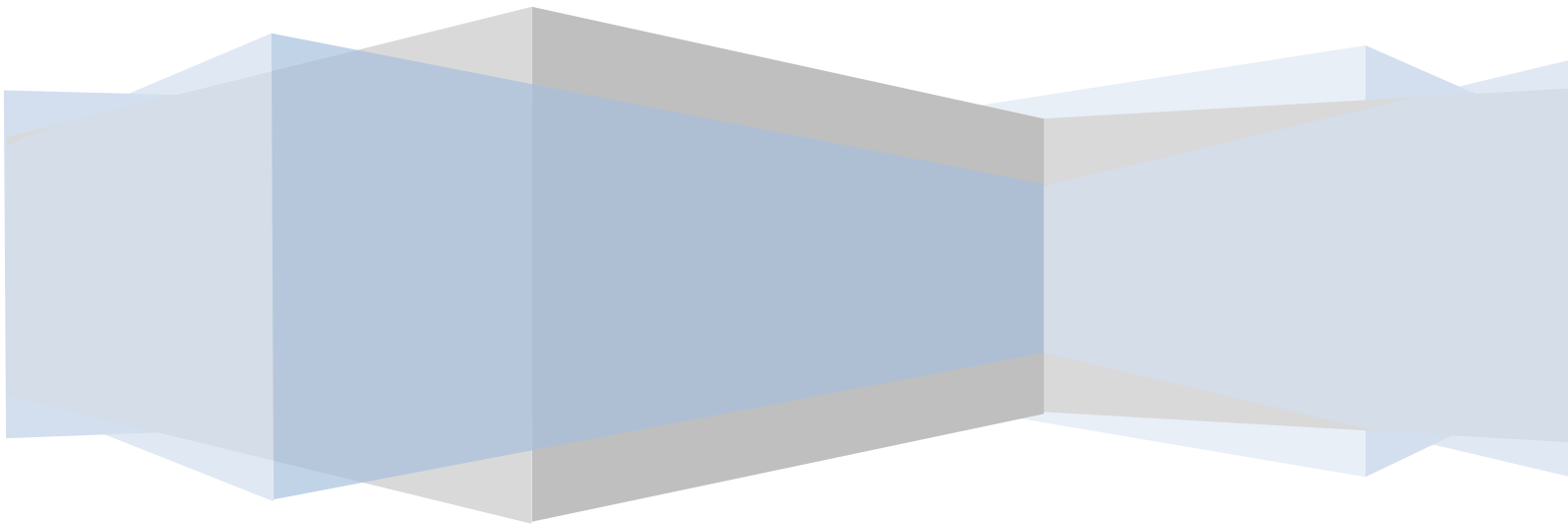


Drainage Strategy & Flood Risk Assessment

Proposed Commercial Development at The Croft, Welton Road, Bromborough



18-1029-REP001-P2

Dated: 02 July 2021



Document Control

Signed:



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Qualifications:

BEng (Hons)

Issue No.	Date	Author	Verified By	Our Ref
P1	04 Dec 2018	MDJ	MDJ	18-1029
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1.0 Introduction

- 1.1 Following instructions from Redsun Projects in November 2018, Muir Associates (UK) Ltd have undertaken an initial assessment of flooding and drainage issues in relation to a proposed development site located at The Croft Retail Park, Welton Road in Bromborough for commercial and Leisure use.
- 1.1.1 The site was previously developed and has since been demolished and remained a grassed field for a number of years.
- 1.1.3 There is currently an existing 1.20m diameter public combined water sewer running from South West to North East which passes through the site in addition to a 300mm diameter public foul sewer which runs from East to West which connects to the Combined Sewer within the site boundary.
- 1.1.4 The Local Authority is Wirral Borough Council (WBC), and the wastewater undertaker is United Utilities (UU).
- 1.1.5 The comments given in this report and recommendations made are based in the information that could be obtained from reasonably accessible sources.
- 1.1.6 Detailed discussions have not yet been held with Wirral LLFA or United Utilities regarding the proposals however a predevelopment application has been submitted to UU and we are currently awaiting their comments.
- 1.1.7 This report has been prepared for the sole use of Redsun Projects Limited.

2.0 Policy Considerations and Objectives

2.1 National Planning Policy Framework:

2.1.1 Section 10 of the National Planning Policy Framework (NPPF) published in March 2012 sets out Government policy on development and flood risk for England. It aims to ensure that flood risk is taken into account at all stages of the planning process, to avoid inappropriate developments in areas at risk of flooding, and to direct development away from areas of highest risk. Where new development is thought necessary in areas of flood risk, the NPPF aims to make it safe, without increasing flood risk elsewhere, and, where possible, reduce the overall flood risk.

2.1.2 The NPPF promotes a sequential risk-based approach to determine the suitability of land for development in flood risk areas. The broad aim of the NPPF is to reduce the number of people and properties within the natural and built environment at risk of flooding. To achieve this aim, planning authorities are required to ensure that flood risk is properly assessed during the initial planning stages of any development.

2.2 Consideration and Objectives

2.2.1 This Flooding and Drainage Assessment Report will consider the following:-

2.2.2 Whether the proposed development is likely to be affected by flooding.

2.2.3 Whether the proposed development will increase flood risk to adjacent properties.

2.2.4 The report will also demonstrate that any existing flood risk or flood risk associated with the proposed development can be satisfactorily managed.

2.2.5 Whether the proposed development is likely to be affected by flooding and whether it will increase flood risk elsewhere.

2.2.6 Specifying the measures proposed to deal with the identified risks, including, where appropriate, proposals to reduce existing and/or future flood risk levels.

2.2.7 Satisfy the Local Authority that any flood risk to the development or additional risk arising from the proposal will be successfully managed so the site can be developed and occupied safely with risk to adjacent properties.

2.3 Local Planning Policy

2.3.1 The Wirral Council Preliminary Strategic Flood risk Assessment was prepared in 2011. The development plan sets out the authorities' policies and proposals for the development and use of land in its area.

2.3.2 The Wirral Council Local Flood Risk Management Strategy was prepared in July 2016 which highlights the aims and objectives of the current policy and guidelines.

2.4 Local Flood Risk Management Strategy (LFRMS)

2.4.1 Wirral Council is the Lead Local Flood Authority (LLFA) for the Wirral borough area and undertakes the flood and coastal erosion risk management functions as described in Sections 4 & 5 of Part 1 of the Flood and Water Management Act 2010 (FWMA).

2.4.2 The Flood & Water Management Act also included a number of measures and responsibilities for the LLFA, which includes the production of a Local Flood Risk Management Strategy (LFRMS) A Local Flood Risk Management Strategy is a requirement under Section 9 of the FWMA for all lead local flood authorities to set out how local flood risks will be managed, who will deliver them and how they will be funded.

2.5 Aims & Objectives

2.5.1 Wirral Council as the LLFA will work with its partners, other flood risk management authorities, individuals, communities and organisations to reduce the threat of flooding and coastal erosion. It will achieve this through the aim and objectives set out in this strategy.

Objective 1:

Understand the local risks of flooding and coastal erosion, working together with partners, other risk management authorities, organisations and the community to identify the causes and put in place long-term plans to manage these risks and make sure that other plans take account of them;

Objective 2:

Ensure that the guiding principles for sustainable development are applied and inappropriate development is avoided in existing and future areas at risk of flood and coastal erosion while elsewhere, carefully managing other land to avoid increasing the risks;

Objective 3:

Where financially viable, build, maintain and improve local flood and coastal erosion management infrastructure and systems to mitigate or reduce the likelihood of harm to people and damage to the economy; environment (natural, historic, built and social) and society as a whole;

Objective 4:

Increase public awareness of the effects of climate change and the implications for an increase in flood risk, engage with people specifically at risk of flooding, to encourage them to take action to manage and/or mitigate the risks that they face and to make their property more resilient;

Objective 5:

Support and assist those bodies responsible for improving the detection, forecasting and issue of warnings of flooding. Plan for and co-ordinate a rapid response to flood emergencies and promote faster recovery from flooding.

3.0 Flooding Issues

3.1 The Site:

- 3.1.1 The site is located between Welton Road and Caldbeck Road. A site location plan is attached in Appendix A.
- 3.1.2 The Ordnance Survey coordinates for the centre of the site are 335000m E and 382800m N.
- 3.1.3 The total developable site area is approximately 2.252 hectares.
- 3.1.4 The site topography is generally flat with levels of between 22.54m - 22.10m, however the site currently has an embankment located to the southern and western boundary with levels raising from between 23.11m – 25.73m.
- 3.1.5 A site topographical survey is attached in Appendix B.
- 3.1.6 A site aerial photograph is attached in Appendix C.
- 3.1.7 From the inspection of the OS maps it does not appear that there are any additional watercourses on or in the immediate vicinity of the site except for the River Mersey.

3.2 Flood Zone Classification:

- 3.2.1 The site is located within Flood Zone 1 on the indicative EA website flood zone map. This zone comprises land assessed as having less than 1 in 100 (<0.1%) annual probability of tidal or river flooding in any year.

3.3 Sources of Flood Risk:

The following table shows a summary of the forms of flood and the potential issues in relation to the site that require further assessment.

Flood Source	Applicable	Comment
Fluvial	X	
Tidal	X	
Run Off	X	
Ground Water	X	Relatively high groundwater levels are unlikely in this location.
Sewers	✓	Public sewers adjacent the boundaries of the site and within the site.
Reservoirs, Canals, etc.	X	There are no reservoirs or canals within close proximity to the site.

3.4 Sequential Test:

- 3.4.1 The Sequential Test should be applied at all stages of planning. Its aim is to steer new development to areas of the lowest probability of flooding.
- 3.4.2 Table 2 of the Technical Guidance to the NPPF (which categorises the flood risk vulnerability of land uses) indicates the proposed development is categorised as a 'more vulnerable' land use.
- 3.4.3 From the EA flood zone map the site is identified as being Flood Zone 1.

- 3.4.4 Table 3 of the Technical Guidance to the NPPF indicates where the proposed land use is 'more vulnerable' development is appropriate in Flood Zone 1. Therefore the Sequential Test has been passed.
- 3.5 Exception Test:
- 3.5.1 Table 3 of the Technical Guidance to the NPPF indicates where the proposed land use is 'more vulnerable' development is considered appropriate in Flood Zone 1 and the exception test is not required.
- 3.5.2 Notwithstanding the above the following sections of this report will demonstrate that the proposed development will be safe from flooding and will not increase the flood risk elsewhere.
- 3.6 Flood Risk Assessment:
- 3.6.1 The site is within Flood Zone 1. This zone comprises land assessed as having less than a 1 in 100 (<0.1%) annual probability of tidal or river flooding in any one year.
- 3.6.2 From the inspection of site levels and following a site walkover the site does not appear to be at risk from inundation of flood waters from surface water runoff from higher land.
- 3.6.3 The effect of groundwater as a flood source is not considered to be an issue at this location.
- 3.6.4 From the inspection of site levels, the site does not appear to be at risk from the inundations of flood waters from overloaded public sewers around the site.
- 3.7 Effect of Development on the Wider Catchment:
- 3.7.1 The proposed re-development will result in an increase of the impermeable area on the site and therefore un-attenuated surface water flows from the development, if not addressed, may increase the flood risk to the local catchment.
- 3.8 Flood Risk Mitigation:
- 3.8.1 The proposed development is in Flood Zone 1.
- 3.8.2 The new site entrances to each of the developed areas will be formed from Welton Road. The proposed site levels will be designed to prevent any flooding occurring from the existing road or higher land.
- 3.8.3 The external levels within the development should be set to route any overland flood waters away from the proposed buildings or high risk areas to mitigate any possible flooding from overland flows.

4.0 Drainage

4.1 Public Sewers:

- 4.1.1 There are separate foul and surface water public sewers located within the vicinity of the site. The public sewer records are within Appendix F and indicate an existing large combined public sewer crossing the site in addition to a foul public sewer on site.
- 4.1.2 It is intended subject to levels to make a new connection at the end of the access road for both foul and surface water drainage.
- 4.1.3 The existing site.
- 4.1.4 The depth of the sewers within the site currently varies, and indicated on the public sewer records.
- 4.1.5 Proposed Drainage Strategy
- 4.1.6 Foul will be discharged to the existing 225mm diameter foul public sewer located on Welton Road adjacent to the site. A new manhole with an approx. depth of 3.50m will be formed in line with the new site entrance.
- 4.1.7 Surface water is proposed to discharge into the existing 300mm diameter surface water public sewer located on Welton Road adjacent to the site. A new manhole with an approx. depth of 3.00m will be formed in line with the new site entrance.

4.2 Existing Drainage:

- 4.2.1 The existing public sewers are indicated as running through the site and on the eastern and southern boundaries of the site.

4.3 Foul Water:

- 4.3.1 There is an existing foul public sewer located within Welton Road.

4.4 Surface Water Drainage:

- 4.4.1 There is an existing surface water public sewer located within Welton Road.
- 4.4.2 The use of soakaways and porous paving will be considered on the development subject to ground conditions and the results of falling head permeability testing in accordance with BRE363: Soakaways. Knowledge of the site and the presences of land drains would appear to indicate the ground conditions are generally unsuitable for this.
- 4.4.3 It is proposed, subject to agreement from United Utilities and Local Planning Authority, to discharge the surface water from the developed site into the existing surface water sewer with restricted flows. It is proposed divide the site into 6 areas Units 1, 2, 3, 4, 5 & Access Road and to restrict each of the connections being limited to 2 l/s to the outgoing pipework, with a final discharge to be limited to 12 l/s.

- 4.4.4 Proposed development Impermeable Area : 17,396m²

4.5 Proposals:

- 4.5.1 It is proposed that a separate foul water drainage systems is provided on the development discharging to the public foul sewer in Welton Road by means of gravity drainage with a new connection onto the public sewer.
- 4.5.2 It would appear a gravity system can be adopted on the site, subject to final levels checks of existing sewers.
- 4.5.3 It is proposed that a separate surface water drainage system is provided on the development which will connect to the existing surface water public sewer in Welton Road by means of gravity drainage with a new connection onto the public sewer.
- 4.5.4 The proposed building finished floor level will be set to avoid any risk of flooding occurring from drainage failure on or off site.

