 min Winter	20.525	0.025	0.0	0.2	0.2	0.5	O K
10080 min Winter	20.523	0.023	0.0	0.2	0.2	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.742	0.0	37.0	3608
8640 min Winter	0.641	0.0	37.9	4400
10080 min Winter	0.567	0.0	38.7	5096

Summary of Results for 100 year Return Period

Half Drain Time : 145 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	20.840	0.340	0.0	0.9	0.9	6.8	O K
30 min Summer	20.975	0.475	0.0	0.9	0.9	9.5	O K
60 min Summer	21.094	0.594	0.0	0.9	0.9	11.8	O K
120 min Summer	21.166	0.666	0.0	0.9	0.9	13.3	O K
180 min Summer	21.162	0.662	0.0	0.9	0.9	13.2	O K
240 min Summer	21.146	0.646	0.0	0.9	0.9	12.9	O K
360 min Summer	21.107	0.607	0.0	0.9	0.9	12.1	O K
480 min Summer	21.065	0.565	0.0	0.9	0.9	11.3	O K
600 min Summer	21.022	0.522	0.0	0.9	0.9	10.4	O K
720 min Summer	20.977	0.477	0.0	0.9	0.9	9.5	O K
960 min Summer	20.875	0.375	0.0	0.9	0.9	7.5	O K
1440 min Summer	20.732	0.232	0.0	0.9	0.9	4.6	O K
2160 min Summer	20.623	0.123	0.0	0.9	0.9	2.4	O K
2880 min Summer	20.578	0.078	0.0	0.8	0.8	1.6	O K
4320 min Summer	20.554	0.054	0.0	0.6	0.6	1.1	O K
5760 min Summer	20.543	0.043	0.0	0.5	0.5	0.9	O K
7200 min Summer	20.538	0.038	0.0	0.4	0.4	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	99.536	0.0	9.1	31
30 min Summer	65.075	0.0	12.3	47
60 min Summer	40.510	0.0	15.5	66
120 min Summer	24.362	0.0	18.8	122
180 min Summer	17.855	0.0	20.8	162
240 min Summer	14.239	0.0	22.1	192
360 min Summer	10.317	0.0	24.1	256
480 min Summer	8.210	0.0	25.6	324
600 min Summer	6.871	0.0	26.8	392
720 min Summer	5.939	0.0	27.8	462
960 min Summer	4.714	0.0	29.4	582
1440 min Summer	3.400	0.0	31.7	810
2160 min Summer	2.448	0.0	34.1	1148
2880 min Summer	1.937	0.0	35.8	1476
4320 min Summer	1.391	0.0	38.1	2204
5760 min Summer	1.099	0.0	39.8	2936
7200 min Summer	0.915	0.0	41.0	3648

Summary of Results for 100 year Return Period

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
8640 min Summer	20.534	0.034	0.0	0.3	0.3	0.7	O K
10080 min Summer	20.531	0.031	0.0	0.3	0.3	0.6	O K
15 min Winter	20.896	0.396	0.0	0.9	0.9	7.9	O K
30 min Winter	21.045	0.545	0.0	0.9	0.9	10.9	O K
60 min Winter	21.179	0.679	0.0	0.9	0.9	13.5	O K
120 min Winter	21.269	0.769	0.0	1.0	1.0	15.3	O K
180 min Winter	21.268	0.768	0.0	1.0	1.0	15.3	O K
240 min Winter	21.243	0.743	0.0	1.0	1.0	14.8	O K
360 min Winter	21.188	0.688	0.0	0.9	0.9	13.7	O K
480 min Winter	21.127	0.627	0.0	0.9	0.9	12.5	O K
600 min Winter	21.062	0.562	0.0	0.9	0.9	11.2	O K
720 min Winter	20.995	0.495	0.0	0.9	0.9	9.9	O K
960 min Winter	20.838	0.338	0.0	0.9	0.9	6.7	O K
1440 min Winter	20.656	0.156	0.0	0.9	0.9	3.1	O K
2160 min Winter	20.572	0.072	0.0	0.8	0.8	1.4	O K
2880 min Winter	20.555	0.055	0.0	0.6	0.6	1.1	O K
4320 min Winter	20.540	0.040	0.0	0.4	0.4	0.8	O K
5760 min Winter	20.534	0.034	0.0	0.3	0.3	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.787	0.0	41.9	4400
10080 min Summer	0.693	0.0	42.6	5032
15 min Winter	99.536	0.0	10.4	34
30 min Winter	65.075	0.0	13.8	48
60 min Winter	40.510	0.0	17.5	68
120 min Winter	24.362	0.0	21.2	120
180 min Winter	17.855	0.0	23.4	172
240 min Winter	14.239	0.0	24.9	202
360 min Winter	10.317	0.0	27.1	274
480 min Winter	8.210	0.0	28.8	348
600 min Winter	6.871	0.0	30.1	422
720 min Winter	5.939	0.0	31.2	498
960 min Winter	4.714	0.0	33.0	616
1440 min Winter	3.400	0.0	35.7	822
2160 min Winter	2.448	0.0	38.4	1120
2880 min Winter	1.937	0.0	40.3	1468
4320 min Winter	1.391	0.0	43.1	2200
5760 min Winter	1.099	0.0	45.0	2928

