SuDS & Foul Drainage Assessment

Land at Clarkson Row, London, NW1 7RA

Client

Penhallow Investments Ltd
C/o 2nd Floor, Gaspe House
St Helier, JE1 1GH
Jersey

Date: December 2020

Ref: 11026

Consulting Engineers

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Schedule of Appendices

Issue	Issue date	Compiled	Checked
Preliminary Issue	11 December 2020	JP	MR
First Issue	03 February 2021	JP	MR

1 Introduction

1.1 This Statement has been prepared for Penhallow Investments Ltd in relation to the proposed scheme on land at Clarkson Row, London, NW1 7RA. No responsibility is accepted to any third party for all or part of this study in connection with this or any other development.

1.2 GTA Civils and Transport Ltd was appointed by the client to provide a SuDS & Foul Drainage Assessment statement, as required by London Borough of Camden (LBC), in order to achieve Planning Approval at said property.

1.3 The drainage strategy has been prepared to support the application for full planning permission for building a block of 8 residential flats. No responsibility is accepted to any third party for all or part of this study in connection with this or any other development.

1.4 The drainage strategy can be found in Appendix C. This shows both the proposed surface water and foul drainage strategies.

2 Existing Site

2.1 The Application Site comprises a concrete hard standing area, with access from Clarkson Row. The site area is approximately 176m^2. A site location map is shown in Appendix A.

2.2 Geology: the BGS online map shows this area's solid bedrock is London Clay (clay, silt and sand). No superficial deposits are recorded.

2.3 Hydrology: The nearest main river is the The River Thames, which is some 3km to the south - southeast. The Regents Canal lies to the north approximately 800m at its closest. The Boating Lake in Regents Park to the west is approximately 960m away.

2.4 Topography: a topographic survey is shown in the Appendix. The site is relatively flat and level, with levels ranging between 27.65m AOD near to the NW corner and 27.35m AOD near to the SE corner.

2.5 Public Sewers: Thames Water's sewer records are shown in Appendix B. The nearest sewer is a 335mm diameter combined sewer along Clarkson Row.

2.6 The records show a short length of sewerage within this site. This will be CCTV surveyed to check there is no flow in from neighbouring land. On the basis that this run is not serving another site, a Section 116 Divestment Application will be submitted to TWU and this run abandoned. The turning (outfall) manhole, ref 021G, will be retained for use in this development.

2.7 Micro Drainage calculations have been prepared to show the existing flow rates from the concreted area (176m^2 rounded up to 0.018ha) in the 3 main storm events. These are:

Storm Return Period	Offsite Flow Rate (l/s)
1 in 1 year	3.0
1 in 30 years	8.5
1 in 100 years	11.2

Drainage calculations are shown in Appendix D.

3 Proposed Surface & Foul Water Drainage Strategy

3.1 The application is for building a block of 8 residential flats. The proposed drainage strategy layout is shown in Appendix C.

3.2 The SuDS Hierarchy (infiltration, watercourses, public sewers, private sewers) was considered and, given the clay soil type and there being unduly limited space over 5m from foundations, the only viable option at this stage is to route the roof's surface water into the combined sewer at a controlled discharge rate.

3.3 For brownfield sites such as this, the offsite flow rate should be restricted to 50% of the pre-development runoff rate. It is proposed to restrict the flow rate to 5.4l/s in the critical '1 in 100 years plus 40% climate change' event. The drainage calculations (using Micro Drainage's Source Control application) are contained within Appendix D.

3.4 These calculations show that a 55mm diameter orifice plate restricts the flow rate to 1.8l/s in the 1 year storm will also restrict the flow to 3.7l/s in the 30 years event – and to 5.4l/s in the 100 years plus 40% CC event. Although the flow rate in the 1 year storm is slightly higher than 50%, the rates in both the 30 years and 100 years +CC events is less than 50% of the existing flow rates. As there is no problem with the sewer's capacity in lesser storm intensities, it is contended this is a reasonable approach. The only alternative is to provide a staged design, which would be more complex, and have a proportionately higher risk of failure.

3.5 The last set of calculations show that 4.0m^3 is needed of attenuation storage. The strategy layout in Appendix C shows an attenuation tank with a volume of 4.18m^3.

3.6 Exceedance flows: if the orifice plate were to get clogged up and the control manhole were to overtop, the resultant flow would be southwards away from the development, other dwellings and nearby buildings. An exceedance flows layout is shown in Appendix C. Note that as the orifice will be protected by a grille (mesh) and so will be considerably less liable to such clogging.

3.7 Maintenance of the SuDS system will be the overall responsibility of the Applicant. The ongoing maintenance regime will be contracted out to a Property Maintenance company. Regular inspections of the SuDS components shall be made in line with industry standards. A compliant Drainage Management and Maintenance Plan has been prepared as a separate document by GTA Civils Ltd.

3.8 The development's foul water will be routed via gravity into the combined sewer at the existing MH ref 021G as shown on both the strategy layout (Appendix C) and TWU sewer records (Appendix B).

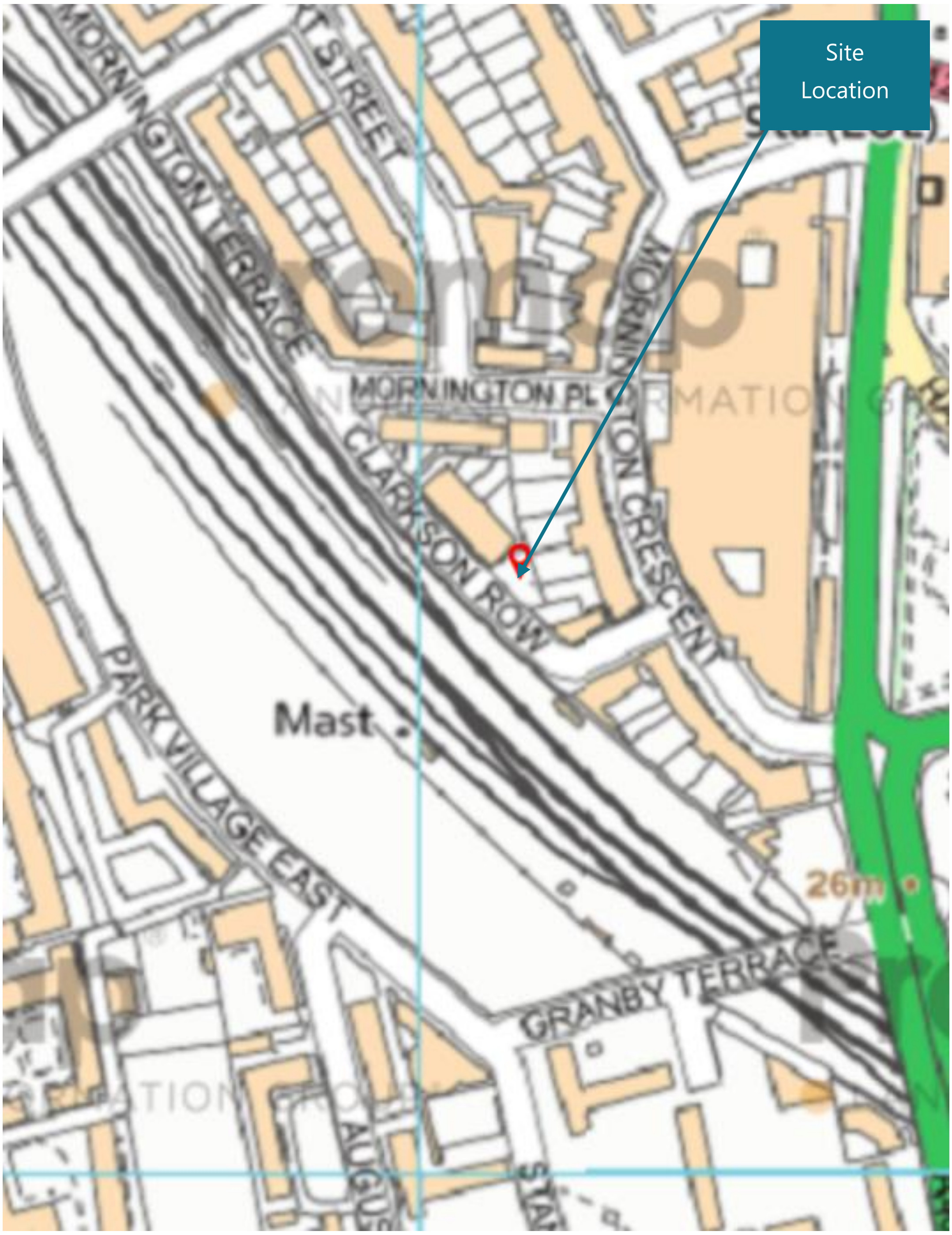
3.9 Permission to discharge the development's surface and foul water into the sewer – by means of 2 Section 106 applications – will be sought from Thames Water, who is the owner of the sewerage network.