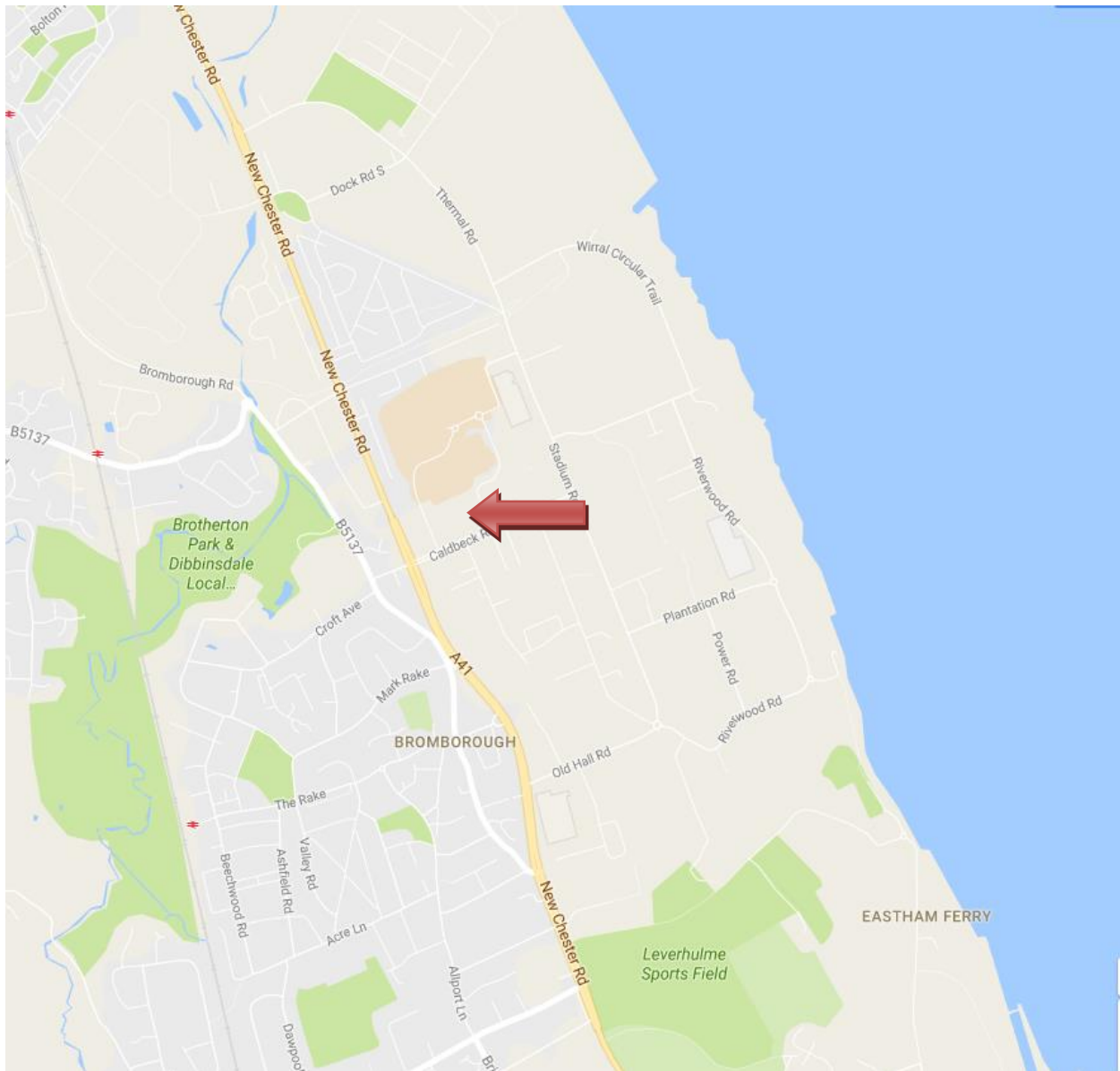
5.0 Summary

The Site	<p>The site is located between Welton Road and Caldbeck Road. A site location plan is attached in Appendix A.</p> <p>The Ordnance Survey coordinates for the centre of the site are 335000m E and 382800m N.</p> <p>The total developable site area is approximately 2.252 hectares.</p> <p>The site topography is generally flat with levels of between 22.54m - 22.10m, however the site currently has an embankment located to the southern and western boundary with levels raising from between 23.11m – 25.73m.</p>
Flooding Issues	<p>The site is within Flood Zone 1. This zone comprises land assessed as having less than a 1 in 100 (<0.1%) annual probability of tidal or river flooding in any one year.</p> <p>From the inspection of site levels and following a site walkover the site may be at risk from inundation of flood waters from surface water runoff from higher land to the west. The effect of groundwater as a flood source is not considered to be an issue at this location.</p> <p>From the inspection of site levels, the site does not appear to be at risk from the inundation of flood waters from overloaded public sewers adjacent the site as any such flood waters would tend to flow past the site along the adopted highways. Floor levels for the proposed buildings will be set as such to allow any overland flood water to pass without causing flooding within the buildings.</p>
Sequential Test	<p>The Sequential Test should be applied at all stages of planning. Its aim is to steer new development to areas at the lowest probability of flooding. Table 2 of the Technical guidance to the NPPF (which categorises the flood risk vulnerability of land uses) indicates the proposed development is categorised as a 'more vulnerable' land use.</p> <p>From the EA flood zone map the site is identified as being Flood Zone 1. Table 3 of the Technical Guidance to the NPPF indicates where the proposed land use is 'more vulnerable' development is appropriate in Flood Zone 1. Therefore the Sequential Test has been passed.</p>
Exception Test	<p>Table 3 of the Technical Guidance to the NPPF indicates where the proposed land use is 'more vulnerable' development is considered appropriate in Flood Zone 1 and the Exception Test is not required.</p> <p>Notwithstanding the above the following sections of this report will demonstrate that the proposed development will be safe from flooding and will not increase flood risk elsewhere.</p>
Flood-Risk Mitigation	<p>The proposed development is in Flood Zone 1. If possible. The new site access road which is indicated to run</p>

	<p>through the site will be ramped down slightly so any existing overland flood waters would flow in the direction of the existing topography and to avoid the buildings being flooded. The external levels around the development should be set to route any overload flood waters in the north east direction as the existing situation.</p>
Foul Drainage	<p>It is proposed that a separate foul water drainage systems is provided on the development discharging to the public foul sewer in Welton Road by means of a new connection onto the existing foul public sewer.</p> <p>It would appear from a review of the drainage plans a gravity system can be adopted on the site subject to final building levels.</p>
Surface Water	<p>The use of soakaways and porous paving will be considered on the development subject to ground conditions and the results of falling head permeability testing in accordance with BRE363: Soakaways.</p> <p>It is proposed, following agreement from United Utilities and Local Planning Authority, to the discharge the surface water from the developed site into the existing surface water sewer located within Welton Road with restricted flows on each development plot prior to connecting in to the new surface water sewer which will be located within the new access road.</p>

Appendix A

Site Location Plan



Appendix C

Site Aerial Photograph



Appendix E

Environment Agency Flood Maps



Flood map for planning

Your reference	Location (easting/northing)	Created
18-1029	335042/382845	3 Dec 2018 3:10

Your selected location is in flood zone 1, an area with a low probability of flooding.

This means:

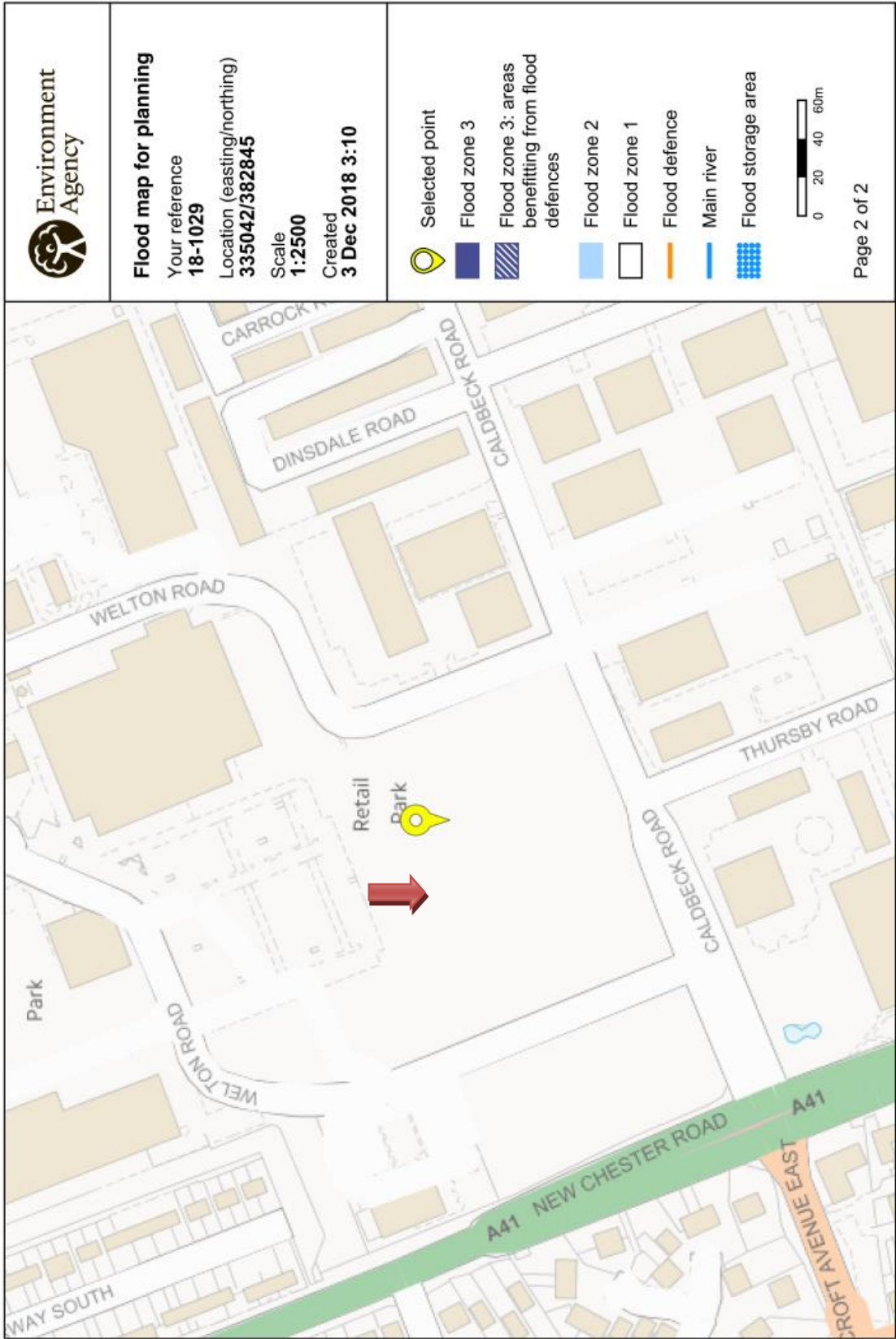
- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

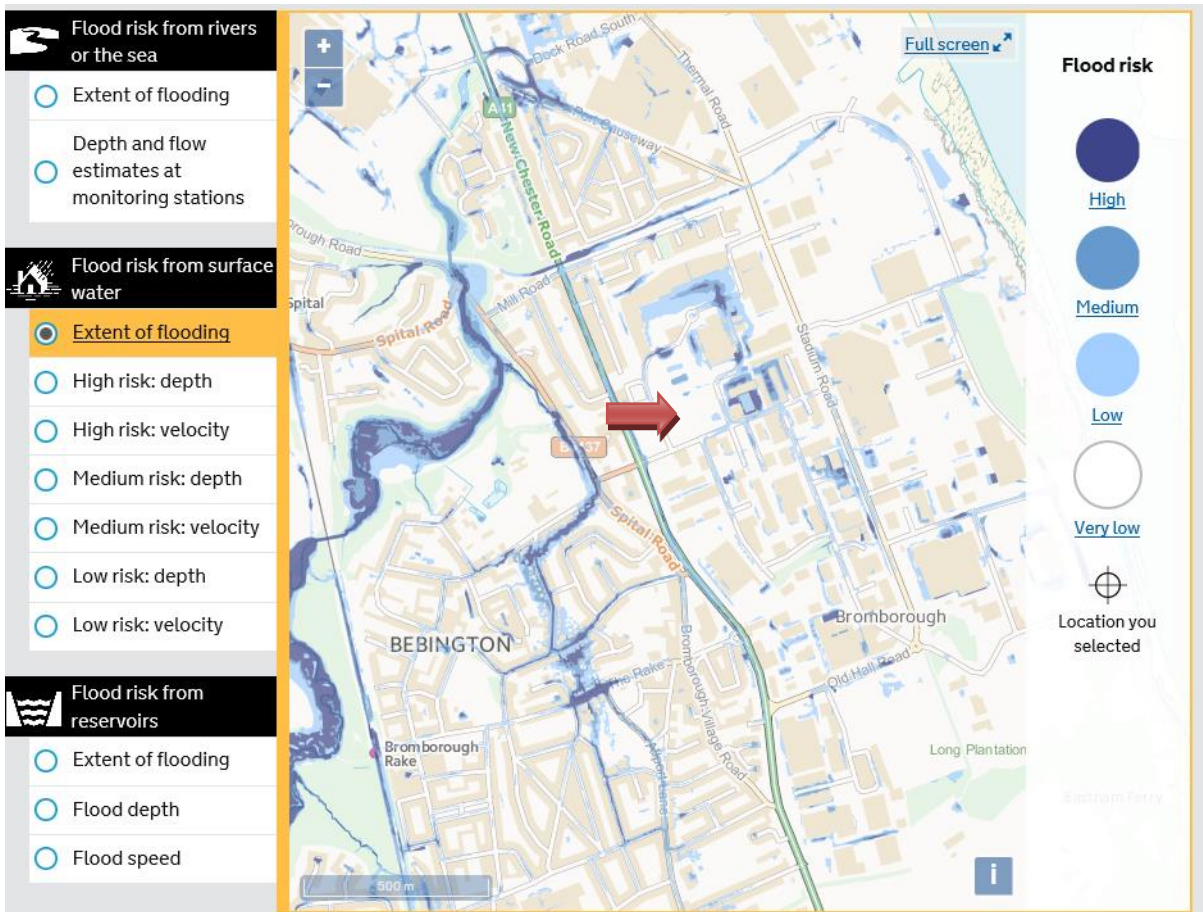
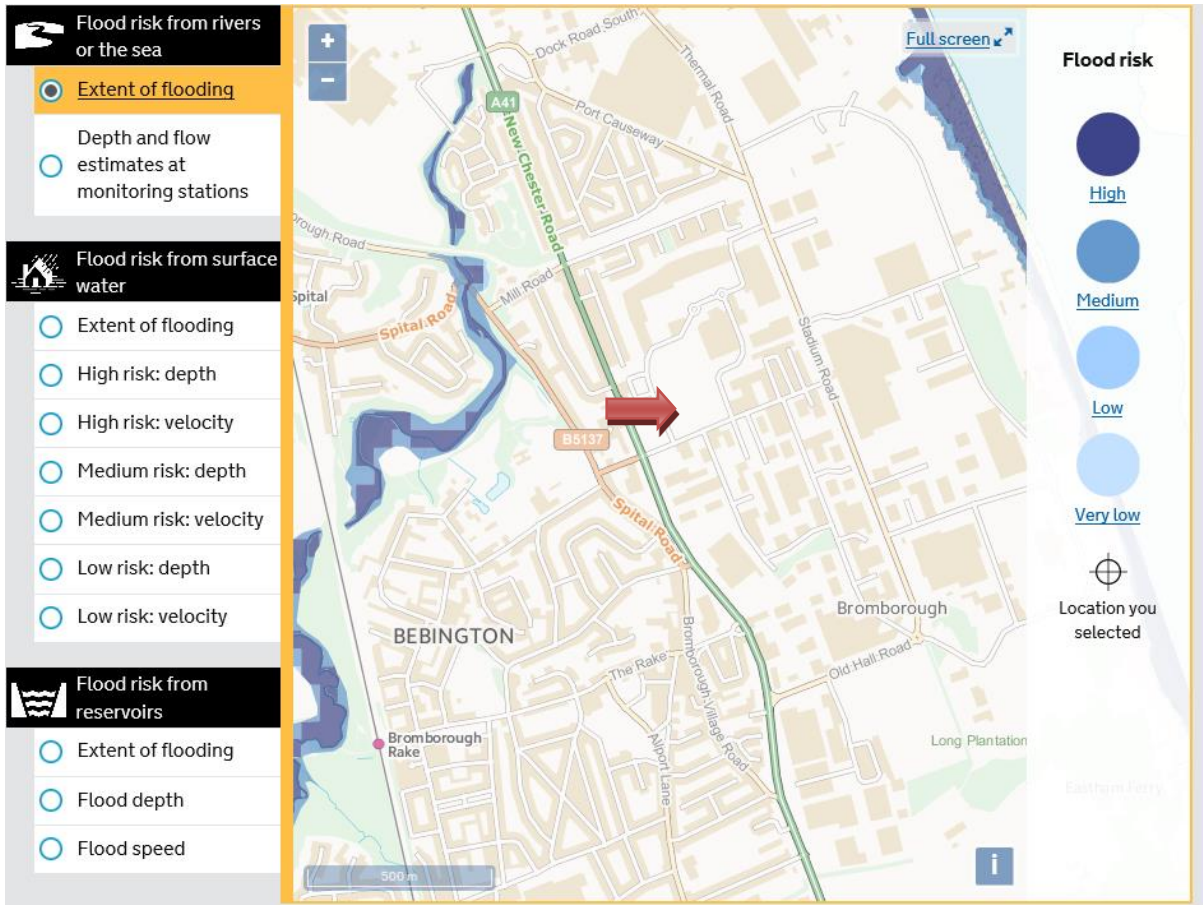
Notes