Summary of Results for 100 year Return Period

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
7200 min Winter	20.530	0.030	0.0	0.3	0.3	0.6	O K
8640 min Winter	20.528	0.028	0.0	0.2	0.2	0.5	O K
10080 min Winter	20.526	0.026	0.0	0.2	0.2	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.915	0.0	46.4	3672
8640 min Winter	0.787	0.0	47.5	4360
10080 min Winter	0.693	0.0	48.4	5136

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

Half Drain Time : 194 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	21.029	0.529	0.0	0.9	0.9	10.6	O K
30 min Summer	21.210	0.710	0.0	0.9	0.9	14.2	O K
60 min Summer	21.383	0.883	0.0	1.0	1.0	17.6	O K
120 min Summer	21.508	1.008	0.0	1.1	1.1	20.1	O K
180 min Summer	21.516	1.016	0.0	1.1	1.1	20.3	O K
240 min Summer	21.498	0.998	0.0	1.1	1.1	19.9	O K
360 min Summer	21.453	0.953	0.0	1.1	1.1	19.0	O K
480 min Summer	21.407	0.907	0.0	1.1	1.1	18.1	O K
600 min Summer	21.359	0.859	0.0	1.0	1.0	17.1	O K
720 min Summer	21.313	0.813	0.0	1.0	1.0	16.2	O K
960 min Summer	21.226	0.726	0.0	1.0	1.0	14.5	O K
1440 min Summer	21.069	0.569	0.0	0.9	0.9	11.4	O K
2160 min Summer	20.824	0.324	0.0	0.9	0.9	6.5	O K
2880 min Summer	20.685	0.185	0.0	0.9	0.9	3.7	O K
4320 min Summer	20.584	0.084	0.0	0.8	0.8	1.7	O K
5760 min Summer	20.561	0.061	0.0	0.7	0.7	1.2	O K
7200 min Summer	20.550	0.050	0.0	0.6	0.6	1.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	139.350	0.0	13.2	39
30 min Summer	91.106	0.0	17.5	50
60 min Summer	56.713	0.0	22.1	70
120 min Summer	34.106	0.0	26.7	122
180 min Summer	24.997	0.0	29.5	174
240 min Summer	19.934	0.0	31.4	202
360 min Summer	14.444	0.0	34.1	266
480 min Summer	11.493	0.0	36.2	332
600 min Summer	9.620	0.0	37.9	400
720 min Summer	8.314	0.0	39.3	468
960 min Summer	6.600	0.0	41.6	606
1440 min Summer	4.760	0.0	44.9	870
2160 min Summer	3.427	0.0	48.4	1216
2880 min Summer	2.712	0.0	50.9	1544
4320 min Summer	1.948	0.0	54.4	2208
5760 min Summer	1.538	0.0	56.9	2936
7200 min Summer	1.281	0.0	58.8	3672

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
8640 min Summer	20.544	0.044	0.0	0.5	0.5	0.9	O K
10080 min Summer	20.539	0.039	0.0	0.4	0.4	0.8	O K
15 min Winter	21.104	0.604	0.0	0.9	0.9	12.1	O K
30 min Winter	21.309	0.809	0.0	1.0	1.0	16.1	O K
60 min Winter	21.506	1.006	0.0	1.1	1.1	20.1	O K
120 min Winter	21.657	1.157	0.0	1.2	1.2	23.1	O K
180 min Winter	21.680	1.180	0.0	1.2	1.2	23.5	O K
240 min Winter	21.656	1.156	0.0	1.2	1.2	23.1	O K
360 min Winter	21.596	1.096	0.0	1.2	1.2	21.9	O K
480 min Winter	21.531	1.031	0.0	1.1	1.1	20.6	O K
600 min Winter	21.462	0.962	0.0	1.1	1.1	19.2	O K
720 min Winter	21.394	0.894	0.0	1.1	1.1	17.8	O K
960 min Winter	21.265	0.765	0.0	1.0	1.0	15.3	O K
1440 min Winter	21.030	0.530	0.0	0.9	0.9	10.6	O K
2160 min Winter	20.692	0.192	0.0	0.9	0.9	3.8	O K
2880 min Winter	20.591	0.091	0.0	0.8	0.8	1.8	O K
4320 min Winter	20.555	0.055	0.0	0.6	0.6	1.1	O K
5760 min Winter	20.544	0.044	0.0	0.5	0.5	0.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.102	0.0	60.3	4384
10080 min Summer	0.970	0.0	61.5	5088
15 min Winter	139.350	0.0	14.9	40
30 min Winter	91.106	0.0	19.8	51
60 min Winter	56.713	0.0	24.8	70
120 min Winter	34.106	0.0	30.1	120
180 min Winter	24.997	0.0	33.1	174
240 min Winter	19.934	0.0	35.3	220
360 min Winter	14.444	0.0	38.4	280
480 min Winter	11.493	0.0	40.7	356
600 min Winter	9.620	0.0	42.6	430
720 min Winter	8.314	0.0	44.2	504
960 min Winter	6.600	0.0	46.8	648
1440 min Winter	4.760	0.0	50.5	938
2160 min Winter	3.427	0.0	54.4	1232
2880 min Winter	2.712	0.0	57.3	1528
4320 min Winter	1.948	0.0	61.3	2200
5760 min Winter	1.538	0.0	64.2	2936

