

134 BROUGHTON STREET,
CHEETHAM HILL

SUSTAINABLE DRAINAGE STRATEGY

Job Number: FRA21 1143

Date: December 2021

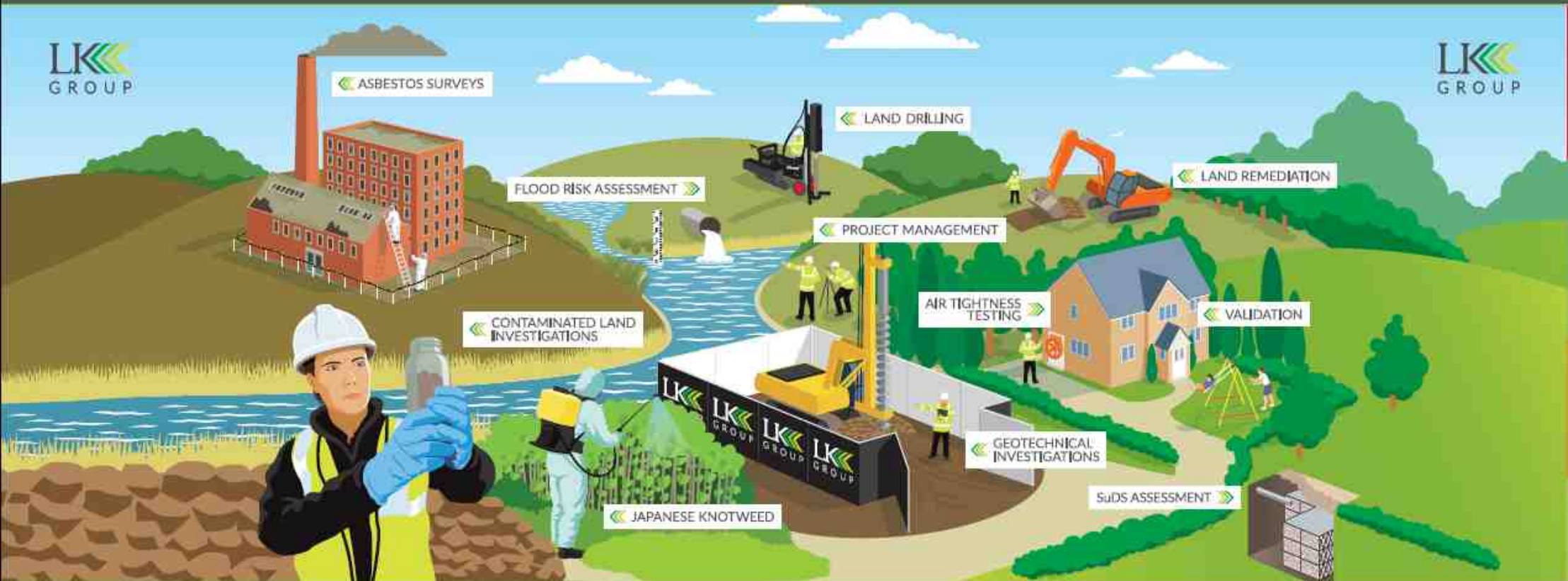
Client: NN Holding Ltd

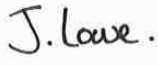


INCREASING LAND VALUE

LK
GROUP

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LK Consult Document Verification			
Site Address	Land at 134 Broughton Street (102-104 Waterloo Road), Cheetham Hill, Manchester		
Report Title	Sustainable Drainage Strategy		
Job Number	FRA 21 1143	Document Ref.	FRA 21 1143 - R0
Date Issued	December 2021	Report Version	R0
Prepared By	Jenna Lowe - Graduate Flood Risk Assessor	Signature	
Reviewed By	Mark Jones - Associate	Signature	

Revision Record			
Revision No.	Date	Nature of Revision	Approved By

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EXECUTIVE SUMMARY

Scope and Background

This Sustainable Drainage (SuDS) Strategy has been undertaken by LK Consult Ltd (LKC) to support a future planning application for the development of land at 134 Broughton Street (102-104 Waterloo Road), Cheetham Hill, Manchester. The development comprises a wholesale retail warehouse and car parking.

LKC has prepared this SuDS Strategy in line with the NPPF and Technical Guidance where appropriate.

Consultations

The Environment Agency (EA) website has been utilised to assess if there are any limitations that may affect the form of SuDS that may be appropriate to this site. The records show that the site is within Flood Zone 1.

The Lead Local Flood Authority and United Utilities have also been contacted during preparation of this report.

Mitigation

Design

The ground conditions beneath the site are recorded as Glacial Till - Devensian Superficial Deposits over Sandstone Bedrock which have been confirmed by the BGS in their borehole records. There is a slight slope towards the south, but this is relatively flat. The site is enclosed by highways and an access road.

The amount of impermeable area drained to the existing drainage system adjacent to the southwestern site boundary will remain the same.

There are a number of manhole covers within and adjacent to the site. There is a private surface water culvert running through the western side of the site and combined sewers to the east of the building and in Waterloo Road and Broughton Street. This may connect to a historic culvert flowing along Waterloo Road. The flows from the site should be restricted to an acceptable level to the Lead Local Flood Authority and United Utilities.

In considering the potential drainage options for the site it is assumed that surface water runoff arising from the development will discharge into the existing surface water culvert or the existing combined drain running through the east of the site if a connection is not practical.

The proposed development will not change the proportion of the site covered by impermeable surfaces and will therefore generate similar runoff. However, attenuation will be required to reduce the flow from the site and to allow for climate change.

The outline drainage strategy considers the use of attenuation-based SuDS to be feasible with a discharge to the combined sewer adjacent to the southwestern boundary of the site. Therefore, the most effective strategy, in line with the SuDS management train, would be to have a detention system at the southern boundary. The required tank or similar has been estimated to be **12.0 m³** for the 1 in 30-year event flow restriction.

Similarly, the estimated volume to be retained on site for the 1 in 100-year storm event including the allowance for climate change is between **24.7 m³** and **31.4 m³**.

The estimated volume can be stored within the site boundary.

Contents

EXECUTIVE SUMMARY **iv**

1	Introduction	1
1.1	Background	1
1.2	Site Details	2
2	Site Setting	3
2.1	Vulnerability	3
2.2	Environmental Setting	3
2.3	Site Reconnaissance	4
2.4	Site and Access Levels	4
3	Consultation	5
4	Sustainable Drainage Strategy	7
4.1	Introduction	7
4.2	Infiltration	7
4.3	Watercourses	8
4.4	Public Sewer	8
4.5	Other Sewers	8
4.6	Surface Water Drainage Strategy	8
4.7	Surface Water Attenuation Requirements	10
4.8	Foul Drainage	11
5	Conclusion	13

Appendices

Appendix A:	Figures, Plans and Drawings
Appendix B:	Site Information
Appendix C:	Environment Agency Data
Appendix D:	Consultee Correspondence
Appendix E:	Calculations

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1 Introduction

1.1 Background

LK Consult Ltd (LKC) were commissioned by NN Holding Ltd to carry out a Sustainable Drainage Strategy for 134 Broughton Street (102-104 Waterloo Road), Cheetham Hill. The report was undertaken in support of a future planning application to redevelop the site for commercial use.

The report will consider the impact of the development on surface water runoff accounting for climate change. The sustainable drainage assessment in Section 4 will provide an overview of the SuDS techniques which could be considered on the site.

This preliminary SuDS assessment complies with the principles presented in the Draft National Standards for Sustainable Drainage Systems (Defra, 2015)¹ and the Planning Practice Guidance (PPG) March 2014². The sustainable drainage assessment is presented with reference to the hydrological and hydrogeological context of the development.

The report findings are based upon professional judgement and are summarised below. The report includes baseline data from the Environment Agency (EA), rainfall data from the Wallingford Studies and Hydrogeological information from the British Geological Survey (BGS). The assessment will summarise and refer to these datasets in the text.

Drainage on the site has been assessed by considering the following key constraints:

- » Topography of the site.
- » Local water features and hydrological context.
- » Underlying geology, soil types and permeability.
- » Layout and geometry of the proposed development.

¹ Non-statutory Technical Standards for Sustainable Drainage Systems – DEFRA March 2015

² Planning Practice Guidance – Department for Communities and Local Government April 2014

1.2 Site Details

A summary of the general site details is presented in Table 1-1. Plans, Drawings and Figures are provided in Appendix A. Figures 1 and 2 indicate the site location and boundary. Figure 3 indicates the proposed development.

Site Details	
Location	134 Broughton Street, to the east of Waterloo Road, Cheetham Hill. The nearest postcode to the site is M8 8AW. Centred at approximate National Grid Reference 383645E, 400125N.
Area	Approximately 0.12Ha.
Topography	42 metres above ordnance datum (AOD) in the north and east of the site and 40m AOD in the south and west. The site gently slopes to the southeast.
Current Land Use	<u>Site</u> The site consists of a convenience store with paved car parking to the west and south. <u>Surrounding Area/ Boundary Treatment</u> North: Commercial Properties. East: Commercial Properties. South: Commercial Properties. West: Residential Properties.
Proposed Development	Construction of a commercial wholesale retail warehouse with ancillary storage and car parking. Access will be from Waterloo Road.

Table 1-1: Summary of site details.

2 Site Setting

2.1 Vulnerability

As an initial phase in identifying which Sustainable Drainage System is appropriate for the site, LKC has consulted the Environment Agency's (EA) website Flood Zone Mapping.

The Flood Zone Mapping indicates the site as being within Flood Zone 1 in the PPG (paragraph 065, Table 1).

The proposed development is for a commercial/non-residential end use, and this is classified within the 'Less Vulnerable' category in the PPG (paragraph 066, Table 2).

2.2 Environmental Setting

LKC have previously undertaken a Preliminary Risk Assessment for the site³ (CL-602-LKC 21 1509-01, November 2021) and pertinent environmental information for the site is summarised in Table 2-1 below.

Summary of the Environmental Setting		
Geology	Superficial	Glacial Till, Devensian - Diamicton. (Clay based)
	Bedrock	Chester Formation - Sandstone.
	BGS Boreholes	BH Ref: SD80SW50, 22m southeast: Clay to 12.04m. BH Ref: SJ89NW42, 290m southeast: Ashes to 0.61m, clay to 5.49m, running sand to 8.23m and hard clay to 12.5m. BH Ref: SJ89NW1480, 130m southwest: Tarmac and cobbles to 0.33m and firm to stiff brown silty clay with pebbles to 4.17m. BH Ref: SJ89NW1481, 200m southeast: Tarmac and brick setts to 0.50m, very soft to stiff brown clayey silt to 4.6m and stiff brown silty clay with occasional pebbles to 6.00m. BH Ref: SJ89NW1476, 300m southeast: Road setts, clayey cinder fill to 1.52m, stiff to hard brown silty clay with occasional pebbles to 4.00m and stiff poorly graded medium/coarse brown slightly sandy silt to 4.85m.
Hydrogeology	Superficial	Secondary Aquifer (Undifferentiated).
	Bedrock	Principal Aquifer. The site is not within a Source Protection Zone.
Hydrology	All adjacent and internal surface water	A culverted watercourse runs through the site in a south-westerly direction and continues to flow southwards under Waterloo Road.
Site History		The historical mapping indicates that no internal or adjacent watercourses were present from 1850. Between 1952 and 1964 historical mapping showed the land was vacant whilst a garage was constructed in 1973. From 1978 the garage was replaced by a store depot.

Table 2-1: Summary of the Environmental Setting.

³ Phase 1 Preliminary Risk Assessment (PRA) report by LK Consult (Ref: CL-602-LKC 21 1509-01, dated November 2021)

2.3 Site Reconnaissance

A site reconnaissance was undertaken on 9th November 2021 and photographs are provided in Appendix B.

Relevant features identified on site are summarised below:

- Hardstood ground covers all the site.
- A single-story building on site with roller shutters was observed in the north and east of the site. (Currently an operational commercial building).
- The single-story building comprises a sewage system to its southern side which is suspected to connect to the combined sewer adjacent the site.
- A drainage pipe on the eastern side of the commercial building was observed suggesting there is an established connection to the combined sewer adjacent the site.
- A round inspection cover was observed on the footpath adjacent the southwestern site boundary (possibly on the line of the culvert).
- Two manhole covers were observed on the site adjacent the east and west of the single-story building public entrance.
- A number of gullies were observed adjacent the vehicular access point from Broughton Street adjacent the southern site boundary.

The surrounding area comprises further industrial and commercial properties to the north, east and south with residential properties across Waterloo Road to the west.

2.4 Site and Access Levels

A topographic survey of the site has been undertaken and information is included on the drawings in Appendix A. The site has an elevation ranging from 40m AOD to 42m AOD respectively. The proposed access would join Waterloo Road at around 14.8m AOD.

3 Consultation

Information from consultees (Environment Agency (EA), Manchester City Council and United Utilities) is summarised in Table 3-1 below.

Relevant correspondence / information is provided in Appendices C (EA) and D (others).

Source	Details	
Environment Agency	Flood Zone 1: Very low risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).	
	Modelled Levels for Lower Irwell Nearest Node: ea013_0208_IRW 13665	Level of 26.96m for 1% annual probability event. Level of 28.34m for 1% event with 30% climate change allowance. Level of 30.02m for 1% event with 70% climate change allowance. Level of 30.64m for 0.1% annual probability event.
Manchester City Council (LLFA)	The site is within a critical drainage area and will require a 50% reduction in runoff.	
United Utilities (UU)	Likely conditions for connecting into their sewerage system	UU would request conditions for a separate system with only foul draining to foul / combined sewers and surface water draining to soakaway/SuDS, watercourse, or surface water sewer. UU would also request for a condition to prevent development within 3m either side of the sewer running through the site. Once evidence is provided, UU will consider a connection to the 940mm x 1280mm diameter public combined sewer within Broughton Street located south of the proposed site at a pass forward flow to be agreed by the Lead Local Flood Authority. United Utilities request that any agreed rate does not exceed 5l/s. UU suggest that the Lead Local Flood Authority should be contacted to discuss a point of discharge to the culverted watercourse crossing the site. UU confirmed that they did not have any record of internal or external sewer flooding of properties in the vicinity of the site as a result of overloaded sewers.
	sewer map	There is a 940mm x 1280mm diameter combined public sewer running parallel to the site's western site boundary along Waterloo Road that turns east into Broughton Street. A 300mm diameter combined sewer runs west and connects into the ovoid sewer south of the site. A surface water/highway drain is observed running through the site in a south-westerly direction and is accessible via a manhole chamber adjacent to the western site boundary.

Table 3-1 (continued): Summary Consultee Information.

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4 Sustainable Drainage Strategy

4.1 Introduction

The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface run-off from development sites through the use of Sustainable Drainage Systems (SuDS), this being complementary to the control of development within the floodplain.

SuDS will not alleviate flooding in an area prone to flooding; however, properly designed SuDS have the potential to prevent the surface water runoff from new development worsening the flood risk. The effective disposal of surface water from development is a material planning consideration in determining proposals for the development and use of land.