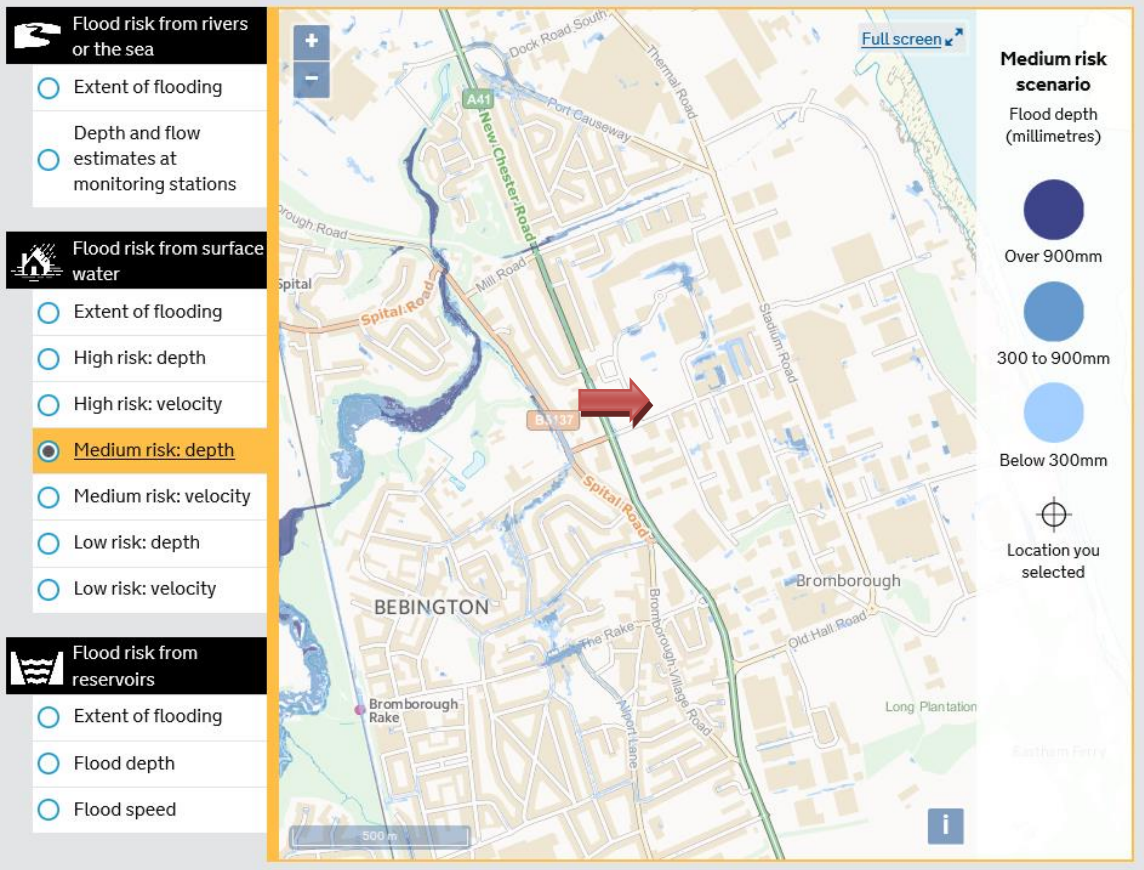
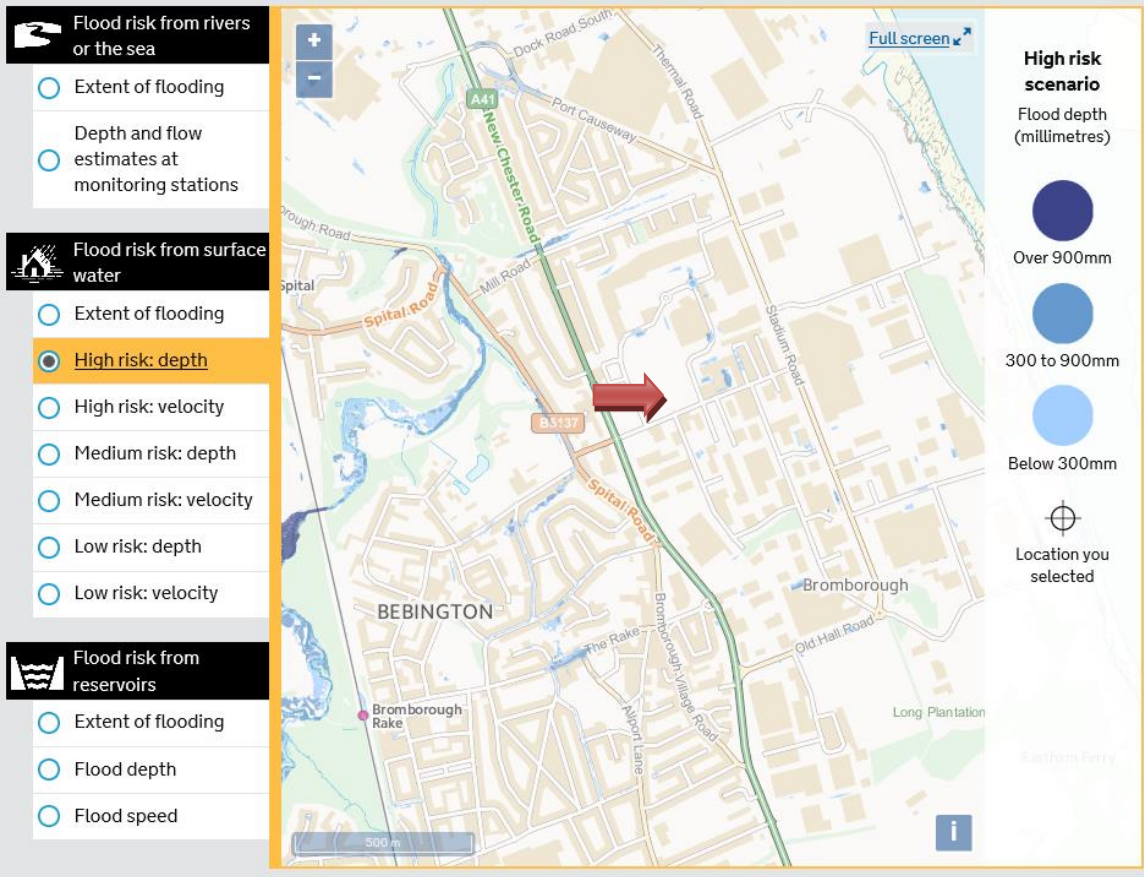
The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

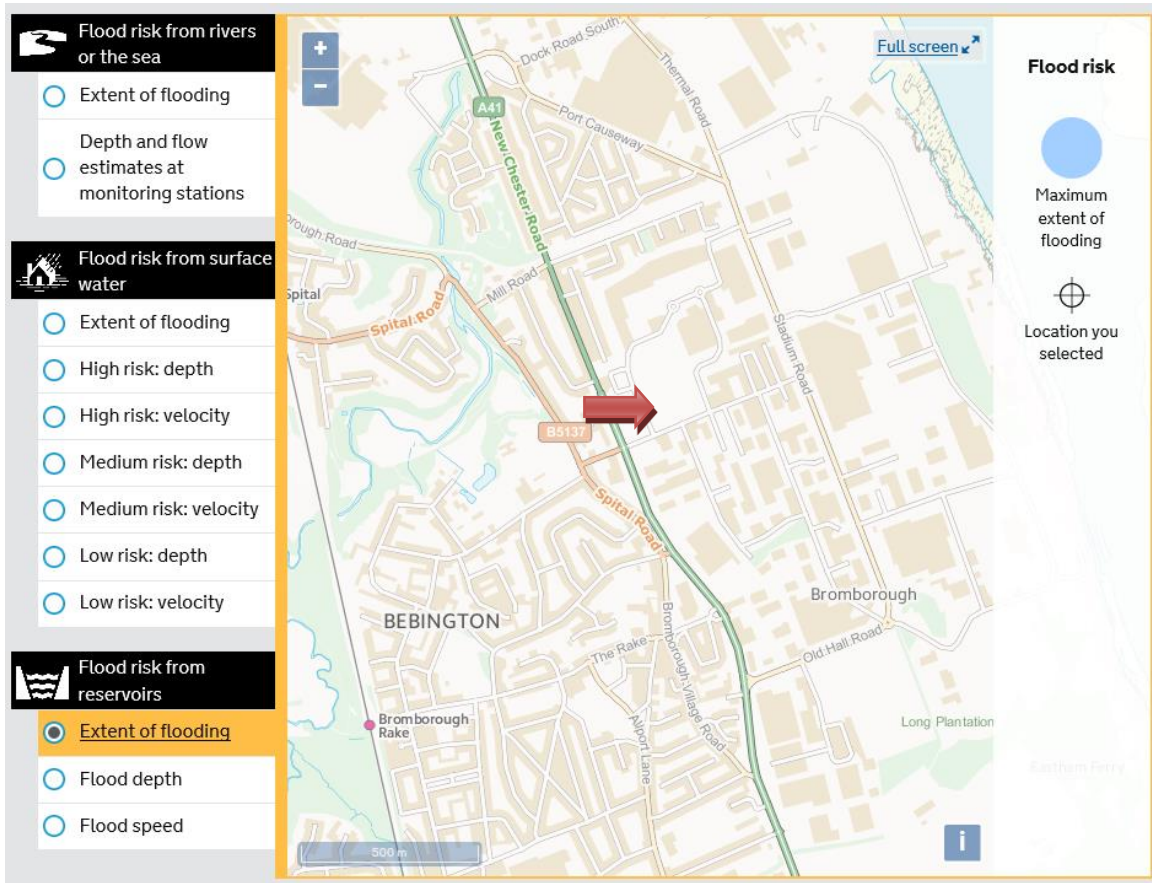
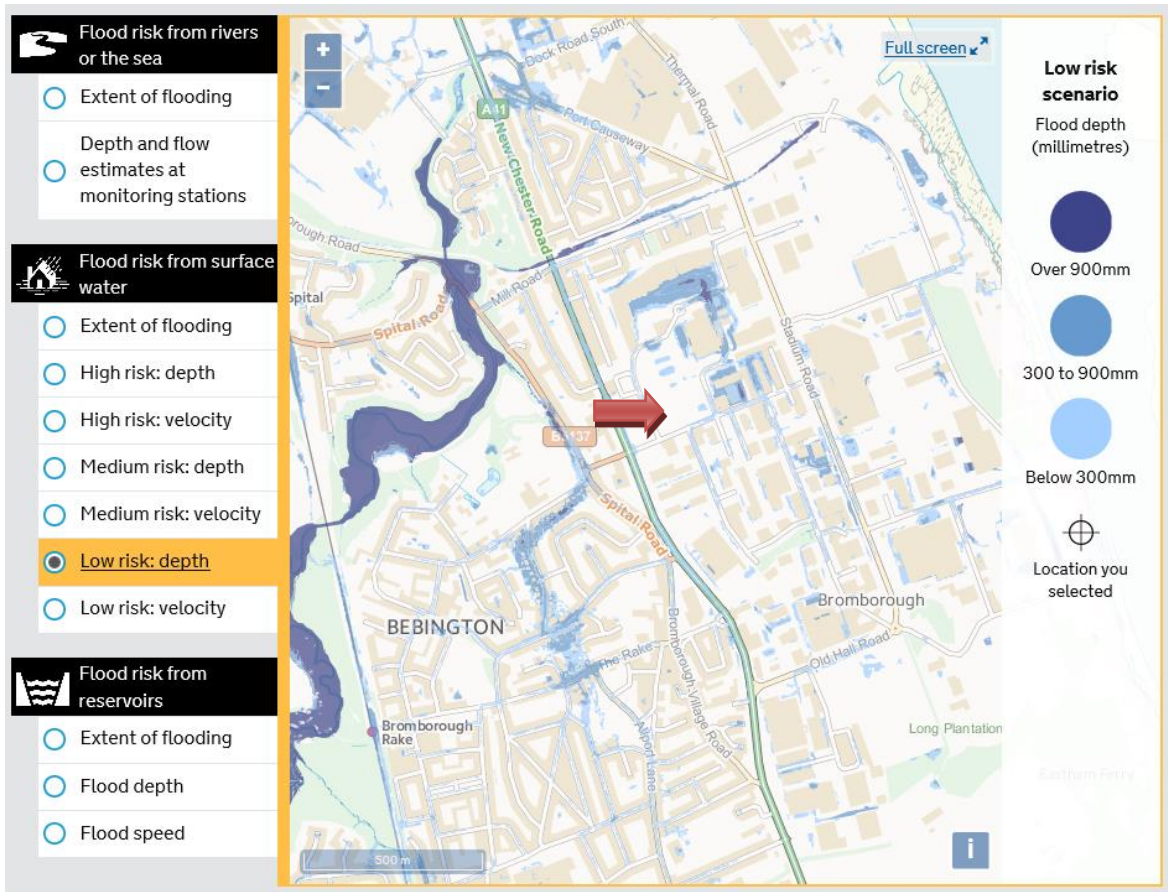
This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

