Appendix A.2 – Thames Water Asset Location Data

Asset location search

Thames Water Property Searches

Herrington Consulting Limited
CANTERBURY
CT4 6DQ

Search address supplied Royal Arsenal Project Office
Beresford Street
London
SE18 6BG

Your reference 3628_TV

Our reference ALS/ALS Standard/2022_4758037

Search date 30 November 2022

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0800 009 4540

Search address supplied: Royal Arsenal Project Office, Beresford Street, London, SE18 6BG

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This searchprovides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0800 009 4540, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0800 316 9800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

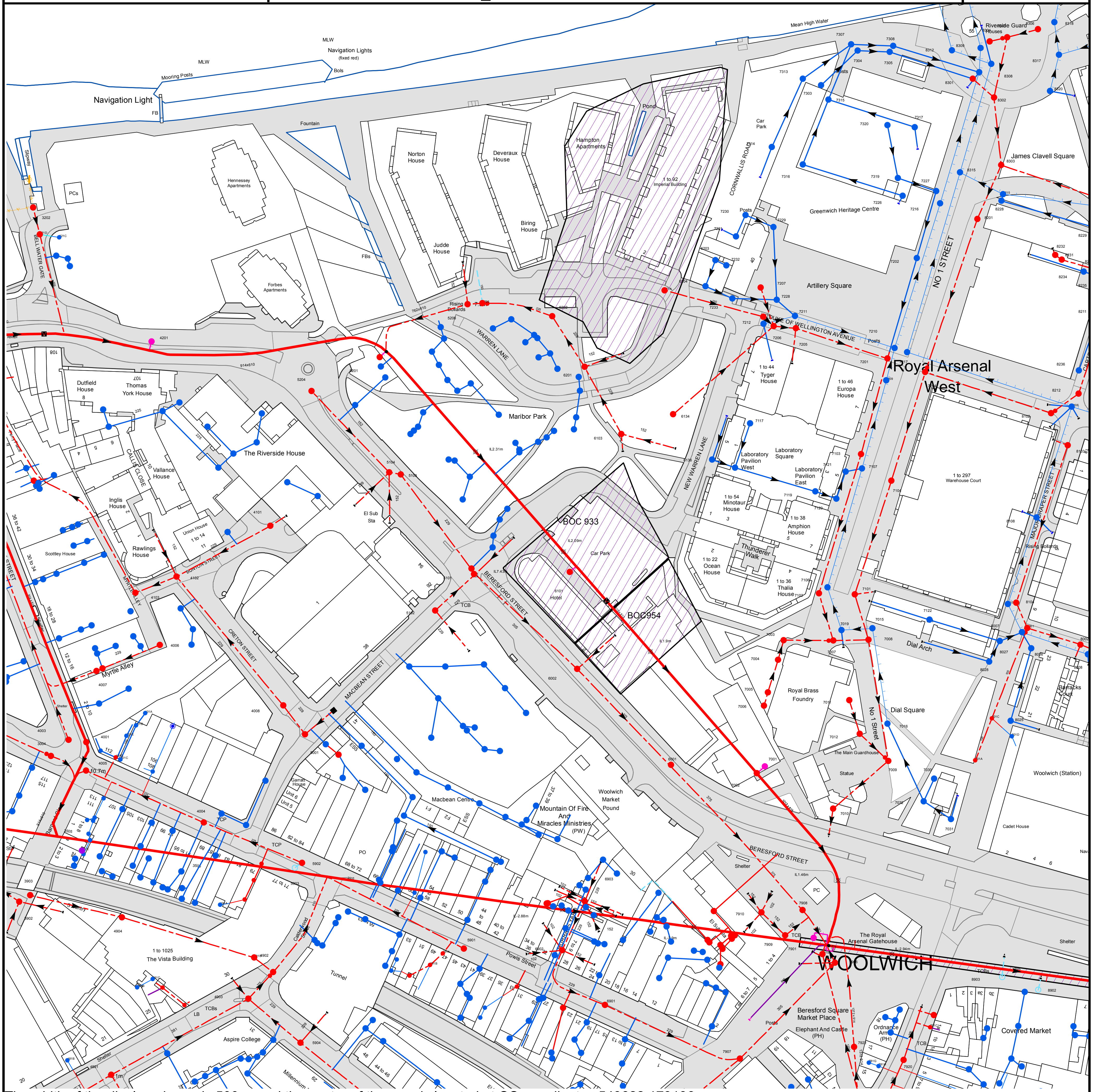
Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2022_4758037



The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 543622,179136

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
8106	n/a	n/a
8212	n/a	n/a
8236	n/a	n/a
8234	n/a	n/a
8229	n/a	n/a
89XX	n/a	n/a
89XY	n/a	n/a
8026	n/a	n/a
8902	9.05	7.37
89YT	n/a	n/a
89YU	n/a	n/a
8002	n/a	n/a
8008	n/a	n/a
89YV	n/a	n/a
8302	n/a	n/a
8305	n/a	n/a
8306	n/a	n/a
8320	n/a	n/a
8318	n/a	n/a
8317	n/a	n/a
7920	9.29	5.79
88VV	n/a	n/a
88UV	n/a	n/a
88VR	n/a	n/a
89XW	n/a	n/a
88UY	n/a	n/a
7907	12.16	8.99
78YU	n/a	n/a
78XX	n/a	n/a
7922	9.89	3.92
89XQ	n/a	n/a
79WX	n/a	n/a
89XS	n/a	n/a
791C	n/a	n/a
69QS	n/a	n/a
79WY	n/a	n/a
79WZ	n/a	n/a
79ZV	n/a	n/a
79WW	n/a	n/a
79WV	n/a	n/a
69QT	n/a	n/a
69QU	n/a	n/a
8903	8.79	7.19
69WR	n/a	n/a
79XX	n/a	n/a
7906	10.22	4.62
69UW	n/a	n/a
791B	10.6	-1.93
69VT	n/a	n/a
69WW	n/a	n/a
79XT	n/a	n/a
79XW	n/a	n/a
69WY	n/a	n/a
69WZ	n/a	n/a
79XS	n/a	n/a
7901	10.22	n/a
6134	n/a	n/a
6136	n/a	n/a
7118	n/a	n/a
7117	n/a	n/a
7119	n/a	n/a
7102	n/a	n/a
7106	n/a	n/a
7120	n/a	n/a
7019	n/a	n/a
7121	n/a	n/a
7101	n/a	n/a
7103	n/a	n/a
7107	n/a	n/a
7015	n/a	n/a
7209	n/a	n/a
7201	n/a	n/a
7104	n/a	n/a
7217	n/a	n/a
7204	n/a	n/a
7122	n/a	n/a
8107	n/a	n/a
8104	n/a	n/a
8007	n/a	n/a
8001	n/a	n/a
8108	n/a	n/a
8102	n/a	n/a
8103	n/a	n/a
6001	10.02	n/a
69WX	n/a	n/a
79XV	n/a	n/a
79XR	n/a	n/a
7002	10.5	1.68
7910	11.73	10.02
7006	n/a	n/a
7001	10.5	n/a

Manhole Reference	Manhole Cover Level	Manhole Invert Level
7005	n/a	n/a
7004	n/a	n/a
7003	n/a	n/a
7909	11.68	9.54
7908	10.26	6.06
7010	n/a	n/a
7007	n/a	n/a
7011	n/a	n/a
7012	n/a	n/a
7008	n/a	n/a
7016	n/a	n/a
7009	n/a	n/a
7032	n/a	n/a
7030	n/a	n/a
7031	n/a	n/a
801A	n/a	n/a
8028	n/a	n/a
801C	n/a	n/a
8027	n/a	n/a
8025	n/a	n/a
801D	n/a	n/a
771A	n/a	n/a
6204	n/a	n/a
6203	n/a	n/a
7232	n/a	n/a
7233	n/a	n/a
7231	n/a	n/a
7230	n/a	n/a
7207	n/a	n/a
771B	n/a	n/a
7212	n/a	n/a
7229	n/a	n/a
7206	n/a	n/a
7228	n/a	n/a
7211	n/a	n/a
7205	n/a	n/a
7316	n/a	n/a
7210	n/a	n/a
7319	n/a	n/a
7226	n/a	n/a
7202	n/a	n/a
7227	n/a	n/a
7216	n/a	n/a
8315	n/a	n/a
8201	n/a	n/a
8303	n/a	n/a
8228	n/a	n/a
8215	n/a	n/a
8232	n/a	n/a
8231	n/a	n/a
69RV	n/a	n/a
69YT	n/a	n/a
69RT	n/a	n/a
69QQ	n/a	n/a
6903	12.62	11.08
69RS	n/a	n/a
69QZ	n/a	n/a
69YS	n/a	n/a
69SW	n/a	n/a
69TV	n/a	n/a
69SS	n/a	n/a
69ST	n/a	n/a
69YV	n/a	n/a
69SV	n/a	n/a
69UY	n/a	n/a
6901	12.6	9.63
69SU	n/a	n/a
69TT	n/a	n/a
69QW	n/a	n/a
69SQ	n/a	n/a
69XR	n/a	n/a
69SZ	n/a	n/a
69UU	n/a	n/a
69UT	n/a	n/a
69XS	n/a	n/a
69UV	n/a	n/a
69XT	n/a	n/a
59VU	n/a	n/a
59XQ	n/a	n/a
59VV	n/a	n/a
59VS	n/a	n/a
59XW	n/a	n/a
59XV	n/a	n/a
59XR	n/a	n/a
59XS	n/a	n/a
59XT	n/a	n/a
59XU	n/a	n/a
69XU	n/a	n/a
69TR	n/a	n/a
69WV	n/a	n/a
60ZR	n/a	n/a
69WU	n/a	n/a
69XW	n/a	n/a

Manhole Reference	Manhole Cover Level	Manhole Invert Level
69TZ	n/a	n/a
69UZ	n/a	n/a
69RZ	n/a	n/a
69VZ	n/a	n/a
69SY	n/a	n/a
69RX	n/a	n/a
60YW	n/a	n/a
69RW	n/a	n/a
6902	12.79	10.88
69XZ	n/a	n/a
69RY	n/a	n/a
50ZR	n/a	n/a
5102	10.09	7.76
5101	9.96	n/a
6101	n/a	n/a
51YT	n/a	n/a
51YU	n/a	n/a
51YV	n/a	n/a
51YW	n/a	n/a
61ZS	n/a	n/a
51YQ	n/a	n/a
51XZ	n/a	n/a
5103	10.06	8.15
5104	10.07	8.25
51XW	n/a	n/a
51XX	n/a	n/a
61YW	n/a	n/a
61YU	n/a	n/a
61YV	n/a	n/a
61YX	n/a	n/a
61YY	n/a	n/a
51ZQ	n/a	n/a
6103	8.76	5.53
61YZ	n/a	n/a
51YZ	n/a	n/a
61ZR	n/a	n/a
51YY	n/a	n/a
61ZQ	n/a	n/a
52XW	n/a	n/a
51YX	n/a	n/a
52YY	n/a	n/a
52YT	n/a	n/a
62YY	n/a	n/a
52XV	n/a	n/a
52YS	n/a	n/a
52YZ	n/a	n/a
62YX	n/a	n/a
62YZ	n/a	n/a
6201	8.59	5.34
52YW	n/a	n/a
52YR	n/a	n/a
62ZQ	n/a	n/a
5201	9.22	n/a
62ZV	n/a	n/a
52YQ	n/a	n/a
62ZR	n/a	n/a
52XZ	n/a	n/a
62ZU	n/a	n/a
62ZT	n/a	n/a
52XT	n/a	n/a
52XY	n/a	n/a
62ZS	n/a	n/a
6202	8.35	5.15
5206	8.28	2.93
5205	8.33	2.98
68YX	n/a	n/a
69QY	n/a	n/a
68YY	n/a	n/a
68WX	n/a	n/a
68XT	n/a	n/a
7314	n/a	n/a
7317	n/a	n/a
7320	n/a	n/a
7315	n/a	n/a
7303	n/a	n/a
7313	n/a	n/a
8301	n/a	n/a
8308	n/a	n/a
8311	n/a	n/a
7305	n/a	n/a
7304	n/a	n/a
8312	n/a	n/a
8309	n/a	n/a
7308	n/a	n/a
7307	n/a	n/a
8304	n/a	n/a
60ZQ	n/a	n/a
50ZU	n/a	n/a
60YX	n/a	n/a
50XV	n/a	n/a
50WY	n/a	n/a
60YY	n/a	n/a
50XU	n/a	n/a

Manhole Reference	Manhole Cover Level	Manhole Invert Level
50WX	n/a	n/a
50YS	n/a	n/a
50XT	n/a	n/a
50YR	n/a	n/a
50XS	n/a	n/a
50XQ	n/a	n/a
50XZ	n/a	n/a
50WU	n/a	n/a
50WT	n/a	n/a
50WW	n/a	n/a
50YV	n/a	n/a
50YX	n/a	n/a
50YW	n/a	n/a
50YY	n/a	n/a
60ZS	n/a	n/a
50YZ	n/a	n/a
60YZ	n/a	n/a
6002	9.99	7.06
50ZQ	n/a	n/a
50YU	n/a	n/a
59UR	n/a	n/a
59UX	n/a	n/a
59UW	n/a	n/a
58VV	n/a	n/a
68VX	n/a	n/a
59YY	n/a	n/a
59YW	n/a	n/a
68WW	n/a	n/a
59UT	n/a	n/a
59VZ	n/a	n/a
59VQ	n/a	n/a
59US	n/a	n/a
59WY	n/a	n/a
59WQ	n/a	n/a
59YT	n/a	n/a
59UV	n/a	n/a
59VX	n/a	n/a
59WU	n/a	n/a
59UZ	n/a	n/a
59WW	n/a	n/a
591B	n/a	n/a
59YQ	n/a	n/a
591A	n/a	n/a
59UY	n/a	n/a
59VT	n/a	n/a
59VW	n/a	n/a
5901	12.71	9.41
4904	12.45	9.99
491B	n/a	n/a
49XV	n/a	n/a
491C	n/a	n/a
49YX	n/a	n/a
49XW	n/a	n/a
4907	n/a	n/a
49XU	n/a	n/a
49XX	n/a	n/a
49YW	n/a	n/a
49VY	n/a	n/a
49VW	n/a	n/a
4908	n/a	n/a
49WQ	n/a	n/a
491A	n/a	n/a
49WZ	n/a	n/a
4903	12.55	9.42
49WY	n/a	n/a
491D	n/a	n/a
49YR	n/a	n/a
49YQ	n/a	n/a
4902	12.43	5.7
49XZ	n/a	n/a
5904	13.26	10.67
59TX	n/a	n/a
59TY	n/a	n/a
59TZ	n/a	n/a
59UQ	n/a	n/a
5903	11.59	9.57
49WT	n/a	n/a
49WX	n/a	n/a
5902	11.61	8.29
49YU	n/a	n/a
49VZ	n/a	n/a
49WS	n/a	n/a
40XU	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.

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

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

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

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

Storm Sewer

Sludge Sewer

Foul Trunk Sewer

Surface Trunk Sewer

Combined Trunk Sewer

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Vacuum

Thames Water Proposed

Vent Pipe

Gallery

Other Sewer Types (Not operated and maintained by Thames Water)

Sewer

Culverted Watercourse

Proposed

Decommissioned Sewer

Content of this drainage network is currently unknown

Ownership of this drainage network is currently unknown

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

Meter

Dam Chase

Vent

Fitting

Operational Controls

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

Ancillary

Drop Pipe

Control Valve

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.

Inlet

Outfall

Undefined End

Other Symbols

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

Change of Characteristic Indicator

Public / Private Pumping Station

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Chamber

Operational Site

Ducts or Crossings

Casement

Ducts may contain high voltage cables. Please check with Thames Water.

Conduit Bridge

Subway

Tunnel

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plan are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the 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 indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimeters. 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, please contact Property Searches on 0800 009 4540.

Asset Location Search Water Map - ALS/ALS Standard/2022_4758037

The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 543622, 179136.

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.

Asset Location Search - Water Key

Water Pipes (Operated & Maintained by Thames Water)

Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

Trunk Main: A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

Supply Main: A supply main indicates that the water main is used as a supply for a single property or group of properties.

Fire Main: Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

Metered Pipe: A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

Casement: Ducts may contain high voltage cables. Please check with Thames Water.