3.10 Appendix E contains the completed Surface Water Drainage Pro-forma, as required by LBC.

- End of Statement -

Appendix A

Site Location Map

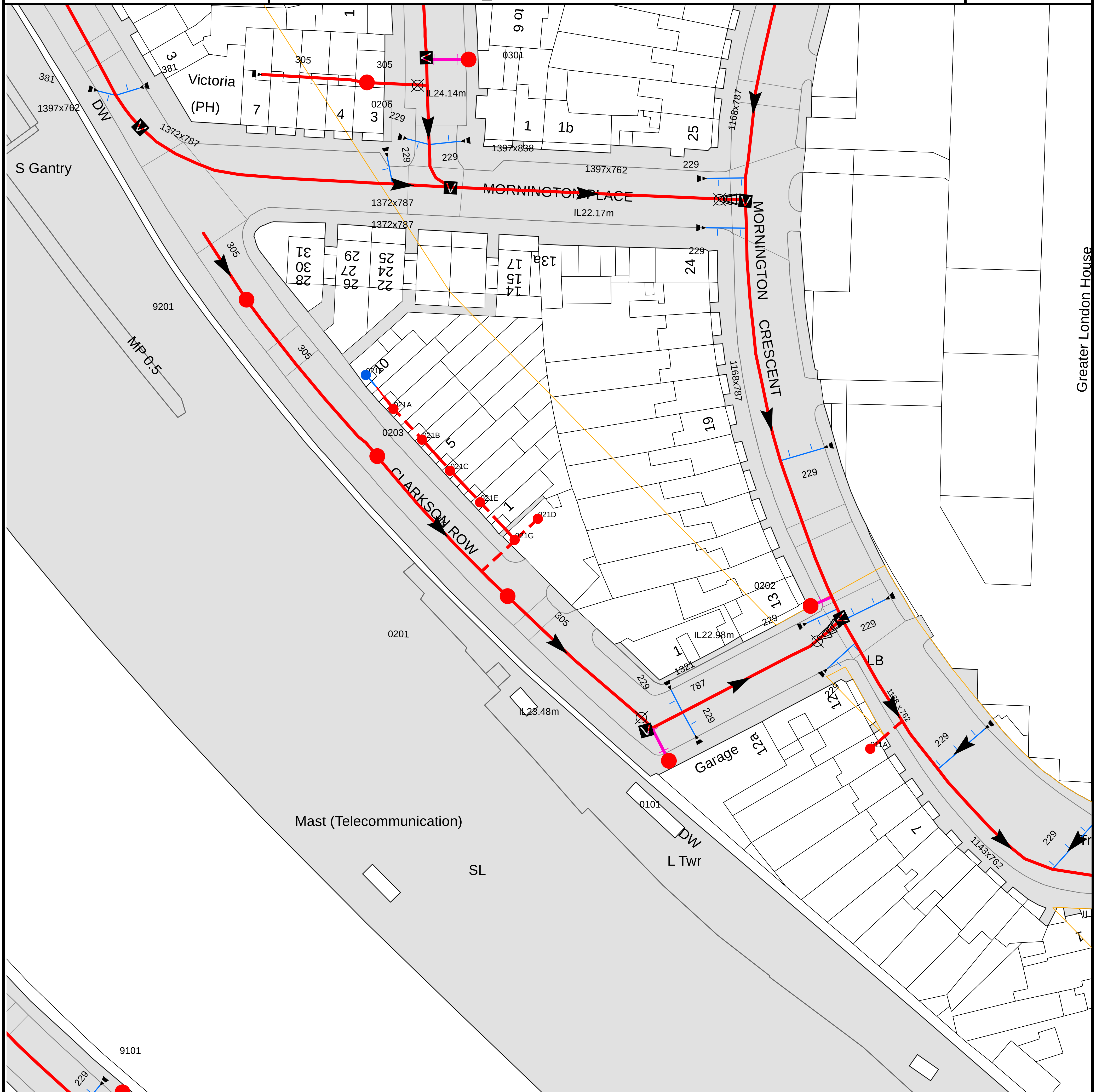


Appendix B

Topographic Survey & Sewer Records

ToR 30.730
ToR 33.315
ToR 31.047
ToW 29.606
27.656
ToT 30.423
ToW 29.326
27.539
ToW 29.607
27.802
27.580
ToT 35.929
27.465
27.271
27.414
27.549
27.402
M/H CL=27.653 UTL
ToF 29.634
ToR 37.463
27.233
27.807
27.567
27.391
27.370
27.463
ToW 29.228
27.172
U/S GUTTER 35.880
M/H CL=27.640 IL=25.881
M/H CL=27.594 IL=25.881
27.796
27.643
ToGATE 29.311
27.357
27.351
27.379
ToGATE 29.351
ToW 29.242
ToBOX 28.102
ToF 29.311
ToW 28.046
ToW 28.802
U/S GUTTER 30.621
ToW 28.846
ToGATE 28.802
ToGATE 29.672
ToF 29.431
ToW 28.032
27.156
27.100
PO CL=27.696 UTL
27.345
STN 02 27.334
RE CL=27.303
27.085
27.628
27.551
STN 03 27.477
27.356
27.302
27.184
M/H CL=27.149 UTL
ToPOLE 35.589
G CL=27.318
27.510
27.602
27.461
27.414

Asset Location Search Sewer Map - ALS/ALS Standard/2020_4301929



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 529034,183211

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
021E	n/a	n/a
021C	n/a	n/a
0203	28.02	24.92
021B	n/a	n/a
021A	n/a	n/a
021F	n/a	n/a
9201	28.72	25.55
0206	n/a	n/a
0301	n/a	n/a
9101	n/a	n/a
0101	n/a	n/a
011A	n/a	n/a
0202	n/a	n/a
0201	27.39	24.21
021G	n/a	n/a
021D	n/a	n/a

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.

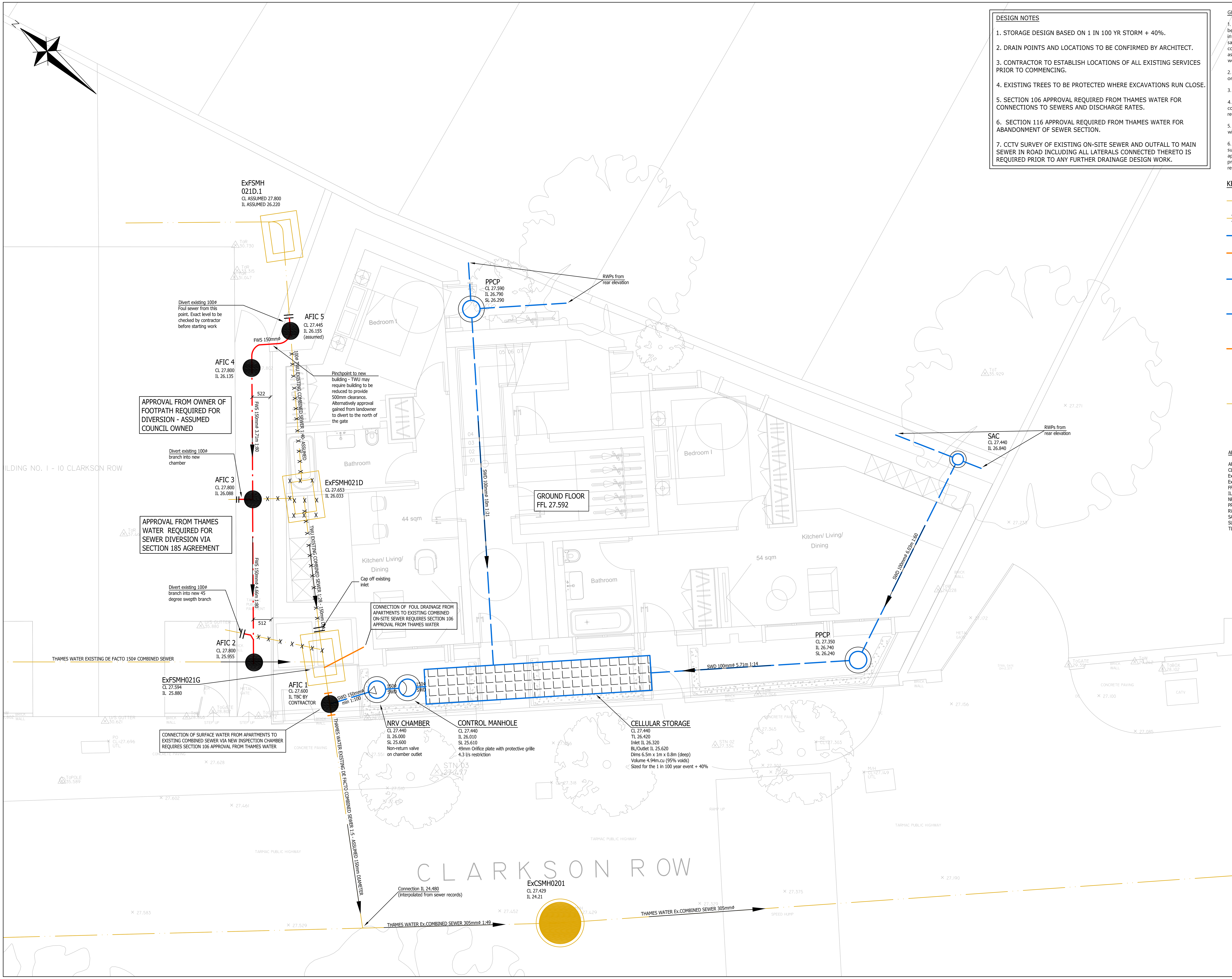
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

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.

