Detailed Drainage Design

22 Honor Street, Manchester, M13 0WY

Reference: 412 -Rev - V3

Date: Feb-24

1 **Introduction**

2 **Site Characteristics**

3 **Discharge Arrangement**

4 **Peak Runoff**

5 **Proposed Sustainable Drainage**

6 **Maintenance and Management Plan**

Appendices

A Distribution Existing and Proposed Areas

B Site Characteristics

C Drainage Calculations

D Drainage System General Arrangement

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Urban Water is a Trading name of RIDA Reports Ltd registered in England and Wales number 10590566

Purpose of this report

1.1 The purpose of this statement is to accompany the detailed technical drawings and details showing the proposed Surface Water drainage system.

Site Characteristics

2.1 The site background is clearly identified through answers to the questions in table 1 below.

Table 1: Site Characteristics . See appendix B for support documentation

TOPIC	QUESTION	ANSWER
Protected species or habitat	Is the site near to designated sites and priority habitats?	No
Flood Plain	Is the site located in the flood plain?	No
Soils and Geology	Soil permeability? - See appendix B for results	No
Space constraints	Space for SuDS components?	No
Topography	Sited on a flat site?	Yes
	Sited on a steep slope (5-15%)	No
	Sited on a very steep slope (>15%)	No
Groundwater	Is the site at groundwater flood risk?	Yes
Contaminated land	Are there contaminated soils on site?	Unknown
Source Protection Zone	Is the site within a SPZ 3?	No
Runoff characteristics	Is the development in a high risk flooding area?	No

Existing and Proposed Site

2.2 The distribution of catchment areas for existing and proposed site is as per table 2 below. See appendix A for details

Table 2 : Existing and Proposed catchment areas in hectares

Description		Existing Site	Proposed Site
Impermeable Areas		0.006	0.007
Permeable Areas	Connected to Drainage	0.000	0.000
	Self Draining Areas	0.000	0.000
Areas Draining Away from drainage System		0.005	0.004
	Total Development Area	0.011	0.011

2.3 It has been assumed that the positively drained areas will have different runoff coefficients depending on the type of surface as follow:

Impermeable Surface	1.0
Permeable Surfaces	0.5
Grass Areas	0.3

Evaluation of Discharge Point

3.1 The SuDS design takes into account Building Regulations Section H3 and the National Planning Practice Guidance. The aim is to discharge surface water run-off as high up the drainage hierarchy, as reasonably practicable:

1. into the ground (infiltration);
2. to a surface water body;
3. to a surface water sewer, highway drain, or another drainage system;
4. to a combined sewer.

3.2 The discharge point has been evaluated following the NPPG and Building regulations. The findings are in table 3 below.

Table 3: Drainage Hierarchy evaluation

Superficial geology classification	The British Geological Society records show that the superficial deposits are Till, Devensian - Diamicton.
Bedrock geology classification	The British Geological Society records of the site show that it is located within the Manchester Marls Formation - Mudstone.
Landis Top Soil Infiltration	The SOILSCAPE's records of the site show that it is located within an area of impeded drainage soils.
Groundwater	The British Geological Survey's flood risk susceptibility maps show that the development has potential for groundwater flooding above ground level. Groundwater levels would tend to vary seasonally and are influenced by ground and meteorological conditions and proximity to water features.
Is infiltration feasible?	Infiltration is not possible on this site due to the findings on groundwater and soils within the site. The groundwater level is likely to be very high on site.
Is a discharge to a watercourse possible?	There are no watercourses in the proximity to the site.
Is a discharge to a surface water sewer possible?	There is no surface water sewer in the proximity to the site.
Is a discharge to a combined sewer possible?	There is a combined water sewer in the proximity to the site. It is possible to connect to the combined water sewer.

Existing and Proposed Peak Run-off Calculations

4.1 The current site is a Brownfield. The peak runoff rate for the existing site was calculated as per table 4 and discharge rates as per table 5.

Table 4: Peak run-off rate calculation method for existing site

Method Used	Calculation Method
	Report 124 Flood Estimation for Small Catchments method has been used to estimate the site peak flow rates
X	This is a brownfield site, runoff rates are calculated in accordance with best practice simulation modelling and using the modified rational method
	This is a brownfield site where the pre-development drainage isn't known. The runoff rates are calculated using the Greenfield model with soil type 5

4.2 The runoff flow produced by the development will be controlled as per table 5.

Table 5: Runoff discharge rate control

Control Used	Description of runoff discharge
	Water will be discharged into the ground via a SuDS as described in table 6 below
	The peak discharge rate has been reduced to Greenfield Qbar flow
	The peak discharge rate has been taken as 0.7 l/s as it is not possible to reduce it to the Greenfield Qbar rate
	The peak discharge rate has been reduced to Brownfield pre-development 1 in 1 flow
X	The peak discharge rate has been reduced by 50% from the existing Brownfield pre-development 1 in 2 flow rate

Run-off flows

4.3 The size of the SuDS has been calculated for all events up to the 1 in 100 including an allowance for climate change of 40%. As per tables above, it is proposed to discharge at a rate of 0.55 l/s. See table 6 for values and appendix C for calculations.

Table 6: Peak discharge rates for SuDS

Return Period Event	Discharge Rate (l/s)			Infiltration Rate (m/hr)
	Existing Greenfield	Existing Brownfield	Proposed	
Qbar	0.10	N/A	N/A	0.0000
1 in 1	0.10	0.90	0.70	0.0000
1 in 2	0.10	1.10	0.70	0.0000
1 in 30	0.10	2.10	0.70	0.0000
1 in 30 + CC	N/A	N/A	0.70	0.0000
1 in 100	0.10	2.60	0.70	0.0000
1 in 100 + CC	N/A	N/A	0.70	0.0000

Proposed Sustainable Drainage System

5.1 The following sustainable drainage systems have been used for this site. The drainage design uses these drainage system through out the site. See table 7 for details.

Table 7: Proposed Drainage System

SuDS Proposed	Feasible	Proposed
Use of green roofs	No	No
Store rainwater for later use	No	No
Use infiltration techniques, for instance soakaways, permeable surfaces	No	No
Attenuate rainwater in ponds or open water features for gradual release	No	No
Attenuate rainwater by storing in tanks or sealed water features for gradual release	Yes	Yes
Discharge Point Proposed		
Discharge rainwater direct to a watercourse	No	No
Discharge rainwater to a surface water sewer/drain	No	No
Discharge rainwater to the combined sewer	Yes	Yes

5.2 The location and details of the SuDS can be seen drainage layouts in appendix D. Calculations are in appendix C.

5.3 The drainage calculations demonstrate:
- No flooding occurs for the 1 in 30 storm events.
- Any flooding for the 1 in 100 year + 40% climate change event can be safely contained on site

5.4 The proposed drainage design demonstrates that the development can be sustainably drained to comply with the requirements of the NPPF.

Management of Exceedance Flows

5.5 The drainage network has been designed to attenuate surface runoff for all events up to and including the 1% AEP + CC(1 in 100 years). However consideration has been given to what may happen when the design capacity of the surface water drainage network is exceeded. Surface water will flow to the lowest points within the site. The flood risk to the buildings would therefore remain low. See appendix D.

Maintenance and Management plan responsibility

6.1 The SuDS will be maintained by The Owner the property

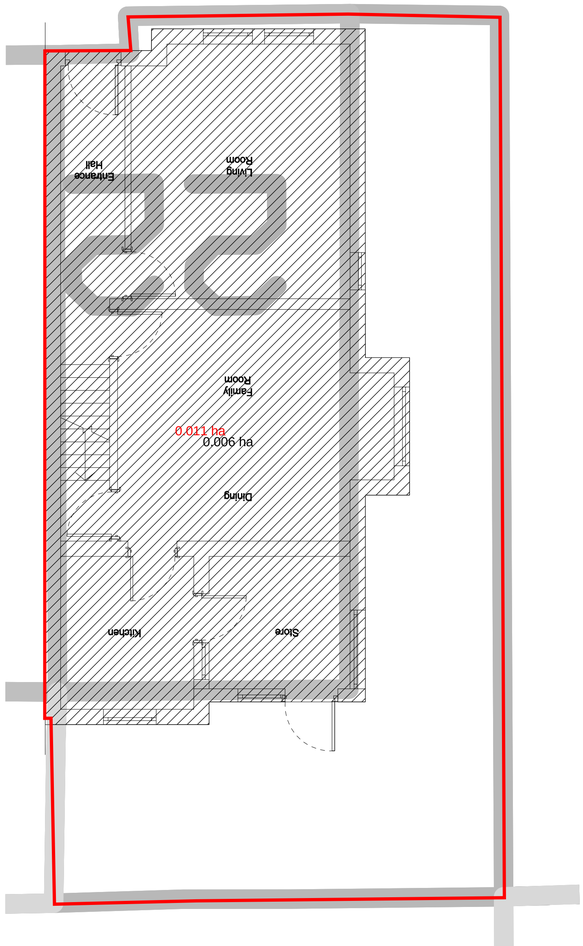
Maintenance and Management plan for proposed SuDS

6.2 The maintenance and Management Plan Guidance from the SuDS Manual, CIRIA C753 (CIRIA, 2015) is to be followed for the effective maintenance of the proposed SuDS techniques outlined above. The maintenance for SuDS structures are as follow:

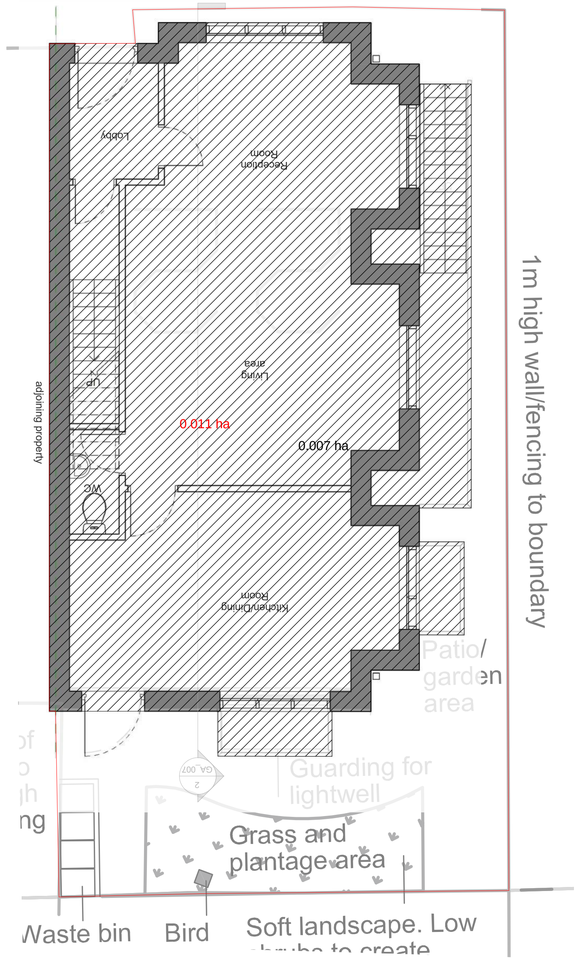
INLETS, OUTLETS, CONTROLS AND INSPECTION CHAMBERS	
Regular Maintenance	**Frequency**
Inlets, outlets and surface control structures	
Inspect surface structures removing obstructions and silt as necessary. Check there is no physical damage.	Monthly
Strim vegetation 1m min. surround to structures and keep hard aprons free from silt and debris	Monthly
Inspection chambers and below ground control chambers	
Remove cover and inspect ensuring water is flowing freely and that the exit route for water is unobstructed. Remove debris and silt. Undertake inspection after leaf fall in autumn	Annually
Occasional Maintenance	
Check topsoil levels are 20mm above edges of baskets and chambers to avoid mower damage	As necessary
Remedial work	**Frequency**
Unpack stone in basket features and unblock or repair and repack stone as design detail as necessary.	As required
Repair physical damage if necessary.	As required

Operation and maintenance requirements for attenuation storage tanks		
Maintenance schedule	**Required action**	**Typical frequency**
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

Appendix A



EXISTING SITE 1:50



PROPOSED SITE 1:50

Do not scale from this drawing. Refer to figured dimensions only. RIDA Reports Ltd registered in England and Wales No. 10590566. This drawing is copyright of RIDA Reports Ltd.

Drawing Scale Bar

Drawing scale	Line length	Drawing scale	Line length
1:5	= 0.25 metres	1:200	= 10.0 metres
1:10	= 0.5 metres	1:250	= 12.5 metres
1:20	= 1.0 metres	1:500	= 25.0 metres
1:25	= 1.25 metres	1:1000	= 50.0 metres
1:50	= 2.5 metres	1:1250	= 62.5 metres
1:100	= 5.0 metres	1:2500	= 125 metres

Measure length of line above for checking of scale

GENERAL NOTES

KEY

PERMEABLE AREAS

IMPERMEABLE AREAS

STUDY AREA

Rev	Details	Date	By	Chkd

Drawing Status:

PRELIMINARY

URBANWATER

Client:

Project:

22 Honor Street, Manchester, M13 0WY

Drawing:

Existing and Proposed Areas
Permeable and Impermeable

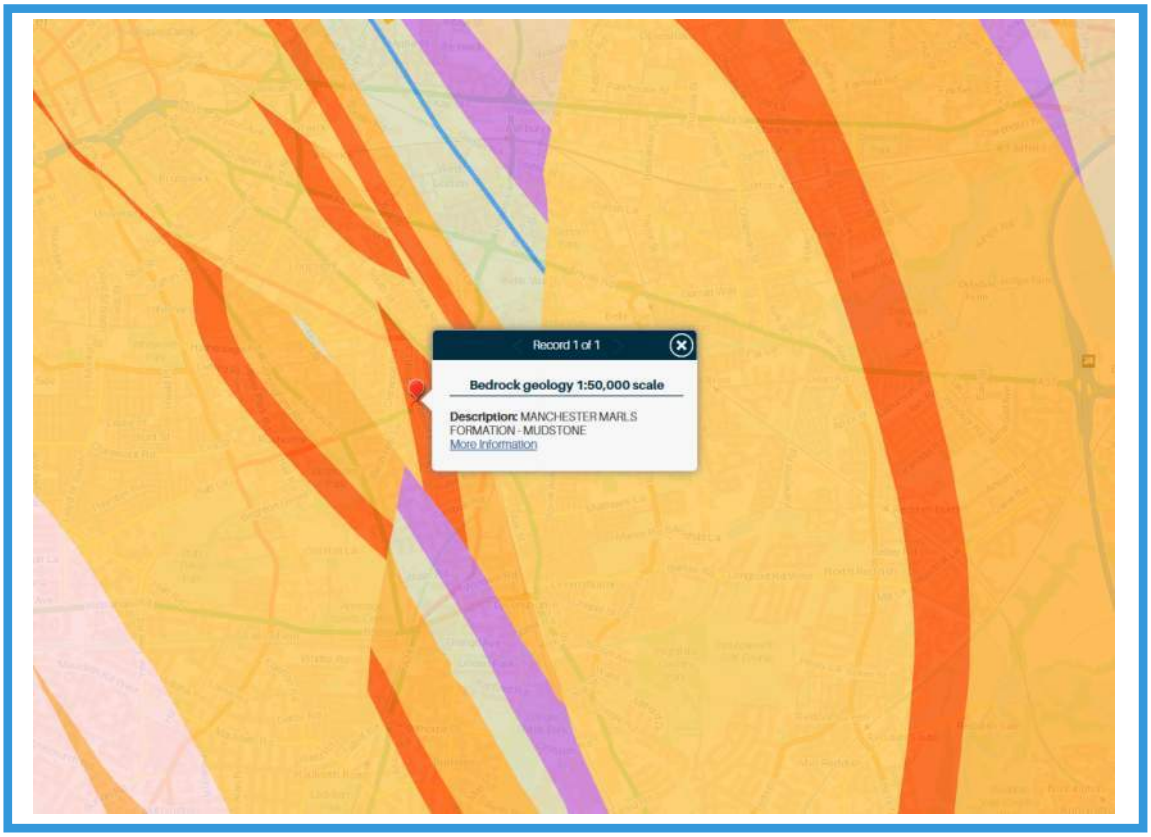
Print Size:	Project No:	Drawing No:	Revision:
A1	0412	002	P1