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indiates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL`s terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law 'The Late Payment of Commercial Debts (Interest) Act 1998'.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water's standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

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Call **0800 009 4540** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

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Appendix A.3 – Surface Water Management Calculations

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Ben Irving
Site name:	Royal Arsenal D&K
Site location:	Woolwich

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	51.49343° N
Longitude:	0.06743° E
Reference:	3876162152
Date:	Feb 28 2024 15:22

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha): 2.3

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.676
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.14

Hydrological characteristics

	Default	Edited
SAAR (mm):	581	569
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		2.19
1 in 1 year (l/s):		1.86
1 in 30 years (l/s):		5.04
1 in 100 year (l/s):		6.99
1 in 200 years (l/s):		8.19

Design Settings

Rainfall Methodology	FEH-22	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	✓
Additional Flow (%)	40	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	1.000	Connection Type	Level Soffits		
Time of Entry (mins)	4.00	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Existing Hardstanding	1.394	4.00	10.000	1900	100.000	100.000	2.200
Existing Discharge			10.000	1900	110.000	100.000	2.300

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	Existing Hardstanding	Existing Discharge	10.000	0.600	7.800	7.700	0.100	100.0	1000	4.05	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	3.344	2626.2	352.7	1.200	1.300	1.394	0.0	245	2.373

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	10.000	100.0	1000	Circular	10.000	7.800	1.200	10.000	7.700	1.300

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	Existing Hardstanding	1900	Manhole	Adoptable	Existing Discharge	1900	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Existing Hardstanding	100.000	100.000	10.000	2.200	1900	0	1.000	7.800	1000
Existing Discharge	110.000	100.000	10.000	2.300	1900	1	1.000	7.700	1000

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Additional Storage (m³/ha)	20.0
Summer CV	1.000	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	1.000	Drain Down Time (mins)	10080	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0	30	0	0	0
10	0	0	0	100	0	0	0

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year 15 minute summer	107.986	30.556	2 year 2880 minute winter	2.013	0.803	10 year 600 minute summer	18.069	4.942
2 year 15 minute winter	75.780	30.556	2 year 4320 minute summer	2.286	0.598	10 year 600 minute winter	12.346	4.942
2 year 30 minute summer	67.422	19.078	2 year 4320 minute winter	1.506	0.598	10 year 720 minute summer	15.779	4.229
2 year 30 minute winter	47.314	19.078	2 year 5760 minute summer	1.925	0.493	10 year 720 minute winter	10.605	4.229
2 year 60 minute summer	44.042	11.639	2 year 5760 minute winter	1.246	0.493	10 year 960 minute summer	12.535	3.301
2 year 60 minute winter	29.261	11.639	2 year 7200 minute summer	1.684	0.430	10 year 960 minute winter	8.303	3.301
2 year 120 minute summer	32.353	8.550	2 year 7200 minute winter	1.087	0.430	10 year 1440 minute summer	8.668	2.323
2 year 120 minute winter	21.495	8.550	2 year 8640 minute summer	1.519	0.387	10 year 1440 minute winter	5.825	2.323
2 year 180 minute summer	26.358	6.783	2 year 8640 minute winter	0.980	0.387	10 year 2160 minute summer	5.945	1.643
2 year 180 minute winter	17.133	6.783	2 year 10080 minute summer	1.400	0.357	10 year 2160 minute winter	4.097	1.643
2 year 240 minute summer	21.327	5.636	2 year 10080 minute winter	0.903	0.357	10 year 2880 minute summer	4.826	1.293
2 year 240 minute winter	14.169	5.636	10 year 15 minute summer	241.468	68.327	10 year 2880 minute winter	3.243	1.293
2 year 360 minute summer	16.390	4.218	10 year 15 minute winter	169.451	68.327	10 year 4320 minute summer	3.587	0.938
2 year 360 minute winter	10.654	4.218	10 year 30 minute summer	153.247	43.364	10 year 4320 minute winter	2.362	0.938
2 year 480 minute summer	12.815	3.387	10 year 30 minute winter	107.542	43.364	10 year 5760 minute summer	2.956	0.757
2 year 480 minute winter	8.514	3.387	10 year 60 minute summer	99.450	26.282	10 year 5760 minute winter	1.913	0.757
2 year 600 minute summer	10.386	2.841	10 year 60 minute winter	66.072	26.282	10 year 7200 minute summer	2.541	0.648
2 year 600 minute winter	7.096	2.841	10 year 120 minute summer	64.787	17.121	10 year 7200 minute winter	1.640	0.648
2 year 720 minute summer	9.155	2.454	10 year 120 minute winter	43.043	17.121	10 year 8640 minute summer	2.255	0.575
2 year 720 minute winter	6.153	2.454	10 year 180 minute summer	50.143	12.903	10 year 8640 minute winter	1.456	0.575
2 year 960 minute summer	7.362	1.939	10 year 180 minute winter	32.594	12.903	10 year 10080 minute summer	2.050	0.523
2 year 960 minute winter	4.877	1.939	10 year 240 minute summer	39.427	10.419	10 year 10080 minute winter	1.323	0.523
2 year 1440 minute summer	5.194	1.392	10 year 240 minute winter	26.194	10.419	30 year 15 minute summer	330.368	93.483
2 year 1440 minute winter	3.491	1.392	10 year 360 minute summer	29.418	7.570	30 year 15 minute winter	231.837	93.483
2 year 2160 minute summer	3.635	1.005	10 year 360 minute winter	19.123	7.570	30 year 30 minute summer	210.827	59.657
2 year 2160 minute winter	2.505	1.005	10 year 480 minute summer	22.579	5.967	30 year 30 minute winter	147.949	59.657
2 year 2880 minute summer	2.996	0.803	10 year 480 minute winter	15.001	5.967	30 year 60 minute summer	137.180	36.253

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year 60 minute winter	91.139	36.253	30 year 4320 minute winter	2.954	1.173	100 year 480 minute winter	27.054	10.761
30 year 120 minute summer	86.820	22.944	30 year 5760 minute summer	3.653	0.935	100 year 600 minute summer	32.630	8.925
30 year 120 minute winter	57.681	22.944	30 year 5760 minute winter	2.364	0.935	100 year 600 minute winter	22.295	8.925
30 year 180 minute summer	66.522	17.118	30 year 7200 minute summer	3.107	0.793	100 year 720 minute summer	28.499	7.638
30 year 180 minute winter	43.241	17.118	30 year 7200 minute winter	2.005	0.793	100 year 720 minute winter	19.153	7.638
30 year 240 minute summer	52.011	13.745	30 year 8640 minute summer	2.733	0.697	100 year 960 minute summer	22.580	5.946
30 year 240 minute winter	34.555	13.745	30 year 8640 minute winter	1.764	0.697	100 year 960 minute winter	14.957	5.946
30 year 360 minute summer	38.539	9.918	30 year 10080 minute summer	2.464	0.629	100 year 1440 minute summer	15.468	4.145
30 year 360 minute winter	25.052	9.918	30 year 10080 minute winter	1.590	0.629	100 year 1440 minute winter	10.395	4.145
30 year 480 minute summer	29.493	7.794	100 year 15 minute summer	434.500	122.948	100 year 2160 minute summer	10.410	2.877
30 year 480 minute winter	19.595	7.794	100 year 15 minute winter	304.912	122.948	100 year 2160 minute winter	7.173	2.877
30 year 600 minute summer	23.550	6.442	100 year 30 minute summer	279.577	79.111	100 year 2880 minute summer	8.294	2.223
30 year 600 minute winter	16.091	6.442	100 year 30 minute winter	196.195	79.111	100 year 2880 minute winter	5.574	2.223
30 year 720 minute summer	20.529	5.502	100 year 60 minute summer	183.286	48.437	100 year 4320 minute summer	5.952	1.556
30 year 720 minute winter	13.796	5.502	100 year 60 minute winter	121.771	48.437	100 year 4320 minute winter	3.919	1.556
30 year 960 minute summer	16.245	4.278	100 year 120 minute summer	115.998	30.655	100 year 5760 minute summer	4.752	1.217
30 year 960 minute winter	10.761	4.278	100 year 120 minute winter	77.066	30.655	100 year 5760 minute winter	3.076	1.217
30 year 1440 minute summer	11.175	2.995	100 year 180 minute summer	89.629	23.064	100 year 7200 minute summer	3.972	1.013
30 year 1440 minute winter	7.510	2.995	100 year 180 minute winter	58.261	23.064	100 year 7200 minute winter	2.564	1.013
30 year 2160 minute summer	7.600	2.100	100 year 240 minute summer	70.609	18.660	100 year 8640 minute summer	3.439	0.877
30 year 2160 minute winter	5.236	2.100	100 year 240 minute winter	46.911	18.660	100 year 8640 minute winter	2.220	0.877
30 year 2880 minute summer	6.120	1.640	100 year 360 minute summer	52.879	13.608	100 year 10080 minute summer	3.058	0.780
30 year 2880 minute winter	4.113	1.640	100 year 360 minute winter	34.373	13.608	100 year 10080 minute winter	1.974	0.780
30 year 4320 minute summer	4.486	1.173	100 year 480 minute summer	40.721	10.761			

Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing Hardstanding	10	8.054	0.254	273.1	3.9428	0.0000	OK
15 minute summer	Existing Discharge	10	7.911	0.211	273.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing Hardstanding	1.000	Existing Discharge	273.3	1.982	0.104	1.3817	106.3

Results for 10 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing Hardstanding	10	8.199	0.399	610.7	6.1838	0.0000	OK
15 minute summer	Existing Discharge	10	8.017	0.317	611.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing Hardstanding	1.000	Existing Discharge	611.1	2.430	0.233	2.5194	237.9

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing Hardstanding	10	8.278	0.478	835.5	7.4094	0.0000	OK
15 minute summer	Existing Discharge	10	8.074	0.374	836.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing Hardstanding	1.000	Existing Discharge	836.1	2.633	0.318	3.1799	325.5

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing Hardstanding	10	8.362	0.562	1098.8	8.7172	0.0000	OK
15 minute summer	Existing Discharge	10	8.134	0.434	1099.6	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing Hardstanding	1.000	Existing Discharge	1099.6	2.823	0.419	3.8957	428.2

Design Settings

Rainfall Methodology	FEH-22	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	✓
Additional Flow (%)	40	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	1.000	Connection Type	Level Soffits		
Time of Entry (mins)	4.00	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Building D5	0.070	4.00	9.700	1200	543675.464	179189.091	0.850
Basin 2			9.000	1200	543672.587	179133.786	0.500
PP South 2	0.024	4.00	10.250	1200	543698.871	179052.612	0.500
PP South 1	0.081	4.00	10.200	1200	543684.677	179063.660	0.500
Basin 1			9.800	1200	543693.315	179069.912	0.300
Building D1	0.083	4.00	9.700	1200	543670.506	179204.678	0.550
Podium D1-5	0.176	7.00	9.700	1200	543675.623	179238.359	0.700
Building D2	0.058	4.00	9.700	1200	543643.687	179232.480	0.550
Building D4	0.070	4.00	9.700	1200	543645.663	179213.242	0.650
PP D1	0.056	4.00	9.700	1200	543679.767	179248.466	0.850
Building K4	0.052	4.00	10.200	1200	543560.053	179182.282	0.400
PP K1	0.064	4.00	10.100	1200	543570.597	179188.333	0.600
Basin 3			9.500	1200	543586.219	179183.390	0.500
Podium D2-4	0.100	7.00	9.600	1200	543625.985	179240.012	0.500
PP D2	0.036	4.00	9.500	1200	543609.673	179248.863	0.850
Building D3	0.076	4.00	9.600	1200	543600.684	179229.486	0.550
Tank	0.050	4.00	9.500	1200	543585.247	179233.184	2.400
Basin 4			8.000	2100	543573.912	179234.177	1.000
Outfall			8.000	1350	543558.720	179247.856	1.500
PP K2	0.019	4.00	10.075	1200	543614.207	179159.093	0.500
Building K5	0.052	4.00	10.200	1200	543544.690	179201.392	0.400
Building K3	0.052	4.00	10.200	1200	543582.162	179164.146	0.400
Hydro-Brake			8.000	2100	543568.092	179239.407	1.300

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
4.000	Building D5	PP D1	59.530	0.600	8.850	8.850	0.000	0.0	300	4.99	50.0
1.002_1	Basin 2	Basin 4	140.766	0.600	8.500	7.300	1.200	117.3	225	12.59	50.0
1.000	PP South 2	Basin 1	18.170	0.600	9.750	9.600	0.150	121.1	150	4.33	50.0
2.000	PP South 1	Basin 1	10.663	0.600	9.700	9.600	0.100	106.6	150	4.18	50.0
1.001	Basin 1	Basin 2	203.077	0.600	9.500	8.500	1.000	203.1	100	10.65	50.0
6.000	Building D1	Podium D1-5	34.067	0.600	9.150	9.000	0.150	227.1	400	4.45	50.0
6.001	Podium D1-5	PP D1	10.924	0.600	9.000	8.850	0.150	72.8	400	7.08	50.0
7.000	Building D4	PP D1	49.029	0.600	9.050	8.900	0.150	326.9	300	4.95	50.0
6.002	PP D1	PP D2	70.163	0.600	8.850	8.650	0.200	350.8	350	8.35	50.0
9.000	Building K4	PP K1	12.157	0.600	9.800	9.500	0.300	40.5	225	4.10	50.0
8.001	PP K1	Basin 3	16.385	0.600	9.500	9.000	0.500	32.8	125	4.54	50.0
8.002	Basin 3	Basin 4	52.257	0.600	9.000	7.750	1.250	41.8	110	5.33	50.0
11.000	Podium D2-4	PP D2	18.676	0.600	9.100	8.850	0.250	74.7	300	7.17	50.0
11.001	PP D2	Tank	38.640	0.600	8.650	7.300	1.350	28.6	225	8.62	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
4.000	1.000	70.7	17.7	0.550	0.550	0.070	0.0	0	∞
1.002_1	1.206	47.9	26.6	0.275	0.475	0.105	0.0	120	1.237
1.000	0.912	16.1	6.1	0.350	0.050	0.024	0.0	64	0.851
2.000	0.972	17.2	20.5	0.350	0.050	0.081	0.0	150	0.991
1.001	0.536	4.2	26.6	0.200	0.400	0.105	0.0	100	0.550
6.000	1.248	156.8	21.0	0.150	0.300	0.083	0.0	98	0.877
6.001	2.214	278.2	65.5	0.300	0.450	0.259	0.0	132	1.824
7.000	0.864	61.1	17.7	0.350	0.500	0.070	0.0	110	0.751
6.002	0.920	88.5	115.1	0.500	0.500	0.455	0.0	350	0.932
9.000	2.061	81.9	13.2	0.175	0.375	0.052	0.0	61	1.527
8.001	1.566	19.2	55.7	0.475	0.375	0.220	0.0	125	1.608
8.002	1.273	12.1	60.5	0.390	0.140	0.239	0.0	110	1.308
11.000	1.821	128.7	25.3	0.200	0.350	0.100	0.0	90	1.426
11.001	2.454	97.6	164.2	0.625	1.975	0.649	0.0	225	2.500

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
13.000	Building D3	Tank	15.957	0.600	9.050	7.400	1.650	9.7	300	4.05	50.0
13.001	Tank	Basin 4	11.293	0.600	7.100	7.000	0.100	112.9	300	8.74	50.0
1.002	Basin 4	Hydro-Brake	20.443	0.600	7.000	6.700	0.300	68.1	225	12.81	50.0
6.000_2	Building D2	PP D2	37.754	0.600	9.150	8.850	0.300	125.8	225	4.54	50.0
12.000	PP K2	Basin 3	37.063	0.600	9.575	9.000	0.575	64.5	100	4.64	50.0
7.000_1	Building K5	PP K1	29.012	0.600	9.800	9.500	0.300	96.7	225	4.36	50.0
6.000_1	Building K3	PP K1	26.810	0.600	9.800	9.500	0.300	89.4	225	4.32	50.0
1.004	Hydro-Brake	Outfall	12.618	0.600	6.700	6.500	0.200	63.1	450	12.89	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
13.000	5.084	359.3	19.2	0.250	1.800	0.076	0.0	47	2.741
13.001	1.478	104.5	196.0	2.100	0.700	0.775	0.0	300	1.498
1.002	1.586	63.1	283.1	0.775	1.075	1.119	0.0	225	1.615
6.000_2	1.164	46.3	14.7	0.325	0.425	0.058	0.0	87	1.034
12.000	0.960	7.5	4.8	0.400	0.400	0.019	0.0	58	1.019
7.000_1	1.329	52.9	13.2	0.175	0.375	0.052	0.0	76	1.106
6.000_1	1.383	55.0	13.2	0.175	0.375	0.052	0.0	74	1.137
1.004	2.562	407.5	283.1	0.850	1.050	1.119	0.0	276	2.757

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
4.000	59.530	0.0	300	Circular	9.700	8.850	0.550	9.700	8.850	0.550
1.002_1	140.766	117.3	225	Circular	9.000	8.500	0.275	8.000	7.300	0.475
1.000	18.170	121.1	150	Circular	10.250	9.750	0.350	9.800	9.600	0.050
2.000	10.663	106.6	150	Circular	10.200	9.700	0.350	9.800	9.600	0.050
1.001	203.077	203.1	100	Circular	9.800	9.500	0.200	9.000	8.500	0.400
6.000	34.067	227.1	400	Circular	9.700	9.150	0.150	9.700	9.000	0.300
6.001	10.924	72.8	400	Circular	9.700	9.000	0.300	9.700	8.850	0.450
7.000	49.029	326.9	300	Circular	9.700	9.050	0.350	9.700	8.900	0.500
6.002	70.163	350.8	350	Circular	9.700	8.850	0.500	9.500	8.650	0.500
9.000	12.157	40.5	225	Circular	10.200	9.800	0.175	10.100	9.500	0.375
8.001	16.385	32.8	125	Circular	10.100	9.500	0.475	9.500	9.000	0.375
8.002	52.257	41.8	110	Circular	9.500	9.000	0.390	8.000	7.750	0.140
11.000	18.676	74.7	300	Circular	9.600	9.100	0.200	9.500	8.850	0.350
11.001	38.640	28.6	225	Circular	9.500	8.650	0.625	9.500	7.300	1.975
13.000	15.957	9.7	300	Circular	9.600	9.050	0.250	9.500	7.400	1.800