Appendix C

Drainage Strategy & Exceedance Flows Layouts



DESIGN NOTES

1. STORAGE DESIGN BASED ON 1 IN 100 YR STORM + 40%.

2. DRAIN POINTS AND LOCATIONS TO BE CONFIRMED BY ARCHITECT.

3. CONTRACTOR TO ESTABLISH LOCATIONS OF ALL EXISTING SERVICES PRIOR TO COMMENCING.

4. EXISTING TREES TO BE PROTECTED WHERE EXCAVATIONS RUN CLOSE.

5. SECTION 106 APPROVAL REQUIRED FROM THAMES WATER FOR CONNECTIONS TO SEWERS AND DISCHARGE RATES.

6. SECTION 116 APPROVAL REQUIRED FROM THAMES WATER FOR ABANDONMENT OF SEWER SECTION.

7. CCTV SURVEY OF EXISTING ON-SITE SEWER AND OUTFALL TO MAIN SEWER IN ROAD INCLUDING ALL LATERALS CONNECTED THERETO IS REQUIRED PRIOR TO ANY FURTHER DRAINAGE DESIGN WORK.

GENERAL NOTES

1. The location, size, depth and identification of existing services that may be shown or referred to on this drawing have been assessed from non intrusive observations , record drawings or the like. The contractor shall safely carry out intrusive investigations, trial holes or soundings prior to commencing work to satisfy himself that it is safe to proceed and that the assessments are accurate. any discrepancies shall be notified to gta prior to works commencing.

2. Tender or billing drawings shall not be used for construction or the ordering of materials.

3. Do not scale. All dimensions and levels to be site confirmed.

4. This drawing shall be read in conjunction with all relevant architects, consultants drawings and specifications, together with H&S plan requirements.

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6. All drawings specifications and recommendations made by gta are subject to Local Authority and other relevant Statutory Authorities approval. Any works or services made abortive due to the client proceeding prior to these approvals is considered wholly at the Clients risk. gta hold no responsibility for resulting abortive works or costs.

KEY

- EXISTING COMBINED SEWER
- SEWER TO BE REMOVED
- SURFACE WATER DRAIN
- FOUL DRAIN
- SAC — SURFACE WATER ACCESS CHAMBER
- PPCP — SURFACE WATER CATCHPIT
- AFIC — ADOPTABLE FOUL INSPECTION CHAMBER
- ExCSMH — EXISTING COMBINED SEWER MANHOLE

ABBREVIATIONS

AFIC	ADOPTABLE FOUL INSPECTION CHAMBER
CL	COVER LEVEL
ExCSMH	EXISTING COMBINED SEWER MANHOLE
ExFSMH	EXISTING FOUL SEWER MANHOLE
FFL	FINISHED FLOOR LEVEL
IL	INVERT LEVEL
NRV	NON-RETURN VALVE
PPCP	POLYPROPYLENE CATCHPIT
RWP	RAINWATER PIPE
SAC	SURFACE WATER CATCHPIT
SL	SUMP LEVEL
TL	TOP LEVEL

Rev	Amendments	Date	Dsn	Chk
P2	Foul sewer diversion shown	14.01.20	JR	MR
P1	INITIAL ISSUE	11.12.20	JR	MR

Status: PLANNING

Client: FORM STRUCTURAL DESIGN

Architect: MAREK WOJCIECHOWSKI ARCHITECTS

Project: CLARKSON ROW NW1 7RA

Title: SITE DRAINAGE STRATEGY

Date: DECEMBER 2020 | Scale @ A1: 1:50

Clients Ref. | Project Ref.: 11026

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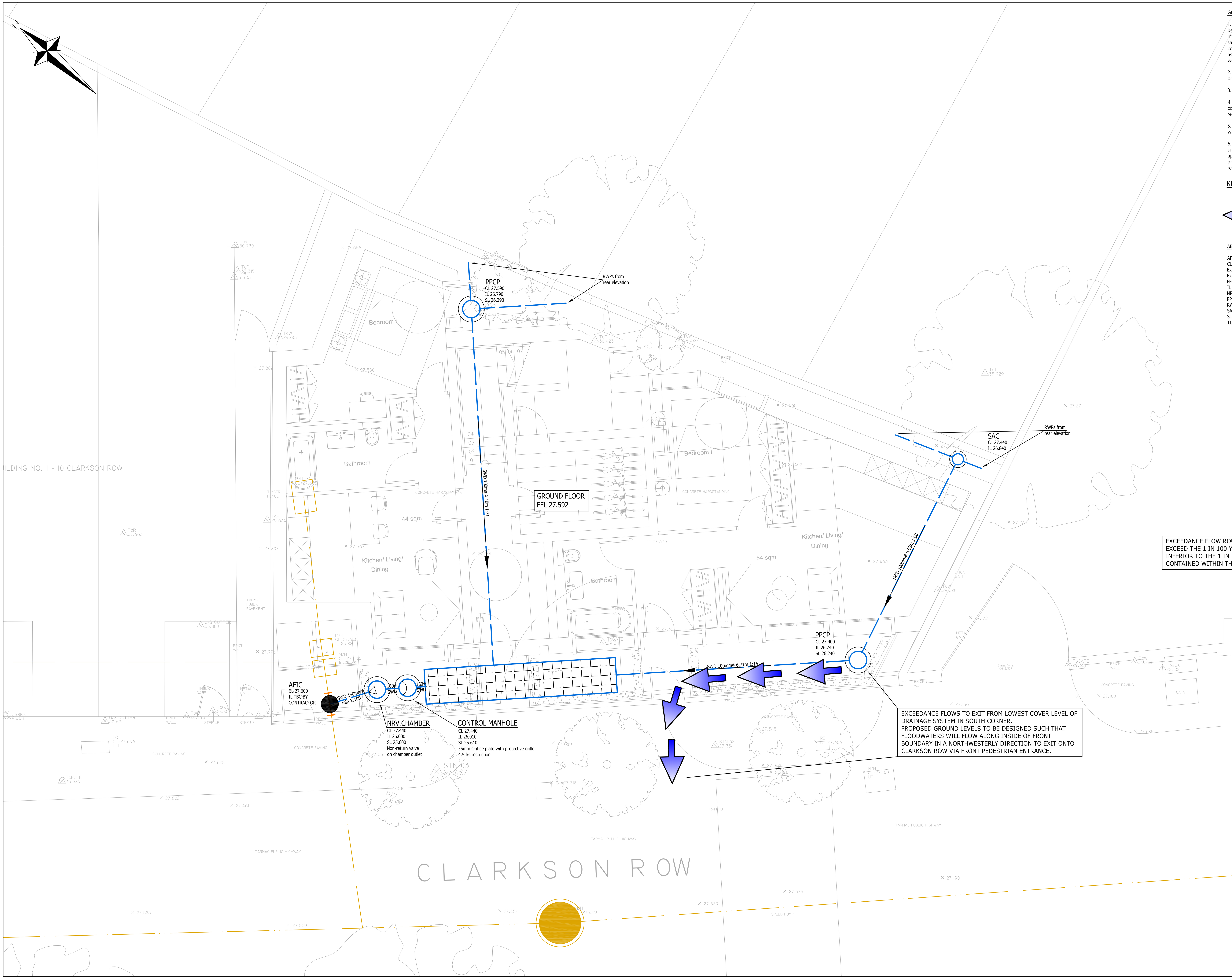
Drawing Number: 11026/1101 | Rev.: P2



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KEY

EXCEEDANCE FLOW ROUTE DIRECTION

ABBREVIATIONS

AFIC	ADOPTABLE FOUL INSPECTION CHAMBER
CL	COVER LEVEL
ExCSMH	EXISTING COMBINED SEWER MANHOLE
ExFSMH	EXISTING FOUL SEWER MANHOLE
FFL	FINISHED FLOOR LEVEL
IL	INVERT LEVEL
NRV	NON-RETURN VALVE
PPCP	POLYPROPYLENE CATCHPIT
RWP	RAINWATER PIPE
SAC	SURFACE WATER CATCHPIT
SL	SUMP LEVEL
TL	TOP LEVEL

Rev	Amendments	Date	Dsn	Chk
P1	INITIAL ISSUE	10.12.20	JR	MR

Status: PLANNING

Client: FORM STRUCTURAL DESIGN

Architect: MAREK WOJCIECHOWSKI ARCHITECTS

Project: CLARKSON ROW NW1 7RA

Title: EXCEEDANCE FLOW ROUTES

Date	Scale @ A1
DECEMBER 2020	1:50
Clients Ref.	Project Ref. 11026

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Drawing Number: 11026/1102 | Rev. P1

