MOMENTUM
structural engineers

Design note

Project	Date	By	Reference
Roundhouse	17.02.2020	dp	2796 DNT 610

Title

Outline Drainage Strategy

Introduction

This document has been prepared as a summary of the drainage of surface water runoff for the existing and proposed conditions.

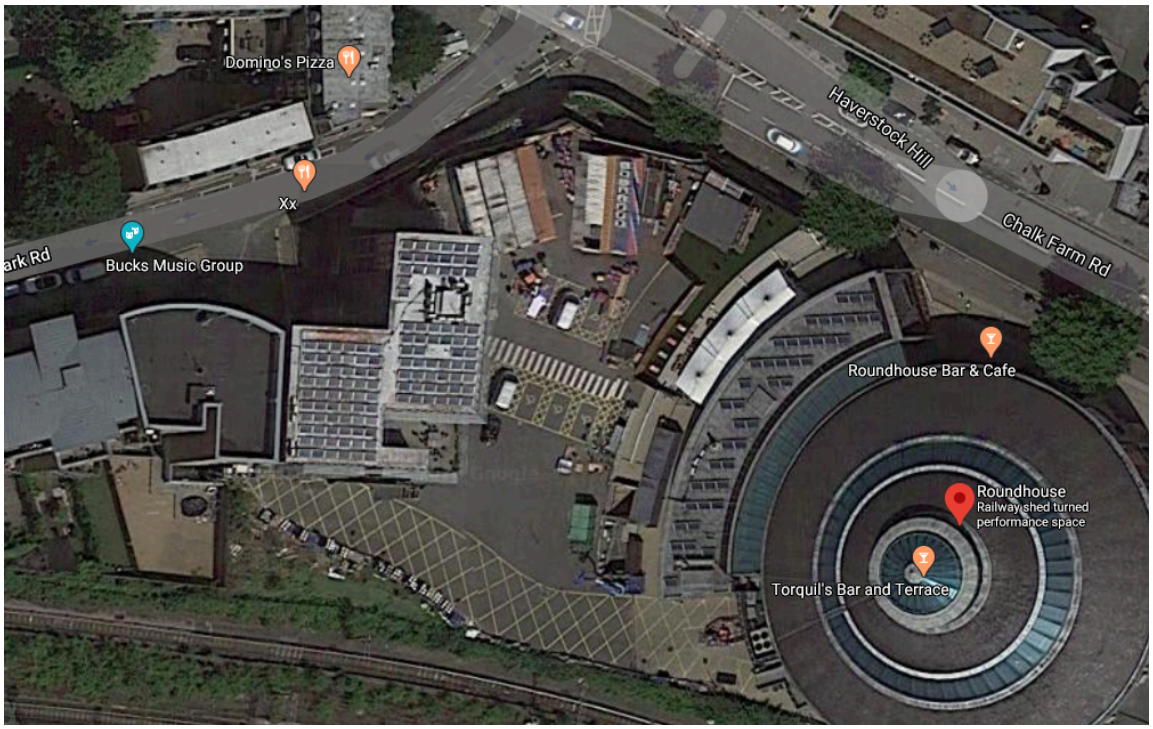
Existing site / drainage

The existing site covers an area of 3330 m² including the roof area of the container admin block. The site comprises impermeable surfaces of shipping containers and hard landscaping. The image below has been taken from internet aerial mapping.

The existing site is relatively flat in level.

Existing Peak Rainfall	1 year l/s	30 yrs l/s	100 yrs l/s
5 min	15.98	121.39	153.26
1 hour	11.84	28.49	37.56
6 hour	3.38	7.41	9.66

The following table is a summary of the volume runoff in cubic metres for various rainfall events and storm durations. No allowance for climate change is used to calculate existing volume runoff.



At this stage we have assumed the site is 100% impermeable.

Existing peak Rainfall and Runoff Volume

The following table is a summary of the peak rainfall in litres/second for various rainfall events and storm durations for the full site area of 3330m². No allowance for climate change is used to calculate existing peak rates.

Existing Volume Runoff	1 year m³	30 yrs m³	100 yrs m³
5 min	15.29	36.42	45.98
1 hour	42.62	102.56	135.2
6 hour	73.05	1060.14	208.6

It is assumed the surface water from the impermeable areas is positively drained and discharged at an un-controlled rate to the public sewer network.

The local water authority asset location search has been included with the appendix of this document. A combined sewer exists in Chalk Farm Road.

Proposed Development

The total proposed developed area is approximately 975 m^2 (0.0975ha) of the 3330 m^2 site. This is split into two developments referred to in this document and the Campus Building and Railside Storage Works. The new campus building to the north of the site covers an area of 687 m^2 and the Railside Storage to the south west corner has a total developed area of 288 m^2.

The proposed Campus Building comprises of the construction of a 3 storey CLT building to provide new studios and shared working space. Approximately 300 m^2 of the campus building has a green roof. The railside storage works is to provide a new ground bearing RC slab to provide a level storage area to the south west of the site adjacent to network rail land. The intention is for the slab to support new container storage units, but these do not form part of the current development and will be introduced at a later date.

Refer to drawings 2796-601 and 602 appended to this document.

The following table is a summary of the zones and corresponding impermeable area after applying factors for interception losses.

Zone	Area m^2	Impermeability factor	Impermeable area m^2
Campus Building	585	0.95	556
Railside Storage	288	0.95	273
Total impermeable area positively drained			829

Due to the use and size of the existing service yard, the locations of the new developments within the site and the order in which the developments are to be constructed, it is not feasible to allow for one attenuation tank for the whole development. As a result the calculations and this document have considered the two developments separately to calculate the proposed run off rates and required storage volumes.

The impermeable areas positively drained will feed into new SuDS attenuation tanks via a conventional system of gullies, pipes and chambers with a flow controlled discharge to the public sewer via private drainage and existing connection.

Proposed Campus Building site / drainage

The campus building has a total proposed developed area of 687m^2 with a 102m^2 area of permeable paving and storage that has been excluded from the calculations and below summary tables.

