Former Xerox Site, Bessemer Road, Welwyn Garden City, Herts

Phase X5

Surface Water / SUDs Design

Application Ref 6/2016/2690/MAJ - Condition 10 Summary Report

Date: Feb 2018

1.0 Introduction

1.1 Infrastructure Design Ltd (IDL) remain appointed by Chase New Homes Ltd to prepare a surface water / SuDS design for their proposed residential development at the Former Xerox site, Bessemer Road, Welwyn Garden City, Herts, in support of clearing Condition 10 of consent ref: 6/2016/2690/MAJ.

1.2 The design is based upon the approved strategy, in report IDL/752/X5/100 (dated March 2017)

2.0 Surface Water Drainage / SuDS

2.1 The surface water drainage design has been devised, based on the current Masterplan site layout prepared by Chase New Homes Ltd, ref: 16 002-420 and in keeping with the guidance contained with the National Planning Policy Framework and SuDS Manual.

2.2 The design has been prepared so as to prevent on and offsite flooding for any storm event, up to and including a 1 in 100 year event, plus an allowance for the potential effects of climate change (+ 40%). Similarly, by extension, the site will not flood for any events up to and including the peak 1 in 30 year event.

2.3 The site lies wholly within a Source Protection Zone 3 (Total Catchment), with the bedrock geology classified as a Principle Aquifer (Superficial deposits classified as a Secondary Aquifer).

2.4 Borehole discharge rates are calculated to be 0.3.l/sec when operating under 50% to 100% head. Increasing to 0.5 l/sec when the bore is operating in full head conditions. The calculations in Appendix B are based on the lower of these figures.

2.5 The existing retained former office buildings, currently being developed internally to provide residential apartments, will continue to benefit from their existing drainage outfalls, as too will their associated parking areas.

2.6 Previously approved Phase X1 and X4 drainage designs adopt a similar approach to that which is proposed for this phase (X5). Note: that each Phase contained stand-alone SuDS features and SW outfalls. Therefore, each phase can function independent of any other.

2.7 Drainage from all new roads and parking areas will discharge via lined permeable paving, incorporating a subbase drain which together will serve to reduce and delay runoff from these areas. This will provide a valuable means of water quality enhancement prior to final discharge.

2.8 The roof areas will collect separately and be conveyed in part via new grass swales. These in turn will discharge into the borehole soakaway. Swales serve to reduce and delay runoff and can provide an amenity value to the site.

2.9 The surface water drainage design has been designed to accommodate all generated volumes of surface water up to and including the peak 1 in 100 year plus climate change (40%) storm event.

2.10 Discharge of these areas to ground will help to relieve the burden on the existing mains surface water sewers.

2.11 Attenuation Requirements (for 1 in 100 year + 40% peak storm event);

Borehole Ref (on layout)	Max Vol	In Swales (0.3m depth)	In P. Paving (voids in subbase)	In BH Chamber	In Crates
BH4	69.0m3	20.2m3	20.7m3	4.1m3	42.9m3

3.0 Enclosures

3.1 Appendix A defines the SuDS Hierarchy, and has been duly completed to show which of these measures has been incorporated and the constraints which preclude the use of others.

3.2 Appendix B provides both pre-development greenfield runoff rates and calculations to determine the subbase depth required for the permeable paving, along with calculations for the proposed attenuation.

3.3 Appendix C includes a copy of the Drainage Layout

3.4 Appendix D includes the CGL soakage test results.

Appendix A - The SUDS Hierarchy

Most Sustainable	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit	Included in the scheme?	Comments
	Living roofs	√	√	√		The new apartment blocks will be in keeping with the adjacent signature blocks and therefore on this occasion green roofs are not deemed suitable.
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	√	√	√		Given the desires of the LPA and viability of the site, density on this development is such that insufficient communal space is available for this larger form of above-ground SuDS feature.
	Filter strips and swales	√	√	√	√	Swales will feature to all new parcels of land, taking runoff from roof areas. Their use will capture the first 5mm of runoff most associated with carrying potential pollutants.
	Infiltration devices -soakaways - infiltration trenches and basins	√	√	√	√	All surface water runoff from the site, other than the first 5mm (first flush) will discharge via borehole soakaways.
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks porous paviours	√	√		√	Permeable paving is proposed to be used extensively across the site in forming new paved areas. This will assist in pollution reduction and the 'delay' of runoff. It will also capture the first 5mm of runoff most associated with carrying potential pollutants.
Least Sustainable	**Tanked systems** - over-sized pipes/tanks - storms/cells	√				Not required.

Appendix B – Surface Water Attenuation Calculations

Greenfield Runoff Rates

&

Permeable Paving, Swale and Soakaway Calculations

Cascade Summary of Results for X5 Swale 1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	X5 BH and Cellular.srcx	(None)

Half Drain Time : 3 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	85.759	0.189	0.0	7.1	7.1	1.6	O K
30 min Summer	85.750	0.180	0.0	6.8	6.8	1.4	O K
60 min Summer	85.719	0.149	0.0	5.9	5.9	1.0	O K
120 min Summer	85.683	0.113	0.0	4.5	4.5	0.6	O K
180 min Summer	85.666	0.096	0.0	3.5	3.5	0.4	O K
240 min Summer	85.655	0.085	0.0	2.9	2.9	0.3	O K
360 min Summer	85.639	0.069	0.0	2.1	2.1	0.2	O K
480 min Summer	85.630	0.060	0.0	1.7	1.7	0.1	O K
600 min Summer	85.625	0.055	0.0	1.4	1.4	0.1	O K
720 min Summer	85.621	0.051	0.0	1.2	1.2	0.1	O K
960 min Summer	85.617	0.047	0.0	1.0	1.0	0.1	O K
1440 min Summer	85.609	0.039	0.0	0.7	0.7	0.1	O K
2160 min Summer	85.603	0.033	0.0	0.5	0.5	0.0	O K
2880 min Summer	85.600	0.030	0.0	0.4	0.4	0.0	O K
4320 min Summer	85.595	0.025	0.0	0.3	0.3	0.0	O K
5760 min Summer	85.592	0.022	0.0	0.2	0.2	0.0	O K
7200 min Summer	85.590	0.020	0.0	0.2	0.2	0.0	O K
8640 min Summer	85.589	0.019	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.153	0.0	4.7	12
30 min Summer	90.705	0.0	6.1	20
60 min Summer	56.713	0.0	7.7	34
120 min Summer	34.246	0.0	9.2	64
180 min Summer	25.149	0.0	10.2	94
240 min Summer	20.078	0.0	10.8	124
360 min Summer	14.585	0.0	11.8	184
480 min Summer	11.622	0.0	12.6	244
600 min Summer	9.738	0.0	13.1	300
720 min Summer	8.424	0.0	13.6	366
960 min Summer	6.697	0.0	14.5	488
1440 min Summer	4.839	0.0	15.7	712
2160 min Summer	3.490	0.0	17.0	1076
2880 min Summer	2.766	0.0	17.9	1424
4320 min Summer	1.989	0.0	19.3	2172
5760 min Summer	1.573	0.0	20.4	2912
7200 min Summer	1.311	0.0	21.2	3576
8640 min Summer	1.129	0.0	21.9	4304

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Cascade Summary of Results for X5 Swale 1.srcx

