Waterman Infrastructure & Environment Limited
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Objection Rebuttal

Technical Note

Date: 03/02/2023

Client Name: London Square Developments Ltd

Document Reference: WIE12357-100-TN-6-2-1

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015 and BS EN ISO 45001:2018)

Issue	Prepared by	Checked & Approved by
	Sean Whelan Senior Engineer	Brendan McCarthy Technical Director
Second		

Introduction

1.1. Waterman has been commissioned by London Square Developments Ltd to provide a rebuttal to the objections raised by London Borough of Richmond upon Thames (LBRuT) with respect to the outline planning application (22/2557/FUL) for the proposed development located at the former Greggs Bakery Site, located at Gould Road, Twickenham TW2 6RT.

1.2. Summary of current objections

- *The LLFA cannot approve discharge to the River Crane until explicit permission has been obtained from the Environment Agency.*
- *The whole site area will drain at greenfield runoff rates (10.3 l/s) which is acceptable. However, it should be clarified how much runoff is expected to discharge via infiltration, and what the expected runoff to the River Crane will be.*
- *The application does not conform to Defra's Non-Statutory Technical Standards for Sustainable Drainage. The calculations do not take the whole site area into account. It must be demonstrated that the site will not flood as a result of the 1 in 30 year rainfall event, that there will be no flooding of buildings as a result of events up to and including the 1 in 100 year rainfall event, and on-site flow as a result of the 1 in 100 year event with a climate change consideration must be suitably managed. Calculations should include the whole site area, including consideration for the permeable areas and areas. Permeable areas may become saturated during heavy rainfall, therefore consideration and calculations for the whole site area should be provided to ensure that the runoff does not increase the risk of flooding to adjacent sites or the River Crane."*

1.3. The Environment Agency have been contacted with regard to discharge from the Site to the River Crane (Appendix A). They confirm that the quantity of water being discharged is "purely a matter for the LLFA". The quality of water being discharged is subject to EA permitting but "it's not a

requirement to have the permit in place before planning permission is granted". This response confirms that the previously raised objection is not a matter for the EA and should be removed.

1.4. The whole site area (1.130 ha) has been used in calculating the Greenfield Runoff Rates for the Site. Permeable areas have been assumed as 30% impermeable so that the contribution of runoff from permeable areas of the Site can be assessed, resulting in an additional area of 0.046 ha to be considered within the drainage design. A total contributing area of 1.024 ha has been used within Source Control, based on the combination of the impermeable area (0.954 ha) and the permeable contribution (0.053 ha).

1.5. The proposed drainage strategy follows a flow matching approach, limiting flows from the Site to the River Crane to greenfield runoff rates for the 1 in 1, 30, 100 and 100 + climate change events. A summary of the surface water runoff from the Site is provided in Table 1 and detailed drainage calculations (including maximum infiltration and pump rates) are provided in Appendix B.

Table 1 - Summary of surface water runoff from the Site

Event	Existing to combined TW sewer (l/s)	Greenfield (l/s)	Proposed pumped to River Crane(l/s)
1 in 1	42.9*	2.3	0*
1 in 30	106.2	7.3	0
1 in 100	139.7	10.3	4.1
1 in 100 + 40%	195.6	-	10.3

**Assumed based on the 1 in 2 year event as Source Control does not allow simulation of the 1 in 1 year event.*

A. EA Correspondence

From: Goodby, George <George.Goodby@environment-agency.gov.uk>
Sent: 01 February 2023 14:33
To: Faherty, Thomas
Cc: Sean Whelan
Subject: Greggs Bakery Applications- LLFA comments - 22/2556/FUL & 22/2557/FUL
Attachments: SL122209-02 (GG) Former Greggs Bakery - Residential .pdf

Hi Thomas,

Hope you're well.

Just to bring to your attention, we've had a query in from the applicant's consultants for the Greggs Bakery sites about the below objection from the LLFA:

"The LLFA cannot approve discharge to the River Crane until explicit permission has been obtained from the Environment Agency."

To confirm – we don't wish to add any further comments to our most recent formal response. The discharge ***quantity*** aspect is purely a matter for the LLFA as the statutory consultee for surface water.

If the LLFA are referring to the ***quality*** of water being discharged then this is something covered by our permitting regime, we would direct the applicant to https://www.gov.uk/guidance/discharges-to-surface-water-and-groundwater-environmental-permits (note that 'surface water' in this instance refers to any water above grounds, which includes rivers). However, much like Flood Risk Activity Permits (FRAPs), it's not a requirement to have the permit in place before planning permission is granted.