Appendix B

SITE GEOLOGY

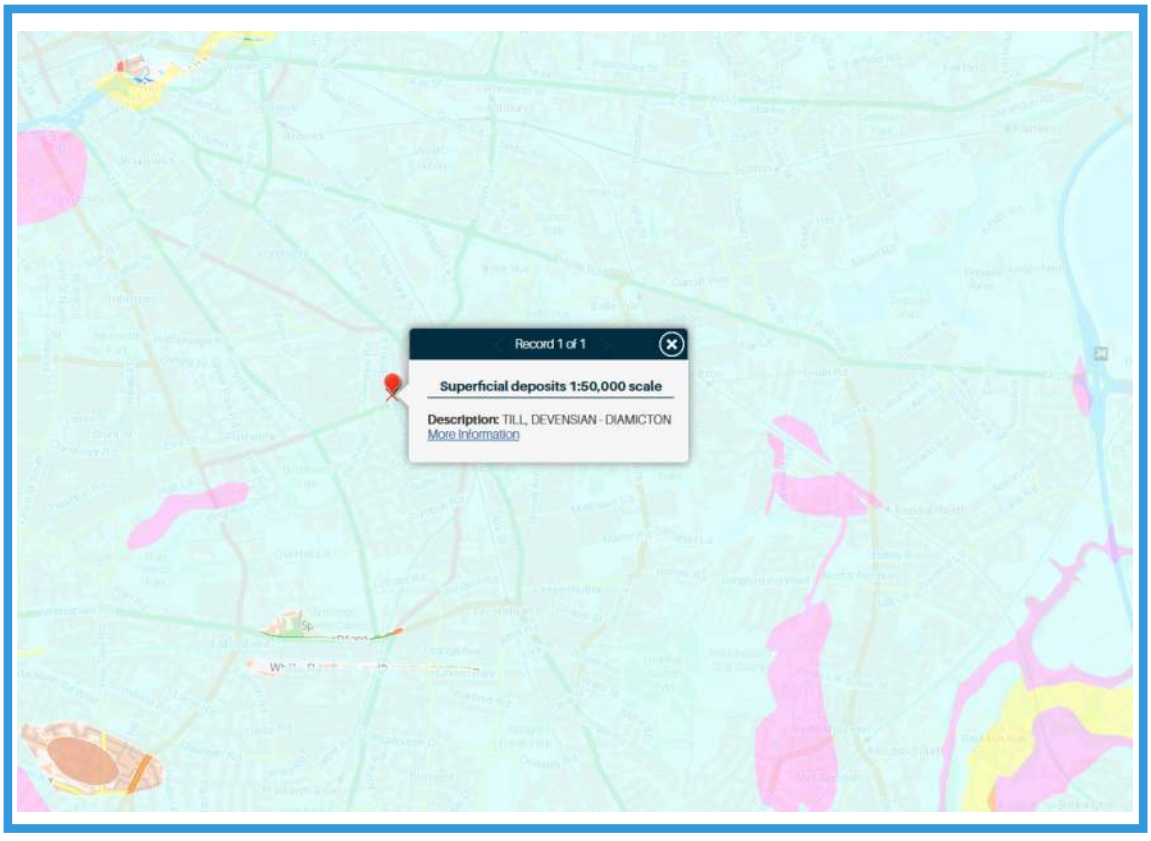
GEOINDEX ONSHORE

GEOLOGY - BEDROCK - MANCHESTER MARLS FORMATION - MUDSTONE



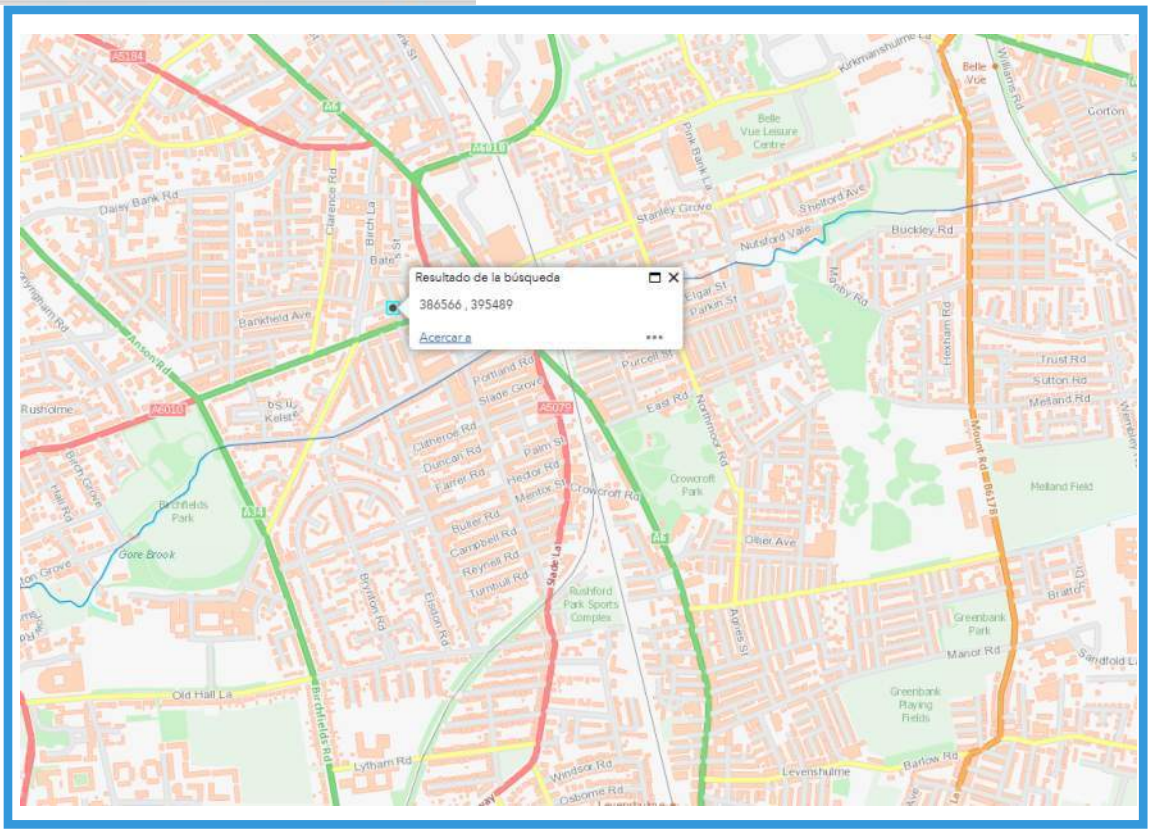
GEOINDEX ONSHORE

GEOLOGY - SUPERFICIAL DEPOSITS - TILL, DEVENSIAN - DIAMICTON



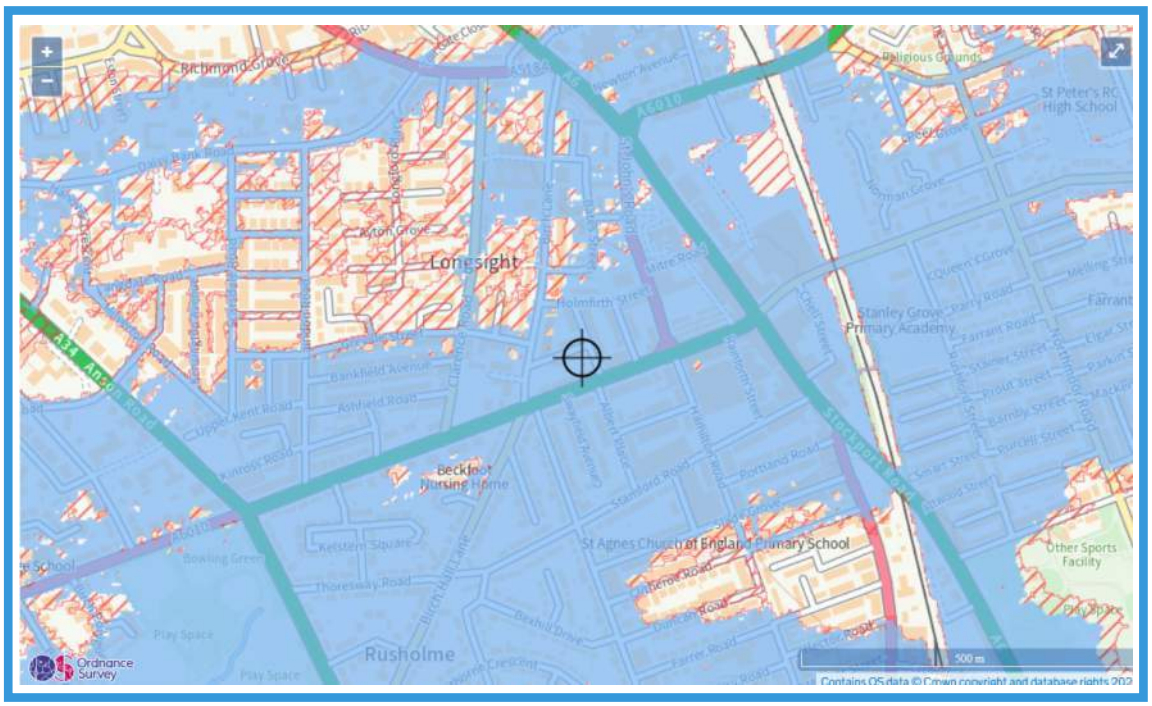
SITE HYDROGEOLOGY

Environment Agency Main River Map



Flood risk from reservoirs

Extent of flooding



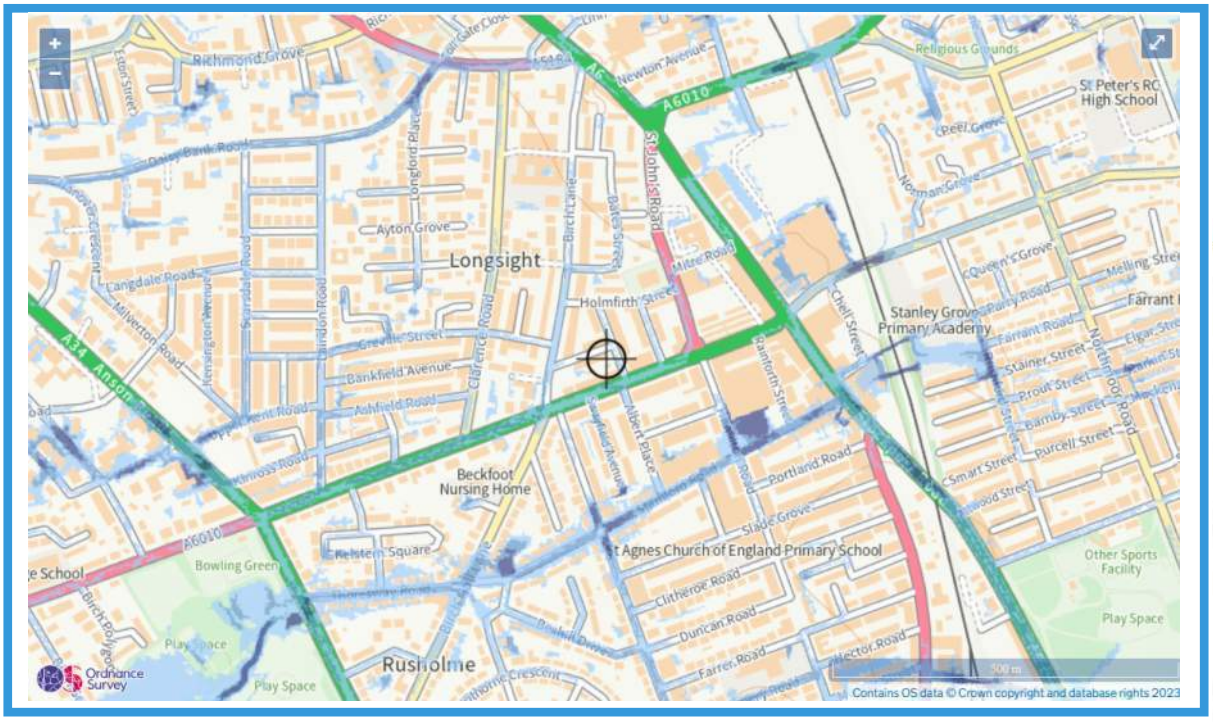
when river levels are normal | when there is also flooding from rivers | Location you selected