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
10080 min Summer	85.588	0.018	0.0	0.2	0.2	0.0	O K
15 min Winter	85.768	0.198	0.0	7.3	7.3	1.7	O K
30 min Winter	85.747	0.177	0.0	6.7	6.7	1.4	O K
60 min Winter	85.703	0.133	0.0	5.3	5.3	0.8	O K
120 min Winter	85.667	0.097	0.0	3.6	3.6	0.4	O K
180 min Winter	85.651	0.081	0.0	2.6	2.6	0.3	O K
240 min Winter	85.640	0.070	0.0	2.1	2.1	0.2	O K
360 min Winter	85.627	0.057	0.0	1.5	1.5	0.1	O K
480 min Winter	85.621	0.051	0.0	1.2	1.2	0.1	O K
600 min Winter	85.618	0.048	0.0	1.0	1.0	0.1	O K
720 min Winter	85.615	0.045	0.0	0.9	0.9	0.1	O K
960 min Winter	85.609	0.039	0.0	0.7	0.7	0.1	O K
1440 min Winter	85.603	0.033	0.0	0.5	0.5	0.0	O K
2160 min Winter	85.598	0.028	0.0	0.4	0.4	0.0	O K
2880 min Winter	85.595	0.025	0.0	0.3	0.3	0.0	O K
4320 min Winter	85.591	0.021	0.0	0.2	0.2	0.0	O K
5760 min Winter	85.589	0.019	0.0	0.2	0.2	0.0	O K
7200 min Winter	85.587	0.017	0.0	0.1	0.1	0.0	O K
8640 min Winter	85.586	0.016	0.0	0.1	0.1	0.0	O K
10080 min Winter	85.585	0.015	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.994	0.0	22.5	5064
15 min Winter	138.153	0.0	5.2	12
30 min Winter	90.705	0.0	6.9	20
60 min Winter	56.713	0.0	8.6	36
120 min Winter	34.246	0.0	10.4	64
180 min Winter	25.149	0.0	11.4	94
240 min Winter	20.078	0.0	12.1	124
360 min Winter	14.585	0.0	13.2	184
480 min Winter	11.622	0.0	14.1	240
600 min Winter	9.738	0.0	14.7	300
720 min Winter	8.424	0.0	15.3	366
960 min Winter	6.697	0.0	16.2	490
1440 min Winter	4.839	0.0	17.6	740
2160 min Winter	3.490	0.0	19.0	1084
2880 min Winter	2.766	0.0	20.1	1452
4320 min Winter	1.989	0.0	21.7	2156
5760 min Winter	1.573	0.0	22.8	2864
7200 min Winter	1.311	0.0	23.8	3512
8640 min Winter	1.129	0.0	24.6	4184
10080 min Winter	0.994	0.0	25.3	5088

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Cascade Rainfall Details for X5 Swale 1.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.018

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

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Cascade Model Details for X5 Swale 1.srcx

Storage is Online Cover Level (m) 86.070

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	12.2
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	1.5	Slope (1:X)	122.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	85.570	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	120.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	85.570
Roughness k (mm)	0.600		

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Cascade Summary of Results for X5 Swale 2.srcx

Upstream Structures	Outflow To	Overflow To
(None)	X5 BH and Cellular.srcx	(None)

Half Drain Time : 2 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	85.598	0.128	0.0	5.1	5.1	0.8	O K
30 min Summer	85.592	0.122	0.0	4.9	4.9	0.7	O K
60 min Summer	85.574	0.104	0.0	4.0	4.0	0.5	O K
120 min Summer	85.553	0.083	0.0	2.8	2.8	0.3	O K
180 min Summer	85.540	0.070	0.0	2.1	2.1	0.2	O K
240 min Summer	85.531	0.061	0.0	1.8	1.8	0.2	O K
360 min Summer	85.523	0.053	0.0	1.3	1.3	0.1	O K
480 min Summer	85.518	0.048	0.0	1.0	1.0	0.1	O K
600 min Summer	85.514	0.044	0.0	0.9	0.9	0.1	O K
720 min Summer	85.510	0.040	0.0	0.8	0.8	0.1	O K
960 min Summer	85.506	0.036	0.0	0.6	0.6	0.0	O K
1440 min Summer	85.501	0.031	0.0	0.4	0.4	0.0	O K
2160 min Summer	85.496	0.026	0.0	0.3	0.3	0.0	O K
2880 min Summer	85.493	0.023	0.0	0.2	0.2	0.0	O K
4320 min Summer	85.489	0.019	0.0	0.2	0.2	0.0	O K
5760 min Summer	85.487	0.017	0.0	0.1	0.1	0.0	O K
7200 min Summer	85.486	0.016	0.0	0.1	0.1	0.0	O K
8640 min Summer	85.485	0.015	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.153	0.0	2.8	11
30 min Summer	90.705	0.0	3.7	19
60 min Summer	56.713	0.0	4.7	34
120 min Summer	34.246	0.0	5.7	64
180 min Summer	25.149	0.0	6.2	94
240 min Summer	20.078	0.0	6.6	124
360 min Summer	14.585	0.0	7.2	182
480 min Summer	11.622	0.0	7.7	244
600 min Summer	9.738	0.0	8.0	306
720 min Summer	8.424	0.0	8.3	366
960 min Summer	6.697	0.0	8.8	482
1440 min Summer	4.839	0.0	9.6	722
2160 min Summer	3.490	0.0	10.4	1100
2880 min Summer	2.766	0.0	11.0	1428
4320 min Summer	1.989	0.0	11.8	2188
5760 min Summer	1.573	0.0	12.5	2928
7200 min Summer	1.311	0.0	13.0	3600
8640 min Summer	1.129	0.0	13.4	4280

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Cascade Summary of Results for X5 Swale 2.srcx

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
10080 min Summer	85.483	0.013	0.0	0.1	0.1	0.0	O K
15 min Winter	85.602	0.132	0.0	5.3	5.3	0.9	O K
30 min Winter	85.587	0.117	0.0	4.7	4.7	0.7	O K
60 min Winter	85.565	0.095	0.0	3.4	3.4	0.4	O K
120 min Winter	85.541	0.071	0.0	2.2	2.2	0.2	O K
180 min Winter	85.528	0.058	0.0	1.6	1.6	0.1	O K
240 min Winter	85.522	0.052	0.0	1.3	1.3	0.1	O K
360 min Winter	85.516	0.046	0.0	1.0	1.0	0.1	O K
480 min Winter	85.510	0.040	0.0	0.8	0.8	0.1	O K
600 min Winter	85.507	0.037	0.0	0.6	0.6	0.1	O K
720 min Winter	85.504	0.034	0.0	0.6	0.6	0.0	O K
960 min Winter	85.501	0.031	0.0	0.4	0.4	0.0	O K
1440 min Winter	85.496	0.026	0.0	0.3	0.3	0.0	O K
2160 min Winter	85.492	0.022	0.0	0.2	0.2	0.0	O K
2880 min Winter	85.489	0.019	0.0	0.2	0.2	0.0	O K
4320 min Winter	85.487	0.017	0.0	0.1	0.1	0.0	O K
5760 min Winter	85.485	0.015	0.0	0.1	0.1	0.0	O K
7200 min Winter	85.483	0.013	0.0	0.1	0.1	0.0	O K
8640 min Winter	85.482	0.012	0.0	0.1	0.1	0.0	O K
10080 min Winter	85.481	0.011	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.994	0.0	13.8	5104
15 min Winter	138.153	0.0	3.2	12
30 min Winter	90.705	0.0	4.2	19
60 min Winter	56.713	0.0	5.2	34
120 min Winter	34.246	0.0	6.3	64
180 min Winter	25.149	0.0	7.0	94
240 min Winter	20.078	0.0	7.4	124
360 min Winter	14.585	0.0	8.1	182
480 min Winter	11.622	0.0	8.6	244
600 min Winter	9.738	0.0	9.0	306
720 min Winter	8.424	0.0	9.3	358
960 min Winter	6.697	0.0	9.9	478
1440 min Winter	4.839	0.0	10.7	728
2160 min Winter	3.490	0.0	11.6	1124
2880 min Winter	2.766	0.0	12.3	1460
4320 min Winter	1.989	0.0	13.2	2176
5760 min Winter	1.573	0.0	14.0	3000
7200 min Winter	1.311	0.0	14.5	3552
8640 min Winter	1.129	0.0	15.0	4208
10080 min Winter	0.994	0.0	15.4	5024