The accepted principles are that surface water arising from a developed area should, as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

The Building Regulations Requirement H3⁴ stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority:

- » an adequate soakaway or other adequate infiltration system,
- » a watercourse or, where that is not practicable,
- » a sewer.

The concept of a sustainable drainage system has been incorporated into the outline drainage strategy for the study area in order to comply with the Flood and Water Management Act 2010⁵.

4.2 Infiltration

The Groundwater Source Protection Zone mapping from the EA website shows that the site is not within any identified protection zones.

A summary of the British Geological Survey superficial and bedrock aquifer descriptions and classifications supplemented by local records is shown in Table 4-1 below:

Classification	Description	Aquifer Classification	Recorded Water Table Depth	Soakaway Potential
Glacial Till - Devensian Superficial Deposits.	Diamicton - Silty, sandy gravelly clay with sand lenses.	Secondary (Undifferentiated).	N/A.	Poor.
Chester Formation Bedrock.	Sandstone.	Principal.	N/A.	Good.

Table 4-1: Geological and Hydrogeological Setting.

⁴ Building Regulations part H3 2010: Approved Document, Drainage and Waste Disposal.

⁵ Flood and Water Management Act 2010: UK Government.

Infiltration methods such as soakaways are unlikely to be feasible, but this may be investigated further at the detailed design stage if required.

There is a slope over the site and surrounding area which indicates that surface water in the vicinity of the site would drain towards the southeast.

4.3 Watercourses

There is a culverted watercourse running through the site in a south-westerly direction. Currently surface water from the site is collected to the on-site drainage systems overland to the southern boundary.

4.4 Public Sewer

There is a combined public sewer running adjacent to the site in Broughton Street and Waterloo Road. There is also a public combined sewer adjacent to the disused depot building and eastern boundary of the site running towards Broughton Street.

4.5 Other Sewers

There is a highway drain running through the site in a south westerly direction which ends on Waterloo Road.

4.6 Surface Water Drainage Strategy

The drainage options relating to the final discharge of surface water for this section of the site are listed in Table 4-2 in order of priority within the NPPF:

Option No:	Drainage Solution	Most feasible solution	Comments
a	Soakaway/Infiltration	N/A	Not likely to be practical due to the size constraints of the site. The site is further constrained by the proximity of the adjacent roads and sewers. Borehole records indicate that clay is present to a depth of 1.52m below the made ground.
b	Connection to Watercourse	1	There is a culverted watercourse running through the site which may be used as a point of discharge. This would require LLFA and UU consent as it appears to terminate at the combined sewer.
c	Discharge into a sewer	2	The depth of the combined sewer adjacent to the western site boundary and levels at the southwestern corner indicate that a connection is possible – subject to approval from the LLFA and UU.

Table 4-2: Drainage options.

Table 4-3 provides a summary of the SuDS options appraisal with consideration of CIRIA C697 (The SUDS Manual)⁶ for the development:

SuDS Option	Appropriate to Development	Comments
Soakaways	X	Due to the nature of the ground conditions, the use of infiltration systems may not be feasible.
Infiltration basin	X	Depressions that store and dispose of water via infiltration. May be not appropriate given the ground conditions.
Filter strip	X	Engineered filters that use vegetation to remove and treat runoff. A filter strip offers no storage and is used solely to remove pollutants from surface water.
Filter drains	*	Linear trenches filled with a permeable granular material, often with a perforated pipe in the base of the trench.
Detention basin	X	Dry depressions designed to hold water for a specific retention time. The use of a detention basin may not be feasible due to the size constraints of the site.
Swales	X	Swales are shallow grass-lined channels that provide capacity for conveying flows at a controlled rate into ponds and watercourses. The use of swales may not be feasible due to size constraints of the site and surrounding infrastructure
Rainwater harvesting	*	Rainwater harvesting collects the rain which falls onto roofs, then stores it in a tank until required for a non-potable use. In the process, a volume of water is kept out of the storm-water management system, thereby helping to reduce flooding risks. Rainwater harvesting systems are currently not included in the development proposals.
Green roofs	*	Green roof installations can help to reduce surface water runoff from roof areas depending on the system specified. Green roofs are not currently included in the development proposals.
Geo-cellular storage systems	✓	Modular block systems can be used to provide an underground storage facility. Any geo-cellular storage systems should be lined with a geo-membrane to provide attenuation storage.
Permeable Pavements – with granular and geo-cellular storage systems	✓	Permeable pavements allow inflow of rainwater into underlying construction. Any geo-cellular storage systems would have to be lined with an impermeable membrane to provide storage rather than infiltration for runoff from highways.
Ponds	X	Attenuation ponds can be used to offset the increase in surface water flows attributable to increased area of hard standing, in order to minimise the risk of flooding to and from the proposed development. Ponds will attenuate the surface water flow prior to discharging to the public surface water sewers.
Oversized Pipes	✓	Oversizing the pipes that make up the on-site drainage network is a cost-effective method for providing attenuation storage within the network. Such systems could be considered on parts of the development where gradients are relatively flat.
Tanks	✓	Prefabricated underground tanks could be considered at the detailed design stage in order to provide storage to attenuate surface water runoff.
Flow control devices	✓	The peak flow rates will be controlled by flow control devices e.g., hydrobrake style flow control systems, and restricted orifices. Flow control devices enable the discharge to be restricted to a constant rate from the development.

Table 4-3: Summary of the SuDS options appraisal.

Notes

✓ Suitable for use given the nature and scale of the development

* Possibly suitable for use – not included in the client and architect design proposal at present

X Not suitable

⁶ CIRIA C697 - The SUDS Manual. London 2015

4.7 Surface Water Attenuation Requirements

From correspondence with United Utilities the flow should be limited to a 'greenfield scenario' for estimating the attenuation volumes required.

It is estimated from the supplied plan (see Appendix A) that the site will have the following designated areas (Table 4-4).

Designated Areas	Plot Area
Total area (ha)	0.12
Impermeable Area (ha)	0.12
Permeable Area (ha)	0.00
Catchment	
Developable Area (ha)	0.12
Impermeable split (ha)	0.12
Permeable split (ha)	0.00

Table 4-4: Assumed plot areas.

Table 4-4 shows the assumed split in area included within the calculations.

It can be seen that there is no change in impermeable area from the existing usage to the proposed. This is likely to require attenuation to reduce the existing flow off site to a level which is acceptable to the LLFA and to UU.

4.7.1 Attenuation Estimate

Surface water storage with brownfield and greenfield runoff estimations based on the HR Wallingford procedure have been undertaken for the development and the output report is presented in Appendix E.

This gives the following runoff rates and attenuation requirements for this section based on the Wallingford IH 124 method:

» Q_{bar} :	0.750 l/s
» 1 in 1-year greenfield runoff rate:	0.641 l/s
» 1 in 30-year greenfield runoff rate:	1.266 l/s
» 1 in 100-year greenfield runoff rate:	1.583 l/s

The existing flows have been estimated below:

» Q_{bar} :	16.2 l/s
» 1 in 1-year existing runoff rate:	12.0 l/s
» 1 in 30-year existing runoff rate:	30.9 l/s
» 1 in 100-year existing runoff rate:	38.8 l/s

The 50% reduced flows are below:

» Q_{bar} :	8.1 l/s
» 1 in 1-year reduced runoff rate:	6.0 l/s
» 1 in 30-year reduced runoff rate:	15.5 l/s
» 1 in 100-year reduced runoff rate:	19.4 l/s

United Utilities has specified an allowable discharge rate of up to 5l/s to their adjacent public combined drain.

All runoff estimates, and subsequent storage estimates are included in Appendix E.

The following attenuation has been estimated for the development using the 5l/s runoff rate and utilises the FSR methodology⁷ as:

- Attenuation storage volume: **12.0 m³** (1 in 30-year event)
- Retention on site volume: **24.7 m³** (1 in 100 year + 20% Climate Change)
- Retention on site volume: **31.4 m³** (1 in 100 year + 40% Climate Change)

Attenuation storage aims to limit the peak rate of runoff from the development to an acceptable level for a range of annual flow rate probabilities before discharging into a sewer or watercourse. As the flow from the development would be restricted there should be little change in the flows within the sewer system and thus the risk of flooding. As a result, any flow contribution from the development should not increase the risk of flooding off-site.

The attenuation required for a 1 in 30-year storm event, requires a storage volume of **12.0 m³** and for the 1 in 100-year event, a storage capacity of between **24.7 m³** and **31.4 m³** will be required from on-site storage as well as SuDS systems. All volumes can be stored within the site boundary and discharges will be limited by flow control devices to the adjacent sewer on Waterloo Road.

The use of permeable paving may be viable dependant on the detailed design of the proposed development. If this drainage technique is considered to be feasible then it will reduce the requirement for attenuation as it will reduce the contributing area.

Assuming that the outline drainage strategy is acceptable to the Local Authority, a more detailed design can be presented and agreed with the appropriate regulatory bodies during the detailed design phase.

4.8 Foul Drainage

An unrestricted connection to the 940 x 1280 combined sewer in Broughton Road would be considered acceptable.

⁷ Flood Studies Report Wallingford NERC 1975.

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5 Conclusion

The site is currently a commercial property (convenience store) with a paved area designated for car parking. The proposal is to develop the site at 134 Broughton Street (102-104 Waterloo Road) into a commercial wholesale retail warehouse with ancillary storage and car parking.

A combination of the constraints on the site and the ground conditions indicate that infiltration may not be practical. The site is also considered to be too constrained due to the proximity of the adjacent roads and proposed foundations for the use of soakaways.

The connection to the surface water drain would be the preferred option but if impractical a connection to the combined sewer would be practical.

There appears to be a connection of the site to the public combined sewer in Broughton Street and Waterloo Road due to the presence of manhole covers within the site boundary. The pre-development advice received from United Utilities considered a flow rate of up to 5l/s would be acceptable if infiltration proved to be impractical.

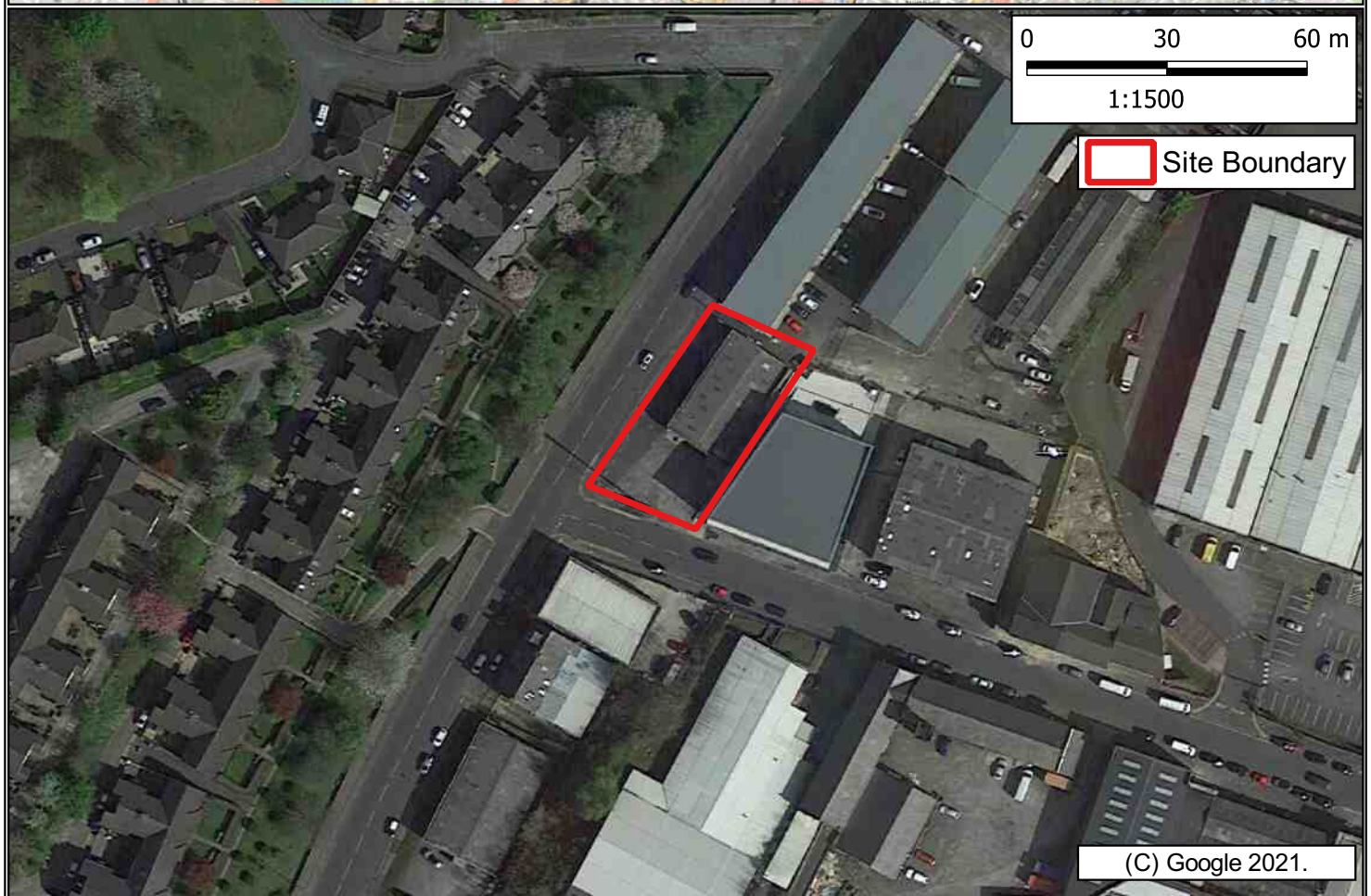
All proposed outflow connections from the development should be agreed with the Local Planning Authority and United Utilities.