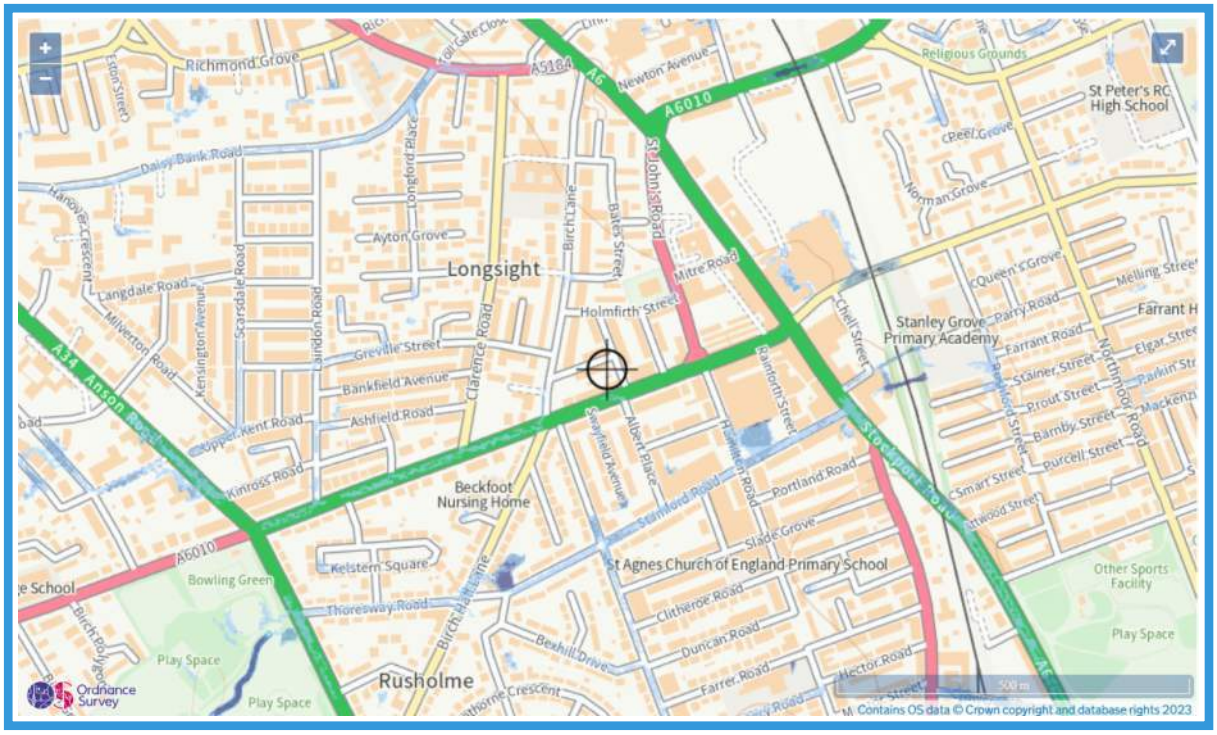
SITE SURFACE WATER FLOOD RISK

Flood risk from surface water

Extent of flooding

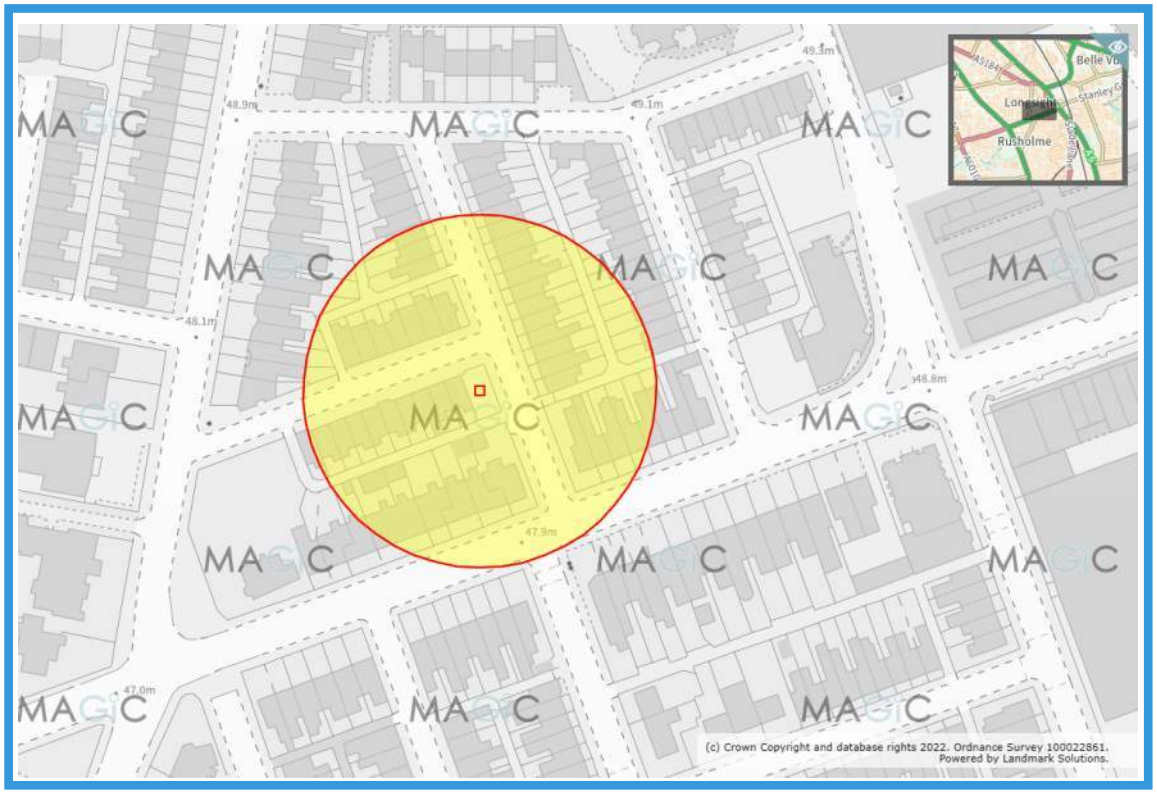
High risk means a chance of flooding greater than 3.3% (1:30)
Medium risk means a chance of flooding of btw 1% (1:100) and 3.3%
Low risk means a chance of flooding of btw 0.1% (1:1000) and 1%
Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding





Over 900mm 300 to 900mm Below 300mm

MAGIC RESULTS



Site Check Results

Site Check Report Report generated on Tue Nov 21 2023
You selected the location: Centroid Grid Ref: SJ86569548
The following features have been found in your search area:

Aquifer Designation Map (Bedrock) (England)

Typology	Secondary B

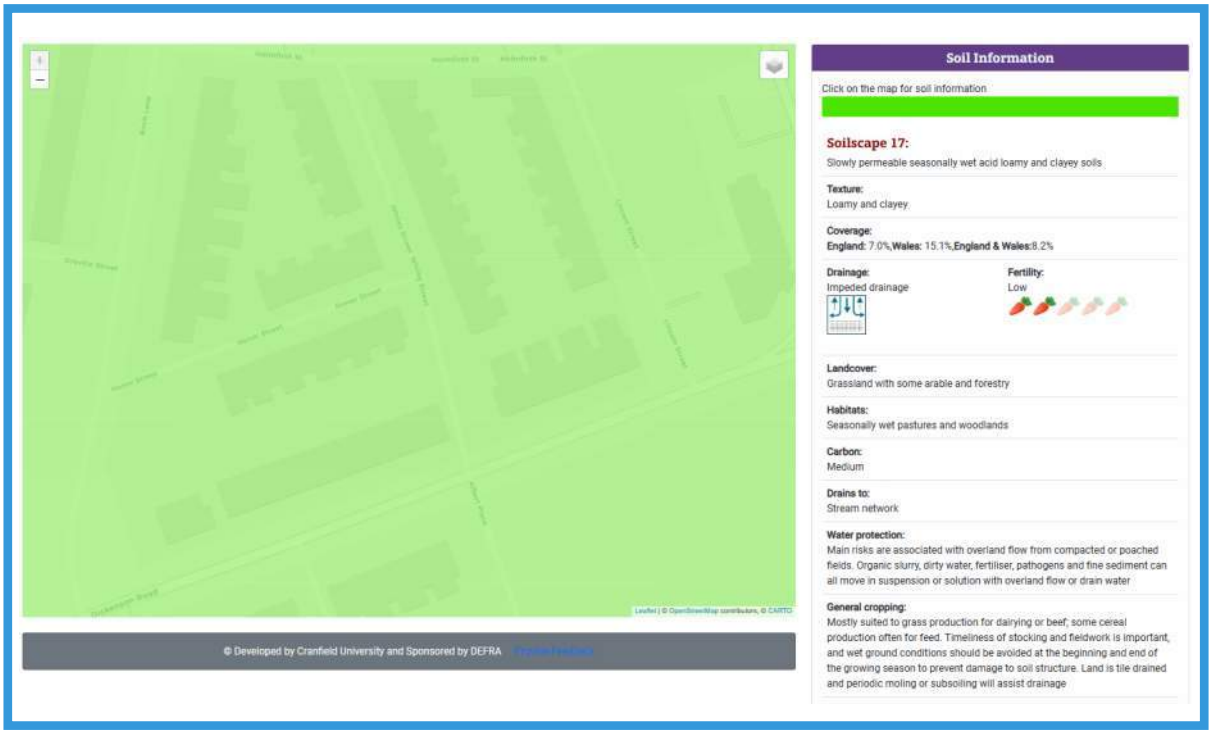
Aquifer Designation Map (Superficial Drift) (England)

Typology	Secondary (undifferentiated)

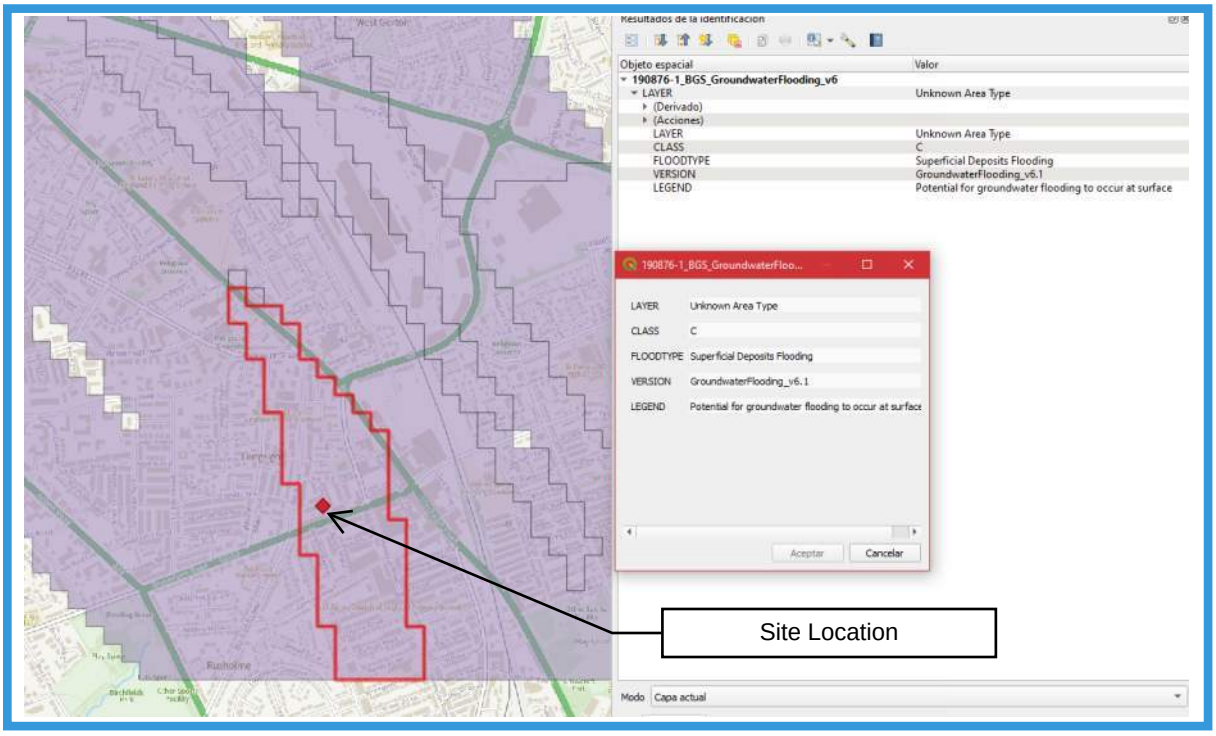
Source Protection Zones merged (England)
No Features found

OK | Cancel | Export to CSV | Print

SOILSCAPES MAP



GROUND WATER FLOOD RISK



Flood map for planning

Your reference	Location (easting/northing)	Created
<Unspecified>	**386564/395487**	**21 Nov 2023 21:23**

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

You will need to do a flood risk assessment if your site is **any of the following:**

- bigger that 1 hectare (ha)
- In an area with critical drainage problems as notified by the Environment Agency
- identified as being at increased flood risk in future by the local authority's strategic flood risk assessment
- at risk from other sources of flooding (such as surface water or reservoirs) and its development would increase the vulnerability of its use (such as constructing an office on an undeveloped site or converting a shop to a dwelling)

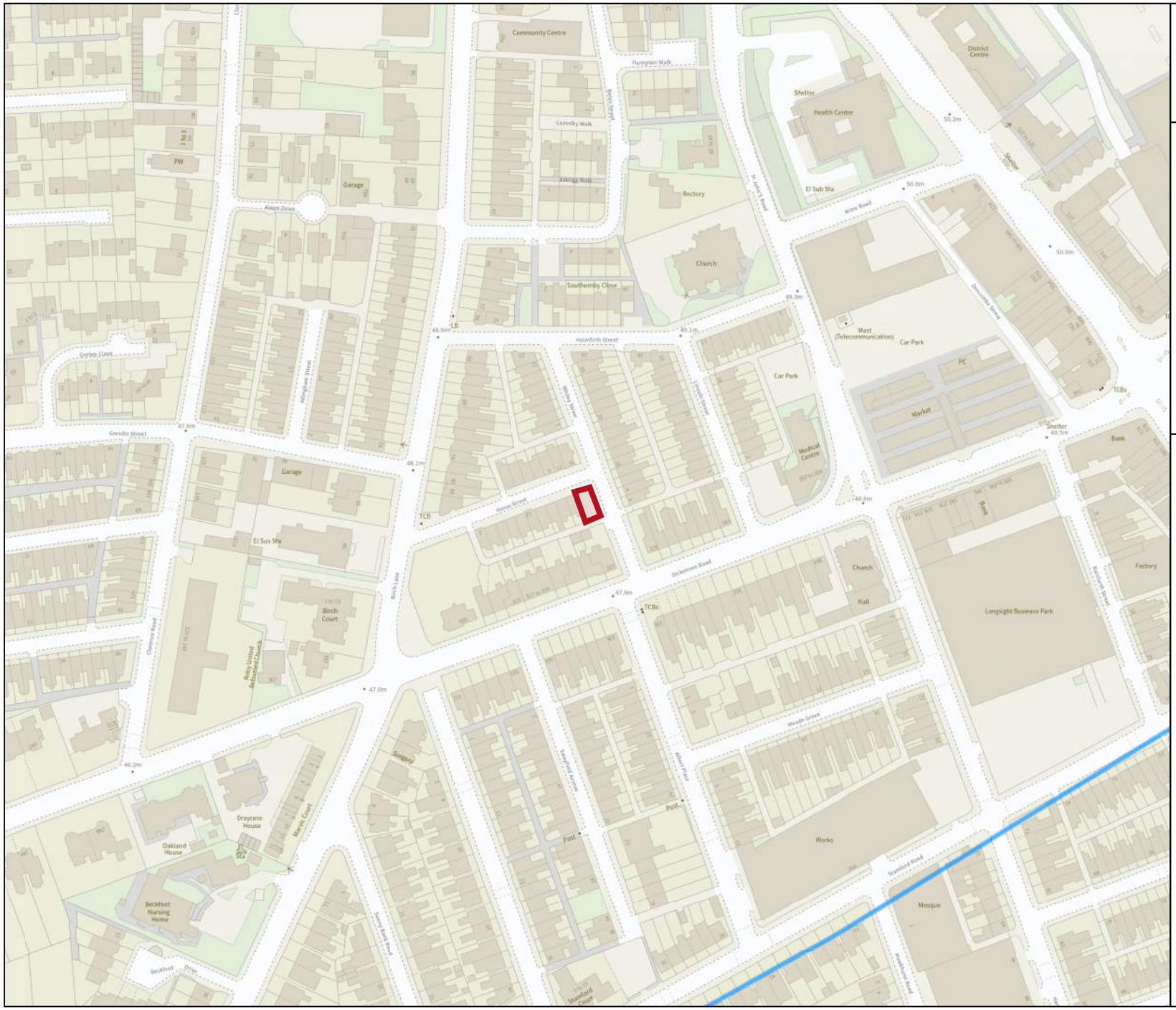
Notes

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 2022 OS 100024198. https://flood-map-for-planning.service.gov.uk/os-terms



Environment Agency

Flood map for planning

Your reference
<Unspecified>

Location (easting/northing)
386564/395487

Scale
1:2500

Created
21 Nov 2023 21:23

- Selected area
- Flood zone 3
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Water storage area

0 20 40 60m

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Site Check Report Report generated on Tue Nov 21 2023
You selected the location: Centroid Grid Ref: SJ86569548
The following features have been found in your search area:

SSSI Impact Risk Zones - to assess planning applications for likely impacts on SSSIs/SACs/SPAs & Ramsar sites (England)

1. DOES PLANNING PROPOSAL FALL INTO ONE OR MORE OF THE CATEGORIES BELOW?	2. IF YES, CHECK THE CORRESPONDING DESCRIPTION(S) BELOW. LPA SHOULD CONSULT NATURAL ENGLAND ON LIKELY RISKS FROM THE FOLLOWING:
All Planning Applications	
Infrastructure	
Wind & Solar Energy	
Minerals, Oil & Gas	
Rural Non Residential	
Residential	
Rural Residential	
Air Pollution	Livestock & poultry units with floorspace > 500m², slurry lagoons & digestate stores > 4000m².
Combustion	General combustion processes >50MW energy input. Incl: energy from waste incineration, other incineration, landfill gas generation plant, pyrolysis/gasification, anaerobic digestion, sewage treatment works, other incineration/ combustion.
Waste	
Composting	
Discharges	
Water Supply	
Notes 1	
Notes 2	
GUIDANCE - How to use the Impact Risk Zones	/Metadata_for_magic/SSSI IRZ User Guidance MAGIC.pdf

Aquifer Designation Map (Bedrock) (England)

Typology	Secondary B

Aquifer Designation Map (Superficial Drift) (England)

Typology	Secondary (undifferentiated)

Areas of Outstanding Natural Beauty (England)
No Features found

Limestone Pavement Orders (England)
No Features found

Local Nature Reserves (England) - points
No Features found

Local Nature Reserves (England)
No Features found

Moorland Line (England)
No Features found

National Nature Reserves (England) - points
No Features found

National Nature Reserves (England)
No Features found

National Parks (England)
No Features found

Ramsar Sites (England) - points
No Features found

Ramsar Sites (England)
No Features found

Proposed Ramsar Sites (England) - points
No Features found

Proposed Ramsar Sites (England)
No Features found

Sites of Special Scientific Interest Units (England) - points
No Features found

Sites of Special Scientific Interest Units (England)
No Features found

Sites of Special Scientific Interest (England) - points
No Features found

Sites of Special Scientific Interest (England)
No Features found

Special Areas of Conservation (England) - points
No Features found

Special Areas of Conservation (England)
No Features found

Possible Special Areas of Conservation (England) - points
No Features found

Possible Special Areas of Conservation (England)
No Features found

Special Protection Areas (England) - points
No Features found

Special Protection Areas (England)
No Features found

Potential Special Protection Areas (England) - points
No Features found

Potential Special Protection Areas (England)
No Features found

Biosphere Reserves (England) - points
No Features found

Biosphere Reserves (England)
No Features found

Less Favoured Areas (England)
No Features found

Nitrate Vulnerable Zones 2017 Designations (England)
No Features found

Wild Bird General Licence Protected Sites Condition Zone (England)
No Features found

Source Protection Zones merged (England)
No Features found

United Utilities
Water for the North West

How to contact us:

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Telephone: 0370 7510101

E-mail: propertysearches@uuplc.co.uk

Rida Reports

4
Beanacre Road,
Hook Norton,
OX15 5UA

FAO:

Your Ref: [0412] 22 Honor Street, Manchester, M13 0WY
Our Ref: UUPS-ORD-532416
Date: 22/11/2023

Dear Sirs

Location: 20 HONOR STREET, MANCHESTER, M13 0WY

I acknowledge with thanks your request dated 20/11/2023 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

United Utilities Water Limited
Registered In England & Wales No. 2366678
Registered Office Haweswater House, Lingley Mere Business Park,
Lingley Green Avenue, Great Sankey, Warrington, WA5 3LP

Water for the North West

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)".

