Residential Re-Development
Land off Bradford Road, Cleckheaton

Surface Water Drainage - Clarification

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Introduction

1. The following note has been prepared by Weetwood Services Ltd ("Weetwood") on behalf of Lakeland Property Management.

2. The note relates to a 2.67 hectare brownfield site located off the A638 Bradford Road known as "Cleckheaton Mills" or "the former Bridon Wires Works".

3. An outline planning application (ref: 2014/62/92988/E) entailing the demolition of an existing building and redevelopment of the site for residential use comprising of 114 dwelling houses was submitted to the local planning authority (Kirklees Council) on 22 September 2014.

4. The planning application was accompanied by a Flood Risk Assessment report prepared by Sanderson Associates ("Proposed Residential Development at Former Bridon Mills Site, Bradford Road, Cleckheaton - Flood Risk Assessment, v1.0, June 2014, Report ref: 7868/DH/001/02").

5. The FRA report confirms that part of the site falls within an area of flood risk. However, it concludes that in line with Policy, the proposed development can be constructed without being at an unacceptable risk of flooding and without increasing the risk to the site itself or other sites in the vicinity.

6. The planning case officer has requested, by way of a letter dated 12 November 2014, additional information relating to drainage of the existing site as set out below:

   The site is mainly Flood Zone 1, but there are areas within zones 2 and 3, and it is acknowledged that you have submitted a Flood Risk Assessment. However prior to determination the following information is required with respect to surface water drainage ie: The submitted FRA assessment states that there is an attenuation tank on site which has a discharge rate (assumed?) of 39l/s. We would require evidence of the existing drainage strategy of this site to this affect in order to approve discharge rates as Land Drainage Authority.

   If this is evidenced we would have no objection to a 30% reduction of discharge which is in line with Kirklees guidelines. The use of any existing attenuation tank and its location

will need to be justified in any scheme, and this will include firm topographical evidence of gullies draining hard standing.

A desk top study shows an area used as a car wash does not appear to be positively drained, also other yard areas may drain into soft landscaping areas so may not form part of the attenuation scheme. This information should be submitted as part of the FRA so it can be verified on site prior to setting appropriate conditions.

7. To address the points raised, a drainage survey has been undertaken and the drainage system has been modelled in MicroDrainage. This briefing note presents the findings and in so doing addresses the above points. The runoff rate provided in this note supercedes the rate proposed in the FRA report.

Existing and Proposed Surface Water Drainage (FRA Report)

8. The FRA report summarises the existing site characteristics and surface water drainage system as follows:

- The site is 91% (24,188 sq m) impermeable and 9% (2,570 sq m) permeable
- Surface water from the impermeable surfaces drains via a 475 mm diameter surface water sewer to a 225 mm diameter public surface water sewer located on Bradford Road.
- Flow to the 225 mm sewer is restricted by a hydrobrake control device
- The capacity of the 225 mm sewer is calculated to be 52.0 l/s based on an assumed pipe gradient of 1:100
- Peak runoff from the site to the 225 mm sewer is estimated to be 39.0 l/s for 1 in 1 year storm event
- On site storage estimated to be between 686 and 1,037 cu m.

9. Based on the above, and the development proposals, the FRA report proposes the following surface water drainage strategy for the redeveloped site (to be confirmed at the detailed design stage):

- The site would be 52% (13,858 sq m) impermeable and 48% (12,900 sq m) permeable
- Surface water from the impermeable surfaces would be reduced by 30% for the 1 in 1 year storm event
- Peak runoff rates up to and including the 1 in 100 year event plus climate change would therefore be limited to 27.0 l/s
- This would require between 532 cu m and 802 cu m of on-site attenuation storage. This is less than already provided on site.

Drainage Survey Findings

10. A drainage survey of the site was undertaken by an independent drainage contractor (Invek Surveys Ltd) on 20 November 2014. The information provided by the drainage survey supercedes the information provided in the FRA report.