I don't have the contact details for your LLFA, I'm afraid, but feel free to forward this on as appropriate.

Best regards,

George Goodby
Planning Advisor –Kent and South London Sustainable Places
Environment Agency | 2 Marsham Street, Seacole Building, London, SW1P 4DF
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Pronouns: he/him (why is this here?)

Does Your Proposal Have Environmental Issues or Opportunities? Speak To Us Early!
If you're planning a new development, we want to work with you to make the process as smooth as possible. We offer a bespoke advice service where you will be assigned a project manager who will be a single point of contact for you at the EA, giving you detailed specialist advice. This early engagement can significantly reduce uncertainty and delays to your project. More information can be found on our website here

B. Detailed Surface Water Calculations

Summary of Results for 100 year Return Period

Half Drain Time : 814 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.166	0.166	3.5	0.0	3.5	201.4	O K
30 min Summer	9.214	0.214	3.5	0.0	3.5	259.6	O K
60 min Summer	9.261	0.261	3.5	0.0	3.5	316.8	O K
120 min Summer	9.324	0.324	3.5	0.0	3.5	393.1	O K
180 min Summer	9.358	0.358	3.5	0.0	3.5	434.5	O K
240 min Summer	9.378	0.378	3.5	0.0	3.5	459.5	O K
360 min Summer	9.398	0.398	3.5	0.0	3.5	483.8	O K
480 min Summer	9.404	0.404	3.5	0.4	3.9	490.8	O K
600 min Summer	9.403	0.403	3.5	0.3	3.8	489.7	O K
720 min Summer	9.399	0.399	3.5	0.0	3.5	484.3	O K
960 min Summer	9.383	0.383	3.5	0.0	3.5	464.8	O K
1440 min Summer	9.349	0.349	3.5	0.0	3.5	424.3	O K
2160 min Summer	9.309	0.309	3.5	0.0	3.5	376.0	O K
2880 min Summer	9.277	0.277	3.5	0.0	3.5	337.1	O K
4320 min Summer	9.228	0.228	3.5	0.0	3.5	276.5	O K
5760 min Summer	9.189	0.189	3.5	0.0	3.5	229.3	O K
7200 min Summer	9.158	0.158	3.5	0.0	3.5	191.8	O K
8640 min Summer	9.133	0.133	3.5	0.0	3.5	161.5	O K
10080 min Summer	9.113	0.113	3.5	0.0	3.5	137.0	O K
15 min Winter	9.186	0.186	3.5	0.0	3.5	225.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	111.350	0.0	199.7	19
30 min Summer	72.194	0.0	252.6	34
60 min Summer	44.597	0.0	326.5	64
120 min Summer	28.219	0.0	412.9	124
180 min Summer	21.183	0.0	463.7	182
240 min Summer	17.105	0.0	497.3	242
360 min Summer	12.442	0.0	537.2	362
480 min Summer	9.820	0.0	558.7	482
600 min Summer	8.130	0.0	570.2	602
720 min Summer	6.948	0.0	575.2	720
960 min Summer	5.395	0.0	572.6	960
1440 min Summer	3.756	0.0	551.0	1152
2160 min Summer	2.608	0.0	688.0	1512
2880 min Summer	2.017	0.0	709.5	1904
4320 min Summer	1.418	0.0	748.1	2720
5760 min Summer	1.113	0.0	783.3	3464
7200 min Summer	0.931	0.0	818.5	4248
8640 min Summer	0.809	0.0	853.6	4936
10080 min Summer	0.722	0.0	888.8	5648
15 min Winter	111.350	0.0	222.0	19