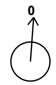
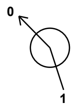
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
4.000	Building D5	1200	Manhole	Adoptable	PP D1	1200	Manhole	Adoptable
1.002_1	Basin 2	1200	Manhole	Adoptable	Basin 4	2100	Manhole	Adoptable
1.000	PP South 2	1200	Manhole	Adoptable	Basin 1	1200	Manhole	Adoptable
2.000	PP South 1	1200	Manhole	Adoptable	Basin 1	1200	Manhole	Adoptable
1.001	Basin 1	1200	Manhole	Adoptable	Basin 2	1200	Manhole	Adoptable
6.000	Building D1	1200	Manhole	Adoptable	Podium D1-5	1200	Manhole	Adoptable
6.001	Podium D1-5	1200	Manhole	Adoptable	PP D1	1200	Manhole	Adoptable
7.000	Building D4	1200	Manhole	Adoptable	PP D1	1200	Manhole	Adoptable
6.002	PP D1	1200	Manhole	Adoptable	PP D2	1200	Manhole	Adoptable
9.000	Building K4	1200	Manhole	Adoptable	PP K1	1200	Manhole	Adoptable
8.001	PP K1	1200	Manhole	Adoptable	Basin 3	1200	Manhole	Adoptable
8.002	Basin 3	1200	Manhole	Adoptable	Basin 4	2100	Manhole	Adoptable
11.000	Podium D2-4	1200	Manhole	Adoptable	PP D2	1200	Manhole	Adoptable
11.001	PP D2	1200	Manhole	Adoptable	Tank	1200	Manhole	Adoptable
13.000	Building D3	1200	Manhole	Adoptable	Tank	1200	Manhole	Adoptable

Pipeline Schedule

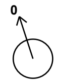
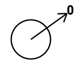
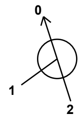
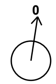
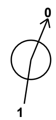
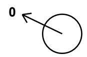
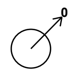
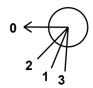
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
13.001	11.293	112.9	300	Circular	9.500	7.100	2.100	8.000	7.000	0.700
1.002	20.443	68.1	225	Circular	8.000	7.000	0.775	8.000	6.700	1.075
6.000_2	37.754	125.8	225	Circular	9.700	9.150	0.325	9.500	8.850	0.425
12.000	37.063	64.5	100	Circular	10.075	9.575	0.400	9.500	9.000	0.400
7.000_1	29.012	96.7	225	Circular	10.200	9.800	0.175	10.100	9.500	0.375
6.000_1	26.810	89.4	225	Circular	10.200	9.800	0.175	10.100	9.500	0.375
1.004	12.618	63.1	450	Circular	8.000	6.700	0.850	8.000	6.500	1.050

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
13.001	Tank	1200	Manhole	Adoptable	Basin 4	2100	Manhole	Adoptable
1.002	Basin 4	2100	Manhole	Adoptable	Hydro-Brake	2100	Manhole	Adoptable
6.000_2	Building D2	1200	Manhole	Adoptable	PP D2	1200	Manhole	Adoptable
12.000	PP K2	1200	Manhole	Adoptable	Basin 3	1200	Manhole	Adoptable
7.000_1	Building K5	1200	Manhole	Adoptable	PP K1	1200	Manhole	Adoptable
6.000_1	Building K3	1200	Manhole	Adoptable	PP K1	1200	Manhole	Adoptable
1.004	Hydro-Brake	2100	Manhole	Adoptable	Outfall	1350	Manhole	Adoptable

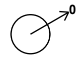
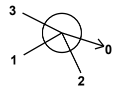
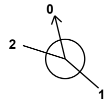
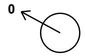
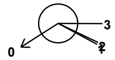
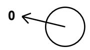
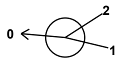
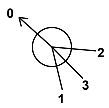
Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
Building D5	543675.464	179189.091	9.700	0.850	1200		0	4.000	8.850	300
Basin 2	543672.587	179133.786	9.000	0.500	1200		1	1.001	8.500	100
							0	1.002_1	8.500	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
PP South 2	543698.871	179052.612	10.250	0.500	1200		0	1.000	9.750	150
PP South 1	543684.677	179063.660	10.200	0.500	1200		0	2.000	9.700	150
Basin 1	543693.315	179069.912	9.800	0.300	1200		1	2.000	9.600	150
							2	1.000	9.600	150
							0	1.001	9.500	100
Building D1	543670.506	179204.678	9.700	0.550	1200		0	6.000	9.150	400
Podium D1-5	543675.623	179238.359	9.700	0.700	1200		1	6.000	9.000	400
							0	6.001	9.000	400
Building D2	543643.687	179232.480	9.700	0.550	1200		0	6.000_2	9.150	225
Building D4	543645.663	179213.242	9.700	0.650	1200		0	7.000	9.050	300
PP D1	543679.767	179248.466	9.700	0.850	1200		1	6.001	8.850	400
							2	7.000	8.900	300
							3	4.000	8.850	300
							0	6.002	8.850	350

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
Building K4	543560.053	179182.282	10.200	0.400	1200		0	9.000	9.800	225
PP K1	543570.597	179188.333	10.100	0.600	1200		1	9.000	9.500	225
							2	6.000_1	9.500	225
							3	7.000_1	9.500	225
							0	8.001	9.500	125
Basin 3	543586.219	179183.390	9.500	0.500	1200		1	12.000	9.000	100
							2	8.001	9.000	125
							0	8.002	9.000	110
Podium D2-4	543625.985	179240.012	9.600	0.500	1200		0	11.000	9.100	300
PP D2	543609.673	179248.863	9.500	0.850	1200		1	11.000	8.850	300
							2	6.000_2	8.850	225
							3	6.002	8.650	350
							0	11.001	8.650	225
Building D3	543600.684	179229.486	9.600	0.550	1200		0	13.000	9.050	300
Tank	543585.247	179233.184	9.500	2.400	1200		1	13.000	7.400	300
							2	11.001	7.300	225
							0	13.001	7.100	300
Basin 4	543573.912	179234.177	8.000	1.000	2100		1	8.002	7.750	110
							2	13.001	7.000	300
							3	1.002_1	7.300	225
							0	1.002	7.000	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Outfall	543558.720	179247.856	8.000	1.500	1350	1	1.004	6.500	450
PP K2	543614.207	179159.093	10.075	0.500	1200	0	12.000	9.575	100
Building K5	543544.690	179201.392	10.200	0.400	1200	0	7.000_1	9.800	225
Building K3	543582.162	179164.146	10.200	0.400	1200	0	6.000_1	9.800	225
Hydro-Brake	543568.092	179239.407	8.000	1.300	2100	1	1.002	6.700	225
						0	1.004	6.700	450

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Additional Storage (m^3/ha)	20.0
Summer CV	1.000	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	1.000	Drain Down Time (mins)	10080	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0	100	0	0	0
10	0	0	0	100	40	0	0
30	0	0	0				

Node Hydro-Brake Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	6.700	Product Number	CTL-SHE-0374-9000-1300-9000
Design Depth (m)	1.300	Min Outlet Diameter (m)	0.450
Design Flow (l/s)	90.0	Min Node Diameter (mm)	

Node PP South 1 Online Orifice Control

Flap Valve	x	Invert Level (m)	9.700	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.025		

Node PP South 2 Online Orifice Control

Flap Valve	x	Invert Level (m)	9.750	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.020		

Node Basin 1 Online Orifice Control

Flap Valve	x	Invert Level (m)	9.500	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.030		

Node Basin 2 Online Orifice Control

Flap Valve	x	Invert Level (m)	8.500	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.025		

Node PP K2 Online Orifice Control

Flap Valve	x	Invert Level (m)	9.575	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.025		

Node Basin 4 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	7.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	40

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	18.2	0.0	0.500	107.6	0.0	1.000	231.3	0.0

Node Tank Soakaway Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Pit Width (m)	20.000	Inf Depth (m)	
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	7.100	Pit Length (m)	3.700	Number Required	1
Safety Factor	2.0	Time to half empty (mins)	82	Depth (m)	0.900		

Node PP D2 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	36.000	Depth (m)	0.750
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	8.650	Length (m)	10.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	34	Slope (1:X)	1000.0		

Node PP D1 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	27.900	Depth (m)	0.750
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	8.850	Length (m)	20.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	27	Slope (1:X)	1000.0		

Node Basin 3 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	9.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	88

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	27.3	0.0	0.500	238.0	0.0

Node PP K1 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	64.000	Depth (m)	0.500
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	9.500	Length (m)	10.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	76	Slope (1:X)	1000.0		

Node PP South 1 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	40.500	Depth (m)	0.400
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	9.700	Length (m)	20.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	1120	Slope (1:X)	1000.0		

Node PP South 2 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	12.000	Depth (m)	0.400
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	9.750	Length (m)	20.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	480	Slope (1:X)	1000.0		

Node Basin 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	9.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	1050

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	42.3	0.0	0.250	121.6	0.0	0.300	140.0	0.0

Node Basin 2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	8.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	1050

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	20.0	0.0	0.500	82.0	0.0

Node PP K2 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	8.000	Depth (m)	0.500
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	9.575	Length (m)	10.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	164	Slope (1:X)	500.0		

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year 15 minute summer	107.986	30.556	2 year 1440 minute summer	5.194	1.392
2 year 15 minute winter	75.780	30.556	2 year 1440 minute winter	3.491	1.392
2 year 30 minute summer	67.422	19.078	2 year 2160 minute summer	3.635	1.005
2 year 30 minute winter	47.314	19.078	2 year 2160 minute winter	2.505	1.005
2 year 60 minute summer	44.042	11.639	2 year 2880 minute summer	2.996	0.803
2 year 60 minute winter	29.261	11.639	2 year 2880 minute winter	2.013	0.803
2 year 120 minute summer	32.353	8.550	2 year 4320 minute summer	2.286	0.598
2 year 120 minute winter	21.495	8.550	2 year 4320 minute winter	1.506	0.598
2 year 180 minute summer	26.358	6.783	2 year 5760 minute summer	1.925	0.493
2 year 180 minute winter	17.133	6.783	2 year 5760 minute winter	1.246	0.493
2 year 240 minute summer	21.327	5.636	2 year 7200 minute summer	1.684	0.430
2 year 240 minute winter	14.169	5.636	2 year 7200 minute winter	1.087	0.430
2 year 360 minute summer	16.390	4.218	2 year 8640 minute summer	1.519	0.387
2 year 360 minute winter	10.654	4.218	2 year 8640 minute winter	0.980	0.387
2 year 480 minute summer	12.815	3.387	2 year 10080 minute summer	1.400	0.357
2 year 480 minute winter	8.514	3.387	2 year 10080 minute winter	0.903	0.357
2 year 600 minute summer	10.386	2.841	10 year 15 minute summer	241.468	68.327
2 year 600 minute winter	7.096	2.841	10 year 15 minute winter	169.451	68.327
2 year 720 minute summer	9.155	2.454	10 year 30 minute summer	153.247	43.364
2 year 720 minute winter	6.153	2.454	10 year 30 minute winter	107.542	43.364
2 year 960 minute summer	7.362	1.939	10 year 60 minute summer	99.450	26.282
2 year 960 minute winter	4.877	1.939	10 year 60 minute winter	66.072	26.282

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
10 year 120 minute summer	64.787	17.121	30 year 15 minute summer	330.368	93.483
10 year 120 minute winter	43.043	17.121	30 year 15 minute winter	231.837	93.483
10 year 180 minute summer	50.143	12.903	30 year 30 minute summer	210.827	59.657
10 year 180 minute winter	32.594	12.903	30 year 30 minute winter	147.949	59.657
10 year 240 minute summer	39.427	10.419	30 year 60 minute summer	137.180	36.253
10 year 240 minute winter	26.194	10.419	30 year 60 minute winter	91.139	36.253
10 year 360 minute summer	29.418	7.570	30 year 120 minute summer	86.820	22.944
10 year 360 minute winter	19.123	7.570	30 year 120 minute winter	57.681	22.944
10 year 480 minute summer	22.579	5.967	30 year 180 minute summer	66.522	17.118
10 year 480 minute winter	15.001	5.967	30 year 180 minute winter	43.241	17.118
10 year 600 minute summer	18.069	4.942	30 year 240 minute summer	52.011	13.745
10 year 600 minute winter	12.346	4.942	30 year 240 minute winter	34.555	13.745
10 year 720 minute summer	15.779	4.229	30 year 360 minute summer	38.539	9.918
10 year 720 minute winter	10.605	4.229	30 year 360 minute winter	25.052	9.918
10 year 960 minute summer	12.535	3.301	30 year 480 minute summer	29.493	7.794
10 year 960 minute winter	8.303	3.301	30 year 480 minute winter	19.595	7.794
10 year 1440 minute summer	8.668	2.323	30 year 600 minute summer	23.550	6.442
10 year 1440 minute winter	5.825	2.323	30 year 600 minute winter	16.091	6.442
10 year 2160 minute summer	5.945	1.643	30 year 720 minute summer	20.529	5.502
10 year 2160 minute winter	4.097	1.643	30 year 720 minute winter	13.796	5.502
10 year 2880 minute summer	4.826	1.293	30 year 960 minute summer	16.245	4.278
10 year 2880 minute winter	3.243	1.293	30 year 960 minute winter	10.761	4.278
10 year 4320 minute summer	3.587	0.938	30 year 1440 minute summer	11.175	2.995
10 year 4320 minute winter	2.362	0.938	30 year 1440 minute winter	7.510	2.995
10 year 5760 minute summer	2.956	0.757	30 year 2160 minute summer	7.600	2.100
10 year 5760 minute winter	1.913	0.757	30 year 2160 minute winter	5.236	2.100
10 year 7200 minute summer	2.541	0.648	30 year 2880 minute summer	6.120	1.640
10 year 7200 minute winter	1.640	0.648	30 year 2880 minute winter	4.113	1.640
10 year 8640 minute summer	2.255	0.575	30 year 4320 minute summer	4.486	1.173
10 year 8640 minute winter	1.456	0.575	30 year 4320 minute winter	2.954	1.173
10 year 10080 minute summer	2.050	0.523	30 year 5760 minute summer	3.653	0.935
10 year 10080 minute winter	1.323	0.523	30 year 5760 minute winter	2.364	0.935

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year 7200 minute summer	3.107	0.793	100 year 2880 minute summer	8.294	2.223
30 year 7200 minute winter	2.005	0.793	100 year 2880 minute winter	5.574	2.223
30 year 8640 minute summer	2.733	0.697	100 year 4320 minute summer	5.952	1.556
30 year 8640 minute winter	1.764	0.697	100 year 4320 minute winter	3.919	1.556
30 year 10080 minute summer	2.464	0.629	100 year 5760 minute summer	4.752	1.217
30 year 10080 minute winter	1.590	0.629	100 year 5760 minute winter	3.076	1.217
100 year 15 minute summer	434.500	122.948	100 year 7200 minute summer	3.972	1.013
100 year 15 minute winter	304.912	122.948	100 year 7200 minute winter	2.564	1.013
100 year 30 minute summer	279.577	79.111	100 year 8640 minute summer	3.439	0.877
100 year 30 minute winter	196.195	79.111	100 year 8640 minute winter	2.220	0.877
100 year 60 minute summer	183.286	48.437	100 year 10080 minute summer	3.058	0.780
100 year 60 minute winter	121.771	48.437	100 year 10080 minute winter	1.974	0.780
100 year 120 minute summer	115.998	30.655	100 year +40% CC 15 minute summer	608.300	172.128
100 year 120 minute winter	77.066	30.655	100 year +40% CC 15 minute winter	426.877	172.128
100 year 180 minute summer	89.629	23.064	100 year +40% CC 30 minute summer	391.408	110.755
100 year 180 minute winter	58.261	23.064	100 year +40% CC 30 minute winter	274.672	110.755
100 year 240 minute summer	70.609	18.660	100 year +40% CC 60 minute summer	256.600	67.812
100 year 240 minute winter	46.911	18.660	100 year +40% CC 60 minute winter	170.479	67.812
100 year 360 minute summer	52.879	13.608	100 year +40% CC 120 minute summer	162.397	42.917
100 year 360 minute winter	34.373	13.608	100 year +40% CC 120 minute winter	107.893	42.917
100 year 480 minute summer	40.721	10.761	100 year +40% CC 180 minute summer	125.480	32.290
100 year 480 minute winter	27.054	10.761	100 year +40% CC 180 minute winter	81.565	32.290
100 year 600 minute summer	32.630	8.925	100 year +40% CC 240 minute summer	98.853	26.124
100 year 600 minute winter	22.295	8.925	100 year +40% CC 240 minute winter	65.675	26.124
100 year 720 minute summer	28.499	7.638	100 year +40% CC 360 minute summer	74.030	19.051
100 year 720 minute winter	19.153	7.638	100 year +40% CC 360 minute winter	48.122	19.051
100 year 960 minute summer	22.580	5.946	100 year +40% CC 480 minute summer	57.009	15.066
100 year 960 minute winter	14.957	5.946	100 year +40% CC 480 minute winter	37.876	15.066
100 year 1440 minute summer	15.468	4.145	100 year +40% CC 600 minute summer	45.682	12.495
100 year 1440 minute winter	10.395	4.145	100 year +40% CC 600 minute winter	31.212	12.495
100 year 2160 minute summer	10.410	2.877	100 year +40% CC 720 minute summer	39.898	10.693
100 year 2160 minute winter	7.173	2.877	100 year +40% CC 720 minute winter	26.814	10.693

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +40% CC 960 minute summer	31.611	8.324	100 year +40% CC 4320 minute winter	5.487	2.178
100 year +40% CC 960 minute winter	20.940	8.324	100 year +40% CC 5760 minute summer	6.653	1.703
100 year +40% CC 1440 minute summer	21.655	5.804	100 year +40% CC 5760 minute winter	4.306	1.703
100 year +40% CC 1440 minute winter	14.553	5.804	100 year +40% CC 7200 minute summer	5.561	1.419
100 year +40% CC 2160 minute summer	14.573	4.028	100 year +40% CC 7200 minute winter	3.589	1.419
100 year +40% CC 2160 minute winter	10.042	4.028	100 year +40% CC 8640 minute summer	4.815	1.228
100 year +40% CC 2880 minute summer	11.611	3.112	100 year +40% CC 8640 minute winter	3.108	1.228
100 year +40% CC 2880 minute winter	7.804	3.112	100 year +40% CC 10080 minute summer	4.281	1.092
100 year +40% CC 4320 minute summer	8.332	2.178	100 year +40% CC 10080 minute winter	2.763	1.092