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
7200 min Winter	20.538	0.038	0.0	0.4	0.4	0.8	O K
8640 min Winter	20.534	0.034	0.0	0.3	0.3	0.7	O K
10080 min Winter	20.532	0.032	0.0	0.3	0.3	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.281	0.0	66.4	3648
8640 min Winter	1.102	0.0	68.1	4288
10080 min Winter	0.970	0.0	69.5	5104

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	0.410	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Green Roof

Area (m^3)	340	Evaporation (mm/day)	3
Depression Storage (mm)	5	Decay Coefficient	0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.006178	32	36	0.001247	64	68	0.000252	96	100	0.000051
4	8	0.005059	36	40	0.001021	68	72	0.000206	100	104	0.000042
8	12	0.004142	40	44	0.000836	72	76	0.000169	104	108	0.000034
12	16	0.003391	44	48	0.000685	76	80	0.000138	108	112	0.000028
16	20	0.002776	48	52	0.000560	80	84	0.000113	112	116	0.000023
20	24	0.002273	52	56	0.000459	84	88	0.000093	116	120	0.000019
24	28	0.001861	56	60	0.000376	88	92	0.000076			
28	32	0.001524	60	64	0.000308	92	96	0.000062			

Time Area Diagram

Total Area (ha) 0.032

Time From:	(mins) To:	Area (ha)
0	4	0.032

Model Details

Storage is Online Cover Level (m) 18.000

Cellular Storage Structure

Invert Level (m) 16.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	24.5	24.5	1.200	24.5	48.3

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0055-1500-1200-1500
Design Head (m)	1.200
Design Flow (l/s)	1.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	55
Invert Level (m)	16.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	1.5	Kick-Flo®	0.493	1.0
Flush-Flo™	0.242	1.2	Mean Flow over Head Range	-	1.2

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	1.1	1.200	1.5	3.000	2.3	7.000	3.4
0.200	1.2	1.400	1.6	3.500	2.4	7.500	3.5
0.300	1.2	1.600	1.7	4.000	2.6	8.000	3.6
0.400	1.2	1.800	1.8	4.500	2.7	8.500	3.7
0.500	1.0	2.000	1.9	5.000	2.9	9.000	3.8
0.600	1.1	2.200	2.0	5.500	3.0	9.500	3.9
0.800	1.2	2.400	2.1	6.000	3.1		
1.000	1.4	2.600	2.1	6.500	3.3		

Summary of Results for 1 year Return Period

Half Drain Time : 23 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	16.064	0.064	0.0	0.8	0.8	1.5	O K
30	min Summer	16.073	0.073	0.0	0.9	0.9	1.7	O K
60	min Summer	16.078	0.078	0.0	1.0	1.0	1.8	O K
120	min Summer	16.092	0.092	0.0	1.1	1.1	2.1	O K
180	min Summer	16.096	0.096	0.0	1.1	1.1	2.2	O K
240	min Summer	16.096	0.096	0.0	1.1	1.1	2.2	O K
360	min Summer	16.090	0.090	0.0	1.1	1.1	2.1	O K
480	min Summer	16.081	0.081	0.0	1.0	1.0	1.9	O K
600	min Summer	16.074	0.074	0.0	1.0	1.0	1.7	O K
720	min Summer	16.068	0.068	0.0	0.9	0.9	1.6	O K
960	min Summer	16.059	0.059	0.0	0.8	0.8	1.4	O K
1440	min Summer	16.048	0.048	0.0	0.6	0.6	1.1	O K
2160	min Summer	16.040	0.040	0.0	0.5	0.5	0.9	O K
2880	min Summer	16.035	0.035	0.0	0.4	0.4	0.8	O K
4320	min Summer	16.029	0.029	0.0	0.3	0.3	0.7	O K
5760	min Summer	16.026	0.026	0.0	0.2	0.2	0.6	O K
7200	min Summer	16.024	0.024	0.0	0.2	0.2	0.5	O K