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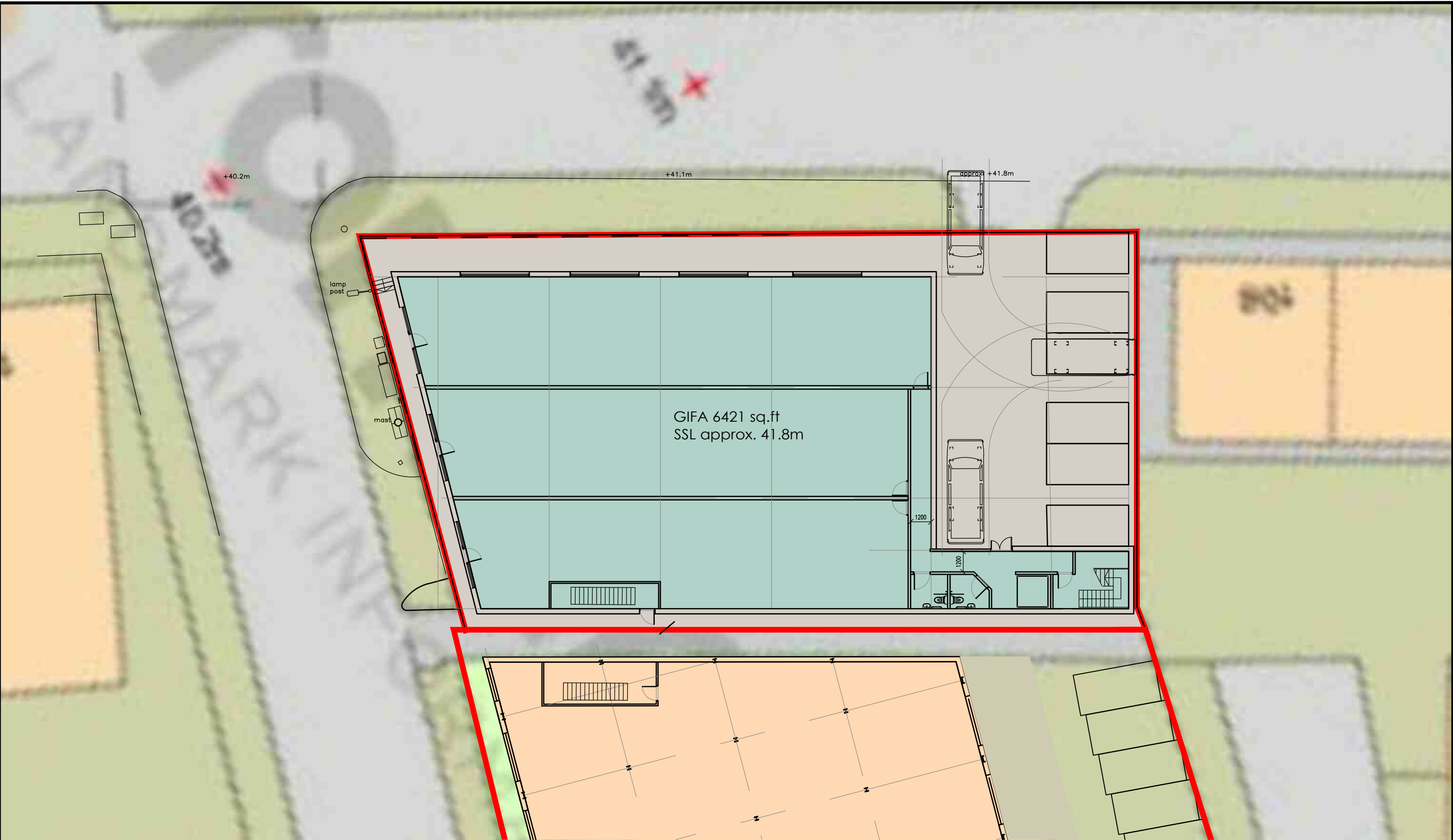
APPENDIX A

FIGURES, PLANS AND DRAWINGS

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Client: NN Holding LTD				Title: Site Location & Boundary Plan				
Site: 102-104 Waterloo Road				Scale (see scale bar): 1:25,000 & 1:1,500 @ A4			Figure: 1	Revision:
Job No.: LKC 21 1509	Drawn By: JT	Checked By: HM	Drawn: November					



DRAFT SITEPLAN
134, BROUGHTON STREET, MANCHESTER

SCALE 1:200 @ A3



FOB Design (UK) Ltd
72A Water Lane,
Wilmslow, Cheshire. SK9 5BB
01625 251644
office@fob-design.com www.fob-design.com

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134, BROUGHTON STREET, MANCHESTER					
PROPOSED WHOLESALE RETAIL WAREHOUSE					
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Checked	DPP	Original	A3	Scale	1:100@A1
26213-SK 02					B

APPENDIX B

SITE INFORMATION

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Geology 1:50,000 Maps Legends

Artificial Ground and Landslip

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	WMGR	Infilled Ground	Artificial Deposit	Not Supplied - Holocene
	MGR	Made Ground (Undivided)	Artificial Deposit	Not Supplied - Holocene
	WGR	Worked Ground (Undivided)	Void	Not Supplied - Holocene
	SLIP	Landslide Deposit	Unknown/Unclassified Entry	Not Supplied - Quaternary

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Not Supplied - Holocene
	TILLD	Till, Devensian	Diamicton	Not Supplied - Devensian
	GFSDD	Glaciofluvial Sheet Deposits, Devensian	Sand and Gravel	Not Supplied - Devensian
	GFDUD	Glaciofluvial Deposits, Devensian	Sand and Gravel	Not Supplied - Devensian
	HMGDD	Hummocky (Moundy) Glacial Deposits, Devensian	Sand and Gravel	Not Supplied - Devensian
	RTD1	River Terrace Deposits, 1	Sand and Gravel	Not Supplied - Quaternary
	PEAT	Peat	Peat	Not Supplied - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	CHES	Chester Formation	Sandstone	Not Supplied - Olenekian
	MM	Manchester Marls Formation	Mudstone	Not Supplied - GUADALUPIAN
	CS	Collyhurst Sandstone Formation	Sandstone	Not Supplied - Cisuralian
	HA	Halesowen Formation	Mudstone, Siltstone and Sandstone	Not Supplied - Westphalian
	HTS	Holt Town Sandstone Bed	Sandstone	Not Supplied - Westphalian
	GML	Great Mine Limestone	Limestone	Not Supplied - Westphalian

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	WDR	Worsley Delf Rock	Sandstone	Not Supplied - Westphalian
	PUCM	Pennine Upper Coal Measures Formation	Mudstone, Siltstone and Sandstone	Not Supplied - Westphalian
	NHSS	Newton Heath Sandstone	Sandstone	Not Supplied - Westphalian
	PMCM	Pennine Middle Coal Measures Formation	Mudstone, Siltstone and Sandstone	Not Supplied - Westphalian
	ETM	Etruria Formation	Sandstone and Mudstone	Not Supplied - Westphalian
		Faults		
		Rock Segments		



Geology 1:50,000 Maps

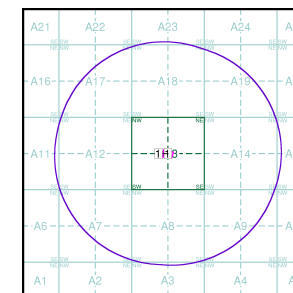
This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.

The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID: 1
 Map Sheet No: 085
 Map Name: Manchester
 Map Date: 2010
 Bedrock Geology: Available
 Superficial Geology: Not Available
 Artificial Geology: Not Available
 Faults: Not Supplied
 Landslip: Not Available
 Rock Segments: Not Supplied

Geology 1:50,000 Maps - Slice A



Order Details:

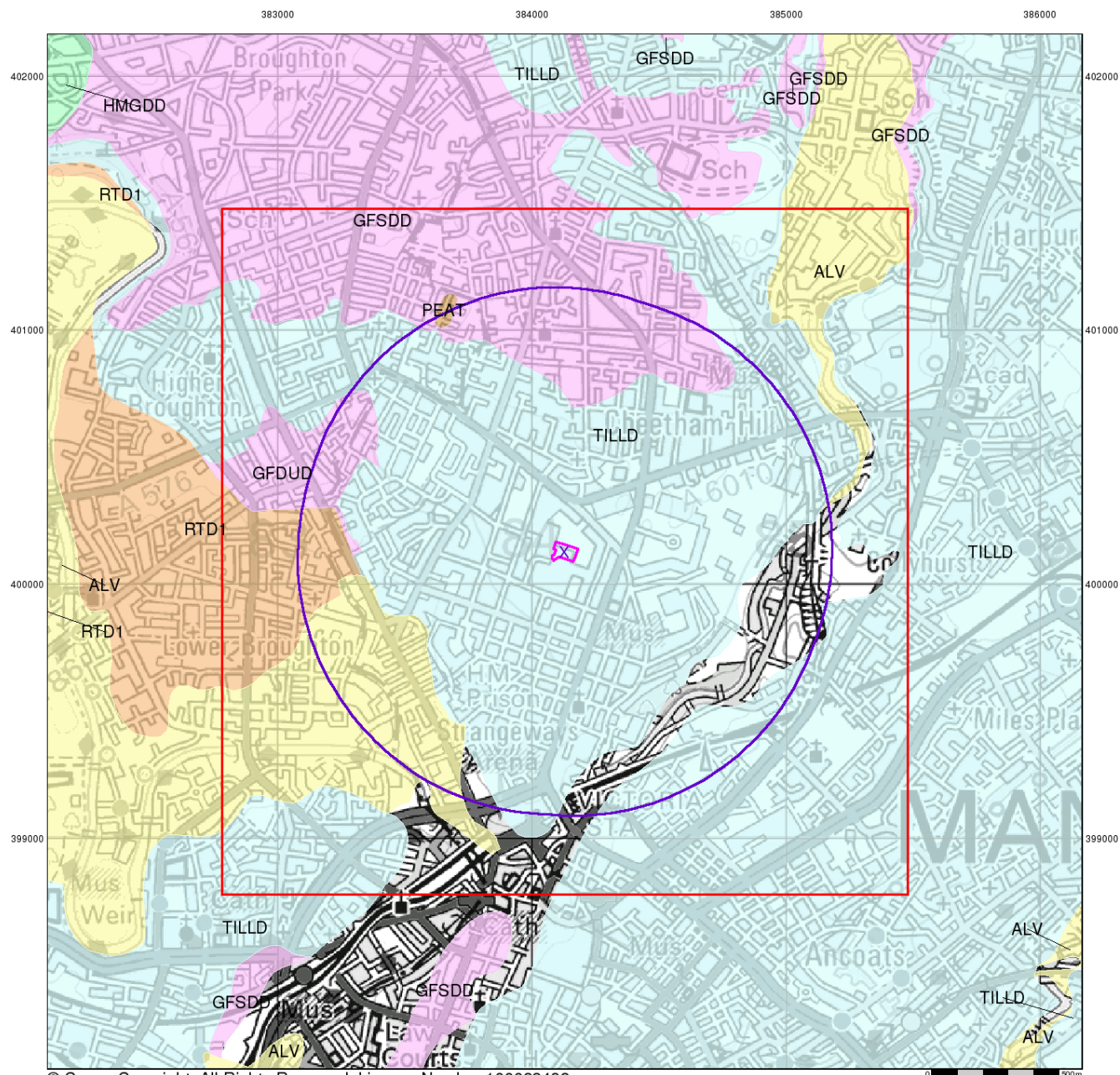
Order Number: 287168804_1_1
 Customer Reference: LKC 21 1508
 National Grid Reference: 384130, 400130
 Slice: A
 Site Area (Ha): 0.51
 Search Buffer (m): 1000

Site Details:

Bradstone Road, Manchester, M8 8WA

Landmark
 INFORMATION GROUP

Tel: 0844 844 9952
 Fax: 0844 844 9951
 Web: www.ernirocheck.co.uk



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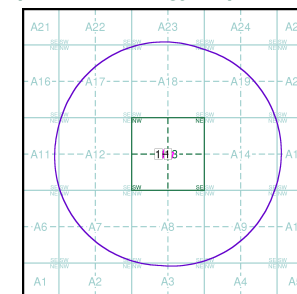
Superficial Geology

Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 1.8 million years from the present.

They rest on older deposits or rocks referred to as Bedrock. This dataset contains Superficial deposits that are of natural origin and 'in place'. Other superficial strata may be held in the Mass Movement dataset where they have been moved, or in the Artificial Ground dataset where they are of man-made origin.

Most of these Superficial deposits are unconsolidated sediments such as gravel, sand, silt and clay, and onshore they form relatively thin, often discontinuous patches or larger spreads.

Superficial Geology Map - Slice A



Order Details:

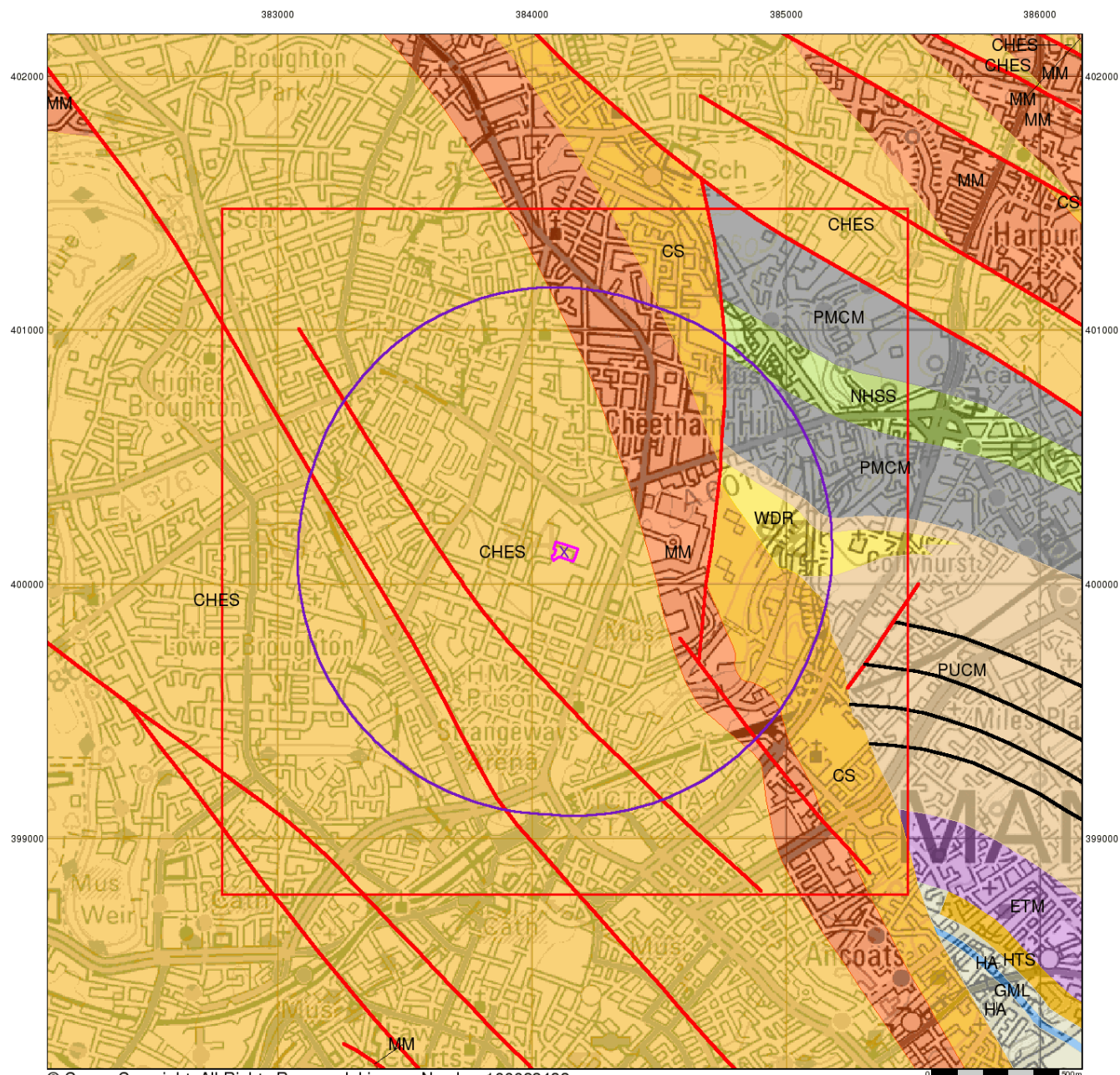
Order Number: 287168804_1_1
 Customer Reference: LKC 21 1508
 National Grid Reference: 384130, 400130
 Slice: A
 Site Area (Ha): 0.51
 Search Buffer (m): 1000

Site Details:

Bradstone Road, Manchester, M8 8WA



Tel: 0844 844 9952
 Fax: 0844 844 9951
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Bedrock and Faults

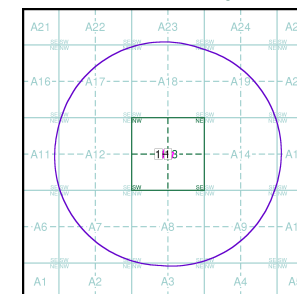
Bedrock geology is a term used for the main mass of rocks forming the Earth and are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

The bedrock has formed over vast lengths of geological time ranging from ancient and highly altered rocks of the Proterozoic, some 2500 million years ago, or older, up to the relatively young Pliocene, 1.8 million years ago.

