Howarth Timber & Building Supplies (Chester)

Proposed Commercial Re-Development
Chester Road
Bretton
Chester

Flood Risk Assessment

Prepared by EWE Associates Ltd
Draft Rev0 October 2019

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CLIENT DETAILS

Howarth Timber & Building Supplies (Chester)

Broughton Works

Chester Road

Bretton

Chester CH4 0DH

CONTRACT

This report describes work commissioned by Howarth Timber & Building Supplies (Chester) following written instruction during September 2019. Howarth Timber & Building Supplies (Chester) representative for the contract was Mr Philip Shaw of Pilgrim Associates Ltd. Lea Favill of EWE Associates Ltd carried out the work.

Date: 10th October 2019

Prepared by: …… …… Lea Favill
Director

REVISION HISTORY

Draft Report Rev0 issued 10th October 2019
- 1No copy issued to Mr Phil Shaw

EXECUTIVE SUMMARY

The total site area affected by this development has been estimated at approximately 6654m² (0.665 ha). The site is currently a commercial development which includes several buildings and yard area. The existing impermeable area within the site has been estimated at 3790m². the remainder of the site is generally compacted stone. The existing site is shown below in the aerial photograph.

The ground levels within the site vary from 6.10mOD and 7.00mOD. It is proposed that the roofed and paved areas within the site is directed to the existing 100mm diameter sewer within the site. The discharge into the sewer will be restricted to 5.72l/s. The impermeable area has been calculated at 6151m² (0.615 hectares). This area will be 100% roofed and paved.

The River Dee is located 2200m to the north east of the site and the local watercourse is located 350m to the north east. The site is located within a very low risk area based on the Environment Agency flood maps for the area.

It is therefore recommended that the internal ground floor of the new building is raised to a level at least 150mm above the adjacent external ground level.

The site is located within a very low risk area based on the Environment Agency flood maps for the area.

It is considered that safe access and egress will be available at all times onto the adjacent Chester Road even during extreme flood events.

It is concluded that the site is located within a very low risk area. The proposed development is simply a re-development of the existing commercial use to make better use of the available space within the site. It is considered that recommended mitigation measures will reduce the risk of flooding to an acceptable level.

CONTENTS

1 INTRODUCTION

1.1 Terms of Reference

This report was commissioned by Howarth Timber & Building Supplies (Chester) to support a planning application for the re-development of an existing commercial development. The site is located within the existing Howarth Timber Site off Chester Road in Bretton. The location of the site is shown on Table 2-1.

The development site lies within Zone C of the Environment Agency Flood Map (version 2.8.2). The site is within Flood Zone C, being the zone with risk of 1 in 100 year (1% Annual Exceedance Probability) or greater for river flooding and 1 in 200 year (0.5% AEP) or greater for tidal/coastal flooding. The development site is within an existing developed area and is less than 1 hectare.

It is usual for the Environment Agency to raise an objection to development applications that are within Flood Zones B or C, or those sites which are in excess of 1 hectare, until the question of flood risk has been properly evaluated.

1.2 Approach to the Assessment

As there are three sources of flood risk – the River Dee, Local watercourses and surface water runoff – it is necessary to determine flood water levels at the site for the desired return periods emanating from the three sources. Consideration has also been given to the site flooding from either overland flow or ponding of localised rainfall within the site.

The River Dee is classified by the Environment Agency as Main River. The Environment Agency flood maps shows that the site is located on the edge of the very low risk zone.

There is a local watercourse approximately 350m to the north east of the site. The local watercourse is the responsibility of the riparian owners. There are no estimated or historical flood levels available for the watercourses.

A walk over survey of the site was conducted by Mr Lea Favill, a senior river engineer during June 2019; during the visit a photograph survey of the site and adjacent watercourse was undertaken. A topographical survey of the site was provided by the client's representative. The survey was related to ordnance survey. The site levels have been referred to in this report and a copy of the survey is provided at Appendix A of this report.

The proposed development involves the re-development of an existing commercial development. It is considered that the impermeable area within the site will be increased upon completion of the development.

The requirements for flood risk assessments are generally as set out in TAN15. The detail and complexity of the study required should be appropriate to the scale and potential impact of the development. For the purposes of this study, the following have been considered: -

- Available information on historical flooding in the area.
- Site level information.
- Details of structures, which may influence hydraulics of the watercourse and consideration of the effect of blockage of structures.
- Estimates of design levels, equivalent to a 200-year (coastal/tidal) and a 100-year (fluvial) return period flood event.
- Allowances for increased flows resulting from the effects of climate change.
- Assess the existing runoff characteristics and the potential impact any proposed development will have on the runoff.

Further guidance is also provided in the CIRIA Research Project 624 “Development and Flood Risk: Guidance for the Construction Industry”.