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Building D5	10	9.016	0.166	13.7	0.4617	0.0000	OK
720 minute summer	Basin 2	990	8.612	0.112	0.4	3.1370	0.0000	OK
360 minute winter	PP South 2	280	9.812	0.062	0.7	3.9103	0.0000	OK
480 minute winter	PP South 1	400	9.776	0.076	1.9	16.3211	0.0000	OK
600 minute summer	Basin 1	690	9.571	0.071	0.5	3.8761	0.0000	OK
15 minute summer	Building D1	10	9.235	0.085	16.3	0.3545	0.0000	OK
15 minute summer	Podium D1-5	10	9.115	0.115	40.9	0.7113	0.0000	OK
15 minute summer	Building D2	10	9.226	0.076	11.4	0.2476	0.0000	OK
15 minute summer	Building D4	10	9.145	0.095	13.7	0.3106	0.0000	OK
120 minute summer	PP D1	70	8.988	0.138	38.1	21.8285	0.0000	OK
15 minute summer	Building K4	9	9.859	0.059	10.2	0.2213	0.0000	OK
120 minute summer	PP K1	70	9.576	0.076	19.7	13.8274	0.0000	OK
120 minute summer	Basin 3	78	9.089	0.089	12.8	4.1674	0.0000	OK
15 minute summer	Podium D2-4	11	9.169	0.069	14.2	0.3559	0.0000	OK
120 minute summer	PP D2	70	8.753	0.103	41.8	10.7987	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Building D5	4.000	PP D1	13.1	0.466	0.185	1.8023	
720 minute summer	Basin 2	Orifice	Basin 4	0.4				
360 minute winter	PP South 2	Orifice	Basin 1	0.2				
480 minute winter	PP South 1	Orifice	Basin 1	0.3				
600 minute summer	Basin 1	Orifice	Basin 2	0.4				
15 minute summer	Building D1	6.000	Podium D1-5	16.2	0.657	0.103	0.8420	
15 minute summer	Podium D1-5	6.001	PP D1	40.7	1.920	0.146	0.3101	
15 minute summer	Building D2	6.000_2	PP D2	11.1	0.951	0.240	0.4400	
15 minute summer	Building D4	7.000	PP D1	12.6	0.720	0.207	0.8608	
120 minute summer	PP D1	6.002	PP D2	28.4	0.971	0.321	2.0623	
15 minute summer	Building K4	9.000	PP K1	10.4	1.671	0.127	0.0889	
120 minute summer	PP K1	8.001	Basin 3	12.4	1.589	0.646	0.1356	
120 minute summer	Basin 3	8.002	Basin 4	11.6	1.433	0.955	0.4215	
15 minute summer	Podium D2-4	11.000	PP D2	14.1	1.181	0.110	0.2231	
120 minute summer	PP D2	11.001	Tank	39.9	2.300	0.408	0.6696	

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Building D3	10	9.093	0.043	14.8	0.1653	0.0000	OK
120 minute summer	Tank	72	7.260	0.160	46.7	11.4906	0.0000	OK
120 minute summer	Basin 4	76	7.179	0.179	55.8	6.7651	0.0000	OK
15 minute summer	Outfall	1	6.500	0.000	39.7	0.0000	0.0000	OK
180 minute summer	PP K2	116	9.664	0.089	1.4	2.0776	0.0000	OK
15 minute summer	Building K5	10	9.873	0.073	10.2	0.2720	0.0000	OK
15 minute summer	Building K3	10	9.871	0.071	10.2	0.2664	0.0000	OK
120 minute summer	Hydro-Brake	76	6.951	0.251	54.3	0.8704	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Building D3	13.000	Tank	14.8	2.484	0.041	0.0951	
120 minute summer	Tank	13.001	Basin 4	44.9	1.184	0.430	0.4598	
120 minute summer	Basin 4	1.002	Hydro-Brake	54.3	1.393	0.861	0.7536	
180 minute summer	PP K2	Orifice	Basin 3	0.4				
15 minute summer	Building K5	7.000_1	PP K1	10.4	1.331	0.197	0.2542	
15 minute summer	Building K3	6.000_1	PP K1	10.4	1.362	0.190	0.2306	
120 minute summer	Hydro-Brake	Hydro-Brake®	Outfall	54.3				190.9

Results for 10 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	Building D5	22	9.120	0.270	26.0	0.7497	0.0000	OK
960 minute summer	Basin 2	1365	8.679	0.179	0.6	5.7630	0.0000	OK
360 minute winter	PP South 2	288	9.864	0.114	1.3	7.7386	0.0000	OK
360 minute winter	PP South 1	352	9.835	0.135	4.3	30.8906	0.0000	OK
600 minute summer	Basin 1	810	9.611	0.111	0.7	6.7960	0.0000	FLOOD RISK
15 minute summer	Building D1	10	9.280	0.130	36.4	0.5388	0.0000	OK
15 minute summer	Podium D1-5	11	9.182	0.182	91.9	1.1208	0.0000	OK
15 minute summer	Building D2	10	9.272	0.122	25.4	0.3950	0.0000	OK
15 minute summer	Building D4	10	9.201	0.151	30.7	0.4976	0.0000	OK
30 minute summer	PP D1	22	9.109	0.259	149.2	42.3206	0.0000	OK
15 minute summer	Building K4	9	9.888	0.088	22.8	0.3281	0.0000	OK
30 minute summer	PP K1	24	9.661	0.161	81.2	30.4181	0.0000	SURCHARGED
120 minute summer	Basin 3	104	9.225	0.225	19.7	17.0952	0.0000	FLOOD RISK
15 minute summer	Podium D2-4	11	9.207	0.107	31.8	0.5502	0.0000	OK
30 minute summer	PP D2	23	8.857	0.207	123.3	22.2679	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	Building D5	4.000	PP D1	23.1	0.466	0.327	3.9121	
960 minute summer	Basin 2	Orifice	Basin 4	0.5				
360 minute winter	PP South 2	Orifice	Basin 1	0.3				
360 minute winter	PP South 1	Orifice	Basin 1	0.5				
600 minute summer	Basin 1	Orifice	Basin 2	0.6				
15 minute summer	Building D1	6.000	Podium D1-5	36.7	0.821	0.234	1.5271	
15 minute summer	Podium D1-5	6.001	PP D1	90.1	2.101	0.324	0.6929	
15 minute summer	Building D2	6.000_2	PP D2	25.1	1.173	0.542	0.8077	
15 minute summer	Building D4	7.000	PP D1	29.1	0.894	0.477	1.6803	
30 minute summer	PP D1	6.002	PP D2	76.8	1.164	0.868	4.7196	
15 minute summer	Building K4	9.000	PP K1	23.0	1.868	0.281	0.2020	
30 minute summer	PP K1	8.001	Basin 3	19.1	1.993	0.995	0.2018	
120 minute summer	Basin 3	8.002	Basin 4	12.7	1.430	1.053	0.4884	
15 minute summer	Podium D2-4	11.000	PP D2	31.7	1.464	0.246	0.4039	
30 minute summer	PP D2	11.001	Tank	99.7	2.695	1.022	1.5079	

Results for 10 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Building D3	10	9.114	0.064	33.2	0.2493	0.0000	OK
120 minute summer	Tank	80	7.565	0.465	99.7	33.4391	0.0000	SURCHARGED
120 minute summer	Basin 4	84	7.506	0.506	90.4	33.8079	0.0000	SURCHARGED
15 minute summer	Outfall	1	6.500	0.000	66.0	0.0000	0.0000	OK
180 minute summer	PP K2	124	9.753	0.178	2.6	4.3578	0.0000	SURCHARGED
15 minute summer	Building K5	9	9.909	0.109	22.8	0.4078	0.0000	OK
15 minute summer	Building K3	9	9.907	0.107	22.8	0.3998	0.0000	OK
120 minute summer	Hydro-Brake	84	7.006	0.306	72.4	1.0598	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Building D3	13.000	Tank	33.2	3.117	0.092	0.1700	
120 minute summer	Tank	13.001	Basin 4	78.4	1.256	0.750	0.7952	
120 minute summer	Basin 4	1.002	Hydro-Brake	72.4	1.820	1.148	0.8130	
180 minute summer	PP K2	Orifice	Basin 3	0.5				
15 minute summer	Building K5	7.000_1	PP K1	23.2	1.471	0.439	0.5469	
15 minute summer	Building K3	6.000_1	PP K1	23.2	1.507	0.421	0.4984	
120 minute summer	Hydro-Brake	Hydro-Brake®	Outfall	72.4				382.8

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	Building D5	21	9.199	0.349	35.7	0.9691	0.0000	SURCHARGED
720 minute winter	Basin 2	1380	8.724	0.224	0.7	7.8243	0.0000	OK
240 minute winter	PP South 2	228	9.901	0.151	2.3	10.4452	0.0000	SURCHARGED
480 minute winter	PP South 1	464	9.877	0.177	4.4	41.2382	0.0000	SURCHARGED
720 minute winter	Basin 1	975	9.640	0.140	0.8	9.1731	0.0000	FLOOD RISK
15 minute summer	Building D1	10	9.306	0.156	49.8	0.6481	0.0000	OK
15 minute summer	Podium D1-5	11	9.231	0.231	125.9	1.4211	0.0000	OK
15 minute summer	Building D2	10	9.301	0.151	34.8	0.4877	0.0000	OK
15 minute summer	Building D4	10	9.236	0.186	42.0	0.6098	0.0000	OK
30 minute summer	PP D1	22	9.196	0.346	204.2	57.0562	0.0000	OK
15 minute summer	Building K4	9	9.904	0.104	31.2	0.3886	0.0000	OK
30 minute summer	PP K1	25	9.730	0.230	111.4	43.9289	0.0000	SURCHARGED
120 minute summer	Basin 3	128	9.286	0.286	19.2	25.3403	0.0000	FLOOD RISK
15 minute summer	Podium D2-4	11	9.228	0.128	43.5	0.6586	0.0000	OK
30 minute summer	PP D2	27	9.020	0.370	171.8	40.1373	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	Building D5	4.000	PP D1	31.7	0.500	0.448	4.1921	
720 minute winter	Basin 2	Orifice	Basin 4	0.6				
240 minute winter	PP South 2	Orifice	Basin 1	0.3				
480 minute winter	PP South 1	Orifice	Basin 1	0.5				
720 minute winter	Basin 1	Orifice	Basin 2	0.7				
15 minute summer	Building D1	6.000	Podium D1-5	50.3	0.866	0.321	1.9813	
15 minute summer	Podium D1-5	6.001	PP D1	122.1	2.151	0.439	0.9422	
15 minute summer	Building D2	6.000_2	PP D2	34.4	1.256	0.744	1.0348	
15 minute summer	Building D4	7.000	PP D1	40.5	0.955	0.663	2.4142	
30 minute summer	PP D1	6.002	PP D2	99.9	1.163	1.128	6.7011	
15 minute summer	Building K4	9.000	PP K1	31.4	1.917	0.383	0.2775	
30 minute summer	PP K1	8.001	Basin 3	20.3	1.972	1.055	0.2018	
120 minute summer	Basin 3	8.002	Basin 4	12.7	1.431	1.045	0.4890	
15 minute summer	Podium D2-4	11.000	PP D2	43.3	1.585	0.337	0.5107	
30 minute summer	PP D2	11.001	Tank	95.6	2.687	0.980	1.5368	

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Building D3	10	9.126	0.076	45.4	0.2942	0.0000	OK
120 minute summer	Tank	90	7.769	0.669	125.7	48.0515	0.0000	SURCHARGED
120 minute summer	Basin 4	92	7.680	0.680	103.1	57.1253	0.0000	SURCHARGED
15 minute summer	Outfall	1	6.500	0.000	74.1	0.0000	0.0000	OK
120 minute summer	PP K2	92	9.817	0.242	4.6	6.0317	0.0000	FLOOD RISK
15 minute summer	Building K5	9	9.930	0.130	31.2	0.4868	0.0000	OK
15 minute summer	Building K3	9	9.928	0.128	31.2	0.4766	0.0000	OK
120 minute summer	Hydro-Brake	92	7.039	0.339	81.9	1.1746	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Building D3	13.000	Tank	45.4	3.391	0.126	0.4229	
120 minute summer	Tank	13.001	Basin 4	91.2	1.295	0.872	0.7952	
120 minute summer	Basin 4	1.002	Hydro-Brake	81.9	2.060	1.299	0.8130	
120 minute summer	PP K2	Orifice	Basin 3	0.6				
15 minute summer	Building K5	7.000_1	PP K1	31.5	1.526	0.597	0.7453	
15 minute summer	Building K3	6.000_1	PP K1	31.5	1.562	0.573	0.6800	
120 minute summer	Hydro-Brake	Hydro-Brake®	Outfall	81.9				513.6

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	Building D5	23	9.341	0.491	47.4	1.3635	0.0000	SURCHARGED
960 minute winter	Basin 2	1785	8.795	0.295	0.8	11.6394	0.0000	FLOOD RISK
240 minute winter	PP South 2	232	9.959	0.209	3.2	14.7871	0.0000	FLOOD RISK
480 minute winter	PP South 1	464	9.946	0.246	6.1	58.3317	0.0000	FLOOD RISK
960 minute winter	Basin 1	1245	9.685	0.185	1.0	13.4206	0.0000	FLOOD RISK
30 minute summer	Building D1	22	9.344	0.194	56.2	0.8068	0.0000	OK
30 minute summer	Podium D1-5	22	9.347	0.347	150.7	2.1373	0.0000	OK
15 minute summer	Building D2	10	9.339	0.189	45.7	0.6137	0.0000	OK
30 minute summer	Building D4	23	9.341	0.291	47.4	0.9551	0.0000	OK
30 minute summer	PP D1	23	9.337	0.487	269.4	81.0402	0.0000	SURCHARGED
15 minute summer	Building K4	9	9.923	0.123	41.0	0.4571	0.0000	OK
60 minute summer	PP K1	44	9.826	0.326	104.0	62.7355	0.0000	FLOOD RISK
180 minute summer	Basin 3	192	9.349	0.349	19.9	35.6613	0.0000	FLOOD RISK
15 minute summer	Podium D2-4	11	9.251	0.151	57.2	0.7771	0.0000	OK
30 minute summer	PP D2	27	9.161	0.511	217.5	55.6757	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	Building D5	4.000	PP D1	43.3	0.615	0.612	4.1921	
960 minute winter	Basin 2	Orifice	Basin 4	0.7				
240 minute winter	PP South 2	Orifice	Basin 1	0.4				
480 minute winter	PP South 1	Orifice	Basin 1	0.6				
960 minute winter	Basin 1	Orifice	Basin 2	0.8				
30 minute summer	Building D1	6.000	Podium D1-5	55.3	0.834	0.353	2.9936	
30 minute summer	Podium D1-5	6.001	PP D1	147.4	1.702	0.530	1.3139	
15 minute summer	Building D2	6.000_2	PP D2	44.7	1.311	0.966	1.2994	
30 minute summer	Building D4	7.000	PP D1	46.3	0.878	0.759	3.4376	
30 minute summer	PP D1	6.002	PP D2	102.3	1.159	1.156	6.7250	
15 minute summer	Building K4	9.000	PP K1	41.0	1.945	0.500	0.3541	
60 minute summer	PP K1	8.001	Basin 3	20.2	1.796	1.053	0.2018	
180 minute summer	Basin 3	8.002	Basin 4	12.9	1.429	1.062	0.4896	
15 minute summer	Podium D2-4	11.000	PP D2	57.0	1.692	0.443	0.7288	
30 minute summer	PP D2	11.001	Tank	99.6	2.649	1.021	1.5368	

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Building D3	10	9.138	0.088	59.7	0.3412	0.0000	OK
120 minute winter	Tank	106	7.906	0.806	124.3	57.9076	0.0000	SURCHARGED
120 minute winter	Basin 4	108	7.812	0.812	106.6	79.8858	0.0000	FLOOD RISK
15 minute summer	Outfall	1	6.500	0.000	79.4	0.0000	0.0000	OK
180 minute summer	PP K2	132	9.914	0.339	4.7	8.5272	0.0000	FLOOD RISK
15 minute summer	Building K5	10	9.957	0.157	41.0	0.5868	0.0000	OK
15 minute summer	Building K3	10	9.953	0.153	41.0	0.5717	0.0000	OK
120 minute winter	Hydro-Brake	108	7.085	0.385	87.3	1.3350	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Building D3	13.000	Tank	59.7	3.645	0.166	0.5620	
120 minute winter	Tank	13.001	Basin 4	94.3	1.340	0.903	0.7952	
120 minute winter	Basin 4	1.002	Hydro-Brake	87.3	2.195	1.384	0.8130	
180 minute summer	PP K2	Orifice	Basin 3	0.7				
15 minute summer	Building K5	7.000_1	PP K1	41.1	1.561	0.777	0.9339	
15 minute summer	Building K3	6.000_1	PP K1	41.1	1.598	0.747	0.8527	
120 minute winter	Hydro-Brake	Hydro-Brake®	Outfall	87.2				686.8