Appendix D

Micro Drainage Calculations

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	25.929	0.049	1.4	0.1	O K
120 min Winter	25.918	0.038	0.9	0.0	O K
180 min Winter	25.914	0.034	0.7	0.0	O K
240 min Winter	25.910	0.030	0.5	0.0	O K
360 min Winter	25.906	0.026	0.4	0.0	O K
480 min Winter	25.903	0.023	0.3	0.0	O K
600 min Winter	25.901	0.021	0.3	0.0	O K
720 min Winter	25.899	0.019	0.2	0.0	O K
960 min Winter	25.897	0.017	0.2	0.0	O K
1440 min Winter	25.894	0.014	0.1	0.0	O K
2160 min Winter	25.892	0.012	0.1	0.0	O K
2880 min Winter	25.891	0.011	0.1	0.0	O K
4320 min Winter	25.890	0.010	0.1	0.0	O K
5760 min Winter	25.889	0.009	0.1	0.0	O K
7200 min Winter	25.888	0.008	0.0	0.0	O K
8640 min Winter	25.888	0.008	0.0	0.0	O K
10080 min Winter	25.887	0.007	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	13.524	0.0	2.0	32
120 min Winter	8.246	0.0	2.5	60
180 min Winter	6.141	0.0	2.8	90
240 min Winter	4.975	0.0	3.0	124
360 min Winter	3.671	0.0	3.3	180
480 min Winter	2.954	0.0	3.6	238
600 min Winter	2.495	0.0	3.8	300
720 min Winter	2.173	0.0	3.9	368
960 min Winter	1.748	0.0	4.2	478
1440 min Winter	1.286	0.0	4.7	742
2160 min Winter	0.947	0.0	5.2	1104
2880 min Winter	0.762	0.0	5.5	1520
4320 min Winter	0.560	0.0	6.1	2192
5760 min Winter	0.450	0.0	6.5	2784
7200 min Winter	0.380	0.0	6.9	3600
8640 min Winter	0.331	0.0	7.2	4648
10080 min Winter	0.295	0.0	7.5	4704

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.439	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.018

Time (mins) From:	To:	Area (ha)
0	4	0.018

Model Details

Storage is Online Cover Level (m) 27.594

Pipe Structure

Diameter (m)	0.150	Length (m)	7.500
Slope (1:X)	5.000	Invert Level (m)	25.880

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	5.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	25.880
Roughness k (mm)	0.600		

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	26.013	0.133	8.5	0.1	O K
30 min Summer	26.000	0.120	7.1	0.1	O K
60 min Summer	25.973	0.093	5.0	0.1	O K
120 min Summer	25.957	0.077	3.4	0.1	O K
180 min Summer	25.949	0.069	2.6	0.1	O K
240 min Summer	25.941	0.061	2.1	0.1	O K
360 min Summer	25.932	0.052	1.6	0.1	O K
480 min Summer	25.926	0.046	1.2	0.0	O K
600 min Summer	25.922	0.042	1.0	0.0	O K
720 min Summer	25.919	0.039	0.9	0.0	O K
960 min Summer	25.914	0.034	0.7	0.0	O K
1440 min Summer	25.908	0.028	0.5	0.0	O K
2160 min Summer	25.904	0.024	0.3	0.0	O K
2880 min Summer	25.901	0.021	0.3	0.0	O K
4320 min Summer	25.897	0.017	0.2	0.0	O K
5760 min Summer	25.895	0.015	0.2	0.0	O K
7200 min Summer	25.894	0.014	0.1	0.0	O K
8640 min Summer	25.893	0.013	0.1	0.0	O K
10080 min Summer	25.892	0.012	0.1	0.0	O K
15 min Winter	26.013	0.133	8.5	0.1	O K
30 min Winter	25.988	0.108	6.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	96.898	0.0	3.3	10
30 min Summer	61.822	0.0	4.2	17
60 min Summer	37.564	0.0	5.1	32
120 min Summer	24.016	0.0	6.5	62
180 min Summer	18.006	0.0	7.3	92
240 min Summer	14.505	0.0	7.8	122
360 min Summer	10.513	0.0	8.5	182
480 min Summer	8.286	0.0	8.9	240
600 min Summer	6.863	0.0	9.3	302
720 min Summer	5.871	0.0	9.5	360
960 min Summer	4.577	0.0	9.9	490
1440 min Summer	3.217	0.0	10.4	718
2160 min Summer	2.264	0.0	11.0	1100
2880 min Summer	1.772	0.0	11.5	1468
4320 min Summer	1.268	0.0	12.3	2152
5760 min Summer	1.010	0.0	13.1	2920
7200 min Summer	0.852	0.0	13.8	3504
8640 min Summer	0.746	0.0	14.5	4336
10080 min Summer	0.670	0.0	15.2	5056
15 min Winter	96.898	0.0	3.7	10
30 min Winter	61.822	0.0	4.7	17

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	25.961	0.081	3.9	0.1	O K
120 min Winter	25.948	0.068	2.5	0.1	O K
180 min Winter	25.938	0.058	1.9	0.1	O K
240 min Winter	25.932	0.052	1.6	0.1	O K
360 min Winter	25.924	0.044	1.1	0.0	O K
480 min Winter	25.919	0.039	0.9	0.0	O K
600 min Winter	25.915	0.035	0.7	0.0	O K
720 min Winter	25.913	0.033	0.6	0.0	O K
960 min Winter	25.909	0.029	0.5	0.0	O K
1440 min Winter	25.904	0.024	0.4	0.0	O K
2160 min Winter	25.900	0.020	0.2	0.0	O K
2880 min Winter	25.897	0.017	0.2	0.0	O K
4320 min Winter	25.894	0.014	0.1	0.0	O K
5760 min Winter	25.893	0.013	0.1	0.0	O K
7200 min Winter	25.892	0.012	0.1	0.0	O K
8640 min Winter	25.891	0.011	0.1	0.0	O K
10080 min Winter	25.891	0.011	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	37.564	0.0	5.7	32
120 min Winter	24.016	0.0	7.3	62
180 min Winter	18.006	0.0	8.2	96
240 min Winter	14.505	0.0	8.8	124
360 min Winter	10.513	0.0	9.5	178
480 min Winter	8.286	0.0	10.0	252
600 min Winter	6.863	0.0	10.4	296
720 min Winter	5.871	0.0	10.7	364
960 min Winter	4.577	0.0	11.1	468
1440 min Winter	3.217	0.0	11.7	750
2160 min Winter	2.264	0.0	12.3	1084
2880 min Winter	1.772	0.0	12.9	1380
4320 min Winter	1.268	0.0	13.8	2172
5760 min Winter	1.010	0.0	14.7	2816
7200 min Winter	0.852	0.0	15.5	3264
8640 min Winter	0.746	0.0	16.2	4224
10080 min Winter	0.670	0.0	17.0	4832

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 529029 183219 TQ 29029 83219
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.018

Time From:	(mins) To:	Area (ha)
0	4	0.018

Model Details

Storage is Online Cover Level (m) 27.594

Pipe Structure

Diameter (m)	0.150	Length (m)	7.500
Slope (1:X)	5.000	Invert Level (m)	25.880

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	5.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	25.880
Roughness k (mm)	0.600		

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	26.038	0.158	11.2	0.2	O K
30 min Summer	26.022	0.142	9.5	0.1	O K
60 min Summer	25.995	0.115	6.7	0.1	O K
120 min Summer	25.968	0.088	4.6	0.1	O K
180 min Summer	25.958	0.078	3.5	0.1	O K
240 min Summer	25.952	0.072	2.9	0.1	O K
360 min Summer	25.942	0.062	2.2	0.1	O K
480 min Summer	25.935	0.055	1.7	0.1	O K
600 min Summer	25.930	0.050	1.4	0.1	O K
720 min Summer	25.927	0.047	1.3	0.0	O K
960 min Summer	25.920	0.040	1.0	0.0	O K
1440 min Summer	25.914	0.034	0.7	0.0	O K
2160 min Summer	25.908	0.028	0.5	0.0	O K
2880 min Summer	25.905	0.025	0.4	0.0	O K
4320 min Summer	25.900	0.020	0.2	0.0	O K
5760 min Summer	25.897	0.017	0.2	0.0	O K
7200 min Summer	25.895	0.015	0.2	0.0	O K
8640 min Summer	25.894	0.014	0.1	0.0	O K
10080 min Summer	25.894	0.014	0.1	0.0	O K
15 min Winter	26.038	0.158	11.2	0.2	O K
30 min Winter	26.011	0.131	8.2	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	128.787	0.0	4.3	10
30 min Summer	82.793	0.0	5.6	17
60 min Summer	50.497	0.0	6.8	32
120 min Summer	32.440	0.0	8.8	62
180 min Summer	24.582	0.0	10.0	92
240 min Summer	19.983	0.0	10.8	122
360 min Summer	14.671	0.0	11.9	184
480 min Summer	11.636	0.0	12.6	240
600 min Summer	9.664	0.0	13.0	306
720 min Summer	8.276	0.0	13.4	362
960 min Summer	6.445	0.0	13.9	480
1440 min Summer	4.497	0.0	14.6	710
2160 min Summer	3.120	0.0	15.2	1096
2880 min Summer	2.407	0.0	15.6	1468
4320 min Summer	1.676	0.0	16.3	2184
5760 min Summer	1.303	0.0	16.9	2872
7200 min Summer	1.078	0.0	17.5	3552
8640 min Summer	0.928	0.0	18.0	4320
10080 min Summer	0.820	0.0	18.6	5080
15 min Winter	128.787	0.0	4.9	10
30 min Winter	82.793	0.0	6.3	17