11. The site drainage layout based on the drainage survey is presented in **Figure 1** and the findings of the drainage survey are summarised below:

- 62% (1.66 ha) of the site is impermeable and 38% (1.01 ha) is permeable.
- Surface water from the impermeable surfaces drains via a 450 mm diameter concrete surface water sewer
- Although not all manholes could be lifted, the 450 mm sewer receives inflows from a number of smaller diameter surface water sewer pipes draining the impermeable

surfaces of the site including the car wash facility located on the north-eastern corner of the site.
- The 450 mm concrete sewer outfalls to a 3 chamber interceptor tank located on the eastern edge of the site.
- The interceptor tank outfall is by way of a 450 mm diameter sewer. This sewer connects into the public surface water sewer at a manhole located in Rawfolds Way (see **Figure 2**).
- The public surface water sewer in Rawfolds Way discharges into Spen River via a 750 mm diameter sewer pipe.
- There is no evidence of an existing attenuation tank or hydrobrake style outlet control on site.

Drainage Network Modelling, Runoff Rates and Storage Calculations

12. A model of the surveyed on-site drainage network to the public sewer outfall to the receiving watercourse (Spen River) has been built in Microdrainage.

13. The Microdrainage outputs (presented in **Annex 1**) confirm the critical storm to be the 15 minute winter event, and the peak outfall rates for the 1 in 1, 1 in 2, 1 in 30 and 1 in 100 annual probability storm events to be 170.5 l/s, 207.9 l/s, 300.9 l/s and 307.7 l/s respectively.

14. For the purposes of the surface water drainage strategy, it is proposed that the surface water runoff generated by a 1 in 100 annual probability rainfall event including an allowance for climate change for the redeveloped site would be limited to the existing 1 in 2 annual probability rate(207.9 l/s) reduced by 30% (i.e. 145.5 l/s). The peak runoff rates for the 1 in 30 and 1 in 100 annual probability events would be reduced by 48% and 53% respectively providing significant betterment.

15. The reduction in runoff rates would be achieved by the provision of on-site attenuation storage and outlet control device. The surface water storage has been modelled using the Detailed Design module of MicroDrainage Source Control (see **Annex 2**).

16. The required storage volume to store the 1 in 100 annual probability rainfall event including a 30% increase in rainfall intensity in order to allow for climate change in accordance with EA guidance[1] for a peak discharge rate of 145.5 l/s is calculated to be 240 m^3.

17. Following site redevelopment, the impermeable area of the site would reduce from 1.66 ha to 1.38 ha. For the 1 in 100, 6 hour storm event, the volume of runoff from the developed site would be 296 m^3 less than the existing site[2], again providing significant benefit compared to the existing arrangements.

Summary

18. A detailed drainage survey of the site has been undertaken. The survey identified that there is no on site attenuation storage and that runoff from the system discharges at an unrestricted rate to the public sewerage network.

[1] Climate Change Allowances for Planners – Guidance to Support the National Planning Policy Framework, September 2013, EA ref: LIT 8496 NA/EAD/Sept 2013/V12

[2] Section 4.5.5 of the SuDS Manual (Ciria C697, 2007) - Guidance on calculating additional volume of runoff caused by development

19. A model of the surface water drainage network has been developed in Microdrainage using the drainage survey information. The model incorporates the receiving public sewer pipes to the system outfall into the Spen River.

20. The network model has been used to determine the actual peak runoff rates at the Spen River outfall from the impermeable surfaces of the existing site.

21. In respect of the site redevelopment it is proposed to limited peak runoff from impermeable surfaces of the redeveloped site to 145.5 l/s. This is based on a 30% reduction in peak runoff from the existing 1 in 2 annual probability storm event.