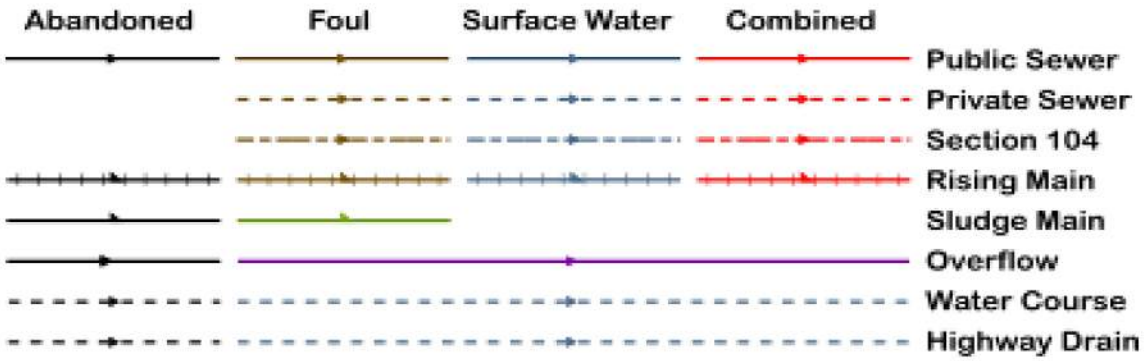
TERMS AND CONDITIONS:

- 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.

United Utilities Water Limited
Registered In England & Wales No. 2366678
Registered Office Haweswater House, Lingley Mere Business Park,
Lingley Green Avenue, Great Sankey, Warrington, WA5 3LP

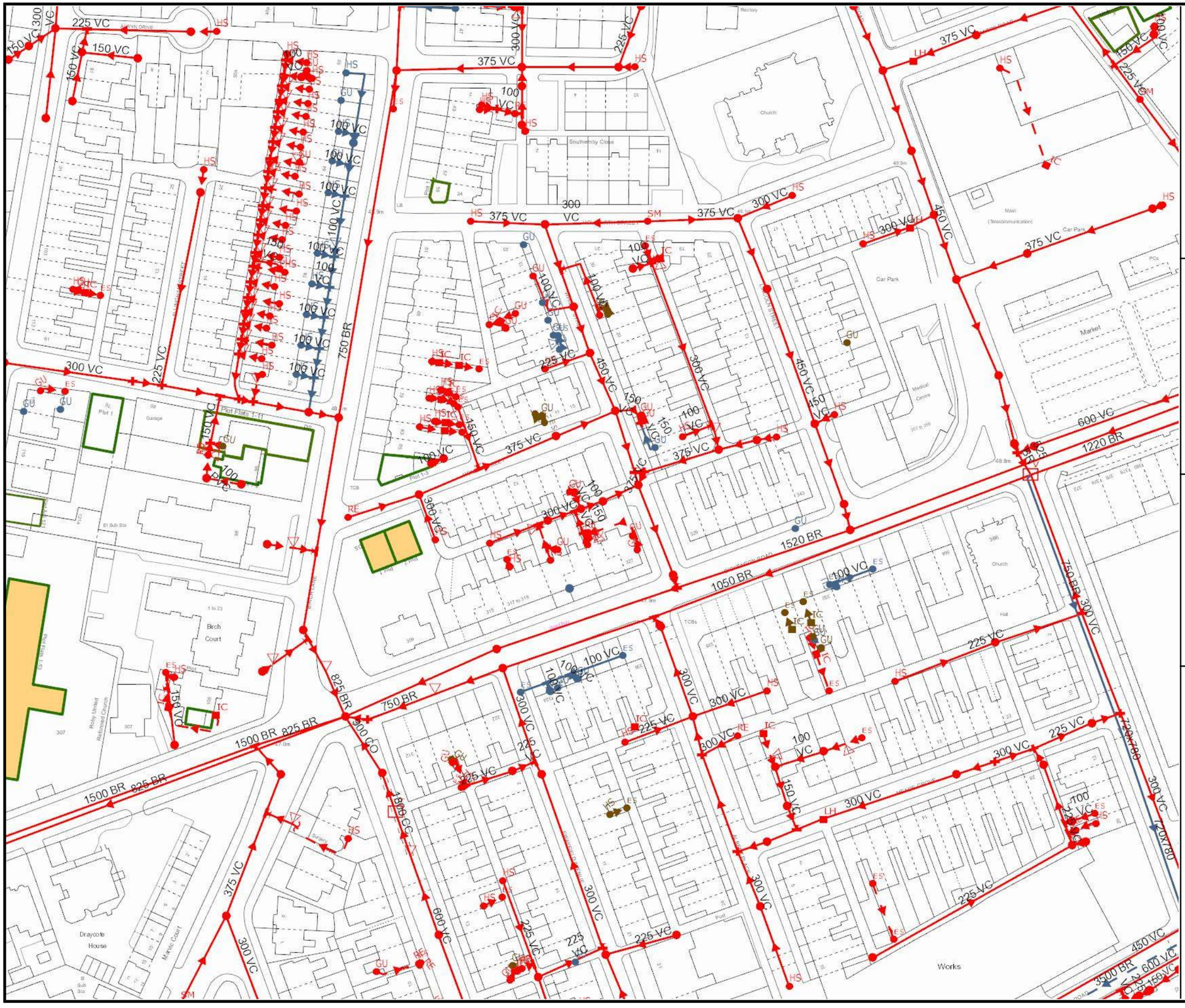
United Utilities
Water for the North West

Wastewater Symbology



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

- Manhole
- HS Head of System
- ES Extent of Survey
- RE Rodding Eye
- IN Inlet
- DP Discharge Point
- HY Vortex
- PE Penstock
- WO Washout Chamber
- VA Valve
- AV Air Valve
- NRV Non Return Valve
- SO Soakaway
- GU Gully
- CA Cascade
- FM Flow Meter
- HA Hatch Box
- OI Oil Interceptor
- SM Summit
- DS Drop Shaft
- OP Orifice Plate
- Side Entry Manhole
- Outfall
- Screen Chamber
- IC Inspection Chamber
- Bifurcation Chamber
- LH Lamp Hole
- T Junction / Saddle
- Catchpit
- Valve Chamber
- Vent Column
- Vortex Chamber
- Penstock Chamber
- T Network Storage Tank
- V Sewer Overflow
- WwTW Ww Treatment Works
- Ww Pumping Station
- Septic Tank
- CK Control Kiosk
- Change of Characteristic



United Utilities

Water for the North West

SEWER RECORDS

Address or Site Reference

20 HONOR STREET,
MANCHESTER,
M13 0WY

Scale: 1:1250

Date: 22/11/2023

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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Appendix C

CAUSEWAY	Rida Reports Limited	File: 22 Honor Street.pfd Network: Storm Network Mario Mora 22/11/2023	Page 1

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	240
FSR Region	England and Wales	Additional Storage (m³/ha)	20.0
M5-60 (mm)	17.000	Check Discharge Rate(s)	✓
Ratio-R	0.400	1 year (l/s)	0.1
Summer CV	0.950	2 year (l/s)	0.1
Winter CV	0.950	30 year (l/s)	0.1
Analysis Speed	Normal	100 year (l/s)	0.1
Skip Steady State	x	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
30	0	0	0
30	40	0	0
100	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.70
Greenfield Method	IH124	Growth Factor 100 year	2.08
Positively Drained Area (ha)	0.011	Betterment (%)	0
SAAR (mm)	879	QBar	0.1
Soil Index	4	Q 1 year (l/s)	0.1
SPR	0.47	Q 2 year (l/s)	0.1
Region	10	Q 30 year (l/s)	0.1
Growth Factor 1 year	0.87	Q 100 year (l/s)	0.1
Growth Factor 2 year	0.93		

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CAUSEWAY	Rida Reports Limited	File: 22 Honor Street.pfd Network: Storm Network Mario Mora 22/11/2023	Page 1

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	240
FSR Region	England and Wales	Additional Storage (m³/ha)	20.0
M5-60 (mm)	17.000	Check Discharge Rate(s)	✓
Ratio-R	0.400	1 year (l/s)	0.9
Summer CV	0.950	2 year (l/s)	1.1
Winter CV	0.950	30 year (l/s)	2.1
Analysis Speed	Normal	100 year (l/s)	2.6
Skip Steady State	x	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
30	0	0	0
30	40	0	0
100	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Brownfield	Betterment (%)	0
Brownfield Method	MRM	Q 1 year (l/s)	0.9
Contributing Area (ha)	0.006	Q 2 year (l/s)	1.1
PIMP (%)	100	Q 30 year (l/s)	2.1
CV	0.950	Q 100 year (l/s)	2.6
Time of Concentration (mins)	6.00		

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Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Inverts
M5-60 (mm)	17.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.950	Include Intermediate Ground	✓
Time of Entry (mins)	6.00	Enforce best practice design rules	✓

Adoptable Manhole Type

Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)
374	1200	749	1500
499	1350	900	1800

>900 Link+900 mm

Max Depth (m)	Diameter (mm)	Max Depth (m)	Diameter (mm)
1.500	1050	99.999	1200

Circular Link Type

Shape	Circular	Auto Increment (mm)	75
Barrels	1	Follow Ground	x

Available Diameters (mm)

100	150

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SO1	0.004	6.00	48.394	450	9.936	11.855	0.500
Tank			48.345		10.046	0.029	1.500
Drainage Channel	0.004	6.00	48.542	150	3.459	-5.072	1.300
Flow Control			48.426	1200	10.102	-4.791	1.701
Outfall			48.426	450	10.067	-10.021	1.751

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	SO1	Tank	5.000	0.600	47.894	46.845	1.049	4.8	100	6.02	50.0
1.001	Tank	Flow Control	12.000	0.600	46.845	46.725	0.120	100.0	100	6.28	50.0
2.000	Drainage Channel	Flow Control	6.649	0.600	47.242	47.129	0.113	58.8	100	6.11	50.0
1.002	Flow Control	Outfall	5.000	0.600	46.725	46.675	0.050	100.0	100	6.39	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	3.566	28.0	0.7	0.400	1.400	0.004	0.0	11	1.457
1.001	0.769	6.0	0.7	1.400	1.601	0.004	0.0	23	0.511
2.000	1.006	7.9	0.7	1.200	1.197	0.004	0.0	20	0.613
1.002	0.769	6.0	1.4	1.601	1.651	0.008	0.0	32	0.621

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Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	5.000	4.8	100	Circular	48.394	47.894	0.400	48.345	46.845	1.400
1.001	12.000	100.0	100	Circular	48.345	46.845	1.400	48.426	46.725	1.601
2.000	6.649	58.8	100	Circular	48.542	47.242	1.200	48.426	47.129	1.197
1.002	5.000	100.0	100	Circular	48.426	46.725	1.601	48.426	46.675	1.651

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	SO1	450	Manhole	Adoptable	Tank		Junction	
1.001	Tank		Junction		Flow Control	1200	Manhole	Adoptable
2.000	Drainage Channel	150	Manhole	Adoptable	Flow Control	1200	Manhole	Adoptable
1.002	Flow Control	1200	Manhole	Adoptable	Outfall	450	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
SO1	9.936	11.855	48.394	0.500	450	0	1.000	47.894	100
Tank	10.046	0.029	48.345	1.500		1	1.000	46.845	100
						0	1.001	46.845	100
Drainage Channel	3.459	-5.072	48.542	1.300	150	0	2.000	47.242	100
Flow Control	10.102	-4.791	48.426	1.701	1200	1	2.000	47.129	100
						2	1.001	46.725	100
						0	1.002	46.725	100
Outfall	10.067	-10.021	48.426	1.751	450	1	1.002	46.675	100

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	240
FSR Region	England and Wales	Additional Storage (m³/ha)	20.0
M5-60 (mm)	17.000	Check Discharge Rate(s)	✓
Ratio-R	0.400	1 year (l/s)	0.9
Summer CV	0.950	2 year (l/s)	1.1
Winter CV	0.950	30 year (l/s)	2.1
Analysis Speed	Normal	100 year (l/s)	2.6
Skip Steady State	x	Check Discharge Volume	x

Storm Durations

15 | 30 | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 960 | 1440

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Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
30	0	0	0
30	40	0	0
100	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Brownfield	Time of Concentration (mins)	6.00
Brownfield Method	MRM	Betterment (%)	0
Contributing Area (ha)	0.006	Q 1 year (l/s)	
PIMP (%)	100	Q 30 year (l/s)	
CV	0.950	Q 100 year (l/s)	

Node Flow Control Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Downstream Link	1.002	Sump Available	✓
Replaces Downstream Link	✓	Product Number	CTL-SHE-0034-7000-1700-7000
Invert Level (m)	46.725	Min Outlet Diameter (m)	0.075
Design Depth (m)	1.700	Min Node Diameter (mm)	1200
Design Flow (l/s)	0.7		

Node Tank Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	46.845
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.96	Time to half empty (mins)	37

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	2.0	0.0	0.400	2.0	0.0	0.800	2.0	0.0	0.801	0.0	0.0

