WARD COLE
consulting engineers

Document:	Flood Risk Assessment & Drainage Strategy		
Project Name:	Residential Development, Cliff Hill, Denby Dale, Huddersfield		
Client:	Urban Group (York) Ltd		
Project Reference:	10/5610		
Date of Issue:	11/07/2023	**Rev:**	E
Engineer:	D. Mutepfa	**Checking Engineer:**	W.E. Hansard

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SCHEDULE OF REVISIONS

REVISION	ISSUE DATE	DESCRIPTION
A	2**6**.05.2022	Appendix C revised in accordance with the latest Architects Site Plan.
B	23.09.2022	Revised to address LLFA comments.
C	02.11.2022	Revised to take into account the existing drainage ditch to the north.
D	24.04.2023	Site layout plan revised.
E	11.07.2023	Site layout and drainage strategy plans revised.

1 Introduction

1.1 Background

Ward Cole Consulting Engineers were commissioned by Urban Group (York) Limited to prepare a flood risk assessment and drainage strategy report for proposed residential development on land off Cumberworth Lane at Cliff Hill in Denby Dale, Huddersfield. The report is to be submitted to support a full planning application to the Local Planning Authority.

The National Planning Policy Framework (NPPF) requires that a site-specific flood risk assessment (FRA) be prepared for development proposals on land 1 ha or more in extent. The FRA must be carried out in accordance with guidelines set out in the NPPF and Planning Practice Guidance. It should be submitted to the Local Planning Authority together with the application for planning permission.

1.2 Location

The development site is situated in the village of Denby Dale, approximately 10 miles southeast of Huddersfield in West Yorkshire. This Greenfield site is surrounded by residential development with farmland to the north-northwest. It can be accessed from Cumberworth Lane to the west.

The National Grid Reference of the approximate centre of the site is 422880, 408710. A site location plan is shown in Appendix A.

1.3 Site Description

The site is irregular shaped, approximately 2 ha in extent. It encompasses a hill, falling away from the middle west to the north, east and south at average gradients of 1:7.5, 1:8.2 and 1:10.6, respectively.

Levels range from just over 184.5m AOD in the middle to 179.5m, 174.0m and 177.0m AOD in the north, east and south respectively. The lowest area is in the east corner of the site at 169.5m AOD. A drainage ditch runs along the northeast boundary, flowing towards the southeast (see *Appendix B* for a topographical survey plan of the existing site).

The British Geological Survey website indicates that the bedrock geology of the area consists of the Pennine Lower Coal Measures Formation And South Wales Lower Coal Measures Formation (undifferentiated) – Mudstone, Siltstone, Sandstone, Coal, Ironstone And Ferricrete, with no superficial deposits recorded. The DEFRA sponsored Soilscapes website describes site soils as loamy and freely draining.

2 Potential Sources of Flooding

2.1 Flood Zone

The proposed development is located within Flood Zone 1, land assessed as having a less than 1 in 1000 annual probability of river or sea flooding, or low flood risk.

2.2 Fluvial Flooding

There are no watercourses close enough to the site to pose significant flood risk.

2.3 Surface Water Flooding

Pluvial or surface water flooding arises out of the inability of surface water runoff to infiltrate into the ground during intense or prolonged rainfall, or due to insufficiencies within the local drainage infrastructure outside of the development site. Urban development adds to the problem by replacing natural open spaces with hard paved impermeable surfaces. Surface water flooding is exacerbated when natural drainage channels or artificial drainage systems have insufficient capacity to absorb the additional runoff. The EA's online flood risk map indicates that the risk of flooding from surface water runoff on the site is very low (see Fig. 1 below).

Fig. 1: EA Flood Map – Surface Water Flooding

During statutory consultation, Kirklees Council (the Lead Local Flood Authority) expressed

concerns about an existing drainage feature in the north that was apparently proposed to be closed up and built over. Following a site inspection by the developer and the LLFA, the existence and route of the drainage ditch was confirmed. It was agreed that this should be incorporated into the proposed site plan.

2.4 Flooding due to Existing Sewers

Sewer flooding may result from blockage, structural failure, or overloading of sewers during intense or prolonged rainfall. High water levels in the receiving watercourses may result in outfall sewers being unable to discharge into rivers in times of flood, resulting in overflooding upstream of sewers, e.g., at manholes and gullies. There is a 150mm diameter combined sewer along Cumberworth Lane and a 225mm diameter foul sewer along Leak Hall Crescent to the east. Local topography and the depth of these sewers are such that they will not pose flood risk to the proposed development.

2.5 Groundwater Flooding

Groundwater flooding occurs when water levels in the ground rise above the surface, e.g., from the underlying aquifer. This tends to occur after prolonged periods of sustained rainfall, with the highest risk being usually in low-lying areas where the water table is likely to be at shallow depth.
Due to the site's high elevation, it is considered that the risk of groundwater emergence is low. Further, as there is no recorded incidence of groundwater flooding in the vicinity, flood risk from this source is low.

2.6 Flooding from Artificial Sources

There is no reservoir or other artificial water body close enough to the site to pose flood risk.

2.7 Historic Flooding

There is no information on any historic flooding in the locality, though surface water flooding incidents were recorded around Denby Dale in October 2000, August 2004, and June 2007.

3 Proposed Development

3.1 Proposed Development

It is proposed to construct 62 dwellings together with associated roads and drainage. The drainage network will incorporate an underground attenuation tank located in an open space that will be developed to provide amenity and biodiversity benefits. The existing drainage ditch mentioned in paragraph 2.3 above has been included in the site layout plan, resulting in the isolation of two plots. A box culvert will be installed on the ditch to enable access between both sites of the drainage feature. The proposed site layout may be seen in Appendix C.

Ground floor levels will be set at least 150mm above adjacent finished site levels, with access provided in accordance with Approved Document M.