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.240	0.240	3.5	0.0	3.5	291.3	O K
60 min Winter	9.293	0.293	3.5	0.0	3.5	355.9	O K
120 min Winter	9.364	0.364	3.5	0.0	3.5	442.7	O K
180 min Winter	9.404	0.404	3.5	0.4	3.9	490.3	O K
240 min Winter	9.424	0.424	3.5	2.5	6.0	515.6	O K
360 min Winter	9.439	0.439	3.5	4.0	7.5	533.4	O K
480 min Winter	9.440	0.440	3.5	4.1	7.7	534.7	O K
600 min Winter	9.437	0.437	3.5	3.8	7.3	530.5	O K
720 min Winter	9.432	0.432	3.5	3.3	6.8	524.4	O K
960 min Winter	9.422	0.422	3.5	2.3	5.8	513.0	O K
1440 min Winter	9.404	0.404	3.5	0.4	3.9	490.5	O K
2160 min Winter	9.356	0.356	3.5	0.0	3.5	432.9	O K
2880 min Winter	9.313	0.313	3.5	0.0	3.5	380.2	O K
4320 min Winter	9.241	0.241	3.5	0.0	3.5	292.5	O K
5760 min Winter	9.183	0.183	3.5	0.0	3.5	222.0	O K
7200 min Winter	9.137	0.137	3.5	0.0	3.5	166.3	O K
8640 min Winter	9.101	0.101	3.5	0.0	3.5	122.6	O K
10080 min Winter	9.074	0.074	3.5	0.0	3.5	90.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	72.194	0.0	276.0	33
60 min Winter	44.597	0.0	365.8	62
120 min Winter	28.219	0.0	461.3	122
180 min Winter	21.183	0.0	515.9	180
240 min Winter	17.105	0.0	551.9	238
360 min Winter	12.442	0.0	595.6	350
480 min Winter	9.820	0.0	618.7	458
600 min Winter	8.130	0.0	629.6	562
720 min Winter	6.948	0.0	630.7	662
960 min Winter	5.395	0.0	614.1	776
1440 min Winter	3.756	0.0	563.3	1184
2160 min Winter	2.608	0.0	770.6	1644
2880 min Winter	2.017	0.0	794.7	2080
4320 min Winter	1.418	0.0	837.1	2940
5760 min Winter	1.113	0.0	877.4	3744
7200 min Winter	0.931	0.0	916.9	4464
8640 min Winter	0.809	0.0	956.1	5104
10080 min Winter	0.722	0.0	995.6	5744

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 515318 173345 TQ 15318 73345
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.978

Time (mins) From:	To:	Area (ha)
0	4	0.978

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01600 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	4050.0	1580.0	0.600	4050.0	1580.0

Pump Outflow Control

Invert Level (m) 9.000

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	10.3000	1.700	10.3000	2.500	10.3000
0.200	0.0000	1.000	10.3000	1.800	10.3000	2.600	10.3000
0.300	0.0000	1.100	10.3000	1.900	10.3000	2.700	10.3000
0.400	0.0000	1.200	10.3000	2.000	10.3000	2.800	10.3000
0.500	10.3000	1.300	10.3000	2.100	10.3000	2.900	10.3000
0.600	10.3000	1.400	10.3000	2.200	10.3000	3.000	10.3000
0.700	10.3000	1.500	10.3000	2.300	10.3000		
0.800	10.3000	1.600	10.3000	2.400	10.3000		

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

Half Drain Time : 696 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.233	0.233	3.5	0.0	3.5	283.0	O K
30 min Summer	9.301	0.301	3.5	0.0	3.5	365.2	O K
60 min Summer	9.368	0.368	3.5	0.0	3.5	447.1	O K
120 min Summer	9.453	0.453	3.5	5.4	8.9	549.9	O K
180 min Summer	9.487	0.487	3.5	9.0	12.5	591.9	O K
240 min Summer	9.501	0.501	3.5	10.3	13.8	608.8	O K
360 min Summer	9.507	0.507	3.5	10.3	13.8	616.1	O K
480 min Summer	9.506	0.506	3.5	10.3	13.8	615.3	O K
600 min Summer	9.503	0.503	3.5	10.3	13.8	611.0	O K
720 min Summer	9.498	0.498	3.5	10.1	13.6	605.6	O K
960 min Summer	9.488	0.488	3.5	9.1	12.6	593.0	O K
1440 min Summer	9.468	0.468	3.5	7.0	10.5	568.2	O K
2160 min Summer	9.443	0.443	3.5	4.4	7.9	538.1	O K
2880 min Summer	9.425	0.425	3.5	2.5	6.1	515.8	O K
4320 min Summer	9.390	0.390	3.5	0.0	3.5	473.4	O K
5760 min Summer	9.343	0.343	3.5	0.0	3.5	417.1	O K
7200 min Summer	9.306	0.306	3.5	0.0	3.5	371.6	O K
8640 min Summer	9.274	0.274	3.5	0.0	3.5	333.1	O K
10080 min Summer	9.247	0.247	3.5	0.0	3.5	300.1	O K
15 min Winter	9.261	0.261	3.5	0.0	3.5	317.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	155.890	0.0	268.8	19
30 min Summer	101.072	0.0	301.8	34
60 min Summer	62.436	0.0	456.0	64
120 min Summer	39.506	0.0	570.7	122
180 min Summer	29.656	0.0	638.9	182
240 min Summer	23.946	0.0	684.5	240
360 min Summer	17.419	0.0	738.8	314
480 min Summer	13.748	0.0	767.2	374
600 min Summer	11.382	0.0	780.1	434
720 min Summer	9.727	0.0	782.1	500
960 min Summer	7.552	0.0	772.8	644
1440 min Summer	5.259	0.0	730.4	936
2160 min Summer	3.651	0.0	963.4	1384
2880 min Summer	2.824	0.0	992.8	1844
4320 min Summer	1.985	0.0	1013.0	2852
5760 min Summer	1.559	0.0	1096.8	3640
7200 min Summer	1.303	0.0	1146.2	4464
8640 min Summer	1.132	0.0	1195.3	5192
10080 min Summer	1.010	0.0	1244.6	5960
15 min Winter	155.890	0.0	290.2	19