The bedrock geology includes many lithologies, often classified into three types based on origin: igneous, metamorphic and sedimentary.

The BGS Faults and Rock Segments dataset includes geological faults (e.g. normal, thrust), and thin beds mapped as lines (e.g. coal seam, gypsum bed). Some of these are linked to other particular 1:50,000 Geology datasets, for example, coal seams are part of the bedrock sequence, most faults and mineral veins primarily affect the bedrock but cut across the strata and post date its deposition.

Bedrock and Faults Map - Slice A



Order Details:

Order Number: 287168804_1_1
 Customer Reference: LKC 21 1508
 National Grid Reference: 384130, 400130
 Slice: A
 Site Area (Ha): 0.51
 Search Buffer (m): 1000

Site Details:

Bradstone Road, Manchester, M8 8WA



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 Fax: 0844 844 9951
 Web: www.ernirocheck.co.uk

v15.0 02-Nov-2021

Page 4 of 5

GEO-RESEARCH LTD.
BRIGHTON ROAD,
HEATON NORRIS,
STOCKPORT, CHESHIRE.

Borehole No. 17 *ST89NW*
Sheet No. 1 *1476*
Date Commenced 20/6/73
Date Completed 21/6/73
Scale 1:50 *8584 9091*

CONTRACT: 'G' SEWER

LOCATION: MANCHESTER

Stratum	Legend	Thick- ness	Depth	Sample No.	N Value	Level	Remarks
			GL				
Road setts. Clayey cinder FILL.		1.520	1.520	B1			Dry
Stiff to hard brown silty CLAY with occasional pebbles		2.230	2.230	D1 U1			Dry
		3.040	3.040	D2			Water Added
		3.940	3.940	U2			
		2.480	2.480	D3			
Stiff poorly graded medium coarse brown slightly sandy SILT		4.400	4.400	U3			Dry
		0.850	0.850				
Borehole complete							On completion of borehole at 4.850 Casing at 3.040 Water Nil. Borehole backfilled as casing withdrawn.

GEO-RESEARCH LTD.

 BRIGHTON ROAD,
 HEATON NORRIS,
 STOCKPORT, CHESHIRE.

Borehole No. 21

SS89NW

Sheet No. 1

1480

Date Commenced 26/6/73

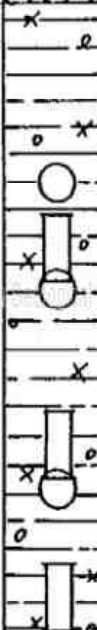
Date Completed 26/6/73

Scale

1:50 8359 9998

CONTRACT: 'G' SEWER

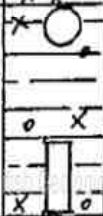
LOCATION: MANCHESTER

Stratum	Legend	Thick- ness	Depth	Sample No.	N Value	Level	Remarks
			GL				
TARMAC and COBBLES		0.330	0.330				Dry
Firm to stiff brown silty CLAY with pebbles			1.500 1.700 2.200 3.000 3.500 4.000 4.170	D1 U1 D2 U2 D3 U3			Damp
Borehole Complete							On completion of borehole at 4.500 Casing at 3.000 Water Nil. Borehole backfilled as casing withdrawn.

GEO-RESEARCH LTD.
BRIGHTON ROAD,
HEATON NORRIS,
STOCKPORT, CHESHIRE.

Borehole No. 22 **SS89NW**
Sheet No. 1 **1481**
Date Commenced 22/6/73
Date Completed 25/6/73
Scale 1:50 **8375 9994**

CONTRACT: 'G' SEWER
LOCATION: MANCHESTER

Stratum	Legend	Thick- ness	Depth	Sample No.	N Value	Level	Remarks
			GL				
TARMAC and BRICK SETTS		0.500	0.500				Damp
Very soft to stiff brown clayey SILT			1.250 1.500 2.250 3.000 4.000 4.100	D1 U1 B1 B2 U2			Damp
Stiff brown silty CLAY with occasional pebbles			4.750 5.500 1.400	B3 U3			Damp
Borehole Complete			6.000				On completion of borehole at 6.000 Casing at 3.500 Water Nil. Borehole backfilled as casing withdrawn.

GEO-RESEARCH LTD.

 BRIGHTON ROAD,
HEATON NORRIS,
STOCKPORT, CHESHIRE.

 Borehole No. 23 *5589WJ*

 Sheet No. 1 *1482*

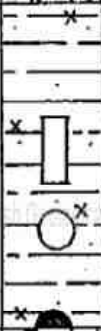
Date Commenced 21/6/73

Date Completed 22/6/73

 Scale 1:50 *8348 9985*

CONTRACT: 'G' SEWER

LOCATION: MANCHESTER

Stratum	Legend	Thick- ness	Depth	Sample No.	N Value	Level	Remarks
			GL				
Cinder and brick FILL		0.770	0.770				Damp
Firm brown and grey mottled silty sandy CLAY			1.500	U1			Damp
			2.250	D1			
		2.120	2.890				
Compact poorly graded brown sandy GRAVEL			3.000	D2 CP1	26		
			3.500	B1			
			4.000	CP2	32		
			4.500	B2			Water Added
			5.000	CP3	84		
		2.610	5.500				
Borehole Complete							On completion of borehole at 5.500 Casing at 5.000 Water Nil. Borehole backfilled as casing withdrawn.



Photograph 1:
View of the
proposed access
road towards the
northwestern
boundary which
connects to
Waterloo Road.



Photograph 2:
A drainage pipe
located on the
current property's
eastern side which
suggests there is
an established
connection to the
combined sewer
adjacent to the site.



Photograph 3:
View of the site
from the
southwestern
border.



Photograph 4:
A manhole cover
located on site
adjacent to the
eastern single-
storey building's
public entrance.



Photograph 5:
View of the current
vehicular access
via Broughton
Street.



Photograph 6:
View of the site
from the
southeastern
boundary.

APPENDIX C

ENVIRONMENT AGENCY DATA

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Flood map for planning

Your reference
134 Broughton

Location (easting/northing)
383615/400077

Created
3 Dec 2021 14:02

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

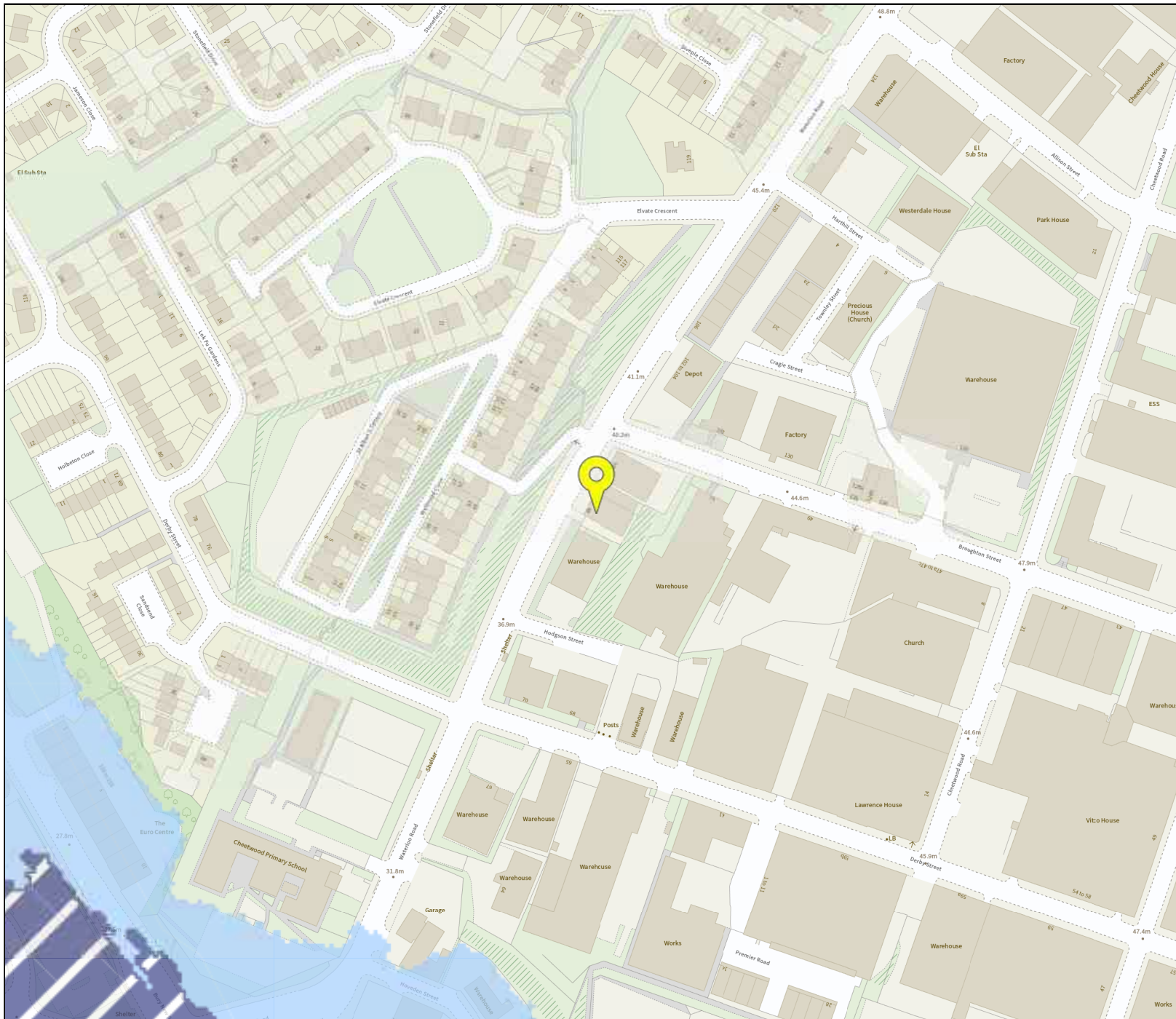
Notes

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.

Flood risk data is covered by the Open Government Licence which sets out the terms and conditions for using government data. <https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

Use of the address and mapping data is subject to Ordnance Survey public viewing terms under Crown copyright and database rights 2021 OS 100024198. <https://flood-map-for-planning.service.gov.uk/os-terms>



Flood map for planning

Your reference
134 Broughton

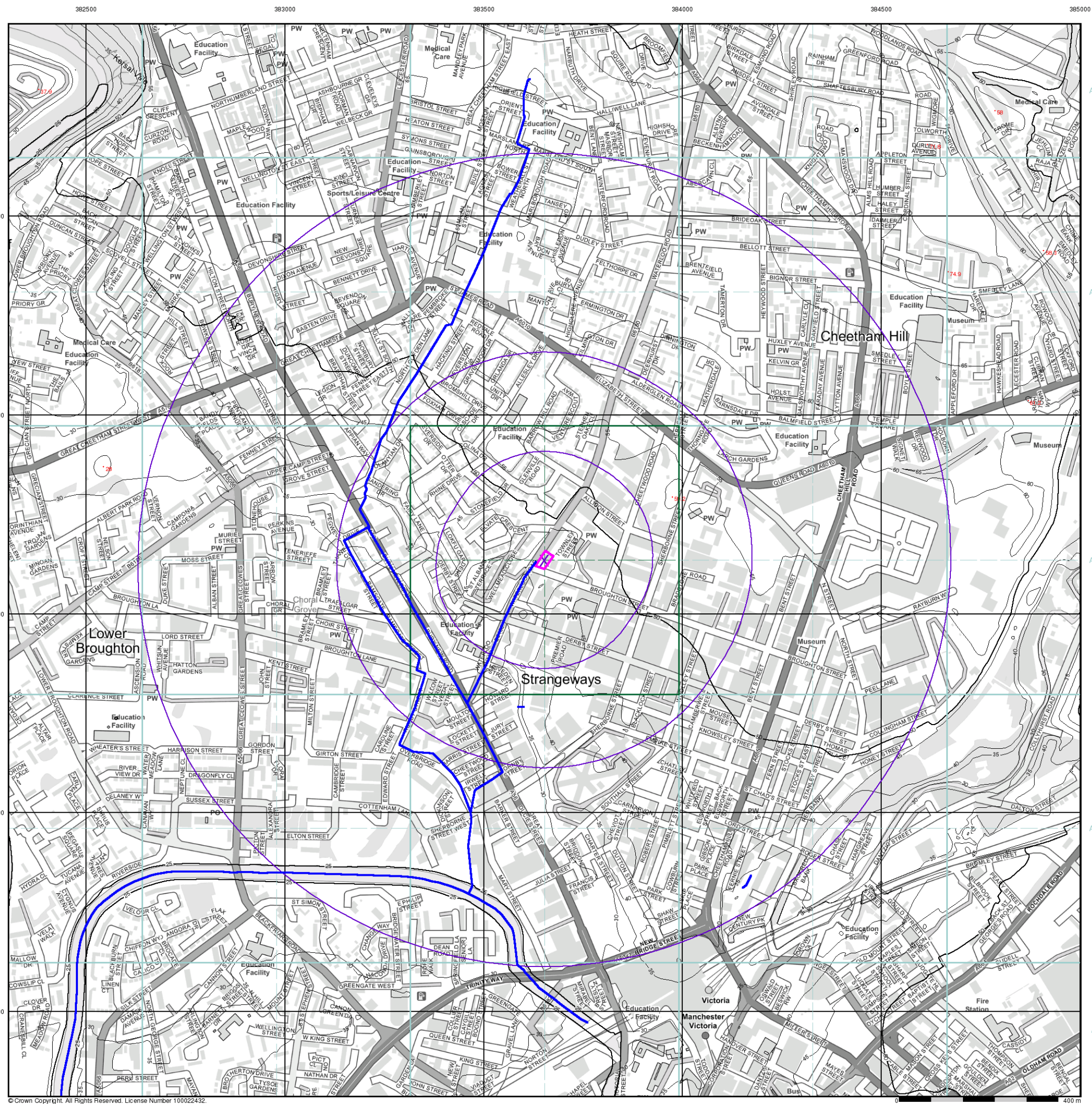
Location (easting/northing)
383615/400077