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Cascade Rainfall Details for X5 Swale 2.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.011

Time (mins) From:	To:	Area (ha)
0	4	0.011

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Cascade Model Details for X5 Swale 2.srcx

Storage is Online Cover Level (m) 85.970

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	13.4
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	1.5	Slope (1:X)	134.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	85.470	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	120.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	85.470
Roughness k (mm)	0.600		

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Cascade Summary of Results for X5 Porous CP.srcx

Upstream Structures	Outflow To	Overflow To
(None)	X5 BH and Cellular.srcx	(None)

Half Drain Time : 10 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	85.634	0.144	0.9	6.8	7.7	6.8	O K
30 min Summer	85.643	0.153	0.9	7.0	7.9	7.3	O K
60 min Summer	85.630	0.140	0.9	6.7	7.6	6.5	O K
120 min Summer	85.598	0.108	0.9	6.1	7.0	4.6	O K
180 min Summer	85.573	0.083	0.9	5.5	6.4	3.0	O K
240 min Summer	85.555	0.065	0.8	5.1	6.0	1.9	O K
360 min Summer	85.533	0.043	0.5	4.5	5.0	0.8	O K
480 min Summer	85.516	0.026	0.2	4.1	4.2	0.3	O K
600 min Summer	85.503	0.013	0.0	3.6	3.7	0.1	O K
720 min Summer	85.492	0.002	0.0	3.3	3.3	0.0	O K
960 min Summer	85.490	0.000	0.0	2.6	2.6	0.0	O K
1440 min Summer	85.490	0.000	0.0	1.9	1.9	0.0	O K
2160 min Summer	85.490	0.000	0.0	1.3	1.3	0.0	O K
2880 min Summer	85.490	0.000	0.0	1.1	1.1	0.0	O K
4320 min Summer	85.490	0.000	0.0	0.8	0.8	0.0	O K
5760 min Summer	85.490	0.000	0.0	0.6	0.6	0.0	O K
7200 min Summer	85.490	0.000	0.0	0.5	0.5	0.0	O K
8640 min Summer	85.490	0.000	0.0	0.4	0.4	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.153	0.0	11.2	14
30 min Summer	90.705	0.0	15.0	22
60 min Summer	56.713	0.0	19.0	40
120 min Summer	34.246	0.0	23.0	72
180 min Summer	25.149	0.0	25.4	102
240 min Summer	20.078	0.0	27.2	130
360 min Summer	14.585	0.0	29.7	188
480 min Summer	11.622	0.0	31.5	248
600 min Summer	9.738	0.0	33.0	306
720 min Summer	8.424	0.0	34.3	364
960 min Summer	6.697	0.0	36.3	0
1440 min Summer	4.839	0.0	39.3	0
2160 min Summer	3.490	0.0	42.3	0
2880 min Summer	2.766	0.0	44.5	0
4320 min Summer	1.989	0.0	47.6	0
5760 min Summer	1.573	0.0	49.7	0
7200 min Summer	1.311	0.0	51.3	0
8640 min Summer	1.129	0.0	52.5	0

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Cascade Summary of Results for X5 Porous CP.srcx

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
10080 min Summer	85.490	0.000	0.0	0.4	0.4	0.0	O K
15 min Winter	85.650	0.160	0.9	7.1	8.0	7.8	O K
30 min Winter	85.658	0.168	0.9	7.2	8.1	8.3	O K
60 min Winter	85.636	0.146	0.9	6.8	7.7	6.9	O K
120 min Winter	85.588	0.098	0.9	5.9	6.8	4.0	O K
180 min Winter	85.556	0.066	0.9	5.2	6.0	2.0	O K
240 min Winter	85.537	0.047	0.6	4.6	5.2	1.0	O K
360 min Winter	85.511	0.021	0.1	3.9	4.0	0.2	O K
480 min Winter	85.492	0.002	0.0	3.3	3.3	0.0	O K
600 min Winter	85.490	0.000	0.0	2.7	2.7	0.0	O K
720 min Winter	85.490	0.000	0.0	2.3	2.3	0.0	O K
960 min Winter	85.490	0.000	0.0	1.9	1.9	0.0	O K
1440 min Winter	85.490	0.000	0.0	1.3	1.3	0.0	O K
2160 min Winter	85.490	0.000	0.0	1.0	1.0	0.0	O K
2880 min Winter	85.490	0.000	0.0	0.8	0.8	0.0	O K
4320 min Winter	85.490	0.000	0.0	0.5	0.5	0.0	O K
5760 min Winter	85.490	0.000	0.0	0.4	0.4	0.0	O K
7200 min Winter	85.490	0.000	0.0	0.4	0.4	0.0	O K
8640 min Winter	85.490	0.000	0.0	0.3	0.3	0.0	O K
10080 min Winter	85.490	0.000	0.0	0.3	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.994	0.0	53.5	0
15 min Winter	138.153	0.0	12.4	14
30 min Winter	90.705	0.0	16.8	24
60 min Winter	56.713	0.0	21.2	42
120 min Winter	34.246	0.0	25.9	74
180 min Winter	25.149	0.0	28.7	104
240 min Winter	20.078	0.0	30.5	132
360 min Winter	14.585	0.0	33.4	188
480 min Winter	11.622	0.0	35.5	244
600 min Winter	9.738	0.0	37.2	0
720 min Winter	8.424	0.0	38.6	0
960 min Winter	6.697	0.0	40.9	0
1440 min Winter	4.839	0.0	44.2	0
2160 min Winter	3.490	0.0	47.6	0
2880 min Winter	2.766	0.0	50.1	0
4320 min Winter	1.989	0.0	53.7	0
5760 min Winter	1.573	0.0	56.1	0
7200 min Winter	1.311	0.0	58.0	0
8640 min Winter	1.129	0.0	59.4	0
10080 min Winter	0.994	0.0	60.6	0

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Cascade Rainfall Details for X5 Porous CP.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.047

Time (mins) From:	To:	Area (ha)
0	4	0.047

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Cascade Model Details for X5 Porous CP.srcx