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year 15 minute summer	92.521	26.180	1 year 600 minute winter	5.249	2.101
1 year 15 minute winter	64.927	26.180	1 year 720 minute summer	6.859	1.838
1 year 30 minute summer	60.022	16.984	1 year 720 minute winter	4.609	1.838
1 year 30 minute winter	42.121	16.984	1 year 960 minute summer	5.653	1.489
1 year 60 minute summer	40.398	10.676	1 year 960 minute winter	3.745	1.489
1 year 60 minute winter	26.839	10.676	1 year 1440 minute summer	4.127	1.106
1 year 120 minute summer	24.980	6.602	1 year 1440 minute winter	2.773	1.106
1 year 120 minute winter	16.596	6.602	2 year 15 minute summer	119.760	33.888
1 year 180 minute summer	19.271	4.959	2 year 15 minute winter	84.042	33.888
1 year 180 minute winter	12.527	4.959	2 year 30 minute summer	77.518	21.935
1 year 240 minute summer	15.301	4.043	2 year 30 minute winter	54.399	21.935
1 year 240 minute winter	10.165	4.043	2 year 60 minute summer	51.720	13.668
1 year 360 minute summer	11.775	3.030	2 year 60 minute winter	34.361	13.668
1 year 360 minute winter	7.654	3.030	2 year 120 minute summer	31.549	8.338
1 year 480 minute summer	9.342	2.469	2 year 120 minute winter	20.961	8.338
1 year 480 minute winter	6.207	2.469	2 year 180 minute summer	24.133	6.210
1 year 600 minute summer	7.682	2.101	2 year 180 minute winter	15.687	6.210

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Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year 240 minute summer	19.039	5.032
2 year 240 minute winter	12.649	5.032
2 year 360 minute summer	14.516	3.735
2 year 360 minute winter	9.436	3.735
2 year 480 minute summer	11.436	3.022
2 year 480 minute winter	7.598	3.022
2 year 600 minute summer	9.363	2.561
2 year 600 minute winter	6.398	2.561
2 year 720 minute summer	8.339	2.235
2 year 720 minute winter	5.605	2.235
2 year 960 minute summer	6.846	1.803
2 year 960 minute winter	4.535	1.803
2 year 1440 minute summer	4.967	1.331
2 year 1440 minute winter	3.338	1.331
30 year 15 minute summer	226.195	64.005
30 year 15 minute winter	158.733	64.005
30 year 30 minute summer	147.452	41.724
30 year 30 minute winter	103.475	41.724
30 year 60 minute summer	98.615	26.061
30 year 60 minute winter	65.517	26.061
30 year 120 minute summer	59.946	15.842
30 year 120 minute winter	39.827	15.842
30 year 180 minute summer	45.598	11.734
30 year 180 minute winter	29.640	11.734
30 year 240 minute summer	35.759	9.450
30 year 240 minute winter	23.758	9.450
30 year 360 minute summer	26.939	6.932
30 year 360 minute winter	17.511	6.932
30 year 480 minute summer	20.981	5.545
30 year 480 minute winter	13.940	5.545
30 year 600 minute summer	17.039	4.661
30 year 600 minute winter	11.642	4.661
30 year 720 minute summer	15.093	4.045
30 year 720 minute winter	10.143	4.045
30 year 960 minute summer	12.278	3.233
30 year 960 minute winter	8.133	3.233
30 year 1440 minute summer	8.788	2.355
30 year 1440 minute winter	5.906	2.355
30 year +40% CC 15 minute summer	316.673	89.607
30 year +40% CC 15 minute winter	222.226	89.607
30 year +40% CC 30 minute summer	206.433	58.413
30 year +40% CC 30 minute winter	144.865	58.413
30 year +40% CC 60 minute summer	138.061	36.485
30 year +40% CC 60 minute winter	91.724	36.485
30 year +40% CC 120 minute summer	83.924	22.179
30 year +40% CC 120 minute winter	55.757	22.179
30 year +40% CC 180 minute summer	63.837	16.427
30 year +40% CC 180 minute winter	41.495	16.427
30 year +40% CC 240 minute summer	50.063	13.230
30 year +40% CC 240 minute winter	33.261	13.230
30 year +40% CC 360 minute summer	37.715	9.705
30 year +40% CC 360 minute winter	24.516	9.705
30 year +40% CC 480 minute summer	29.374	7.763
30 year +40% CC 480 minute winter	19.515	7.763
30 year +40% CC 600 minute summer	23.854	6.525
30 year +40% CC 600 minute winter	16.299	6.525
30 year +40% CC 720 minute summer	21.130	5.663
30 year +40% CC 720 minute winter	14.201	5.663
30 year +40% CC 960 minute summer	17.189	4.526
30 year +40% CC 960 minute winter	11.387	4.526
30 year +40% CC 1440 minute summer	12.303	3.297
30 year +40% CC 1440 minute winter	8.269	3.297
100 year 15 minute summer	291.766	82.560
100 year 15 minute winter	204.748	82.560
100 year 30 minute summer	191.982	54.324
100 year 30 minute winter	134.724	54.324
100 year 60 minute summer	129.253	34.158
100 year 60 minute winter	85.873	34.158
100 year 120 minute summer	78.836	20.834
100 year 120 minute winter	52.377	20.834
100 year 180 minute summer	59.966	15.431
100 year 180 minute winter	38.980	15.431
100 year 240 minute summer	46.975	12.414
100 year 240 minute winter	31.209	12.414
100 year 360 minute summer	35.264	9.075
100 year 360 minute winter	22.923	9.075
100 year 480 minute summer	27.350	7.228
100 year 480 minute winter	18.171	7.228
100 year 600 minute summer	22.137	6.055
100 year 600 minute winter	15.126	6.055
100 year 720 minute summer	19.562	5.243
100 year 720 minute winter	13.147	5.243
100 year 960 minute summer	15.851	4.174
100 year 960 minute winter	10.500	4.174
100 year 1440 minute summer	11.278	3.023
100 year 1440 minute winter	7.579	3.023
100 year +40% CC 15 minute summer	408.473	115.584
100 year +40% CC 15 minute winter	286.647	115.584
100 year +40% CC 30 minute summer	268.775	76.054
100 year +40% CC 30 minute winter	188.614	76.054
100 year +40% CC 60 minute summer	180.954	47.821
100 year +40% CC 60 minute winter	120.222	47.821
100 year +40% CC 120 minute summer	110.370	29.168
100 year +40% CC 120 minute winter	73.327	29.168
100 year +40% CC 180 minute summer	83.953	21.604
100 year +40% CC 180 minute winter	54.572	21.604
100 year +40% CC 240 minute summer	65.765	17.380
100 year +40% CC 240 minute winter	43.693	17.380
100 year +40% CC 360 minute summer	49.370	12.705
100 year +40% CC 360 minute winter	32.092	12.705
100 year +40% CC 480 minute summer	38.291	10.119
100 year +40% CC 480 minute winter	25.439	10.119
100 year +40% CC 600 minute summer	30.992	8.477
100 year +40% CC 600 minute winter	21.176	8.477

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Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +40% CC 720 minute summer	27.387	7.340	100 year +40% CC 960 minute winter	14.700	5.844
100 year +40% CC 720 minute winter	18.406	7.340	100 year +40% CC 1440 minute summer	15.789	4.232
100 year +40% CC 960 minute summer	22.191	5.844	100 year +40% CC 1440 minute winter	10.611	4.232

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Results for 1 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SO1	10	47.903	0.009	0.5	0.0030	0.0000	OK
30 minute summer	Tank	23	46.869	0.024	0.5	0.0464	0.0000	OK
15 minute summer	Drainage Channel	12	47.259	0.017	0.5	0.0014	0.0000	OK
30 minute summer	Flow Control	24	46.870	0.145	1.0	0.1636	0.0000	SURCHARGED
15 minute summer	Outfall	1	46.675	0.000	0.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SO1	1.000	Tank	0.5	1.187	0.018	0.0037	
30 minute summer	Tank	1.001	Flow Control	0.5	0.165	0.081	0.0557	
15 minute summer	Drainage Channel	2.000	Flow Control	0.5	0.555	0.063	0.0060	
30 minute summer	Flow Control	Hydro-Brake®	Outfall	0.4				0.6

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Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SO1	11	47.905	0.011	0.7	0.0035	0.0000	OK
30 minute winter	Tank	24	46.899	0.054	0.5	0.1045	0.0000	OK
15 minute summer	Drainage Channel	11	47.263	0.021	0.7	0.0016	0.0000	OK
30 minute winter	Flow Control	26	46.900	0.175	1.0	0.1983	0.0000	SURCHARGED
15 minute summer	Outfall	1	46.675	0.000	0.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SO1	1.000	Tank	0.7	1.187	0.025	0.0099	
30 minute winter	Tank	1.001	Flow Control	0.5	0.165	0.082	0.0731	
15 minute summer	Drainage Channel	2.000	Flow Control	0.7	0.612	0.088	0.0076	
30 minute winter	Flow Control	Hydro-Brake®	Outfall	0.4				0.8

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Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SO1	10	47.908	0.014	1.2	0.0045	0.0000	OK
30 minute winter	Tank	30	47.092	0.247	1.3	0.4751	0.0000	SURCHARGED
15 minute summer	Drainage Channel	11	47.269	0.027	1.2	0.0022	0.0000	OK
30 minute winter	Flow Control	30	47.092	0.367	1.5	0.4148	0.0000	SURCHARGED
15 minute summer	Outfall	1	46.675	0.000	0.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SO1	1.000	Tank	1.2	1.188	0.043	0.0212	
30 minute winter	Tank	1.001	Flow Control	0.7	0.180	0.114	0.0939	
15 minute summer	Drainage Channel	2.000	Flow Control	1.2	0.711	0.152	0.0112	
30 minute winter	Flow Control	Hydro-Brake®	Outfall	0.4				1.6

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Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SO1	11	47.911	0.017	1.7	0.0053	0.0000	OK
60 minute winter	Tank	49	47.266	0.421	1.1	0.8079	0.0000	SURCHARGED
15 minute summer	Drainage Channel	11	47.275	0.033	1.7	0.0026	0.0000	OK
60 minute winter	Flow Control	49	47.265	0.540	1.0	0.6111	0.0000	SURCHARGED
15 minute summer	Outfall	1	46.675	0.000	0.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SO1	1.000	Tank	1.7	1.385	0.061	0.0217	
60 minute winter	Tank	1.001	Flow Control	0.5	0.165	0.079	0.0939	
15 minute summer	Drainage Channel	2.000	Flow Control	1.7	0.781	0.215	0.0167	
60 minute winter	Flow Control	Hydro-Brake®	Outfall	0.4				2.8

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Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SO1	11	47.910	0.016	1.6	0.0052	0.0000	OK
30 minute winter	Tank	31	47.229	0.384	1.7	0.7374	0.0000	SURCHARGED
15 minute summer	Drainage Channel	11	47.274	0.032	1.6	0.0025	0.0000	OK
30 minute winter	Flow Control	31	47.229	0.504	1.4	0.5698	0.0000	SURCHARGED
15 minute summer	Outfall	1	46.675	0.000	0.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SO1	1.000	Tank	1.6	1.385	0.057	0.0216	
30 minute winter	Tank	1.001	Flow Control	0.6	0.197	0.100	0.0939	
15 minute summer	Drainage Channel	2.000	Flow Control	1.6	0.769	0.202	0.0138	
30 minute winter	Flow Control	Hydro-Brake®	Outfall	0.4				2.1

Flow+ v10.6.234 Copyright © 1988-2024 Causeway Technologies Ltd

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SO1	11	47.913	0.019	2.2	0.0061	0.0000	OK
60 minute winter	Tank	52	47.421	0.576	1.3	1.1061	0.0000	SURCHARGED
60 minute winter	Drainage Channel	52	47.421	0.179	1.2	0.0141	0.0000	SURCHARGED
60 minute winter	Flow Control	52	47.421	0.696	1.3	0.7870	0.0000	SURCHARGED
15 minute summer	Outfall	1	46.675	0.000	0.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SO1	1.000	Tank	2.2	1.385	0.079	0.0221	
60 minute winter	Tank	1.001	Flow Control	0.4	0.197	0.075	0.0939	
60 minute winter	Drainage Channel	2.000	Flow Control	1.2	0.711	0.152	0.0520	
60 minute winter	Flow Control	Hydro-Brake®	Outfall	0.5				3.6

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Appendix D

Do not scale from this drawing. Refer to figured dimensions only. RIDA Reports Ltd registered in England and Wales No. 10590566. This drawing is copyright of RIDA Reports Ltd.

Drawing Scale Bar

Drawing scale	Line length	Drawing scale	Line length
1:5 =	0.25 metres	1:200 =	10.0 metres
1:10 =	0.5 metres	1:250 =	12.5 metres
1:20 =	1.0 metres	1:500 =	25.0 metres
1:25 =	1.25 metres	1:1000 =	50.0 metres
1:50 =	2.5 metres	1:1250 =	62.5 metres
1:100 =	5.0 metres	1:2500 =	125 metres

Measure length of line above for checking of scale

GENERAL NOTES

1. All dimensions are in millimetres and levels in m AOD unless stated otherwise.

2. Do not scale. If in any doubt, consult Engineer.

3. Read in conjunction with the architects and engineers schedule drawings.

4. Check inverts and sizes of existing pipes prior to the commencement of any work. Report any discrepancies to the engineer and await instructions.

5. The location of services is shown as indicative. This drawing should be read in conjunction with the utilities drawings. No warranty to their accuracy can be given. The contractor shall take all necessary measures to satisfy himself as to the location of the existing services and connection points. Excavation should be undertaken in compliance with HSG47.

6. Concrete structures design sulphate class and ACEC concrete class unknown.

7. Pipework to be 110mm Thermoplastics U-PVC (Polypipe or similar) installed at levels marked on this drawing UNO. Pipe bedding should be class Z in pipes within 1.5m of the building or shallower than 700mm below ground level. For all other areas the pipe bedding should be class S.

8. Joints and fittings for gravity sewers shall comply with the relevant provisions of BS EN 1401-1, BS EN 1852 and BS EN 12666-1. Pipes shall have a limit of 6% deformation. Pipes shall be SN8 ring stiffness and stamped accordingly. Pipe sections shall not be longer than 3m.

9. Plastic chambers and rings, including demarcation chambers,shall comply with BS EN 3598-1 or BS EN 13598-2 as appropriate.

10. Inspection chamber covers and frames shall comply with the relevant provisions of BS EN 124 and should be double sealed.

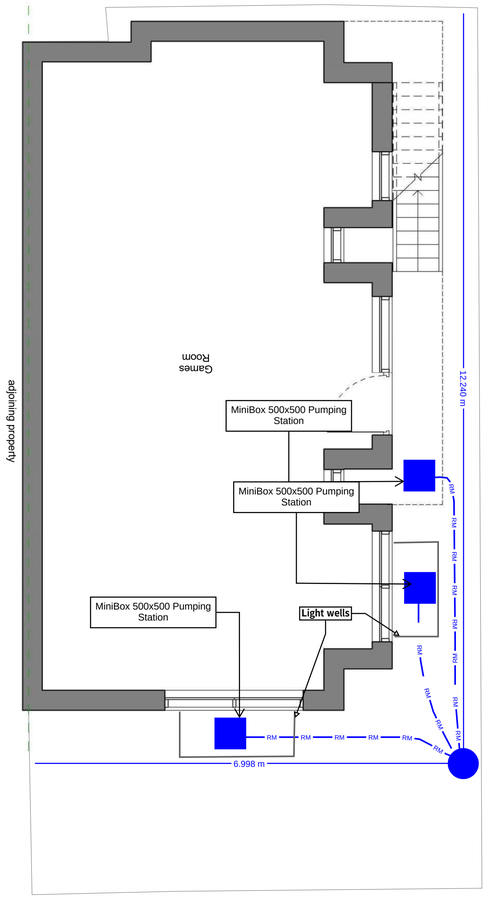
11. All inspection chamber covers shall be the non-ventilating type and shall have closed keyways.