	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15	min Summer	31.246	0.0	2.1	15
30	min Summer	20.306	0.0	3.2	23
60	min Summer	12.800	0.0	4.5	60
120	min Summer	7.903	0.0	6.0	88
180	min Summer	5.931	0.0	6.9	120
240	min Summer	4.833	0.0	7.6	152
360	min Summer	3.601	0.0	8.7	214
480	min Summer	2.913	0.0	9.5	272
600	min Summer	2.471	0.0	10.1	332
720	min Summer	2.161	0.0	10.6	390
960	min Summer	1.748	0.0	11.4	510
1440	min Summer	1.296	0.0	12.6	750
2160	min Summer	0.962	0.0	13.9	1104
2880	min Summer	0.779	0.0	14.7	1472
4320	min Summer	0.577	0.0	15.8	2200
5760	min Summer	0.467	0.0	16.4	2936
7200	min Summer	0.396	0.0	17.0	3648

Summary of Results for 1 year Return Period

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
8640 min Summer	16.022	0.022	0.0	0.2	0.2	0.5	O K
10080 min Summer	16.020	0.020	0.0	0.2	0.2	0.5	O K
15 min Winter	16.072	0.072	0.0	0.9	0.9	1.7	O K
30 min Winter	16.081	0.081	0.0	1.0	1.0	1.9	O K
60 min Winter	16.099	0.099	0.0	1.1	1.1	2.3	O K
120 min Winter	16.111	0.111	0.0	1.1	1.1	2.6	O K
180 min Winter	16.110	0.110	0.0	1.1	1.1	2.6	O K
240 min Winter	16.104	0.104	0.0	1.1	1.1	2.4	O K
360 min Winter	16.087	0.087	0.0	1.0	1.0	2.0	O K
480 min Winter	16.074	0.074	0.0	1.0	1.0	1.7	O K
600 min Winter	16.065	0.065	0.0	0.9	0.9	1.5	O K
720 min Winter	16.058	0.058	0.0	0.8	0.8	1.3	O K
960 min Winter	16.049	0.049	0.0	0.6	0.6	1.1	O K
1440 min Winter	16.040	0.040	0.0	0.5	0.5	0.9	O K
2160 min Winter	16.033	0.033	0.0	0.4	0.4	0.8	O K
2880 min Winter	16.029	0.029	0.0	0.3	0.3	0.7	O K
4320 min Winter	16.024	0.024	0.0	0.2	0.2	0.6	O K
5760 min Winter	16.021	0.021	0.0	0.2	0.2	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.347	0.0	17.4	4352
10080 min Summer	0.310	0.0	17.8	5136
15 min Winter	31.246	0.0	2.5	15
30 min Winter	20.306	0.0	3.8	24
60 min Winter	12.800	0.0	5.3	60
120 min Winter	7.903	0.0	6.9	94
180 min Winter	5.931	0.0	8.0	128
240 min Winter	4.833	0.0	8.8	160
360 min Winter	3.601	0.0	10.0	222
480 min Winter	2.913	0.0	10.8	278
600 min Winter	2.471	0.0	11.5	336
720 min Winter	2.161	0.0	12.1	396
960 min Winter	1.748	0.0	13.1	510
1440 min Winter	1.296	0.0	14.5	744
2160 min Winter	0.962	0.0	16.0	1104
2880 min Winter	0.779	0.0	17.0	1472
4320 min Winter	0.577	0.0	18.4	2180
5760 min Winter	0.467	0.0	19.2	2944

Summary of Results for 1 year Return Period

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
7200 min Winter	16.020	0.020	0.0	0.1	0.1	0.5	O K
8640 min Winter	16.018	0.018	0.0	0.1	0.1	0.4	O K
10080 min Winter	16.017	0.017	0.0	0.1	0.1	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.396	0.0	19.8	3656
8640 min Winter	0.347	0.0	20.2	4440
10080 min Winter	0.310	0.0	20.6	5184