Storage is Online Cover Level (m) 86.190

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.04680	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	34.5
Max Percolation (l/s)	57.5	Slope (1:X)	500.0
Safety Factor	3.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	85.490	Membrane Depth (m)	0

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	200.0	Coefficient of Contraction	0.600
Length (m)	10.000	Upstream Invert Level (m)	85.400
Roughness k (mm)	0.600		

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Cascade Summary of Results for X5 BH and Cellular.srcx

Upstream Structures	Outflow To	Overflow To
X5 Porous CP.srcx X5 Swale 1.srcx X5 Swale 2.srcx	(None)	(None)

Half Drain Time : 884 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	84.890	0.490	0.3	0.3	0.6	25.2	O K
30 min Summer	85.050	0.650	0.3	0.3	0.6	33.4	O K
60 min Summer	85.214	0.814	0.3	0.3	0.6	41.8	O K
120 min Summer	85.366	0.966	0.4	0.3	0.7	49.5	O K
180 min Summer	85.441	1.041	0.4	0.3	0.7	53.4	O K
240 min Summer	85.490	1.090	0.4	0.3	0.7	55.9	O K
360 min Summer	85.543	1.143	0.4	0.3	0.7	58.6	O K
480 min Summer	85.562	1.162	0.4	0.3	0.7	59.6	O K
600 min Summer	85.559	1.159	0.4	0.3	0.7	59.4	O K
720 min Summer	85.545	1.145	0.4	0.3	0.7	58.7	O K
960 min Summer	85.515	1.115	0.4	0.3	0.7	57.2	O K
1440 min Summer	85.452	1.052	0.4	0.3	0.7	54.0	O K
2160 min Summer	85.362	0.962	0.4	0.3	0.7	49.3	O K
2880 min Summer	85.278	0.878	0.3	0.3	0.6	45.1	O K
4320 min Summer	85.128	0.728	0.3	0.3	0.6	37.3	O K
5760 min Summer	84.996	0.596	0.3	0.3	0.6	30.6	O K
7200 min Summer	84.883	0.483	0.3	0.3	0.6	24.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.153	0.0	26.2	35
30 min Summer	90.705	0.0	34.7	48
60 min Summer	56.713	0.0	43.7	68
120 min Summer	34.246	0.0	53.3	124
180 min Summer	25.149	0.0	59.2	182
240 min Summer	20.078	0.0	63.6	242
360 min Summer	14.585	0.0	70.3	362
480 min Summer	11.622	0.0	75.2	480
600 min Summer	9.738	0.0	79.0	600
720 min Summer	8.424	0.0	82.0	672
960 min Summer	6.697	0.0	86.9	780
1440 min Summer	4.839	0.0	93.4	1036
2160 min Summer	3.490	0.0	101.7	1448
2880 min Summer	2.766	0.0	107.2	1848
4320 min Summer	1.989	0.0	115.2	2640
5760 min Summer	1.573	0.0	121.1	3408
7200 min Summer	1.311	0.0	125.6	4176

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Cascade Summary of Results for X5 BH and Cellular.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	84.785	0.385	0.3	0.3	0.6	19.8	O K
10080 min Summer	84.704	0.304	0.3	0.3	0.6	15.6	O K
15 min Winter	84.949	0.549	0.3	0.3	0.6	28.2	O K
30 min Winter	85.128	0.728	0.3	0.3	0.6	37.4	O K
60 min Winter	85.311	0.911	0.4	0.3	0.7	46.7	O K
120 min Winter	85.488	1.088	0.4	0.3	0.7	55.8	O K
180 min Winter	85.584	1.184	0.4	0.3	0.7	60.7	O K
240 min Winter	85.647	1.247	0.4	0.3	0.7	64.0	O K
360 min Winter	85.719	1.319	0.4	0.3	0.7	67.7	O K
480 min Winter	85.743	1.343	0.4	0.3	0.7	68.9	O K
600 min Winter	85.745	1.345	0.4	0.3	0.7	69.0	O K
720 min Winter	85.736	1.336	0.4	0.3	0.7	68.6	O K
960 min Winter	85.700	1.300	0.4	0.3	0.7	66.7	O K
1440 min Winter	85.620	1.220	0.4	0.3	0.7	62.6	O K
2160 min Winter	85.496	1.096	0.4	0.3	0.7	56.2	O K
2880 min Winter	85.374	0.974	0.4	0.3	0.7	50.0	O K
4320 min Winter	85.151	0.751	0.3	0.3	0.6	38.5	O K
5760 min Winter	84.960	0.560	0.3	0.3	0.6	28.7	O K
7200 min Winter	84.799	0.399	0.3	0.3	0.6	20.5	O K
8640 min Winter	84.668	0.268	0.3	0.3	0.6	13.7	O K
10080 min Winter	84.569	0.169	0.3	0.3	0.6	8.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.129	0.0	129.3	4856
10080 min Summer	0.994	0.0	132.4	5552
15 min Winter	138.153	0.0	29.2	37
30 min Winter	90.705	0.0	38.8	50
60 min Winter	56.713	0.0	48.8	70
120 min Winter	34.246	0.0	59.7	122
180 min Winter	25.149	0.0	66.5	180
240 min Winter	20.078	0.0	71.8	238
360 min Winter	14.585	0.0	79.5	354
480 min Winter	11.622	0.0	84.6	468
600 min Winter	9.738	0.0	88.7	580
720 min Winter	8.424	0.0	92.0	688
960 min Winter	6.697	0.0	97.1	894
1440 min Winter	4.839	0.0	99.9	1110
2160 min Winter	3.490	0.0	114.1	1560
2880 min Winter	2.766	0.0	120.4	2016
4320 min Winter	1.989	0.0	129.4	2852
5760 min Winter	1.573	0.0	136.0	3632
7200 min Winter	1.311	0.0	141.2	4392
8640 min Winter	1.129	0.0	145.4	5024
10080 min Winter	0.994	0.0	149.0	5648

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Cascade Rainfall Details for X5 BH and Cellular.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.034

Time (mins) From:	To:	Area (ha)
0	4	0.034

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Cascade Model Details for X5 BH and Cellular.srcx

Storage is Online Cover Level (m) 86.190

Cellular Storage Structure

Invert Level (m) 84.400 Safety Factor 3.0
Infiltration Coefficient Base (m/hr) 0.04680 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.04680

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	54.0	54.0	2.600	0.0	104.0
0.200	54.0	59.9	2.800	0.0	104.0
0.400	54.0	65.8	3.000	0.0	104.0
0.600	54.0	71.6	3.200	0.0	104.0
0.800	54.0	77.5	3.400	0.0	104.0
1.000	54.0	83.4	3.600	0.0	104.0
1.200	54.0	89.3	3.800	0.0	104.0
1.400	54.0	95.2	4.000	0.0	104.0
1.600	54.0	101.0	4.200	0.0	104.0
1.800	0.0	104.0	4.400	0.0	104.0
2.000	0.0	104.0	4.600	0.0	104.0
2.200	0.0	104.0	4.800	0.0	104.0
2.400	0.0	104.0	5.000	0.0	104.0