12. Testing of pipelines should be as follow:

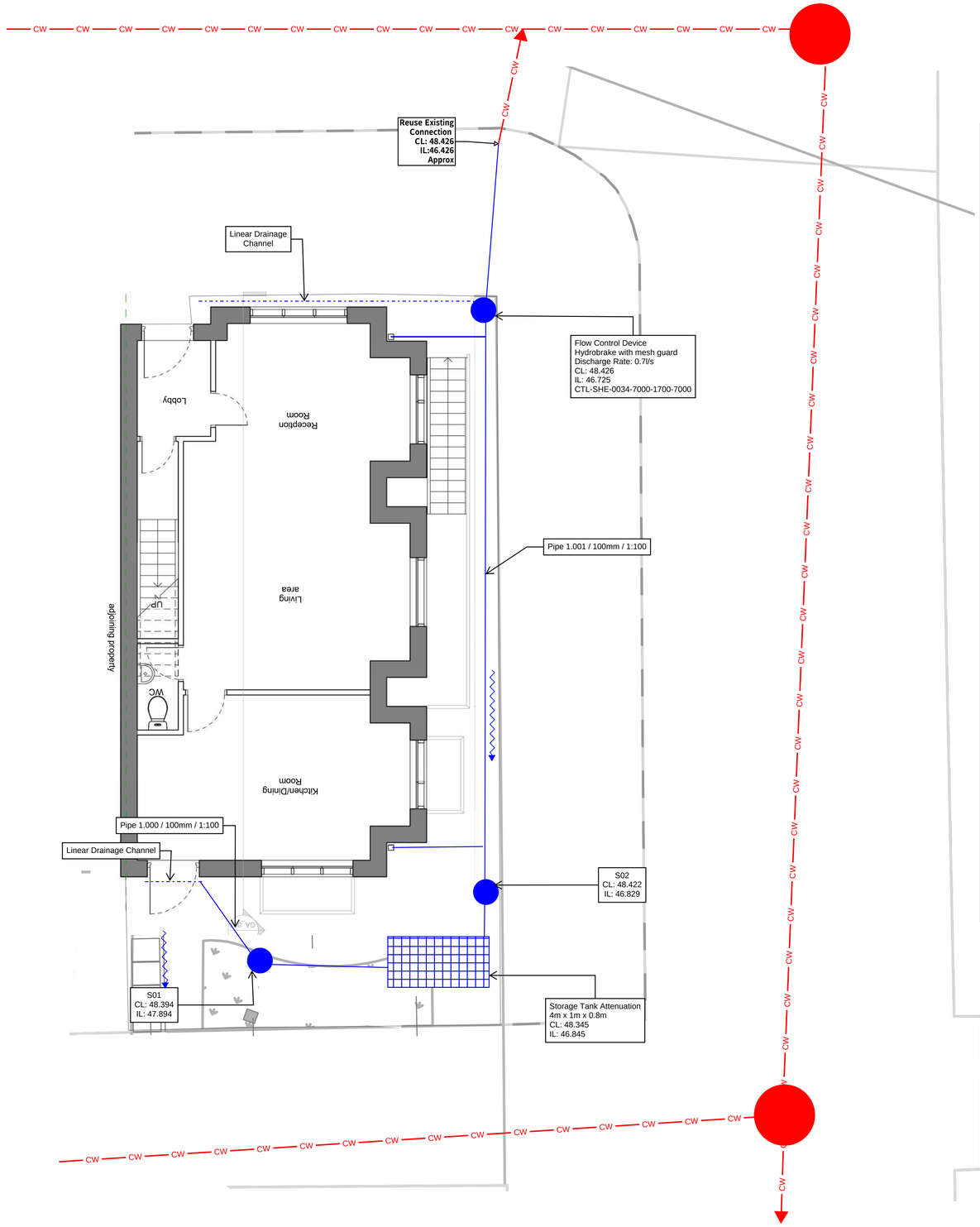
Gravity Pipework: Air pipe testing. Pipework should withstand a pressure of 100mm water gauge and this should not fall by more than 25mm in a 5minute period. However where traps or gullies are connected they should withstand a pressure of 50mm water gauge and this should not fall by more than 12mm in a 5minute period. It is recommended that pipework installations are tested in sections rather than waiting to complete in one operation.

13. Manhole covers to be set square to the building. Covers of existing manholes to be adjusted to match final ground levels.

14. Granular Bedding for pipes shall be constructed by spreading and compacting granular bedding material over the full width of the pipe trench. After the pipes have been laid, additional granular material shall, if required, be placed and compacted equally on each side of the pipes and, where practicable, this shall be done in sequence with the removal of the trench supports.



BASEMENT DRAINAGE PLAN
1:50



GROUND FLOOR DRAINAGE PLAN
1:50

KEY

- Proposed Surface Water Sewer Pipe
- Exceedance Flows
- Linear Drainage Channel
- Silt Trap
- Existing Combined Sewer Pipe

Rev	Details	Date	By	Ch'd
P3	Hydrobrake details updated	06.02.2024	MM	ARD
P2	Updated Design	05.01.2024	MM	ARD

Drawing Status:
PRELIMINARY

URBANWATER

Client:

Project:
22 Honor Street, Manchester, M13 0WY

Drawing:
Proposed Drainage Strategy

Print Size:	Scale:	Project No:	Drawing No:	Revision:
A1	1:50	0412	003	P2

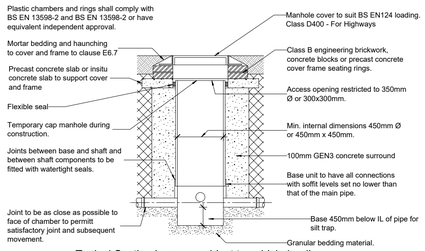
Do not scale from this drawing. Refer to figured dimensions only. RIDA Reports Ltd registered in England and Wales No. 10590566. This drawing is copyright of RIDA Reports Ltd.

Drawing Scale Bar

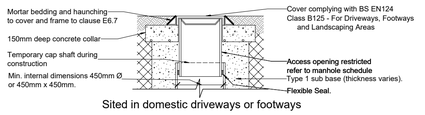
Drawing scale	Line length	Drawing scale	Line length
1:5	= 0.25 metres	1:200	= 10.0 metres
1:10	= 0.5 metres	1:250	= 12.5 metres
1:20	= 1.0 metres	1:500	= 25.0 metres
1:25	= 1.25 metres	1:1000	= 50.0 metres
1:50	= 2.5 metres	1:1250	= 62.5 metres
1:100	= 5.0 metres	1:2500	= 125 metres

Measure length of line above for checking of scale

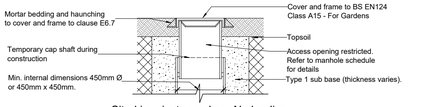
GENERAL NOTES



Typical Section in areas subject to vehicle loading



Sited in domestic driveways or footways

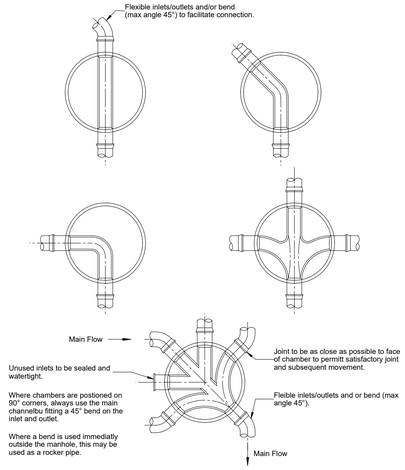


Sited in private garden - No loading

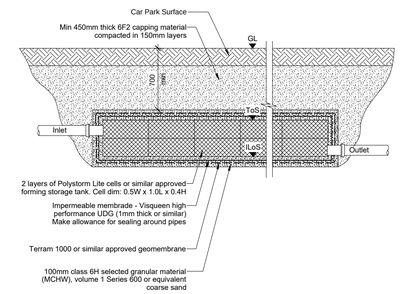
Notes:

1. Refer to drawing 8193 for base layouts.

Silt Trap Plastic



Chamber Type 3 Base Layouts



NOTES:

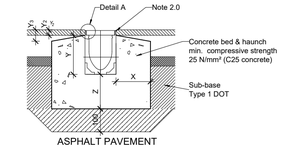
1. Permeable modular storage cell with 95% minimum void ratio. Ultimate compressive strength of 400kN/m² minimum. Resistant to chemicals likely to be found in rain water and durability of a minimum of 40 years.

2. Dimensions as applicable to the manufacturers recommendations for given storage requirement UNO.

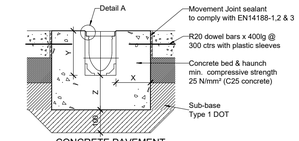
3. Air Vents should be provided as per suppliers recommendations

4. See GA drgs for pipe sizes and layout and IL, ILoS, ToS, GL levels.

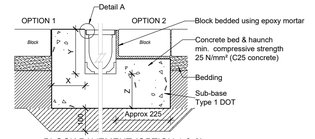
Cellular Attenuation System - Landscape Area



ASPHALT PAVEMENT



CONCRETE PAVEMENT

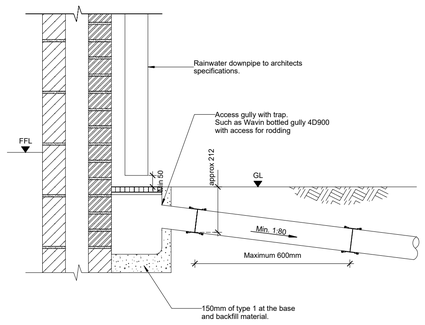


BLOCK PAVEMENT (OPTION 1 & 2)

Minimum Dimensions of Concrete Surround

Load Class		A15	B125	C250	D400*	F900
Minimum Dimensions (mm)	X	100	150	150	250	300
	Y	Full Channel Height *(Less Y2 where necessary)*				
	Z	100	150	150	250	300
Maximum Dimensions (mm)	Y_1	35	35	35	35	35
	Y_2	100	60	60	60	35

8341 - Linear Drainage Channel Detail (Steel)

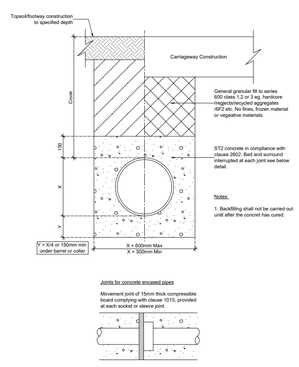


NOTES:

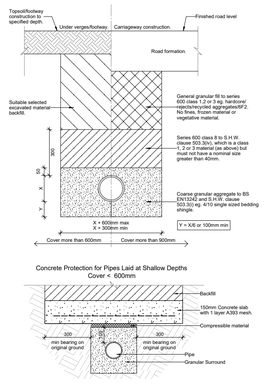
1. This details shows the standard generic arrangement.

2. The pipe and connector details will be different for each manufacturer of the components. They are to be in installed in accordance with the manufacturers recommendations.

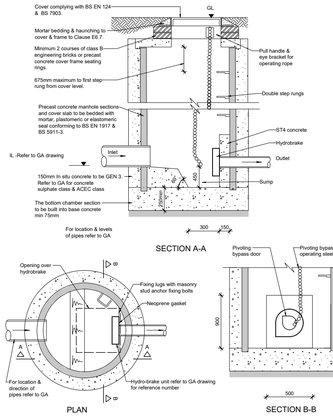
8250 - External Rainwater (High Level)



Pipe Bedding Detail Type Z



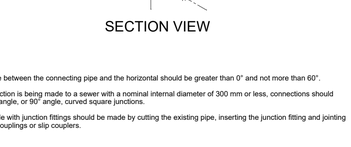
Pipe Bedding Detail Type S



NOTE:
1. Refer to GA for manhole size and Hydrobrake reference number

2. Hydrobrake to be installed as per supplier's recommendations

Flow Control Device Chamber- Hydrobrake



PLAN VIEW

SECTION VIEW

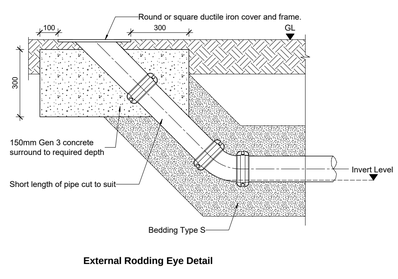
NOTES:

1. The vertical angle between the connecting pipe and the horizontal should be greater than 0° and not more than 60°.

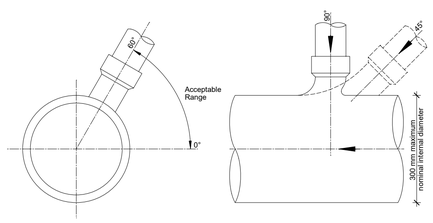
2. Where the connection is being made to a sewer with a nominal internal diameter of 300 mm or less, connections should be made using 45° angle, or 90° angle, curved square junctions.

3. Connections made with junction fittings should be made by cutting the existing pipe, inserting the junction fitting and jointing with flexible repair couplings or slip couplers.

Lateral Connection to private sewer



External Rodding Eye Detail



Cross-Sectional View of Sewer

Plan View of Sewer

NOTES:

1. The vertical angle between the connecting pipe and the horizontal should be greater than 0° and not more than 60°.

2. Where the connection is being made to a sewer with a nominal internal diameter of 300 mm or less, connections should be made using 45° angle, or 90° angle, curved square junctions.

3. Connections made with junction fittings should be made by cutting the existing pipe, inserting the junction fitting and jointing with flexible repair couplings or slip couplers.

4. Where the connection is being made to a sewer with a nominal internal diameter greater than 300 mm:

a) Where the diameter of the connecting pipe is greater than half the diameter of the sewer, the connection of an access point should be constructed;
or
b) where the diameter of the connecting pipe is less than or equal to half the diameter of the sewer, then the connection should be made using a preformed saddle fitting.

Lateral Connection to public sewer

Rev	Details	Date	By	Ch'd
2	Updated Design	05.01.2024	MM	ARD

Drawing Status:

PRELIMINARY

URBANWATER

Client:

Project:

22 Honor Street, Manchester, M13 0WY

Drawing:

Standard Details

Print Size:	Scale:	Project No:	Drawing No:	Revision:
A1	NTS	0412	006	P2



Going with the flow

Precision engineering of flow control in surface water management

© Hydro International 2020

Hydro International®

White Paper

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1 Introduction

This White Paper provides information and guidance on the principles and best practice for managing surface water using flow attenuation and control techniques, with case study examples. The paper includes advice on the importance of correct specification and the options and considerations involved in making the right choices.

Who is the White Paper for?

- Consulting Engineers
- Architects
- Landscape Architects
- Developers & Housebuilders
- Civil & Building Contractors
- Water Companies
- Environment Agencies
- Environmental & Flooding Consultants
- Drainage Engineers
- Highways Engineers
- Local Authority Drainage
- Planning
- Highways Officers
- Builders' Merchants

2 Executive Summary

Precision-engineering of flow control is a contemporary approach to managing the water environment that still has much untapped potential and is using a growing variety of technologies and techniques.

Slowing down the flow of surface water and controlling its release into the water environment is a natural process that is, quite literally, as old as the hills themselves. Yet the simple and sustainable idea behind flow attenuation is the basis of a modern engineering principle.

Understanding and applying the science behind flow control is critical if communities are to find the most cost-effective ways to prevent, control or contain flooding.

Sustainable engineering interventions seek to return surface water flows as closely as possible to pre-development or greenfield rates and to replicate natural drainage paths and processes.

Typically, this is achieved by controlling the peak rate of discharge and introducing flow attenuation. The same principles apply, whether implemented in a watercourse, a Sustainable Drainage System (SuDS) or below ground in a combined sewer.

Flow controls regulate flow by flattening out peak volumes, thereby protecting the downstream catchment from flooding. Precision-engineered flow control devices can be used by engineers to design predictable and pragmatic solutions.

Choosing the right flow control technology for the outflow depends on a number of factors, which are explored fully in this paper. The most critical considerations for effective flow control design include:

Ensuring the smallest possible amount of storage to mitigate against lost value of development land and cost of construction.