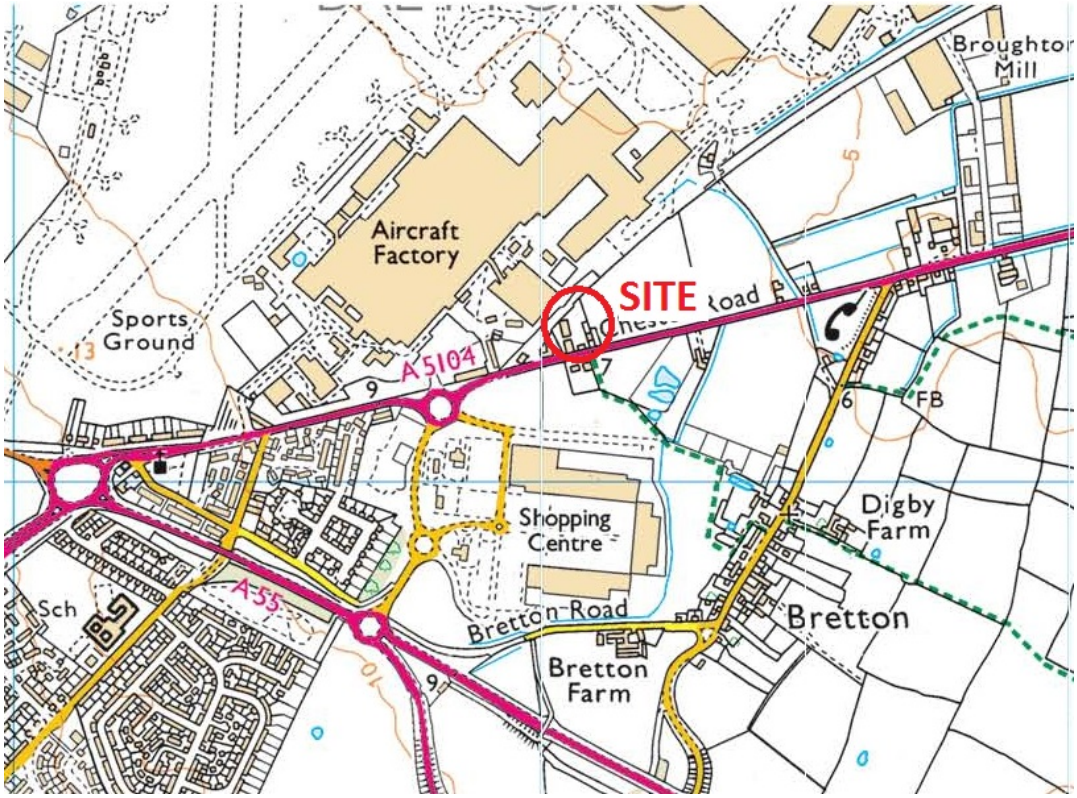
2 DETAILS OF THE SITE

2.1 Site Details

Table 2-1 Development Location

Site Name:	Howarth Timber Chester Road Bretton
Purpose of Development:	Commercial
Existing Land Use:	Commercial
OS NGR:	SJ 35069 64279
Country:	Wales
County:	Flintshire
Local Planning Authority:	Flintshire County Council
Internal Drainage Board:	Not Applicable
Other Authority (e.g. British Waterways/ Harbour Authority)	Not Applicable

Location Plan:



Ordnance Survey Licence no.: WL1005160

2.2 Site Description

The total site area affected by this development has been estimated at approximately 6654m² (0.665 ha). The site is currently a commercial development which includes several buildings and yard area. The existing impermeable area within the site has been estimated at 3790m². the remainder of the site is generally compacted stone. The existing site is shown below in the aerial photograph. The existing site plan which shows the impermeable area and sewers within the site is provided at Appendix A of this report.

The ground levels within the site vary from 6.10mOD and 7.00mOD. The ground levels within the site are illustrated in Appendix A of this report.