3.2 Flood Mitigation Measures

These are not considered essential for this development. However, extra surface water runoff storage capacity will be provided in the proposed attenuation tank, over and above that required for the 1 in 100 year storm event plus an allowance for climate change. This is considered to be appropriate due to the site's steep gradients.

4 Drainage Strategy

4.1 Existing Drainage

As previously stated, there is a combined sewer in Cumberworth Lane and a foul sewer along Leak Hall Crescent, as well as a drainage ditch along the north-eastern boundary. The drainage ditch terminates in a 300mm diameter culvert. A headwall and trash screen to the requirements of the Lead Local Flood Authority will be installed at the head of the culverted ditch.

Yorkshire Water indicated in pre-development consultation its acceptance for foul water drainage from the proposed development to discharge into the existing sewer along Leak Hall Crescent (see Appendix D).

4.2 Surface Water Drainage

Sustainable urban drainage systems (SUDS) involve managing surface water runoff as close to its source as possible. The design of the system for surface water runoff disposal has considered the hierarchy of drainage options stipulated in Document H of the Building Regulations and the Planning Practice Guidance, i.e., infiltration, surface water bodies, and sewers.

It is possible that due to the coal mining history of the area, infiltration techniques may not be feasible as a means of surface water disposal. Recent adjacent residential development (Eastwood Homes) precluded the disposal of runoff by infiltration into the ground despite soakage rates at shallow depths being found to be satisfactory. Additionally, the Lead Local Flood Authority (Kirklees Council) rules out the use of infiltration techniques due to possible re-emergence of water on steep sites. The proposed drainage strategy assumes that infiltration methods will not be feasible for the reasons given above.

Therefore, it is proposed that surface water runoff from the proposed development will be discharged into the existing drainage ditch, at the maximum rate of 5 l/s as stipulated by the LLFA. The LLFA also advised that improvement engineering works are planned to be carried out on the ditch, and this could affect when discharge into it may be possible. Discharge consent may be required from Kirklees Council.

The proposed drainage plan may be seen in Appendix E. The surface water drainage network includes an underground attenuation tank that will store approximately 689m^3 of runoff during a 1% Annual Exceedance Probability storm plus 30% allowance for climate change, with outflows restricted to 5 l/s (by means of a vortex flow control device) for all rainfall events and durations. Hydraulic simulations indicate that there will be no flooding in any part of the system during critical rainfall events up to and including the 1% AEP event plus a 30% allowance for climate change (see MicroDrainage results in Appendix F). The tank replaces the attenuation basin previously proposed, the LLFA having expressed concerns about the potential for possible failure of an elevated basin with a steep outer embankment, which would consequently pose flood risk downstream.

Exceedance flows arising out of extreme events greater than the design storm or blockages will be routed along internal roads to either Cumberworth Lane or to the open space with the attenuation tank and drainage ditch to the north-east.

The main drainage will be offered for adoption under Section 104 of the Water Industry Act to Yorkshire Water. Prior to adoption, the maintenance and management of the attenuation tank, drainage ditch and other drainage components will fall under a management company set up in terms of Section 106 of the Town & Country Planning Act.

4.3 Foul Drainage

Foul drainage from the developed site will discharge indirectly to the public sewer in Leak Hall Crescent via an existing connection through the neighbouring residential development. The main foul drainage system will be adopted by Yorkshire Water under a Section 104 agreement.

5 Conclusion

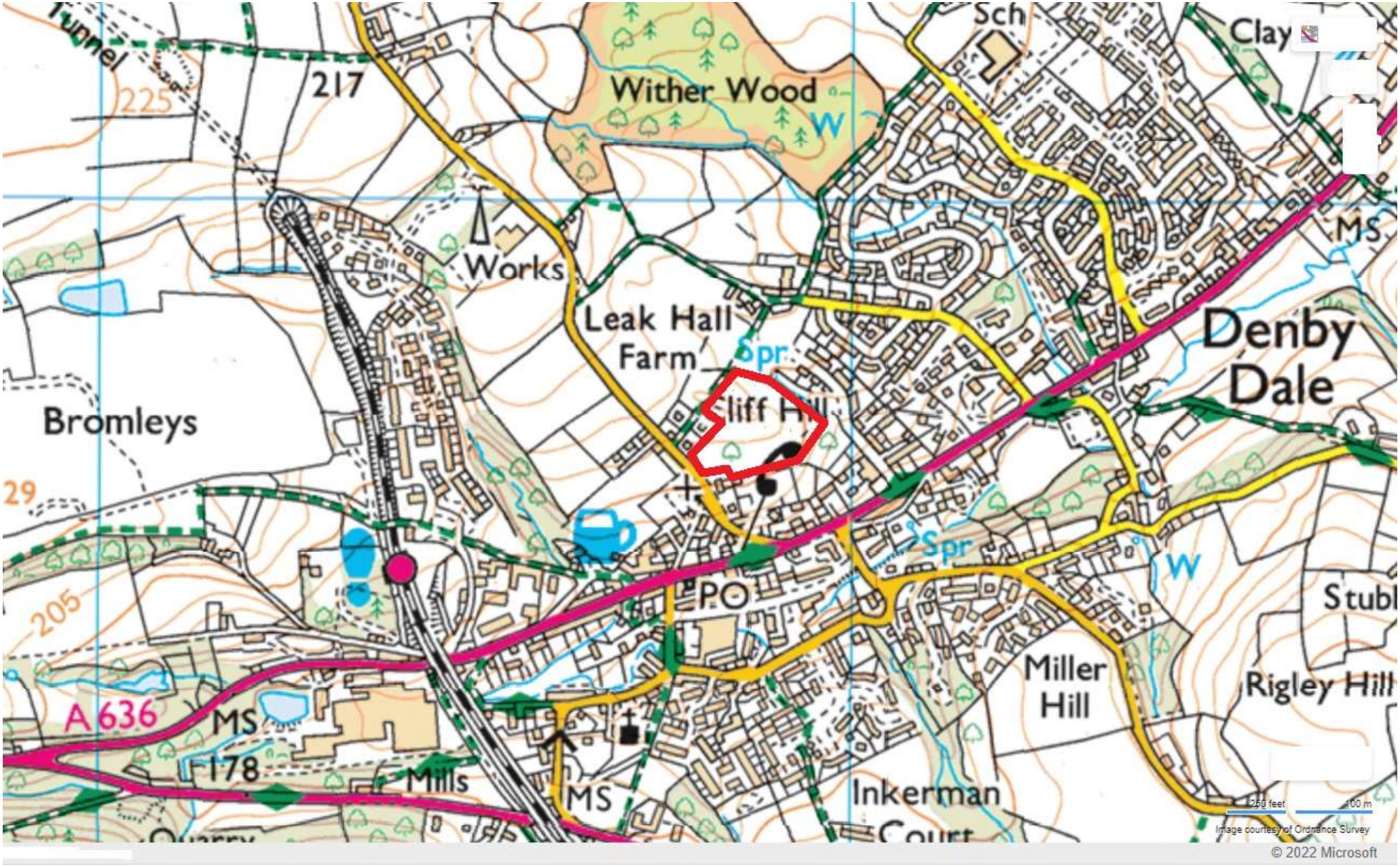
The proposed development lies within Flood Zone 1 where the annual risk of flooding from rivers and the sea is low, and in which all development is appropriate. The risk of surface water flooding is also low.