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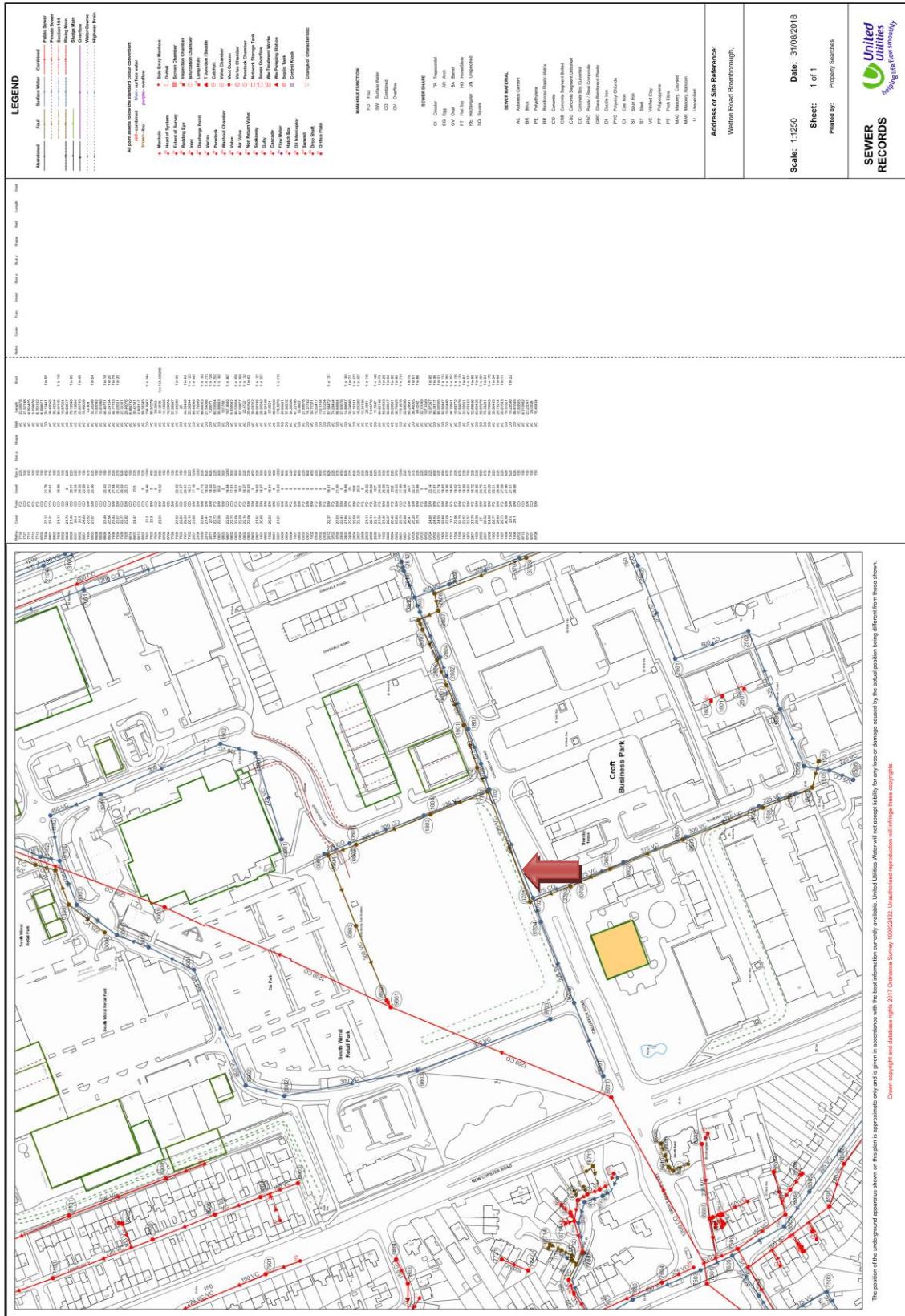






Appendix F

United Utilities Sewer Records



Appendix H

Preliminary Attenuation Tank Sizing



MasterDrain
SW

**Muir Associates (UK)
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Job No. 18-1029		
Sheet no. 1		
Date 25/06/21		
By	Checked	Reviewed

Project **The Croft Welton Road Bromborough - Unit 1**

Title **Hydrograph Storage Analysis for Wirral**

Data:-

Location = Wirral	Grid reference = SJ9766
M5-60 (mm) = 19	r = 0.40
Soil index = 0.45	SAAR (mm/yr) = 800
Return period = 100	WRAP = 4
UCWI = 0.0	Climate change = +30%

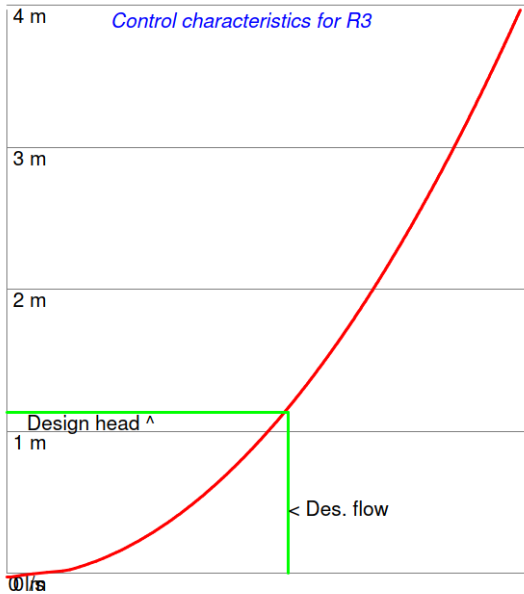
Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Percentage runoff = 95.0% (manual setting)

Imperv. area = 4257 m ²	Pervious area = 0 m ²
Total area = 4257 m ²	Equiv area = 4044 m ² (Tot. area x % runoff).
Total runoff = 314.4 m ³	Discharge rate = 2.000 l/s

Design Head = 1.2m	Peak flow = 1.99 l/s
Control device = R3	Orifice diam = 37.8 mm
Max. calc. depth = 1.2 m	Available depth = 0.0 m ³

Pipeline storage = 0.0 m ³	Available MH storage = 0.0 m ³
Offline storage = 0.0 m ³	Peak input flow = 36.39 l/s
Total storage = 296.0 m ³	



Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.01	0.04	2.01	2.59
0.05	0.39	2.05	2.61
0.10	0.58	2.10	2.65
0.15	0.71	2.15	2.68
0.20	0.82	2.20	2.71
0.25	0.91	2.25	2.74
0.30	1.00	2.30	2.77
0.35	1.08	2.35	2.80
0.40	1.15	2.40	2.83
0.45	1.22	2.45	2.86
0.50	1.29	2.50	2.89
0.55	1.35	2.55	2.92
0.60	1.41	2.60	2.94
0.65	1.47	2.65	2.97
0.70	1.53	2.70	3.00
0.75	1.58	2.75	3.03
0.80	1.63	2.80	3.06
0.85	1.68	2.85	3.08
0.90	1.73	2.90	3.11
0.95	1.78	2.95	3.14
1.00	1.83	3.00	3.16
1.05	1.87	3.05	3.19
1.10	1.91	3.10	3.21
1.15	1.96	3.15	3.24
1.20	2.00	3.20	3.27
1.25	2.04	3.25	3.29
1.30	2.08	3.30	3.32
1.35	2.12	3.35	3.34
1.40	2.16	3.40	3.37
1.45	2.20	3.45	3.39
1.50	2.24	3.50	3.42
1.55	2.27	3.55	3.44
1.60	2.31	3.60	3.46
1.65	2.35	3.65	3.49
1.70	2.38	3.70	3.51
1.75	2.42	3.75	3.54
1.80	2.45	3.80	3.56
1.85	2.48	3.85	3.58
1.90	2.52	3.90	3.61
1.95	2.55	3.95	3.63
2.00	2.58	4.00	3.65

Calculation data provided by Crown Water Ltd, SLS 7NT



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SW

Muir Associates (UK) Limited

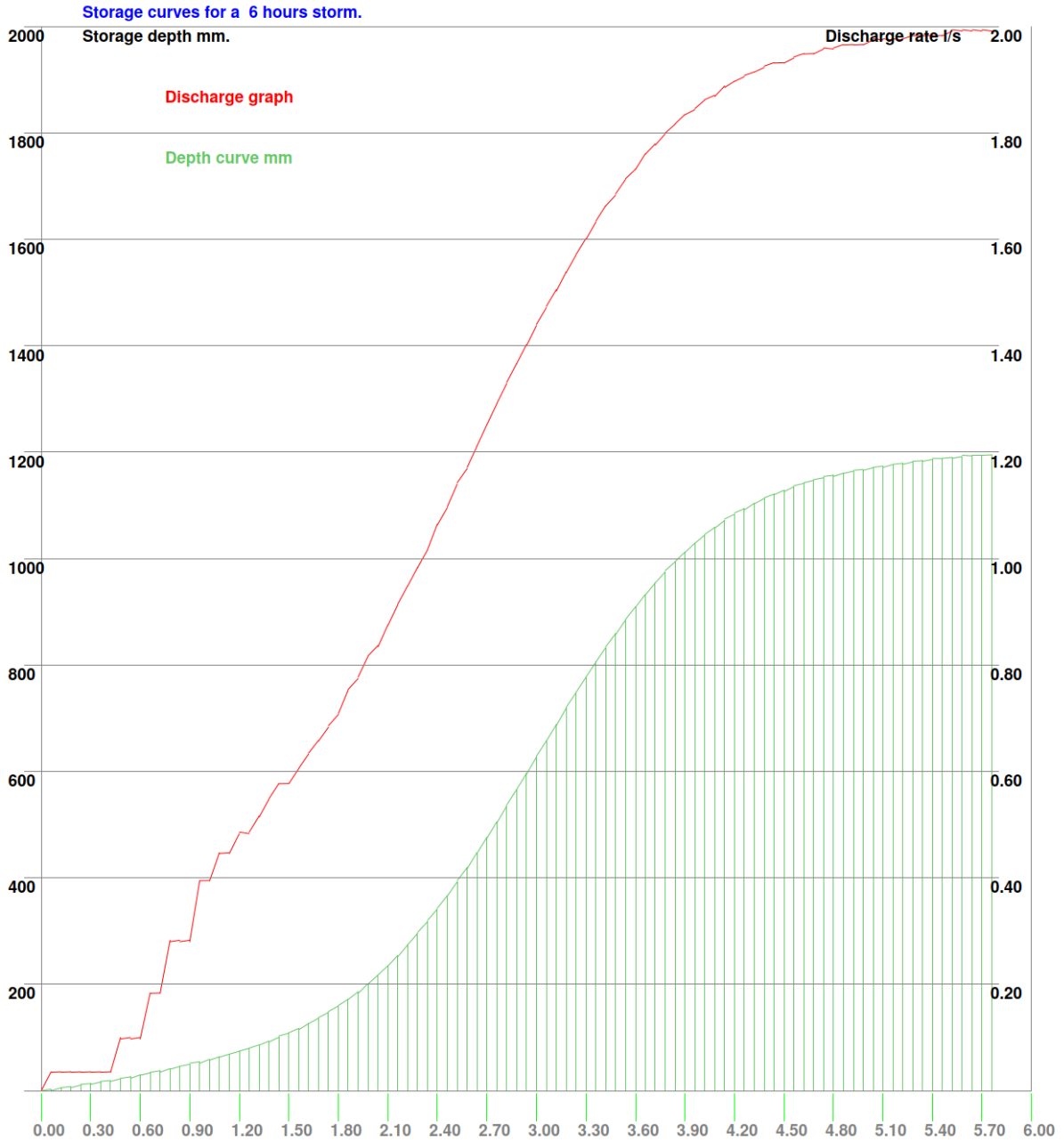
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Job No.	18-1029		
Sheet no.	2		
Date	25/06/21		
By	Checked	Reviewed	

Project **The Croft Welton Road Bromborough - Unit 1**

Title **Hydrograph Storage Analysis for Wirral**





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Job No.	18-1029		
Sheet no.	3		
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By	Checked	Reviewed	

Project	The Croft Welton Road Bromborough - Unit 1		
Title	Hydrograph Storage Analysis for Wirral		

Incremental rainfall figures.

Storm Mins	Storage Depth mm	Control Flow l/s	Storm Mins	Storage Depth mm	Control Flow l/s
3.6	2.5	0.04	183.6	657.4	1.47
7.2	5.1	0.04	187.2	687.9	1.51
10.8	7.7	0.04	190.8	718.2	1.54
14.4	10.4	0.04	194.4	747.9	1.57
18.0	13.1	0.04	198.0	777.0	1.60
21.6	16.0	0.04	201.6	805.3	1.63
25.2	19.1	0.04	205.2	832.7	1.66
28.8	22.3	0.10	208.8	859.2	1.68
32.4	25.7	0.10	212.4	884.7	1.71
36.0	29.3	0.10	216.0	909.2	1.73
39.6	33.2	0.18	219.6	932.4	1.76
43.2	37.1	0.18	223.2	954.2	1.78
46.8	41.1	0.28	226.8	974.7	1.80
50.4	45.2	0.28	230.4	994.0	1.82
54.0	49.6	0.28	234.0	1012.1	1.83
57.6	54.2	0.39	237.6	1028.7	1.84
61.2	58.8	0.39	241.2	1044.3	1.86
64.8	63.5	0.45	244.8	1058.6	1.87
68.4	68.5	0.45	248.4	1071.5	1.89
72.0	73.8	0.48	252.0	1083.2	1.90
75.6	79.7	0.48	255.6	1094.0	1.91
79.2	86.0	0.52	259.2	1104.0	1.91
82.8	92.8	0.55	262.8	1113.0	1.92
86.4	100.2	0.58	266.4	1121.1	1.93
90.0	108.1	0.58	270.0	1128.5	1.93
93.6	116.7	0.61	273.6	1135.2	1.94
97.2	126.0	0.63	277.2	1141.4	1.95
100.8	136.1	0.66	280.8	1147.0	1.95
104.4	147.1	0.68	284.4	1152.0	1.96
108.0	159.0	0.71	288.0	1156.5	1.96
111.6	171.8	0.75	291.6	1160.6	1.97
115.2	185.7	0.77	295.2	1164.2	1.97
118.8	200.9	0.82	298.8	1167.6	1.97
122.4	217.4	0.84	302.4	1170.8	1.97
126.0	234.9	0.88	306.0	1173.9	1.97
129.6	253.8	0.91	309.6	1176.8	1.97
133.2	273.9	0.95	313.2	1179.4	1.97
136.8	295.1	0.98	316.8	1181.9	1.98
140.4	317.6	1.02	320.4	1184.2	1.98
144.0	341.4	1.06	324.0	1186.4	1.98
147.6	366.5	1.10	327.6	1188.4	1.98
151.2	392.5	1.14	331.2	1190.1	1.99
154.8	419.5	1.17	334.8	1191.7	1.99
158.4	447.2	1.21	338.4	1193.0	1.99
162.0	475.9	1.25	342.0	1194.2	1.99
165.6	505.2	1.29	345.6	1195.2	1.99
169.2	535.2	1.33	349.2	1196.2	1.99
172.8	565.7	1.37	352.8	1197.1	1.99
176.4	596.2	1.40	356.4	1197.9	1.99
180.0	626.8	1.44	360.0	1198.7	1.99

Using the Get Max button causes the program to step through a series of storm durations until a maximum volume is obtained.

Each duration is sampled 600 times and the results recorded. The storm durations (hrs) are:-

0.25, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 18, 20, 24, 30, 36, 42, 48, 54, 60, 66, 72, 84, 96, 120, 150, 175, 200, 250, 300, 375, 500, 750, 1000, 1250, 1500, 1570, 2000, 2500, 3000, 3500, 4000

It should be noted that the six hour storm frequently requested rarely demonstrates the worst case for storage.