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	Building D5	24	9.671	0.821	66.4	2.2820	0.0000	FLOOD RISK
1440 minute winter	Basin 2	2400	8.885	0.385	0.9	17.2998	0.0000	FLOOD RISK
360 minute winter	PP South 2	344	10.051	0.301	3.2	21.6124	0.0000	FLOOD RISK
480 minute winter	PP South 1	472	10.050	0.350	8.5	84.0619	0.0000	FLOOD RISK
960 minute winter	Basin 1	1380	9.742	0.242	1.2	19.7687	0.0000	FLOOD RISK
30 minute summer	Building D1	24	9.662	0.512	78.7	2.1246	0.0000	FLOOD RISK
30 minute summer	Podium D1-5	24	9.684	0.684	201.0	4.2166	0.0000	FLOOD RISK
15 minute summer	Building D2	10	9.554	0.404	64.0	1.3091	0.0000	FLOOD RISK
30 minute summer	Building D4	24	9.670	0.620	66.4	2.0373	0.0000	FLOOD RISK
30 minute summer	PP D1	24	9.665	0.815	355.1	125.9562	0.0000	FLOOD RISK
120 minute summer	Building K4	82	9.990	0.190	23.5	0.7076	0.0000	OK
120 minute summer	PP K1	82	9.988	0.488	98.8	94.4202	0.0000	FLOOD RISK
180 minute summer	Basin 3	212	9.448	0.448	21.5	54.9958	0.0000	FLOOD RISK
30 minute summer	Podium D2-4	27	9.498	0.398	77.0	2.0419	0.0000	FLOOD RISK
30 minute summer	PP D2	27	9.489	0.839	260.8	82.1737	0.0000	FLOOD RISK

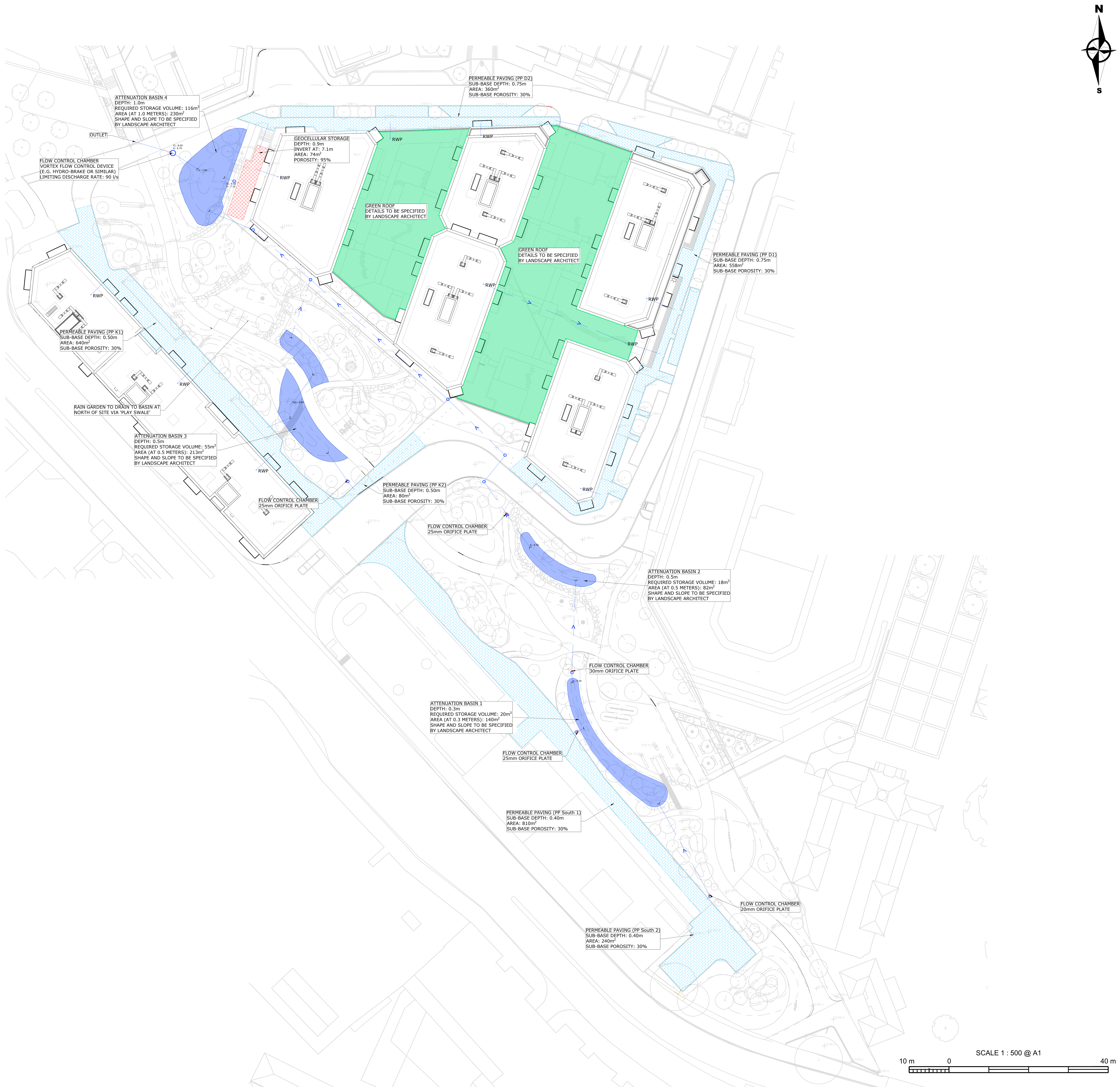
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	Building D5	4.000	PP D1	61.5	0.873	0.870	4.1921	
1440 minute winter	Basin 2	Orifice	Basin 4	0.8				
360 minute winter	PP South 2	Orifice	Basin 1	0.5				
480 minute winter	PP South 1	Orifice	Basin 1	0.8				
960 minute winter	Basin 1	Orifice	Basin 2	0.9				
30 minute summer	Building D1	6.000	Podium D1-5	73.0	0.835	0.465	4.2648	
30 minute summer	Podium D1-5	6.001	PP D1	187.1	1.827	0.673	1.3676	
15 minute summer	Building D2	6.000_2	PP D2	58.6	1.475	1.266	1.4949	
30 minute summer	Building D4	7.000	PP D1	59.9	0.868	0.981	3.4526	
30 minute summer	PP D1	6.002	PP D2	107.1	1.150	1.210	6.7250	
120 minute summer	Building K4	9.000	PP K1	23.4	1.231	0.285	0.4589	
120 minute summer	PP K1	8.001	Basin 3	21.4	1.736	1.112	0.2018	
180 minute summer	Basin 3	8.002	Basin 4	13.3	1.423	1.096	0.4947	
30 minute summer	Podium D2-4	11.000	PP D2	78.5	1.766	0.610	1.3152	
30 minute summer	PP D2	11.001	Tank	101.3	2.677	1.038	1.5368	

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Building D3	10	9.156	0.106	83.6	0.4121	0.0000	OK
120 minute winter	Tank	116	8.085	0.985	126.7	64.8297	0.0000	SURCHARGED
120 minute winter	Basin 4	122	7.987	0.987	118.5	116.6111	0.0000	FLOOD RISK
15 minute summer	Outfall	1	6.500	0.000	85.0	0.0000	0.0000	OK
180 minute winter	PP K2	144	10.072	0.497	4.3	12.6399	0.0000	FLOOD RISK
15 minute summer	Building K5	11	10.098	0.298	57.4	1.1132	0.0000	FLOOD RISK
15 minute summer	Building K3	11	10.074	0.274	57.4	1.0237	0.0000	FLOOD RISK
180 minute summer	Hydro-Brake	164	7.218	0.518	89.8	1.7941	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Building D3	13.000	Tank	83.6	3.968	0.233	0.5630	
120 minute winter	Tank	13.001	Basin 4	106.2	1.508	1.016	0.7952	
120 minute winter	Basin 4	1.002	Hydro-Brake	89.8	2.259	1.424	0.8130	
180 minute winter	PP K2	Orifice	Basin 3	0.9				
15 minute summer	Building K5	7.000_1	PP K1	53.0	1.584	1.003	1.1538	
15 minute summer	Building K3	6.000_1	PP K1	53.6	1.622	0.974	1.0663	
180 minute summer	Hydro-Brake	Hydro-Brake®	Outfall	89.8				1081.9

Appendix A.4 – Indicative Drainage Layout



GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS, ARCHITECTS AND SPECIALISTS DRAWINGS AND THE SPECIFICATION.
2. ALL WORK IS TO BE CARRIED OUT IN ACCORDANCE WITH THE RELEVANT BRITISH STANDARDS, EUROPEAN NORMS, CODES OF PRACTICE AND BUILDING PRACTICE.
3. ALL DIMENSIONS ARE TO BE CHECKED BY THE CONTRACTOR PRIOR TO STARTING THE WORKS ON SITE. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
4. ALL DRAINAGE SYSTEMS WILL NEED TO BE INSTALLED AND DESIGNED FOR SUITABLE LOADING REQUIREMENTS.
5. THE CONTRACTOR SHALL OBTAIN PRIOR APPROVAL AND ALL NECESSARY LICENCES FROM THE THE HIGHWAY AUTHORITY AND/OR SEWERAGE UNDERTAKER BEFORE CARRYING OUT ANY WORKS.
6. THIS DRAWING WAS PRODUCED FOR USE IN CONJUNCTION WITH A PLANNING SUBMISSION AND SHOULD NOT BE USED FOR OTHER PURPOSES. A MORE DETAILED DESIGN INCLUDING PRODUCT SPECIFICATIONS WILL NEED TO BE PRODUCED PRIOR TO CONSTRUCTION.

KEY:

- SURFACE WATER DRAIN
- CL: XX.XX IL: XX.XX — SURFACE WATER MANHOLE
- CL: XX.XX IL: XX.XX — SURFACE WATER PPIC
- RWP — RAINWATER PIPE
- FLOW CONTROL DEVICE
- PERMEABLE SURFACE
- GEOCELLULAR ATTENUATION TANK
- DRAINAGE ATTENUATION BASIN/SWALE
- GREEN ROOF

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Tel : 01227 833855
enquiries@herringtonconsulting.co.uk
www.herringtonconsulting.co.uk

Rev	Description	Author	Checked	Date
P0	First issue	EC	BI	29/02/24

CLIENT
Berkeley Homes (East Thames) Ltd

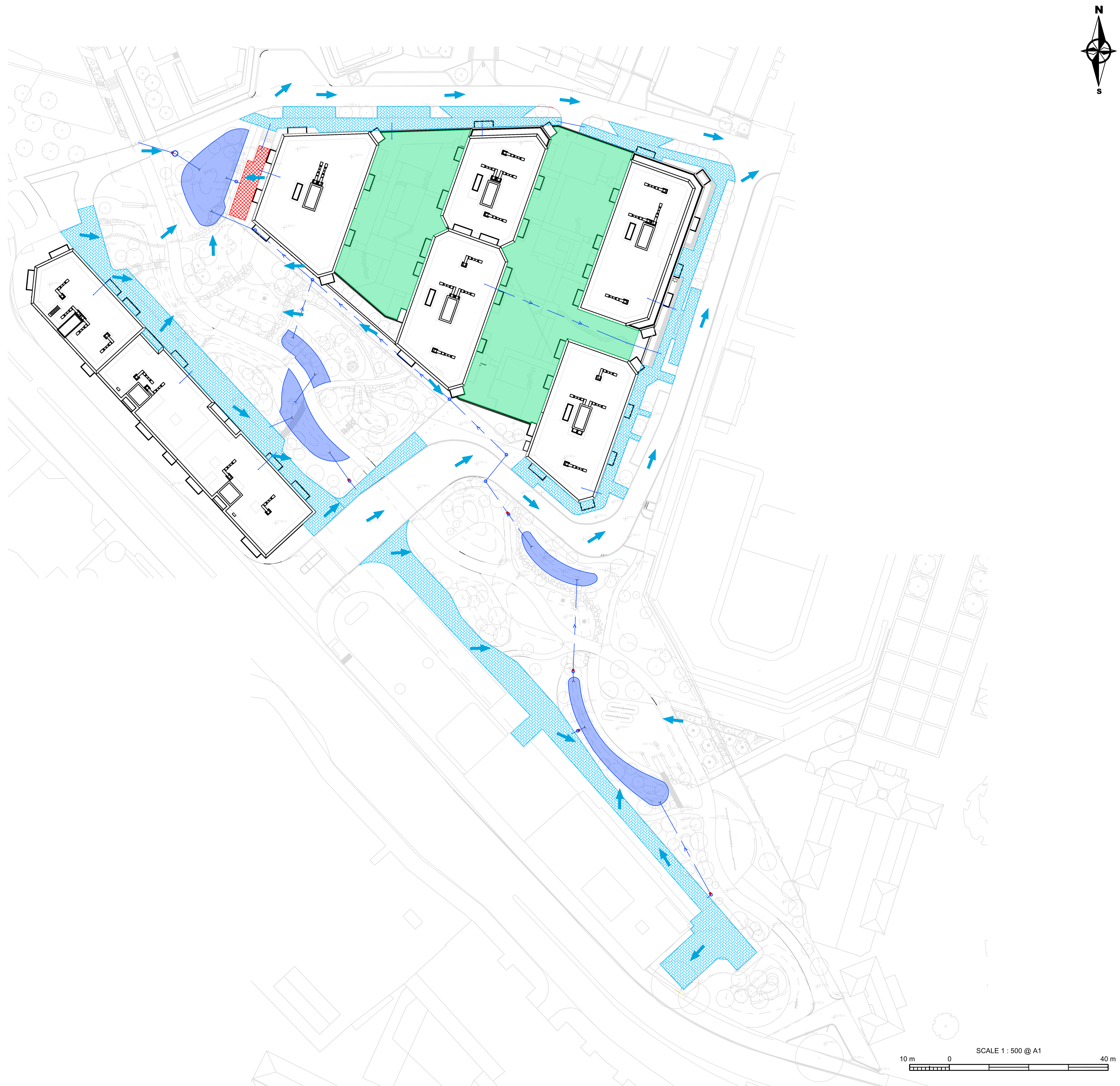
PROJECT
The Ropeyards, Royal Arsenal Riverside
Plots D & K

SCALE	PROJ REF	ORIGINATOR	CHECKED BY
1:500	3628	EC	BI

HC DWG REF.
3628_DWG_r0

DWG TITLE
INDICATIVE SURFACE WATER DRAINAGE LAYOUT

DWG No.
HC-3628-501



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KEY:

SURFACE WATER DRAIN
SURFACE WATER MANHOLE
SURFACE WATER PPIC
RAINWATER PIPE
FLOW CONTROL DEVICE
PERMEABLE SURFACE
GEOCELLULAR ATTENUATION TANK
DRAINAGE ATTENUATION BASIN/SWALE
GREEN ROOF
FLOW ROUTE DURING EXCEEDANCE OR BLOCKAGE SCENARIO

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Tel : 01227 833855
enquiries@herringtonconsulting.co.uk
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P0	First issue	EC	BI	29/02/24

CLIENT: Berkeley Homes (East Thames) Ltd

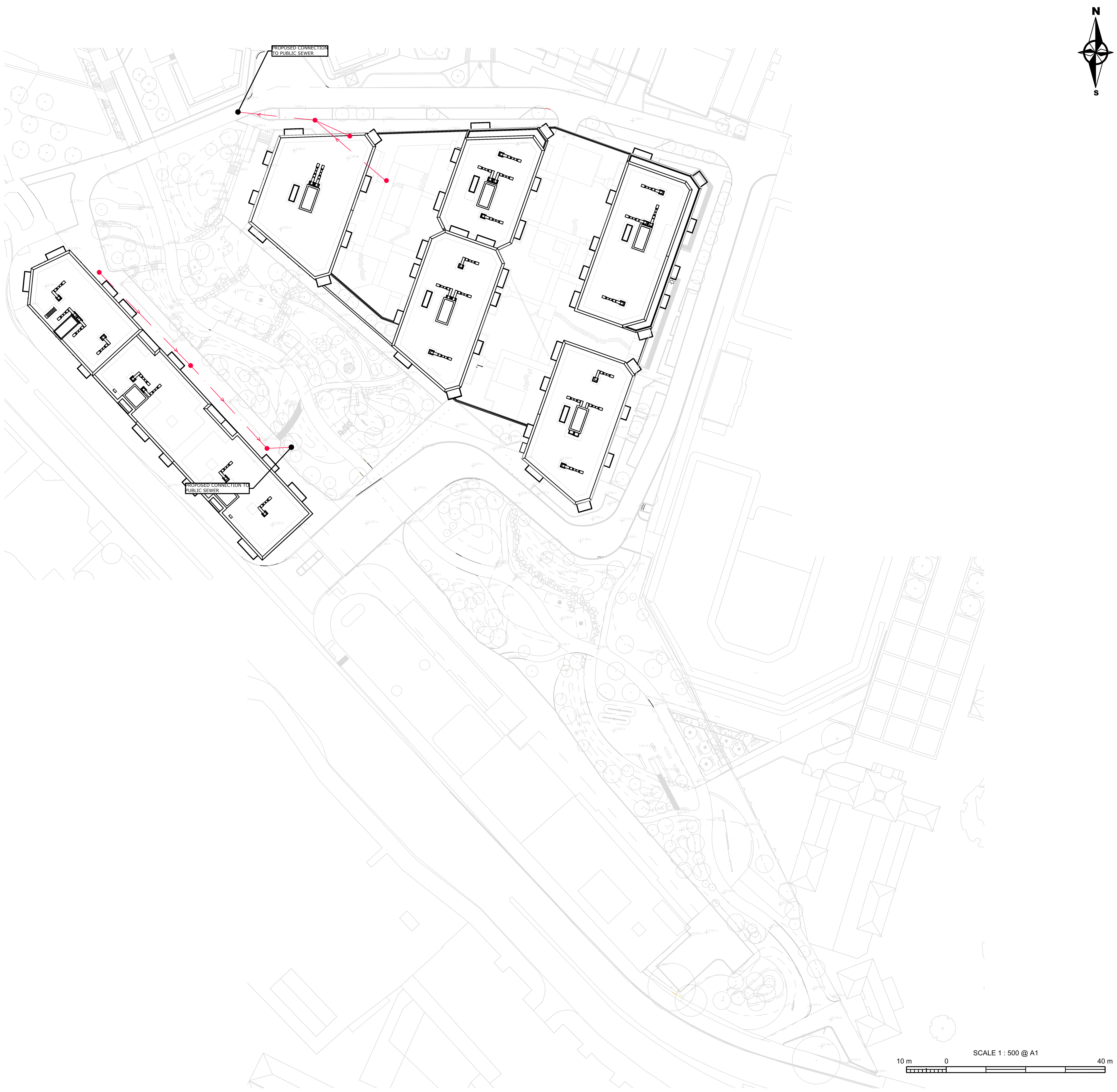
PROJECT: The Ropeyards, Royal Arsenal Riverside Plots D & K

SCALE	PROJ REF	ORIGINATOR	CHECKED BY
1:500	3628	EC	BI

HC DWG REF: 3628_DWG_r0

DWG TITLE: EXCEEDANCE ROUTE

DWG No.: HC-3628-502



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KEY:

- EXISTING FOUL WATER SEWER
- EXISTING FOUL WATER CHAMBER
- FOUL WATER DRAIN
- FOUL WATER MANHOLE

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CLIENT: Berkeley Homes (East Thames) Ltd

PROJECT: The Ropeyards, Royal Arsenal Riverside
Plots D & K

SCALE	PROJ REF	ORIGINATOR	CHECKED BY
1:500	3628	EC	BI

HC DWG REF: 3628_DWG_r0

DWG TITLE: INDICATIVE FOUL WATER DRAINAGE LAYOUT

DWG No.: HC-3628-601

Appendix A.5 – Maintenance Schedules

Operation and Maintenance Schedule – Swales		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass - to retain grass height within specified design range (typically 75mm-150mm tall) Grass clippings should not be left adjacent to feature.	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly (unless prior inspections suggest higher frequency inspections are required)
	Inspect inlets and facility surface for silt accumulation establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of sediment, oils or petrol residues using safe standard practices	As required

General Maintenance Requirements for Swales.