Ensuring reliability of the flow control, by minimising the risk of blockage and through use of systems that can be depended upon to operate when most needed...in flood conditions.

The paper outlines the options and considerations for specification of flow control devices.

3 Slowing the Flow - Managing Water Quantity

In a completely undeveloped environment, the natural catchment has an inherent capacity to respond to the rainfall that lands on it, acting both to slow down and to absorb the stormwater.

By introducing impermeable surfaces and altering natural drainage paths and processes, not only through urban development but also for agriculture, we have reduced our resilience to flooding. At the same time, we have generally built our commercial and social infrastructures around rivers and estuaries – these natural flood plains are precisely the places most likely to be developed intensively.

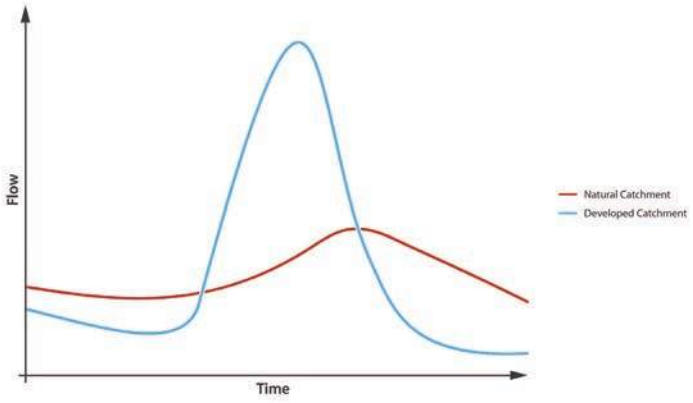


Figure 1

In an undeveloped catchment, the surface water flow is generally a small proportion of the total rainfall, with the larger share being absorbed by the soil and vegetation. However, by removing vegetation and introducing impermeable surfaces, the opportunities for evapo-transpiration and infiltration via the natural environment are lost. Surface flow might account for as little as 10% of the total rainfall landing in a completely natural catchment, but might be 50% in a developed environment, even up to 90% in ultra-urban settings.

On developed land the response of the surface flow alters dramatically. In Figure 1 the blue line shows the rapid rise of flow, much higher peak flow rates, and resulting runoff volume compared to a greenfield environment (red line).

Flow control engineering (Figure 2) regulates the flow by flattening out peak volumes, thereby protecting the downstream catchment from flooding.

Through engineering intervention to control the flow of water, our aim is to replicate as closely as possible the hydraulic response of the natural catchment.

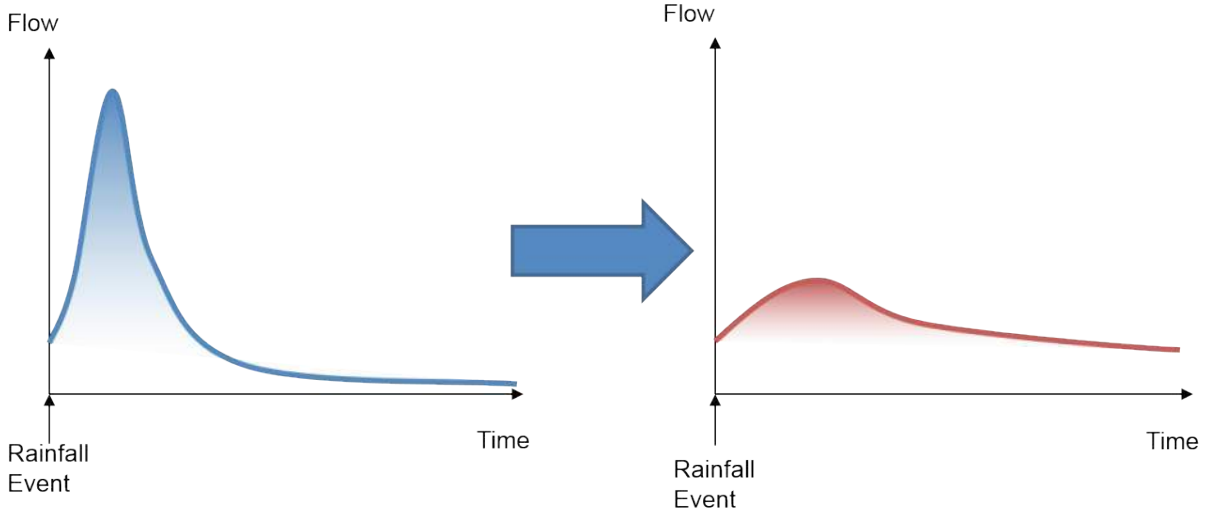


Figure 2

Flow attenuation is a well-proven and widely-applied sustainable engineering solution for projects of all shapes and sizes – from giant flood prevention schemes protecting cities, to everyday small-catchment drainage schemes. The flow control choices made by designers and specifiers every day have a huge impact in achieving effective flood prevention, as well as on the installation and lifetime costs of a project.

Whether in a river, a Sustainable Drainage System (SuDS) or below ground in a surface water only or combined sewer, the same rules of precision engineering apply. Flow control techniques, including the use of manufactured devices, range from the smallest to the largest in size and are commonplace solutions in our urban environments on residential and commercial developments, highways, sewers and even wastewater treatment plants.

Hydro-Brake® Optimum Case Study

'Optimum' Savings for Developer with 21st Century Drainage

Situation

The Gracemount development, which showcases sustainable construction, is the first phase of Edinburgh City Council's 21st Century Homes project for much-needed affordable housing.

Problem

Scottish Water set the discharge consent for the site to 4.5 l/s/ha. This needed to be cost-effectively met – collecting runoff from 1.9 ha of hard surfaces including roofs to 215 homes, all access roads and car parking. In the tightly built-up location there was limited space for landscaping features.



Photo courtesy of Edinburgh City Council



Solution

The use of three Hydro-Brake® Optimum vortex flow controls enabled the developer to meet the discharge consent for the site and protect the development over a wide range of event probabilities from 1 in 30 years to 1 in 100 years, whilst saving around 30% in construction costs.

The stormwater storage required was divided into three and installed under landscaping, in 1500 mm concrete pipes under the access road and large aggregate banks under the car park. Hydro International's modular block Stormcell® system is installed under the landscaping.

Outcome

Using the Hydro-Brake® Optimum meant that the storage volume required could be reduced from 597 m^3 to 487 m^3, which in turn meant a saving of around 30% in construction costs for the storage.

Read the full case study

4 Designing for Water Quantity and Sustainable Drainage Systems



The Eden Park Housing Development (above) demonstrates how proprietary and 'natural' SuDS elements can be specified to provide an optimum solution. Here, some of the attenuated flows are stored underground enabling the land to be used for amenity purposes. (Photo courtesy of Cole Easdon)

Achieving the optimum and most sustainable surface water management that most closely mimics the natural, greenfield response, may require a balance of blue, green and grey infrastructure approaches. In the UK, the accepted approach to achieving this is through the use of SuDS; in the United States, the equivalent approach is known as low-impact development (LID).

The principles of SuDS are first and foremost to mimic natural drainage paths and processes and deal with rainwater as close as possible to where it falls. SuDS represent a best practice engineering and management approach that uses a full toolbox of components to achieve sustainable principles.

Good SuDS schemes satisfy both quantity and quality objectives and are likely to provide multiple benefits to the community by promoting local amenity and biodiversity.

Water quantity is one of the "four pillars of Sustainable Drainage Systems" (SuDS) as defined by CIRIA C753 The SuDS Manual to "control the quantity of the runoff to support the management of flood risk and maintain and protect the natural water cycle."



The Elvetham Heath housing development (above) in Hampshire used 18 Hydro-Brake® vortex flow controls as part of an exemplar SuDS scheme.

As outlined in the SuDS Manual, designing for water quantity should include such considerations as re-using surface water as a resource, managing flood risk, protecting the ecology of the receiving waters, preserving natural hydrology and allowing for climate change. Our series of introductory webinars on C753 The SuDS Manual are a useful resource for anyone requiring further detail. **Watch the recordings here**.

Since 2015, new regulations and technical guidance have been introduced across the devolved regions to provide a framework for local authority consent to new developments through the planning system. A growing number of local authorities, sometimes working together across geographical regions, are also developing SuDS guidance specific to their local requirements.

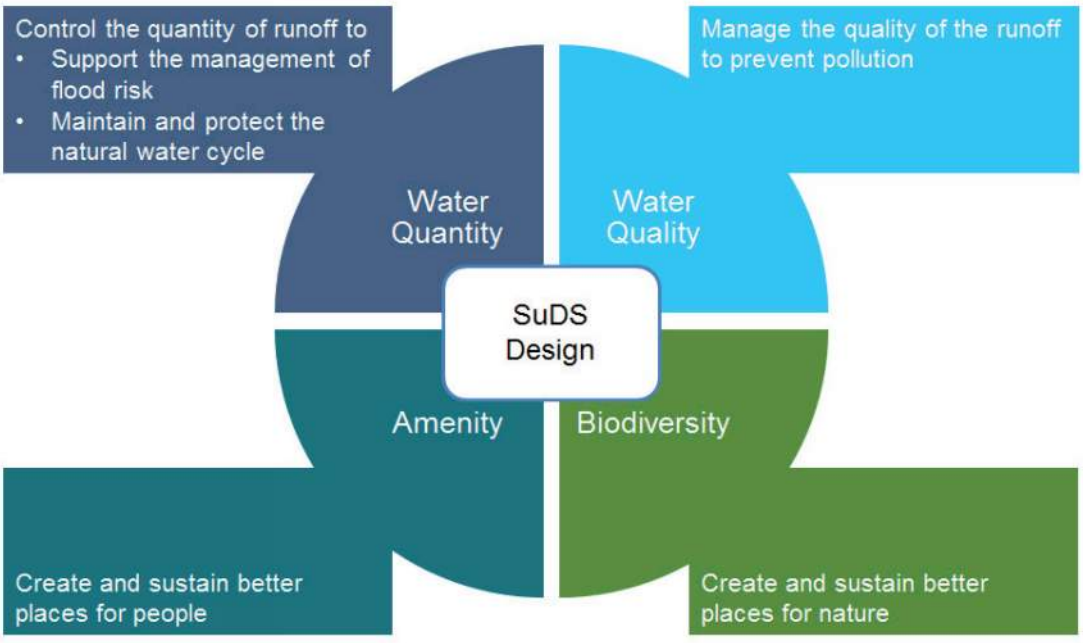


Figure 3 - The Four Pillars of SuDS Construction (Source: CIRIA C753 The SuDS Manual 2015)

5 Flow Control Attenuation and Storage

The engineer's objective is generally to make the drainage solution behave in a hydraulically similar way to the pre-development, natural environment. Controlling surface water runoff as close as possible to the place where it falls is a core principle of SuDS. Infiltration into the ground is considered the ideal, but often developed land and ground conditions mean it is not possible for enough water to soak into the ground quickly enough and surface water builds up. Rather than allowing unmanageable peak volumes of rainwater to develop and cause flooding, surface water must be stored and its volume released in a controlled manner.

Typically, this is achieved by controlling the peak rate of discharge and introducing flow attenuation. Flow attenuation structures generally comprise a storage volume and an outflow control. Flow attenuation structures can take many forms, from below-ground, hard-engineered tanks to above ground wetlands or water bodies, conveyance channels such as swales and trenches and even roof top storage.







An award-winning flood prevention scheme in Dulwich for Southwark Council involved the construction of above- and below-ground temporary flood storage to capture overland flow during periods of heavy rainfall. A key element of the flood defences is underground geocellular block storage from Hydro International to provide a fully inspectable solution that is sensitive to the needs of the park locations.

Engineering the correct flood protection starts with evaluating the available temporary storage area upstream. This dictates the best flow control technology, as each results in a different volume of storage depending on its performance characteristics.

Choosing the right flow control technology for the outflow depends on a number of considerations including:

- **Storage volume:** The volume of the available upstream storage and any limiting factors; for example properties at the perimeter of an area that will be temporarily flooded.
- **Maintenance:** Flow controls with small openings or clearances may be inappropriate in a location where there is a high risk of blockages from litter or vegetation.
- **Accessibility:** A solution without any moving parts may be more appropriate if access for inspection is difficult.
- **External power requirement:** It is advisable for the flow control operation not to depend on availability of external power, especially if these are located in areas at high risk of flooding, or in remote or inaccessible locations.
- **Sensitivity of the receiving watercourse:** A smaller outlet diameter may increase the force of the surface water discharge and therefore lead to greater risk of erosion.
- **Drain down:** The drainage design may need to ensure rapid drain down of the storage volume after a rainfall event, to ensure maximum resilience of the protected area to future flood events.
- **Complexity:** In some cases, the design solution may require multi-stage or complex systems that are precision-engineered to respond to different types of rainfall events.
- **Independent accredited performance and design**, such as BBA Product Approval or WRc Approved™.

Why is it important to minimise upstream storage?

Ensuring the smallest possible amount of surface water storage is a critical consideration to effective flow control design.

Why? Because creating storage is expensive.

Whether you choose a wet pond, a dry detention basin, or an underground tank, building stormwater storage costs time and money. It may also take away valuable land that could otherwise be used for building or amenity, if this land is not suitable for multiple uses.

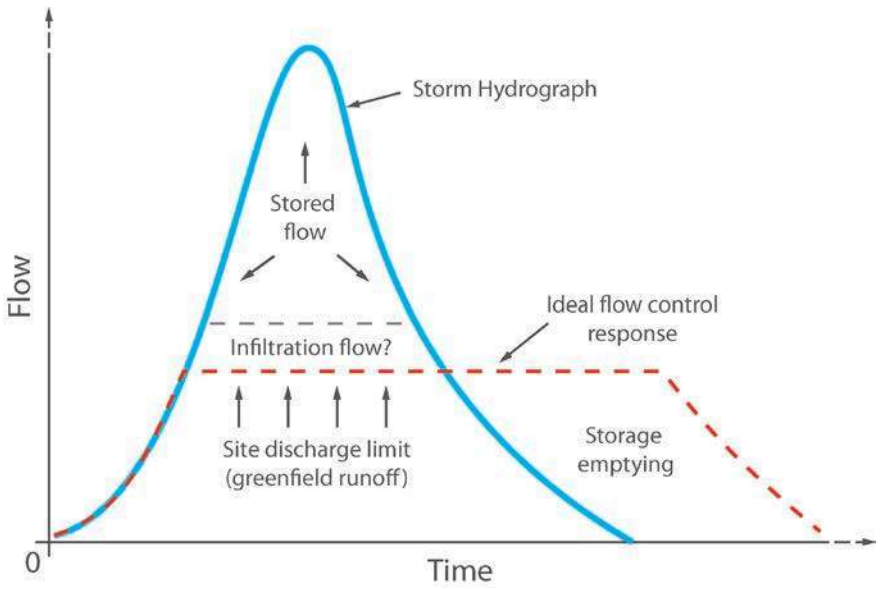


Figure 4 - Flood Storage Hydrograph - Ideal Flow Control

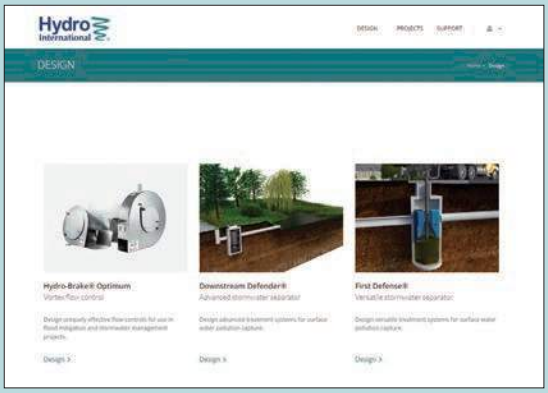
Selection and Sizing of Flow Control Devices

To estimate the correct attenuation volume, and therefore select the correct type and size of flow control device, designers may use industry-standard software packages such as Innovyze's MicroDrainage® and Causeway Flow.