The following table is a summary of the peak rainfall in litres/second for various rainfall events and storm durations. A climate change allowance of 40% has been used to calculate proposed runoff rates.

Proposed Peak Rainfall	1 year l/s	30 yrs l/s	100 yrs l/s
5 min	11.84	28.94	37.14
1 hour	2.91	6.56	8.59
6 hour	0.82	1.66	2.14

The following table is a summary of the volume runoff in cubic metres for various rainfall events and storm durations.

Proposed Volume Runoff	1 year m^3	30 yrs m^3	100 yrs m^3
5 min	3.55	8.68	11.14
1 hour	10.46	23.63	30.92
6 hour	17.72	35.95	46.2

Due to the inclusion of climate change allowance and only a marginal decrease in impermeable area the proposed peak runoff rates and volumes have been increased for all rainfall events and storm durations.

Peak flow control

The following table is a summary of the comparison of peak unattenuated runoff rates for the 1 in 100 year rainfall event.

Comparison	5 min	1 hour	6 hour
Existing	31.62 l/s	7.75 l/s	1.99 l/s
Proposed	37.14 l/s	8.59 l/s	2.14 l/s
Betterment	-15%	-10%	-7%

The table shows that there is an increase on the existing situation. It is good practice to provide a betterment when connected to the public sewer. For this project a 50%

betterment up to and including the 1 hour storm event would be desirable.

Clause S3 within the Non-statutory technical standards for sustainable drainage systems produced by Defra states :

For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

The following table is a summary of the greenfield runoff rate estimation in litres/second for various rainfall events for the developed area of the campus building:

QBar l/s	1 year l/s	30 yrs l/s	100 yrs l/s
0.29	0.25	0.68	0.94

2 l/s is the practical minimum for a vortex flow control to prevent blockage and other maintenance issues. To provide the required betterment we have used this value as a maximum discharge into the existing system and used the 2 l/s limit to calculate the attenuation volume required for the new campus building.

This is as close to as reasonably practical to the greenfield runoff rate for the 1 in 100 year rainfall event. The proposed rate does not exceed the pre-development rate and therefore complies with the above clause S3.

Proposed Railside works site / drainage

The following table is a summary of the peak rainfall in litres/second for various rainfall events and storm durations. A climate change allowance of 40% has been used to calculate proposed runoff rates.

Proposed Peak Rainfall	1 year l/s	30 yrs l/s	100 yrs l/s
5 min	5.81	14.21	18.24
1 hour	1.43	3.22	4.22
6 hour	0.4	0.82	1.05

The following table is a summary of the volume runoff in cubic metres for various rainfall events and storm durations. A climate change allowance of 40% has been used to calculate proposed volume runoff.

Proposed Volume Runoff	1 year m^3	30 yrs m^3	100 yrs m^3
5 min	1.74	4.26	5.47
1 hour	5.14	11.6	15.18
6 hour	8.7	17.65	22.68

Due to the inclusion of climate change allowance and only a marginal decrease in impermeable area the proposed peak runoff rates and volumes have been increased for all rainfall events and storm durations.

Peak flow control

The following table is a summary of the comparison of peak unattenuated runoff rates for the 1 in 100 year rainfall event.

Comparison	5 min	1 hour	6 hour
Existing	13.26 l/s	3.25 l/s	0.84 l/s
Proposed	18.24 l/s	4.22 l/s	1.06 l/s
Betterment	-27%	-23%	-21%

As expected the table shows that there is an increase on the existing situation and attenuation is required.

The following table is a summary of the greenfield runoff rate estimation in litres/second for various rainfall events :

QBar l/s	1 year l/s	30 yrs l/s	100 yrs l/s
0.12	0.11	0.28	0.39

As for the Campus building a 2 l/s limit was taken to determine the required attenuation volume for the Railside storage development and to comply with clause S3.

Overall Site Discharge Betterment

It is proposed that a discharge rate of 4 l/s is adopted for this site for the connection to the public sewer. This rate is split equally over two control chambers from separate attenuation volumes. 2 l/s is the practical minimum for a vortex flow control to prevent blockage and other maintenance issues.

The following table is a summary of the comparison of existing pre-attenuation and proposed discharge rates for the 1 in 100 year rainfall event. The existing values assume a 40% increase to allow for climate change if the site is not attenuated and the proposed run off includes the 2355m2 of undeveloped site to provide a more accurate comparison.

All the proposed runoff values include a 40% allowance for climate change.

Comparison	5 min	1 hour
Existing (3330m²)	222.46 l/s	51.44 l/s
Proposed (2355m²+ 4 l/s)	157.33 +4 l/s	36.38 + 4 l/s
Betterment	27.5%	21.5%

The proposed discharge rate achieves a betterment of over 20% for a 1 hour event for the whole site (3330m²), even though only 29% of the site is being developed. When considering only the area of development (i.e 975m²), compared to the existing rates the betterment is in excess of the 50%.

Volume control

Clause S5 within the Non-statutory technical standards for sustainable drainage systems produced by Defra states :

Where reasonably practicable, for developments which have been previously developed, the runoff volume 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, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

The opportunities on the site to provide long term storage in addition to the attenuation storage proposed are limited.

Open water features or additional infiltration opportunities are not possible due site use and ground conditions at depth.

Permeable paving and infiltration are proposed to be used for the re-landscaping around the proposed building.

The green roof proposed will reduce overall volume runoff from the site during summer months.

At present, as the 6 hour volume does exceed the runoff volume prior to re-development the inclusion of the green roof and possible permeable paving would therefore comply with the above clause S5.

Attenuation Volume

Attenuation storage has been calculated using the following criteria :

- For storage for the Campus building -Total impermeable area positively drained = 556m²
- For storage for Railside works -Total impermeable area positively drained = 273m²
- 1 in 100 year rainfall event
- A climate change allowance of 40%
- A free volume of storage of 0.95
- A peak discharge rate of 2 litres/second at each flow control

Refer to calculations 3316-CLC-612 and 613 appended to this document.

The following table is a summary of the attenuation storage required in cubic metres.