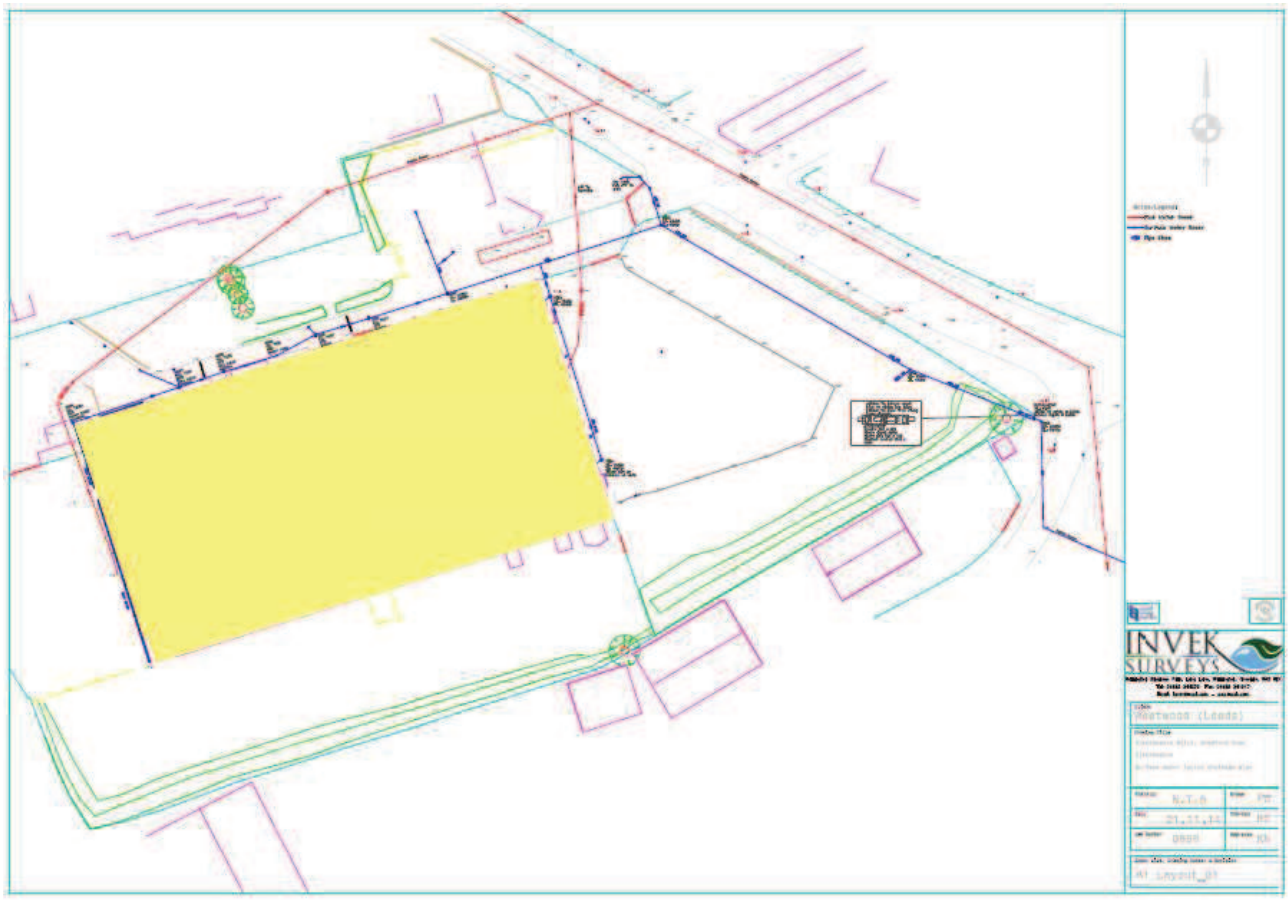
22. The reduction in peak runoff rate would be achieved through the provision of a new on-site attenuation storage facility. To store the 1 in 100 annual probability event with a 30% climate change allowance would require approximately 240 m^3 (not taking into account storage provided within the on-site sewer pipes).

23. The type of storage facility used on site would be confirmed when details of the surface water drainage scheme are submitted to the local planning authority to discharge the relevant planning condition.

24. Prior to the drainage survey being undertaken, it was believed that there was already on-site attenuation storage that could be utilised by the redeveloped site. This is not the case. If sub-surface storage is used (e.g. cellular storage) the installation cost would be expected to be of the order £66,000. The cost of providing the attenuation storage will be an additional cost not foreseen when the planning application was submitted.