Scale
1:2500

Created
3 Dec 2021 14:02

-  Selected point
-  Flood zone 3
-  Flood zone 3: areas benefitting from flood defences
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Flood storage area

0 20 40 60m



General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

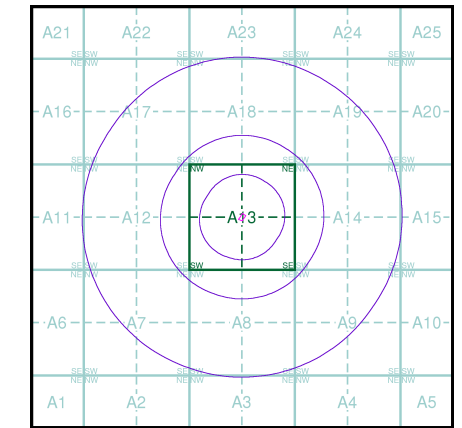
OS Water Network Data

- Canal
- Reservoir
- Foreshore
- Marsh
- Tidal River
- Inland River
- Drain
- Other
- Lake
- Transfer
- Lock Or Flight Of Locks
- Sea

Contours (height in meters)

- Standard Contour
- Master Contour
- Spot Height
- MLW Mean Low Water
- MHW Mean High Water

OS Water Network Map - Slice A



Order Details

Order Number: 287237626_1_1
 Customer Ref: LKC 21 1509
 National Grid Reference: 383650, 400130
 Slice: A
 Site Area (Ha): 0.1
 Search Buffer (m): 1000

Site Details

134 Broughton Street, Manchester, M8 8AN



Tel: 0844 844 9952
 Fax: 0844 844 9951
 Web: www.envirocheck.co.uk

APPENDIX D

CONSULTEE CORRESPONDENCE

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Jenna Lowe

From: Perry, Graham <Graham.Perry@uuplc.co.uk>
Sent: 15 November 2021 21:28
To: LK SuDS & Floods
Cc: Wastewater Developer Services
Subject: Pre Development Enquiry for : 134 Broughton Street M8 8NN UU reference Number : 4200044844

Pre Development Enquiry for: 134 Broughton Street M8 8NN UU reference Number : 4200044844

We have carried out an assessment of your application which is based on the information provided. This pre-development advice on your drainage strategy will be valid for 12 months. Your drainage strategy will need to be reviewed by other competent authorities as part of the planning process, and we advise that you carry out the necessary site investigations to confirm the viability of your proposals.

If your investigations require access to our public sewer network, we ask that you contact our network engineers with a request for an access certificate via our main contact telephone number 0345 3723223 or refer to the link below:

<https://www.unitedutilities.com/builders-developers/working-near-our-assets/>

Flooding

Although there are no registered flooding issues in the immediate area of the site, predicted surcharge levels within the receiving sewer system are very high and flooding is a real risk

Foul Water

Foul flow from this site will be allowed to drain into the public foul water/combined sewer system.

Our preferred point of discharge would be to the 930mm x 1280mm diameter public combined sewer within Broughton Street located to the south of your proposed development at an unrestricted rate.

If you are able to identify an alternative, more suitable point of discharge, we request that you contact us at your earliest convenience so that we can assess suitability.

Surface Water

All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80, (Reference ID: 7-080-20150323), of the National Planning Practice Guidance. We also recommend you prioritise the use of multi-functional sustainable drainage systems for the management of surface water in accordance with national planning policy.

Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable.

This is outlined as follows, in order of priority:

- 1. into the ground (infiltration);**
- 2. to a surface waterbody;**

3. to a surface water sewer or highway drain;

4. to a combined sewer.

For guidance, The **North West SuDS Pro-Forma** provides information on the appropriate evidence required at each stage of the hierarchy, to demonstrate how each level has been discounted.

The Lead Local Flood Authority has responsibility for all surface water drainage concerns and their input to your proposal is critical. You should also consider whether it is necessary to discuss your proposal with the Environment Agency, or Internal Drainage Board (if operating in your area).

The Local Planning Authority are the determining authority for any application for planning permission and the appropriate authority for determining cost viability of a proposed drainage scheme, such assessments are outside of the jurisdiction of United Utilities.

Infiltration

Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible.

A detailed evidence based feasibility assessment must be carried out in line with Chapter 25 of the CIRIA SuDS Manual 2015 to determine whether infiltration is a suitable method of surface water disposal.

Particular attention must be paid to Ground Water Source Protection Zones to ensure that the risk of pollution to these valuable resources is not compromised. Details can be obtained from the government website:

<https://www.gov.uk/guidance/groundwater-source-protection-zones-spzs#find-groundwater-spzs>

If your site is in a Groundwater Source Protection Zone, you should have regard to the Environment Agency's approach to Groundwater Protection. Information on this is available via the link below:

<https://www.gov.uk/government/publications/groundwater-protection-position-statements>

Please note that such a location could have implications for the principle of your development and the need for additional mitigating measures to protect the groundwater environment and public water supply in the detailed design of your site.

Waterbody

If an evidence based assessment has been carried out and confirms that infiltration is not feasible, we recommend that you contact the Lead Local Flood Authority and/or Environment Agency to discuss a point of discharge to the culverted watercourse crossing the site .

We would encourage you to identify and engage with any third party landowner and riparian owner to agree access and discharge rights to the water body if this is not in your ownership.

Highway Drainage

If an evidence based assessment has been carried out and confirms that infiltration is not feasible, we recommend that you investigate the possibility of draining surface water to the highway drain where this ultimately discharges to a watercourse, by contacting the relevant Highway Authority.

Public Sewer

In accordance with the hierarchy of drainage options within the National Planning Practice Guidance, both discharge to ground via infiltration and discharge to a waterbody should be discounted prior to consideration of discharging surface water to the public sewer system. Evidence should be provided to demonstrate how these have been discounted, as outlined in the North West SuDS pro-forma.

Once evidence is provided as outlined above, United Utilities will consider a connection to the 940mm 1280mm diameter public combined sewer within Broughton Street located south of the proposed site at a pass forward flow to be agreed by the Lead Local Flood Authority. United Utilities request that any agreed rate does not exceed 5l/s.

As a Water Company, we have no obligation to accept highway drainage into our public sewer network. However, should your proposals include runoff from highways, we would request that consideration is given to SuDS components that deliver source control are incorporated within the design of the scheme to reduce the volume and frequency of discharges of these flows to the public sewer.

Levels

For low-lying sites, (where the ground level of the site or the level of a basement is below the ground level at the point where the drainage connects to the public sewer), care should be taken to ensure that the property is not at increased risk of flooding. If these circumstances exist, we recommend that you contact us to discuss further. It could affect the detailed design of your site and result in the need to incorporate appropriate mitigating measures in your drainage scheme.

Land drainage / Overland flows / track drainage

United Utilities have no obligation, and furthermore we do not accept land drainage, overland flows or track drainage into the public sewerage network under any circumstances

Existing Wastewater Assets Crossing the Site

According to our public sewer records there are public sewers located within your site boundary. We will require unrestricted access to the sewer for maintenance purposes, we would ask that you maintain a minimum clearance of 6m which is measured 3m from the centre line of the pipe unless there happens to be a formal easement agreement in place, in which case the specified easement width would apply. If you cannot achieve this then you may wish to consider diverting and or abandoning the public sewer.

Please refer to the link below to obtain full details of the processes involved with sewer diversions:

<https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-diversions/>

Existing Water Assets Crossing the Site

It is the developer responsibility to identify utilities on-site. Where clean water assets are shown on our records, we recommend that you contact our Water Pre-Development Team, via the following email address:

DeveloperServicesWater@uuplc.co.uk. Further information for this service can be found on our website via the link below:

<https://www.unitedutilities.com/builders-developers/larger-developments/pre-development/water-pre-dev/>

Connection Application

Although we may discuss and agree discharge points and rates in principle, please be aware that you will have to apply for a formal sewer connection. This is so that we can assess the method of construction, Health & Safety requirements and to ultimately inspect the connection when it is made. Details of the application process and the form itself can be obtained from our website by following the link below:

<https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-connections/>

We recommend that the detailed design should confirm the locations of all utilities in the area and ensure that any proposed drainage solution considers routing and clash checks where required.

If we can be of any further assistance please don't hesitate to contact us further.

Kind regards,

Graham Perry



Graham Perry
Development Engineer
Developer Services
M: 07557 577548
T: 01925 679405
unitedutilities.com

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Visit: unitedutilities.com/wow

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www.unitedutilities.com/subsidiaries

LKGroup**Unit 29 Eton Business Park
Eton Hill Road, Radcliffe
Radcliffe, Greater
M26 2ZS****FAO:****How to contact us:****United Utilities Water Limited
Property Searches
Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP****Telephone: 0370 7510101****E-mail: propertysearches@uuplc.co.uk****Your Ref: FRA21 1143
Our Ref: UUPS-ORD-341024
Date: 03/11/2021****Dear Sirs****Location: 134 Broughton Street**

I acknowledge with thanks your request dated 02/11/2021 for information on the location of our services.

Please find enclosed plans showing the approximate position of United Utilities' apparatus known to be in the vicinity of this site.

The enclosed plans are being provided to you subject to the United Utilities terms and conditions for both the wastewater and water distribution plans which are shown attached.

If you are planning works anywhere in the North West, please read United Utilities' access statement before you start work to check how it will affect our network. <http://www.unitedutilities.com/work-near-asset.aspx>.

I trust the above meets with your requirements and look forward to hearing from you should you need anything further.

If you have any queries regarding this matter please [contact us](#).

Yours Faithfully,



Karen McCormack
Property Searches Manager

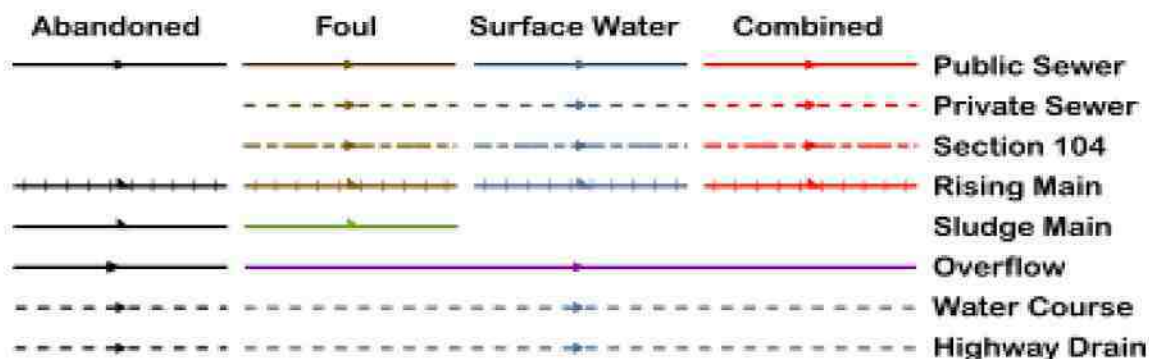
TERMS AND CONDITIONS - WASTEWATER AND WATER DISTRIBUTION PLANS

These provisions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the agreement for the self construction of water mains) (UUWL apparatus) of United Utilities Water Limited "(UUWL)".

TERMS AND CONDITIONS:

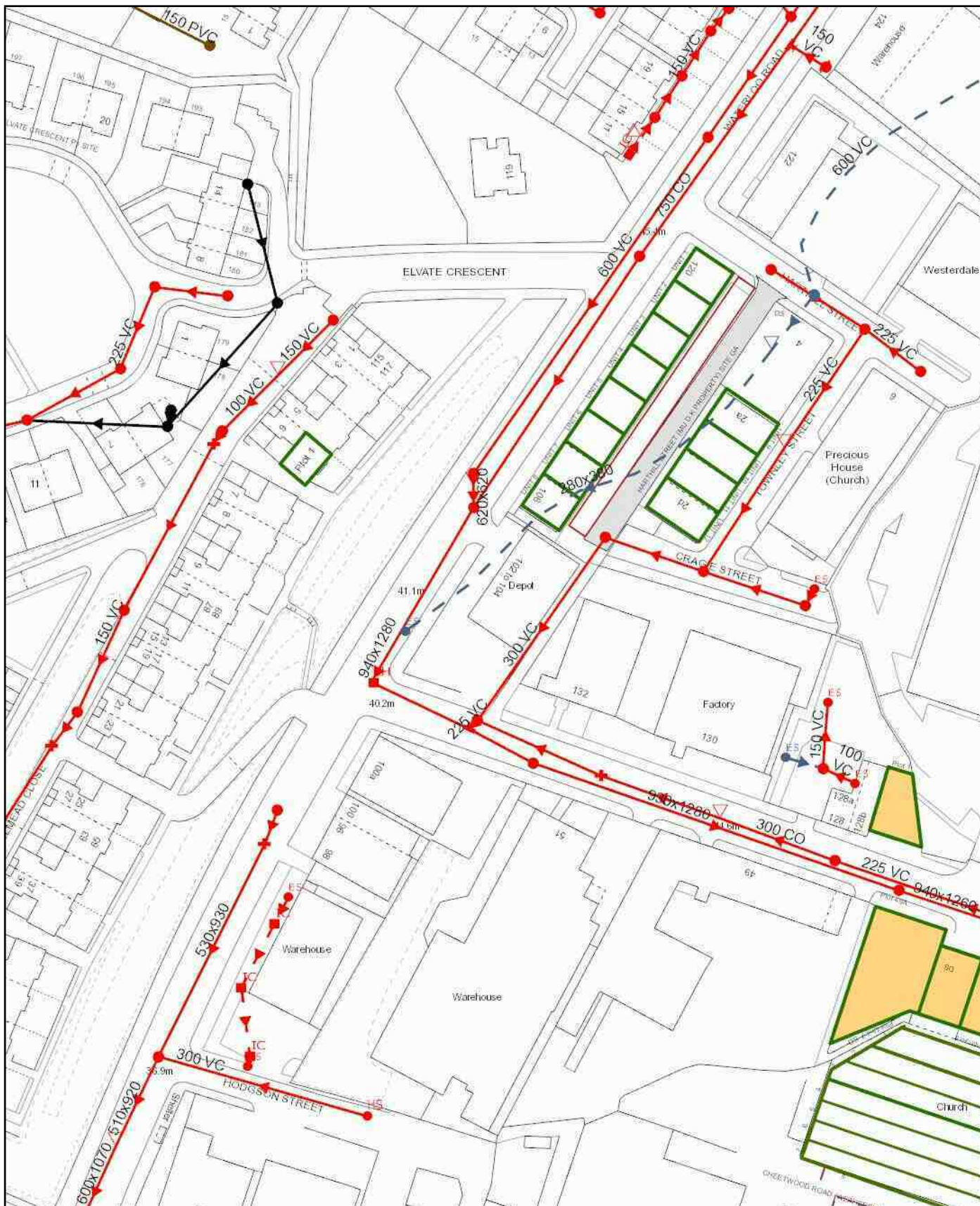
- This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out in this agreement or the documents referred to in it.
- This Map and any information supplied with it is provided for general guidance only and no representation, undertaking or warranty as to its accuracy, completeness or being up to date is given or implied.
- In particular, the position and depth of any UUWL apparatus shown on the Map are approximate only. UUWL strongly recommends that a comprehensive survey is undertaken in addition to reviewing this Map to determine and ensure the precise location of any UUWL apparatus. The exact location, positions and depths should be obtained by excavation trial holes.
- The location and position of private drains, private sewers and service pipes to properties are not normally shown on this Map but their presence must be anticipated and accounted for and you are strongly advised to carry out your own further enquiries and investigations in order to locate the same.
- The position and depth of UUWL apparatus is subject to change and therefore this Map is issued subject to any removal or change in location of the same. The onus is entirely upon you to confirm whether any changes to the Map have been made subsequent to issue and prior to any works being carried out.
- This Map and any information shown on it or provided with it must not be relied upon in the event of any development, construction or other works (including but not limited to any excavations) in the vicinity of UUWL apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or other distribution systems.
- No person or legal entity, including any company shall be relieved from any liability howsoever and whensoever arising for any damage caused to UUWL apparatus by reason of the actual position and/or depths of UUWL apparatus being different from those shown on the Map and any information supplied with it.
- If any provision contained herein is or becomes legally invalid or unenforceable, it will be taken to be severed from the remaining provisions which shall be unaffected and continue in full force and affect.
- This agreement shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts, save that nothing will prevent UUWL from bringing proceedings in any other competent jurisdiction, whether concurrently or otherwise.