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	25.977	0.097	5.3	0.1	O K
120 min Winter	25.957	0.077	3.4	0.1	O K
180 min Winter	25.949	0.069	2.6	0.1	O K
240 min Winter	25.941	0.061	2.1	0.1	O K
360 min Winter	25.932	0.052	1.6	0.1	O K
480 min Winter	25.927	0.047	1.3	0.0	O K
600 min Winter	25.922	0.042	1.0	0.0	O K
720 min Winter	25.919	0.039	0.9	0.0	O K
960 min Winter	25.914	0.034	0.7	0.0	O K
1440 min Winter	25.908	0.028	0.5	0.0	O K
2160 min Winter	25.904	0.024	0.3	0.0	O K
2880 min Winter	25.900	0.020	0.3	0.0	O K
4320 min Winter	25.896	0.016	0.2	0.0	O K
5760 min Winter	25.894	0.014	0.1	0.0	O K
7200 min Winter	25.893	0.013	0.1	0.0	O K
8640 min Winter	25.892	0.012	0.1	0.0	O K
10080 min Winter	25.892	0.012	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	50.497	0.0	7.6	32
120 min Winter	32.440	0.0	9.8	62
180 min Winter	24.582	0.0	11.2	92
240 min Winter	19.983	0.0	12.1	118
360 min Winter	14.671	0.0	13.3	176
480 min Winter	11.636	0.0	14.1	230
600 min Winter	9.664	0.0	14.6	298
720 min Winter	8.276	0.0	15.0	368
960 min Winter	6.445	0.0	15.6	470
1440 min Winter	4.497	0.0	16.3	702
2160 min Winter	3.120	0.0	17.0	1056
2880 min Winter	2.407	0.0	17.5	1440
4320 min Winter	1.676	0.0	18.2	2208
5760 min Winter	1.303	0.0	18.9	2888
7200 min Winter	1.078	0.0	19.6	3560
8640 min Winter	0.928	0.0	20.2	4256
10080 min Winter	0.820	0.0	20.8	4968

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 529029 183219 TQ 29029 83219
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.018

Time (mins) From:	To:	Area (ha)
0	4	0.018

Model Details

Storage is Online Cover Level (m) 27.594

Pipe Structure

Diameter (m)	0.150	Length (m)	7.500
Slope (1:X)	5.000	Invert Level (m)	25.880

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	5.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	25.880
Roughness k (mm)	0.600		

Summary of Results for 1 year Return Period

Half Drain Time : 4 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	26.111	0.111	0.0	1.5	1.5	0.6	O K
30 min Summer	26.110	0.110	0.0	1.5	1.5	0.6	O K
60 min Summer	26.090	0.090	0.0	1.3	1.3	0.5	O K
120 min Summer	26.068	0.068	0.0	1.0	1.0	0.4	O K
180 min Summer	26.058	0.058	0.0	0.8	0.8	0.3	O K
240 min Summer	26.051	0.051	0.0	0.7	0.7	0.3	O K
360 min Summer	26.043	0.043	0.0	0.5	0.5	0.2	O K
480 min Summer	26.038	0.038	0.0	0.4	0.4	0.2	O K
600 min Summer	26.034	0.034	0.0	0.4	0.4	0.2	O K
720 min Summer	26.031	0.031	0.0	0.3	0.3	0.2	O K
960 min Summer	26.028	0.028	0.0	0.3	0.3	0.1	O K
1440 min Summer	26.024	0.024	0.0	0.2	0.2	0.1	O K
2160 min Summer	26.021	0.021	0.0	0.1	0.1	0.1	O K
2880 min Summer	26.019	0.019	0.0	0.1	0.1	0.1	O K
4320 min Summer	26.016	0.016	0.0	0.1	0.1	0.1	O K
5760 min Summer	26.014	0.014	0.0	0.1	0.1	0.1	O K
7200 min Summer	26.013	0.013	0.0	0.1	0.1	0.1	O K
8640 min Summer	26.012	0.012	0.0	0.1	0.1	0.1	O K
10080 min Summer	26.012	0.012	0.0	0.0	0.0	0.1	O K
15 min Winter	26.119	0.119	0.0	1.5	1.5	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	33.658	0.0	1.1	12
30 min Summer	21.713	0.0	1.5	20
60 min Summer	13.524	0.0	1.8	36
120 min Summer	8.242	0.0	2.2	64
180 min Summer	6.136	0.0	2.5	96
240 min Summer	4.971	0.0	2.7	126
360 min Summer	3.667	0.0	3.0	186
480 min Summer	2.950	0.0	3.2	246
600 min Summer	2.491	0.0	3.4	306
720 min Summer	2.170	0.0	3.5	368
960 min Summer	1.745	0.0	3.8	484
1440 min Summer	1.283	0.0	4.2	732
2160 min Summer	0.945	0.0	4.6	1100
2880 min Summer	0.760	0.0	4.9	1456
4320 min Summer	0.558	0.0	5.4	2200
5760 min Summer	0.449	0.0	5.8	2872
7200 min Summer	0.379	0.0	6.1	3592
8640 min Summer	0.330	0.0	6.4	4384
10080 min Summer	0.294	0.0	6.7	5088
15 min Winter	33.658	0.0	1.3	12

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
30 min Winter	26.110	0.110	0.0	1.5	1.5	0.6	O K
60 min Winter	26.082	0.082	0.0	1.2	1.2	0.4	O K
120 min Winter	26.059	0.059	0.0	0.8	0.8	0.3	O K
180 min Winter	26.049	0.049	0.0	0.6	0.6	0.3	O K
240 min Winter	26.044	0.044	0.0	0.5	0.5	0.2	O K
360 min Winter	26.036	0.036	0.0	0.4	0.4	0.2	O K
480 min Winter	26.031	0.031	0.0	0.3	0.3	0.2	O K
600 min Winter	26.028	0.028	0.0	0.3	0.3	0.1	O K
720 min Winter	26.026	0.026	0.0	0.2	0.2	0.1	O K
960 min Winter	26.024	0.024	0.0	0.2	0.2	0.1	O K
1440 min Winter	26.021	0.021	0.0	0.1	0.1	0.1	O K
2160 min Winter	26.018	0.018	0.0	0.1	0.1	0.1	O K
2880 min Winter	26.016	0.016	0.0	0.1	0.1	0.1	O K
4320 min Winter	26.013	0.013	0.0	0.1	0.1	0.1	O K
5760 min Winter	26.012	0.012	0.0	0.1	0.1	0.1	O K
7200 min Winter	26.011	0.011	0.0	0.0	0.0	0.1	O K
8640 min Winter	26.010	0.010	0.0	0.0	0.0	0.1	O K
10080 min Winter	26.010	0.010	0.0	0.0	0.0	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	21.713	0.0	1.6	21
60 min Winter	13.524	0.0	2.0	36
120 min Winter	8.242	0.0	2.5	66
180 min Winter	6.136	0.0	2.8	96
240 min Winter	4.971	0.0	3.0	126
360 min Winter	3.667	0.0	3.3	186
480 min Winter	2.950	0.0	3.6	250
600 min Winter	2.491	0.0	3.8	304
720 min Winter	2.170	0.0	3.9	368
960 min Winter	1.745	0.0	4.2	486
1440 min Winter	1.283	0.0	4.7	724
2160 min Winter	0.945	0.0	5.1	1084
2880 min Winter	0.760	0.0	5.5	1428
4320 min Winter	0.558	0.0	6.1	2204
5760 min Winter	0.449	0.0	6.5	2984
7200 min Winter	0.379	0.0	6.9	3624
8640 min Winter	0.330	0.0	7.2	4440
10080 min Winter	0.294	0.0	7.5	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.440	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.018

Time From:	(mins) To:	Area (ha)
0	4	0.018

Model Details

Storage is Online Cover Level (m) 27.440

Cellular Storage Structure

Invert Level (m) 26.000 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	5.5	5.5	1.300	0.0	13.5
0.100	5.5	6.4	1.400	0.0	13.5
0.200	5.5	7.4	1.500	0.0	13.5
0.300	5.5	8.3	1.600	0.0	13.5
0.400	5.5	9.3	1.700	0.0	13.5
0.500	5.5	10.2	1.800	0.0	13.5
0.600	5.5	11.1	1.900	0.0	13.5
0.700	5.5	12.1	2.000	0.0	13.5
0.800	5.5	13.0	2.100	0.0	13.5
0.900	0.0	13.5	2.200	0.0	13.5
1.000	0.0	13.5	2.300	0.0	13.5
1.100	0.0	13.5	2.400	0.0	13.5
1.200	0.0	13.5	2.500	0.0	13.5