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.337	0.337	3.5	0.0	3.5	409.6	O K
60 min Winter	9.413	0.413	3.5	1.3	4.8	501.4	O K
120 min Winter	9.501	0.501	3.5	10.3	13.8	608.3	O K
180 min Winter	9.542	0.542	3.5	10.3	13.8	659.0	O K
240 min Winter	9.565	0.565	3.5	10.3	13.8	686.8	O K
360 min Winter	9.580	0.580	3.5	10.3	13.8	704.4	O K
480 min Winter	9.575	0.575	3.5	10.3	13.8	698.5	O K
600 min Winter	9.569	0.569	3.5	10.3	13.8	691.1	O K
720 min Winter	9.560	0.560	3.5	10.3	13.8	680.7	O K
960 min Winter	9.539	0.539	3.5	10.3	13.8	655.2	O K
1440 min Winter	9.501	0.501	3.5	10.3	13.8	609.0	O K
2160 min Winter	9.470	0.470	3.5	7.2	10.7	570.6	O K
2880 min Winter	9.448	0.448	3.5	4.9	8.4	543.9	O K
4320 min Winter	9.417	0.417	3.5	1.8	5.3	507.2	O K
5760 min Winter	9.372	0.372	3.5	0.0	3.5	452.2	O K
7200 min Winter	9.315	0.315	3.5	0.0	3.5	382.6	O K
8640 min Winter	9.266	0.266	3.5	0.0	3.5	322.9	O K
10080 min Winter	9.223	0.223	3.5	0.0	3.5	271.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	101.072	0.0	301.9	34
60 min Winter	62.436	0.0	508.2	64
120 min Winter	39.506	0.0	637.2	120
180 min Winter	29.656	0.0	712.9	178
240 min Winter	23.946	0.0	762.1	234
360 min Winter	17.419	0.0	818.8	344
480 min Winter	13.748	0.0	846.2	434
600 min Winter	11.382	0.0	858.8	468
720 min Winter	9.727	0.0	865.4	542
960 min Winter	7.552	0.0	866.8	692
1440 min Winter	5.259	0.0	835.7	968
2160 min Winter	3.651	0.0	1079.0	1424
2880 min Winter	2.824	0.0	1111.6	1876
4320 min Winter	1.985	0.0	1095.5	2896
5760 min Winter	1.559	0.0	1228.5	3976
7200 min Winter	1.303	0.0	1283.8	4824
8640 min Winter	1.132	0.0	1339.4	5616
10080 min Winter	1.010	0.0	1394.0	6352

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 515318 173345 TQ 15318 73345
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.978

Time (mins) From:	To:	Area (ha)
0	4	0.978

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01600 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	4050.0	1580.0	0.600	4050.0	1580.0

Pump Outflow Control

Invert Level (m) 9.000

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	10.3000	1.700	10.3000	2.500	10.3000
0.200	0.0000	1.000	10.3000	1.800	10.3000	2.600	10.3000
0.300	0.0000	1.100	10.3000	1.900	10.3000	2.700	10.3000
0.400	0.0000	1.200	10.3000	2.000	10.3000	2.800	10.3000
0.500	10.3000	1.300	10.3000	2.100	10.3000	2.900	10.3000
0.600	10.3000	1.400	10.3000	2.200	10.3000	3.000	10.3000
0.700	10.3000	1.500	10.3000	2.300	10.3000		
0.800	10.3000	1.600	10.3000	2.400	10.3000		