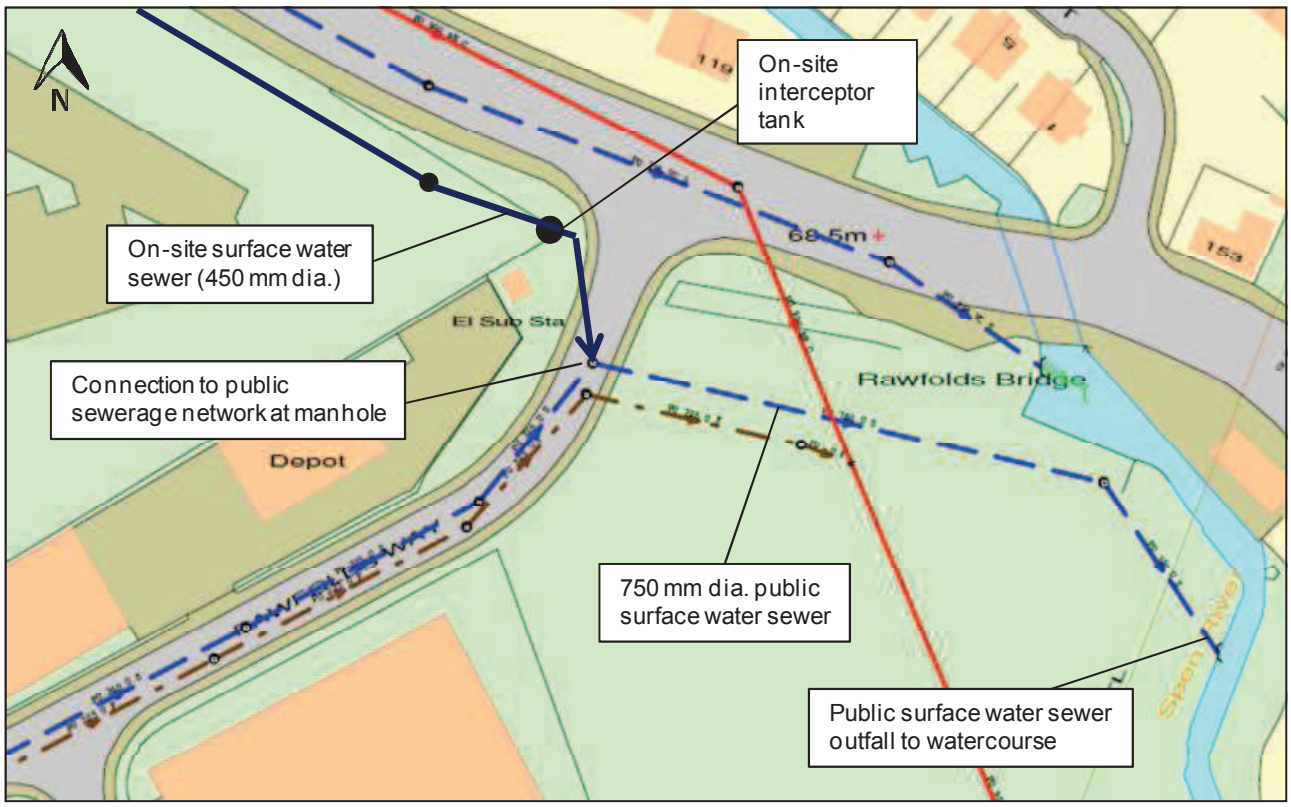
25. The proposals presented in this clarification note supersede the outline surface water drainage strategy presented in the FRA report, and should be used to inform an appropriate pre-commencement planning condition.

Figure 1 – Site Drainage Layout



Note: This plan is also provided in digital format with this clarification note.

Figure 2 – Connection of Site Surface Water Drainage to Public Sewer Network



Annex 1: Microdrainage Modelling Outputs

Existing Network Details for Storm

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
	2.000	21.431	0.310	69.1	0.096	4.00	0.600	o	150
*	3.000	61.701	0.155	398.1	0.298	4.00	0.600	o	300
*	3.001	52.537	1.020	51.5	0.375	0.00	0.600	o	300
	3.002	44.574	1.000	44.6	0.358	0.00	0.600	o	300
	2.001	23.951	0.217	110.4	0.172	0.00	0.600	o	450
*	4.000	42.014	0.310	135.5	0.115	4.00	0.600	o	225
*	4.001	8.365	0.062	134.9	0.000	0.00	0.600	o	225
	2.002	31.181	0.283	110.2	0.037	0.00	0.600	o	450
*	5.000	9.448	0.250	37.8	0.076	4.00	0.600	o	300
	2.003	70.603	0.390	181.0	0.000	0.00	0.600	o	450
	6.000	29.859	0.175	170.6	0.133	4.00	0.600	o	225
	2.004	28.728	0.130	221.0	0.000	0.00	0.600	o	450