Storage	Free volume m³	Storage Provided m³
Campus	23.72	27
Railside	8.8	9.2

Foul Water (Campus Building only)

Foul water will be discharged to the public sewer in Chalk Farm Road via the existing connection through TWA manhole reference 2301.

Summary

Surface water runoff will be captured in SuDS features where possible.

Green roof and permeable paving will provide long term storage opportunities to reduce volume runoff.

Surface water runoff from impermeable surfaces will be collected, transported to and stored in below ground SuDS attenuation tanks.

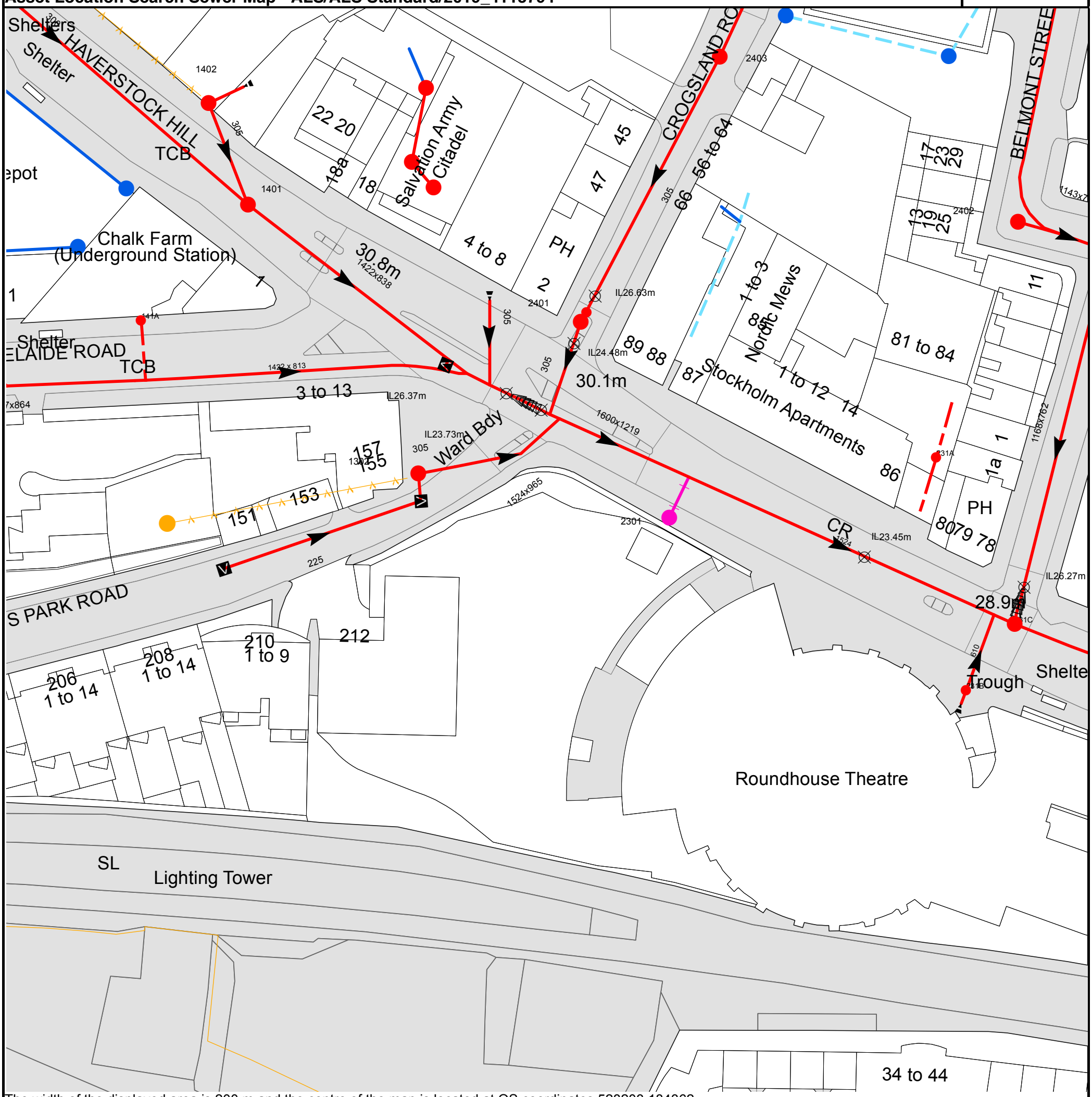
The outflow from the SuDS attenuation tanks will be controlled prior to discharge into the public sewer via the existing connection through TWA manhole reference 2301.

Appendix

Contents

- Local water authority asset location search
- Drawings
- Calculations
- Drainage Hierarchy
- Maintenance

Asset Location Search Sewer Map - ALS/ALS Standard/2019_4113794



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 528203,184362

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
231B	n/a	n/a
231C	n/a	n/a
2301	n/a	n/a
1302	30.77	26.84
231A	n/a	n/a
2401	30.19	n/a
141A	n/a	n/a
14BF	n/a	n/a
2402	29.91	26.52
1401	31.06	27.24
14BG	n/a	n/a
14BC	n/a	n/a
14BB	n/a	n/a
1402	n/a	n/a
14BA	n/a	n/a
2403	30.82	28.25
24BJ	n/a	n/a
24BI	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