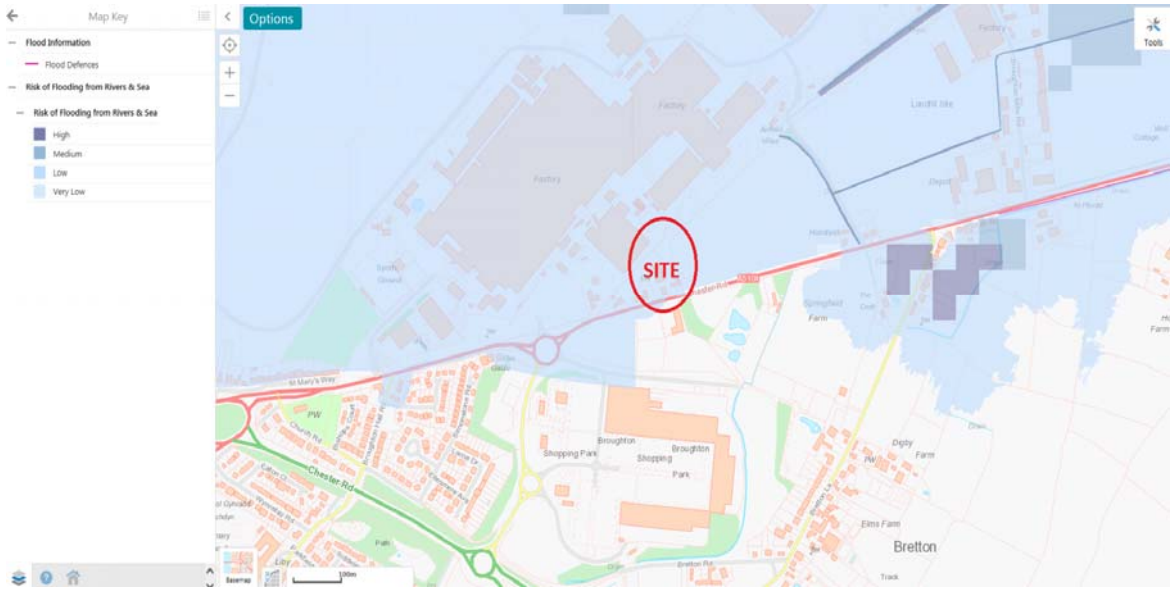
It is proposed that the roofed and paved areas within the site is directed to the existing 100mm diameter sewer within the site. The discharge into the sewer will be restricted to 5.72l/s. The impermeable area has been calculated at 6151m² (0.615 hectares). This area will be 100% roofed and paved. The proposed layout plans are provided at Appendix B.

3 INITIAL ASSESSMENT

3.1 Past Flooding History

A search on the British Hydrological Society Chronology of British Hydrological Events website[1] found no records of past flooding within the Bretton area.

Undertaking an internet based search for flooding in the area provided no further information.

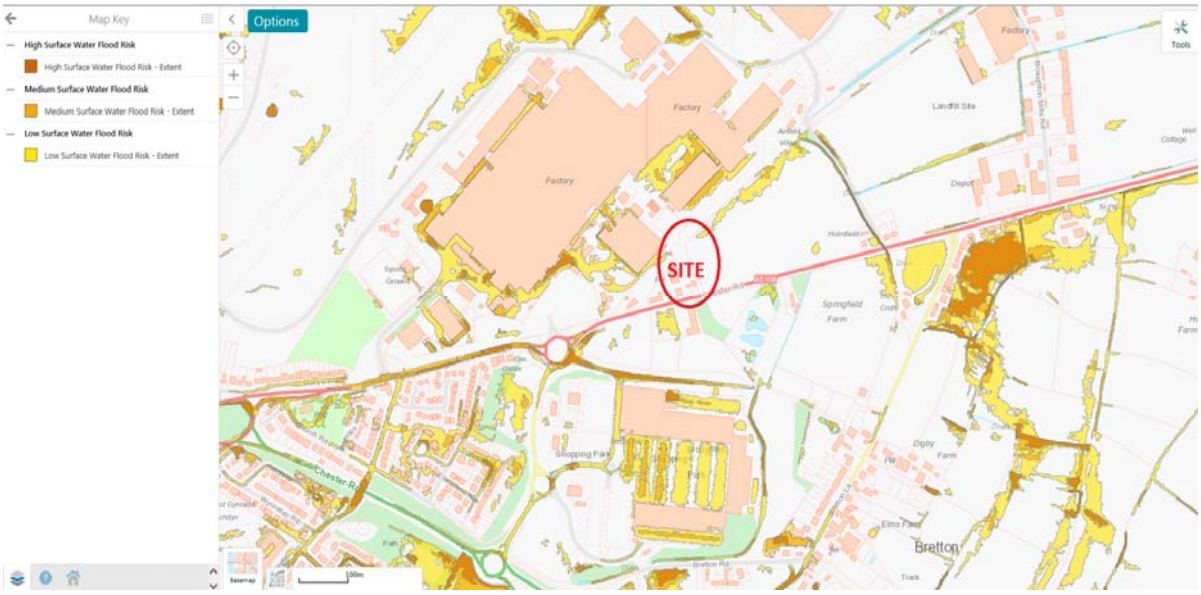


3.2 Environment Agency Reservoir Flood Risk

1 http://www.dundee.ac.uk/geography/cbhe/

The site is not within an area which is affected by flood risk from a reservoir or canal.

3.3 Environment Agency Surface Water Flood Risk



According to the Environment Agency surface water flood risk map of the area the site is not at risk.

3.4 Possible Flooding Mechanisms

As there is a single source of flood risk which requires detailed consideration – onsite runoff – it is necessary to determine flood water levels at the site for the desired return periods emanating from this source.