Wastewater Symbolology



All point assets follow the standard colour convention: **red** – combined **brown** - foul
blue – surface water **purple** - overflow

Manhole	Side Entry Manhole
Head of System	Outfall
Extent of Survey	Screen Chamber
Rodding Eye	Inspection Chamber
Inlet	Bifurcation Chamber
Discharge Point	Lamp Hole
Vortex	T Junction / Saddle
Penstock	Catchpit
Washout Chamber	Valve Chamber
Valve	Vent Column
Air Valve	Vortex Chamber
Non Return Valve	Penstock Chamber
Soakaway	Network Storage Tank
Gully	Sewer Overflow
Cascade	Ww Treatment Works
Flow Meter	Ww Pumping Station
Hatch Box	Septic Tank
Oil Interceptor	Control Kiosk
Summit	
Drop Shaft	Change of Characteristic
Orifice Plate	



Scale: 1:1250
Date: 03/11/2021

SEWER RECORDS



Address or Site Reference: 134 Broughton Street
Printed by: Property Searches

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

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Jenna Lowe

From: LK SuDS & Floods
Sent: 04 November 2021 10:02
To: floodriskmanagement@manchester.gov.uk
Cc: Jenna Lowe; l.aspinall@thelkgroup.com; m.jones@thelkgroup.com
Subject: FRA Query - FRA 21 1143 - 134 Broughton Street, Manchester
Attachments: SK 02 B (DRAFT SITEPLAN).pdf

Dear Sir/Madam,

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA), for a site located at 134 Broughton Street, Cheetham Hill, Manchester. Nearest Postcode M8 8NN, centred at approximate National Grid Reference 383646E, 400126N.

The area of interest appears to be within Flood Zone 1.

BGS data indicates that the site is within an area underlain by Till, Devensian – Diamicton superficial deposits and Chester Formation – Sandstone bedrock.

The site location is attached to this email.

To complete the FRA, we would be grateful if you could supply us with the following, if available, for the vicinity of the site:

- Details of any flood defences in the immediate area, including their extent, crest levels (and datum), assumed level of standard, construction and maintenance regime, as well as any other structures which may influence the local hydraulics.
- Records of any historic flood events and potential sources of flooding from rivers, land drainage, groundwater, foul and surface water sewers on site and in the area.
- Any restrictions applied to ordinary watercourses and sewers in the area.
- Highway drainage restrictions and records.
- Indications if the site is within the Critical Drainage Area.
- Policies that may relate to Sustainable Drainage Systems (SuDS).

If you have any queries, please do not hesitate to get in touch.

We are, of course, happy to pay your reasonable charge for this service. Please let me know by return what information is available, what the charge will be, and we will pay the relevant fees by debit card as soon as possible.

Any advice or recommendations you may have regarding the potential discharges from the development of this site would also be appreciated.

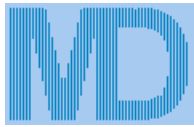
We will be in contact with all other relevant authorities to get a more complete understanding of the issues in the area.

Regards,
Jenna

APPENDIX E

CALCULATIONS

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Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
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Project **Broughton Street Greenfield Scenario**

Title **IoH 124 Runoff calcs for Broughton Street**

Hydrological Data:-

FSR Hydrology:-

Location	= Broughton Street	Grid reference	= SD8301
M5-60 (mm)	= 18	r	= 0.34
Soil runoff	= 0.45	SAAR (mm/yr)	= 950
WRAP	= 4	Area	= England & Wales
Hydrological area	= 10	Hydrological zone	= 4

Soil classification for WRAP type 4

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

Design data:-

Area = 0.0012 Km² - 0.12 Ha - 1200 m²

Calculation method:-

Runoff is calculated from:-

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

where

AREA = Site area in Km²

SAAR = Standard Average Annual Rainfall (mm/yr)

SOIL = Soil value derived from Winter Rainfall Acceptance Potential

$Q_{\text{BAR(rural)}}$ = Runoff (cumecs)

$Q_{\text{BAR(rural)}}$ 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 0.002

Mean Annual Peak Flow $Q_{\text{BAR(rural)}} = 0.75 \text{ l/s}$



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Radcliffe M26 2ZS
Tel: 0161 763 7200
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Project **Broughton Street Greenfield Scenario**

Title **IoH 124 Runoff calcs for Broughton Street**

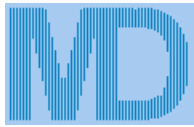
Values for $Q_{BAR(rural)}$

Ret. per.	m ³ /hr	l/s	l/s/ha	Ret. per.	m ³ /hr	l/s	l/s/ha
1yr	2.306	0.641	5.338	100yr+20%	6.836	1.899	15.825
2yr	2.523	0.701	5.840	100yr+30%	7.406	2.057	17.144
5yr	3.283	0.912	7.599	100yr+40%	7.976	2.216	18.463
10yr	3.744	1.040	8.666	200yr	6.511	1.809	15.071
30yr	4.558	1.266	10.550	200yr + 30%	8.464	2.351	19.593
50yr	5.019	1.394	11.618	500yr	7.406	2.057	17.144
100yr	5.697	1.583	13.188	1000yr	8.247	2.291	19.091

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.93	1.21	1.38	1.68	1.85	2.10	2.40	2.73	3.04

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.



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Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

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Project	Broughton Street 30 Year Event
Title	Broughton Street 30 Year Event

Data:-

FSR Hydrology:-

Location = Broughton Street

M5-60 (mm) = 18

Soil index = 0.45

Return period = 30

UCWI = 100.8

Grid reference = SD8301

r = 0.34

SAAR (mm/yr) = 950

WRAP = 4

Climate change = 0

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

Runoff factor (RF) = 81.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = $\frac{\text{Impervious Area} \times 100}{(\text{Impervious Area} + \text{Pervious Area})}$

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 1200 m²

Total area (TA) = 1200 m²

Mean disch. rate = 5.000 l/s

Additional flow = 0.00 l/s

Pervious area = 0 m²

Equiv area = 972 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 0

Calculated data:-

Time to max = 26.0 mins

Rainfall at max = 46.98 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 12.0 m³

Allowed discharge rate = 5.000 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 8.00 mm/hr

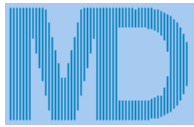
Calculated storage volume = 0.0 m³

Allowed discharge rate = 5.000 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	1526.8	1125	12.1	400 x 600	66.6	500 x 500	48.0
150	678.6	1200	10.6	600 x 900	29.0	500 x 750	32.0
225	301.6	1275	9.4	800 x 1200	16.3	500 x 1000	24.0
300	169.6	1350	8.4			750 x 1000	16.0
375	108.6	1425	7.5			750 x 1200	13.3
450	75.4	1500	6.8			750 x 1500	10.7
525	55.4	1575	6.2			1000 x 1000	12.0
600	42.4	1650	5.6			1000 x 1200	10.0
675	33.5	1725	5.1			1000 x 1500	8.0
750	27.1	1800	4.7			1000 x 1800	6.7
825	22.4	1875	4.3			1000 x 2000	6.0
900	18.8	1950	4.0			1500 x 1500	5.3
975	16.1	2025	3.7			1500 x 1800	4.4
1050	13.8	2100	3.5			1500 x 2000	4.0



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Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

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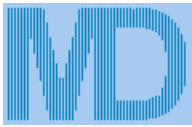
Project	Broughton Street 30 Year Event
Title	Broughton Street 30 Year Event

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Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	79.0	12.798	3.000	9.798
20	55.0	17.762	6.000	11.762
30	43.0	20.934	9.000	11.934
40	36.0	23.318	12.000	11.318
50	31.0	25.248	15.000	10.248
60	28.0	26.879	18.000	8.879
70	25.0	28.298	21.000	7.298
80	23.0	29.557	24.000	5.557
90	21.0	30.690	27.000	3.690
100	20.0	31.722	30.000	1.722
110	18.0	32.671	33.000	0.000
120	17.0	33.549	36.000	0.000
130	16.0	34.367	39.000	0.000
140	15.0	35.133	42.000	0.000
150	15.0	35.853	45.000	0.000
160	14.0	36.532	48.000	0.000
170	13.0	37.176	51.000	0.000
180	13.0	37.787	54.000	0.000
190	12.0	38.368	57.000	0.000
200	12.0	38.923	60.000	0.000
210	12.0	39.454	63.000	0.000
220	11.0	39.962	66.000	0.000
230	11.0	40.450	69.000	0.000
240	11.0	40.919	72.000	0.000
250	10.0	41.370	75.000	0.000
260	10.0	41.805	78.000	0.000
270	10.0	42.224	81.000	0.000
280	9.0	42.629	84.000	0.000
290	9.0	43.021	87.000	0.000
300	9.0	43.400	90.000	0.000
310	9.0	43.767	93.000	0.000
320	9.0	44.123	96.000	0.000
330	8.0	44.497	99.000	0.000
340	8.0	44.852	102.000	0.000
350	8.0	45.199	105.000	0.000
360	8.0	45.539	108.000	0.000
370	8.0	45.871	111.000	0.000
380	8.0	46.197	114.000	0.000
390	7.0	46.515	117.000	0.000
400	7.0	46.828	120.000	0.000
410	7.0	47.134	123.000	0.000
420	7.0	47.434	126.000	0.000
430	7.0	47.729	129.000	0.000
440	7.0	48.019	132.000	0.000
450	7.0	48.303	135.000	0.000
460	7.0	48.583	138.000	0.000
470	6.0	48.858	141.000	0.000
480	6.0	49.128	144.000	0.000
490	6.0	49.394	147.000	0.000
500	6.0	49.656	150.000	0.000
510	6.0	49.914	153.000	0.000
520	6.0	50.167	156.000	0.000
530	6.0	50.417	159.000	0.000
540	6.0	50.664	162.000	0.000
550	6.0	50.906	165.000	0.000
560	6.0	51.146	168.000	0.000
570	6.0	51.382	171.000	0.000
580	5.0	51.615	174.000	0.000
590	5.0	51.844	177.000	0.000
600	5.0	52.071	180.000	0.000