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
	2.000	From Car Wash	70.730	69.500	1.080	70.510	69.190	1.170		1200
*	3.000	Slot Drain	72.610	71.215	1.095	72.530	71.060	1.170		1200
*	3.001	MH06	72.530	71.060	1.170	71.510	70.040	1.170		1200
	3.002	MH09	71.510	70.040	1.170	70.510	69.040	1.170		1200
	2.001	MH01	70.510	68.890	1.170	69.951	68.673	0.828		1350
*	4.000	MH04	70.050	69.270	0.555	70.000	68.960	0.815		1200
*	4.001	MH03	70.000	68.960	0.815	69.951	68.898	0.828		1200
	2.002	Junction	69.951	68.673	0.828	69.290	68.390	0.450		1350
*	5.000	From Car Wash	69.232	68.790	0.142	69.290	68.540	0.450		1200
	2.003	MH02	69.290	68.390	0.450	69.030	68.000	0.580		1350
	6.000	Assumed	68.720	68.400	0.095	69.030	68.225	0.580		1200
	2.004	MH05	69.030	68.000	0.580	69.370	67.870	1.050		1350

Existing Network Details for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
2.005	5.858	0.440	13.3	0.000	0.00	0.600	o	450
2.006	25.905	1.070	24.2	0.000	0.00	0.600	o	450

PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
2.005	Interceptor	69.370	67.870	1.050	69.230	67.430	1.350		1350
2.006	MH12	69.230	67.430	1.350	68.160	66.360	1.350		1350

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Back (m
From Car Wash	70.730	1.230	Open Manhole	1200	2.000	69.500	150				
Slot Drain	72.610	1.395	Open Manhole	1200	3.000	71.215	300				
MH06	72.530	1.470	Open Manhole	1200	3.001	71.060	300	3.000	71.060	300	
MH09	71.510	1.470	Open Manhole	1200	3.002	70.040	300	3.001	70.040	300	
MH01	70.510	1.620	Open Manhole	1350	2.001	68.890	450	2.000	69.190	150	
								3.002	69.040	300	
MH04	70.050	0.780	Open Manhole	1200	4.000	69.270	225				
MH03	70.000	1.040	Open Manhole	1200	4.001	68.960	225	4.000	68.960	225	
Junction	69.951	1.278	Open Manhole	1350	2.002	68.673	450	2.001	68.673	450	
								4.001	68.898	225	
From Car Wash	69.232	0.442	Open Manhole	1200	5.000	68.790	300				
MH02	69.290	0.900	Open Manhole	1350	2.003	68.390	450	2.002	68.390	450	
								5.000	68.540	300	
Assumed	68.720	0.320	Open Manhole	1200	6.000	68.400	225				
MH05	69.030	1.030	Open Manhole	1350	2.004	68.000	450	2.003	68.000	450	
								6.000	68.225	225	
Interceptor	69.370	1.500	Open Manhole	1350	2.005	67.870	450	2.004	67.870	450	
MH12	69.230	1.800	Open Manhole	1350	2.006	67.430	450	2.005	67.430	450	
Public Sewer	68.160	1.800	Open Manhole	0		OUTFALL		2.006	66.360	450	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
2.000	o	150	From Car Wash	70.730	69.500	1.080	Open Manhole	1200
3.000	o	300	Slot Drain	72.610	71.215	1.095	Open Manhole	1200
3.001	o	300	MH06	72.530	71.060	1.170	Open Manhole	1200
3.002	o	300	MH09	71.510	70.040	1.170	Open Manhole	1200
2.001	o	450	MH01	70.510	68.890	1.170	Open Manhole	1350
4.000	o	225	MH04	70.050	69.270	0.555	Open Manhole	1200
4.001	o	225	MH03	70.000	68.960	0.815	Open Manhole	1200
2.002	o	450	Junction	69.951	68.673	0.828	Open Manhole	1350
5.000	o	300	From Car Wash	69.232	68.790	0.142	Open Manhole	1200
2.003	o	450	MH02	69.290	68.390	0.450	Open Manhole	1350
6.000	o	225	Assumed	68.720	68.400	0.095	Open Manhole	1200
2.004	o	450	MH05	69.030	68.000	0.580	Open Manhole	1350
2.005	o	450	Interceptor	69.370	67.870	1.050	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
2.000	21.431	69.1	MH01	70.510	69.190	1.170	Open Manhole	1350
3.000	61.701	398.1	MH06	72.530	71.060	1.170	Open Manhole	1200
3.001	52.537	51.5	MH09	71.510	70.040	1.170	Open Manhole	1200
3.002	44.574	44.6	MH01	70.510	69.040	1.170	Open Manhole	1350
2.001	23.951	110.4	Junction	69.951	68.673	0.828	Open Manhole	1350
4.000	42.014	135.5	MH03	70.000	68.960	0.815	Open Manhole	1200
4.001	8.365	134.9	Junction	69.951	68.898	0.828	Open Manhole	1350
2.002	31.181	110.2	MH02	69.290	68.390	0.450	Open Manhole	1350
5.000	9.448	37.8	MH02	69.290	68.540	0.450	Open Manhole	1350
2.003	70.603	181.0	MH05	69.030	68.000	0.580	Open Manhole	1350
6.000	29.859	170.6	MH05	69.030	68.225	0.580	Open Manhole	1350
2.004	28.728	221.0	Interceptor	69.370	67.870	1.050	Open Manhole	1350
2.005	5.858	13.3	MH12	69.230	67.430	1.350	Open Manhole	1350