Summary of Results for 2 year Return Period

Half Drain Time : 451 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.052	0.052	3.5	0.0	3.5	63.0	O K
30 min Summer	9.065	0.065	3.5	0.0	3.5	78.4	O K
60 min Summer	9.076	0.076	3.5	0.0	3.5	92.9	O K
120 min Summer	9.107	0.107	3.5	0.0	3.5	129.5	O K
180 min Summer	9.121	0.121	3.5	0.0	3.5	147.0	O K
240 min Summer	9.128	0.128	3.5	0.0	3.5	156.0	O K
360 min Summer	9.133	0.133	3.5	0.0	3.5	161.5	O K
480 min Summer	9.133	0.133	3.5	0.0	3.5	161.2	O K
600 min Summer	9.131	0.131	3.5	0.0	3.5	159.0	O K
720 min Summer	9.128	0.128	3.5	0.0	3.5	156.0	O K
960 min Summer	9.122	0.122	3.5	0.0	3.5	148.6	O K
1440 min Summer	9.109	0.109	3.5	0.0	3.5	133.0	O K
2160 min Summer	9.093	0.093	3.5	0.0	3.5	112.8	O K
2880 min Summer	9.080	0.080	3.5	0.0	3.5	96.7	O K
4320 min Summer	9.061	0.061	3.5	0.0	3.5	74.6	O K
5760 min Summer	9.051	0.051	3.5	0.0	3.5	61.9	O K
7200 min Summer	9.046	0.046	3.2	0.0	3.2	56.0	O K
8640 min Summer	9.043	0.043	3.0	0.0	3.0	52.0	O K
10080 min Summer	9.040	0.040	2.8	0.0	2.8	48.9	O K
15 min Winter	9.058	0.058	3.5	0.0	3.5	70.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	35.477	0.0	64.5	18
30 min Summer	22.462	0.0	81.8	33
60 min Summer	13.751	0.0	100.3	62
120 min Summer	9.973	0.0	145.7	122
180 min Summer	7.853	0.0	172.2	182
240 min Summer	6.504	0.0	190.2	240
360 min Summer	4.863	0.0	213.4	338
480 min Summer	3.900	0.0	228.3	392
600 min Summer	3.269	0.0	239.1	452
720 min Summer	2.821	0.0	247.7	516
960 min Summer	2.228	0.0	260.8	652
1440 min Summer	1.593	0.0	279.8	922
2160 min Summer	1.146	0.0	302.1	1316
2880 min Summer	0.915	0.0	321.5	1676
4320 min Summer	0.679	0.0	357.8	2380
5760 min Summer	0.557	0.0	391.7	3056
7200 min Summer	0.483	0.0	424.9	3752
8640 min Summer	0.434	0.0	457.5	4496
10080 min Summer	0.398	0.0	489.9	5240
15 min Winter	35.477	0.0	72.3	18

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.073	0.073	3.5	0.0	3.5	88.2	O K
60 min Winter	9.086	0.086	3.5	0.0	3.5	104.8	O K
120 min Winter	9.121	0.121	3.5	0.0	3.5	146.6	O K
180 min Winter	9.138	0.138	3.5	0.0	3.5	167.2	O K
240 min Winter	9.147	0.147	3.5	0.0	3.5	178.2	O K
360 min Winter	9.153	0.153	3.5	0.0	3.5	186.1	O K
480 min Winter	9.152	0.152	3.5	0.0	3.5	185.2	O K
600 min Winter	9.149	0.149	3.5	0.0	3.5	181.3	O K
720 min Winter	9.146	0.146	3.5	0.0	3.5	177.1	O K
960 min Winter	9.137	0.137	3.5	0.0	3.5	166.6	O K
1440 min Winter	9.118	0.118	3.5	0.0	3.5	143.8	O K
2160 min Winter	9.093	0.093	3.5	0.0	3.5	113.3	O K
2880 min Winter	9.073	0.073	3.5	0.0	3.5	89.1	O K
4320 min Winter	9.050	0.050	3.5	0.0	3.5	60.8	O K
5760 min Winter	9.043	0.043	3.0	0.0	3.0	51.7	O K
7200 min Winter	9.038	0.038	2.7	0.0	2.7	45.8	O K
8640 min Winter	9.034	0.034	2.4	0.0	2.4	41.6	O K
10080 min Winter	9.032	0.032	2.2	0.0	2.2	38.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	22.462	0.0	91.5	33
60 min Winter	13.751	0.0	112.4	62
120 min Winter	9.973	0.0	163.2	120
180 min Winter	7.853	0.0	192.9	178
240 min Winter	6.504	0.0	213.1	234
360 min Winter	4.863	0.0	239.1	346
480 min Winter	3.900	0.0	255.7	450
600 min Winter	3.269	0.0	267.9	486
720 min Winter	2.821	0.0	277.5	558
960 min Winter	2.228	0.0	292.2	710
1440 min Winter	1.593	0.0	313.3	998
2160 min Winter	1.146	0.0	338.4	1404
2880 min Winter	0.915	0.0	360.1	1764
4320 min Winter	0.679	0.0	400.8	2380
5760 min Winter	0.557	0.0	438.8	3112
7200 min Winter	0.483	0.0	476.0	3824
8640 min Winter	0.434	0.0	512.5	4576
10080 min Winter	0.398	0.0	548.7	5248