Orifice Outflow Control

Diameter (m) 0.049 Discharge Coefficient 0.600 Invert Level (m) 26.000

Summary of Results for 30 year Return Period

Half Drain Time : 10 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	26.321	0.321	0.0	2.7	2.7	2.0	O K
30 min Summer	26.328	0.328	0.0	2.8	2.8	2.0	O K
60 min Summer	26.282	0.282	0.0	2.5	2.5	1.7	O K
120 min Summer	26.226	0.226	0.0	2.2	2.2	1.4	O K
180 min Summer	26.178	0.178	0.0	2.0	2.0	1.1	O K
240 min Summer	26.144	0.144	0.0	1.7	1.7	0.9	O K
360 min Summer	26.101	0.101	0.0	1.4	1.4	0.6	O K
480 min Summer	26.078	0.078	0.0	1.2	1.2	0.5	O K
600 min Summer	26.066	0.066	0.0	1.0	1.0	0.4	O K
720 min Summer	26.060	0.060	0.0	0.9	0.9	0.4	O K
960 min Summer	26.051	0.051	0.0	0.7	0.7	0.3	O K
1440 min Summer	26.041	0.041	0.0	0.5	0.5	0.3	O K
2160 min Summer	26.033	0.033	0.0	0.3	0.3	0.2	O K
2880 min Summer	26.028	0.028	0.0	0.3	0.3	0.2	O K
4320 min Summer	26.024	0.024	0.0	0.2	0.2	0.1	O K
5760 min Summer	26.022	0.022	0.0	0.1	0.1	0.1	O K
7200 min Summer	26.020	0.020	0.0	0.1	0.1	0.1	O K
8640 min Summer	26.018	0.018	0.0	0.1	0.1	0.1	O K
10080 min Summer	26.017	0.017	0.0	0.1	0.1	0.1	O K
15 min Winter	26.358	0.358	0.0	2.9	2.9	2.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	96.898	0.0	3.3	13
30 min Summer	61.822	0.0	4.2	21
60 min Summer	37.564	0.0	5.1	38
120 min Summer	24.016	0.0	6.5	68
180 min Summer	18.006	0.0	7.3	98
240 min Summer	14.505	0.0	7.8	128
360 min Summer	10.513	0.0	8.5	188
480 min Summer	8.286	0.0	8.9	248
600 min Summer	6.863	0.0	9.3	306
720 min Summer	5.871	0.0	9.5	368
960 min Summer	4.577	0.0	9.9	488
1440 min Summer	3.217	0.0	10.4	724
2160 min Summer	2.264	0.0	11.0	1088
2880 min Summer	1.772	0.0	11.5	1460
4320 min Summer	1.268	0.0	12.3	2192
5760 min Summer	1.010	0.0	13.1	2912
7200 min Summer	0.852	0.0	13.8	3624
8640 min Summer	0.746	0.0	14.5	4352
10080 min Summer	0.670	0.0	15.2	5088
15 min Winter	96.898	0.0	3.7	14

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
30 min Winter	26.353	0.353	0.0	2.9	2.9	2.2	O K
60 min Winter	26.280	0.280	0.0	2.5	2.5	1.7	O K
120 min Winter	26.198	0.198	0.0	2.1	2.1	1.2	O K
180 min Winter	26.143	0.143	0.0	1.7	1.7	0.9	O K
240 min Winter	26.109	0.109	0.0	1.5	1.5	0.7	O K
360 min Winter	26.072	0.072	0.0	1.1	1.1	0.4	O K
480 min Winter	26.061	0.061	0.0	0.9	0.9	0.4	O K
600 min Winter	26.054	0.054	0.0	0.7	0.7	0.3	O K
720 min Winter	26.049	0.049	0.0	0.6	0.6	0.3	O K
960 min Winter	26.042	0.042	0.0	0.5	0.5	0.3	O K
1440 min Winter	26.033	0.033	0.0	0.3	0.3	0.2	O K
2160 min Winter	26.027	0.027	0.0	0.2	0.2	0.2	O K
2880 min Winter	26.024	0.024	0.0	0.2	0.2	0.1	O K
4320 min Winter	26.021	0.021	0.0	0.1	0.1	0.1	O K
5760 min Winter	26.018	0.018	0.0	0.1	0.1	0.1	O K
7200 min Winter	26.017	0.017	0.0	0.1	0.1	0.1	O K
8640 min Winter	26.016	0.016	0.0	0.1	0.1	0.1	O K
10080 min Winter	26.015	0.015	0.0	0.1	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	61.822	0.0	4.7	22
60 min Winter	37.564	0.0	5.7	40
120 min Winter	24.016	0.0	7.3	70
180 min Winter	18.006	0.0	8.2	100
240 min Winter	14.505	0.0	8.8	130
360 min Winter	10.513	0.0	9.5	188
480 min Winter	8.286	0.0	10.0	246
600 min Winter	6.863	0.0	10.4	306
720 min Winter	5.871	0.0	10.7	362
960 min Winter	4.577	0.0	11.1	492
1440 min Winter	3.217	0.0	11.7	732
2160 min Winter	2.264	0.0	12.3	1104
2880 min Winter	1.772	0.0	12.9	1456
4320 min Winter	1.268	0.0	13.8	2168
5760 min Winter	1.010	0.0	14.7	2984
7200 min Winter	0.852	0.0	15.5	3568
8640 min Winter	0.746	0.0	16.2	4344
10080 min Winter	0.670	0.0	17.0	4856

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 529029 183219 TQ 29029 83219
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.018

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.018

Model Details

Storage is Online Cover Level (m) 27.440

Cellular Storage Structure

Invert Level (m) 26.000 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	6.5	5.5	1.300	0.0	13.5
0.100	6.5	6.4	1.400	0.0	13.5
0.200	6.5	7.4	1.500	0.0	13.5
0.300	6.5	8.3	1.600	0.0	13.5
0.400	6.5	9.3	1.700	0.0	13.5
0.500	6.5	10.2	1.800	0.0	13.5
0.600	6.5	11.1	1.900	0.0	13.5
0.700	6.5	12.1	2.000	0.0	13.5
0.800	6.5	13.0	2.100	0.0	13.5
0.900	0.0	13.5	2.200	0.0	13.5
1.000	0.0	13.5	2.300	0.0	13.5
1.100	0.0	13.5	2.400	0.0	13.5
1.200	0.0	13.5	2.500	0.0	13.5

Orifice Outflow Control

Diameter (m) 0.049 Discharge Coefficient 0.600 Invert Level (m) 26.000

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

Half Drain Time : 12 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	26.648	0.648	0.0	4.0	4.0	4.0	O K
30 min Summer	26.689	0.689	0.0	4.1	4.1	4.3	O K
60 min Summer	26.623	0.623	0.0	3.9	3.9	3.8	O K
120 min Summer	26.535	0.535	0.0	3.6	3.6	3.3	O K
180 min Summer	26.447	0.447	0.0	3.3	3.3	2.8	O K
240 min Summer	26.373	0.373	0.0	3.0	3.0	2.3	O K
360 min Summer	26.268	0.268	0.0	2.5	2.5	1.7	O K
480 min Summer	26.201	0.201	0.0	2.1	2.1	1.2	O K
600 min Summer	26.157	0.157	0.0	1.8	1.8	1.0	O K
720 min Summer	26.128	0.128	0.0	1.6	1.6	0.8	O K
960 min Summer	26.092	0.092	0.0	1.3	1.3	0.6	O K
1440 min Summer	26.063	0.063	0.0	0.9	0.9	0.4	O K
2160 min Summer	26.050	0.050	0.0	0.6	0.6	0.3	O K
2880 min Summer	26.043	0.043	0.0	0.5	0.5	0.3	O K
4320 min Summer	26.034	0.034	0.0	0.4	0.4	0.2	O K
5760 min Summer	26.028	0.028	0.0	0.3	0.3	0.2	O K
7200 min Summer	26.026	0.026	0.0	0.2	0.2	0.2	O K
8640 min Summer	26.024	0.024	0.0	0.2	0.2	0.1	O K
10080 min Summer	26.023	0.023	0.0	0.2	0.2	0.1	O K
15 min Winter	26.735	0.735	0.0	4.2	4.2	4.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	180.301	0.0	6.1	14
30 min Summer	115.911	0.0	7.8	22
60 min Summer	70.695	0.0	9.5	38
120 min Summer	45.416	0.0	12.3	70
180 min Summer	34.415	0.0	13.9	102
240 min Summer	27.977	0.0	15.1	132
360 min Summer	20.539	0.0	16.6	192
480 min Summer	16.291	0.0	17.6	252
600 min Summer	13.529	0.0	18.3	310
720 min Summer	11.587	0.0	18.8	370
960 min Summer	9.022	0.0	19.5	490
1440 min Summer	6.296	0.0	20.4	726
2160 min Summer	4.367	0.0	21.2	1092
2880 min Summer	3.370	0.0	21.8	1448
4320 min Summer	2.347	0.0	22.8	2196
5760 min Summer	1.824	0.0	23.6	2880
7200 min Summer	1.510	0.0	24.5	3608
8640 min Summer	1.299	0.0	25.2	4248
10080 min Summer	1.148	0.0	26.0	4976
15 min Winter	180.301	0.0	6.8	14