Summary of Results for 30 year Return Period

Half Drain Time : 82 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	16.195	0.195	0.0	1.2	1.2	4.5	O K
30	min Summer	16.289	0.289	0.0	1.2	1.2	6.7	O K
60	min Summer	16.378	0.378	0.0	1.2	1.2	8.8	O K
120	min Summer	16.432	0.432	0.0	1.2	1.2	10.1	O K
180	min Summer	16.430	0.430	0.0	1.2	1.2	10.0	O K
240	min Summer	16.418	0.418	0.0	1.2	1.2	9.7	O K
360	min Summer	16.382	0.382	0.0	1.2	1.2	8.9	O K
480	min Summer	16.340	0.340	0.0	1.2	1.2	7.9	O K
600	min Summer	16.298	0.298	0.0	1.2	1.2	6.9	O K
720	min Summer	16.259	0.259	0.0	1.2	1.2	6.0	O K
960	min Summer	16.196	0.196	0.0	1.2	1.2	4.6	O K
1440	min Summer	16.119	0.119	0.0	1.1	1.1	2.8	O K
2160	min Summer	16.074	0.074	0.0	1.0	1.0	1.7	O K
2880	min Summer	16.059	0.059	0.0	0.8	0.8	1.4	O K
4320	min Summer	16.045	0.045	0.0	0.6	0.6	1.0	O K
5760	min Summer	16.039	0.039	0.0	0.5	0.5	0.9	O K
7200	min Summer	16.034	0.034	0.0	0.4	0.4	0.8	O K

	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15	min Summer	76.671	0.0	7.7	32
30	min Summer	49.712	0.0	10.5	45
60	min Summer	30.811	0.0	13.4	68
120	min Summer	18.537	0.0	16.5	120
180	min Summer	13.628	0.0	18.3	150
240	min Summer	10.910	0.0	19.7	182
360	min Summer	7.952	0.0	21.6	244
480	min Summer	6.352	0.0	23.1	306
600	min Summer	5.333	0.0	24.2	370
720	min Summer	4.621	0.0	25.2	430
960	min Summer	3.685	0.0	26.8	548
1440	min Summer	2.675	0.0	29.0	776
2160	min Summer	1.940	0.0	31.3	1116
2880	min Summer	1.543	0.0	32.9	1472
4320	min Summer	1.117	0.0	35.0	2200
5760	min Summer	0.887	0.0	36.4	2920
7200	min Summer	0.742	0.0	37.3	3592

Summary of Results for 30 year Return Period

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
8640 min Summer	16.031	0.031	0.0	0.3	0.3	0.7	O K
10080 min Summer	16.029	0.029	0.0	0.3	0.3	0.7	O K
15 min Winter	16.235	0.235	0.0	1.2	1.2	5.5	O K
30 min Winter	16.343	0.343	0.0	1.2	1.2	8.0	O K
60 min Winter	16.447	0.447	0.0	1.2	1.2	10.4	O K
120 min Winter	16.520	0.520	0.0	1.2	1.2	12.1	O K
180 min Winter	16.516	0.516	0.0	1.2	1.2	12.0	O K
240 min Winter	16.490	0.490	0.0	1.2	1.2	11.4	O K
360 min Winter	16.422	0.422	0.0	1.2	1.2	9.8	O K
480 min Winter	16.351	0.351	0.0	1.2	1.2	8.2	O K
600 min Winter	16.284	0.284	0.0	1.2	1.2	6.6	O K
720 min Winter	16.227	0.227	0.0	1.2	1.2	5.3	O K
960 min Winter	16.147	0.147	0.0	1.2	1.2	3.4	O K
1440 min Winter	16.078	0.078	0.0	1.0	1.0	1.8	O K
2160 min Winter	16.055	0.055	0.0	0.7	0.7	1.3	O K
2880 min Winter	16.045	0.045	0.0	0.6	0.6	1.0	O K
4320 min Winter	16.036	0.036	0.0	0.4	0.4	0.8	O K
5760 min Winter	16.031	0.031	0.0	0.3	0.3	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.641	0.0	37.9	4400
10080 min Summer	0.567	0.0	38.3	5032
15 min Winter	76.671	0.0	8.8	34
30 min Winter	49.712	0.0	12.0	48
60 min Winter	30.811	0.0	15.3	72
120 min Winter	18.537	0.0	18.7	120
180 min Winter	13.628	0.0	20.8	170
240 min Winter	10.910	0.0	22.3	198
360 min Winter	7.952	0.0	24.4	264
480 min Winter	6.352	0.0	26.1	328
600 min Winter	5.333	0.0	27.4	390
720 min Winter	4.621	0.0	28.5	448
960 min Winter	3.685	0.0	30.3	558
1440 min Winter	2.675	0.0	32.8	764
2160 min Winter	1.940	0.0	35.5	1120
2880 min Winter	1.543	0.0	37.3	1452
4320 min Winter	1.117	0.0	39.9	2192
5760 min Winter	0.887	0.0	41.5	2936

Summary of Results for 30 year Return Period

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
7200 min Winter	16.028	0.028	0.0	0.3	0.3	0.7	O K
8640 min Winter	16.026	0.026	0.0	0.2	0.2	0.6	O K
10080 min Winter	16.024	0.024	0.0	0.2	0.2	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.742	0.0	42.7	3664
8640 min Winter	0.641	0.0	43.5	4376
10080 min Winter	0.567	0.0	44.2	5120