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Job No. 18-1029		
Sheet no. 1		
Date 29/06/21		
By	Checked	Reviewed

Project **The Croft Welton Road Bromborough Unit 2**
Title **Hydrograph Storage Analysis for Wirral**

Data:-

Location = Wirral	Grid reference = SJ9766
M5-60 (mm) = 19	r = 0.40
Soil index = 0.45	SAAR (mm/yr) = 800
Return period = 100	WRAP = 4
UCWI = 0.0	Climate change = +30%

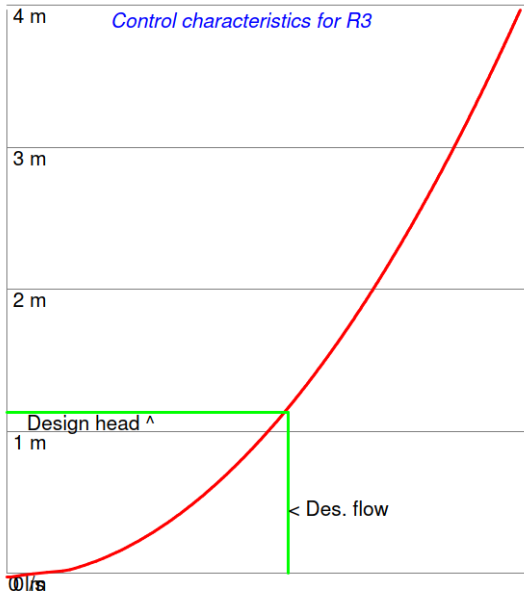
Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Percentage runoff = 95.0% (manual setting)

Imperv. area = 3160 m ²	Pervious area = 0 m ²
Total area = 3160 m ²	Equiv area = 3002 m ² (Tot. area x % runoff).
Total runoff = 233.4 m ³	Discharge rate = 2.000 l/s

Design Head = 1.2m	Peak flow = 1.99 l/s
Control device = R3	Orifice diam = 37.8 mm
Max. calc. depth = 1.2 m	Available depth = 0.0 m ³

Pipeline storage = 0.0 m ³	Available MH storage = 0.0 m ³
Offline storage = 0.0 m ³	Peak input flow = 27.01 l/s
Total storage = 213.0 m ³	



Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.01	0.04	2.01	2.59
0.05	0.39	2.05	2.61
0.10	0.58	2.10	2.65
0.15	0.71	2.15	2.68
0.20	0.82	2.20	2.71
0.25	0.91	2.25	2.74
0.30	1.00	2.30	2.77
0.35	1.08	2.35	2.80
0.40	1.15	2.40	2.83
0.45	1.22	2.45	2.86
0.50	1.29	2.50	2.89
0.55	1.35	2.55	2.92
0.60	1.41	2.60	2.94
0.65	1.47	2.65	2.97
0.70	1.53	2.70	3.00
0.75	1.58	2.75	3.03
0.80	1.63	2.80	3.06
0.85	1.68	2.85	3.08
0.90	1.73	2.90	3.11
0.95	1.78	2.95	3.14
1.00	1.83	3.00	3.16
1.05	1.87	3.05	3.19
1.10	1.91	3.10	3.21
1.15	1.96	3.15	3.24
1.20	2.00	3.20	3.27
1.25	2.04	3.25	3.29
1.30	2.08	3.30	3.32
1.35	2.12	3.35	3.34
1.40	2.16	3.40	3.37
1.45	2.20	3.45	3.39
1.50	2.24	3.50	3.42
1.55	2.27	3.55	3.44
1.60	2.31	3.60	3.46
1.65	2.35	3.65	3.49
1.70	2.38	3.70	3.51
1.75	2.42	3.75	3.54
1.80	2.45	3.80	3.56
1.85	2.48	3.85	3.58
1.90	2.52	3.90	3.61
1.95	2.55	3.95	3.63
2.00	2.58	4.00	3.65

Calculation data provided by Crown Water Ltd, SLS 7NT



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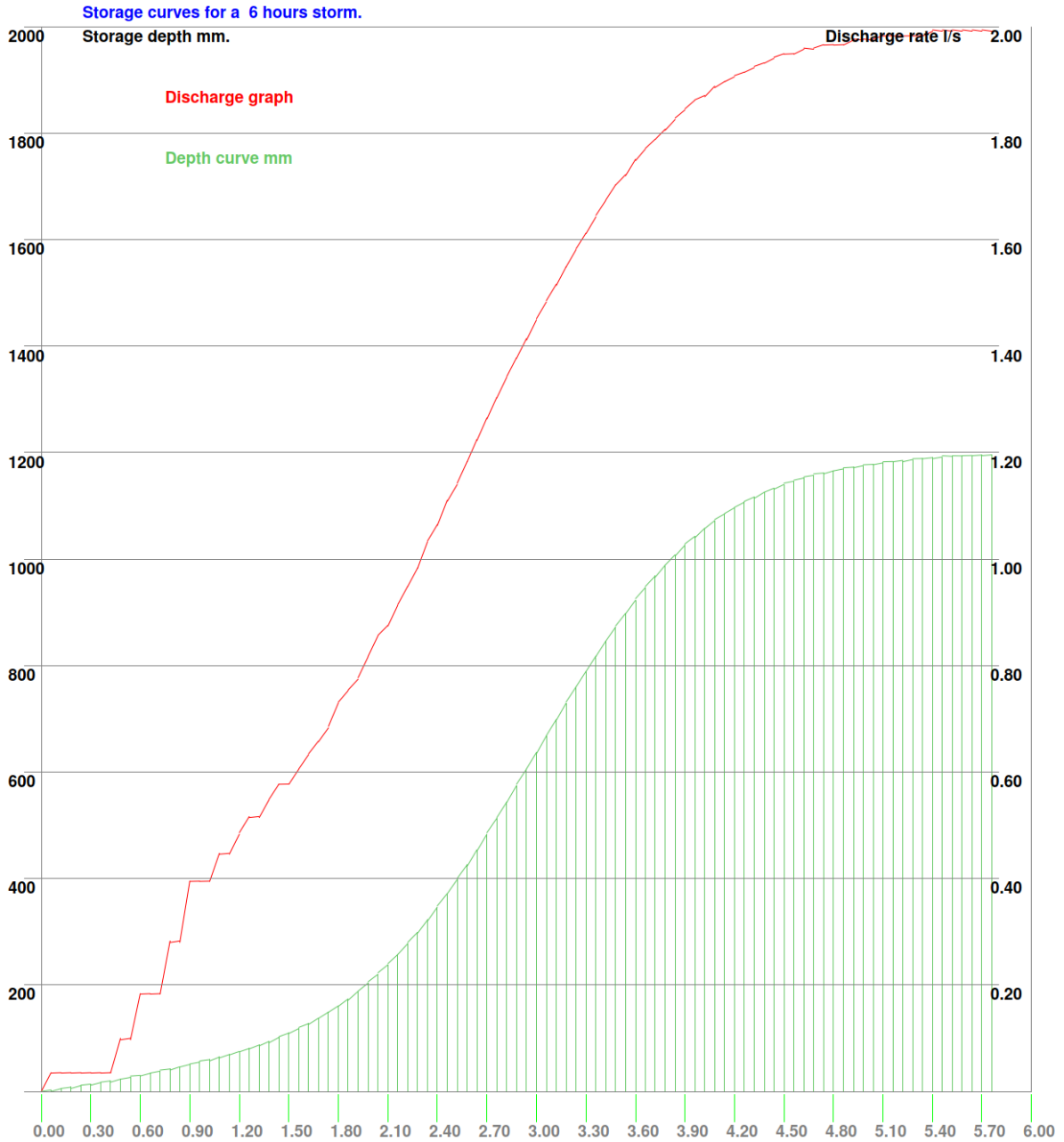
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Job No.	18-1029		
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Date	29/06/21		
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Project **The Croft Welton Road Bromborough Unit 2**
Title **Hydrograph Storage Analysis for Wirral**





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Job No.	18-1029		
Sheet no.	3		
Date	29/06/21		
By	Checked	Reviewed	

Project	The Croft Welton Road Bromborough Unit 2
Title	Hydrograph Storage Analysis for Wirral

Incremental rainfall figures.

Storm Mins	Storage Depth mm	Control Flow l/s	Storm Mins	Storage Depth mm	Control Flow l/s
3.6	2.6	0.04	183.6	667.8	1.48
7.2	5.2	0.04	187.2	698.7	1.52
10.8	7.9	0.04	190.8	729.5	1.55
14.4	10.7	0.04	194.4	759.7	1.58
18.0	13.5	0.04	198.0	789.2	1.61
21.6	16.5	0.04	201.6	817.9	1.64
25.2	19.6	0.04	205.2	845.6	1.67
28.8	23.0	0.10	208.8	872.3	1.70
32.4	26.4	0.10	212.4	898.1	1.72
36.0	30.1	0.18	216.0	922.9	1.75
39.6	33.9	0.18	219.6	946.2	1.77
43.2	37.9	0.18	223.2	968.2	1.79
46.8	42.0	0.28	226.8	988.7	1.81
50.4	46.2	0.28	230.4	1008.1	1.83
54.0	50.6	0.39	234.0	1026.1	1.84
57.6	55.1	0.39	237.6	1042.7	1.86
61.2	59.7	0.39	241.2	1058.2	1.87
64.8	64.5	0.45	244.8	1072.3	1.89
68.4	69.5	0.45	248.4	1085.0	1.90
72.0	74.9	0.48	252.0	1096.5	1.91
75.6	80.7	0.52	255.6	1107.1	1.91
79.2	87.0	0.52	259.2	1116.7	1.92
82.8	93.9	0.55	262.8	1125.4	1.93
86.4	101.4	0.58	266.4	1133.2	1.94
90.0	109.4	0.58	270.0	1140.2	1.95
93.6	118.0	0.61	273.6	1146.5	1.95
97.2	127.4	0.63	277.2	1152.2	1.96
100.8	137.7	0.66	280.8	1157.4	1.96
104.4	148.8	0.68	284.4	1161.9	1.97
108.0	160.9	0.73	288.0	1166.0	1.97
111.6	173.8	0.75	291.6	1169.5	1.97
115.2	187.9	0.77	295.2	1172.6	1.97
118.8	203.4	0.82	298.8	1175.5	1.97
122.4	220.1	0.86	302.4	1178.2	1.97
126.0	237.9	0.88	306.0	1180.8	1.98
129.6	257.1	0.91	309.6	1183.1	1.98
133.2	277.5	0.95	313.2	1185.2	1.98
136.8	299.1	0.98	316.8	1187.1	1.98
140.4	322.0	1.03	320.4	1188.9	1.98
144.0	346.2	1.06	324.0	1190.6	1.99
147.6	371.8	1.11	327.6	1192.0	1.99
151.2	398.3	1.14	331.2	1193.1	1.99
154.8	425.7	1.18	334.8	1194.1	1.99
158.4	454.0	1.22	338.4	1194.8	1.99
162.0	483.1	1.26	342.0	1195.4	1.99
165.6	513.0	1.30	345.6	1195.9	1.99
169.2	543.5	1.34	349.2	1196.2	1.99
172.8	574.5	1.38	352.8	1196.6	1.99
176.4	605.5	1.41	356.4	1196.8	1.99
180.0	636.7	1.45	360.0	1197.0	1.99

Using the Get Max button causes the program to step through a series of storm durations until a maximum volume is obtained.

Each duration is sampled 600 times and the results recorded. The storm durations (hrs) are:-

0.25, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 18, 20, 24, 30, 36, 42, 48, 54, 60, 66, 72, 84, 96, 120, 150, 175, 200, 250, 300, 375, 500, 750, 1000, 1250, 1500, 1570, 2000, 2500, 3000, 3500, 4000

It should be noted that the six hour storm frequently requested rarely demonstrates the worst case for storage.



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Job No. 18-1029		
Sheet no. 1		
Date 29/06/21		
By	Checked	Reviewed

Project **The Croft Welton Road Bromborough Unit 3**

Title **Hydrograph Storage Analysis for Wirral**

Data:-

Location = Wirral	Grid reference = SJ9766
M5-60 (mm) = 19	r = 0.40
Soil index = 0.45	SAAR (mm/yr) = 800
Return period = 100	WRAP = 4
UCWI = 0.0	Climate change = +30%

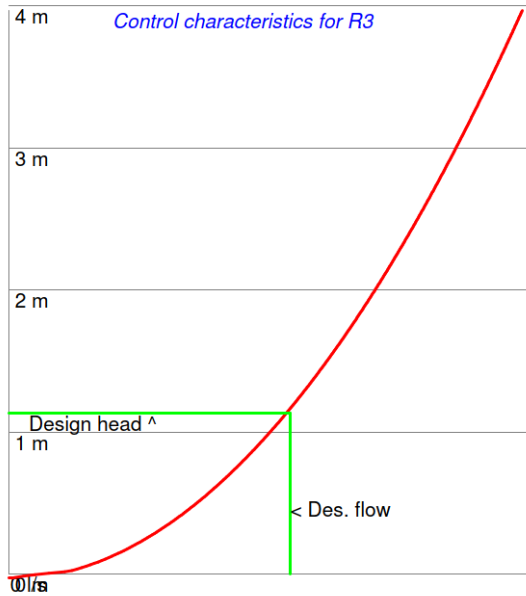
Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Percentage runoff = 95.0% (manual setting)

Imperv. area = 2925 m ²	Pervious area = 0 m ²
Total area = 2925 m ²	Equiv area = 2779 m ² (Tot. area x % runoff).
Total runoff = 216.0 m ³	Discharge rate = 2.000 l/s

Design Head = 1.2m	Peak flow = 1.99 l/s
Control device = R3	Orifice diam = 37.8 mm
Max. calc. depth = 1.2 m	Available depth = 0.0 m ³

Pipeline storage = 0.0 m ³	Available MH storage = 0.0 m ³
Offline storage = 0.0 m ³	Peak input flow = 25.00 l/s
Total storage = 195.0 m ³	



Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.01	0.04	2.01	2.59
0.05	0.39	2.05	2.61
0.10	0.58	2.10	2.65
0.15	0.71	2.15	2.68
0.20	0.82	2.20	2.71
0.25	0.91	2.25	2.74
0.30	1.00	2.30	2.77
0.35	1.08	2.35	2.80
0.40	1.15	2.40	2.83
0.45	1.22	2.45	2.86
0.50	1.29	2.50	2.89
0.55	1.35	2.55	2.92
0.60	1.41	2.60	2.94
0.65	1.47	2.65	2.97
0.70	1.53	2.70	3.00
0.75	1.58	2.75	3.03
0.80	1.63	2.80	3.06
0.85	1.68	2.85	3.08
0.90	1.73	2.90	3.11
0.95	1.78	2.95	3.14
1.00	1.83	3.00	3.16
1.05	1.87	3.05	3.19
1.10	1.91	3.10	3.21
1.15	1.96	3.15	3.24
1.20	2.00	3.20	3.27
1.25	2.04	3.25	3.29
1.30	2.08	3.30	3.32
1.35	2.12	3.35	3.34
1.40	2.16	3.40	3.37
1.45	2.20	3.45	3.39
1.50	2.24	3.50	3.42
1.55	2.27	3.55	3.44
1.60	2.31	3.60	3.46
1.65	2.35	3.65	3.49
1.70	2.38	3.70	3.51
1.75	2.42	3.75	3.54
1.80	2.45	3.80	3.56
1.85	2.48	3.85	3.58
1.90	2.52	3.90	3.61
1.95	2.55	3.95	3.63
2.00	2.58	4.00	3.65