Storage volume (m³) = 12.0 m³



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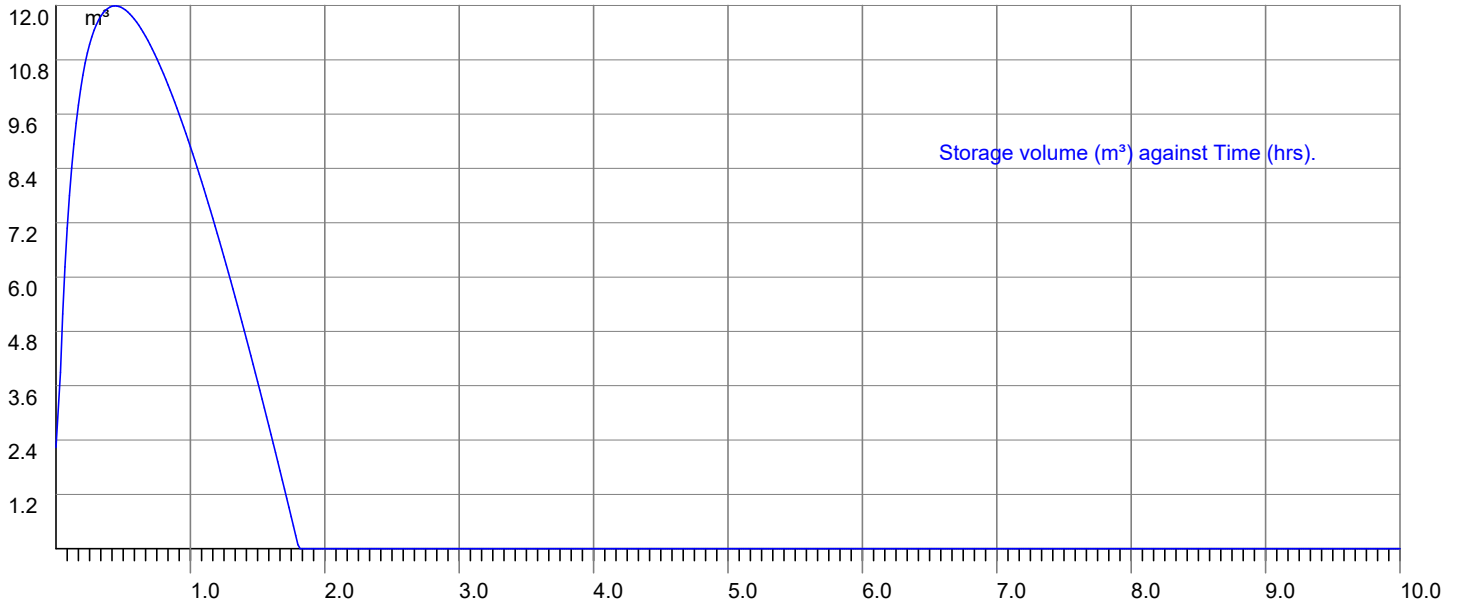
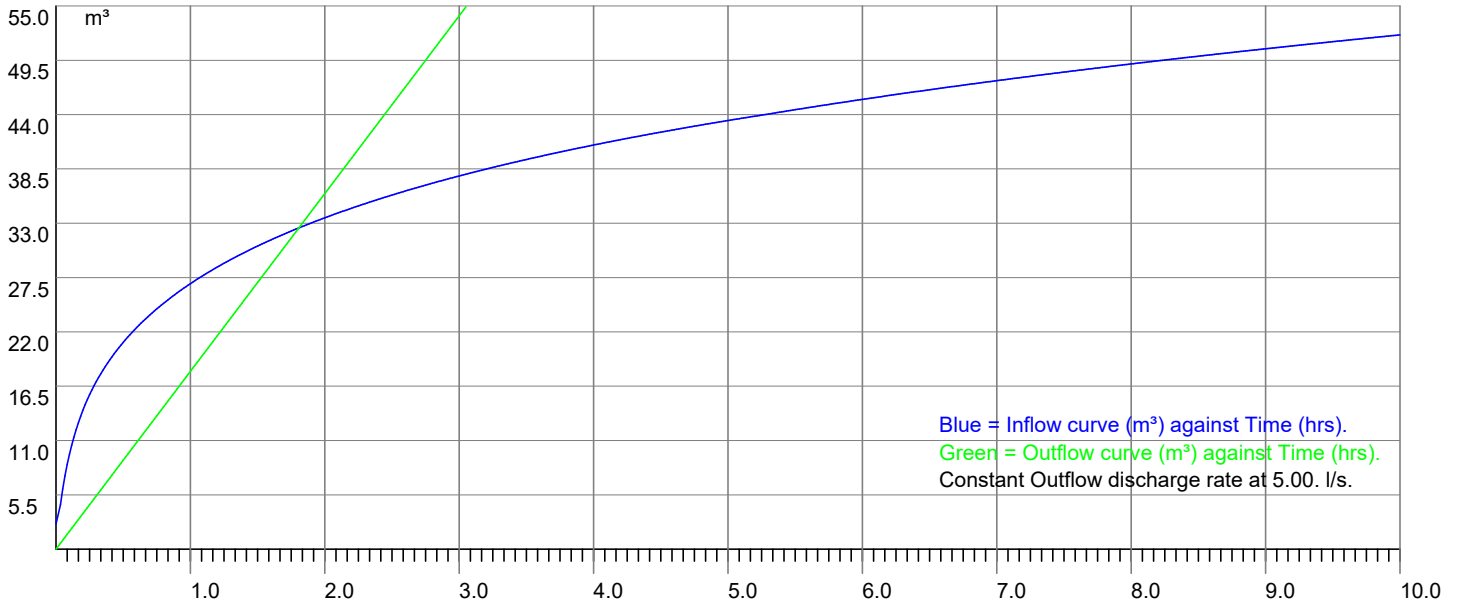
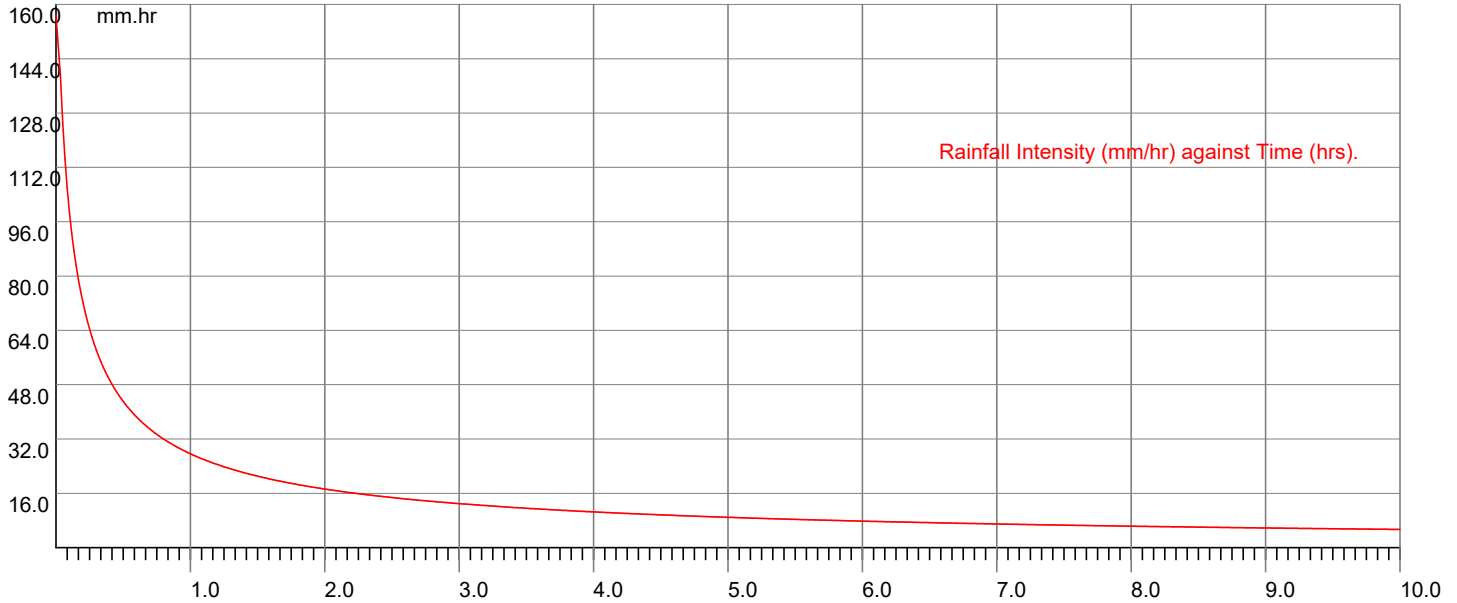
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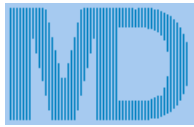
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Radcliffe M26 2ZS
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email: m.jones@thelkgroup.com

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Project **Broughton Street 30 Year Event**

Title **Broughton Street 30 Year Event**





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Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

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Project **Broughton Street 30 Year Event**

Title **Broughton Street 30 Year Event**

Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

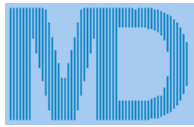
Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage. The outflow volume is constant throughout the process at the specified discharge rate.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps. The outflow volume varies with the hydraulic head on the control device using flow equations provided by the control manufacturer. This is a far more accurate method than the peak flow method and often results in bigger storage volumes.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.



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Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

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Project	Broughton Street 100 Year Event plus 20% Climate Change
Title	Broughton Street 100 Year Event plus 20% Climate Change

Data:-

FSR Hydrology:-

Location = Broughton Street

M5-60 (mm) = 18

Soil index = 0.45

Return period = 100

UCWI = 100.8

Grid reference = SD8301

r = 0.34

SAAR (mm/yr) = 950

WRAP = 4

Climate change = 20

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

Runoff factor (RF) = 81.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = $\text{Impervious Area} \times 100 / (\text{Impervious Area} + \text{Pervious Area})$

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 1200 m²

Total area (TA) = 1200 m²

Mean disch. rate = 5.000 l/s

Additional flow = 0.00 l/s

Pervious area = 0 m²

Equiv area = 972 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 20

Calculated data:-

Time to max = 47.0 mins

Rainfall at max = 51.00 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 24.7 m³

Allowed discharge rate = 5.000 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 12.00 mm/hr

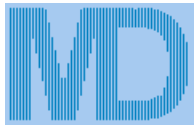
Calculated storage volume = 0.0 m³

Allowed discharge rate = 5.000 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	3149.6	1125	24.9	400 x 600	137.4	500 x 500	98.9
150	1399.8	1200	21.9	600 x 900	59.8	500 x 750	66.0
225	622.1	1275	19.4	800 x 1200	33.6	500 x 1000	49.5
300	350.0	1350	17.3			750 x 1000	33.0
375	224.0	1425	15.5			750 x 1200	27.5
450	155.5	1500	14.0			750 x 1500	22.0
525	114.3	1575	12.7			1000 x 1000	24.7
600	87.5	1650	11.6			1000 x 1200	20.6
675	69.1	1725	10.6			1000 x 1500	16.5
750	56.0	1800	9.7			1000 x 1800	13.7
825	46.3	1875	9.0			1000 x 2000	12.4
900	38.9	1950	8.3			1500 x 1500	11.0
975	33.1	2025	7.7			1500 x 1800	9.2
1050	28.6	2100	7.1			1500 x 2000	8.2



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Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

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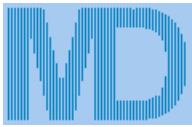
Project **Broughton Street 100 Year Event plus 20% Climate Change**

Title **Broughton Street 100 Year Event plus 20% Climate Change**

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	121.0	19.634	3.000	16.634
20	85.0	27.624	6.000	21.624
30	67.0	32.741	9.000	23.741
40	56.0	36.592	12.000	24.592
50	49.0	39.707	15.000	24.707
60	44.0	42.334	18.000	24.334
70	39.0	44.611	21.000	23.611
80	36.0	46.625	24.000	22.625
90	33.0	48.432	27.000	21.432
100	31.0	50.071	30.000	20.071
110	29.0	51.570	33.000	18.570
120	27.0	52.953	36.000	16.953
130	26.0	54.234	39.000	15.234
140	24.0	55.429	42.000	13.429
150	23.0	56.546	45.000	11.546
160	22.0	57.596	48.000	9.596
170	21.0	58.586	51.000	7.586
180	20.0	59.521	54.000	5.521
190	20.0	60.407	57.000	3.407
200	19.0	61.248	60.000	1.248
210	18.0	62.048	63.000	0.000
220	18.0	62.810	66.000	0.000
230	17.0	63.539	69.000	0.000
240	17.0	64.235	72.000	0.000
250	16.0	64.901	75.000	0.000
260	16.0	65.540	78.000	0.000
270	15.0	66.153	81.000	0.000
280	15.0	66.742	84.000	0.000
290	14.0	67.308	87.000	0.000
300	14.0	67.853	90.000	0.000
310	14.0	68.378	93.000	0.000
320	13.0	68.884	96.000	0.000
330	13.0	69.445	99.000	0.000
340	13.0	69.968	102.000	0.000
350	12.0	70.478	105.000	0.000
360	12.0	70.977	108.000	0.000
370	12.0	71.465	111.000	0.000
380	12.0	71.942	114.000	0.000
390	11.0	72.409	117.000	0.000
400	11.0	72.866	120.000	0.000
410	11.0	73.314	123.000	0.000
420	11.0	73.753	126.000	0.000
430	11.0	74.183	129.000	0.000
440	10.0	74.606	132.000	0.000
450	10.0	75.021	135.000	0.000
460	10.0	75.428	138.000	0.000
470	10.0	75.828	141.000	0.000
480	10.0	76.221	144.000	0.000
490	10.0	76.608	147.000	0.000
500	10.0	76.988	150.000	0.000
510	9.0	77.362	153.000	0.000
520	9.0	77.730	156.000	0.000
530	9.0	78.092	159.000	0.000
540	9.0	78.449	162.000	0.000
550	9.0	78.801	165.000	0.000
560	9.0	79.147	168.000	0.000
570	9.0	79.488	171.000	0.000
580	8.0	79.824	174.000	0.000
590	8.0	80.156	177.000	0.000
600	8.0	80.483	180.000	0.000

Storage volume (m³) = 24.7 m³



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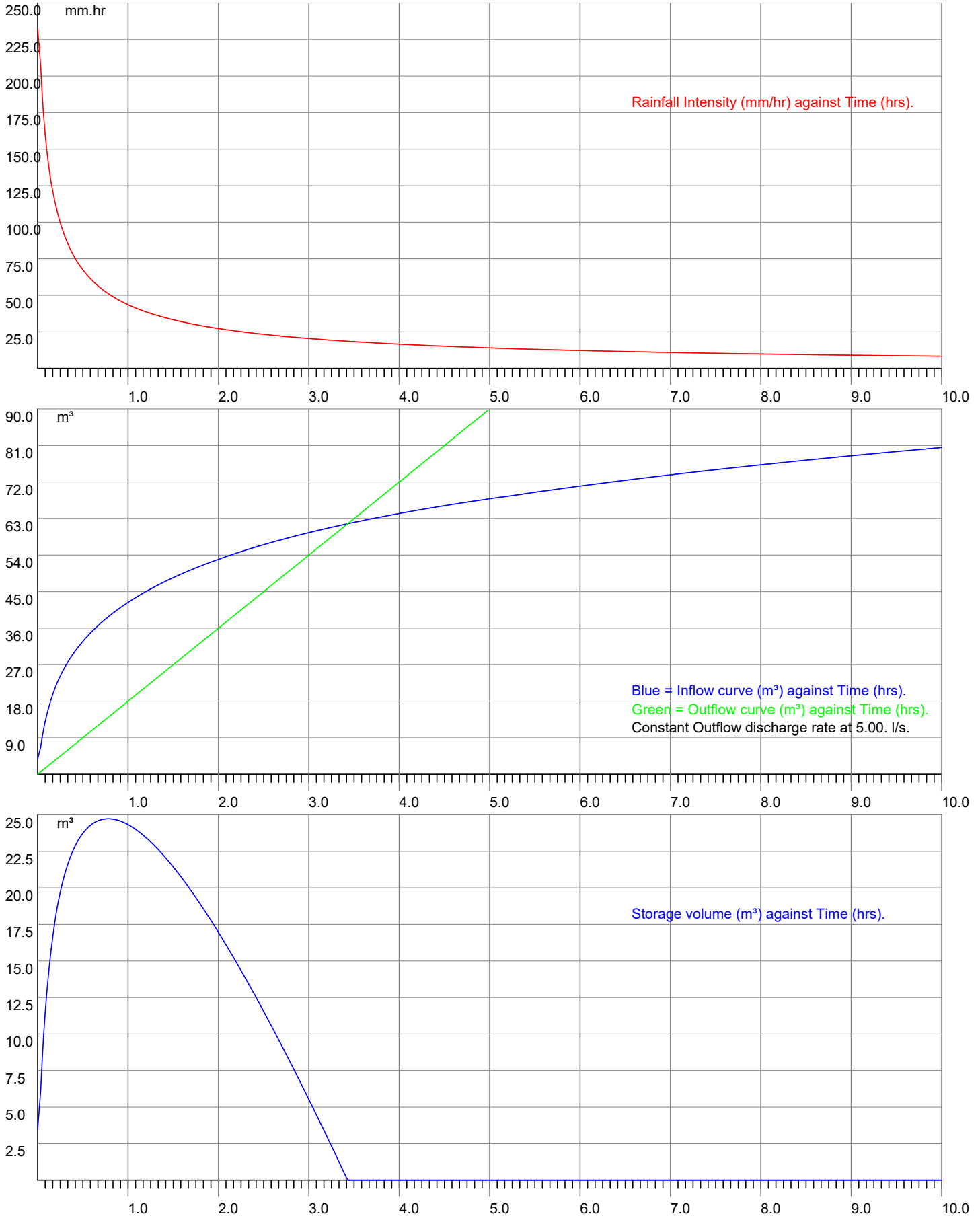
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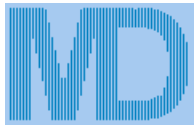
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Project **Broughton Street 100 Year Event plus 20% Climate Change**

Title **Broughton Street 100 Year Event plus 20% Climate Change**





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Project	Broughton Street 100 Year Event plus 20% Climate Change
Title	Broughton Street 100 Year Event plus 20% Climate Change

Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

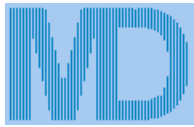
Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage. The outflow volume is constant throughout the process at the specified discharge rate.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps. The outflow volume varies with the hydraulic head on the control device using flow equations provided by the control manufacturer. This is a far more accurate method than the peak flow method and often results in bigger storage volumes.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.