Summary of Results for 100 year Return Period

Half Drain Time : 124 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	16.298	0.298	0.0	1.2	1.2	6.9	O K
30 min Summer	16.436	0.436	0.0	1.2	1.2	10.1	O K
60 min Summer	16.571	0.571	0.0	1.2	1.2	13.3	O K
120 min Summer	16.661	0.661	0.0	1.2	1.2	15.4	O K
180 min Summer	16.663	0.663	0.0	1.2	1.2	15.4	O K
240 min Summer	16.647	0.647	0.0	1.2	1.2	15.1	O K
360 min Summer	16.606	0.606	0.0	1.2	1.2	14.1	O K
480 min Summer	16.558	0.558	0.0	1.2	1.2	13.0	O K
600 min Summer	16.506	0.506	0.0	1.2	1.2	11.8	O K
720 min Summer	16.444	0.444	0.0	1.2	1.2	10.3	O K
960 min Summer	16.345	0.345	0.0	1.2	1.2	8.0	O K
1440 min Summer	16.209	0.209	0.0	1.2	1.2	4.9	O K
2160 min Summer	16.112	0.112	0.0	1.1	1.1	2.6	O K
2880 min Summer	16.077	0.077	0.0	1.0	1.0	1.8	O K
4320 min Summer	16.055	0.055	0.0	0.7	0.7	1.3	O K
5760 min Summer	16.045	0.045	0.0	0.6	0.6	1.0	O K
7200 min Summer	16.039	0.039	0.0	0.5	0.5	0.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	99.536	0.0	10.5	37
30 min Summer	65.075	0.0	14.3	52
60 min Summer	40.510	0.0	18.2	74
120 min Summer	24.362	0.0	22.3	122
180 min Summer	17.855	0.0	24.6	166
240 min Summer	14.239	0.0	26.3	196
360 min Summer	10.317	0.0	28.6	260
480 min Summer	8.210	0.0	30.4	328
600 min Summer	6.871	0.0	31.8	396
720 min Summer	5.939	0.0	33.0	456
960 min Summer	4.714	0.0	34.9	574
1440 min Summer	3.400	0.0	37.6	802
2160 min Summer	2.448	0.0	40.4	1140
2880 min Summer	1.937	0.0	42.3	1472
4320 min Summer	1.391	0.0	44.8	2204
5760 min Summer	1.099	0.0	46.4	2904
7200 min Summer	0.915	0.0	47.5	3672

Summary of Results for 100 year Return Period

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
8640 min Summer	16.036	0.036	0.0	0.4	0.4	0.8	O K
10080 min Summer	16.033	0.033	0.0	0.4	0.4	0.8	O K
15 min Winter	16.353	0.353	0.0	1.2	1.2	8.2	O K
30 min Winter	16.517	0.517	0.0	1.2	1.2	12.0	O K
60 min Winter	16.659	0.659	0.0	1.2	1.2	15.3	O K
120 min Winter	16.762	0.762	0.0	1.2	1.2	17.7	O K
180 min Winter	16.769	0.769	0.0	1.2	1.2	17.9	O K
240 min Winter	16.743	0.743	0.0	1.2	1.2	17.3	O K
360 min Winter	16.685	0.685	0.0	1.2	1.2	15.9	O K
480 min Winter	16.616	0.616	0.0	1.2	1.2	14.3	O K
600 min Winter	16.539	0.539	0.0	1.2	1.2	12.6	O K
720 min Winter	16.444	0.444	0.0	1.2	1.2	10.3	O K
960 min Winter	16.295	0.295	0.0	1.2	1.2	6.9	O K
1440 min Winter	16.136	0.136	0.0	1.2	1.2	3.2	O K
2160 min Winter	16.071	0.071	0.0	0.9	0.9	1.6	O K
2880 min Winter	16.055	0.055	0.0	0.7	0.7	1.3	O K
4320 min Winter	16.042	0.042	0.0	0.5	0.5	1.0	O K
5760 min Winter	16.036	0.036	0.0	0.4	0.4	0.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.787	0.0	48.3	4336
10080 min Summer	0.693	0.0	48.8	5136
15 min Winter	99.536	0.0	12.0	40
30 min Winter	65.075	0.0	16.2	56
60 min Winter	40.510	0.0	20.6	76
120 min Winter	24.362	0.0	25.2	122
180 min Winter	17.855	0.0	27.8	172
240 min Winter	14.239	0.0	29.6	206
360 min Winter	10.317	0.0	32.3	276
480 min Winter	8.210	0.0	34.3	350
600 min Winter	6.871	0.0	35.9	426
720 min Winter	5.939	0.0	37.3	488
960 min Winter	4.714	0.0	39.4	598
1440 min Winter	3.400	0.0	42.5	808
2160 min Winter	2.448	0.0	45.6	1124
2880 min Winter	1.937	0.0	47.8	1472
4320 min Winter	1.391	0.0	50.8	2200
5760 min Winter	1.099	0.0	52.8	2840