Operation and Maintenance Schedule – Geo-Cellular Storage System		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months then annually
	Remove debris and sediment from the catchment surface, wherever is presents a risk to the performance of the drainage system,	Monthly, or as required based on inspection frequencies.
	Remove sediment from pre-treatment structurers (e.g. sediment traps) and from internal forebays	Annually or as required based on inspection frequencies
Remedial Actions	Repair; inlets, outlets, overflow pipes, and vent mechanisms	As required, based on inspections
	Replace tank or geotextile if significant damage is observed or geotextile is torn.	As required
Monitoring	Inspect and check all inlets, outlets, vents, and overflows to ensure that they are in good condition and operating as designed.	Following installation, and annually hereafter
	Survey inside of tank, and at any sediment trap mechanisms, for sediment build-up and remove sediment if necessary. Use inspections to develop a regular maintenance and inspection procedure for sediment removal.	Every 5 years, or as required if inspections show high siltation rates.

General Operation and Maintenance Table for Geo-Cellular Storage Systems

Operation and Maintenance Schedule – Swales		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range (typically 75mm-150mm tall) Grass clippings should not be left adjacent to feature.	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly (unless prior inspections suggest higher frequency inspections are required)
	Inspect inlets and facility surface for silt accumulation establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of sediment, oils or petrol residues using safe standard practices	As required

General Maintenance Requirements for Swales.

Operation and Maintenance Schedule – Geo-Cellular Storage System		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months then annually
	Remove debris and sediment from the catchment surface, wherever is presents a risk to the performance of the drainage system,	Monthly, or as required based on inspection frequencies.
	Remove sediment from pre-treatment structurers (e.g. sediment traps) and from internal forebays	Annually or as required based on inspection frequencies
Remedial Actions	Repair; inlets, outlets, overflow pipes, and vent mechanisms	As required, based on inspections
	Replace tank or geotextile if significant damage is observed or geotextile is torn.	As required
Monitoring	Inspect and check all inlets, outlets, vents, and overflows to ensure that they are in good condition and operating as designed.	Following installation, and annually hereafter
	Survey inside of tank, and at any sediment trap mechanisms, for sediment build-up and remove sediment if necessary. Use inspections to develop a regular maintenance and inspection procedure for sediment removal.	Every 5 years, or as required if inspections show high siltation rates.

General Operation and Maintenance Table for Geo-Cellular Storage Systems

Operation and Maintenance Schedule – Green Roofs		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Routine Inspection	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Routine maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (i.e. year one), replace all dead plants as required	Monthly (usually the responsibility of the manufacturer)
	Post establishment replace dead plants as required (where >5% of coverage)	Annually (in Autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow gasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial Actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

General Operation and Maintenance Table for Green Roofs.

Operation and Maintenance Schedule – Rain Gardens / Bioretention Systems		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Routine Inspection	Inspect infiltration surfaces for any silting or ponding and record the dewatering time of the raingarden or bioretention system. Look for any areas of standing water. Inspect any hidden elements of the drainage for the feature e.g. underdrains, overflows etc. If standing water or damage is discovered instigate remedial maintenance.	Quarterly inspections, system to be artificially filled with water or inspections to directly follow periods of heavy rainfall.
	Check operation of underdrains by inspection of flows after rainfall.	Annually
	Assess planting for disease infection poor growth invasive species etc. and replace as necessary.	Quarterly (more frequent inspection may be required depending on plants used and during growing season)
	Inspect inlets and outlets for blockage or damage to any scour protection	Quarterly, or whenever standing water is observed for significant periods of time following rainfall events.
Routine maintenance	Remove litter and surface debris. Weed area to remove nuisance plants.	Quarterly (or more frequently for tidiness and aesthetic reasons)
	Replace any plants to maintain planting density	As required, care should be taken to select replacement plants that are suitable for the soil substrate used within the bioretention system.
	Remove sediment, litter, and debris build-up from around any inlets, downpipes, and forebay.	Quarterly to biannually (adjust based on observed accumulation frequencies)
Occasional Maintenance and Remedial Actions	Infill any holes or scour in the filter medium, improve erosion protection if required.	As required following routine inspection or observations of damage / poor operation.
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch.	As required following routine inspection or observations of damage / poor operation.
	Remove and replace filter medium and vegetation above	As required following routine inspection however is unlikely to be required more frequently than every ~20 years.
	Replace scour protection if dislodged or damaged	As required following routine inspection or observations of damage / poor operation.

General Operation and Maintenance Table for Rain Gardens / Bioretention Systems

Note: Raingardens and bioretention systems are often designed in conjunction with site landscaping, as a result bespoke maintenance requirements are frequently required. Maintenance for any raingardens or bioretention systems should take into consideration any bespoke maintenance requirements that are specific to the final design.

Operation and Maintenance Schedule – Pervious paving / surfacing		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Maintenance	Brushing and vacuuming (for driveways this can be a standard cosmetic sweep over whole surface).	At minimum once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – particular attention must be payed to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds or management using a suitable weed killer which will not adversely affect water quality. Weed killer should be applied directly into the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving / surfacing.	As required when damage or erosion is detected following inspection. For block paving systems jointing material to be replaced shortly after installation and subsequently when required.
	Remedial work to any depressions. Rutting and cracked or broken blocks and replace lost jointing material (where block paving is used).	
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

General Maintenance Requirements for Permeable Surfacing (additional requirements may apply depending on type of surfacing material used).

Operation and Maintenance Schedule – Green Roofs		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Routine Inspection	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Routine maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (i.e. year one), replace all dead plants as required	Monthly (usually the responsibility of the manufacturer)
	Post establishment replace dead plants as required (where >5% of coverage)	Annually (in Autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow gasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial Actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

General Operation and Maintenance Table for Green Roofs.

Operation and Maintenance Schedule – Rain Gardens / Bioretention Systems		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Routine Inspection	Inspect infiltration surfaces for any silting or ponding and record the dewatering time of the raingarden or bioretention system. Look for any areas of standing water. Inspect any hidden elements of the drainage for the feature e.g. underdrains, overflows etc. If standing water or damage is discovered instigate remedial maintenance.	Quarterly inspections, system to be artificially filled with water or inspections to directly follow periods of heavy rainfall.
	Check operation of underdrains by inspection of flows after rainfall.	Annually
	Assess planting for disease infection poor growth invasive species etc. and replace as necessary.	Quarterly (more frequent inspection may be required depending on plants used and during growing season)
	Inspect inlets and outlets for blockage or damage to any scour protection	Quarterly, or whenever standing water is observed for significant periods of time following rainfall events.
Routine maintenance	Remove litter and surface debris. Weed area to remove nuisance plants.	Quarterly (or more frequently for tidiness and aesthetic reasons)
	Replace any plants to maintain planting density	As required, care should be taken to select replacement plants that are suitable for the soil substrate used within the bioretention system.
	Remove sediment, litter, and debris build-up from around any inlets, downpipes, and forebay.	Quarterly to biannually (adjust based on observed accumulation frequencies)
Occasional Maintenance and Remedial Actions	Infill any holes or scour in the filter medium, improve erosion protection if required.	As required following routine inspection or observations of damage / poor operation.
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch.	As required following routine inspection or observations of damage / poor operation.
	Remove and replace filter medium and vegetation above	As required following routine inspection however is unlikely to be required more frequently than every ~20 years.
	Replace scour protection if dislodged or damaged	As required following routine inspection or observations of damage / poor operation.

General Operation and Maintenance Table for Rain Gardens / Bioretention Systems

Note: Raingardens and bioretention systems are often designed in conjunction with site landscaping, as a result bespoke maintenance requirements are frequently required. Maintenance for any raingardens or bioretention systems should take into consideration any bespoke maintenance requirements that are specific to the final design.

Operation and Maintenance Schedule – Pervious paving / surfacing		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Maintenance	Brushing and vacuuming (for driveways this can be a standard cosmetic sweep over whole surface).	At minimum once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – particular attention must be payed to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds or management using a suitable weed killer which will not adversely affect water quality. Weed killer should be applied directly into the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving / surfacing.	As required when damage or erosion is detected following inspection. For block paving systems jointing material to be replaced shortly after installation and subsequently when required.
	Remedial work to any depressions. Rutting and cracked or broken blocks and replace lost jointing material (where block paving is used).	
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

General Maintenance Requirements for Permeable Surfacing (additional requirements may apply depending on type of surfacing material used).

Appendix A.6 – Surface Water Drainage Scheme for Adjacent Site

BERKELEY HOMES (EAST THAMES) LTD.

SUBMISSION FOR PLANNING CONDITION 62, "SURFACE WATER DRAINAGE SCHEME".

ROYAL ARSENAL RIVERSIDE, WOOLWICH WATERFRONT PARK (DELTA & TERRACES)

Report No. Z507-RSK-ZZ-XX-RP-CR-00013

JANUARY 2019

CONTENTS

APPENDICES

1 PREFACE

Whilst this report has been prepared specifically with respect to character areas 5 and 6 of the Waterfront Park, this being known as the, “Delta and Terraces”, it has also been necessary to address the following as part of this report:

i) The drainage strategy for the whole of the Waterfront Park public open space.
ii) The drainage strategy for remaining land parcels making up the Waterfront Masterplan area.

For clarity and consistency throughout this report the following references have been adopted:

Royal Arsenal Riverside (RAR)	-	This describes the whole of the Royal Arsenal development site, both east and west of No. 1 Street
Waterfront Masterplan Area	-	This describes the portion of the RAR which lies to east of No. 1 Street
Waterfront Park	-	This describes the future public open space that will eventually become Maribor Park.
Delta & Terraces	-	This describes the character areas forming the Waterfront Park (Character Areas 5 and 6).
Plot A Scheme	-	This describe the development parcel immediately to east of the Delta & Terraces that is the subject of a separate Planning Condition 62 report.
D Blocks	-	This describes a future residential development land parcel which forms part of the Waterfront Masterplan area and which lies immediately adjacent to the Waterfront Park.

K Blocks	-	This describes a future residential development land parcel which forms part of the Waterfront Masterplan area and which lies immediately adjacent to the Waterfront Park.

All other references made in this report relate to development that is either completed or is substantially complete and has already been through the planning approval process.

2 INTRODUCTION

2.1 General

This document has been prepared with reference to the following planning approved Flood Risk Assessment (FRA) reports.

- Scott Wilson Report
  "The Warren, Royal Arsenal Flood Risk Assessment". (March 2008).

- URS Report
  "The Waterfront Royal Arsenal Outline Planning Application – 09. Flood Risk Assessment". (January 2013).

In addition to the above, this report also takes on board comments of the Royal Borough of Greenwich as the Lead Local Flood Authority (LLFA), which are reproduced below for ease of reference:

1) *Greenfield runoff, Pre-development runoff and Post-development runoff figures to be supplied for the peak discharge rates.*
2) *The outfall is either pipes, existing or new and at times assumed to be tide locked? If so what happens? (Surcharging of the manhole is not acceptable)*
3) *Have the EA/MMO and PLA given consent to the new outfall?*
4) *What pollution control measures are in place prior to the outfall and what other methods are being employed to manage pollution/sediment etc.*
5) *Maintenance plan? The system is designed to stop surface water flooding for the lifetime of the development how will this system be managed and maintained to ensure it works for the lifetime of the development?*
6) *It is mentioned that the 1:100 year event the footway/Thames path will be allowed to flood – This is not acceptable the 1:100 (+CC) must be held within the development, this needs to be clarified.*

This report relates to Waterfront Park (Otherwise known as the, "Maribor or Linear Park"), which received planning approval as referenced under Section 2.2 on the following page.

2.2 Planning Condition

The purpose of this report is to provide all the information necessary for the Local Planning Authority, “Royal Borough of Greenwich”, to discharge Planning Condition 62 respective to the planning approval associated with the Waterfront Park.

This document has been prepared to specifically address the requirements contained within Planning Condition 62.

<u>Condition 62 states</u>

“Development of the relevant part of the site shall not begin until a surface water drainage scheme for that part of the site, based on sustainable drainage principles and an assessment of the hydrological context of the development, has been submitted to, and approved in writing by, the Local Planning Authority. The scheme shall subsequently be implemented in accordance with the approved details before the development of that part of the site is completed. The scheme shall also include:

(a) Green roofs.

(b) Reduced run off rates to any sewer

(c) details of how the scheme shall be maintained and managed after completion

This planning condition effectively combines the requirements of the following two stakeholders:

i) Lead Local Flood Authority (LLFA)
ii) Environment Agency (EA)

It should be noted that all the early consultation in respect of the FRA’s as listed under Section 2.1 above was undertaken with the Environment Agency (EA), however due to recent legislative changes the Royal Borough of Greenwich (RBG) as the Lead Local Flood Authority (LLFA) are now considered to be the primary approving body. Confirmation of the EA’s deferral to the LLFA is confirmed within the correspondence contained under Appendix B of this report

The specific purpose of this planning condition report is therefore to satisfy the requirements of RBG as both the Local Planning Authority and the Lead Local Flood Authority.

2.3 Site Description and Location

The Waterfront Park development proposal follows the parameters and principles set out in the outline planning permission, reference 13/0117/O and more specifically the approved, “Public Open Space Strategy”.

The Waterfront Park can be described as taking the form of a Linear Park starting at the, “Source”, located just to the west of No1. Street and immediately south of the Royal Arsenal Riverside Phase 3 development. The linear park runs from east to west following the alignment of the A206 Beresford Street before turning north to run between the Royal Arsenal Riverside (RAR) Plot A Scheme and Phase 8, terminating adjacent to the River Thames as per the illustrative images presented under Appendix A of this report.

The Waterfront Park will provide for most of the open space on the Waterfront portion of the RAR and will be delivered in phases. An overview of the Waterfront Park is given on the images contained under Appendix A, however this report relates more specifically to the Delta and Terraces portion of the park, the limits of which are shown in Figure 1 below.