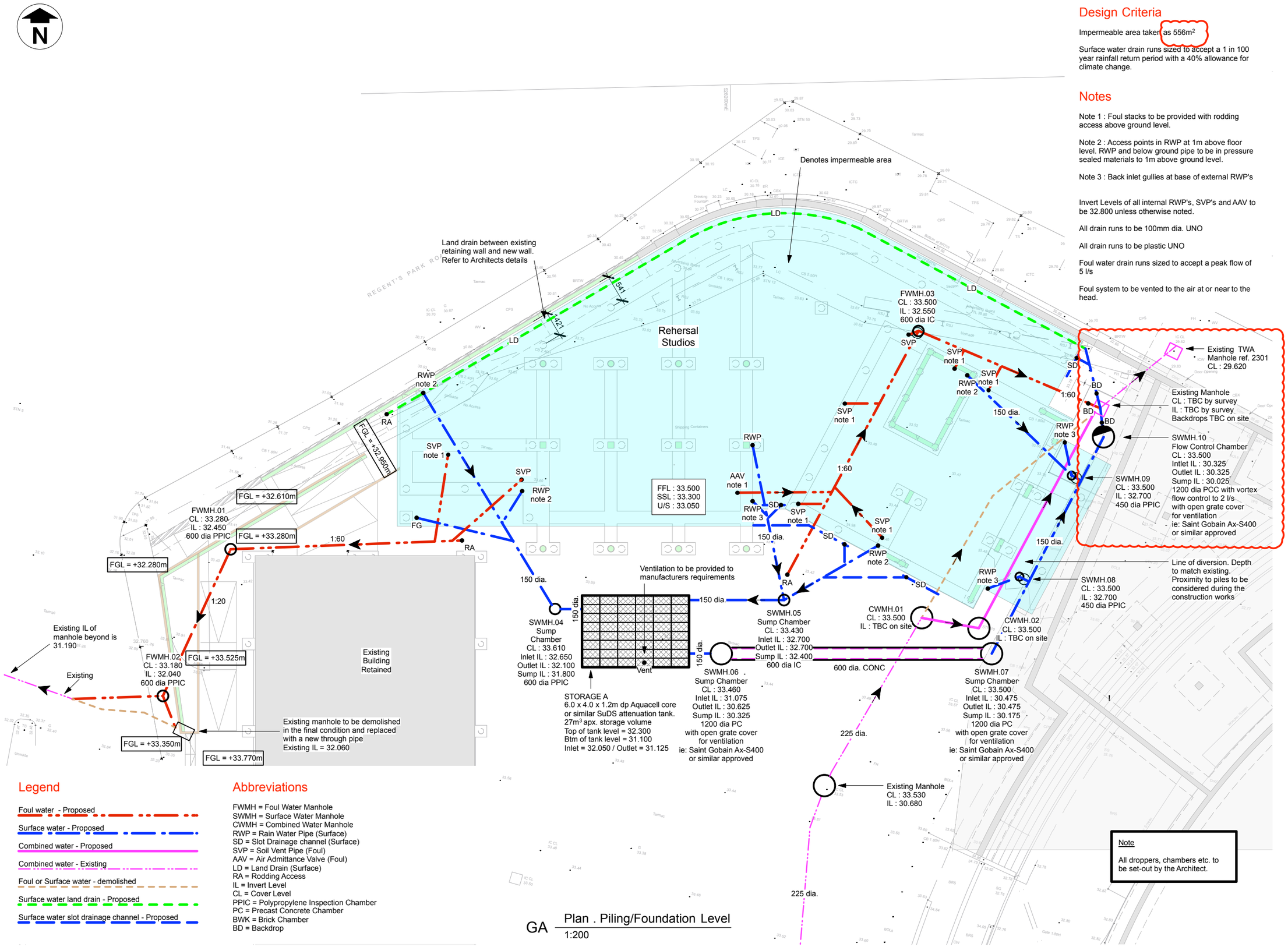
Other Sewer Types (Not Operated or Maintained by Thames Water)

- 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.

A3



Design Criteria

Impermeable area taken as 556m²

Surface water drain runs sized to accept a 1 in 100 year rainfall return period with a 40% allowance for climate change.

Notes

Note 1 : Foul stacks to be provided with rodding access above ground level.

Note 2 : Access points in RWP at 1m above floor level. RWP and below ground pipe to be in pressure sealed materials to 1m above ground level.

Note 3 : Back inlet gullies at base of external RWP's

Invert Levels of all internal RWP's, SVP's and AAV to be 32.800 unless otherwise noted.

All drain runs to be 100mm dia. UNO

All drain runs to be plastic UNO

Foul water drain runs sized to accept a peak flow of 5 l/s

Foul system to be vented to the air at or near to the head.

Legend

- Foul water - Proposed
- Surface water - Proposed
- Combined water - Proposed
- Combined water - Existing
- Foul or Surface water - demolished
- Surface water land drain - Proposed
- Surface water slot drainage channel - Proposed

Abbreviations

FWMH = Foul Water Manhole
SWMH = Surface Water Manhole
CWMH = Combined Water Manhole
RWP = Rain Water Pipe (Surface)
SD = Slot Drainage channel (Surface)
SVP = Soil Vent Pipe (Foul)
AAV = Air Admittance Valve (Foul)
LD = Land Drain (Surface)
RA = Rodding Access
IL = Invert Level
CL = Cover Level
PPIC = Polypropylene Inspection Chamber
PC = Precast Concrete Chamber
BWK = Brick Chamber
BD = Backdrop

GA Plan . Piling/Foundation Level
1:200

Note

All droppers, chambers etc. to be set-out by the Architect.

NOT FOR CONSTRUCTION

Rev	Date	By
T1	23.09.20	dp
T0	18.05.20	dp
01	02.04.20	CC
00	31.03.20	dp

Work Stage - ACE / (RIBA)
RIBA Stage 4

Reason For Issue
Tender

Project Title
The Roundhouse
Chalk Farm Road
Camden
London

Client
The Roundhouse

Architect
Reed Watts

Drawing Title
GA Plan
Below Ground Drainage
Sheet 1

Date
Feb 2020

Drawn by
dp

Scale at A3
1:200

Checked by
JB

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Project No. 2796 | Drawing Ref. 601 | Revision T1