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	26.761	0.761	0.0	4.3	4.3	4.7	O K
60 min Winter	26.651	0.651	0.0	4.0	4.0	4.0	O K
120 min Winter	26.505	0.505	0.0	3.5	3.5	3.1	O K
180 min Winter	26.385	0.385	0.0	3.0	3.0	2.4	O K
240 min Winter	26.300	0.300	0.0	2.6	2.6	1.8	O K
360 min Winter	26.194	0.194	0.0	2.1	2.1	1.2	O K
480 min Winter	26.137	0.137	0.0	1.7	1.7	0.8	O K
600 min Winter	26.104	0.104	0.0	1.4	1.4	0.6	O K
720 min Winter	26.084	0.084	0.0	1.2	1.2	0.5	O K
960 min Winter	26.065	0.065	0.0	1.0	1.0	0.4	O K
1440 min Winter	26.051	0.051	0.0	0.7	0.7	0.3	O K
2160 min Winter	26.041	0.041	0.0	0.5	0.5	0.3	O K
2880 min Winter	26.034	0.034	0.0	0.4	0.4	0.2	O K
4320 min Winter	26.027	0.027	0.0	0.2	0.2	0.2	O K
5760 min Winter	26.025	0.025	0.0	0.2	0.2	0.2	O K
7200 min Winter	26.023	0.023	0.0	0.2	0.2	0.1	O K
8640 min Winter	26.021	0.021	0.0	0.1	0.1	0.1	O K
10080 min Winter	26.020	0.020	0.0	0.1	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	115.911	0.0	8.8	23
60 min Winter	70.695	0.0	10.7	42
120 min Winter	45.416	0.0	13.7	74
180 min Winter	34.415	0.0	15.6	106
240 min Winter	27.977	0.0	16.9	136
360 min Winter	20.539	0.0	18.6	194
480 min Winter	16.291	0.0	19.7	252
600 min Winter	13.529	0.0	20.5	312
720 min Winter	11.587	0.0	21.0	370
960 min Winter	9.022	0.0	21.8	492
1440 min Winter	6.296	0.0	22.8	728
2160 min Winter	4.367	0.0	23.8	1100
2880 min Winter	3.370	0.0	24.5	1432
4320 min Winter	2.347	0.0	25.5	2200
5760 min Winter	1.824	0.0	26.5	2856
7200 min Winter	1.510	0.0	27.4	3616
8640 min Winter	1.299	0.0	28.3	4256
10080 min Winter	1.148	0.0	29.2	5056

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 529029 183219 TQ 29029 83219
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.018

Time From:	(mins) To:	Area (ha)
0	4	0.018

Model Details

Storage is Online Cover Level (m) 27.440

Cellular Storage Structure

Invert Level (m) 26.000 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	6.5	5.5	1.300	0.0	13.5
0.100	6.5	6.4	1.400	0.0	13.5
0.200	6.5	7.4	1.500	0.0	13.5
0.300	6.5	8.3	1.600	0.0	13.5
0.400	6.5	9.3	1.700	0.0	13.5
0.500	6.5	10.2	1.800	0.0	13.5
0.600	6.5	11.1	1.900	0.0	13.5
0.700	6.5	12.1	2.000	0.0	13.5
0.800	6.5	13.0	2.100	0.0	13.5
0.900	0.0	13.5	2.200	0.0	13.5
1.000	0.0	13.5	2.300	0.0	13.5
1.100	0.0	13.5	2.400	0.0	13.5
1.200	0.0	13.5	2.500	0.0	13.5

Orifice Outflow Control

Diameter (m) 0.049 Discharge Coefficient 0.600 Invert Level (m) 26.000

Appendix E

LBC SuDS Pro-forma

Advice Note on contents of a Surface Water Drainage Statement

London Borough of Camden

1. Introduction

1.1 The Government has strengthened planning policy on the provision of sustainable drainage and new consultation arrangements for 'major' planning applications will come into force from 6 April 2015 as defined in the Written Ministerial Statement (18th Dec 2014).

1.2 The new requirements make Lead Local Flood Authorises statutory consultees with respect to flood risk and SuDS for all major applications. Previously the Environment Agency had that statutory responsibility for sites above 1ha in flood zone 1.

1.3 Therefore all 'major' planning applications submitted from 6 April 2015 are required demonstrate compliance with this policy and we'd encourage this is shown in a **Surface Water Drainage Statement**.

1.4 The purpose of this advice note is to set out what information should be included in such statements.

2. Requirements

2.1 It is essential that the type of Sustainable Drainage System (SuDS) for a site, along with **details of its extent and position**, is identified within the planning application to clearly demonstrate that the proposed SuDS can be accommodated within the development.

2.2 It will now not be acceptable to leave the design of SuDs to a later stage to be dealt with by planning conditions.

2.3 The NPPF paragraph 103 requires that developments do not increase flood risk elsewhere, and gives priority to the use of SuDS. Major developments must include SuDS for the management of run-off, unless demonstrated to be inappropriate. The proposed minimum standards of operation must be appropriate and as such, a **maintenance plan** should be included within the Surface Water Drainage Statement,clearly demonstrating that the SuDS have been designed to ensure that the maintenance and operation requirements are economically proportionate Planning Practice Guidance suggests that this should be considered by reference to the costs that would be incurred by consumers for the use of an effective drainage system connecting directly to a public sewer.

2.4 Camden Council will use planning conditions or obligations to ensure that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

2.5 Within Camden, SuDS systems must be designed in accordance with London Plan policy 5.13. This requires that developments 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 in line with the following **drainage hierarchy**:

1 store rainwater for later use
2 use infiltration techniques, such as porous surfaces in non-clay areas
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
6 discharge rainwater to a surface water sewer/drain
7 discharge rainwater to the combined sewer.

2.6 The hierarchy above seeks to ensure that surface water run-off is controlled as near to its source as possible to mimic natural drainage systems and retain water on or near to the site, in contrast to traditional drainage approaches, which tend to pipe water off-site as quickly as possible.

2.7 Before disposal of surface water to the public sewer is considered all other options set out in the drainage hierarchy should be exhausted. When no other practicable alternative exists to dispose of surface water other than the public sewer, the Water Company or its agents should confirm that there is adequate spare capacity in the existing system taking future development requirements into account.

2.8 Best practice guidance within the non-statutory technical standards for the design, maintenance and operation of sustainable drainage systems will also need to be followed. Runoff volumes from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the **greenfield runoff volume** for the same event.

2.9 Camden Development Policy 23 (Water) requires developments to reduce pressure on combined sewer network and the risk of flooding by limiting the rate of run-off through sustainable urban drainage systems. This policy also requires that developments in areas known to be at risk of surface water flooding are designed to cope with being flooded. Camden's SFRA surface water flood maps, updated SFRA figures 6 (LFRZs), and 4e (increased susceptibility to elevated groundwater) , as well as the Environment Agency updated flood maps for surface water (ufmfsw), should be referred to when determining whether developments are in an area at risk of flooding.

2.10 Camden Planning Guidance 3 (CPG3) requires developments to achieve a greenfield run off rate once SuDS have been installed. Where it can be demonstrated that this is not feasible, a minimum 50% reduction in run off rate across the development is required. Further guidance on how to reduce the risk of flooding can be found in CPG3 paragraphs 11.4-11.8.

2.11 Where an application is part of a larger site which already has planning permission it is essential that the new proposal does not compromise the drainage scheme already approved.

3. Further information and guidance

3.1 Applicants are strongly advised to discuss their proposals with the Lead Local Flood Authority at the pre-application stage to ensure that an acceptable SuDS scheme is submitted.

3.2 For general clarification of these requirements please Camden's Local Planning Authority or Lead Local Flood Authority

Surface Water Drainage Pro-forma for new developments

This pro-forma accompanies our advice note on surface water drainage. Developers should complete this form and submit it to the Local Planning Authority, referencing from where in their submission documents this information is taken. The pro-forma is supported by the Defra/EA guidance on Rainfall Runoff Management and uses the storage calculator on www.UKsuds.com. This pro-forma is based on current industry best practice and focuses on ensuring surface water drainage proposals meet national and local policy requirements. The pro-forma should be considered alongside other supporting SuDS Guidance.

1. Site Details

Site	CLARKSON ROW
Address & post code or LPA reference	CLARKSON ROW, LONDON NW1 7RA
Grid reference	529037, 183210
Is the existing site developed or Greenfield?	DEVELOPED
Is the development in a LFRZ or in an area known to be at risk of surface or ground water flooding? If yes, please demonstrate how this is managed, in line with DP23?	The site is not in an LFRZ, nor is it susceptible to flooding from surface water/groundwater, according to maps available online and in the SFRA/SWMP.
Total Site Area served by drainage system (excluding open space) (Ha)*	0.0176

***** The Greenfield runoff off rate from the development which is to be used for assessing the requirements for limiting discharge flow rates and attenuation storage from a site should be calculated for the area that forms the drainage network for the site whatever size of site and type of drainage technique. Please refer to the Rainfall Runoff Management document or CIRIA manual for detail on this.

2. Impermeable Area

	Existing	Proposed	Difference (Proposed-Existing)	Notes for developers
Impermeable area (ha)	0.176	0.176	0	If the proposed amount of impermeable surface is greater, then runoff rates and volumes will increase. Section 6 must be filled in. If proposed impermeability is equal or less than existing, then section 6 can be skipped and section 7 filled in.
Drainage Method (infiltration/sewer/watercourse)	Sewer	Sewer	N/A	If different from the existing, please fill in section 3. If existing drainage is by infiltration and the proposed is not, discharge volumes may increase. Fill in section 6.

3. Proposing to Discharge Surface Water via

	Yes	No	Evidence that this is possible	Notes for developers
Existing and proposed MicroDrainage calculations	X			Please provide MicroDrainage calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology or the results of a full infiltration test (see line below) if infiltration is proposed.
Infiltration		x		e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed.
To watercourse		x		e.g. Is there a watercourse nearby?
To surface water sewer	x		YET TO BE OBTAINED	Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above				e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above.
Has the drainage proposal had regard to the SuDS hierarchy?	X			Evidence must be provided to demonstrate that the proposed Sustainable Drainage strategy has had regard to the SuDS hierarchy as outlined in Section 2.5 above.
Layout plan showing where the sustainable drainage infrastructure will be located on site.	X		Drawing 11026/1101	Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development.