Summary of Results for 100 year Return Period

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
7200 min Winter	16.032	0.032	0.0	0.4	0.4	0.7	O K
8640 min Winter	16.029	0.029	0.0	0.3	0.3	0.7	O K
10080 min Winter	16.027	0.027	0.0	0.3	0.3	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.915	0.0	54.1	3672
8640 min Winter	0.787	0.0	55.1	4368
10080 min Winter	0.693	0.0	55.9	5160

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

Half Drain Time : 189 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	16.497	0.497	0.0	1.2	1.2	11.6	O K
30 min Summer	16.691	0.691	0.0	1.2	1.2	16.1	O K
60 min Summer	16.872	0.872	0.0	1.3	1.3	20.3	O K
120 min Summer	17.012	1.012	0.0	1.4	1.4	23.6	O K
180 min Summer	17.030	1.030	0.0	1.4	1.4	24.0	O K
240 min Summer	17.012	1.012	0.0	1.4	1.4	23.6	O K
360 min Summer	16.965	0.965	0.0	1.4	1.4	22.5	O K
480 min Summer	16.915	0.915	0.0	1.3	1.3	21.3	O K
600 min Summer	16.863	0.863	0.0	1.3	1.3	20.1	O K
720 min Summer	16.813	0.813	0.0	1.3	1.3	18.9	O K
960 min Summer	16.717	0.717	0.0	1.2	1.2	16.7	O K
1440 min Summer	16.538	0.538	0.0	1.2	1.2	12.5	O K
2160 min Summer	16.280	0.280	0.0	1.2	1.2	6.5	O K
2880 min Summer	16.162	0.162	0.0	1.2	1.2	3.8	O K
4320 min Summer	16.079	0.079	0.0	1.0	1.0	1.8	O K
5760 min Summer	16.061	0.061	0.0	0.8	0.8	1.4	O K
7200 min Summer	16.051	0.051	0.0	0.7	0.7	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	139.350	0.0	15.4	47
30 min Summer	91.106	0.0	20.7	58
60 min Summer	56.713	0.0	26.2	78
120 min Summer	34.106	0.0	31.9	124
180 min Summer	24.997	0.0	35.2	176
240 min Summer	19.934	0.0	37.5	206
360 min Summer	14.444	0.0	40.9	268
480 min Summer	11.493	0.0	43.4	336
600 min Summer	9.620	0.0	45.4	404
720 min Summer	8.314	0.0	47.1	470
960 min Summer	6.600	0.0	49.8	606
1440 min Summer	4.760	0.0	53.8	876
2160 min Summer	3.427	0.0	57.8	1196
2880 min Summer	2.712	0.0	60.7	1528
4320 min Summer	1.948	0.0	64.6	2204
5760 min Summer	1.538	0.0	67.3	2936
7200 min Summer	1.281	0.0	69.2	3672

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
8640 min Summer	16.045	0.045	0.0	0.6	0.6	1.0	O K
10080 min Summer	16.041	0.041	0.0	0.5	0.5	1.0	O K
15 min Winter	16.580	0.580	0.0	1.2	1.2	13.5	O K
30 min Winter	16.793	0.793	0.0	1.2	1.2	18.5	O K
60 min Winter	16.998	0.998	0.0	1.4	1.4	23.2	O K
120 min Winter	17.160	1.160	0.0	1.5	1.5	27.0	O K
180 min Winter	17.193	1.193	0.0	1.5	1.5	27.8	O K
240 min Winter	17.170	1.170	0.0	1.5	1.5	27.2	O K
360 min Winter	17.107	1.107	0.0	1.4	1.4	25.8	O K
480 min Winter	17.036	1.036	0.0	1.4	1.4	24.1	O K
600 min Winter	16.961	0.961	0.0	1.4	1.4	22.4	O K
720 min Winter	16.886	0.886	0.0	1.3	1.3	20.6	O K
960 min Winter	16.744	0.744	0.0	1.2	1.2	17.3	O K
1440 min Winter	16.436	0.436	0.0	1.2	1.2	10.1	O K
2160 min Winter	16.158	0.158	0.0	1.2	1.2	3.7	O K
2880 min Winter	16.081	0.081	0.0	1.0	1.0	1.9	O K
4320 min Winter	16.056	0.056	0.0	0.7	0.7	1.3	O K
5760 min Winter	16.045	0.045	0.0	0.6	0.6	1.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.102	0.0	70.7	4400
10080 min Summer	0.970	0.0	71.8	5136
15 min Winter	139.350	0.0	17.5	48
30 min Winter	91.106	0.0	23.4	59
60 min Winter	56.713	0.0	29.6	78
120 min Winter	34.106	0.0	36.0	122
180 min Winter	24.997	0.0	39.7	176
240 min Winter	19.934	0.0	42.3	222
360 min Winter	14.444	0.0	46.0	284
480 min Winter	11.493	0.0	48.9	358
600 min Winter	9.620	0.0	51.2	432
720 min Winter	8.314	0.0	53.1	506
960 min Winter	6.600	0.0	56.1	650
1440 min Winter	4.760	0.0	60.6	914
2160 min Winter	3.427	0.0	65.2	1192
2880 min Winter	2.712	0.0	68.4	1500
4320 min Winter	1.948	0.0	73.0	2200
5760 min Winter	1.538	0.0	76.1	2888