A3

Legend

- Foul water - Proposed
- Surface water - Proposed
- Combined water - Proposed
- Combined water - Existing
- Foul or Surface water - demolished
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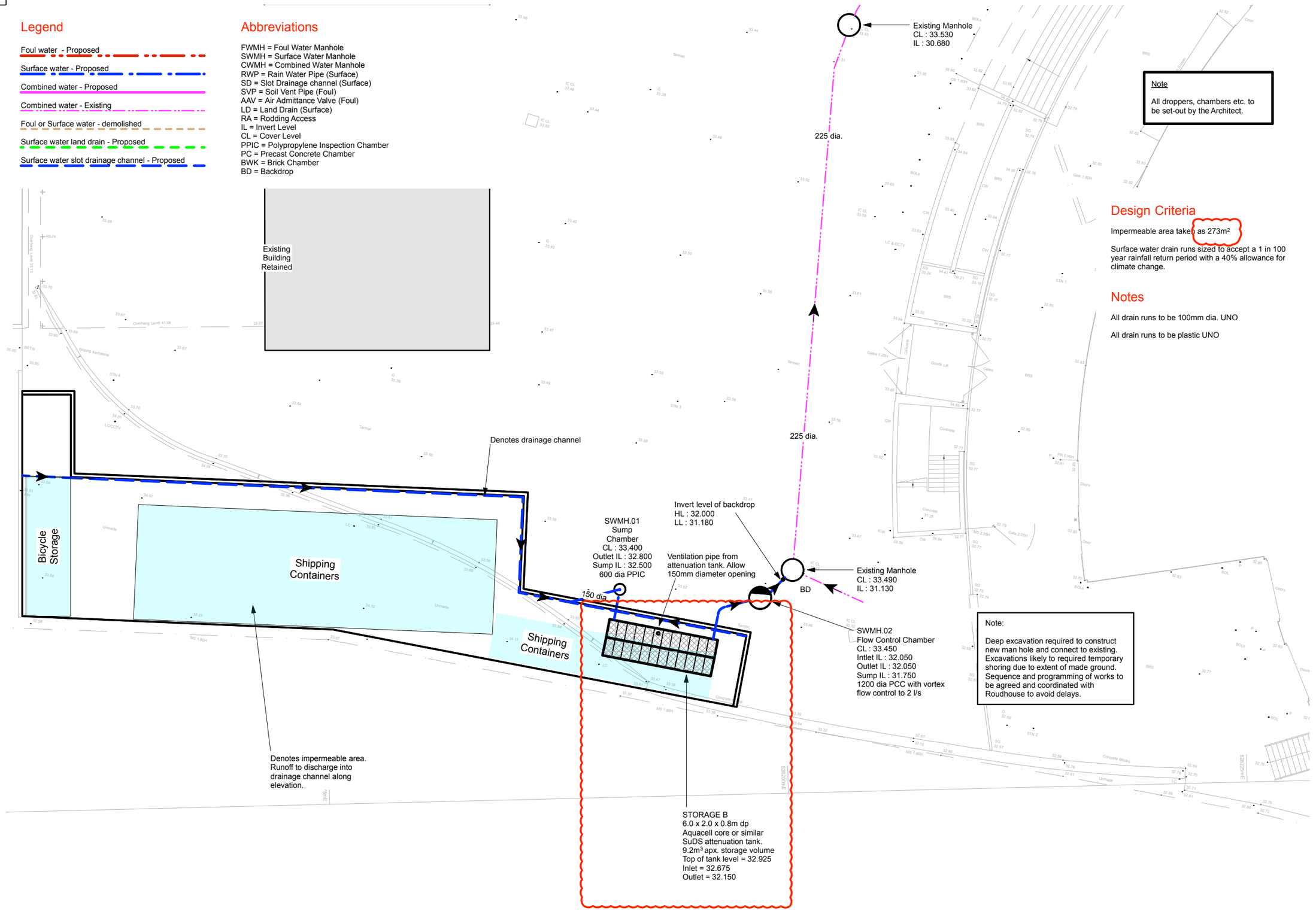

Design Criteria

Impermeable area taken as 273m²

Surface water drain runs sized to accept a 1 in 100 year rainfall return period with a 40% allowance for climate change.

Notes

All drain runs to be 100mm dia. UNO

All drain runs to be plastic UNO

NOT FOR CONSTRUCTION

Rev	Date	By
T3	23.09.20	dp
T2	15.07.20	CC
T1	30.06.20	CC
00	31.03.20	dp

Work Stage - ACE / (RIBA)
RIBA Stage 4

Reason For Issue
Tender

Project Title
The Roundhouse
Chalk Farm Road
Camden
London

Client
The Roundhouse

Architect
Reed Watts

Drawing Title
GA Plan
Below Ground Drainage
Railside

Date
Feb 2020

Drawn by
dp

Scale at A3
1:200

Checked by
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Project No.	Drawing Ref.	Revision
2796	602	T3

Project

Roundhouse

MOMENTUM structural engineers

Title	Date	By	Reference
Attenuation Storage - CAMPUS	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Storage Inflow l/s	Storage Flow l/s	Free Volume Required m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	240.50	556	37.14	11.14	37.14	35.14	10.54	0.067	20.04
10	600	174.47	556	26.95	16.17	26.95	24.95	14.97	0.048	29.08
15	900	142.71	556	22.04	19.84	22.04	20.04	18.04	0.040	35.68
30	1,800	90.87	556	14.04	25.26	14.04	12.04	21.66	0.025	45.44
60	3,600	55.61	556	8.59	30.92	8.59	6.59	23.72	0.015	55.61
120	7,200	32.77	556	5.06	36.44	5.06	3.06	22.04	0.009	65.54
240	14,400	19.10	556	2.95	42.47	2.95	0.95	13.67	0.005	76.39
360	21,600	13.85	556	2.14	46.20	2.14	0.14	3.00	0.004	83.09
600	36,000	9.08	556	1.40	50.49	1.40	-0.60	-21.51	0.003	90.81
1,440	86,400	4.50	556	0.70	60.10	0.70	-1.30	-112.70	0.001	108.10

User Input

Impermeable Area	556	.....	m^2
Storage Outflow	2.00	.....	Allowable discharge rate
Free Volume	0.95	.....	Free volume of storage chamber
Urban Creep	1.00	.....	Allowance for future urban creep
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	40	.....	Increase of rainfall intensity due to global warming (%)
Return Period	100	.....	Return period for rainfall (Yrs)

Design Summary

Largest Free Volume (m^3)	23.72
with Urban Creep Allowance (m^3)	23.72
Total Storage To Be Provided (m^3)	24.97