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
2.006	o	450	MH12	69.230	67.430	1.350	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
2.006	25.905	24.2	Public Sewer	68.160	66.360	1.350	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
2.006	Public Sewer	68.160	66.360	0.000	0	0

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.346
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180
Return Period(s) (years)	1, 2, 30, 100
Climate Change (%)	0, 0, 0, 0

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
2.000	15 Winter	100	0%	30/15 Summer				
3.000	15 Winter	100	0%	30/15 Summer	100/15 Summer			4
3.001	15 Winter	100	0%	30/15 Summer	100/15 Summer			4
3.002	15 Winter	100	0%	30/15 Summer	100/15 Summer			4
2.001	15 Winter	100	0%	30/15 Summer				
4.000	15 Winter	100	0%	30/15 Summer				
4.001	15 Winter	100	0%	30/15 Summer				
2.002	15 Winter	100	0%	30/15 Summer				
5.000	30 Winter	100	0%	30/15 Summer	30/15 Winter			6
2.003	15 Winter	100	0%	30/15 Summer	100/15 Winter			1
6.000	15 Winter	100	0%	30/15 Summer	100/15 Summer			5
2.004	15 Winter	100	0%	2/15 Summer				
2.005	15 Winter	100	0%					
2.006	15 Winter	100	0%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
2.000	From Car Wash	70.614	0.964	0.000	1.43	0.0	28.8	FLOOD RISK
3.000	Slot Drain	72.622	1.107	11.873	1.68	0.0	88.5	FLOOD
3.001	MH06	72.535	1.175	5.201	1.00	0.0	146.2	FLOOD
3.002	MH09	71.523	1.183	13.050	1.36	0.0	211.9	FLOOD
2.001	MH01	69.980	0.640	0.000	1.10	0.0	281.2	SURCHARGED

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m^3)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
4.000	MH04	69.986	0.491	0.000	0.87	0.0	36.9	FLOOD RISK
4.001	MH03	69.769	0.584	0.000	0.97	0.0	33.9	FLOOD RISK
2.002	Junction	69.716	0.593	0.000	1.21	0.0	322.5	FLOOD RISK
5.000	From Car Wash	69.246	0.156	13.698	0.50	0.0	62.5	FLOOD
2.003	MH02	69.290	0.450	0.086	1.27	0.0	284.4	FLOOD
6.000	Assumed	68.724	0.099	3.624	0.99	0.0	36.7	FLOOD
2.004	MH05	68.656	0.206	0.000	1.66	0.0	307.9	SURCHARGED
2.005	Interceptor	68.182	-0.138	0.000	0.82	0.0	307.8	OK
2.006	MH12	67.669	-0.211	0.000	0.55	0.0	307.7	OK