Pump Outflow Control

Invert Level (m) 84.400

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.3000	0.900	0.3000	1.700	0.3000	2.500	0.3000
0.200	0.3000	1.000	0.3000	1.800	0.3000	2.600	0.3000
0.300	0.3000	1.100	0.3000	1.900	0.3000	2.700	0.3000
0.400	0.3000	1.200	0.3000	2.000	0.3000	2.800	0.3000
0.500	0.3000	1.300	0.3000	2.100	0.3000	2.900	0.3000
0.600	0.3000	1.400	0.3000	2.200	0.3000	3.000	0.3000
0.700	0.3000	1.500	0.3000	2.300	0.3000		
0.800	0.3000	1.600	0.3000	2.400	0.3000		

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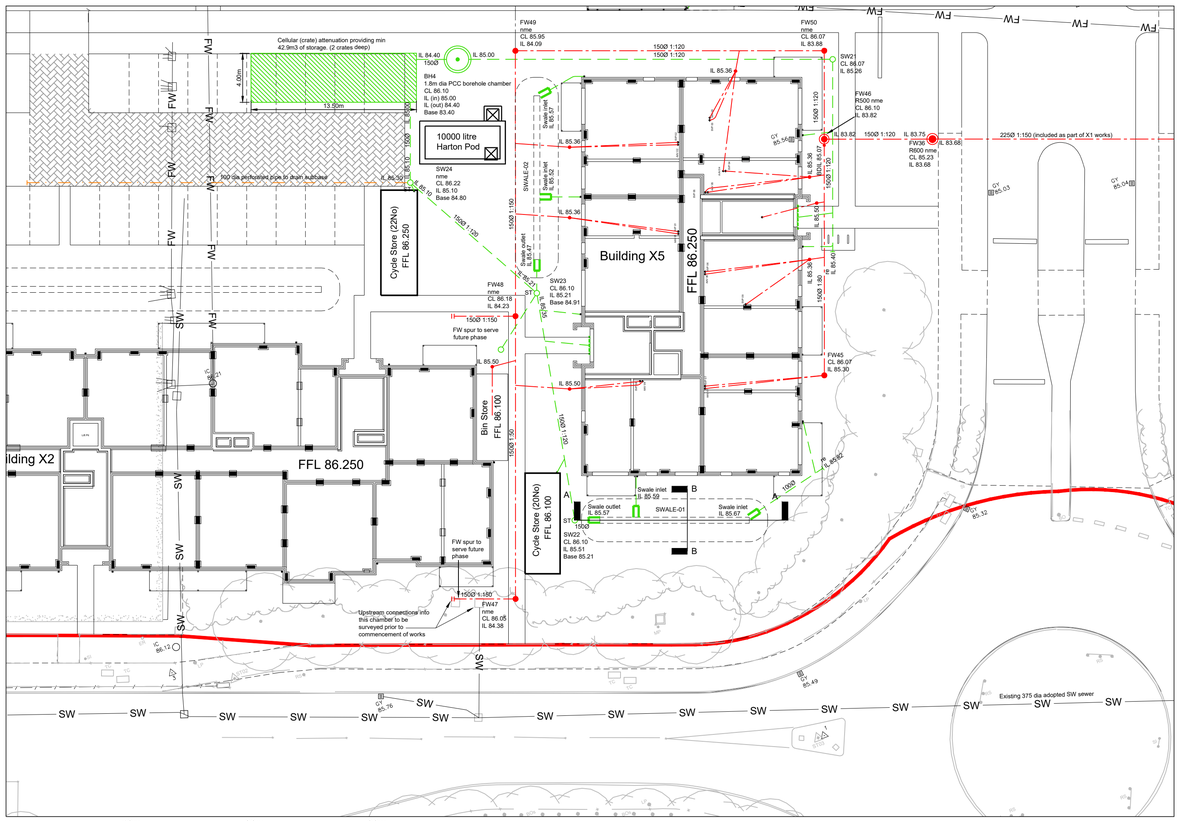
Appendix C – Drainage Layout



Key

- Existing foul water sewer
- Private foul water drainage as detailed on IDL/752/X5/07/02 construction details. External backdrop where noted 'BD'
- Private storm water drainage as detailed on IDL/752/X5/07/02 construction details.
- R600 — Denotes 600 dia (Wavin Range 600), 3000mm deep max with 4 no. max inlets / outlets up to 300mm dia, as detailed on IDL/752/X5/07/02 construction details. Where >1200mm deep, use reduced size access cover.
- Polypropylene universal inspection chambers 1200 deep max, 450 dia, 100 inlet / outlet connections (6 no. max) or 150 inlet/outlet connections (4 no max) as detailed on IDL/752/X5/07/02 construction details.
- nme — Polypropylene 'non-entry' inspection chambers 3000 deep max, 450 dia (with 300 dia. or square cover) 100 inlet / outlet connections (6 no. max), or 150 inlet/outlet connections (4 no max) as detailed on IDL/752/X5/07/02 construction details.
- Denotes 250 min dia PPIC, 600mm deep with 4 no. max 100 dia inlets / outlets, as detailed on IDL/752/X5/07/02 construction details. Where depth to invert >600mm use Wavin 315 or similar IC.
- st — Polypropylene silt trap with 300mm min sump as detailed on IDL/752/X5/07/02 construction details.
- re — Rodding eye same dia. as downstream drain as detailed on construction details drawing IDL/752/X5/07/02
- PCC surface water borehole soakaway as detailed below
- Denotes crate-type attenuation storage, as Messrs Wavin Aquacell or similar and approved. As detailed below.
- Denotes extent of permeable block-paved access roads.
- Denotes uPVC perforated pipe, laid as land drain below subbase level of porous road and parking area construction. Refer to detail on IDL/752/X5/07/02. Diameter as shown on layout. Min depth to invert to be 0.6m and to be laid no flatter than 1:200.
- Level threshold drainage as per architect's BDPC drawing.
- Site Boundary

Notes (cont'd)

17 All drain runs from SVP's, stub stacks or FW gullies to be laid at min. 1:40 gradient unless otherwise stated.

18 Svp's, stub stacks & RWP's are shown indicative only. Refer to Architectural dimensioned GA's for accurate locations

19 House/Flat drainage to be laid prior to erection of scaffold.

20 All cover and invert levels shown are in metres. All pipe diameters are in millimetres U.N.O.

21 All chambers located in trafficked areas to have concrete surround.

22 IMPORTANT NOTE:
At depths where groundwater ingress is encountered, consider the use of a sump / pump arrangement.
Where excavations are >1m deep, consider the use of full perimeter trench support.

23 IMPORTANT NOTE:
The new sewer connections are be successfully made prior to commencing any upstream drainage works.

24 IMPORTANT NOTE:
All inspection chambers to be installed min 500mm off the face of the building in order to avoid gas meter locations.

CONTRACT DOCUMENT

Notes

1 This drawing is to be read in conjunction with the private drainage construction details IDL/752/07/06 and all other relevant contract documents.

2 All private drainage works to be carried out in accordance with the provisions laid down in BS EN 752 & The Building Regulations, Part H.

3 Levels shown in buildings are Finished Floor Level.

4 Drainage under adopted roads to be either:-
a) Vitrified Clayware to BSEN295.
b) Concrete to BS 5911, Class M. Laterals to be formed of either vitrified clay or "Extra Strength", concrete "Class M",

5 Before commencing any Sewer or drainage works, the Developer's Groundworker must satisfy themselves, the developer and the Local Authority of actual levels and conditions of existing sewers.