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Project

Roundhouse

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Title	Date	By	Reference
Attenuation Storage - RAILSIDE	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Storage Inflow l/s	Storage Flow l/s	Free Volume Required m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	240.50	273	18.24	5.47	18.24	16.24	4.87	0.067	20.04
10	600	174.47	273	13.23	7.94	13.23	11.23	6.74	0.048	29.08
15	900	142.71	273	10.82	9.74	10.82	8.82	7.94	0.040	35.68
30	1,800	90.87	273	6.89	12.40	6.89	4.89	8.80	0.025	45.44
60	3,600	55.61	273	4.22	15.18	4.22	2.22	7.98	0.015	55.61
120	7,200	32.77	273	2.48	17.89	2.48	0.48	3.49	0.009	65.54
240	14,400	19.10	273	1.45	20.86	1.45	-0.55	-7.94	0.005	76.39
360	21,600	13.85	273	1.05	22.68	1.05	-0.95	-20.52	0.004	83.09
600	36,000	9.08	273	0.69	24.79	0.69	-1.31	-47.21	0.003	90.81
1,440	86,400	4.50	273	0.34	29.51	0.34	-1.66	-143.29	0.001	108.10

User Input

Impermeable Area	273	.....	m^2
Storage Outflow	2.00	.....	Allowable discharge rate
Free Volume	0.95	.....	Free volume of storage chamber
Urban Creep	1.00	.....	Allowance for future urban creep
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	40	.....	Increase of rainfall intensity due to global warming (%)
Return Period	100	.....	Return period for rainfall (Yrs)

Design Summary

Largest Free Volume (m^3)	8.80
with Urban Creep Allowance (m^3)	8.80
Total Storage To Be Provided (m^3)	9.27

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Project

Roundhouse

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Title	Date	By	Reference
CAMPUS - Existing Runoff - 1 Yr	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	55.11	687	10.52	3.16
10	600	38.37	687	7.32	4.39
15	900	31.18	687	5.95	5.35
30	1,800	20.06	687	3.83	6.89
60	3,600	12.80	687	2.44	8.79
120	7,200	7.92	687	1.51	10.89
240	14,400	4.89	687	0.93	13.43
360	21,600	3.66	687	0.70	15.07
600	36,000	2.48	687	0.47	17.04
1,440	86,400	1.32	687	0.25	21.84

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.015	4.59
0.011	6.39
0.009	7.79
0.006	10.03
0.004	12.80
0.002	15.84
0.001	19.55
0.001	21.94
0.001	24.81
0.000	31.79

User Input

Impermeable Area	687	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	0	.....	Increase of rainfall intensity due to global warming (%)

Currently set up for England and Wales Only

Project

Roundhouse

MOMENTUM structural engineers

Title	Date	By	Reference
CAMPUS - Existing Runoff - 30 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	131.23	687	25.04	7.51
10	600	93.81	687	17.90	10.74
15	900	76.57	687	14.61	13.15
30	1,800	49.23	687	9.40	16.91
60	3,600	30.80	687	5.88	21.16
120	7,200	18.48	687	3.53	25.40
240	14,400	10.95	687	2.09	30.10
360	21,600	8.01	687	1.53	33.04
600	36,000	5.31	687	1.01	36.48
1,440	86,400	2.69	687	0.51	44.34

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.036	10.94
0.026	15.63
0.021	19.14
0.014	24.62
0.009	30.80
0.005	36.97
0.003	43.81
0.002	48.09
0.001	53.11
0.001	64.55

User Input

Impermeable Area	687	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	0	.....	Increase of rainfall intensity due to global warming (%)

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MOMENTUM structural engineers

Title	Date	By	Reference
CAMPUS - Existing Runoff - 100 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	165.69	687	31.62	9.49	0.046	13.81
10	600	120.42	687	22.98	13.79	0.033	20.07
15	900	98.94	687	18.88	16.99	0.027	24.73
30	1,800	64.22	687	12.26	22.06	0.018	32.11
60	3,600	40.60	687	7.75	27.89	0.011	40.60
120	7,200	24.30	687	4.64	33.38	0.007	48.59
240	14,400	14.31	687	2.73	39.33	0.004	57.25
360	21,600	10.44	687	1.99	43.03	0.003	62.64
600	36,000	6.90	687	1.32	47.39	0.002	68.97
1,440	86,400	3.46	687	0.66	56.99	0.001	82.95

User Input

Impermeable Area	687	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	0	.....	Increase of rainfall intensity due to global warming (%)

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MOMENTUM structural engineers

Title	Date	By	Reference
ENTIRE SITE - Existing Runoff - 1 Yr	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	55.11	3,330	50.98	15.29
10	600	38.37	3,330	35.49	21.29
15	900	31.18	3,330	28.84	25.95
30	1,800	20.06	3,330	18.56	33.40
60	3,600	12.80	3,330	11.84	42.62
120	7,200	7.92	3,330	7.33	52.76
240	14,400	4.89	3,330	4.52	65.11
360	21,600	3.66	3,330	3.38	73.05
600	36,000	2.48	3,330	2.29	82.62
1,440	86,400	1.32	3,330	1.23	105.86

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.015	4.59
0.011	6.39
0.009	7.79
0.006	10.03
0.004	12.80
0.002	15.84
0.001	19.55
0.001	21.94
0.001	24.81
0.000	31.79

User Input

Impermeable Area	3,330	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	0	.....	Increase of rainfall intensity due to global warming (%)

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Title	Date	By	Reference
ENTIRE SITE - Existing Runoff - 30 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	131.23	3,330	121.39	36.42
10	600	93.81	3,330	86.77	52.06
15	900	76.57	3,330	70.83	63.75
30	1,800	49.23	3,330	45.54	81.97
60	3,600	30.80	3,330	28.49	102.56
120	7,200	18.48	3,330	17.10	123.10
240	14,400	10.95	3,330	10.13	145.90
360	21,600	8.01	3,330	7.41	160.14
600	36,000	5.31	3,330	4.91	176.84
1,440	86,400	2.69	3,330	2.49	214.94