4. Peak Discharge Rates – This is the maximum flow rate at which storm water runoff leaves the site during a particular storm event.

	Existing Rates (l/s)	Proposed Rates (l/s)	Difference (l/s) (Proposed-Existing)	% Difference (difference /existing x 100)	Notes for developers
Greenfield QBAR	N/A	N/A	N/A	N/A	QBAR is approx. 1 in 2 storm event. Provide this if Section 6 (QBAR) is proposed.
1 in 1	3.0	1.5	-1.5	50	Proposed discharge rates (with mitigation) should aim to be equivalent to greenfield rates for all corresponding storm events. As a minimum, peak discharge rates must be reduced by 50% from the existing sites for all corresponding rainfall events.
1 in 30	8.5	2.9	-5.6	65.9	
1in 100	11.2	4.3	-6.9	61.6	
1 in 100 plus climate change	N/A	4.5	N/A	N/A	The proposed 1 in 100 +CC peak discharge rate (with mitigation) should aim to be equivalent to greenfield rates. As a minimum, proposed 1 in 100 +CC peak discharge rate must be reduced by 50% from the existing 1 in 100 runoff rate sites.

5. Calculate additional volumes for storage –The total volume of water leaving the development site. New hard surfaces potentially restrict the amount of stormwater that can go to the ground, so this needs to be controlled so not to make flood risk worse to properties downstream.

	Greenfield runoff volume (m^3)	Existing Volume (m^3)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	Notes for developers
1 in 1	N/A	7.5	7.5	0	Proposed discharge volumes (with mitigation) should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable and as a minimum should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased section 6 must be filled in.
1 in 30	N/A	17.0	17.0	0	
1in 100 6 hour	N/A	13.3	13.3	0	
1 in 100 6 hour plus climate change	N/A	18.6	18.6	0	The proposed 1 in 100 +CC discharge volume should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable. As a minimum, to mitigate for climate change the proposed 1 in 100 +CC volume discharge from site must be no greater than the existing 1 in 100 storm event. If not, flood risk increases under climate change.

6. Calculate attenuation storage – Attenuation storage is provided to enable the rate of runoff from the site into the receiving watercourse to be limited to an acceptable rate to protect against erosion and flooding downstream. The attenuation storage volume is a function of the degree of development relative to the greenfield discharge rate.

		Notes for developers
Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates (m^3)	N/A	Volume of water to attenuate on site if discharging at a greenfield run off rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to reduce rates by 50% (m^3)	N/A	Volume of water to attenuate on site if discharging at a 50% reduction from existing rates. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to meet [OTHER RUN OFF RATE (as close to greenfield rate as possible] (m^3)	N/A	Volume of water to attenuate on site if discharging at a rate different from the above – please state in 1st column what rate this volume corresponds to. On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to retain rates as existing (m^3)	N/A	Volume of water to attenuate on site if discharging at existing rates. Can't be used where discharge volumes are increasing
Percentage of attenuation volume stored above ground,	N/A	Percentage of attenuation volume which will be held above ground in swales/ponds/basins/green roofs etc. If 0, please demonstrate why.

7. How is Storm Water stored on site?

Storage is required for the additional volume from site but also for holding back water to slow down the rate from the site. This is known as attenuation storage and long term storage. The idea is that the additional volume does not get into the watercourses, or if it does it is at an exceptionally low rate. You can either infiltrate the stored water back to ground, or if this isn't possible hold it back with on site storage. Firstly, can infiltration work on site?

			Notes for developers
Infiltration	**State the Site's Geology and known Source Protection Zones (SPZ)**	LONDON CLAY	Avoid infiltrating in made ground. Infiltration rates are highly variable and refer to Environment Agency website to identify and source protection zones (SPZ)
	Are infiltration rates suitable?	ASSUMED NOT SUITABLE	Infiltration rates should be no lower than $1x10^{-6}$ m/s.
	State the distance between a proposed infiltration device base and the ground water (GW) level	N/A	Need 1m (min) between the base of the infiltration device & the water table to protect Groundwater quality & ensure GW doesn't enter infiltration devices. Avoid infiltration where this isn't possible.

	Were infiltration rates obtained by desk study or infiltration test?	DESK STUDY - ASSUMED NOT SUITABLE DUE TO LONDON CLAY GEOLOGY	Infiltration rates can be estimated from desk studies at most stages of the planning system if a back up attenuation scheme is provided..
	Is the site contaminated? If yes, consider advice from others on whether infiltration can happen.	NOT KNOWN AT THIS STAGE	Advice on contaminated Land in Camden can be found on our supporting documents webpage Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered.
In light of the above, is infiltration feasible?	**Yes/No? If the answer is No, please identify how the storm water will be stored prior to release**	NO, DUE TO GEOLOGY AND ABSENCE OF FREE SPACE >5m FROM STRUCTURES. STORM WATER WILL BE STORED IN A CELLULAR TANK	If infiltration is not feasible how will the additional volume be stored?. The applicant should then consider the following options in the next section.

Storage requirements

The developer must confirm that either of the two methods for dealing with the amount of water that needs to be stored on site.

Option 1 Simple – Store both the additional volume and attenuation volume in order to make a final discharge from site at the greenfield run off rate. This is preferred if no infiltration can be made on site. This very simply satisfies the runoff rates and volume criteria.

Option 2 Complex – If some of the additional volume of water can be infiltrated back into the ground, the remainder can be discharged at a very low rate of 2 l/sec/hectare. A combined storage calculation using the partial permissible rate of 2 l/sec/hectare and the attenuation rate used to slow the runoff from site.

		Notes for developers
Please confirm what option has been chosen and how much storage is required on site.	1	The developer at this stage should have an idea of the site characteristics and be able to explain what the storage requirements are on site and how it will be achieved.

8. Please confirm

		Notes for developers
Which Drainage Systems measures have been used, including green roofs?	ATTENUATION	SUDS can be adapted for most situations even where infiltration isn't feasible e.g. impermeable liners beneath some SUDS devices allows treatment but not infiltration. See CIRIA SUDS Manual C697.
Drainage system can contain in the 1 in 30 storm event without flooding	YES	This a requirement for sewers for adoption & is good practice even where drainage system is not adopted.
Will the drainage system contain the 1 in 100 +CC storm event? If no please demonstrate how buildings and utility plants will be protected.	YES	National standards require that the drainage system is designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.
Any flooding between the 1 in 30 & 1 in 100 plus climate change storm events will be safely contained on site.	YES	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased.
How will exceedance events be catered on site without increasing flood risks (both on site and outside the development)?	WILL FLOW OUT INTO THE MAIN ROAD (CLARKSON ROW)	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased. Exceedance events are defined as those larger than the 1 in 100 +CC event.
How are rates being restricted (vortex control, orifice etc)	ORIFICE PLATE WITH PROTECTIVE GRILLE	Detail of how the flow control systems have been designed to avoid pipe blockages and ease of maintenance should be provided.
Please confirm the owners/adopters of the entire drainage systems throughout the development. Please list all the owners.	MANAGEMENT COMPANY (TO BE ELECTED)	If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit must be submitted with this Proforma.
How is the entire drainage system to be maintained?	REFER TO ACCOMPANYING DRAINAGE MAINTENANCE & MANAGEMENT SCHEDULE	If the features are to be maintained directly by the owners as stated in answer to the above question please answer yes to this question and submit the relevant maintenance schedule for each feature. If it is to be maintained by others than above please give details of each feature and the maintenance schedule. Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided. Details must demonstrate that maintenance and operation requirements are economically proportionate. Poorly maintained drainage can lead to increased flooding problems in the future.

9. Evidence Please identify where the details quoted in the sections above were taken from. i.e. Plans, reports etc. Please also provide relevant drawings that need to accompany your proforma, in particular exceedance routes and ownership and location of SuDS (maintenance access strips etc

Pro-forma Section	Document reference where details quoted above are taken from	Page Number
Section 2		
Section 3	REFER TO SUDS AND FOUL DRAINAGE ASSESSMENT	
Section 4	REFER TO SUDS AND FOUL DRAINAGE ASSESSMENT	
Section 5	REFER TO SUDS AND FOUL DRAINAGE ASSESSMENT	
Section 6		
Section 7	REFER TO SUDS AND FOUL DRAINAGE ASSESSMENT	
Section 8	REFER TO SUDS AND FOUL DRAINAGE ASSESSMENT	

The above form should be completed using evidence from the Flood Risk Assessment and site plans. It should serve as a summary sheet of the drainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.

This form is completed using factual information from the Flood Risk Assessment and Site Plans and can be used as a summary of the surface water drainage strategy on this site.

Form Completed By: JOHN ROBERTS
Qualification of person responsible for signing off this pro-forma: CIVIL ENGINEER

Company: GTA CIVILS & TRANSPORT
On behalf of (Client's details): Penhallow Investments Ltd C/o 2nd Floor, Gaspe House, St Helier JE1 1GH, Jersey
Date: 11 DECEMBER 2020

gta
Civils & Transport

Civil Engineering - Transport Planning - Flood Risk

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