The proposed surface water drainage system that incorporates stormwater attenuation will reduce the risk of flooding on the site and to surrounding properties. Surface water runoff outflow from the development will be restricted to the LLFA stipulated rate of 5 l/s. MicroDrainage hydraulic simulation results confirm that there will be no flooding in the surface water drainage network for all rainfall events up to the 1% Annual Exceedance Probability event including 30% allowance for climate change. Exceedance flows arising from extreme rainfall events or blockages in the drainage system will be directed through internal roads to Cumberworth Lane and to the proposed open space and existing drainage ditch to the north-east.

Concerns raised by the LLFA regarding an existing drainage feature in the northern part of the site have been addressed as agreed during a site meeting between the developer and the LLFA. It is considered that overall flood risk to the proposed development is low and flood risk to neighbouring properties will not increase because of the development.

Appendix A

Site Location Plan


Tunnel
225
217
Wither Wood
W
Sch
Clay
MS
Works
Leak Hall
Farm
Spr
Cliff Hill
Denby
Dale
Bromleys
29
205
Spr
W
PO
Stubl
Miller
Hill
Rigley Hill
A636
MS
178
Mills
MS
Inkerman
Court
250 feet
100 m
Image courtesy of Ordnance Survey
© 2022 Microsoft

Appendix B

Topographical Survey Plan

N

Grid : OS National Grid.
Using the OS GPS Network and applying OSTN15 transformation and then removing the scale factor for true distances with a one-step transformation centred on CP1

Datum : OS Level Datum.
Using the OS GPS Network and applying OSGM15 National Geoid Model to obtain local area corrections.

Station Listing

Station	Easting	Northing	Level
CP1	422878.239	408710.745	183.935
CP2	422834.635	408675.075	180.406
CP3	422914.045	408743.543	181.043
S1	422826.520	408763.751	180.425
S2	422794.656	408721.489	184.196
S3	422757.060	408669.822	180.474
S4	422812.108	408615.375	173.313
T1	422996.957	408705.365	164.241
T2	422992.405	408743.633	169.677
T3	422920.188	408804.569	176.156
T4	422861.351	408815.494	178.685

Layout Key

(1) (2)

KEY

AIR VALVE	AV	KERB OUTLET	KO
BENCH MARK	BM	LAMP POST	LP
BIN	BIN	MANHOLE (CIRCULAR)	MH
BOLLARD	BOL	MANHOLE (RECTANGULAR)	MH
BORE HOLE	BH	MANHOLE (TRIANGULAR)	MH
BRITISH TELECOM COVER	BT	MARKER POST	MKR
BUS STOP	BUS	GULLY	GU
CABLE TV COVER	CATV	RODDING EYE	RE
CABLE TV SUPPLY	CA	SIGN POST	SIGN
COLUMN	COL	TELECOM COVER	TEL
DROPPED KERB	DK	TELEGRAPH POLE	TP
EARTHING POINT	ER	THRESHOLD LEVEL	THL
ELECTRICITY COVER	ELEC	TRAFFIC LIGHT	TL
ELECTRICITY POLE	EP	TRIAL PIT	PIT
FIRE HYDRANT	FH	WASH OUT	WO
GAS VALVE	GAS	WATER METER	WM
GATE		WATER STOP COCK	SC
INSPECTION COVER (CIRCULAR)	IC	WATER STOP VALVE	SV
INSPECTION COVER (RECTANGULAR)	IC		
COVER LEVEL	CL	CHAMBER BASE LEVEL	Ch.L
INVERT LEVEL	IL	WATER SURFACE LEVEL	WL
UNABLE TO RAISE	UTR	UNABLE TO MEASURE	UTM
GIRTH OF TREE TRUNK	G	DIAMETER OF TREE TRUNK	D
HEIGHT TO TOP OF TREE CANOPY	H	MULTI BOLE TREE	MB

Rev	Date	Drawn	Description	Check
-	--/--/----	--	--	--

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Client
URBAN DEVELOPMENTS (YORK) LTD

Site
CLIFF HILL
DENBY LANE

Title
TOPOGRAPHICAL SURVEY

Surveyed	JS / TW	Drawn	JS
Check	DA	Date	27/10/2021
Scale 1:250	Job No P21-01216	Sheet Size A0	Rev 01

DWG Ref

Project Number	Origin	Zone	Level	Desc	Type	Role	Sheet
P21-01216	MET	EXT	XX	TOP	M3	G	001