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.036	10.94
0.026	15.63
0.021	19.14
0.014	24.62
0.009	30.80
0.005	36.97
0.003	43.81
0.002	48.09
0.001	53.11
0.001	64.55

User Input

Impermeable Area	3,330	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	0	.....	Increase of rainfall intensity due to global warming (%)

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Roundhouse

MOMENTUM structural engineers

Title	Date	By	Reference
ENTIRE SITE - Existing Runoff - 100 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	165.69	3,330	153.26	45.98
10	600	120.42	3,330	111.39	66.83
15	900	98.94	3,330	91.51	82.36
30	1,800	64.22	3,330	59.40	106.93
60	3,600	40.60	3,330	37.56	135.20
120	7,200	24.30	3,330	22.47	161.81
240	14,400	14.31	3,330	13.24	190.63
360	21,600	10.44	3,330	9.66	208.60
600	36,000	6.90	3,330	6.38	229.68
1,440	86,400	3.46	3,330	3.20	276.23

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.046	13.81
0.033	20.07
0.027	24.73
0.018	32.11
0.011	40.60
0.007	48.59
0.004	57.25
0.003	62.64
0.002	68.97
0.001	82.95

User Input

Impermeable Area	3,330	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	0	.....	Increase of rainfall intensity due to global warming (%)

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MOMENTUM structural engineers

Title	Date	By	Reference
RAILSIDE - Existing Runoff - 1 Yr	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	55.11	288	4.41	1.32
10	600	38.37	288	3.07	1.84
15	900	31.18	288	2.49	2.24
30	1,800	20.06	288	1.60	2.89
60	3,600	12.80	288	1.02	3.69
120	7,200	7.92	288	0.63	4.56
240	14,400	4.89	288	0.39	5.63
360	21,600	3.66	288	0.29	6.32
600	36,000	2.48	288	0.20	7.15
1,440	86,400	1.32	288	0.11	9.16

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.015	4.59
0.011	6.39
0.009	7.79
0.006	10.03
0.004	12.80
0.002	15.84
0.001	19.55
0.001	21.94
0.001	24.81
0.000	31.79

User Input

Impermeable Area	288	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	0	.....	Increase of rainfall intensity due to global warming (%)

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MOMENTUM structural engineers

Title	Date	By	Reference
RAILSIDE - Existing Runoff - 30 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	131.23	288	10.50	3.15
10	600	93.81	288	7.50	4.50
15	900	76.57	288	6.13	5.51
30	1,800	49.23	288	3.94	7.09
60	3,600	30.80	288	2.46	8.87
120	7,200	18.48	288	1.48	10.65
240	14,400	10.95	288	0.88	12.62
360	21,600	8.01	288	0.64	13.85
600	36,000	5.31	288	0.42	15.29
1,440	86,400	2.69	288	0.22	18.59

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.036	10.94
0.026	15.63
0.021	19.14
0.014	24.62
0.009	30.80
0.005	36.97
0.003	43.81
0.002	48.09
0.001	53.11
0.001	64.55

User Input

Impermeable Area	288	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	0	.....	Increase of rainfall intensity due to global warming (%)

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Roundhouse

MOMENTUM structural engineers

Title	Date	By	Reference
RAILSIDE - Existing Runoff - 100 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	165.69	288	13.26	3.98
10	600	120.42	288	9.63	5.78
15	900	98.94	288	7.91	7.12
30	1,800	64.22	288	5.14	9.25
60	3,600	40.60	288	3.25	11.69
120	7,200	24.30	288	1.94	13.99
240	14,400	14.31	288	1.14	16.49
360	21,600	10.44	288	0.84	18.04
600	36,000	6.90	288	0.55	19.86
1,440	86,400	3.46	288	0.28	23.89

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.046	13.81
0.033	20.07
0.027	24.73
0.018	32.11
0.011	40.60
0.007	48.59
0.004	57.25
0.003	62.64
0.002	68.97
0.001	82.95

User Input

Impermeable Area	288	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	0	.....	Increase of rainfall intensity due to global warming (%)

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MOMENTUM structural engineers

Title	Date	By	Reference
CAMPUS - Proposed Runoff - 1 Yr	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	76.63	556	11.84	3.55	0.021	6.39
10	600	54.45	556	8.41	5.05	0.015	9.07
15	900	44.75	556	6.91	6.22	0.012	11.19
30	1,800	29.24	556	4.52	8.13	0.008	14.62
60	3,600	18.82	556	2.91	10.46	0.005	18.82
120	7,200	11.62	556	1.79	12.92	0.003	23.23
240	14,400	7.10	556	1.10	15.79	0.002	28.40
360	21,600	5.31	556	0.82	17.72	0.001	31.86
600	36,000	3.62	556	0.56	20.11	0.001	36.17
1,440	86,400	1.93	556	0.30	25.82	0.001	46.43

User Input

Impermeable Area	556	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	40	.....	Increase of rainfall intensity due to global warming (%)

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MOMENTUM structural engineers

Title	Date	By	Reference
CAMPUS - Proposed Runoff - 30 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	187.36	556	28.94	8.68	0.052	15.61
10	600	134.27	556	20.74	12.44	0.037	22.38
15	900	108.92	556	16.82	15.14	0.030	27.23
30	1,800	69.06	556	10.67	19.20	0.019	34.53
60	3,600	42.50	556	6.56	23.63	0.012	42.50
120	7,200	25.19	556	3.89	28.01	0.007	50.38
240	14,400	14.76	556	2.28	32.84	0.004	59.06
360	21,600	10.78	556	1.66	35.95	0.003	64.67
600	36,000	7.13	556	1.10	39.63	0.002	71.27
1,440	86,400	3.62	556	0.56	48.28	0.001	86.83

User Input

Impermeable Area	556	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	40	.....	Increase of rainfall intensity due to global warming (%)

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MOMENTUM structural engineers