Calculation data provided by Crown Water Ltd, SL5 7NT



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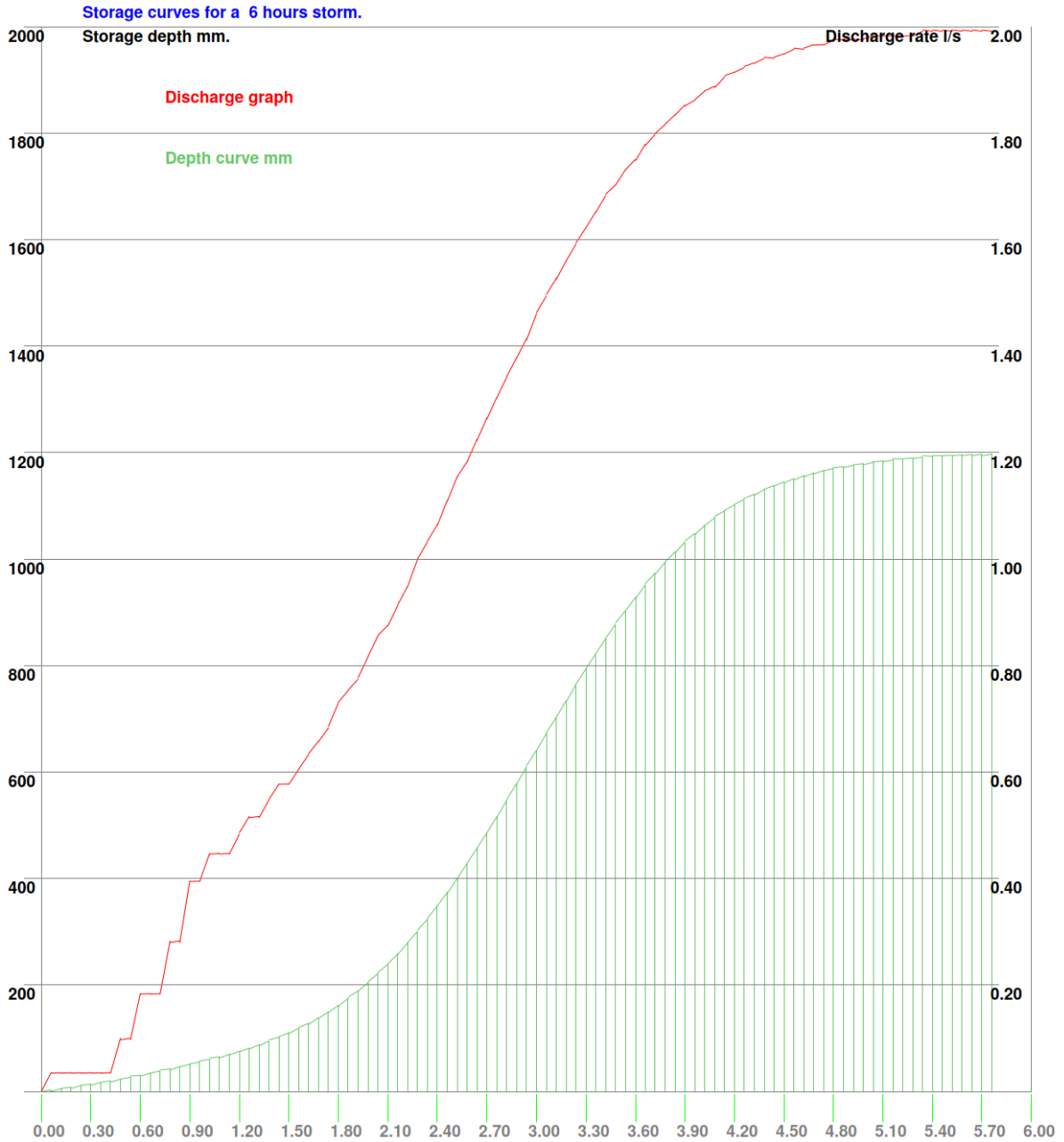
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Job No.	18-1029		
Sheet no.	2		
Date	29/06/21		
By	Checked	Reviewed	

Project **The Croft Welton Road Bromborough Unit 3**
Title **Hydrograph Storage Analysis for Wirral**





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Job No.	18-1029		
Sheet no.	3		
Date	29/06/21		
By	Checked	Reviewed	

Project	The Croft Welton Road Bromborough Unit 3
Title	Hydrograph Storage Analysis for Wirral

Incremental rainfall figures.

Storm Mins	Storage Depth mm	Control Flow l/s	Storm Mins	Storage Depth mm	Control Flow l/s
3.6	2.7	0.04	183.6	671.9	1.49
7.2	5.3	0.04	187.2	703.0	1.53
10.8	8.0	0.04	190.8	734.0	1.56
14.4	10.8	0.04	194.4	764.3	1.59
18.0	13.6	0.04	198.0	794.0	1.62
21.6	16.6	0.04	201.6	822.8	1.65
25.2	19.8	0.04	205.2	850.6	1.68
28.8	23.2	0.10	208.8	877.5	1.70
32.4	26.7	0.10	212.4	903.4	1.73
36.0	30.4	0.18	216.0	928.3	1.75
39.6	34.3	0.18	219.6	951.7	1.78
43.2	38.3	0.18	223.2	973.7	1.80
46.8	42.4	0.28	226.8	994.3	1.82
50.4	46.6	0.28	230.4	1013.7	1.83
54.0	51.0	0.39	234.0	1031.7	1.85
57.6	55.5	0.39	237.6	1048.3	1.86
61.2	60.2	0.45	241.2	1063.7	1.88
64.8	64.9	0.45	244.8	1077.9	1.89
68.4	69.9	0.45	248.4	1090.5	1.91
72.0	75.3	0.48	252.0	1101.9	1.91
75.6	81.1	0.52	255.6	1112.4	1.92
79.2	87.5	0.52	259.2	1121.9	1.93
82.8	94.4	0.55	262.8	1130.5	1.94
86.4	101.9	0.58	266.4	1138.2	1.94
90.0	109.9	0.58	270.0	1145.1	1.95
93.6	118.6	0.61	273.6	1151.2	1.96
97.2	128.0	0.63	277.2	1156.9	1.96
100.8	138.3	0.66	280.8	1161.9	1.97
104.4	149.5	0.68	284.4	1166.3	1.97
108.0	161.7	0.73	288.0	1170.2	1.97
111.6	174.7	0.75	291.6	1173.6	1.97
115.2	188.8	0.77	295.2	1176.5	1.97
118.8	204.4	0.82	298.8	1179.2	1.97
122.4	221.3	0.86	302.4	1181.8	1.98
126.0	239.1	0.88	306.0	1184.2	1.98
129.6	258.4	0.91	309.6	1186.3	1.98
133.2	279.0	0.95	313.2	1188.2	1.98
136.8	300.8	1.00	316.8	1190.0	1.98
140.4	323.8	1.03	320.4	1191.6	1.99
144.0	348.2	1.06	324.0	1193.1	1.99
147.6	373.9	1.11	327.6	1194.3	1.99
151.2	400.6	1.15	331.2	1195.2	1.99
154.8	428.2	1.18	334.8	1196.0	1.99
158.4	456.7	1.22	338.4	1196.6	1.99
162.0	486.0	1.26	342.0	1197.0	1.99
165.6	516.1	1.30	345.6	1197.2	1.99
169.2	546.8	1.34	349.2	1197.4	1.99
172.8	578.0	1.38	352.8	1197.5	1.99
176.4	609.3	1.41	356.4	1197.5	1.99
180.0	640.6	1.46	360.0	1197.6	1.99

Using the Get Max button causes the program to step through a series of storm durations until a maximum volume is obtained.

Each duration is sampled 600 times and the results recorded. The storm durations (hrs) are:-

0.25, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 18, 20, 24, 30, 36, 42, 48, 54, 60, 66, 72, 84, 96, 120, 150, 175, 200, 250, 300, 375, 500, 750, 1000, 1250, 1500, 1570, 2000, 2500, 3000, 3500, 4000

It should be noted that the six hour storm frequently requested rarely demonstrates the worst case for storage.



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Job No. 18-1029		
Sheet no. 1		
Date 29/06/21		
By	Checked	Reviewed

Project **The Croft Welton Road Bromborough Unit 4**
Title **Hydrograph Storage Analysis for Wirral**

Data:-

Location = Wirral	Grid reference = SJ9766
M5-60 (mm) = 19	r = 0.40
Soil index = 0.45	SAAR (mm/yr) = 800
Return period = 100	WRAP = 4
UCWI = 0.0	Climate change = +30%

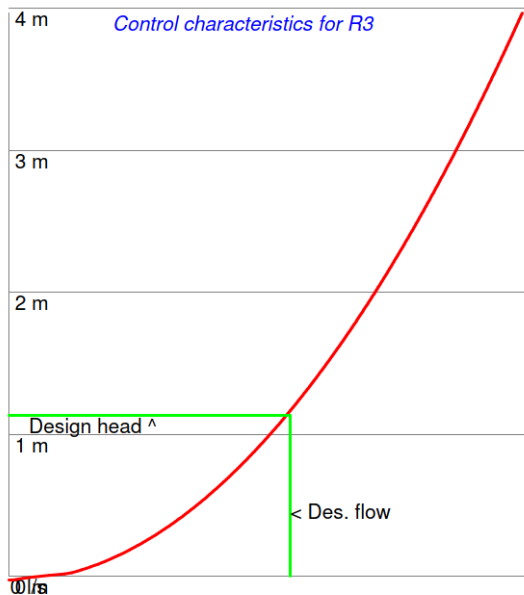
Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Percentage runoff = 95.0% (manual setting)

Imperv. area = 2451 m ²	Pervious area = 0 m ²
Total area = 2451 m ²	Equiv area = 2328 m ² (Tot. area x % runoff).
Total runoff = 181.0 m ³	Discharge rate = 2.000 l/s

Design Head = 1.2m	Peak flow = 1.99 l/s
Control device = R3	Orifice diam = 37.8 mm
Max. calc. depth = 1.19 m	Available depth = 0.0 m ³

Pipeline storage = 0.0 m ³	Available MH storage = 0.0 m ³
Offline storage = 0.0 m ³	Peak input flow = 20.95 l/s
Total storage = 160.0 m ³	



Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.01	0.04	2.01	2.59
0.05	0.39	2.05	2.61
0.10	0.58	2.10	2.65
0.15	0.71	2.15	2.68
0.20	0.82	2.20	2.71
0.25	0.91	2.25	2.74
0.30	1.00	2.30	2.77
0.35	1.08	2.35	2.80
0.40	1.15	2.40	2.83
0.45	1.22	2.45	2.86
0.50	1.29	2.50	2.89
0.55	1.35	2.55	2.92
0.60	1.41	2.60	2.94
0.65	1.47	2.65	2.97
0.70	1.53	2.70	3.00
0.75	1.58	2.75	3.03
0.80	1.63	2.80	3.06
0.85	1.68	2.85	3.08
0.90	1.73	2.90	3.11
0.95	1.78	2.95	3.14
1.00	1.83	3.00	3.16
1.05	1.87	3.05	3.19
1.10	1.91	3.10	3.21
1.15	1.96	3.15	3.24
1.20	2.00	3.20	3.27
1.25	2.04	3.25	3.29
1.30	2.08	3.30	3.32
1.35	2.12	3.35	3.34
1.40	2.16	3.40	3.37
1.45	2.20	3.45	3.39
1.50	2.24	3.50	3.42
1.55	2.27	3.55	3.44
1.60	2.31	3.60	3.46
1.65	2.35	3.65	3.49
1.70	2.38	3.70	3.51
1.75	2.42	3.75	3.54
1.80	2.45	3.80	3.56
1.85	2.48	3.85	3.58
1.90	2.52	3.90	3.61
1.95	2.55	3.95	3.63
2.00	2.58	4.00	3.65

Calculation data provided by Crown Water Ltd, SLS 7NT



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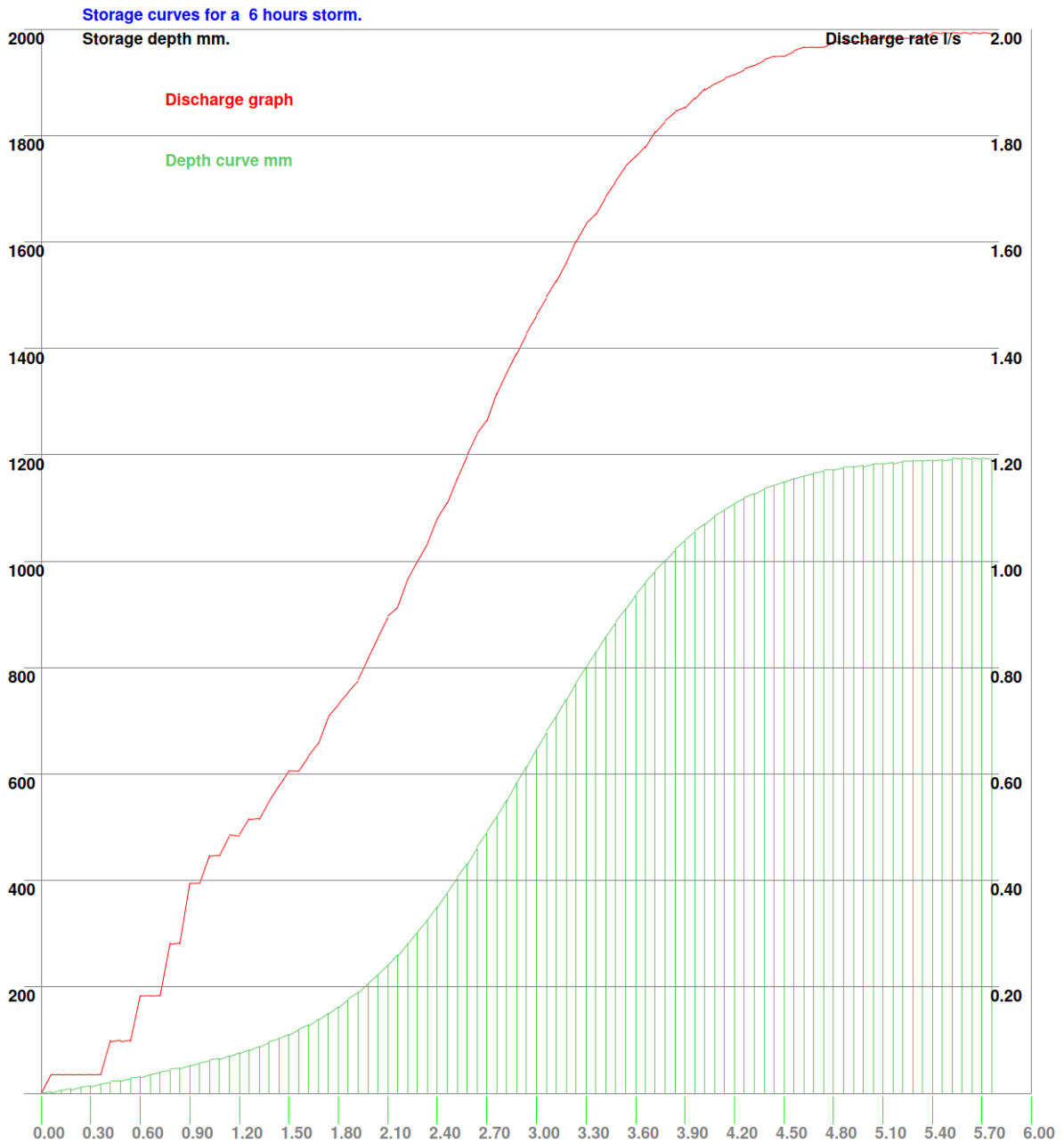
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Job No.	18-1029	
Sheet no.	2	
Date	29/06/21	

Project **The Croft Welton Road Bromborough Unit 4**

Title **Hydrograph Storage Analysis for Wirral**

By	Checked	Reviewed





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Job No.	18-1029		
Sheet no.	3		
Date	29/06/21		
By	Checked	Reviewed	

Project	The Croft Welton Road Bromborough Unit 4		
Title	Hydrograph Storage Analysis for Wirral		

Incremental rainfall figures.