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
7200 min Winter	16.040	0.040	0.0	0.5	0.5	0.9	O K
8640 min Winter	16.036	0.036	0.0	0.4	0.4	0.8	O K
10080 min Winter	16.033	0.033	0.0	0.4	0.4	0.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.281	0.0	78.5	3600
8640 min Winter	1.102	0.0	80.2	4408
10080 min Winter	0.970	0.0	81.7	5136

Appendix 7

LONDON BOROUGH OF RICHMOND UPON THAMES

LoDEG

1. Project & Site Details

Project / Site Name (including sub-catchment / stage / phase where appropriate)	Howson Terrace Redevelopment
Address & post code	Howson Terrace, Richmond Hill, Richmond upon Thames, TW10 6RU
OS Grid ref. (Easting, Northing)	E 518,100
	N 174250
LPA reference (if applicable)	
Brief description of proposed work	Demolition of 3 existing blocks and erection of a 5 storey block of 30 No. retirement accommodation
Total site Area	2300 m^2
Total existing impervious area	670 m^2
Total proposed impervious area	1200 m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	No
Existing drainage connection type and location	to 150mm surface water drain located within the site
Designer Name	Nisha Parajuli
Designer Position	Senior Engineer
Designer Company	Cole Easdon Consultants

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility

Superficial geology classification	None	
Bedrock geology classification	London Clay	
Site infiltration rate	N/A	m/s
Depth to groundwater level	N/A	m below ground level
Is infiltration feasible?	No	

2b. Drainage Hierarchy

	Feasible (Y/N)	*Proposed (Y/N)*
1 store rainwater for later use	N	N
2 use infiltration techniques, such as porous surfaces in non-clay areas	N	N
3 attenuate rainwater in ponds or open water features for gradual release	N	N
4 attenuate rainwater by storing in tanks or sealed water features for gradual release	N	Y
5 discharge rainwater direct to a watercourse	N	N
6 discharge rainwater to a surface water sewer/drain	Y	Y
7 discharge rainwater to the combined sewer.	N	N

2c. Proposed Discharge Details

Proposed discharge location	To existing surface water drains
Has the owner/regulator of the discharge location been consulted?	N/A

LONDON BOROUGH OF RICHMOND UPON THAMES

LoDEG

3. Drainage Strategy

3a. Discharge Rates & Required Storage

	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m^3)*	*Proposed discharge rate (l/s)*
Qbar	0.8			
1 in 1	0.7	6	N/A	2
1 in 30	1.9	16	N/A	2.1
1 in 100	2.7	20	N/A	2.2
1 in 100 + CC			52	2.7
Climate change allowance used		40%		
3b. Principal Method of Flow Control		Hydrobrakes		

3c. Proposed SuDS Measures

	Catchment area (m^2)	*Plan area (m^2)*	*Storage vol. (m^3)*
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	525	525	0
Blue roofs	0	0	0
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	0	0	0
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	675		52
Total	**1200**	**525**	**52**

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	Site underlain by London Clay with no infiltration potential (CEC SuDS Report Sect 2.9,3.8)
Drainage hierarchy (2b)	Green roof and attenuation tanks and hydrobrakes (CEC SuDS Report Sect 3.8-3.12)
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Discharge into the existing drain (CEC SuDS Report Sect 3.10-3.11)
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Discharge restricted to greenfield rate (CEC SuDS Report Sect 3.10-3.11)
Proposed SuDS measures & specifications (3b)	Green roof and attenuation tanks and hydrobrakes (CEC SuDS Report Sect 3.10-3.11)
4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	CEC SuDS Report Appendix 2
Detailed drainage design drawings, including exceedance flow routes	CEC Plan 7488/501 [Proposed Drainage Strategy] CEC SuDS Report Appendix 1
Detailed landscaping plans	CEC SuDS Report Appendix 2
Maintenance strategy	CEC SuDS Report Sect 3.18-3.19
Demonstration of how the proposed SuDS measures improve:	Green roof with pretreatment devices (CEC SuDS Report Sect 3.12,3.17)
a) water quality of the runoff?	
b) biodiversity?	
c) amenity?	