Appendix C

Proposed Site Plan

Suitability Code:
A3
For Planning

SCHEDULE		
TYPE A	9X	TYPE A - 2 BED GIA 71.2m²
TYPE B	3X	TYPE B - 3 BED GIA 86.4m²
TYPE C	6X	TYPE C - 4 BED GIA 143.3m²
TYPE D	14X	TYPE D - 4 BED GIA 133.9m²
TYPE H	4X	TYPE H - 4 BED GIA 141.9m²
TYPE K	19X	TYPE E - 3 BED GIA 100m²
TYPE L	2X	TYPE F - 3 BED GIA 120m²
TYPE M	2X	TYPE 2 - 2 BED GIA 76m²
TYPE N	3X	TYPE 1 - 1 BED GIA 58m²
TOTAL UNITS - 62		

Unit mix
1 bed = 5%
2 Bed = 18%
3 Bed = 39%
4 Bed = 38%

GIFA
6668m2

P04	AMENDMENTS TO LAYOUT PLOTS 26-28 E TYPE CHANGED TO D GARAGE ADDED TO PLOT 49	30.06.23	TC	MH
P03	AMENDMENTS TO LAYOUT PLOTS 19-28	28.06.23	TC	MH
P02	MINOR AMENDMENTS	26.06.23	TC	MH
P01	DRAWING ISSUE	06.06.23	TC	MH
REV	COMMENT	DATE	DR	CH

BBA
BREWSTER BYE ARCHITECTS
5 NORTH HILL ROAD, LEEDS, HEADINGLEY, LS6 2EN
T: 0113 2754000
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CLIENT

.\LOGOS\Urban Logo.png

JOB TITLE
RESDENTIAL DEVELOPMENT
DENBY DALE

PROPOSED
SITE PLAN

Drawn: TC Scale: 1:500 @ A2
Date: JUN 23 Checked: MH

DWG NO 57116-BBA- 09 -Z00 -DR-A- 0201 REV: P04

Appendix D

Yorkshire Water Correspondence

YorkshireWater

Mr D Mutepfa
Ward Cole
Fosse House
Roman Wharf
Lincoln
LN1 1SR
daniel@wardcole.co.uk

Yorkshire Water Services
Developer Services
Pre-Development Team
PO BOX 52
Bradford
BD3 7AY

Tel: 0345 120 8482
Fax:

Email:
technical.sewerage@yorkshirewater.co.uk

Your Ref:
Our Ref: X016577

For telephone enquiries ring:
Chris Roberts on 0345 120 8482

22nd September 2021

Dear Mr Murepfa,

Cliff Hill, Cumberworth Lane, Denby Dale, Huddersfield, HD8 8RZ - Pre-Planning Sewerage Enquiry U386095 (RESIDENTIAL)

Thank you for your recent enquiry and remittance. Our official VAT receipt has been sent to you under separate cover. Please find enclosed a complimentary extract from the Statutory Sewer Map which indicates the recorded position of the public sewers. Please note that as of October 2011 and the private to public sewer transfer, there are many uncharted Yorkshire Water assets currently not shown on our records.

The following comments reflect our view, with regard to the public sewer network only, based on a 'desk top' study of the site and are valid for a maximum period of twelve months:

YorkshireWater

Development of the site should take place with separate systems for foul and surface water drainage. The separate systems should extend to the points of discharge to be agreed.

Foul Water

Foul water domestic waste can discharge to the 225 mm diameter public combined sewer recorded in Leak Hall Road, at a point to the north east of the site.

Surface Water

The developer's attention is drawn to Requirement H3 of the Building Regulations 2000. This establishes a preferred hierarchy for surface water disposal. Consideration should firstly be given to discharge to soakaway, infiltration system and watercourse in that priority order.

Sustainable Drainage Systems (SuDS), for example the use of soakaways and/or permeable hardstanding etc, may be a suitable solution for surface water disposal appropriate in this situation. You are advised to seek comments on the suitability of SuDS in this instance from the appropriate authorities.

As the proposed site is currently undeveloped no surface water is known to have previously discharged to the public sewer network

As such, the local public sewer network does not have capacity to accept any surface water from the proposed site. If SuDS are not viable, the developer is advised to contact the Environment Agency/local Land Drainage Authority/Internal Drainage Board with a view to establishing a suitable watercourse for discharge.

It is understood that a watercourse is located to the north of the site. This appears to be the obvious place for surface water disposal (if SuDS are not viable). Please note Yorkshire Water cannot provide plans of culverted watercourses or highway drains. To obtain plans please contact the Lead Local Flood Authority for more details.

Please note further restrictions on surface water disposal from the site may be imposed by other parties. You are strongly advised to seek advice/comments from the Environment Agency/Land Drainage Authority/Internal Drainage Board, with regard to surface water disposal from the site.

Other Observations

Any new connection to an existing public sewer will require the prior approval of Yorkshire Water. You may apply on line or obtain an application form from our website (www.yorkshirewater.com) or by telephoning 0345 120 84 82.

An off-site foul and surface water sewer may be required which may be provided by the developer and considered for adoption under Section 104 of the Water Industry Act 1991. Please telephone 0345 120 84 82 for advice on sewer adoptions. Alternatively, the developer may in certain circumstances be able to requisition off-site sewers under Section 98 of the Water Industry Act 1991 for which an application must be made in writing. For further information, please telephone 0345 120 84 82.

Prospectively adoptable sewers and pumping stations must be designed and constructed in accordance with the Codes for Adoption as supplemented by Yorkshire Water's requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site. Please contact our Developer Services Team (telephone 0345 120 84 82) for further information.

All the above comments are based upon the information and records available at the present time and is subject to formal planning approval agreement. The information contained in this letter together with that shown on any extract from the Statutory Sewer Map that may be enclosed is believed to be correct and is supplied in good faith.