The River Dee which is approximately 2200m to the north east of the proposed development. The River Dee is defended by earth embankments which are elevated above the adjacent natural ground level. The Environment Agency flood map shows the site is located at the edge of the very low risk area. It is therefore considered that only extreme flood events could impact on the lower end of the site where no buildings are to be located. As such no further consideration has been given to the River Dee.

The local watercourse is the responsibility of the riparian owners and located to the 350m north east of the development site. The watercourses are not defended by earth embankments or flood walls and as such rely upon the natural ground level to provide a flood defence. The surface water flood maps do not show any flooding from this watercourse impact on the site. As such no further consideration has been given to the local watercourse.

The proposed development will increase the impermeable area and hence runoff from the site will be increased. Consideration will need to be given to the existing drainage route and the drainage characteristics in order to evaluate the impact surface water runoff from the site will have on the site and elsewhere.

There is no higher ground directly adjacent to the site which may encourage overland flow on to the site. As such no further consideration has been given to overland flow onto the site. There are no depressed areas within the site which could encourage ponding. As such no further consideration has been given to ponding.

4 QUANTATIVE FLOOD RISK ASSESSMENT

4.1 Requirements of the Environment Agency

The Environment Agency, as part of its development control procedures, generally require finished floor levels to be set above the 1% AEP flood water level at the site. The development is commercial, as such it is considered that access and egress from the development site will be essential during times of extreme floods.

4.2 Increase Runoff due to the Development

Existing Runoff from the Site

The total site area affected by this development has been estimated at approximately 6654m² (0.665 ha). The site is currently a commercial development which includes several buildings and yard area.

There is surface water drainage system within the site which collects runoff from the buildings, access road and yard areas within the site. During the site visit there was evidence of roof gutters and downpipes to all the buildings and drainage channels and gullies to access road and yard areas. It is therefore considered that the site is positively drained.

The manholes where lifted within the site and it appears that the drainage is directed north via a 100mm diameter surface water sewer. At the northern boundary of the site the sewer is only 1.25m deep. The sewer heads north into the adjacent commercial development where it is believed to turn east to discharge into an open watercourse.

The existing impermeable area within the site has been estimated at 3790m². the remainder of the site is generally compacted stone.

The existing site plan which shows the impermeable area and sewers within the site is provided at Appendix A of this report.

The site is within an area with an SPR value of 39.9% suggesting that the site will not allow adequate infiltration.

Table 4-1: Modified Rational Method flows from existing site 0.379 hectares

Return Period	Flow in litres per second (l/s)
1 in 1 year	32.13
1 in 30 year	99.63
1 in 100 year	139.07

The Modified Rational Method has been used to calculate the existing runoff from the impermeable part of the site. The calculation sheet is provided at Appendix C of this report.

However, the discharge from the site is currently controlled by the final length of 100mm diameter sewer which exits the site to the north. The sewer has a gradient of 1 in 83. Using the pipe table provided at Appendix D the peak pipe capacity has been estimate at 5.72l/s.

Any discharge from the site will require the consent of the appropriate water authority/riparian owner, as such, they will also need to be approached to agree the discharge restriction from the site.

Therefore, a peak discharge rate of 5.72l/s has been adopted for this development.

Discharge to surface water sewer

It is proposed that the roofed and paved areas within the site is directed to the existing 100mm diameter sewer within the site. The discharge into the sewer will be restricted to 5.72l/s. The impermeable area has been calculated at 6151m² (0.615 hectares). This area will be 100% roofed and paved.

An assessment of the required balance volume has been made using the estimated post development impermeable area of 0.615 hectares discharging to the 100mm diameter sewer at a peak rate of 5.72ls. Using WinDes Source Control software developed by Microdrainage the required attenuation has been calculated for the 1 in 100 year plus climate change (30%) event.

Reference should be made to Appendix E where the calculation sheets are provided. The attenuation size has been tabulated below in Table 2. It is estimated that during the 1 in 100 year plus climate change (30%) event that 327.5m³ of storage will be required. This will be provided within a 0.4m deep crate tank. The drainage strategy drawing provided at Appendix F shows the initial drainage strategy for the site which includes the tank.

Table 4-2: WinDes 1 in 100 year+CC Storage Volume

Return Period	Required Attenuation	Approx Volume (m³)
1 in 100 year + CC	715m2 of 0.4m deep crate tank	327.5

5 MITIGATION MEASURES

5.1 Raising Floor Levels/Land Raising

The River Dee is located 2200m to the north east of the site and the local watercourse is located 350m to the north east. The site is located within a very low risk area based on the Environment Agency flood maps for the area.

It is therefore recommended that the internal ground floor of the new building is raised to a level at least 150mm above the adjacent external ground level.

5.2 Emergency Access and Egress

The site is located within a very low risk area based on the Environment Agency flood maps for the area.