6 Buried concrete to satisfy the requirements of BRE Special Digest 1 as predetermined by the site's Geotechnical Report

7 All abandoned, buried obstructions encountered during the construction of Highway & Drainage Works are to be broken out to bed level of drains and sewers, and to the formation of carparks and drives etc., and to sufficient depth to allow for laying service company's mains and services.

8 Depth and Location of existing services to be traced prior to any excavation.

9 All private drainage to be laid to levels shown using flexibly jointed pipes, either uPVC to BS 4660 and BS 5481 or vitrified clayware to BS EN 295.

10 Generally pipes to have granular Bed & Surround in accordance with manufacturers recommendations, ensuring adequate protection with respect to depth and location. Where bedding material is placed at depths susceptible to ground water ingress, it is to be wrapped in a geotextile (Terram 700 or better).

11 Private precast concrete manholes and catchpits to be constructed using conc. box sections or circular rings to BS 5911-200, with 150mm conc. surround, size and construction to comply with Table 12 of Approved Document, Part H.

12 Rodding eyes, etc are to be laid to manufacturers minimum cover and depth to allow adequate fall from adjoining unit.

13 Access panels are to be provided to all rainwater pipes, a max. 600 above finished ground level.

14 All manholes / inspection chambers in hard surfaced areas, to have recessed covers. These are to be orientated such as to minimise cut blocks.

15 All pipework to be 100mmØ unless otherwise stated, 150mm dia from road gullies.

16 All levels in metres (m) unless specified otherwise.

17 Upon completion of all underground drainage works, the groundworker is to provide a written report and CCTV record of the as built foul and surface water drainage systems installed

Rev	Description	Date
C	Swale cross sections added.	13.04.18
B	Balcony sizes increased. SVP09 added.	12.03.18
A	Note 24 added. Levels to attenuation detail revised.	24.01.18
0	Issued for ConDoc	30.11.17
2	Issued for Prelim	06.11.17

Status:

ConDoc Issue

Indicative Only

Scale :	1:250@A1		
Date :	Oct 2017	Checked:	Approved:
Drawn :	IDL	DC	PT

Title :

Drainage Layout X5 Building

Project :

Xerox Site, Welwyn Garden City

Drg. No:	Rev:	File Ref:	752-07-01
IDL/752/X5/07/01	C	Plot Ref:	752-X5-07-07.pdf

33 The Point
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CHASE NEW HOMES

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Jasmine House
8 Park Way
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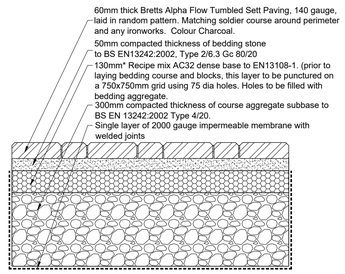
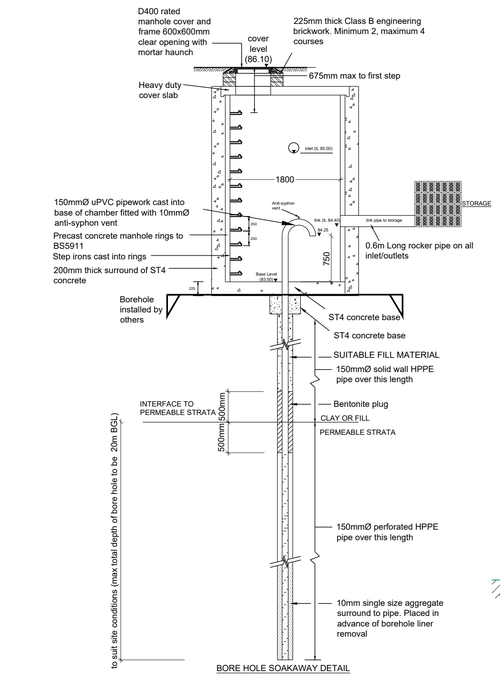
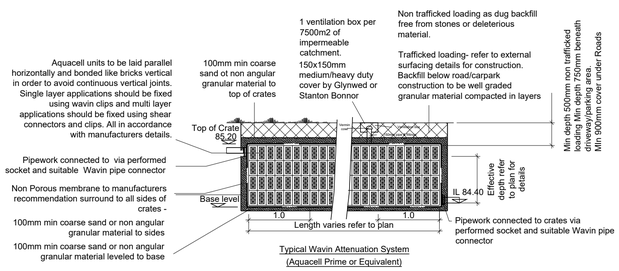


Block Paved Access Road

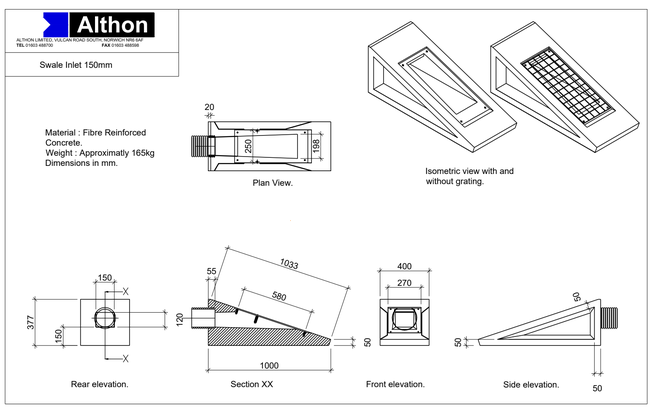
Where shown thus:

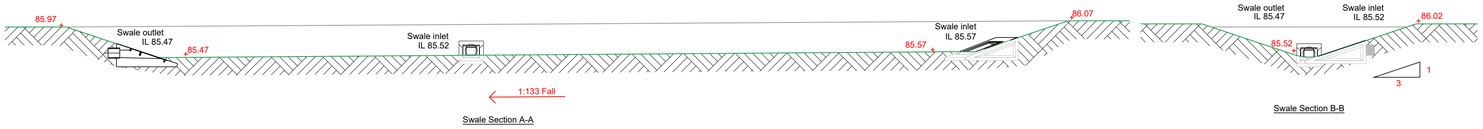


BORE HOLE SOAKAWAY DETAIL



Typical Wavin Attenuation System
(Aquacell Prime or Equivalent)





Appendix D – Soakage Test Results

(FULL SI REPORT AVAILABLE ON REQUEST)

Providing Ground Solutions

4 Godalming Business Centre
Woolsack Way, Godalming
Surrey, GU7 1XW
Telephone: 01483 310600
Fax: 01483 527285
cgl@cgl-uk.com
www.cgl-uk.com

26 January, 2016

Mr. Steve Hall
Chase Green Developments
16-18 Howard Business Park
Howard Close
Waltham Abbey
Essex EN9 1XE

Your ref:

Our ref: CG/18369B

Please reply to: Oliver Rhodes/Eoin O'Sullivan

Dear Steve Hall

Factual report of deep borehole soakaway at Xerox site, Welwyn Garden City

On 20th January 2016, a specialist drilling contractor was mobilised to the above site in order to test the permeability of the bedrock strata and, if deemed suitable by the drainage engineer, install a deep borehole soakaway. This follows the instruction received from Chase Green Developments.

Ground conditions

After utility drawings were consulted and the ground was scanned using a cable avoidance tool and signal generator, the borehole was drilled from ground surface using a Teredo DC93 (tracked rotary drilling rig). The drilling method utilised a compressed air flush and as such the strata boundaries are approximate. The ground conditions encountered are summarised below in Table 1.