Rainfall Details

Rainfall Model	FEH
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 515318 173345 TQ 15318 73345
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.978

Time (mins) From:	To:	Area (ha)
0	4	0.978

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01600 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	4050.0	1580.0	0.600	4050.0	1580.0

Pump Outflow Control

Invert Level (m) 9.000

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	10.3000	1.700	10.3000	2.500	10.3000
0.200	0.0000	1.000	10.3000	1.800	10.3000	2.600	10.3000
0.300	0.0000	1.100	10.3000	1.900	10.3000	2.700	10.3000
0.400	0.0000	1.200	10.3000	2.000	10.3000	2.800	10.3000
0.500	10.3000	1.300	10.3000	2.100	10.3000	2.900	10.3000
0.600	10.3000	1.400	10.3000	2.200	10.3000	3.000	10.3000
0.700	10.3000	1.500	10.3000	2.300	10.3000		
0.800	10.3000	1.600	10.3000	2.400	10.3000		

Summary of Results for 30 year Return Period

Half Drain Time : 976 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.127	0.127	3.5	0.0	3.5	154.7	O K
30 min Summer	9.163	0.163	3.5	0.0	3.5	197.5	O K
60 min Summer	9.197	0.197	3.5	0.0	3.5	238.9	O K
120 min Summer	9.245	0.245	3.5	0.0	3.5	297.5	O K
180 min Summer	9.269	0.269	3.5	0.0	3.5	327.0	O K
240 min Summer	9.283	0.283	3.5	0.0	3.5	343.4	O K
360 min Summer	9.294	0.294	3.5	0.0	3.5	356.7	O K
480 min Summer	9.294	0.294	3.5	0.0	3.5	357.5	O K
600 min Summer	9.290	0.290	3.5	0.0	3.5	352.6	O K
720 min Summer	9.284	0.284	3.5	0.0	3.5	344.6	O K
960 min Summer	9.270	0.270	3.5	0.0	3.5	327.5	O K
1440 min Summer	9.246	0.246	3.5	0.0	3.5	299.0	O K
2160 min Summer	9.217	0.217	3.5	0.0	3.5	263.8	O K
2880 min Summer	9.193	0.193	3.5	0.0	3.5	234.8	O K
4320 min Summer	9.156	0.156	3.5	0.0	3.5	189.9	O K
5760 min Summer	9.128	0.128	3.5	0.0	3.5	155.5	O K
7200 min Summer	9.106	0.106	3.5	0.0	3.5	129.0	O K
8640 min Summer	9.089	0.089	3.5	0.0	3.5	108.3	O K
10080 min Summer	9.076	0.076	3.5	0.0	3.5	92.4	O K
15 min Winter	9.143	0.143	3.5	0.0	3.5	173.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	85.786	0.0	155.2	19
30 min Summer	55.190	0.0	198.0	34
60 min Summer	33.902	0.0	248.1	64
120 min Summer	21.638	0.0	316.8	124
180 min Summer	16.227	0.0	356.5	182
240 min Summer	13.077	0.0	383.0	242
360 min Summer	9.483	0.0	416.1	362
480 min Summer	7.471	0.0	436.4	482
600 min Summer	6.183	0.0	450.8	600
720 min Summer	5.285	0.0	461.6	714
960 min Summer	4.112	0.0	476.7	806
1440 min Summer	2.884	0.0	494.1	1038
2160 min Summer	2.028	0.0	535.0	1432
2880 min Summer	1.587	0.0	558.3	1844
4320 min Summer	1.140	0.0	601.5	2632
5760 min Summer	0.912	0.0	641.5	3352
7200 min Summer	0.774	0.0	680.3	4104
8640 min Summer	0.681	0.0	718.4	4760
10080 min Summer	0.614	0.0	756.1	5448
15 min Winter	85.786	0.0	173.4	19