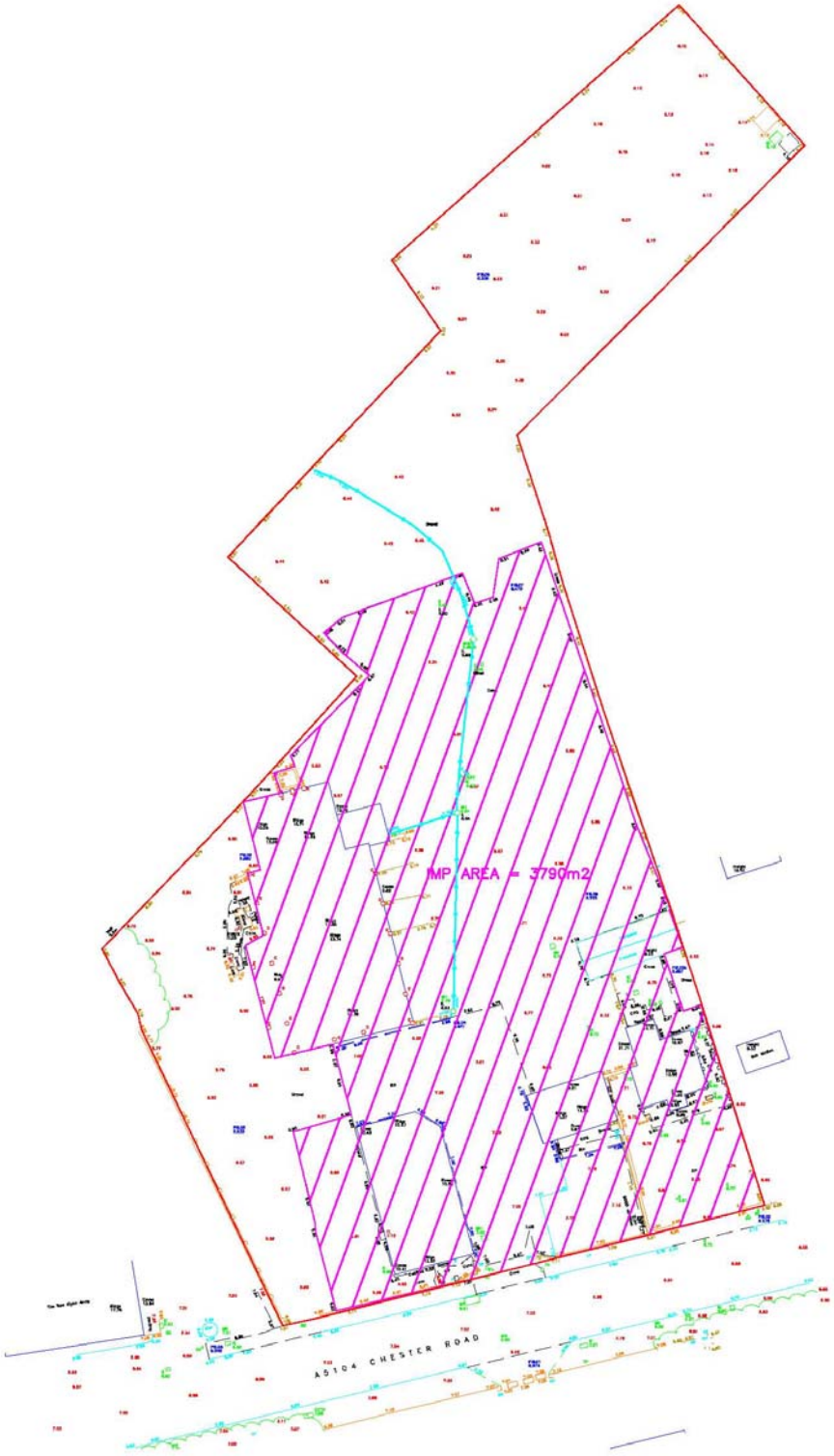
It is considered that safe access and egress will be available at all times onto the adjacent Chester Road even during extreme flood events.

6 CONCLUSION

It is concluded that the site is located within a very low risk area. The proposed development is simply a re-development of the existing commercial use to make better use of the available space within the site. It is considered that recommended mitigation measures will reduce the risk of flooding to an acceptable level.