Table 1 Proven ground conditions

Stratum	Depth to top of stratum (mbgl)
Grass over brown clayey sandy gravel. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse of abundant brick, flint and occasional concrete. Occasional pockets of brown sandy clay. [MADE GROUND]	0.0
Dark orange brown sandy gravelly CLAY. Gravel is subangular to subrounded, fine to medium of flint. 4.0m to 4.5m Becoming clayey sandy GRAVEL. Gravel is subangular to subrounded fine to medium of flint. [LOWESTOFT FORMATION]	3.0
Pale grey brown slightly sandy silty CLAY. Sand is fine to coarse. Occasional to frequent fine to medium gravel of chalk and flint. 6.0m becoming very gravelly, possibly clayey sandy gravel. [LOWESTOFT FORMATION]	4.5

INVESTORS IN PEOPLE | Gold

DIRECTORS
Ian Marychurch MSc BSc CEng MICE CGeol FGS CMgr MCMI MIoD Dip IoD
Nick Langdon MSc DIC BEng CEng CEnv FICE FGS FCMI MIoD

Card Geotechnics Limited
Registered in England and Wales No. 2993862
Registered Office at
4 Godalming Business Centre, Woolsack Way
Godalming, Surrey, GU7 1XW

Stratum	Depth to top of stratum (mbgl)
Grey and orange brown SAND AND GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse of flint. [LOWESTOFT FORMATION]	7.5
Recovered as structureless CHALK composed of silty GRAVEL. Gravel is medium density and white. Matrix is white, to greyish white with frequent brown clay infill. (Dc grade chalk) 10.0 brown clay infill is absent. Density increasing, indicative of structured CHALK. [LEWES NODULAR CHALK FORMATION/SEAFORD CHALK FORMATION UNDIFFERENTIATED]	8.0 12.0 (proven to 16mbgl)

No groundwater strikes were recorded during the drilling process.

The borehole log is included in Appendix A.

Infiltration (falling head) testing

The borehole was cased to 9.75mbgl, and was extended in open hole below this to 16mbgl.

A single falling head test was carried out within the borehole. Water was decanted into the borehole from a towed bowser to a level 0.8mbgl. The water level was then measured using a dip meter at frequent time intervals after this for a total of 70 minutes.

The infiltration rate has been calculated using both Horvslev's general approach[1] and the basic time lag method[2]. The calculated infiltration rate values are 8.63 $x10^{-7}$ m/s and 1.53 $x10^{-6}$ m/s respectively. These values are typical of a clast supported (Dc) grade chalk[3].

The measurements from the falling head test are included in Appendix B, as well as a calculation of the infiltration rate.

It is noted that the variation in infiltration rates indicates that the soakaway test has been undertaken at a depth range that is straddling the interface between structureless and structured chalk.

Installation of deep borehole soakaway

The raw data was relayed to the drainage engineer on completion of the soakaway test, whose preliminary calculations gave an infiltration rate of 1.3 $x10^{-5}$ m/s. The drainage engineer thus deemed the well to be potentially viable as a deep soakaway and instructed the CGL engineer to install a well in the borehole.

The well installation was of 125mm slotted pipe with glass pea gravel backfill from 16mbgl to 9.5mbgl. Above this, it was installed with 125mm plain pipe with a bentonite seal to the ground surface.

[1] Horvslev, 1951. Time Lag and Soil Permeability in Ground-Water Observations.
[2] CIRIA report 113: control of groundwater for temporary works.
[3] CIRIA C574: Engineering in chalk.

We trust that the above meets your current requirements, but should you have any queries, please do not hesitate to contact us.

Yours sincerely

Oliver Rhodes, Graduate Engineer

Encl: *Appendix A – Borehole log*
Appendix B – Falling head calculation sheet

APPENDIX A

CGL borehole log

ROTARY BOREHOLE LOG

Project				BOREHOLE No
Xerox site, Bessemer Road				BH03
Job No	Date	Ground Level (m)	Co-ordinates (m)	
CG/18369B	21-01-16 25-01-16			
Client				Sheet
Chase Green Developments				1 of 2

RUN DETAILS				Water	STRATA				Geology	Instrument /Backfill
Depth Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level		Legend	Depth (Thick-ness)	DESCRIPTION Discontinuities	Main		
						(3.00) 3.00		Grass over brown clayey sandy gravel. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse of abundant brick, flint and occasional concrete. Occasional pockets of brown sandy clay. [MADE GROUND]		
						(1.50) 4.50		Dark orange brown sandy gravelly CLAY. Gravel is subangular to subrounded, fine to medium of flint. [LOWESTOFT FORMATION] 4.00 - 4.50 Becoming clayey sandy GRAVEL. Gravel is subangular to subrounded fine to medium of flint.		
						(3.00) 7.50		Pale grey brown slightly sandy silty CLAY. Sand is fine to coarse. Occasional to frequent fine to medium gravel of chalk and flint. [LOWESTOFT FORMATION] 6.00 Becoming very gravelly, possibly clayey sandy GRAVEL.		
						(0.50) 8.00		Grey and orange brown SAND AND GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse of flint. [LOWESTOFT FORMATION]		
								Recovered as structureless CHALK composed of silty GRAVEL. Gravel is medium density and white. Matrix is white, to greyish white with frequent brown clay infill. [LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION UNDIFFERENTIATED]		

Drilling Progress and Water Observations							Rotary Flush			
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	From	To	Type	Returns

GENERAL REMARKS

1. Position scanned with CAT and genny prior to drilling.
2. Borehole drilled from ground surface.
3. No groundwater strikes recorded during drilling.
4. Monitoring installation: GL to 9.5mbgl - plain pipe with bentonite seal; 9.5mbgl to 16mbgl - slotted pipe with glass pea gravel filter.

All dimensions in metres Scale 1:63	Logged By OJR	Method/ Plant Used Teredo DC93	Checked By EOS

CGL ROTARY BH - LARGE REMARKS CG18369B.GPJ CGL.GINT STD AGS 3_1.GDT 26/1/16

ROTARY BOREHOLE LOG

Project				BOREHOLE No
Xerox site, Bessemer Road				BH03
Job No	Date	Ground Level (m)	Co-ordinates (m)	
CG/18369B	21-01-16 25-01-16			
Client				Sheet
Chase Green Developments				2 of 2

RUN DETAILS					STRATA					
Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Water	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities	DESCRIPTION: Main	Geology	Instrument /Backfill
						(8.00)		Recovered as structureless CHALK composed of silty GRAVEL. Gravel is medium density and white. Matrix is white, to greyish white with frequent brown clay infill. [LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION UNDIFFERENTIATED] *(continued)* 10.00 Brown clay infill is absent. Occasional flint gravel/cobbles. 12.00 Increasing density noted, indicative of structured, unweathered CHALK.		
						16.00		*(Borehole terminated at 16m)*		

Drilling Progress and Water Observations							Rotary Flush			
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	From	To	Type	Returns

GENERAL REMARKS

1. Position scanned with CAT and genny prior to drilling.
2. Borehole drilled from ground surface.
3. No groundwater strikes recorded during drilling.
4. Monitoring installation: GL to 9.5mbgl - plain pipe with bentonite seal; 9.5mbgl to 16mbgl - slotted pipe with glass pea gravel filter.