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.182	0.182	3.5	0.0	3.5	221.7	O K
60 min Winter	9.221	0.221	3.5	0.0	3.5	268.5	O K
120 min Winter	9.276	0.276	3.5	0.0	3.5	335.4	O K
180 min Winter	9.304	0.304	3.5	0.0	3.5	369.6	O K
240 min Winter	9.320	0.320	3.5	0.0	3.5	389.0	O K
360 min Winter	9.334	0.334	3.5	0.0	3.5	406.3	O K
480 min Winter	9.337	0.337	3.5	0.0	3.5	409.6	O K
600 min Winter	9.335	0.335	3.5	0.0	3.5	406.6	O K
720 min Winter	9.329	0.329	3.5	0.0	3.5	400.0	O K
960 min Winter	9.314	0.314	3.5	0.0	3.5	381.2	O K
1440 min Winter	9.283	0.283	3.5	0.0	3.5	343.9	O K
2160 min Winter	9.244	0.244	3.5	0.0	3.5	296.6	O K
2880 min Winter	9.210	0.210	3.5	0.0	3.5	254.7	O K
4320 min Winter	9.154	0.154	3.5	0.0	3.5	187.0	O K
5760 min Winter	9.111	0.111	3.5	0.0	3.5	135.0	O K
7200 min Winter	9.080	0.080	3.5	0.0	3.5	96.8	O K
8640 min Winter	9.058	0.058	3.5	0.0	3.5	71.0	O K
10080 min Winter	9.049	0.049	3.4	0.0	3.4	59.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	55.190	0.0	220.2	33
60 min Winter	33.902	0.0	277.9	62
120 min Winter	21.638	0.0	354.9	122
180 min Winter	16.227	0.0	399.0	180
240 min Winter	13.077	0.0	428.3	238
360 min Winter	9.483	0.0	464.6	356
480 min Winter	7.471	0.0	486.5	470
600 min Winter	6.183	0.0	501.5	584
720 min Winter	5.285	0.0	512.4	694
960 min Winter	4.112	0.0	526.4	904
1440 min Winter	2.884	0.0	536.4	1122
2160 min Winter	2.028	0.0	599.2	1560
2880 min Winter	1.587	0.0	625.4	1992
4320 min Winter	1.140	0.0	673.8	2808
5760 min Winter	0.912	0.0	718.6	3528
7200 min Winter	0.774	0.0	762.1	4184
8640 min Winter	0.681	0.0	804.7	4760
10080 min Winter	0.614	0.0	846.9	5336

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 515318 173345 TQ 15318 73345
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.978

Time (mins) From:	To:	Area (ha)
0	4	0.978

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01600 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	4050.0	1580.0	0.600	4050.0	1580.0

Pump Outflow Control

Invert Level (m) 9.000

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	10.3000	1.700	10.3000	2.500	10.3000
0.200	0.0000	1.000	10.3000	1.800	10.3000	2.600	10.3000
0.300	0.0000	1.100	10.3000	1.900	10.3000	2.700	10.3000
0.400	0.0000	1.200	10.3000	2.000	10.3000	2.800	10.3000
0.500	10.3000	1.300	10.3000	2.100	10.3000	2.900	10.3000
0.600	10.3000	1.400	10.3000	2.200	10.3000	3.000	10.3000
0.700	10.3000	1.500	10.3000	2.300	10.3000		
0.800	10.3000	1.600	10.3000	2.400	10.3000		

CALCULATIONS

Company:	WIE	Office:	London
Sheet No:	1 of 3	Project No:	WIE12357
By	S Whelan	Date	30.01.23
Checked:	B McCarthy	Date	30.01.23

Project Title: **Greggs Bakery, Twickenham - Scheme 2**

Calculations Title: **Surface Water Management - Summary Sheet**

LOCATION	CALCULATIONS						OPTIONS
	Surface water at the Site will be managed in accordance with the London Plan requirements, i.e. surface water discharge restricted to a maximum rate of 50% of the existing rate, including for the impacts of climate change.						
	Existing surface water discharge regime (M100_60):						
		Area (ha)	Calculation method	Discharge Rate			
	Site Area	1.130	Wallingford (Page 2)	139.7	l/s		
	(calculated with PIMP of 100 %)						
	Existing Site Characteristics						
	Existing soft landscaping			=	0.000	ha	
	Area positively drained			=	1.130	ha	
	Proposed Site Characteristics						
	Proposed soft landscaping (assume as 30% impermable)			=	0.152	ha	
	Area positively drained			=	0.978	ha	
	Area for use in Micro Drainage (impermeable area + 0.3 x permeable are			=	1.024	ha	
	Proposed surface water discharge regime:						
	Discharge rate for Greenfield Q100 rate	9.08	l/s/ha x 1.130 ha	=	10.3	l/s	
	Intial attenuation estimate						
	Total attenuation required on-site for 10.3 l/s restriction			=	705	m^3	
	SuDS Details						
	Area			=	4500	m^2	
	Area for attenuation (allowing for 10% loss for utilities trenches)			=	4050	m^2	
	Depth			=	0.7	m	
	Voids			=	0.3	m	
	Volume			=	851	m^3	
	Area for infiltration (allowing for 5m offset from structures)			=	1580	m^2	
	Infiltration rate			=	4.47E-06	m/s	
	Infiltration rate			=	7.1	l/s	
	Infiltration rate			=	0.016	m/hr	
	Overpumping to the River Crane at the Site's greenfield rate			=	10.3	l/s	