Storm Mins	Storage Depth mm	Control Flow l/s	Storm Mins	Storage Depth mm	Control Flow l/s
3.6	2.7	0.04	183.6	677.3	1.49
7.2	5.4	0.04	187.2	708.7	1.53
10.8	8.2	0.04	190.8	739.9	1.56
14.4	11.0	0.04	194.4	770.5	1.60
18.0	13.9	0.04	198.0	800.3	1.63
21.6	17.0	0.04	201.6	829.3	1.65
25.2	20.2	0.10	205.2	857.3	1.68
28.8	23.5	0.10	208.8	884.3	1.71
32.4	27.0	0.10	212.4	910.3	1.74
36.0	30.8	0.18	216.0	935.2	1.76
39.6	34.7	0.18	219.6	958.7	1.78
43.2	38.8	0.18	223.2	980.7	1.81
46.8	42.9	0.28	226.8	1001.2	1.83
50.4	47.1	0.28	230.4	1020.5	1.84
54.0	51.5	0.39	234.0	1038.5	1.85
57.6	56.1	0.39	237.6	1054.9	1.87
61.2	60.7	0.45	241.2	1070.2	1.89
64.8	65.4	0.45	244.8	1084.1	1.90
68.4	70.4	0.48	248.4	1096.5	1.91
72.0	75.7	0.48	252.0	1107.6	1.91
75.6	81.6	0.52	255.6	1117.8	1.92
79.2	87.9	0.52	259.2	1127.1	1.93
82.8	94.9	0.55	262.8	1135.4	1.94
86.4	102.4	0.58	266.4	1142.7	1.95
90.0	110.4	0.61	270.0	1149.2	1.95
93.6	119.1	0.61	273.6	1155.0	1.96
97.2	128.5	0.63	277.2	1160.2	1.97
100.8	138.9	0.66	280.8	1164.8	1.97
104.4	150.2	0.71	284.4	1168.8	1.97
108.0	162.4	0.73	288.0	1172.2	1.97
111.6	175.4	0.75	291.6	1175.1	1.97
115.2	189.7	0.77	295.2	1177.6	1.97
118.8	205.4	0.82	298.8	1179.9	1.97
122.4	222.4	0.86	302.4	1182.0	1.98
126.0	240.4	0.89	306.0	1183.9	1.98
129.6	259.9	0.91	309.6	1185.6	1.98
133.2	280.7	0.97	313.2	1187.0	1.98
136.8	302.6	1.00	316.8	1188.3	1.98
140.4	325.8	1.03	320.4	1189.4	1.98
144.0	350.5	1.08	324.0	1190.4	1.99
147.6	376.5	1.11	327.6	1191.1	1.99
151.2	403.4	1.15	331.2	1191.5	1.99
154.8	431.3	1.20	334.8	1191.8	1.99
158.4	460.0	1.24	338.4	1191.9	1.99
162.0	489.7	1.26	342.0	1191.8	1.99
165.6	520.1	1.32	345.6	1191.5	1.99
169.2	551.1	1.35	349.2	1191.2	1.99
172.8	582.5	1.39	352.8	1190.8	1.99
176.4	614.1	1.43	356.4	1190.3	1.99
180.0	645.7	1.46	360.0	1189.8	1.98

Using the Get Max button causes the program to step through a series of storm durations until a maximum volume is obtained.

Each duration is sampled 600 times and the results recorded. The storm durations (hrs) are:-

0.25, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 18, 20, 24, 30, 36, 42, 48, 54, 60, 66, 72, 84, 96, 120, 150, 175, 200, 250, 300, 375, 500, 750, 1000, 1250, 1500, 1570, 2000, 2500, 3000, 3500, 4000

It should be noted that the six hour storm frequently requested rarely demonstrates the worst case for storage.



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Job No.
18-1029

Sheet no.
1

Date
29/06/21

Project
The Croft Welton Road Bromborough Unit 5

Title
Hydrograph Storage Analysis for Wirral

By	Checked	Reviewed

Data:-

Location = Wirral	Grid reference = SJ9766
M5-60 (mm) = 19	r = 0.40
Soil index = 0.45	SAAR (mm/yr) = 800
Return period = 100	WRAP = 4
UCWI = 0.0	Climate change = +30%

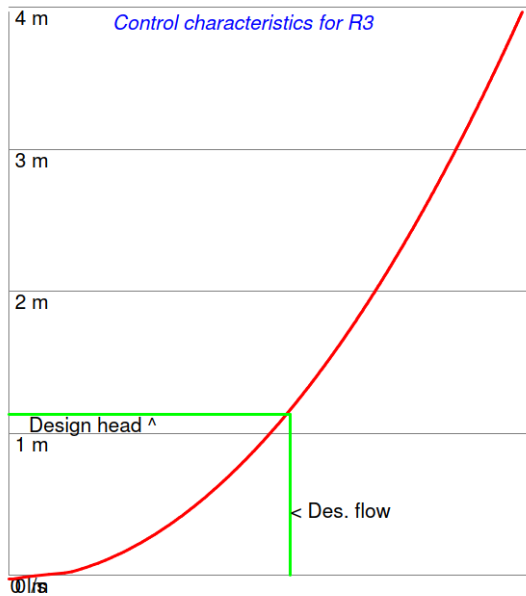
Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Percentage runoff = 95.0% (manual setting)

Imperv. area = 2961 m ²	Pervious area = 0 m ²
Total area = 2961 m ²	Equiv area = 2813 m ² (Tot. area x % runoff).
Total runoff = 218.7 m ³	Discharge rate = 2.000 l/s

Design Head = 1.2m	Peak flow = 1.99 l/s
Control device = R3	Orifice diam = 37.8 mm
Max. calc. depth = 1.2 m	Available depth = 0.0 m ³

Pipeline storage = 0.0 m ³	Available MH storage = 0.0 m ³
Offline storage = 0.0 m ³	Peak input flow = 25.31 l/s
Total storage = 198.0 m ³	



Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.01	0.04	2.01	2.59
0.05	0.39	2.05	2.61
0.10	0.58	2.10	2.65
0.15	0.71	2.15	2.68
0.20	0.82	2.20	2.71
0.25	0.91	2.25	2.74
0.30	1.00	2.30	2.77
0.35	1.08	2.35	2.80
0.40	1.15	2.40	2.83
0.45	1.22	2.45	2.86
0.50	1.29	2.50	2.89
0.55	1.35	2.55	2.92
0.60	1.41	2.60	2.94
0.65	1.47	2.65	2.97
0.70	1.53	2.70	3.00
0.75	1.58	2.75	3.03
0.80	1.63	2.80	3.06
0.85	1.68	2.85	3.08
0.90	1.73	2.90	3.11
0.95	1.78	2.95	3.14
1.00	1.83	3.00	3.16
1.05	1.87	3.05	3.19
1.10	1.91	3.10	3.21
1.15	1.96	3.15	3.24
1.20	2.00	3.20	3.27
1.25	2.04	3.25	3.29
1.30	2.08	3.30	3.32
1.35	2.12	3.35	3.34
1.40	2.16	3.40	3.37
1.45	2.20	3.45	3.39
1.50	2.24	3.50	3.42
1.55	2.27	3.55	3.44
1.60	2.31	3.60	3.46
1.65	2.35	3.65	3.49
1.70	2.38	3.70	3.51
1.75	2.42	3.75	3.54
1.80	2.45	3.80	3.56
1.85	2.48	3.85	3.58
1.90	2.52	3.90	3.61
1.95	2.55	3.95	3.63
2.00	2.58	4.00	3.65

Calculation data provided by Crown Water Ltd, SL5 7NT



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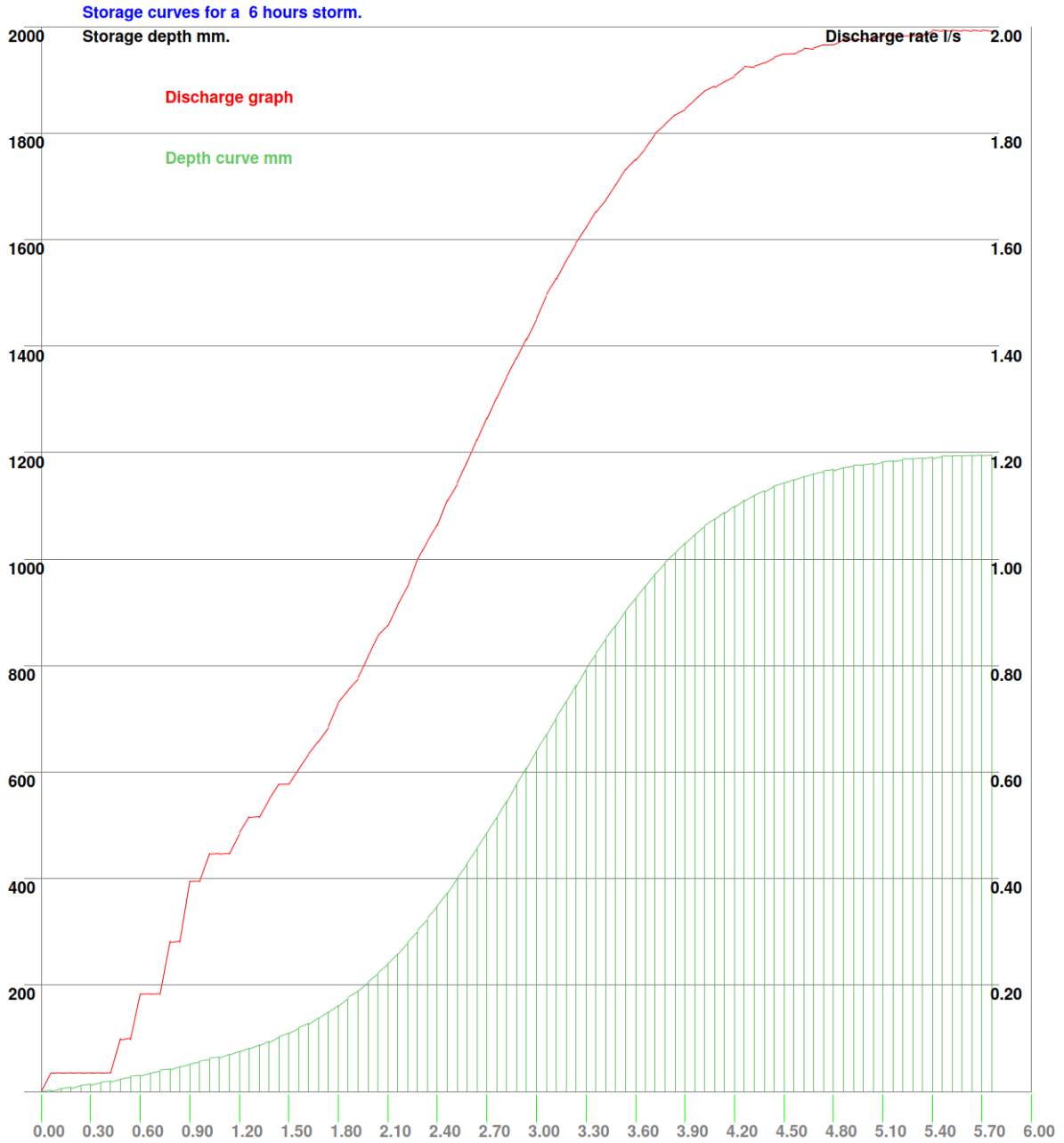
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Job No.	18-1029	
Sheet no.	2	
Date	29/06/21	
By	Checked	Reviewed

Project **The Croft Welton Road Bromborough Unit 5**

Title **Hydrograph Storage Analysis for Wirral**





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Job No.	18-1029		
Sheet no.	3		
Date	29/06/21		
By	Checked	Reviewed	

Project	The Croft Welton Road Bromborough Unit 5
Title	Hydrograph Storage Analysis for Wirral

Incremental rainfall figures.

Storm Mins	Storage Depth mm	Control Flow l/s	Storm Mins	Storage Depth mm	Control Flow l/s
3.6	2.7	0.04	183.6	670.4	1.49
7.2	5.3	0.04	187.2	701.5	1.53
10.8	8.0	0.04	190.8	732.3	1.56
14.4	10.7	0.04	194.4	762.6	1.59
18.0	13.6	0.04	198.0	792.2	1.62
21.6	16.6	0.04	201.6	821.0	1.65
25.2	19.7	0.04	205.2	848.8	1.67
28.8	23.1	0.10	208.8	875.6	1.70
32.4	26.6	0.10	212.4	901.5	1.73
36.0	30.3	0.18	216.0	926.2	1.75
39.6	34.2	0.18	219.6	949.7	1.77
43.2	38.2	0.18	223.2	971.6	1.80
46.8	42.3	0.28	226.8	992.2	1.82
50.4	46.4	0.28	230.4	1011.5	1.83
54.0	50.8	0.39	234.0	1029.5	1.84
57.6	55.4	0.39	237.6	1046.1	1.86
61.2	60.0	0.45	241.2	1061.5	1.88
64.8	64.7	0.45	244.8	1075.6	1.89
68.4	69.7	0.45	248.4	1088.3	1.90
72.0	75.1	0.48	252.0	1099.7	1.91
75.6	80.9	0.52	255.6	1110.2	1.92
79.2	87.3	0.52	259.2	1119.8	1.92
82.8	94.2	0.55	262.8	1128.4	1.93
86.4	101.7	0.58	266.4	1136.0	1.94
90.0	109.7	0.58	270.0	1142.9	1.95
93.6	118.3	0.61	273.6	1149.1	1.95
97.2	127.7	0.63	277.2	1154.8	1.96
100.8	138.0	0.66	280.8	1159.8	1.96
104.4	149.2	0.68	284.4	1164.2	1.97
108.0	161.3	0.73	288.0	1168.1	1.97
111.6	174.3	0.75	291.6	1171.5	1.97
115.2	188.4	0.77	295.2	1174.5	1.97
118.8	204.0	0.82	298.8	1177.2	1.97
122.4	220.8	0.86	302.4	1179.8	1.97
126.0	238.6	0.88	306.0	1182.3	1.98
129.6	257.9	0.91	309.6	1184.4	1.98
133.2	278.4	0.95	313.2	1186.4	1.98
136.8	300.1	1.00	316.8	1188.1	1.98
140.4	323.1	1.03	320.4	1189.8	1.98
144.0	347.4	1.06	324.0	1191.3	1.99
147.6	373.1	1.11	327.6	1192.5	1.99
151.2	399.7	1.14	331.2	1193.5	1.99
154.8	427.2	1.18	334.8	1194.3	1.99
158.4	455.7	1.22	338.4	1194.9	1.99
162.0	484.9	1.26	342.0	1195.4	1.99
165.6	515.0	1.30	345.6	1195.7	1.99
169.2	545.6	1.34	349.2	1195.8	1.99
172.8	576.7	1.38	352.8	1196.0	1.99
176.4	607.9	1.41	356.4	1196.1	1.99
180.0	639.2	1.45	360.0	1196.1	1.99

Using the Get Max button causes the program to step through a series of storm durations until a maximum volume is obtained.