YorkshireWater

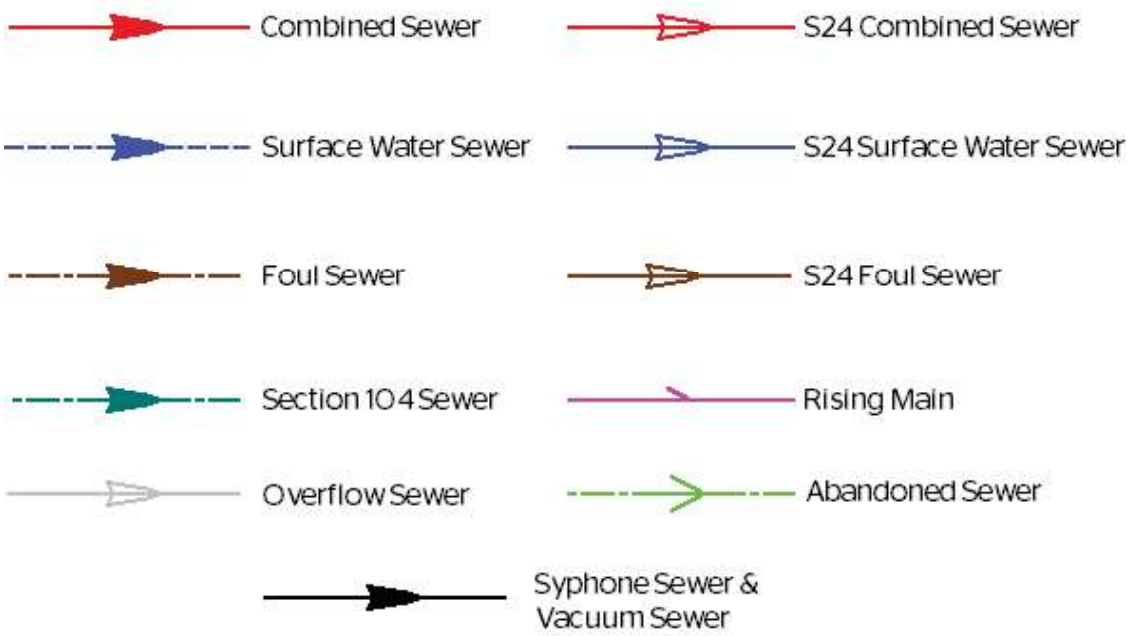
Please note that capacity in the public sewer network is not reserved for specific future development. It is used up on a 'first come, first served' basis. You should visit the site and establish the line and level of any public sewers affecting your proposals before the commencement of any design work.

Yours sincerely

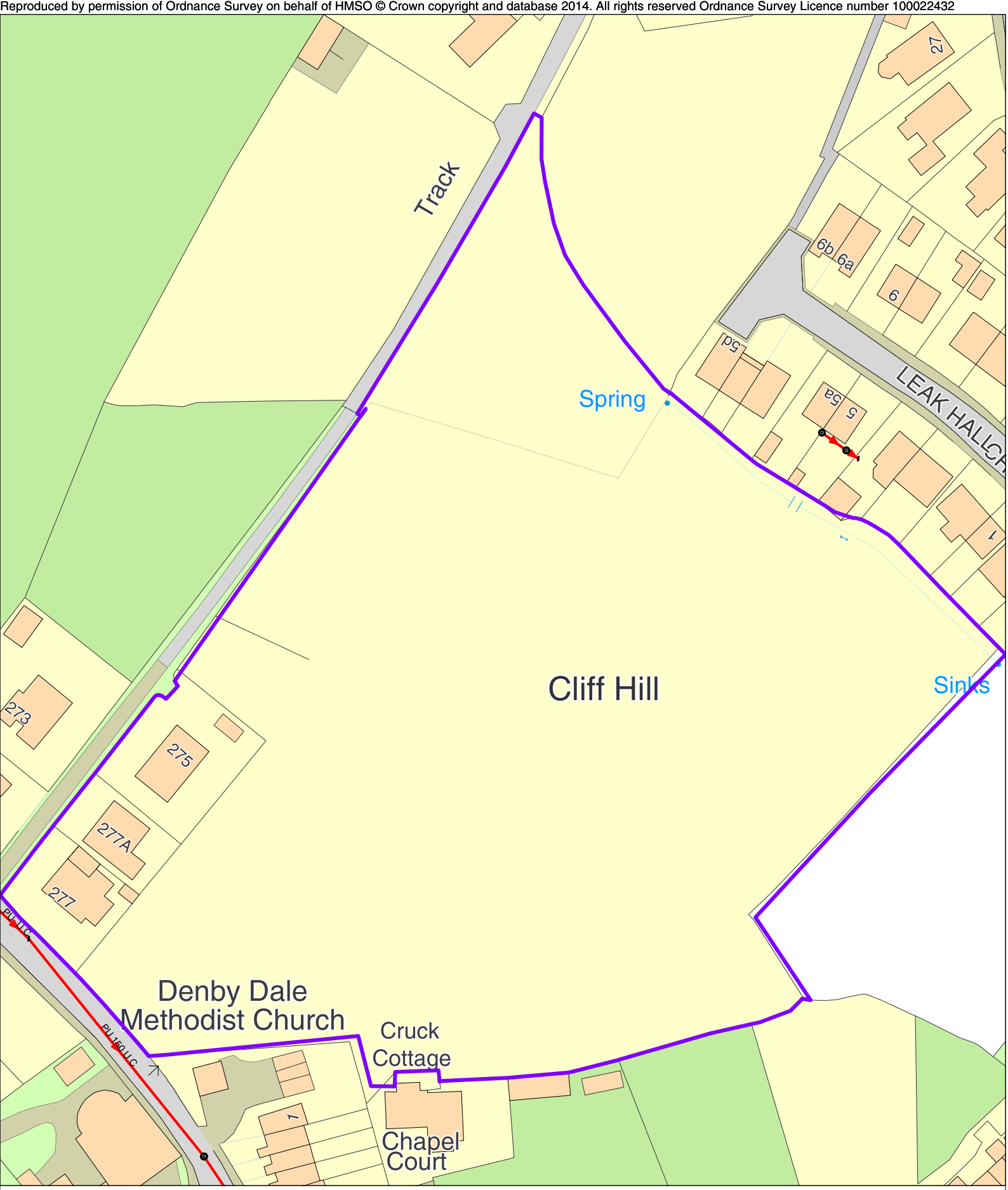
Chris Roberts
Development Services Technician