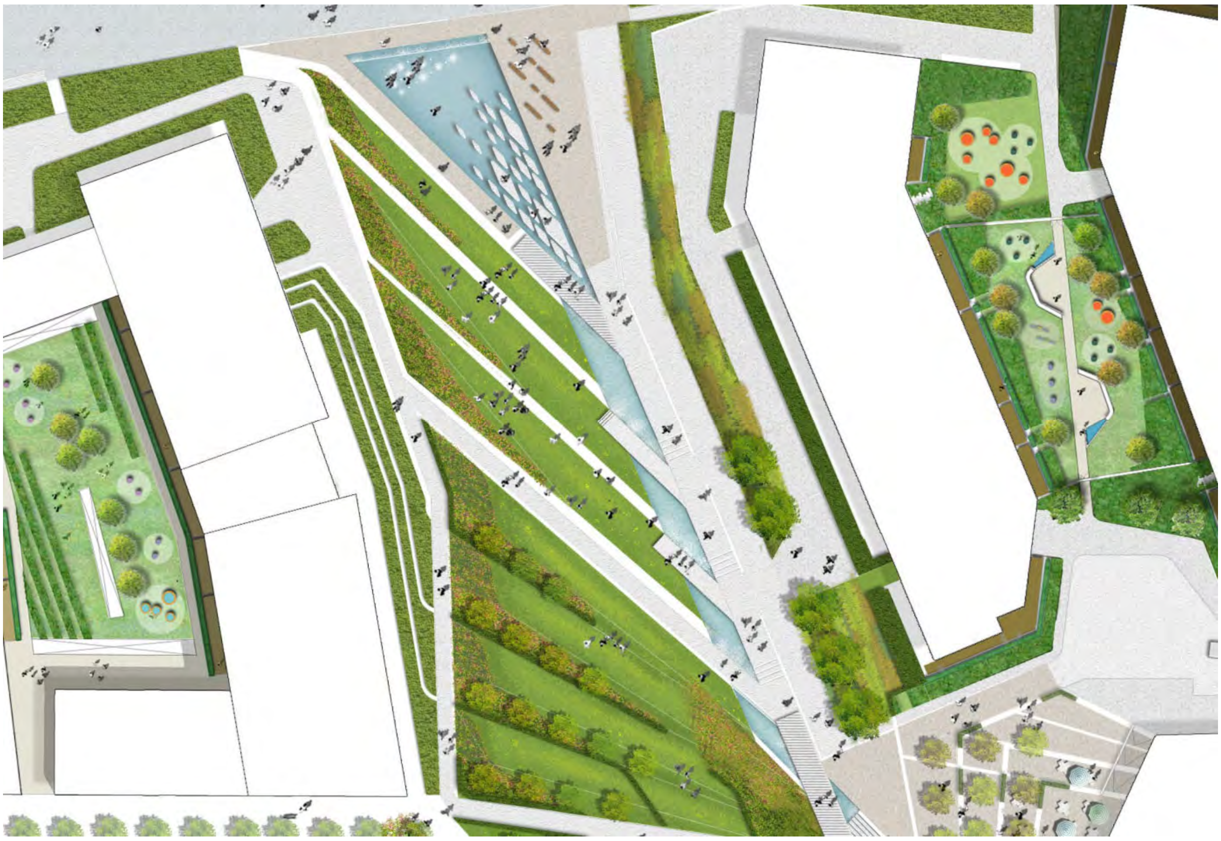

Figure 1 - Waterfront Park - Delta & Terraces Area

Refer also to the aerial photograph contained under Appendix A for a more definitive view of how this site relates to other geographical landmarks in Woolwich.

2.4 Development Proposals

The Waterfront Park is a new four-acre Linear Park providing a green link between the Royal Arsenal and the River Thames.

The planning approved scheme incorporates the following concepts

i. This proposed public park has been designed around a new waterway that will meander through several changing landscapes with differing features.

ii. This park, whilst forming a very important public realm open space on the Royal Arsenal Riverside development, will also act to facilitate flexible open space for play and leisure for the residents of Woolwich town and the wider communities.

iii. This park will be of high quality with a prestigious appearance, the finishes to which will be commensurate with those already established on the Royal Arsenal Riverside development.

The Waterfront Park when completed will consist of the following distinct landscaped areas:

1 The Source
2 The Sensory Gardens
3 The Lawn
4 The Piazza
5 The Terraces
6 The Delta

Refer to Figure 2 on the following page for confirmation of the locations within the Waterfront Park of the above listed landscaped / character area.

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Figure 2 – Waterfront Park, Character Areas

2.5 Previous Site Usage

The land on which the Waterfront Park is to be constructed has in the recent past been used for the following purposes.

1. Public open space including a skateboard park
2. Public car park
3. Temporary access road serving to the RAR sales centre, occupied residential properties and construction site compounds.
4. Various site compounds and materials storage areas.

Refer to the aerial photograph contained under Appendix C for illustrative confirmation of the above.

Based on the information obtained from Thames Water and confirmed by drainage investigation works undertaken on site, all hard paved areas shown on the aerial photograph contained under Appendix C are known to discharge into a surface water drainage network below the site, which in turn discharges into the trunk sewer passing below the site. It has been confirmed by Thames Water that the classification of this trunk sewer is, “Combined”. The existing drainage networks currently serving the Waterfront Masterplan land area are shown under Appendix D.

Based on the above it is clear that the previous site usage was predominately brownfield classification, with a significant portion of it being hard paved and positively drained to public sewers.

2.6 Previous Planning Condition Reports

The following previously submitted planning condition reports have significant relevance to this report and are therefore listed below for reference purposes.

1. RSK Report No. Z507-RSK-ZZ-XX-RP-CR-00010

2. RSK Report No. Z507-RSK-ZZ-XX-RP-CR-00014

2.6.1 Planning Condition 29

RSK report no. Z507-RSK-ZZ-XX-RP-CR-00010 was specifically issued to address the requirements of Planning Condition 29 and therefore this document outlines the Drainage Strategy to be implemented within the Delta & Terraces portion of the Waterfront Park.

2.6.2 Planning Condition 67

RSK report no. Z507-RSK-ZZ-XX-RP-CR-00014 was specifically issued to address the requirements of Planning Condition 67 and therefore this document confirms that the drainage proposals to be employed within the Delta and Terraces area will obviate any necessity to utilize infiltration techniques for the disposal of surface water runoff.

2.7 Strategic Considerations

Whilst this report has been produced to detail the drainage scheme proposals for the Delta and Terraces portion of the Waterfront Park, more strategic considerations have needed to be taken into account to ensure that the remaining phases of the Waterfront Masterplan area can be built out, whilst at the same time conforming with the principles of the “Flood Risk Assessments” associated with it. Refer to Section 3 below for further information respective to the aforementioned FRAs.

Strategic considerations can be considered to have come into play within this report whenever reference is made to the Waterfront Masterplan area, or in fact when discussion goes beyond the Delta and Terraces to incorporate the whole of the Waterfront Park public open space.

3 FLOOD RISK ASSESSMENT HISTORY

3.1 General Comment

As stated under Section 2.1 of this report there have been two Flood Risk Assessments covering the Waterfront Masterplan, both of which have relevance in respect of the development of the drainage scheme presented in this report.

The contents and findings of the FRA's have been taken into account within the surface water drainage scheme promoted by this report. The influencing aspects of the FRA's are presented below for information purposes.

3.2 Outline Planning (Waterfront Masterplan)

Scott Wilson report, "The Warren, Royal Arsenal Flood Risk Assessment (March 2008)", was submitted in support of the outline planning application (LPA ref 13/0117/O) dated 19th June 2013 for the Waterfront Masterplan area which included the Waterfront Park.

With respect to the above FRA the fundamental requirements of the surface water drainage strategy for the whole of the Waterfront Masterplan area were outlined under Section 9 on pages 25 to 31. For convenience these fundamentals are listed below.

- All surface water is to outfall into the tidal River Thames.
- A new outfall is to be constructed to facilitated discharge into the tidal River Thames.
- Attenuation provisions are to be incorporated into the surface water drainage design to limit the size of the required outfall and reduce peak discharge rates.
- Where possible infiltration techniques are to be adopted to limit the flow reaching the outfall.
- SuDs features are to be incorporated into the surface water drainage design including brown roofs and permeable paving where practicable.

3.3 Outline Planning (Updated Waterfront Masterplan)

The URS report, "The Waterfront Royal Arsenal Outline Planning Application – 09. Flood Risk Assessment (January 2013)", was produced and submitted to support an updated Masterplan at the outline planning application level for the proposed mixed residential, commercial and retail development on the western part of the Royal Arsenal Riverside site known as the, "Waterfront".

With respect to the abovementioned FRA the fundamental requirements of the surface water drainage strategy for the whole of the Waterfront Masterplan area were outlined under Section 6.2 on pages 19 to 21. For convenience and reference a summary of these fundamentals has been listed below.

- The surface water drainage strategy should, as far as practicable, aspire to reduce runoff from the new development

- The surface water drainage strategy should take account of the fact that on a previously developed site it may not always be possible to achieve the idealistic rate of reduced runoff due to cohesive sub-soils, underlying pollutant contamination and a lack of available space.

- Irrespective of the above the proposed surface water drainage scheme should be designed to ensure that the existing runoff rate is not exceeded throughout the lifetime of the development, including an appropriate allowance for climate change.

- The new development should not increase the risk of surface water flooding to others elsewhere.

- The principle of using the Modified Rational Method for determining the existing surface water discharge from the site is established under Section 6.2.7.

- It is acknowledged in the FRA addendum that a new outfall into the tidal River Thames will be required to service the Waterfront Park and all surface water runoff will discharge to that outfall.

- It is identified that sufficient storage must be introduced into the surface water drainage scheme to accommodate the extra requirement for storage during tide lock conditions.

- It is identified that green roof areas will be introduced into the development to provide an increase in soft landscaping and thereby at the same time a significant reduction in impermeable paving.

It should be noted that at outline planning stage the climate change allowance had always been envisaged to be 30% in line with current guidance at that time and to match the standards adopted across other occupied portions of the Royal Arsenal Riverside development. This allowance has subsequently been revisited and has been revised to accord with the most recent Environment Agency guidance, thereby increasing it to 40%.

4 EXISTING SITE DRAINAGE

4.1 Waterfront Masterplan Catchment Areas

The existing catchment areas for the whole of the Waterfront Masterplan area are present on Figure 3 as contained under Appendix E. For convenience these areas are also scheduled in the table below.

Table 4.1 Waterfront Masterplan Catchment Areas

Catchment Reference	Development Included	Area (Ha)	Status	Outfall Reference No.
C1	C Block (Phase 5) E Block (Phase 3) New Warren Lane & historic development	3.879	Fully completed with property occupations	1
C2	Blocks B1, B2 & B3 (Phases 6,7 & 8)	0.108	Substantially completed with property occupations	2
* C3	D Blocks K Blocks Waterfront Park area	1.880	Future development that has outline planning approval but is either: i) Awaiting clearance of planning conditions. ii) Progressing through the planning process. iii) Yet to be submitted for full planning.	3
C4	A Blocks	0.915	Under construction	4
C5	Access road and adjacent public realm areas	0.223	Partially completed, partially under construction.	Discharges to public sewer

** As land dedicated for future development the substantial portion of this catchment is currently discharging into Thames Water's public sewer network. Future infrastructure will be installed to allow this catchment to discharge into the River Thames via the Waterfront Park utilizing outfall no. 3 as indicated on Figure 3 contained under Appendix E.*

It can be seen from Table 4.1 on the previous page that a substantial portion of the built out Waterfront Masterplan area is already catered for in terms of surface water drainage, with all relevant infrastructure having already been installed to facilitate the discharge of this surface water directly into the River Thames.

As previously mentioned significant portions of the Masterplan area which have yet to be built out in line with the approved development proposals. It is known that these portions are draining into the existing underlying public sewer network. It should be noted that historically this has always been the case. The principles established within the Waterfront Masterplan FRAs require that surface water disposal to public sewer network to be obviated as far as is practicable, this principle also being endorsed by Thames Water.

4.2 Waterfront Park (Catchment C3)

From the catchment areas plan discussed under Section 4.1 above it is clear that the extents of the Waterfront Park will be fully encompassed within Catchment area C3. The remaining future phases of the Waterfront Masterplan area, that require provision for surface water drainage disposal, are also to be incorporated into this catchment.

It has been established that the future Waterfront Park will need to become the route corridor into which all runoff from the remaining Masterplan development will be conveyed down to outfall no. 3. Implementation of a new surface water drainage network below Waterfront Park will effectively remove all historical discharge into the existing public sewer network and this has been reviewed in more detail later on in this report.

The extents of Catchment C3 and the proportions of which contribute to the public sewer network are shown on the drawings contained under Appendix E and are scheduled below for convenience.

<u>Table 4.2 Waterfront Park Catchment (Excluding Delta & Terraces)</u>

Catchment Reference	Catchment Ref.	Total Area (Ha)	Impermeable Area (Ha)	Outfall Reference No.
C3	Waterfront Park and adjacent land allocated for future development	1.880	*1.472	3

**The impermeable portion of this sub-catchment is significant being 78% of the total area.*

4.3 Delta and Terraces

The Delta and Terraces can be seen to be a sub-catchment of the Waterfront Park (Catchment C3) and the extents of this sub-catchment, including the extents of the existing impermeable areas, are reviewed more closely below.

The Delta and Terraces portion of the Waterfront Park is presented on Figure 5 under Appendix E of this report. The table below schedules the areas associated with this sub-catchment.

Table 4.3 Delta and Terraces Sub-catchment

Catchment Reference	Sub-catchment Ref.	Total Area (Ha)	Impermeable Area (Ha)	Outfall Reference No.
C3	Waterfront Park, Delta and Terraces.	0.408	*0.185	3

**The impermeable portion of this sub-catchment is significant being 45% of the total area*

4.4 Existing Development

4.4.1 General

All catchment areas within the Waterfront Masterplan area are presented on Figure 3 under Appendix E. Each catchment, including where they drain to, is described below.

4.4.2 Catchment Area C1

A substantial portion of this catchment is made up of historic / heritage buildings, however the following new development has also been incorporated:

i. Apartment Block C
ii. Apartment Block E
iii. New Warren Lane
iv. Extension of the Duke of Wellington Avenue

The outfall servicing this catchment is an existing outfall located at the end of No. 1 Street. Utilization of this outfall was approved by the Environment Agency and a large diameter surface water sewer, incorporating tide lock storage provision, links this catchment to the outfall no. 1.

4.4.3 Catchment Area C2

This catchment is formed entirely of new development incorporating three apartment blocks (B1, B2 & B3) known as Phase 6, 7 & 8. This catchment is totally self-contained in respect of its surface water drainage provision and is serviced by outfall no. 2 which discharges into the River Thames. The utilization of this outfall has been approved by the Environment Agency.

It should be noted that due to the constraints of Phase 6, 7 & 8, it was not possible to accommodate the access road and associated public realm area to the south of the apartment blocks and therefore this hard pave area has been drained independently forming part of catchment C5, refer below for further information.

4.4.4 Catchment Area C3

This catchment is predominately made up of land within the Waterfront Masterplan area that has been assigned, via the planning process, as future public open space. This open space land is to be utilized for the formation of the Waterfront Park. This catchment also incorporates land assigned for further future residential development, this being the D & K blocks as indicated on the information contained under Appendix E.

The surface water drainage strategy for the Delta & Terraces portion of the Waterfront Park has previously been defined within RSK report no. RSK507-ZZ-XX-RP-CR-00010, submitted to clear Planning Condition 29. In brief all future surface water runoff from this sub-catchment will be discharged into the River Thames via a new outfall, this being in accordance with the principles established within the planning approved Waterfront Masterplan FRA.

Strategically the Delta & Terraces portion of the Waterfront Park also forms the route corridor for the drainage network that will service the whole of catchment C3 including the aforementioned land assigned for future residential development.

4.4.5 Catchment Area C4

This catchment consists entirely of new development incorporating six apartment blocks forming the, “Plot A Scheme”. This catchment is to be totally self-contained in respect of its surface water drainage provision. This catchment will discharge to the River Thames via outfall no. 4; this being an existing outfall that previously serviced the Bell Water Gate car park.

The details of the surface water drainage proposals for the Plot A scheme are contained within RSK report no. Z427-RSK-ZZ-XX-RP-CR-0007, submitted to clear the surface water drainage planning condition associated with the Plot A Scheme. This report is currently with the Royal Borough of Greenwich for consideration.

4.4.6 Catchment C5

This catchment is the only catchment within the Waterfront Masterplan area that does not discharge in the River Thames. As stated previously under section 4.4.3 above the constraints of Phases 6, 7 & 8 (B blocks) have prevented a small area of access road and public realm space being able to be connected into the outfall serving this catchment. The only viable solution to this problem was therefore to negotiate a Water Industry Act S106 sewer connection with Thames Water.

Based on the fact that the existing impermeable portions of the Waterfront Masterplan area have always historically discharged into Thames Water's sewer network and the policy of taking this surface water out of the sewer networks as each phase of the RAR comes forward for development has significantly reduced flows entering these sewers. Irrespective, as part of the S106 approval process, a commitment was given to Thames Water that runoff from catchment C5 would be restricted to a much reduced level in line with the principles of the Waterfront Masterplan FRA. A large attenuation storage tank was therefore installed below Catchment C5 and a flow control chamber containing a hydrobrake was installed to restrict the runoff entering the public sewer network. The peak discharge for this catchment was agreed as part of the S106 sewer connection approval process.

Currently the temporary access road running down from the Warren Lane roundabout to the Duke of Wellington Avenue is the only existing hard paved area still draining into Thames Water's public sewer network upstream of the new connection installed to service catchment C5. In this regard a further commitment was also made to Thames Water to apply for a Water Industry Act S116 abandonment of the upstream sewers once this temporary access road is removed. It should be noted that the removal of this access road more than offsets the agreed peak discharge coming from Catchment C5.

All future roads replacing this aforementioned temporary access road will be drained to the River Thames utilizing the surface water drainage network to be installed below the Waterfront Park (Catchment C3).

4.4.7 Royal Arsenal Hotel

Whilst this hotel does not specifically form part of the Waterfront Masterplan area it has been included for completeness of information as it is effectively encompassed on three sides by future development included within the Masterplan area.

This hotel in drainage terms does not communicate with the Royal Arsenal Riverside development as it has its own foul and surface water drainage provisions. The hotel is serviced by independent foul and surface water sewer connections running out under Beresford Street. In this regard all surface water drainage from this hotel is seen to pass directly to public sewer.

The hotel utilizes attenuation tanks within its grounds to limit the peak discharge down to a rate as agreed with Thames Water. The attenuation tank provisions are also currently utilized to service the temporary car park to the rear of the hotel. This temporary car park incorporates permeable paving which effectively provides its own attenuation provision and therefore only trickles flow into hotel's surface water attenuation tanks.

It should be noted that the future implementation of the Waterfront Park will require this temporary car park to be removed and its link to the hotel attenuation tanks will therefore be severed at that time. The portion of Waterfront Park replacing the car park forms part of catchment C3 and will therefore drain to the River Thames as part of the strategy for draining this catchment.