Each duration is sampled 600 times and the results recorded. The storm durations (hrs) are:-

0.25, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 18, 20, 24, 30, 36, 42, 48, 54, 60, 66, 72, 84, 96, 120, 150, 175, 200, 250, 300, 375, 500, 750, 1000, 1250, 1500, 1570, 2000, 2500, 3000, 3500, 4000

It should be noted that the six hour storm frequently requested rarely demonstrates the worst case for storage.



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Job No. 18-1029		
Sheet no. 1		
Date 02/07/21		
By	Checked	Reviewed

Project	The Croft Welton Road Bromborough Access Road	
Title	Hydrograph Storage Analysis for Wirral	

Data:-

Location = Wirral	Grid reference = SJ9766
M5-60 (mm) = 19	r = 0.40
Soil index = 0.45	SAAR (mm/yr) = 800
Return period = 30	WRAP = 4
UCWI = 0.0	Climate change = +0%

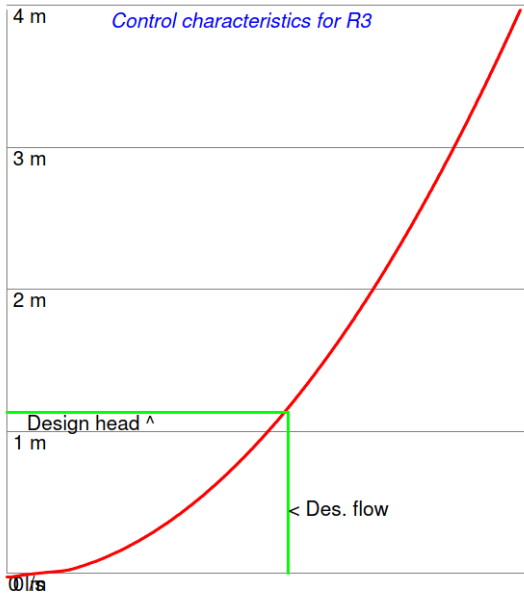
Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Percentage runoff = 95.0% (manual setting)

Imperv. area = 1642 m ²	Pervious area = 0 m ²
Total area = 1642 m ²	Equiv area = 1560 m ² (Tot. area x % runoff).
Total runoff = 71.7 m ³	Discharge rate = 2.000 l/s

Design Head = 1.2m	Peak flow = 1.98 l/s
Control device = R3	Orifice diam = 37.8 mm
Max. calc. depth = 1.19 m	Available depth = 0.0 m ³

Pipeline storage = 0.0 m ³	Available MH storage = 0.0 m ³
Offline storage = 0.0 m ³	Peak input flow = 8.30 l/s
Total storage = 51.0 m ³	



Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.01	0.04	2.01	2.59
0.05	0.39	2.05	2.61
0.10	0.58	2.10	2.65
0.15	0.71	2.15	2.68
0.20	0.82	2.20	2.71
0.25	0.91	2.25	2.74
0.30	1.00	2.30	2.77
0.35	1.08	2.35	2.80
0.40	1.15	2.40	2.83
0.45	1.22	2.45	2.86
0.50	1.29	2.50	2.89
0.55	1.35	2.55	2.92
0.60	1.41	2.60	2.94
0.65	1.47	2.65	2.97
0.70	1.53	2.70	3.00
0.75	1.58	2.75	3.03
0.80	1.63	2.80	3.06
0.85	1.68	2.85	3.08
0.90	1.73	2.90	3.11
0.95	1.78	2.95	3.14
1.00	1.83	3.00	3.16
1.05	1.87	3.05	3.19
1.10	1.91	3.10	3.21
1.15	1.96	3.15	3.24
1.20	2.00	3.20	3.27
1.25	2.04	3.25	3.29
1.30	2.08	3.30	3.32
1.35	2.12	3.35	3.34
1.40	2.16	3.40	3.37
1.45	2.20	3.45	3.39
1.50	2.24	3.50	3.42
1.55	2.27	3.55	3.44
1.60	2.31	3.60	3.46
1.65	2.35	3.65	3.49
1.70	2.38	3.70	3.51
1.75	2.42	3.75	3.54
1.80	2.45	3.80	3.56
1.85	2.48	3.85	3.58
1.90	2.52	3.90	3.61
1.95	2.55	3.95	3.63
2.00	2.58	4.00	3.65

Calculation data provided by Crown Water Ltd, SLS 7NT



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Job No.
18-1029

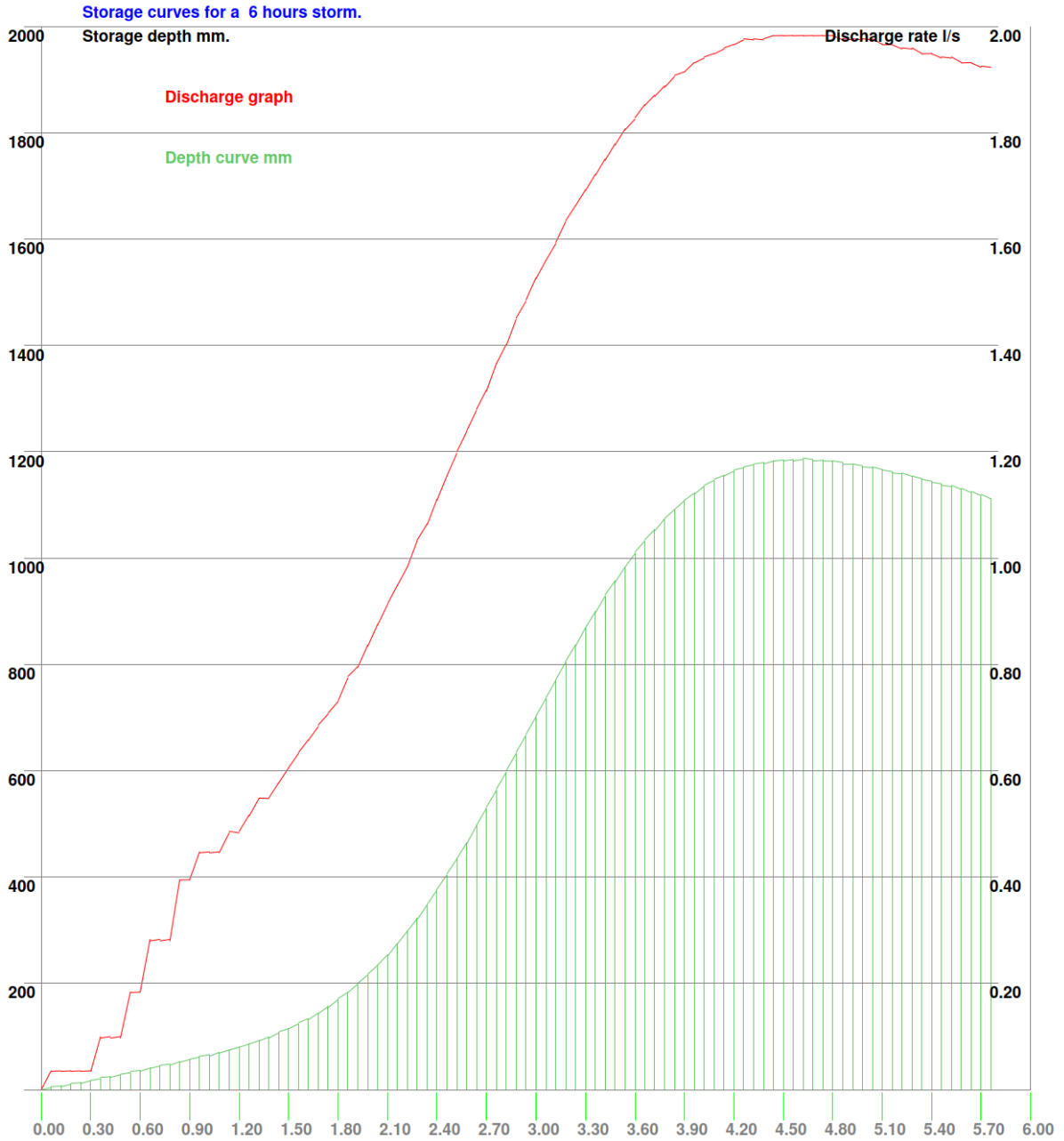
Sheet no.
2

Date
02/07/21

Project
The Croft Welton Road Bromborough Access Road

Title
Hydrograph Storage Analysis for Wirral

By	Checked	Reviewed





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Job No.	18-1029		
Sheet no.	3		
Date	02/07/21		
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Project	The Croft Welton Road Bromborough Access Road
Title	Hydrograph Storage Analysis for Wirral

Incremental rainfall figures.

Storm Mins	Storage Depth mm	Control Flow l/s	Storm Mins	Storage Depth mm	Control Flow l/s
3.6	3.4	0.04	183.6	735.9	1.56
7.2	6.6	0.04	187.2	770.0	1.59
10.8	9.9	0.04	190.8	803.8	1.63
14.4	13.3	0.04	194.4	836.7	1.66
18.0	16.8	0.04	198.0	868.6	1.69
21.6	20.5	0.10	201.6	899.3	1.72
25.2	24.1	0.10	205.2	928.7	1.75
28.8	28.0	0.10	208.8	956.8	1.78
32.4	32.0	0.18	212.4	983.5	1.81
36.0	36.0	0.18	216.0	1008.8	1.83
39.6	40.3	0.28	219.6	1032.2	1.85
43.2	44.2	0.28	223.2	1053.7	1.87
46.8	48.4	0.28	226.8	1073.4	1.89
50.4	52.7	0.39	230.4	1091.5	1.91
54.0	56.8	0.39	234.0	1107.8	1.91
57.6	61.2	0.45	237.6	1122.2	1.93
61.2	65.5	0.45	241.2	1135.2	1.94
64.8	70.0	0.45	244.8	1146.4	1.95
68.4	74.8	0.48	248.4	1155.8	1.96
72.0	79.9	0.48	252.0	1163.5	1.97
75.6	85.7	0.52	255.6	1170.1	1.97
79.2	92.1	0.55	259.2	1175.4	1.97
82.8	98.9	0.55	262.8	1179.5	1.97
86.4	106.6	0.58	266.4	1182.5	1.98
90.0	114.8	0.61	270.0	1184.4	1.98
93.6	123.7	0.63	273.6	1185.5	1.98
97.2	133.5	0.66	277.2	1185.9	1.98
100.8	144.3	0.68	280.8	1185.4	1.98
104.4	156.2	0.71	284.4	1184.3	1.98
108.0	169.1	0.73	288.0	1182.5	1.98
111.6	183.2	0.77	291.6	1180.0	1.97
115.2	198.5	0.80	295.2	1177.0	1.97
118.8	215.5	0.84	298.8	1173.8	1.97
122.4	234.1	0.88	302.4	1170.3	1.97
126.0	253.8	0.91	306.0	1166.7	1.97
129.6	275.1	0.95	309.6	1162.8	1.97
133.2	298.0	0.98	313.2	1158.5	1.96
136.8	322.2	1.03	316.8	1154.1	1.96
140.4	347.8	1.06	320.4	1149.6	1.95
144.0	375.2	1.11	324.0	1144.9	1.95
147.6	404.0	1.15	327.6	1139.9	1.94
151.2	433.9	1.20	331.2	1134.6	1.94
154.8	464.8	1.24	334.8	1129.1	1.93
158.4	496.6	1.28	338.4	1123.3	1.93
162.0	529.5	1.32	342.0	1117.4	1.92
165.6	563.1	1.37	345.6	1111.3	1.92
169.2	597.4	1.40	349.2	1105.1	1.91
172.8	632.1	1.45	352.8	1098.9	1.91
176.4	666.8	1.48	356.4	1092.6	1.91
180.0	701.4	1.53	360.0	1086.3	1.90

Using the Get Max button causes the program to step through a series of storm durations until a maximum volume is obtained.

Each duration is sampled 600 times and the results recorded. The storm durations (hrs) are:-

0.25, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 18, 20, 24, 30, 36, 42, 48, 54, 60, 66, 72, 84, 96, 120, 150, 175, 200, 250, 300, 375, 500, 750, 1000, 1250, 1500, 1570, 2000, 2500, 3000, 3500, 4000

It should be noted that the six hour storm frequently requested rarely demonstrates the worst case for storage.

Appendix J

IoH 124 Runoff Calcs $Q_{BAR(rural)}$



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			Sheet no. 1
			Date 29/11/18
Project The Croft, Welton Road Bromborough	By MDJ	Checked	Reviewed
Title IoH 124 Runoff Calcs for Wirral			

Hydrological Data:-

FSR Hydrology:-

Location = Wirral	Grid reference = SJ9766
M5-60 (mm) = 19	r = 0.40
Soil runoff = 0.45	SAAR (mm/yr) = 800
WRAP = 4	Area = England & Wales
Hydrological area = 9	Hydrological zone = 8

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Design data:-

Area = 0.02265 Km² - 2.265 Ha - 22650 m²

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(rural)} = 0.00108 \text{ AREA}^{0.89} \cdot \text{SAAR}^{1.17} \cdot \text{SOIL}^{2.17}$$

where

AREA = Site area in Km²
 SAAR = Standard Average Annual Rainfall (mm/yr)
 SOIL = Soil value derived from Winter Rainfall Acceptance Potential
 $Q_{BAR(rural)}$ = Runoff (cumecs)

$Q_{BAR(rural)}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

Calculated data:-

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.045

Mean Annual Peak Flow $Q_{BAR(rural)}$ = 11.63 l/s



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Values for $Q_{BAR(t_{retal})}$

Ret. per.	m ³ /hr	l/s	l/s/ha	Ret. per.	m ³ /hr	l/s	l/s/ha
1yr	35.597	9.888	4.366	100yr+20%	109.555	30.432	13.436
2yr	38.947	10.819	4.776	100yr+30%	118.684	32.968	14.555
5yr	51.092	14.192	6.266	100yr+40%	127.814	35.504	15.675
10yr	59.468	16.519	7.293	200yr	104.697	29.082	12.840
30yr	73.288	20.358	8.988	200yr + 30%	136.106	37.807	16.692
50yr	81.245	22.568	9.964	500yr	119.773	33.270	14.689
100yr	91.296	25.360	11.196	1000yr	133.593	37.109	16.384

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	200yr	500yr	1000yr
0.85	0.93	1.22	1.42	1.75	1.94	2.50	2.86	3.19

The above is based on the Institute of Hydrology Report 124 to which you are referred for further details (see Sect 7).
Note that the 200 and above year growth curves were taken from W5-074.



Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:

Site name:

Site location:

Site Details

Latitude:

Longitude:

Reference:

Date:

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

Runoff estimation approach

Site characteristics

Total site area (ha):

Methodology

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	767	767
Hydrological region:	10	10
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	1.7	1.7
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

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

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

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

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

(3) Is SPR/SPRHOST ≤ 0.3?

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

Greenfield runoff rates

	Default	Edited
Q _{BAR} (l/s):	12.07	12.07
1 in 1 year (l/s):	10.5	10.5
1 in 30 years (l/s):	20.51	20.51
1 in 100 year (l/s):	25.1	25.1
1 in 200 years (l/s):	28.6	28.6

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.