Such tools are developed in close co-operation with manufacturers to integrate full performance data for each device. Engineers, hydrologists and planners can be confident that the software will enable them to optimise their drainage designs and specify the best components for the job, whilst complying with local regulations and standards.

The software can do a lot of the hard work in selecting and sizing the correct device according to the drainage parameters and best possible outcomes, depending on the priorities for that site. The software then enables the engineer to validate and output detailed design drawings straight from the system.

Hydro International have an online design tool at **hydro-int.design**.



hydro-int.design

Explore the Options with our Online Design Tool

Our online design tool is a sizing engine that gives you the flexibility to compare flow control design options, output detailed design drawings and hydraulic data and import the results into commercially-available hydraulic modelling software.

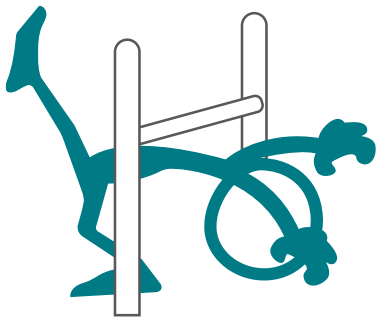
The tool also has the added options to size and design the First Defense® and Downstream Defender® stormwater treatment separators.

The tool also allows you to save project designs and submit them to our expert technical team for a free design review.

6 Controlling to Very Low (Greenfield Equivalent) Flow Rates

One of the most frequently asked of frequently asked questions in relation to flow control systems is the so-called “limbo question”:

"How low can you go?"



That is to say, “What is the minimum acceptable opening size for a flow control?” or “What is the minimum flow rate to which you can control?”

How do flow rate and blockage risk relate to one another?

For passive flow control devices, the rate of discharge through the device is directly related to the cross sectional area of the opening or orifice and the head (or pressure) of water that builds up behind the flow control device. If we take a simple orifice plate as an example, the discharge flow rate is governed by the following equation:

$$Q = Cd.A.\sqrt{(2.g.h)}$$

Where:

Q = Discharge flow rate (m^3/s)

Cd = Co-efficient of discharge. A constant which relates to the way in which the orifice has been cut. Typically 0.6 for a sharp edged orifice in a thin plate

A = Cross sectional area of the orifice (m^2)

g = Acceleration due to gravity (9.81 m/s^2)

h = head (m)

Other flow controls, such as our Hydro-Brake® Optimum vortex flow controls, have differing governing equations, but flow is always a function of cross sectional area and head (Q = fn (A, h)).

So, if we are looking to control discharge from our development sites to ever lower flow rates, with the aim of matching pre-development or greenfield run-off rates, we generally need to operate our flow controls with lower heads (shallower storage systems) or with smaller openings.

However, as the flow control is the point at which the flow rate is restricted, it is also a risk point for a blockage within our surface water management system. If we want to reduce our risk of a blockage occurring or minimise our maintenance commitment, then we need to look to keep opening sizes as large as possible. This means lower heads (shallower storage systems) or higher discharge rates from our flow control devices.

Minimising discharge rate and minimising blockage risk / maintenance are therefore opposing goals.

What does industry guidance say?

There are now a variety of industry guidance documents applied at national and regional levels and they are not totally consistent in terms of their stance on minimum flow rates or minimum flow control sizes. The approaches range from BS8582:2013, which states “controls smaller than 25 mm are possible if protected [from blockage]” up to the advice given by water companies, which can set a minimum acceptable opening size for adoptable flow controls for surface water only systems of 150 mm. Some of these are highlighted in the table below:

Organisation / Document	Minimum Flow Control Size / Minimum Flow Rate
Sewers for Adoption 6th Ed	75 mm
Sewers for Scotland 3rd Ed	75 mm
Sewers for Adoption 7th Ed	100 mm
Design and Construction Guidance, (Sewerage Sector Guidance, Appendix C)	>50 mm for protected static controls and >100mm for unprotected static controls.
The SuDS Manual (C753)	75 mm or 100 mm if to be adopted by sewer undertaker. ‘Significantly smaller’ if private / adopted by other organisation, if appropriate and agreed
BS8582:2013	As agreed with future owner (minimum flow threshold could be 5 l/s or lower) (controls <25 mm are possible if protected)
EA SC030219	5 l/s

So, in this case, the industry guidance unfortunately does not necessarily provide us with absolute clarity, however, the trend is to move towards a risk based decision on a site-by-site basis.

What is practical?

Features / Flow Control Type	Hydro-Brake® Optimum [2]	Hydro-Brake® Orifice	Hydro-Brake® Agile
Minimum Flow Rate (l/s) [1]	0.7	2.5	4.5
Minimum Opening Size (mm)	30	30	Varies with flow rate / head

Notes:

1. Smaller units to control lower flows may be possible in some circumstances
2. Limit of range as covered by BBA / WRc Approved independent verification. Smaller units may be possible in some circumstances

Risk Reduction Measures

Risk is defined by the Health & Safety Executive as the likelihood or frequency of a hazard actually causing its adverse effects, eg. “The annual risk of a worker in Great Britain experiencing a fatal accident [effect] at work [hazard] is less than one in 100,000 [likelihood]”.

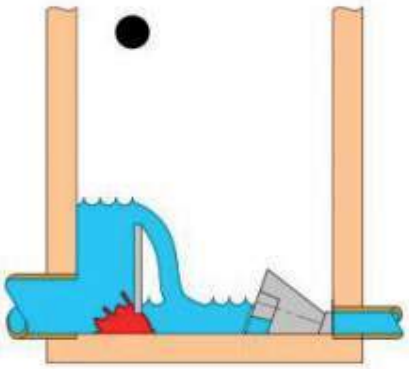
More closely related to drainage systems, this risk can be expressed as “Sewer blockages [hazard] leading to a flooding or maintenance incidents [effect] occur around 2,000 times per month [likelihood] in Wales” (source: **http://www.dwrcymru.com/en/My-Wastewater/Lets-Stop-the-Block.aspx**).

Where small flow controls are required to restrict to very low flow rates, the risk should be assessed and, where necessary, risk reduction measures applied as discussed on HR Wallingford's **www.uksuds.com** website (see **http://bit.ly/uksuds_minflow**).

Risk reduction measures include mesh baskets / screens and sacrificial devices. These can move the point of blockage to more accessible areas to ease maintenance (reduce the effect) and help to reduce the likelihood or frequency portion of the risk. Robust and well maintained SuDS upstream of the flow control can also work effectively to reduce the likelihood of blockage occuring.



Orifice with mesh basket



Sacrificial orifice plate in front of vortex flow control



Hydro-Static® Screen protecting flow control

Further risk reduction can be integrated into the design by ensuring that appropriate overflow measures, exceedance pathways, inspection / maintenance or even monitoring & early warning alarm systems are in place.



Flow Control chamber with bypass weir



Level sensor system with Hydro-Logic® Flexi Logger data logger / telemetry device

7 Balancing Space and Cost

Choosing the correct flow control is crucial to achieving a cost-effective solution.

With such a range of choices, it is easy to be tempted into choosing a lower price flow control device. However, such compromises could end up being costly. Care must be taken in assessing all aspects of an installation, not just the device cost, to achieve the required and most cost-effective stormwater control. Often the highest performing flow control results in the lowest total installation and lifetime cost. Furthermore, substitution of a specified flow control device with another unit, without revisiting the storage calculations, could lead to an increase in flood risk either on the site in question or in the downstream catchment. Or both.

Float-Operated Flow Control

To get closest to the "ideal" characteristic, as outlined in Figure 4 (page 10), and therefore the smallest upstream storage volume, a float-operated flow control provides precise performance by creating a continuously variable orifice that changes in direct relation to the water height and enables rapid drain down to protect against the next peak flow.

Vortex Flow Control

Using an active flow control may not be appropriate due to site and project considerations. In these cases, using a passive flow control, most likely a vortex flow control, is the correct solution. The most advanced can be precision-engineered to achieve the best-possible hydraulic response and therefore closest to the "ideal" characteristic for a device without any moving parts or external power requirements.

As the diameter of the vortex flow control is much greater (up to 300%) than for the equivalent flow orifice plate, the device is far less prone to blockage. Vortex flow control devices can operate over an extensive size range from less than 100 mm to over 2 m diameters with flows from just a few litres per second up to 12 m^3/s for large-scale watercourse schemes.

Why All Vortex Flow Controls are not the same

It is no secret that many vortex flow controls on the market are based on Hydro International's technology. The specification of a Hydro-Brake® flow control 'or equivalent' is standard practice to designers using industry-standard modelling software packages.

Choosing vortex technology over conventional flow control such as a penstock or orifice plate can save surface water storage and consequent construction costs by up to 50%. However, any site with a Hydro-Brake® Optimum flow control will need up to 15% less storage than if an alternative vortex control is used.

By saving on surface water storage, Hydro-Brake® Optimum therefore promises additional savings in excavation costs and frees up more land for building to maximise the developers' Return on Investment. Hydro-Brake® Optimum is the only vortex flow control to be independently certified by both the BBA and WRc.



In Northallerton, North Yorkshire (right), Hydro-Brake® vortex flow controls protect 170 properties from flooding. They enable excess water to be held back in specially built flood storage basins on agricultural land.

8 Vortex Flow Controls for Watercourse Flood Alleviation

Civil engineers have applied the proven ability of vortex flow controls for larger-scale flood alleviation measures for rivers and watercourses, leading to some of the most spectacular schemes. The technology has been 'supersized' in watercourse projects across the country and is now a familiar approach that is successfully protecting more than 4,000 homes and businesses in cities, towns and villages.

One of the biggest advantages of the vortex flow control technology to manage flash river flooding is that it comes into operation automatically as the river levels rise. There is no power needed, no-one needs to be there to operate the flood defence in an emergency, and there are no moving parts or electrical systems that could fail. The flood storage can be custom-designed and the capacity and reach of upstream storage areas precisely calculated.

Similarly to small flow controls in Critical Drainage Areas, there are risks associated with flood storage reservoirs. At this scale, it is not so much the frequency / likelihood of a hazard occurring that is the concern, but rather that the consequences may be much greater. Flood storage reservoirs that store over 10,000 m^3 of water are regulated and must meet certain health & safety criteria (for more info see **https://britishdams.org/reservoir-safety/res-safety-resources/**). Water level monitoring, telemetry and early warning systems that are configured to notify reservoir operators and, potentially, the general public of rising water levels are often vital components in ensuring effective risk management of the reservoir.







Flood Alleviation schemes at White Cart, Glasgow (left), Weedon Bec, Northamptonshire (top right) and Much Wenlock, Shropshire (bottom right) which includes the use of Smart Monitoring technology to provide insight into water levels.

Hydro-Brake® Flood Case Study

Hydro-Brake® Flood protects over 600 properties in Wigan, cutting flood risk to 1%.

Situation

The town of Wigan UK, was hit by flooding on average twice a year, and had been suffering from floods for more than 30 years.

Problem

Over 600 properties in Wigan were exposed to flood risk from the River Douglas and its tributaries every year.

Solution

The UK Environment Agency implemented the Wigan Flood Alleviation Scheme, a £12M, two-phase flood protection project that incorporated embankments, flow controls and temporary flood storage, designed in a way that blended engineered solutions with natural features to provide optimal flood protection.

Phase 1 involved construction of new and raised flood defence walls and embankments on the River Douglas through central Wigan

Phase 2 involved the construction of a 150m long, 8m high earth dam across the River Douglas Valley, forming an upstream storage reservoir, and a new 100m long concrete culvert constructed beneath the dam. Inside that culvert two Hydro-Brake® Flood flow controls provide precisely designed flow control to hold back flood water and store it upstream, protecting downstream properties from flood damage.





Outcome

The dam has created a potential 400,000 m^3 of flood storage extending along a kilometre of the Douglas valley, and the Hydro-Brake® Flood flow controls use this flood storage to prevent flood waters from reaching Wigan. The flood alleviation system now provides greatly increased flood protection to 1 in 100 years, or 1% risk of flooding from the river in any given year.

Read the full case study

9 Conclusions: Engineering a Balance

- Changing weather patterns as a result of climate change are making it more important than ever to precision-engineer flow control and attenuation to mitigate flood risk.
- Sustainable engineering interventions concentrate on replicating the natural catchment response using an appropriate mix of blue, green and grey infrastructure.
- Pragmatic flow control choices must balance a number of criteria to achieve optimum performance with the best project value.
- Ensuring the smallest possible amount of surface water volume is often the most important consideration to managing flood risk with affordable development costs.
- The selection and sizing of flow control devices must therefore be optimised to suit the site-specific conditions. This includes consideration of available upstream storage, future maintenance and accessibility, sensitivity of the receiving watercourse, drain down requirements.
- A range of flow control devices is available to achieve optimum performance from the smallest to the largest schemes. Particular care must be taken to select the right device, and avoid compromising the engineered response by switching out to an inferior product.
- Engineers can use a range of support to optimise their designs, including freely-available online software tools and manufacturers' technical expertise.

Choosing flow control technology at the heart of a flood prevention scheme, SuDS System, drainage or sewer network provides a sustainable and reliable technology for engineers, planners, developers and water companies. Precision engineering of flow control devices and growing experience of other successful schemes, enables engineers to design practical and predictable solutions and to "future-proof" schemes for changing conditions as a result of climate change.

Over recent years, the UK has experienced an ever-increasing number of severe flood events. In the last decade, records for the amount of rainfall have been broken again and again. Is climate change starting to have a demonstrable effect? Is the historical data on which we base our hydraulic modelling calculations still reliable, or are we less able to predict the likelihood of future events?

No-one can say for sure, but scientists and meteorologist are increasingly in agreement that intense rainfall events are one of the likely consequences of a warming planet; as the earth's atmosphere warms up it has the capacity to store more moisture – and so the potential for extreme rainfall and flooding.

In these circumstances, precision engineering must continue to play a vital role in ensuring we are building infrastructure for future generations; infrastructure that can be relied on to provide long-term protection, with predictable and affordable maintenance.

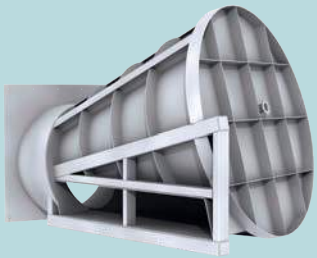
10 Where to go for further information

Find out how our Hydro-Brake® Flow Control Series range and other stormwater management solutions can help you build better SuDS, prevent flooding and improve the quality of surface water runoff by visiting our website: **hydro-int.com** or clicking on the product names below.

Hydro-Brake® Flow Control Series



Hydro-Brake® Optimum



Hydro-Brake® Flood



Hydro-Brake® Agile



Hydro-Brake® Orifice

Storage and Infiltration

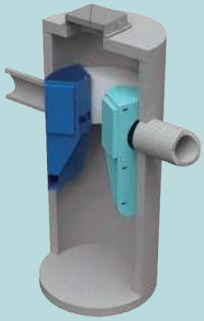


Stormbloc® Optimum

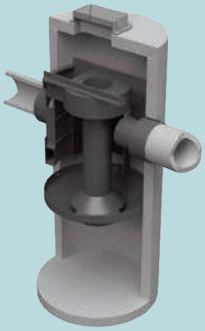


Stormcell®

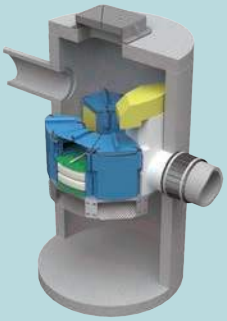
Treatment - The Hydro StormTrain® Series of Surface Water Treatment Devices



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Hydro International®