APPENDICES

Appendix A: - Existing Site Levels



Appendix B: - Proposed Layout Plans

Appendix C: - Modified Rational Runoff Calculation

Modified Rational Method

Length (m)	95	m
Area (ha)	0.379	Ha
Max Height	7.0	mAOD
Min Height	6.5	mAOD
DeltaH	0.5	
Slope (%)	0.55	
Te (mins)	16.08	mins
ARF	0.998	
SAAR	707.000	mm
UCWI	70	mm
PIMP	100.0	%
SOIL	0.50	
Percentage Runoff PR	80.16	
DEEPSTOR	0.95	

Cv	0.8016	
Cr	1.3	
allowable outflow		
1 year	32.13	l/s

Return Period flood: 1 years
Post Development Rainfall: 2 years

Rainfall Duration (hours)	Rainfall Duration (days)	Rainfall Depth (mm)	Effective Depth (mm)	Rainfall Intensity (mm/hr)	FLOW (l/s)	FLOW (l/s/ha)
0.25	0.010	5.2	5.4	20.8	22.8	60.3
0.27	0.011	7.9	8.2	28.3	32.1	84.8
0.5	0.021	8.43	8.8	16.9	18.5	48.8
0.75	0.031	10	10.4	13.3	14.6	38.6
1	0.042	11.27	11.7	11.3	12.4	32.6
1.25	0.052	12.36	12.9	9.9	10.9	28.6
1.5	0.063	13.32	13.9	8.9	9.7	25.7
1.75	0.073	14.18	14.8	8.1	8.9	23.5
2	0.083	14.97	15.6	7.5	8.2	21.7
2.25	0.094	15.7	16.4	7.0	7.7	20.2
2.5	0.104	16.38	17.1	6.6	7.2	19.0
2.75	0.115	17.02	17.7	6.2	6.8	17.9
3	0.125	17.63	18.4	5.9	6.5	17.0
3.25	0.135	18.21	19.0	5.6	6.2	16.2
3.5	0.146	18.75	19.5	5.4	5.9	15.5
3.75	0.156	19.28	20.1	5.1	5.6	14.9
4	0.167	19.78	20.6	4.9	5.4	14.3
4.25	0.177	20.27	21.1	4.8	5.2	13.8

Modified Rational Method

Length (m)	95	m
Area (ha)	0.379	Ha
Max Height	7.0	mAOD
Min Height	6.5	mAOD
DeltaH	0.5	
Slope (%)	0.55	
Te (mins)	16.08	mins
ARF	0.998	
SAAR	707.000	mm
UCWI	70	mm
PIMP	100.0	%
SOIL	0.50	
Percentage Runoff PR	80.16	
DEEPSTOR	0.95	

Cv	0.8016	
Cr	1.3	
allowable outflow		
30 year	99.63	l/s

Return Period flood: 30 years
Post Development Rainfall: 50 years

Rainfall Duration (hours)	Rainfall Duration (days)	Rainfall Depth (mm)	Effective Depth (mm)	Rainfall Intensity (mm/hr)	FLOW (l/s)	FLOW (l/s/ha)
0.25	0.010	19.5	21.2	78.0	85.6	226.0
0.27	0.011	24.5	25.5	90.7	99.6	262.9
0.5	0.021	26.13	27.2	52.3	57.4	151.4
0.75	0.031	29.99	31.3	40.0	43.9	115.8
1	0.042	33.02	34.4	33.0	36.3	95.7
1.25	0.052	35.55	37.0	28.4	31.2	82.4
1.5	0.063	37.75	39.3	25.2	27.6	72.9
1.75	0.073	39.69	41.4	22.7	24.9	65.7
2	0.083	41.45	43.2	20.7	22.8	60.0
2.25	0.094	43.06	44.9	19.1	21.0	55.4
2.5	0.104	44.55	46.4	17.8	19.6	51.6
2.75	0.115	45.93	47.9	16.7	18.3	48.4
3	0.125	47.23	49.2	15.7	17.3	45.6
3.25	0.135	48.46	50.5	14.9	16.4	43.2
3.5	0.146	49.62	51.7	14.2	15.6	41.1
3.75	0.156	50.72	52.9	13.5	14.9	39.2
4	0.167	51.77	53.9	12.9	14.2	37.5
4.25	0.177	52.78	55.0	12.4	13.6	36.0

Modified Rational Method

Length (m)	95	m
Area (ha)	0.379	Ha
Max Height	7.0	mAOD
Min Height	6.5	mAOD
DeltaH	0.5	
Slope (%)	0.55	
Te (mins)	16.08	mins
ARF	0.998	
SAAR	707.000	mm
UCWI	70	mm
PIMP	100.0	%
SOIL	0.50	
Percentage Runoff PR	80.16	
DEEPSTOR	0.95	