CALCULATIONS

Company:	WIE	Office:	London
Sheet No:	2 of 3	Project No:	WIE12357
By	S Whelan	Date	30.01.23
Checked:	B McCarthy	Date	30.01.23

Project Title: **Greggs Bakery, Twickenham - Scheme 2**

Calculations Title: **Surface Water Management (M100_60)**

LOCATION	CALCULATIONS				OPTIONS
	Calculations based on: Design and Analysis of urban storm drainage. The Wallingford Procedure, Volume 1 Principles methods and practice.				
	User Input Data				
	Total site area		1.130	ha	
	SAAR (From FEH)		627		
	Rainfall Intensity (From FEH)		46.4		
	PIMP (% impervious)		100	%	
	Soil Type		0.40		
	Very Low Runoff (well drained sandy, loamy or earthy peat soils)		0.15		
	Low Runoff (Very permeable soils (e.g. gravel, sand)		0.30		
	Moderate (Very fine sands, silts and sedimentary clays)		0.40		
	High Runoff (Clayey or loamy soils)		0.45		
	Very High Runoff (Soils of the wet uplands)		0.50		
Fig. 9.7	UCWI (From Figure 9.7 of Wallingford Method)		58		
Eqn. 13	Qp (peak discharge) = 2.78 Cv CR i A				
	Where: Qp (Peak Discharge)	i = rainfall intensity	A = Total Area		
From FEH	Average rainfall Intensity (i)				
	44.6	mm			
Eqn 7.20	Cv = PR/100				
Eqn 7.3	PR = (0.829 PIMP) + (25.0 SOIL) + (0.078 UCWI) - 20.7				
	PIMP (Percentage of catchment which is impervious)		100	%	
Page 52	Note: PIMP can not be less than 40%		40	%	
	Thus value of PIMP to be used		100	%	
	Soil: 0.40	UCWI: 57.67			
	PR =		76.70		
	Thus Cv =		0.77		
Sec 7.10	CR (Recommended for simulation and design)		1.3		
	Qp for 1 in 100 year 60 minute duration =	**139.7**	**l/s** or 123.6	l/s/ha	

CALCULATIONS

Company:	WIE	Office:	London
Sheet No:	3 of 3	Project No:	WIE12357
By	S Whelan	Date	30.01.23
Checked:	B McCarthy	Date	30.01.23

Project Title: **Greggs Bakery, Twickenham - Scheme 2**

Calculations Title: **Surface Water Management (IoH124)**

LOCATION	CALCULATIONS	OPTIONS

In order to calculate the rate of surface water discharge from the permeable portion of the Site, the Windes Microdrainage version 2019.1 Source Control module has been utilised. Rural runoff has been calculated using the IoH 124 Methodology. The input and output data for which are shown below;

An area of 50ha has been used in the calculations as this is the lowest catchment area which the IoH 124 method can calculate. The 50ha output is then prorated as set out in IoH 124

Waterman Group	Page 1
Pickfords Wharf Clink Street London, SE1 9DG	
Date 03/03/2022 10:02 File	Designed by csch3 Checked by
Innovyze	Source Control 2020.1.3

IH 124 Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	50.000	Urban	0.000
SAAR (mm)	601	Region Number	Region 6

Results l/s

QBAR Rural	142.3
QBAR Urban	142.3
Q100 years	454.0
Q1 year	121.0
Q2 years	125.4
Q5 years	182.2
Q10 years	230.6
Q20 years	285.1
Q25 years	305.7
Q30 years	322.5
Q50 years	372.9
Q100 years	454.0
Q200 years	533.7
Q250 years	559.3
Q1000 years	734.4

Qbar (1 in 2.333)	142.3	l/s/50ha	2.8	l/s/ha	2.8 l/s
1 in 1	121.0	l/s/50ha	2.4	l/s/ha	2.4 l/s
1 in 30	322.5	l/s/50ha	6.5	l/s/ha	7.3 l/s
1 in 100	454.0	l/s/50ha	9.1	l/s/ha	10.3 l/s