Property Identfier

Sewer Legend



Water Legend



Public Waste Water Network 18/08/2021 15:56:47 OS Grid Coordinates: 422763 : 408615 Map Name : SE2208NE svcGISSafeMovePD

Appendix E

Proposed Drainage Strategy Plan

KEY

- Section 104 Adoptable Foul Sewer
- Section 104 Surface Water Sewer
- Private Foul Drain
- Private Surface Water Drain
- Existing Foul Sewer
- Sewer Easement
- Site Boundary
- Road Gully & 150mmØ Drain — g
- Rainwater Pipe, Rodding Eye — RWP, RE
- Foul Connection (svp, ss, sink, etc) — FW

NOTES

1. THE PROPOSED ADOPTABLE DRAINAGE IS SUBJECT TO S104 AGREEMENT WITH YORKSHIRE WATER.
2. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS' AND ARCHITECT'S DRAWINGS.
3. THE ADOPTABLE FOUL & SURFACE WATER SEWERS ARE TO BE CONSTRUCTED IN ACCORDANCE WITH THE DESIGN AND CONSTRUCTION GUIDANCE (APPENDIX C, SEWERAGE SECTOR GUIDANCE), THE CIVIL ENGINEERING SPECIFICATION FOR THE WATER INDUSTRY (7TH EDITION) AND YORKSHIRE WATER REQUIREMENTS.
4. ALL SEWER CONSTRUCTION MATERIALS SHALL BE BS KITE MARKED.
5. ROOT BARRIER PROTECTION IS TO BE PROVIDED FOR ANY SEWERS LOCATED WITHIN TREE CANOPY AREAS.
6. A PROTECTIVE GEOTEXTILE / PLASTIC MEMBRANE IS TO BE APPLIED TO ALL FOUL SEWERS LAID ABOVE STORMWATER PIPES.
7. ALL ROAD GULLY DRAINS TO BE 150mmø AND ENCASED IN 150mm CONCRETE SURROUND AT JUNCTION WITH MAIN SEWER.
8. BENDS ON GULLY LATERALS TO BE NO GREATER THAN 22.5°.
9. UNLESS OTHERWISE INDICATED, PRIVATE FOUL DRAINS WILL BE 100mmø LAID AT 1:80 MINIMUM GRADIENT; PRIVATE SURFACE WATER DRAINS WILL BE 150mmø LAID AT 1:150 MINIMUM GRADIENT.

EXCEEDANCE FLOW ROUTES

rev.	date	description	Drawn	Chkd
E	11.07.23	Site plan updated and drainage adjusted to suit.	DM	WEH
D	24.04.23	Site plan updated and drainage adjusted to suit.	DM	WEH
C	02.11.22	Site plan and drainage layout revised to take into account existing drainage ditch to the north.	DM	WEH
B	23.09.22	Site plan updated and drainage adjusted to suit.	DM	WEH
A	13.09.22	Runoff outflows restricted to 5 l/s; attenuation basin replaced with adoptable attenuation tank.	DM	WEH
-	29.04.22	Preliminary issue.	DM	WEH

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client: Urban Developments Ltd

project: Denby Dale, Huddersfield

drawing title: Proposed Drainage Layout

scale: 1:250 (A0) status: Planning

job number: 10-5610 drawing number: 500 revision: E

Appendix F

MicroDrainage Hydraulic Simulation Results

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	25.472	0.175	145.6	0.070	4.00	0.0	0.600		o	300	Pipe/Conduit	
1.001	34.364	0.150	229.1	0.058	0.00	0.0	0.600		o	300	Pipe/Conduit	
2.000	17.783	0.250	71.1	0.028	4.00	0.0	0.600		o	225	Pipe/Conduit	
3.000	14.530	0.250	58.1	0.050	4.00	0.0	0.600		o	225	Pipe/Conduit	
2.001	28.185	1.125	25.1	0.089	0.00	0.0	0.600		o	300	Pipe/Conduit	
2.002	30.317	3.175	9.5	0.066	0.00	0.0	0.600		o	300	Pipe/Conduit	
1.002	28.773	0.200	143.9	0.095	0.00	0.0	0.600		o	375	Pipe/Conduit	
1.003	20.281	0.150	135.2	0.061	0.00	0.0	0.600		o	375	Pipe/Conduit	
1.004	17.084	0.150	113.9	0.070	0.00	0.0	0.600		o	375	Pipe/Conduit	
1.005	26.698	0.200	133.5	0.061	0.00	0.0	0.600		o	375	Pipe/Conduit	
1.006	11.693	1.800	6.5	0.013	0.00	0.0	0.600		o	375	Pipe/Conduit	
4.000	14.854	0.155	95.8	0.032	4.00	0.0	0.600		o	150	Pipe/Conduit	
4.001	19.771	0.185	106.9	0.052	0.00	0.0	0.600		o	225	Pipe/Conduit	
4.002	11.474	0.085	135.0	0.071	0.00	0.0	0.600		o	300	Pipe/Conduit	
4.003	24.386	0.135	180.6	0.051	0.00	0.0	0.600		o	300	Pipe/Conduit	
4.004	18.599	1.125	16.5	0.048	0.00	0.0	0.600		o	300	Pipe/Conduit	
1.007	10.538	1.600	6.6	0.024	0.00	0.0	0.600		o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	4.33	176.400	0.070	0.0	0.0	0.0	1.30	92.0	9.5
1.001	50.00	4.88	176.225	0.128	0.0	0.0	0.0	1.03	73.1	17.3
2.000	50.00	4.19	180.700	0.028	0.0	0.0	0.0	1.55	61.7	3.8
3.000	50.00	4.14	180.700	0.050	0.0	0.0	0.0	1.72	68.3	6.8
2.001	50.00	4.34	180.375	0.167	0.0	0.0	0.0	3.15	222.9	22.6
2.002	50.00	4.44	179.250	0.233	0.0	0.0	0.0	5.12	361.7	31.6
1.002	50.00	5.20	176.000	0.456	0.0	0.0	0.0	1.51	166.6	61.7
1.003	50.00	5.41	175.800	0.517	0.0	0.0	0.0	1.56	171.9	70.0
1.004	50.00	5.58	175.650	0.587	0.0	0.0	0.0	1.70	187.4	79.5
1.005	50.00	5.87	175.500	0.648	0.0	0.0	0.0	1.57	173.0	87.7
1.006	50.00	5.89	175.300	0.661	0.0	0.0	0.0	7.15	789.4	89.5
4.000	50.00	4.24	175.410	0.032	0.0	0.0	0.0	1.03	18.1	4.3
4.001	50.00	4.50	175.180	0.084	0.0	0.0	0.0	1.26	50.3	11.4
4.002	50.00	4.64	174.920	0.155	0.0	0.0	0.0	1.35	95.5	21.0
4.003	50.00	4.99	174.835	0.206	0.0	0.0	0.0	1.17	82.5	27.9
4.004	50.00	5.07	174.700	0.254	0.0	0.0	0.0	3.89	274.7	34.4
1.007	50.00	5.92	173.500	0.939	0.0	0.0	0.0	7.10	783.9	127.2