Cv	0.8016	
Cr	1.3	
allowable outflow		
100 year	139.07	l/s

Return Period flood: 100 years
Post Development Rainfall: 140 years

Rainfall Duration (hours)	Rainfall Duration (days)	Rainfall Depth (mm)	Effective Depth (mm)	Rainfall Intensity (mm/hr)	FLOW (l/s)	FLOW (l/s/ha)
0.25	0.010	28	29.2	112.0	123.0	324.5
0.27	0.011	34.2	35.6	126.7	139.1	367.0
0.5	0.021	36.39	37.9	72.8	79.9	210.8
0.75	0.031	41.38	43.1	55.2	60.6	159.8
1	0.042	45.25	47.2	45.3	49.7	131.1
1.25	0.052	48.46	50.5	38.8	42.6	112.3
1.5	0.063	51.22	53.4	34.1	37.5	98.9
1.75	0.073	53.67	55.9	30.7	33.7	88.8
2	0.083	55.87	58.2	27.9	30.7	80.9
2.25	0.094	57.87	60.3	25.7	28.2	74.5
2.5	0.104	59.72	62.2	23.9	25.2	69.2
2.75	0.115	61.44	64.0	22.3	24.5	64.7
3	0.125	63.05	65.7	21.0	23.1	60.9
3.25	0.135	64.56	67.3	19.9	21.8	57.5
3.5	0.146	65.99	68.8	18.9	20.7	54.6
3.75	0.156	67.34	70.2	18.0	19.7	52.0
4	0.167	68.63	71.5	17.2	18.8	49.7
4.25	0.177	69.86	72.8	16.4	18.0	47.6

Appendix D: - Pipe Table

COLEBROOK WHITE

Roughness	1.5	mm	U/S level	5.94	m
Diam(mm)	100	mm	D/S level	5.69	m
Length	20.77	m	Gradient	0.01203659	

83.08

PROPOR'N DEPTH	WETTED PERIMETER	AREA OF FLOW	HYDRAULIC MEAN DEPTH	VELOCITY (m/s)	DISCHARGE (l/s)	DEPTH (mm)	SURFACE WIDTH (mm)
FULL	0.31415927	0.007853982	0.0250000	0.73	5.72	100	
0.01	0.02003348	1.32933E-05	0.0006636	0.04	0.00	1	20
0.02	0.02837941	3.74853E-05	0.0013209	0.07	0.00	2	28
0.03	0.0348166	6.86551E-05	0.0019719	0.11	0.01	3	34
0.04	0.04027158	0.000105377	0.0026167	0.13	0.01	4	39
0.05	0.04510268	0.000146815	0.0032551	0.16	0.02	5	44
0.1	0.06435011	0.000408753	0.0063520	0.27	0.11	10	60
0.15	0.07953988	0.000738747	0.0092878	0.36	0.27	15	71
0.2	0.09272952	0.001118238	0.0120591	0.44	0.49	20	80
0.25	0.10471976	0.001535462	0.0146626	0.50	0.77	25	87
0.3	0.11592795	0.001981684	0.0170941	0.56	1.11	30	92
0.35	0.12661037	0.002449805	0.0193492	0.61	1.49	35	95
0.4	0.13694384	0.002933698	0.0214226	0.65	1.92	40	98
0.45	0.14706289	0.003427825	0.0233086	0.69	2.38	45	99
0.5	0.15707963	0.003926991	0.0250000	0.73	2.86	50	100
0.55	0.16709637	0.004426156	0.0264886	0.76	3.36	55	99
0.6	0.17721542	0.004920284	0.0277644	0.78	3.85	60	98
0.65	0.1875489	0.005404177	0.0288148	0.80	4.33	65	95
0.7	0.19823132	0.005872298	0.0296235	0.82	4.80	70	92
0.75	0.20943951	0.00631852	0.0301687	0.83	5.23	75	87
0.8	0.22142974	0.006735744	0.0304193	0.83	5.61	80	80
0.85	0.23461938	0.007115235	0.0303267	0.83	5.91	85	71
0.9	0.24980915	0.007445229	0.0298037	0.82	6.11	90	60
0.95	0.26905658	0.007707167	0.0286452	0.80	6.16	95	44
1	0.31415927	0.007853982	0.0250000	0.73	5.72	100	0

Appendix E: - WINDES Calculation

EWE Associates Ltd		Page 1
Windy Ridge Barn Thealby Lane Winterton DN15 9TG		Micro Drainage
Date 05/07/2019 18:22	Designed By Windows7	
File 100yr+CC30% tank ...	Checked By	
Micro Drainage	Source Control W.12.4	