Annex 2: Surface Water Storage Modelling Outputs

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.807	0.707	130.0	169.9	O K
30 min Summer	0.962	0.862	135.8	207.1	O K
60 min Summer	1.020	0.920	139.9	221.0	O K
120 min Summer	0.942	0.842	134.4	202.4	O K
180 min Summer	0.822	0.722	130.1	173.6	O K
240 min Summer	0.690	0.590	130.1	141.8	O K
360 min Summer	0.541	0.441	120.7	106.0	O K
480 min Summer	0.466	0.366	105.7	87.9	O K
600 min Summer	0.417	0.317	93.5	76.2	O K
720 min Summer	0.382	0.282	83.7	67.7	O K
960 min Summer	0.334	0.234	69.8	56.2	O K
1440 min Summer	0.278	0.178	53.0	42.8	O K
2160 min Summer	0.232	0.132	39.5	31.8	O K
2880 min Summer	0.205	0.105	31.9	25.2	O K
4320 min Summer	0.172	0.072	23.6	17.3	O K
5760 min Summer	0.152	0.052	18.9	12.5	O K
7200 min Summer	0.139	0.039	15.9	9.3	O K
8640 min Summer	0.129	0.029	13.9	6.9	O K
10080 min Summer	0.121	0.021	12.4	5.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	96.918	16
30 min Summer	67.029	25
60 min Summer	44.405	42
120 min Summer	28.487	76
180 min Summer	21.655	108
240 min Summer	17.694	136
360 min Summer	13.184	194
480 min Summer	10.704	252
600 min Summer	9.097	312
720 min Summer	7.960	372
960 min Summer	6.440	492
1440 min Summer	4.766	736
2160 min Summer	3.518	1100
2880 min Summer	2.831	1468
4320 min Summer	2.079	2200
5760 min Summer	1.668	2896
7200 min Summer	1.408	3672
8640 min Summer	1.226	4304
10080 min Summer	1.090	5128

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	0.908	0.808	132.0	194.1	O K
30 min Winter	1.070	0.970	143.3	233.1	O K
60 min Winter	1.100	1.000	145.2	240.2	O K
120 min Winter	0.940	0.840	134.3	202.0	O K
180 min Winter	0.732	0.632	130.1	151.9	O K
240 min Winter	0.578	0.478	125.9	114.8	O K
360 min Winter	0.450	0.350	101.9	84.0	O K
480 min Winter	0.385	0.285	84.7	68.6	O K
600 min Winter	0.344	0.244	72.8	58.7	O K
720 min Winter	0.315	0.215	64.1	51.7	O K
960 min Winter	0.275	0.175	52.1	42.2	O K
1440 min Winter	0.230	0.130	38.8	31.2	O K
2160 min Winter	0.193	0.093	28.7	22.2	O K
2880 min Winter	0.170	0.070	23.1	16.9	O K
4320 min Winter	0.144	0.044	17.0	10.5	O K
5760 min Winter	0.128	0.028	13.7	6.6	O K
7200 min Winter	0.117	0.017	11.5	4.0	O K
8640 min Winter	0.108	0.008	10.0	2.0	O K
10080 min Winter	0.102	0.002	8.9	0.5	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	96.918	17
30 min Winter	67.029	26
60 min Winter	44.405	44
120 min Winter	28.487	80
180 min Winter	21.655	112
240 min Winter	17.694	138
360 min Winter	13.184	196
480 min Winter	10.704	254
600 min Winter	9.097	314
720 min Winter	7.960	374
960 min Winter	6.440	494
1440 min Winter	4.766	736
2160 min Winter	3.518	1100
2880 min Winter	2.831	1468
4320 min Winter	2.079	2200
5760 min Winter	1.668	2880
7200 min Winter	1.408	3592
8640 min Winter	1.226	4400
10080 min Winter	1.090	5136

Rainfall Details

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)	17.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 1.385

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.000	4-8	0.385

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.100

Depth (m)	Area (m²)
0.000	240.3

Hydro-Brake® Outflow Control

Design Head (m) 1.100 Hydro-Brake® Type Md7 Invert Level (m) 0.000
Design Flow (l/s) 145.5 Diameter (mm) 453

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.6	1.200	151.7	3.000	239.9	7.000	366.4
0.200	30.7	1.400	163.9	3.500	259.1	7.500	379.3
0.300	59.5	1.600	175.2	4.000	277.0	8.000	391.7
0.400	88.8	1.800	185.8	4.500	293.8	8.500	403.8
0.500	113.2	2.000	195.9	5.000	309.7	9.000	415.5
0.600	128.2	2.200	205.4	5.500	324.8	9.500	426.9
0.800	125.0	2.400	214.6	6.000	339.2		
1.000	138.5	2.600	223.3	6.500	353.1		

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