4.5 Pre-development Surface Water Runoff

4.5.1 Greenfield Runoff

To accord with the LLFA's request for Greenfield runoff calculations, these have been undertaken utilizing the HR Wallingford tool kit specifically developed for this purpose. A summary of the result of these calculations are presented in table below.

Table 4.4 – Greenfield Runoff (Waterfront Park – Whole Area, Excluding Delta and Terraces

Return Period	Q Bar (l/s)
1 in 1yr	6.2
1 in 30yr	16.79
1 in 100yr	23.28

For full details refer to the calculation sheets contained under Appendix F.

Table 4.5 – Greenfield Runoff (Delta & Terraces Sub-catchment Only)

Return Period	Q Bar (l/s)
1 in 1yr	1.35
1 in 30yr	3.64
1 in 100yr	5.05

For full details refer to the calculation sheets contained under Appendix F.

4.5.2 Brownfield Runoff

As previously stated in this report substantial portions of the land area dedicated for the Waterfront Park are currently hard paved and are positively drained into the public sewer network, refer to Figures 4 and 5 under Appendix E for the extents of these hard paved areas.

The tables below schedule the following:

i) Area of existing hard paving to be found within Catchment 3 (Future Waterfront Park, not including the Delta and Terraces).

ii) Area of existing hard paving to be found specifically within the Delta and Terraces portion of the Waterfront Park.

Table 4.6 Waterfront Park – Existing Impermeable Area

Catchment	Total Area	Impermeable Area	Proportion Impermeable
C3	1.880	1.472	78%

Table 4.7 Delta and Terraces – Existing Impermeable Area

Catchment	Total Area	Impermeable Area	Proportion Impermeable
C3	0.408	0.185	45%

As the full details of the underlying drainage network servicing these hard paved areas is unknown, it is not possible to run simulations within Microdrainage for the purpose of determining brownfield runoff rates respective to the following critical storms:

1 in 1 yr,

1 in 30yr

1 in 100yr

Taking a precautionary approach an approximation of the brownfield surface water runoff can be established by applying the Modified Rational Method, utilizing the average peak rainfall intensities as predicted by the Flood Studies Report (FSR).

The average peak rainfall intensities as extracted from Mircodrainage for the relevant geographic region are scheduled in the table below.

Table 4.8 Predicted Average Peak Rainfall Intensity

Critical Storm Frequency (yrs)	Duration (Mins)	Rainfall Intensity mm/hr
1 in 1	15	32
1 in 30	15	79
1 in 100	15	144

Waterfront Park – Whole Catchment

Applying the Modified Rational Method

Q = 2.78 CiA

Q = Peak discharge

C = Dimensionless co-efficient

i = The average rainfall intensity during time of concentration

A = Contributing catchment area

C = Cv x Cr

Cv = 0.75

Cr = 1.3

Therefore

Q = 2.78 x 0.975 x i x A

Applying the relevant rainfall intensities to the above formula provides the results as tabulated below.

Table 4.9 - Existing Peak Discharge To Public Sewer
Waterfront Park (Excluding Delta & Terraces).

Critical Storm Frequency	Peak Discharge (L/s)
1 in 1	128
1 in 30	315
1 in 100	574

<u>Delta & Terraces Area</u>

Applying the Modified Rational Method to just the Delta & Terraces portion of the Waterfront Park results in the predicted peak discharges rates given in table below.

Table 4.9a – Existing Peak Discharge to Public Sewer
Delta and Terraces Only.

Critical Storm Frequency	Peak Discharge (L/s)
1 in 1	35
1 in 30	87
1 in 100	159

Pre-development Summary

- Substantial portions of the land dedicated for future public open space are currently hard paved and are serviced by drainage networks connecting into the public sewer network.
- The brownfield runoff from these areas has been calculated using the Modified Rational Method.
- With the implementation of the Waterfront Park these existing hard paved areas will be broken up and the underlying drainage systems made redundant.
- All future runoff from the Waterfront Park itself and adjacent development will be piped through the park and will discharge via a new outfall into the River Thames.
- The predicted peak discharge rates contained within Table 4.9 and 4.9a will be used to establish a suitable peak discharge for the new river outfall, subject to the considerations and constraints discussed under Section 5 below.

5 PROPOSED SURFACE WATER SCHEME

5.1 Considerations and Constraints

5.1.1 General

The Waterfront Masterplan FRAs dictate that all surface water runoff should discharge into the River Thames and not into the public sewer network. In addition a substantial reduction in peak discharge respective to the existing predevelopment state must be achieved by the new surface water scheme.

5.1.2 Infiltration

The Masterplan FRAs require consideration be given to the use of infiltration techniques for surface water disposal. This requirement has already be undertaken within RSK report no. Z507-RSK-ZZ-XX-RP-CR-00014, submitted respective to Planning Condition 67 (Infiltration).

5.1.3 Infrastructure Constraints

To accord with the requirements of the approving stakeholders, the new outfall into the River Thames has been restricted in diameter to 300mm. This limitation on the outfall effectively constrains the upstream piped network to pipe sizes not exceeding 300mm, thereby limiting the hydraulic capacity of the network as a whole.

In respect of this limitation on pipe sizes, the peak discharge for the 1 in 100yr event including allowance for climate change must be restricted to flow rates capable of being conveyed within 300mm diameter pipes, taking into account the achievable gradients for the laying of these pipes on site. Where this requirement cannot be achieved then attenuation storage provisions will have to be introduced in conjunction with flow control devices.

5.1.4 Hydraulic Capacity

Taking a precautionary approach on limiting the discharge into the River Thames it is proposed that the future drainage network that will service the Waterfront Park and the future residential development areas immediately adjacent to it will be designed to meet the criteria stated below.

i) Will be capable of conveying to the outfall the runoff for all storm scenarios up to and including the 1 in 100yr event with a 40% allowance for climate change.
ii) Will take into account the effects of tide lock conditions coinciding with the above.
iii) Will restrict surcharging to a level that will NOT pose a risk of manhole covers being lifted.
iv) Will ensure that the peak discharge rate at the outfall does not exceed that calculated for the predevelopment condition during the 1 in 1yr critical storm.

For further discussion on the drainage scheme proposals refer to Section 6 of this report. For more information in respect of the peak discharge betterment, refer to Section 7 of this report.

5.1.5 Pollution Control and Water Quality Improvement

All surface from hard paved areas within the Waterfront Park will be positively drained to an underlying surface water drainage network. This drainage network will incorporate catchpit chambers to help remove silts and other detritus. In addition geotextile lined gravel filtration trenches will be utilized periodically along the system to help filter and thereby improve water quality.

Where lawned areas of the park are required to have land drainage installed, these drains will incorporate geotextile sleeves around the perforated pipe to prevent the ingress of silts and other organic matter. All land drainage will pass through and intercepting catchpit chambers before entering the main surface water drainage network.

The above principles are demonstrated on the detailed drainage drawings contained under Appendix G.

The water quality improvement that will result from the filtration process as water passes through the geotextile separation layers and the gravel filled trenches will include but not be limited to the following:

- Filtration removing silts and detritus
- Neutralizing of acidic PH values

The quality of the water discharging into the river Thames will be seen to be significantly improved over that historically discharged into the public sewer system.

Water quality improvement respective to runoff from the residential development (D & K Blocks) adjacent to the Waterfront Park will be dealt with as part of the surface water drainage schemes specific to this development and therefore falls outside the scope of this report.

6 HYDRAULIC MODELLING

6.1.1 General

The hydraulic modelling of the proposed surface water drainage scheme presented in this report has been undertaken for all storm scenarios up to and including the 1 in 100yr event with an allowance of 40% for the effects of climate change.

The results of this modelling are presented under Appendix H and these results confirm that the Waterfront Park including the Delta and Terraces portion of it poses no risk in terms of the flooding of the site and / or the land adjacent to it. In this regard no flooding of the Thames River walk path (This being the lowest point of the Waterfront Park) will occur even during the 1 in 100yr climate change event and assuming also that this event coincides with tide lock conditions.

6.1.2 Future Surface Water Runoff Allowances

Whilst this report relates specifically to the Delta and Terraces, consideration has had to be given respective to the surface water runoff contribution that will come from the remaining phases of the Waterfront Masterplan area as this will need to be conveyed through the piped network to be installed below the Delta and Terraces.

Based on the restriction of pipes being limited to 300mm diameter in the Delta and Terraces area, the maximum allowance that can be made for future runoff contribution is **90l/s** and this has been introduced as a dry weather flow entering the Delta and Terraces piped network at the head of the system to be installed. Refer to the hydraulic simulation contained under Appendix H for confirmation.

6.1.3 Future Development

The future D & K Blocks are to be constructed on land parcels which are severely constrained by both new and historic buried infrastructure. In this regard the potential for incorporating attenuation features within these parcels is known to be very limited.

The Waterfront Park, being public open space, has significant areas of relatively unconstrained land and therefore provides the ideal location for attenuation storage. It is therefore proposed that all the future attenuation requirements necessary to meet the criteria listed under Section 5.1.4 above will be installed below Character Areas 2 & 3 of the Waterfront Park. Refer to Figure 2 on page 7 of this report for the location of these character areas within the Waterfront Park.

Currently there is no intention to restrict peak discharge from either the D or K Blocks, however the SuDs features necessary to meet planning requirements including green roofs will be expected to be incorporated into the drainage schemes for these Blocks.

These SuDs features will be taken into account when modelling the surface water runoff contributions for the D and K Blocks.

The extents of the future attenuation provision to be installed below the Waterfront Park will form part of the detailed design of character areas 2 & 3 and is therefore outside the scope of this report.

Due to the steeply sloping nature of the Delta and Terraces it is not intended to place any attenuation in this area.

6.1.4 Hydraulic Modelling of Gravel Filtration Trench

Based on advice provided by MicroDrainage the gravel filled filtration trench shown on the drainage scheme drawings contained under Appendix G has been modelled as a conduit and the associated file for this conduit is included with the hydraulic simulation information under Appendix H.

6.1.5 Attenuation Storage

As stated under Section 6.1,2, no attenuation storage will be provided within the Delta and Terraces area.

Future attenuation requirements associated with the remainder of the Waterfront Park and the future residential development adjacent to it will be calculated as part of the design of the drainage schemes serving these sub-catchments.

Whilst the requirement for attenuation and the locations in which this attenuation could be installed have been considered in this report, the actual volumetric size and extents of this attenuation falls outside the scope of this report. Future attenuation cannot be accurately designed and detailed without more definitive information being available respective to the D and K Blocks residential development.

6.1.6 Tide Lock Allowance.

With regard to the modelling of the proposed surface water drainage scheme a significant betterment has been allowed for by increasing the highest tide lock level from the Highest Astronomical Tide level at 4.35 to 4.8m, an increase of 0.45m. In this regard the following should be noted.

- The London Port Authority and EA only require tide lock conditions up to and including the HAT level to be taken into account when approving the outfall works.
- Should the high tide level actually rise above the betterment level of 4.8m then it could only be as a result of a high spring tide coinciding with storm surge conditions. This would be seen as a very rare and extreme event and in such

cases the tide level would inevitably breach the river wall and flood the Thames river walk path to a significant depth.

The hydraulic modelling for both the HAT and the betterment (4.8m allowance) has been included under Appendix H.

6.1.7 Outfall Proposal

The new outfall will be formed by core drilling a hole through the existing river wall and installing a 300mm diameter pipe. The outfall will have a flap valve fitted over the end of the pipe, this being attached to the river wall. It is anticipated that the stakeholders involved in the approval of the works will also require a secondary non return type valve to be installed on the outfall pipe work just upstream of the end of this pipe.

6.1.8 Non Return Valves

Non return valves have been modelled into the system to obviate the backflow of river water into the network during tide lock conditions. In addition to which they are a requirement of the Stakeholders associated with the approval of the river outfall works.

7 PEAK DISCHARGE BETTERMENT

Taking a precautionary approach in line with the requirements stated under Section 5.1.4 of this report, the maximum peak discharge rate for all storm scenarios up to and including the 1 in 100yr event with allowance for climate change would be.

128 + 35 = **163 l/s**

The above figures being derived from tables 4.9 and 4.9a on page 20 of this report.

The simulations undertaken for the surface water drainage scheme to be installed within the Delta and Terraces show the maximum peak discharge for all storm scenarios with allowance for climate change to be limited to **138 l/s**.

154 > 138 therefore it is seen that the drainage scheme presented in this report gives a betterment over the current 1 in 1yr peak discharge entering the public sewer network.

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8 WORKS TO RIVER OUTFALL APPROVAL

All works to be undertaken within 16m of the Thames river wall require the approval of the Environment Agency (EA). In addition all works requiring access to the Thames River which affect the river wall require the approval of the London Port Authority (LPA) and the Marine Management Organisation (MMO).

The above three bodies are in effect the principal stakeholders in the approval of the works required to the outfall which will service the Plot A Scheme. Formal applications to all three stakeholders have been made under the following references:

Approving Body	Approval Reference No.
Environment Agency	Awaiting confirmation of approval reference no.
London Port Authority	Awaiting confirmation of approval reference no.
Marine Management Organization	MLA/2018/00313

9 SUDS / DRAINAGE MAINTENANCE

9.1 General

The surface water drainage scheme as presented within this report has been designed to be as simple and efficient as possible in order to reduce future maintenance liability.

It is recognized that the SuDs features incorporated within the Delta and Terraces drainage scheme are an integral part of the drainage design and therefore the drainage system relies on these features to maintain its performance to the levels predicted by the hydraulic simulations contained within this report.

In order to ensure that the surface water drainage system continues to properly function for the life time of the building will require the SuDs features to be adequately maintained, refer below for comment on the minimum recommended maintenance requirements.

9.2 Catchpit Chambers and Piped Networks

The inspection and maintenance of larger catchpit chambers will be an ongoing continuous process. These catchpits located on the main surface water drains will need to be inspected annually to see if they require cleaning out.

The smaller catchpits located at the point of connection between the land drainage and the main drain will need to be inspected biannually as they may be more prone to siltation.

All catchpits close to the river shall be inspected after any one off extreme events where very high tide levels have been experienced.

The piped network should only require a CCTV survey to be undertaken on 10yr rotation basis.

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9.3 Gravel Filtration Trenches

Although designed to be very low maintenance the gravel filtration trench will need to be dug out and replaced every 20 to 25yrs.

9.4 Flap Valves / Non Return Valves

The surface water drainage scheme as presented in this report contains a number of flap valve / non return valves. These are essential to the hydraulic performance of the surface water drainage scheme and as such need to be adequately maintained.

In general flap and non-return valves should be inspected and tested bi-annually to ensure that they are fully operational.

Lightweight, low maintenance type valves (GRP or similar) will be utilised within the surface water drainage system, these being protected from external factors. The flap valve on the end of the outfall pipe and fixed to the river wall will be a much heavier duty type as this will be the most vulnerable to damage. In this regard this flap valve will need to be inspected more regularly on a 3monthly cycle.

In addition to the above requirements, all flap / non return valves will need to be inspected after any one off extreme events where very high tide levels have been experienced.

Appendix A.7 – Royal Borough of Greenwich SuDS Proforma

ROYAL borough of GREENWICH

GREATER**LONDON**AUTHORITY

LoDEG

1. Project & Site Details

Project / Site Name (including sub-catchment / stage / phase where appropriate)	The Ropeyards Royal Arsenal Riverside, Plots D & K (Buildings D1, D2, D3, D4, D5 and K3 K4, K5)
Address & post code	Land between Duke of Wellington Avenue and Beresford Street, London, SE18 6NP
OS Grid ref. (Easting, Northing)	E 543619 N 179194
LPA reference (if applicable)	
Brief description of proposed work	Submission of Reserved Matters (Appearance, Landscaping, Layout and Scale) pursuant to Condition 2 of planning permission reference 16/3025/MA, dated 17.03.2017, for residential units and non-residential
Total site Area	23000 m^2
Total existing impervious area	13940 m^2
Total proposed impervious area	11140 m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	No
Existing drainage connection type and location	SW - gullies on existing parking and highway assumed to drain to highway
Designer Name	Ben Irving
Designer Position	Drainage Engineer
Designer Company	Herrington Consulting Ltd

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility

Superficial geology classification	Head (clay, silt, sand and gravel)
Bedrock geology classification	Thanet Formation (sand)
Site infiltration rate	m/s
Depth to groundwater level	m below ground level
Is infiltration feasible?	No

2b. Drainage Hierarchy

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

2c. Proposed Discharge Details

Proposed discharge location	ll within a separate part of Royal Arsenal Ri
Has the owner/regulator of the discharge location been consulted?	N/A

3. Drainage Strategy

3a. Discharge Rates & Required Storage				
	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m^3)*	*Proposed discharge rate (l/s)*
Qbar	2.2			
1 in 1		273		54.3
1 in 30	5	836		81.9
1 in 100	7	1100		87.2
1 in 100 + CC				89.8
Climate change allowance used		40%		
3b. Principal Method of Flow Control		Vortex Flow Control Device		

3c. Proposed SuDS Measures	Catchment area (m^2)	Plan area (m^2)	Storage vol. (m^3)
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	2760	2000	0
Blue roofs	0	0	0
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	7170	0	441
Swales	0	0	0
Basins/ponds	0	690	209
Attenuation tanks	1260		63
Total	11190	2690	713

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	Section 8.2
Drainage hierarchy (2b)	Section 8.2
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	S8.2, 8.4, 9.2/Appendix A.2, A.4, A.6
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Appendix A.3
Proposed SuDS measures & specifications (3b)	S8.4, Appendix A.4

4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	Submitted by others
Detailed drainage design drawings, including exceedance flow routes	Appendix A.4
Detailed landscaping plans	Submitted by others
Maintenance strategy	Appendix A.5
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	Section 8.4
b) biodiversity?	Section 8.4
c) amenity?	Section 8.4