All dimensions in metres Scale 1:63	Logged By OJR	Method/ Plant Used Teredo DC93	Checked By EOS

CGL ROTARY BH - LARGE REMARKS CG18369B.GPJ CGL.GINT STD AGS 3_1.GDT 26/1/16

APPENDIX B

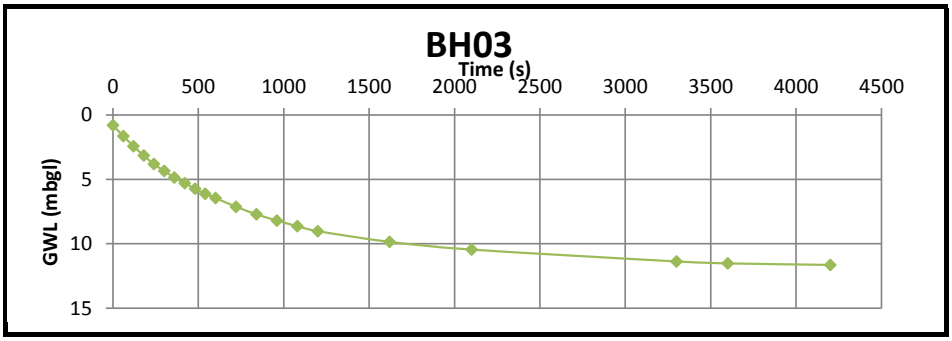
Falling head calculation sheet

Falling Head Test - BH03

Xerox Site
CG/18369B
22nd January 2016

Made by OJR
Checked by KAS

Time (mins)	Time(s)	Depth (m)	H (m)	H/Ho
0	0	0.8	15.2	1
1	60	1.63	14.37	0.9453947
2	120	2.42	13.58	0.8934211
3	180	3.15	12.85	0.8453947
4	240	3.81	12.19	0.8019737
5	300	4.35	11.65	0.7664474
6	360	4.86	11.14	0.7328947
7	420	5.28	10.72	0.7052632
8	480	5.73	10.27	0.6756579
9	540	6.11	9.89	0.6506579
10	600	6.44	9.56	0.6289474
12	720	7.12	8.88	0.5842105
14	840	7.71	8.29	0.5453947
16	960	8.19	7.81	0.5138158
18	1080	8.64	7.36	0.4842105
20	1200	9.02	6.98	0.4592105
27	1620	9.85	6.15	0.4046053
35	2100	10.45	5.55	0.3651316
55	3300	11.37	4.63	0.3046053
60	3600	11.52	4.48	0.2947368
70	4200	11.64	4.36	0.2868421



General Approach (After Horvslev 1951)

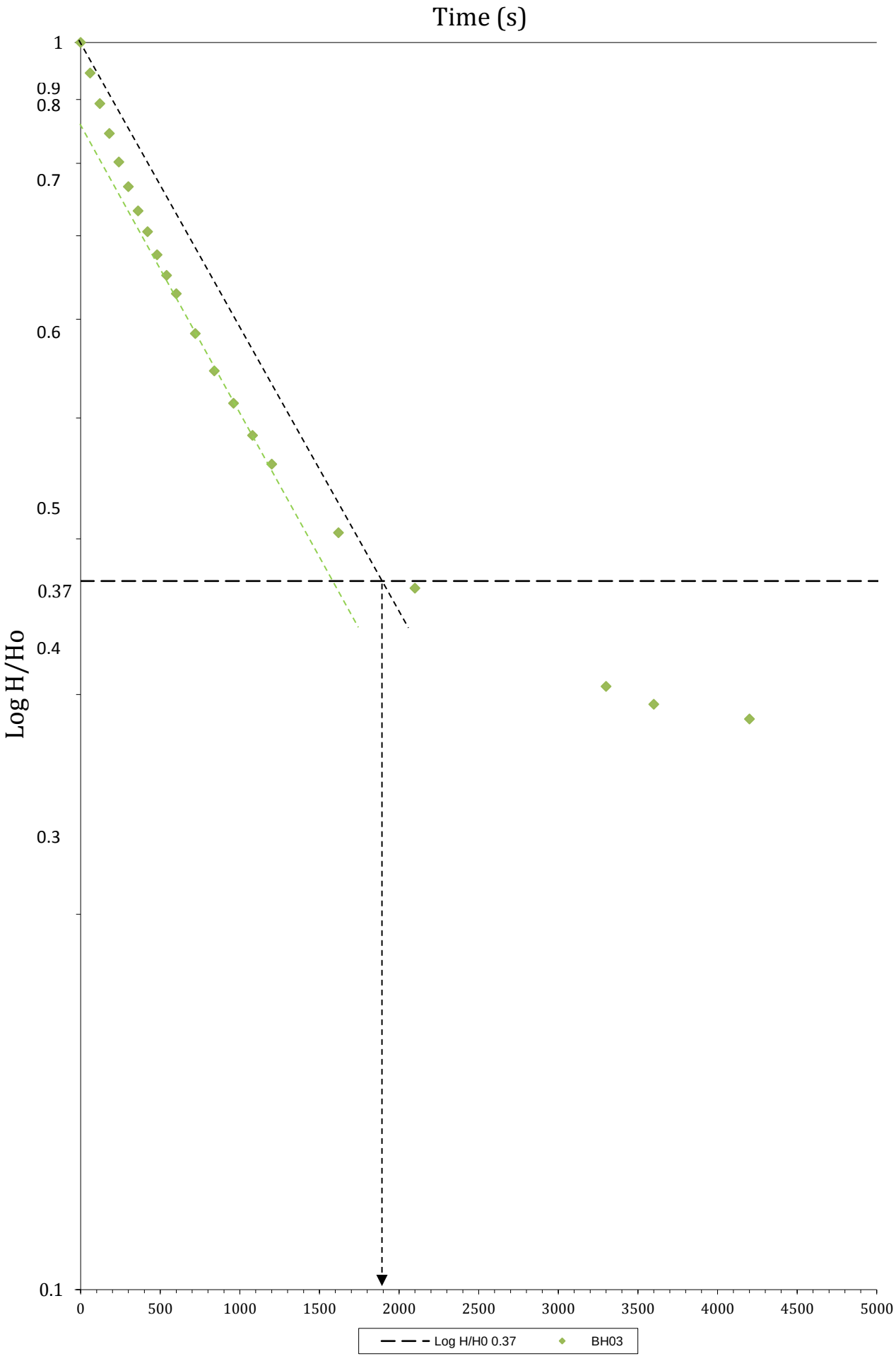
Well depth	16	mbgl
Well pipe diameter	200	mm
F	10.82	intake Factor - Fig 7 BS5930 (1999) & CIRIA report 113
D	0.2	m - Diameter of standpipe
H1	15.2	m
H2	4.36	m
t1	0	s
t2	4200	s
A	0.031415927	m2

$$k = \frac{A}{F(t_2 - t_1)} \ln \frac{H_1}{H_2}$$

k = **8.63E-07** **m/s**

Basic Time Lag Method

T	1900	Basic Time Lag - from graph (s)
k	1.53E-06	m/s


Time (s)
Log H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.37
0.4
0.3
0.1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Log H/H0 0.37
BH03