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	5.967	0.267	5.4	190.7	O K
30 min Summer	6.001	0.301	5.4	215.5	O K
60 min Summer	6.038	0.338	5.4	241.4	O K
120 min Summer	6.072	0.372	5.4	266.2	O K
180 min Summer	6.089	0.389	5.4	278.2	O K
240 min Summer	6.098	0.398	5.4	284.6	O K
360 min Summer	6.104	0.404	5.4	288.5	Flood Risk
480 min Summer	6.100	0.400	5.4	286.2	Flood Risk
600 min Summer	6.096	0.396	5.4	282.9	O K
720 min Summer	6.091	0.391	5.4	279.3	O K
960 min Summer	6.094	0.394	5.4	281.4	O K
1440 min Summer	6.088	0.388	5.4	277.6	O K
2160 min Summer	6.067	0.367	5.4	262.2	O K
2880 min Summer	6.039	0.339	5.4	242.1	O K
4320 min Summer	5.948	0.248	5.4	177.3	O K
5760 min Summer	5.892	0.192	5.4	137.1	O K
7200 min Summer	5.863	0.163	5.1	116.4	O K
8640 min Summer	5.845	0.145	4.7	103.8	O K
10080 min Summer	5.833	0.133	4.3	95.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	169.665	27
30 min Summer	96.546	41
60 min Summer	54.938	70
120 min Summer	31.262	128
180 min Summer	22.479	186
240 min Summer	17.789	244
360 min Summer	12.792	362
480 min Summer	10.123	458
600 min Summer	8.442	508
720 min Summer	7.279	570
960 min Summer	5.935	698
1440 min Summer	4.452	976
2160 min Summer	3.339	1388
2880 min Summer	2.722	1792
4320 min Summer	1.937	2508
5760 min Summer	1.522	3128
7200 min Summer	1.262	3824
8640 min Summer	1.083	4504
10080 min Summer	0.951	5248

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Micro Drainage	Source Control W.12.4	

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	5.999	0.299	5.4	214.1	O K
30 min Winter	6.039	0.339	5.4	242.2	O K
60 min Winter	6.080	0.380	5.4	271.5	O K
120 min Winter	6.121	0.421	5.4	299.9	Flood Risk
180 min Winter	6.144	0.444	5.4	314.0	Flood Risk
240 min Winter	6.159	0.459	5.4	321.8	Flood Risk
360 min Winter	6.170	0.470	5.4	327.5	Flood Risk
480 min Winter	6.168	0.468	5.4	326.3	Flood Risk
600 min Winter	6.158	0.458	5.4	321.7	Flood Risk
720 min Winter	6.146	0.446	5.4	315.3	Flood Risk
960 min Winter	6.148	0.448	5.4	316.0	Flood Risk
1440 min Winter	6.131	0.431	5.4	306.6	Flood Risk
2160 min Winter	6.091	0.391	5.4	279.5	O K
2880 min Winter	6.043	0.343	5.4	244.9	O K
4320 min Winter	5.909	0.209	5.4	149.4	O K
5760 min Winter	5.858	0.158	5.0	113.0	O K
7200 min Winter	5.835	0.135	4.3	96.7	O K
8640 min Winter	5.821	0.121	3.8	86.7	O K
10080 min Winter	5.811	0.111	3.4	79.6	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	169.665	27
30 min Winter	96.546	41
60 min Winter	54.938	70
120 min Winter	31.262	126
180 min Winter	22.479	184
240 min Winter	17.789	240
360 min Winter	12.792	354
480 min Winter	10.123	464
600 min Winter	8.442	568
720 min Winter	7.279	608
960 min Winter	5.935	746
1440 min Winter	4.452	1058
2160 min Winter	3.339	1516
2880 min Winter	2.722	1936
4320 min Winter	1.937	2552
5760 min Winter	1.522	3176
7200 min Winter	1.262	3832
8640 min Winter	1.083	4576
10080 min Winter	0.951	5256

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Micro Drainage	Source Control W.12.4	

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
Site Location	334950 364300 SJ 34950 64300
C (1km)	-0.024
D1 (1km)	0.297
D2 (1km)	0.401
D3 (1km)	0.271
E (1km)	0.288
F (1km)	2.419
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.615

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.200	4-8	0.200	8-12	0.200	12-16	0.015

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Micro Drainage	Source Control W.12.4	

Model Details

Storage is Online Cover Level (m) 6.400

Tank or Pond Structure

Invert Level (m) 5.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	715.0	1.400	0.0	2.800	0.0	4.200	0.0
0.200	715.0	1.600	0.0	3.000	0.0	4.400	0.0
0.400	715.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	0.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	0.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	0.0	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

Hydro-Brake® Outflow Control

Design Head (m) 0.700 Hydro-Brake® Type Md4 Invert Level (m) 5.700
Design Flow (l/s) 5.7 Diameter (mm) 94

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.8	1.200	7.5	3.000	11.9	7.000	18.2
0.200	5.4	1.400	8.1	3.500	12.9	7.500	18.9
0.300	4.6	1.600	8.7	4.000	13.8	8.000	19.5
0.400	4.5	1.800	9.2	4.500	14.6	8.500	20.1
0.500	4.9	2.000	9.7	5.000	15.4	9.000	20.7
0.600	5.3	2.200	10.2	5.500	16.1	9.500	21.2
0.800	6.2	2.400	10.7	6.000	16.9		
1.000	6.9	2.600	11.1	6.500	17.6		

Appendix F: - Drainage Strategy Drawing