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
1.008	3.113	0.450	6.9	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
1.009	27.000	0.001	27000.0	0.000	0.00	0.0		0.050	→[↓]		Cellular Storage	
1.010	3.113	0.039	79.8	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
1.011	23.538	0.160	147.1	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
1.012	16.495	0.100	165.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
1.013	4.689	0.050	93.8	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.008	50.00	5.93	171.900	0.939	0.0	0.0	0.0	6.93	764.9	127.2
1.009	43.51	10.05	169.850	0.939	0.0	0.0	0.0	0.11	2867.1	127.2
1.010	43.44	10.09	169.849	0.939	0.0	0.0	0.0	1.46	58.2«	127.2
1.011	42.67	10.45	169.810	0.939	0.0	0.0	0.0	1.08	42.8«	127.2
1.012	42.11	10.72	169.650	0.939	0.0	0.0	0.0	1.02	40.4«	127.2
1.013	42.00	10.78	169.550	0.939	0.0	0.0	0.0	1.35	53.7«	127.2

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o		SW1	178.100	176.400	1.400	Open Manhole	1200
1.001	o	300	SW2	179.250	176.225	2.725	Open Manhole	1200
2.000	o	225	SW3	182.100	180.700	1.175	Open Manhole	600
3.000	o	225	SW4	183.100	180.700	2.175	Open Manhole	600
2.001	o	300	SW5	182.470	180.375	1.795	Open Manhole	1200
2.002	o	300	SW6	181.550	179.250	2.000	Open Manhole	1200
1.002	o	375	SW7	181.200	176.000	4.825	Open Manhole	1350
1.003	o	375	SW8	181.150	175.800	4.975	Open Manhole	1350
1.004	o	375	SW9	180.500	175.650	4.475	Open Manhole	1350
1.005	o	375	SW10	180.200	175.500	4.325	Open Manhole	1350
1.006	o	375	SW11	179.500	175.300	3.825	Open Manhole	1350
4.000	o	150	SW13	177.300	175.410	1.740	Open Manhole	600
4.001	o	225	SW14	176.850	175.180	1.445	Open Manhole	600
4.002	o	300	SW15	178.000	174.920	2.780	Open Manhole	1200
4.003	o	300	SW16	178.400	174.835	3.265	Open Manhole	1200
4.004	o	300	SW17	178.660	174.700	3.660	Open Manhole	1200
1.007	o	375	SW18	179.125	173.500	5.250	Open Manhole	1350
1.008	o	375	SW19	176.000	171.900	3.725	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	25.472	145.6	SW2	179.250	176.225	2.725	Open Manhole	1200
1.001	34.364	229.1	SW7	181.200	176.075	4.825	Open Manhole	1350
2.000	17.783	71.1	SW5	182.470	180.450	1.795	Open Manhole	1200
3.000	14.530	58.1	SW5	182.470	180.450	1.795	Open Manhole	1200
2.001	28.185	25.1	SW6	181.550	179.250	2.000	Open Manhole	1200
2.002	30.317	9.5	SW7	181.200	176.075	4.825	Open Manhole	1350
1.002	28.773	143.9	SW8	181.150	175.800	4.975	Open Manhole	1350
1.003	20.281	135.2	SW9	180.500	175.650	4.475	Open Manhole	1350
1.004	17.084	113.9	SW10	180.200	175.500	4.325	Open Manhole	1350
1.005	26.698	133.5	SW11	179.500	175.300	3.825	Open Manhole	1350
1.006	11.693	6.5	SW18	179.125	173.500	5.250	Open Manhole	1350
4.000	14.854	95.8	SW14	176.850	175.255	1.445	Open Manhole	600
4.001	19.771	106.9	SW15	178.000	174.995	2.780	Open Manhole	1200
4.002	11.474	135.0	SW16	178.400	174.835	3.265	Open Manhole	1200
4.003	24.386	180.6	SW17	178.660	174.700	3.660	Open Manhole	1200
4.004	18.599	16.5	SW18	179.125	173.575	5.250	Open Manhole	1350
1.007	10.538	6.6	SW19	176.000	171.900	3.725	Open Manhole	1350
1.008	3.113	6.9	SWATTN	172.450	171.450	0.625	Open Manhole	3000