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The LK Group

www.thelkgroup.com

Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 1		
Date 06/12/21		
By	Checked	Reviewed

Project	Broughton Street 100 Year Event plus 40% Climate Change
Title	Broughton Street 100 Year Event plus 40% Climate Change

Data:-

FSR Hydrology:-

Location = Broughton Street

M5-60 (mm) = 18

Soil index = 0.45

Return period = 100

UCWI = 100.8

Grid reference = SD8301

r = 0.34

SAAR (mm/yr) = 950

WRAP = 4

Climate change = 40

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

Runoff factor (RF) = 81.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = $\text{Impervious Area} \times 100 / (\text{Impervious Area} + \text{Pervious Area})$

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 1200 m²

Total area (TA) = 1200 m²

Mean disch. rate = 5.000 l/s

Additional flow = 0.00 l/s

Pervious area = 0 m²

Equiv area = 972 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 40

Calculated data:-

Time to max = 56.0 mins

Rainfall at max = 53.15 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 31.4 m³

Allowed discharge rate = 5.000 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 14.00 mm/hr

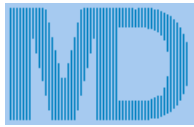
Calculated storage volume = 0.0 m³

Allowed discharge rate = 5.000 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	4001.2	1125	31.6	400 x 600	174.6	500 x 500	125.7
150	1778.3	1200	27.8	600 x 900	76.0	500 x 750	83.8
225	790.4	1275	24.6	800 x 1200	42.7	500 x 1000	62.8
300	444.6	1350	22.0			750 x 1000	41.9
375	284.5	1425	19.7			750 x 1200	34.9
450	197.6	1500	17.8			750 x 1500	27.9
525	145.2	1575	16.1			1000 x 1000	31.4
600	111.1	1650	14.7			1000 x 1200	26.2
675	87.8	1725	13.4			1000 x 1500	20.9
750	71.1	1800	12.3			1000 x 1800	17.5
825	58.8	1875	11.4			1000 x 2000	15.7
900	49.4	1950	10.5			1500 x 1500	14.0
975	42.1	2025	9.8			1500 x 1800	11.6
1050	36.3	2100	9.1			1500 x 2000	10.5



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Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

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Sheet no. 2		
Date 06/12/21		
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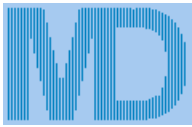
Project **Broughton Street 100 Year Event plus 40% Climate Change**

Title **Broughton Street 100 Year Event plus 40% Climate Change**

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	141.0	22.906	3.000	19.906
20	99.0	32.228	6.000	26.228
30	79.0	38.198	9.000	29.198
40	66.0	42.691	12.000	30.691
50	57.0	46.324	15.000	31.324
60	51.0	49.389	18.000	31.389
70	46.0	52.047	21.000	31.047
80	42.0	54.396	24.000	30.396
90	39.0	56.504	27.000	29.504
100	36.0	58.416	30.000	28.416
110	34.0	60.165	33.000	27.165
120	32.0	61.778	36.000	25.778
130	30.0	63.273	39.000	24.273
140	29.0	64.667	42.000	22.667
150	27.0	65.971	45.000	20.971
160	26.0	67.196	48.000	19.196
170	25.0	68.350	51.000	17.350
180	24.0	69.441	54.000	15.441
190	23.0	70.474	57.000	13.474
200	22.0	71.456	60.000	11.456
210	21.0	72.389	63.000	9.389
220	21.0	73.279	66.000	7.279
230	20.0	74.128	69.000	5.128
240	19.0	74.940	72.000	2.940
250	19.0	75.718	75.000	0.718
260	18.0	76.463	78.000	0.000
270	18.0	77.178	81.000	0.000
280	17.0	77.865	84.000	0.000
290	17.0	78.526	87.000	0.000
300	16.0	79.162	90.000	0.000
310	16.0	79.774	93.000	0.000
320	16.0	80.365	96.000	0.000
330	15.0	81.019	99.000	0.000
340	15.0	81.629	102.000	0.000
350	15.0	82.225	105.000	0.000
360	14.0	82.807	108.000	0.000
370	14.0	83.376	111.000	0.000
380	14.0	83.932	114.000	0.000
390	13.0	84.477	117.000	0.000
400	13.0	85.010	120.000	0.000
410	13.0	85.533	123.000	0.000
420	13.0	86.045	126.000	0.000
430	12.0	86.547	129.000	0.000
440	12.0	87.040	132.000	0.000
450	12.0	87.524	135.000	0.000
460	12.0	87.999	138.000	0.000
470	12.0	88.466	141.000	0.000
480	11.0	88.925	144.000	0.000
490	11.0	89.376	147.000	0.000
500	11.0	89.819	150.000	0.000
510	11.0	90.256	153.000	0.000
520	11.0	90.685	156.000	0.000
530	11.0	91.108	159.000	0.000
540	10.0	91.524	162.000	0.000
550	10.0	91.934	165.000	0.000
560	10.0	92.338	168.000	0.000
570	10.0	92.736	171.000	0.000
580	10.0	93.129	174.000	0.000
590	10.0	93.515	177.000	0.000
600	10.0	93.897	180.000	0.000

Storage volume (m³) = 31.4 m³



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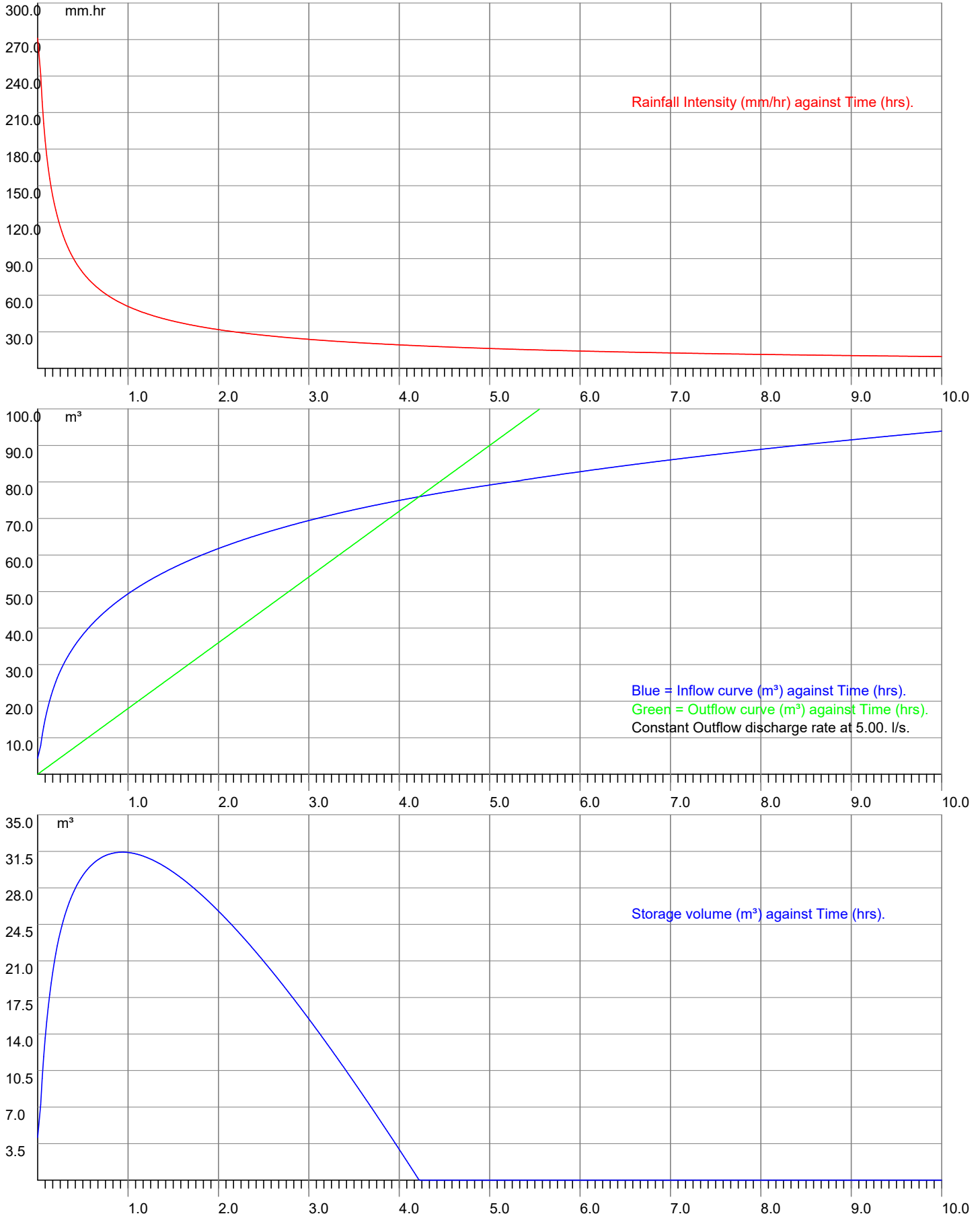
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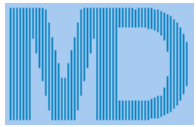
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Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 3		
Date 06/12/21		
By	Checked	Reviewed

Project **Broughton Street 100 Year Event plus 40% Climate Change**

Title **Broughton Street 100 Year Event plus 40% Climate Change**





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Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 4		
Date 06/12/21		
By	Checked	Reviewed

Project	Broughton Street 100 Year Event plus 40% Climate Change
Title	Broughton Street 100 Year Event plus 40% Climate Change

Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

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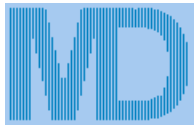
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The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps. The outflow volume varies with the hydraulic head on the control device using flow equations provided by the control manufacturer. This is a far more accurate method than the peak flow method and often results in bigger storage volumes.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.



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www.thelkgroup.com

Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 1		
Date 06/12/21		
By	Checked	Reviewed

Project **Existing Qbar Broughton Street**

Title **Existing Qbar Broughton Street**

Area data:-

FSR data

M5-60 = 18

Soil index = 0.45

WRAP value = 4

$r = 0.34$

SAAR = 950

Nat grid = SD8301

Site data:-

Ret. period (yrs) = 2.33

Time of entry = 6.00

Impervious area drained = 1200 m²

Site slope = Medium 2% - 3.5%

Length of overland flow = 0.00

ToC = 6.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 0 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 81.0%

Rainfall rate = 60.1 mm/Hr

UCWI = 98.5

Runoff rate (gross) = 16.2 l/s

Methods

Runoff factor (RF) = 81.0, calculated from:-

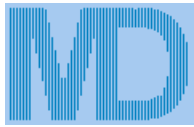
$\text{Runoff factor} = (0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

$\text{PIMP} = \frac{\text{Impervious Area} \times 100}{(\text{Impervious Area} + \text{Pervious Area})}$

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 1		
Date 06/12/21		
By	Checked	Reviewed

Project **1 Year Existing Runoff Broughton Street**

Title **1 Year Existing Runoff Broughton Street**

Area data:-

FSR data

M5-60 = 18

Soil index = 0.45

WRAP value = 4

$r = 0.34$

SAAR = 950

Nat grid = SD8301

Site data:-

Ret. period (yrs) = 1

Time of entry = 8.00

Impervious area drained = 1200 m²

Site slope = Medium 2% - 3.5%

Length of overland flow = 0.00

ToC = 8.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 0 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 81.0%

Rainfall rate = 44.4 mm/Hr

UCWI = 98.5

Runoff rate (gross) = 12.0 l/s

Methods

Runoff factor (RF) = 81.0, calculated from:-

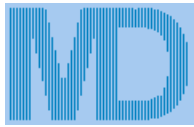
$\text{Runoff factor} = (0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

$\text{PIMP} = \frac{\text{Impervious Area} \times 100}{(\text{Impervious Area} + \text{Pervious Area})}$

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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The LK Group

www.thelkgroup.com

Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 1		
Date 06/12/21		
By	Checked	Reviewed

Project **30 Year Existing Runoff Broughton Street**

Title **30 Year Existing Runoff Broughton Street**

Area data:-

FSR data

M5-60 = 18

Soil index = 0.45

WRAP value = 4

$r = 0.34$

SAAR = 950

Nat grid = SD8301

Site data:-

Ret. period (yrs) = 30

Time of entry = 4.00

Impervious area drained = 1200 m²

Site slope = Medium 2% - 3.5%

Length of overland flow = 0.00

ToC = 4.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 0 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 81.0%

Rainfall rate = 114.5 mm/Hr

UCWI = 98.5

Runoff rate (gross) = 30.9 l/s

Methods

Runoff factor (RF) = 81.0, calculated from:-

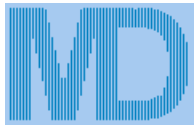
$\text{Runoff factor} = (0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

$\text{PIMP} = \frac{\text{Impervious Area} \times 100}{(\text{Impervious Area} + \text{Pervious Area})}$

UCWI = Calculated value for Wetness Index

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The LK Group

www.thelkgroup.com

Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 1		
Date 06/12/21		
By	Checked	Reviewed

Project **100 Year Existing Runoff Broughton Road**

Title **100 Year Existing Runoff Broughton Road**

Area data:-

FSR data

M5-60 = 18

Soil index = 0.45

WRAP value = 4

r = 0.34

SAAR = 950

Nat grid = SD8301

Site data:-

Ret. period (yrs) = 100

Time of entry = 4.00

Impervious area drained = 1200 m²

Site slope = Medium 2% - 3.5%

Length of overland flow = 0.00

ToC = 4.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 0 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 81.0%

Rainfall rate = 143.7 mm/Hr

UCWI = 98.5

Runoff rate (gross) = 38.8 l/s

Methods

Runoff factor (RF) = 81.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = $\text{Impervious Area} \times 100 / (\text{Impervious Area} + \text{Pervious Area})$

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program

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Based across the UK with
offices in Manchester,
London, Liverpool and Glasgow.

Manchester (Head Office)

Unit 29,
Eton Business Park
Eton Hill Rd, Radcliffe
M26 2ZS

t: 0161 763 7200
e: info@thelkgroup.com

London

2 Falcon Gate
Welwyn Garden City
Hertfordshire
AL7 1TW

t: 01707 909059
e: info@thelkgroup.com

Glasgow

Wright Business Centre
1 Lonmay Road
Glasgow
G33 4EL

t: 0141 773 6269
e: info@thelkgroup.com

Liverpool

The Corn Exchange
Fenwick Street
Liverpool
L2 7QL

t: 0151 235 8716
e: info@thelkgroup.com



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