Title	Date	By	Reference
CAMPUS - Proposed Runoff - 100 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	240.50	556	37.14	11.14	0.067	20.04
10	600	174.47	556	26.95	16.17	0.048	29.08
15	900	142.71	556	22.04	19.84	0.040	35.68
30	1,800	90.87	556	14.04	25.26	0.025	45.44
60	3,600	55.61	556	8.59	30.92	0.015	55.61
120	7,200	32.77	556	5.06	36.44	0.009	65.54
240	14,400	19.10	556	2.95	42.47	0.005	76.39
360	21,600	13.85	556	2.14	46.20	0.004	83.09
600	36,000	9.08	556	1.40	50.49	0.003	90.81
1,440	86,400	4.50	556	0.70	60.10	0.001	108.10

User Input

Impermeable Area	556	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	40	.....	Increase of rainfall intensity due to global warming (%)

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MOMENTUM structural engineers

Title	Date	By	Reference
RAILSIDE - Proposed Runoff - 1 Yr	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	76.63	273	5.81	1.74	0.021	6.39
10	600	54.45	273	4.13	2.48	0.015	9.07
15	900	44.75	273	3.39	3.05	0.012	11.19
30	1,800	29.24	273	2.22	3.99	0.008	14.62
60	3,600	18.82	273	1.43	5.14	0.005	18.82
120	7,200	11.62	273	0.88	6.34	0.003	23.23
240	14,400	7.10	273	0.54	7.75	0.002	28.40
360	21,600	5.31	273	0.40	8.70	0.001	31.86
600	36,000	3.62	273	0.27	9.87	0.001	36.17
1,440	86,400	1.93	273	0.15	12.68	0.001	46.43

User Input

Impermeable Area	273	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	40	.....	Increase of rainfall intensity due to global warming (%)

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Title	Date	By	Reference
RAILSIDE - Proposed Runoff - 30 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	187.36	273	14.21	4.26	0.052	15.61
10	600	134.27	273	10.18	6.11	0.037	22.38
15	900	108.92	273	8.26	7.43	0.030	27.23
30	1,800	69.06	273	5.24	9.43	0.019	34.53
60	3,600	42.50	273	3.22	11.60	0.012	42.50
120	7,200	25.19	273	1.91	13.75	0.007	50.38
240	14,400	14.76	273	1.12	16.12	0.004	59.06
360	21,600	10.78	273	0.82	17.65	0.003	64.67
600	36,000	7.13	273	0.54	19.46	0.002	71.27
1,440	86,400	3.62	273	0.27	23.70	0.001	86.83

User Input

Impermeable Area	273	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	40	.....	Increase of rainfall intensity due to global warming (%)

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Title	Date	By	Reference
RAILSIDE - Proposed Runoff - 100 Yrs	**23/09/2020**	**DP**	**2796 -CLC-**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	240.50	273	18.24	5.47	0.067	20.04
10	600	174.47	273	13.23	7.94	0.048	29.08
15	900	142.71	273	10.82	9.74	0.040	35.68
30	1,800	90.87	273	6.89	12.40	0.025	45.44
60	3,600	55.61	273	4.22	15.18	0.015	55.61
120	7,200	32.77	273	2.48	17.89	0.009	65.54
240	14,400	19.10	273	1.45	20.86	0.005	76.39
360	21,600	13.85	273	1.05	22.68	0.004	83.09
600	36,000	9.08	273	0.69	24.79	0.003	90.81
1,440	86,400	4.50	273	0.34	29.51	0.001	108.10

User Input

Impermeable Area	273	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate	40	.....	Increase of rainfall intensity due to global warming (%)

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With reference to Drainage Hierarchy

The following are the considerations in respect to the above policy :

Criteria	Project specific comments
Store rainwater for later re-use	Not considered feasible due to space-planning requirements, and lack of demand for grey water use.
Use infiltration techniques, such as porous surfaces in non-clay areas	Permeable paving is proposed where possible as part of the landscaping design.
Attenuate rainwater in ponds or open water features for gradual release	None present therefore not applicable.
Attenuate rainwater by storing in tanks or sealed water features for gradual release	Two below ground storage tanks with a total of 36m^3 has been adopted for this project to retain a 100 yr / 6 hour return period storm. This includes for a 40% climate change allowance. The outflow from the storage to the public sewer will be restricted to a runoff rate of 4 l/s.
Discharge rainwater direct to a water course	None present therefore not applicable.
Discharge rainwater to a surface water sewer / drain	None present therefore not applicable.
Discharge rainwater to a combined sewer	Site discharge will be attenuated and connected to the existing sewer in Chalk Farm Road.

Management and maintenance

Regular maintenance is required to ensure that the surface water drainage system operates efficiently and does not cause flooding to the property or surrounding buildings and land. Such work is part of the day-to-day responsibility of all owners and occupiers. Maintenance is most effective when carried out regularly, on a planned cycle. Good maintenance needs the regular investment of small amounts of time and money, but the cost of preparing and carrying out a planned maintenance programme should be far less than the costs resulting from a series of unplanned major repairs, and will help plan future financial commitments.

Maintenance is routine work which is necessary to protect the drainage system. When carried out on a planned basis, maintenance helps to prevent the types of failure which occur predictably within the life drainage system. Maintenance falls into four main categories :

- Inspection to assess condition, report any problems and decide whether repair or other work is necessary.
- Specific tasks such as clearing debris from manholes / inspection chambers and pipes.
- Minor repairs such as fixing loose covers.
- Maintenance differs from repair which is work carried out to put right defects or damage and work to return the drainage system to a good condition on a long-term basis.

The following are the considerations in respect to the above :

SuDS component	**Project specific comments**
Permeable paving	Ensure surfaces are washed regularly to ensure that the surface texture functions properly.
Underground storage tank	CCTV inspection after every major storm and at regular intervals according to the specific maintenance plan for the site. Silt traps prior to inlet pipework should be routinely inspected and cleaned out to minimise debris reaching the tank.
Flow control system	Vortex Valve units have no moving parts therefore maintenance requirements are minimal. Manual intervention would be required in the event of a blockage. A tornado Vortex Valve has an emergency drain-down facility consisting of an integral, pivoting door mounted onto the front face of the unit, which can be opened manually from ground level using the stainless steel rope provided. Once the door is open a larger aperture is exposed, allowing drain-down.