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.009	→[↓]		SWATTN	172.450	169.850	0.500	Open Manhole	3000
1.010	o	225	SWATTN OUTLET	175.000	169.849	4.926	Open Manhole	3000
1.011	o	225	SW20	175.000	169.810	4.965	Open Manhole	1500
1.012	o	225	SW21	174.000	169.650	4.125	Open Manhole	1200
1.013	o	225	SW22	172.350	169.550	2.575	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.009	27.000	27000.0	SWATTN OUTLET	175.000	169.849	3.051	Open Manhole	3000
1.010	3.113	79.8	SW20	175.000	169.810	4.965	Open Manhole	1500
1.011	23.538	147.1	SW21	174.000	169.650	4.125	Open Manhole	1200
1.012	16.495	165.0	SW22	172.350	169.550	2.575	Open Manhole	1200
1.013	4.689	93.8	SWHW	170.000	169.500	0.275	Open Manhole	0

Online Controls for Storm

Hydro-Brake® Optimum Manhole: SW20, DS/PN: 1.011, Volume (m³): 9.2

Unit Reference	MD-SHE-0091-5000-2040-5000
Design Head (m)	2.040
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	91
Invert Level (m)	169.810
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.040	5.0	Kick-Flo®	0.815	3.3
Flush-Flo™	0.398	4.1	Mean Flow over Head Range	-	3.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	0.800	3.4	2.000	5.0	4.000	6.9	7.000	8.9
0.200	3.8	1.000	3.6	2.200	5.2	4.500	7.2	7.500	9.2
0.300	4.0	1.200	3.9	2.400	5.4	5.000	7.6	8.000	9.5
0.400	4.1	1.400	4.2	2.600	5.6	5.500	8.0	8.500	9.8
0.500	4.1	1.600	4.5	3.000	6.0	6.000	8.3	9.000	10.1
0.600	4.0	1.800	4.7	3.500	6.4	6.500	8.6	9.500	10.3

Storage Structures for Storm

Cellular Storage Pipe: 1.009

Manning's N	0.050	Infiltration Coefficient Side (m/hr)	0.00000
Invert Level (m)	169.850	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	364.5	364.5	2.000	364.5	526.5	2.100	0.0	526.5

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

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.000
Region	England and Wales	Ratio R	0.320
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 25, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	SW1	15 Winter	1	+0%	30/15 Summer				176.466
1.001	SW2	15 Winter	1	+0%	30/15 Summer				176.322
2.000	SW3	15 Winter	1	+0%					180.738
3.000	SW4	15 Winter	1	+0%					180.749
2.001	SW5	15 Winter	1	+0%					180.437
2.002	SW6	15 Winter	1	+0%					179.307
1.002	SW7	15 Winter	1	+0%	30/15 Summer				176.153
1.003	SW8	15 Winter	1	+0%	30/15 Summer				175.963
1.004	SW9	15 Winter	1	+0%	30/15 Summer				175.820
1.005	SW10	15 Winter	1	+0%	30/15 Summer				175.680
1.006	SW11	15 Winter	1	+0%					175.392
4.000	SW13	15 Winter	1	+0%	100/15 Summer				175.461
4.001	SW14	15 Winter	1	+0%	100/15 Summer				175.250
4.002	SW15	15 Winter	1	+0%	30/15 Summer				175.018
4.003	SW16	15 Winter	1	+0%	30/15 Summer				174.948
4.004	SW17	15 Winter	1	+0%					174.767
1.007	SW18	15 Winter	1	+0%	100/15 Summer				173.614
1.008	SW19	15 Winter	1	+0%	30/15 Summer				172.060
1.009	SWATTN	480 Winter	1	+0%					170.226
1.010	SWATTN OUTLET	480 Winter	1	+0%	1/60 Summer				170.226
1.011	SW20	480 Winter	1	+0%	1/30 Summer				170.240
1.012	SW21	720 Winter	1	+0%					169.700
1.013	SW22	240 Winter	1	+0%					169.604

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SW1	-0.234	0.000	0.11			9.2	OK	
1.001	SW2	-0.203	0.000	0.22			14.9	OK	
2.000	SW3	-0.187	0.000	0.07			3.7	OK	
3.000	SW4	-0.176	0.000	0.11			6.6	OK	
2.001	SW5	-0.238	0.000	0.10			19.5	OK	
2.002	SW6	-0.243	0.000	0.08			26.3	OK	
1.002	SW7	-0.222	0.000	0.35			50.8	OK	
1.003	SW8	-0.212	0.000	0.39			57.0	OK	
1.004	SW9	-0.205	0.000	0.42			63.7	OK	
1.005	SW10	-0.195	0.000	0.46			69.6	OK	
1.006	SW11	-0.283	0.000	0.14			71.1	OK	
4.000	SW13	-0.099	0.000	0.25			4.2	OK	
4.001	SW14	-0.155	0.000	0.21			9.6	OK	
4.002	SW15	-0.202	0.000	0.23			16.9	OK	
4.003	SW16	-0.187	0.000	0.30			22.2	OK	
4.004	SW17	-0.233	0.000	0.11			27.2	OK	
1.007	SW18	-0.261	0.000	0.20			99.6	OK	
1.008	SW19	-0.215	0.000	0.38			99.7	OK	
1.009	SWATTN	-1.724	0.000	0.00		330	17.3	OK	
1.010	SWATTN OUTLET	0.152	0.000	0.18			5.4	SURCHARGED	
1.011	SW20	0.205	0.000	0.10			4.1	SURCHARGED	
1.012	SW21	-0.175	0.000	0.11			4.1	OK	
1.013	SW22	-0.171	0.000	0.13			4.1	OK	