# 916 HALIFAX ROAD
# HARTSHEAD MOOR
# BD19 6LR

## Drainage Strategy

DOCUMENT No:
22091-DSR-001-A

13th MAY 2025

## Issue Sheet.

| Prepared | Date | | Checked | Date |
|---|---|---|---|---|
| M M | 13-05-25 | | M M | 13-05-25 |

| Revisions | Comment | Date |
|---|---|---|
| A | Initial Issue | 13-05-25 |
| | | |
| | | |
| | | |

The report is based on the information that has been acquired and / or made available to Advant Engineers via the various searches and consultations undertaken as part of the Drainage Strategy. In some cases, anecdotal information has been relied upon, where documented evidence has been lacking.

The conclusions drawn in the above report are considered correct although any subsequent additional information may allow refinement of the conclusions.

All work carried out in preparing this report has utilised and is based upon Advant Engineers current professional knowledge and understanding of current UK standards and codes, technology and legislation. Changes in this legislation and guidance may occur at any time in the future and cause any conclusions to become inappropriate or incorrect.

This report has been prepared using information contained in maps and documents prepared by others. Advant Engineers can accept no responsibility for the accuracy of such information.

# Table of Contents

# 1. Introduction

1.1. Advant Engineers Ltd has been commissioned by Barnes Homes Ltd, to undertake a Drainage Strategy in connection with the proposed development at the land at 916 Halifax Road, Hartshead Moor. The proposal consists of 11 new build dwellings with associated parking and access road.

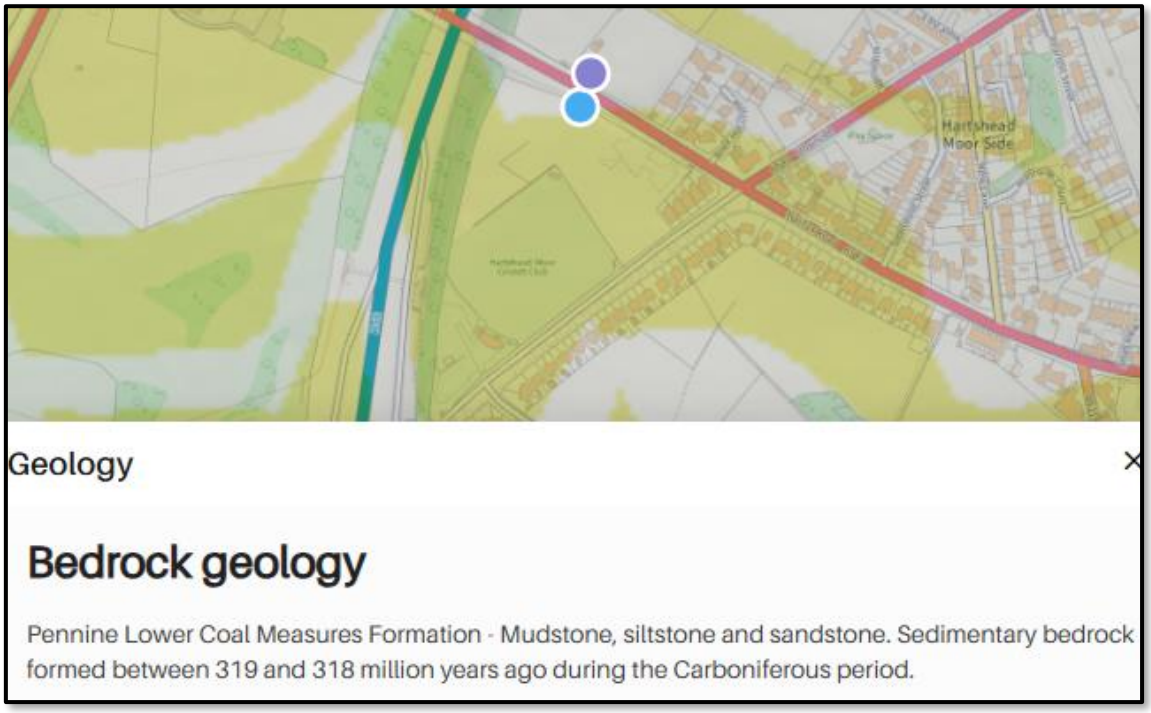
1.2. This report should be read in conjunction with drawing 22091-104 and associated architectural and engineering drawings.

# 2. Existing Site

2.1. The site is currently forms part of the garden to 916 Halifax Road, and is therefore classed as a greenfield site, the access to the site will be from Halifax Road. The overall site area is 3,939m² (0.394ha).

2.2. This site can be located at the following co-ordinates 417089E 424709N and the nearest postcode is BD19 6LR and can be seen on the below extract.

2.3. At the time of writing this report a site investigation had not been undertaken, we have therefore referred to the BGS website to determine the expected ground conditions, which are described as follows:




2.4. The site falls from the South to the North with a high point of 157.49 and a low point of 149.78 which gives an approximate gradient of 1:10. (See Appendix A for Survey).

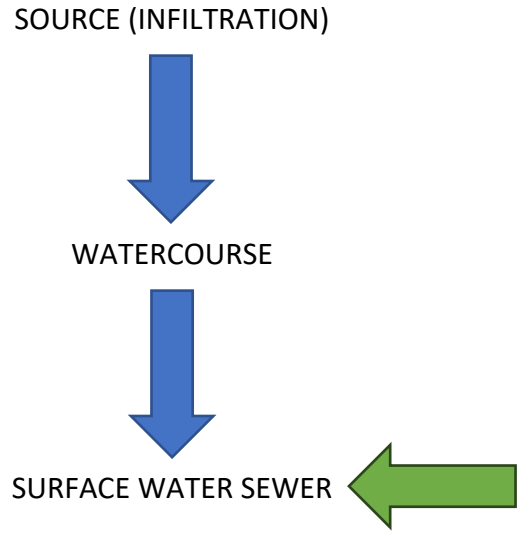
## 3. Proposed Development

3.1. The proposed development is for 11 new build dwellings with associated parking and a new access road into the site, the access road is to be adopted. (See Appendix B for layout)

# 4. Drainage Strategy

### 4.1. Surface Water

4.2. The surface water drainage should be designed in accordance with the SUD hierarchy providing evidence to each step before moving on to the next one, the SUDS hierarchy is as follows:




4.3. From the BGS website it is inconclusive as to the infiltration factors of the ground, however it has been considered due to the very steep nature of the ground and the elevated position of the site compared to the field down hill of the site that any concentrated infiltration would have a high probability of breaching the surface further downhill, therefore the use of soakaways has been discounted.

4.4. Next in the hierarchy is to discharge to a water course, as there are no watercourses in the vicinity then this has also been discounted.

4.5. Therefore, the surface water is proposed to discharge to the existing public surface water sewer located in the adjacent field which then flows down Moorside Road. (See Appendix C for sewer records).

4.6. The site is currently a field therefore it will be treated as Greenfield and Greenfield rates should be calculated.

4.7. The existing greenfield runoff rates for the site and restrict the proposed discharge to the equivalent rate, the greenfield rates for the site are as follows (See Appendix D for Greenfield Calc):

Qbar = 2.3 l/s
1 in 1 Year = 1.99 l/s
1 in 30 Year = 4.05 l/s
1 in 100 Year = 4.81 l/s

4.8. We are unable to achieve the QBar rate, therefore we are proposing as rate of **3.5l/s** via a vortex flow control and provide attenuation on site to accommodate the 1 in 100 year + 45% climate change rainfall event. (See Appendix E for Calcs).

4.9. The main drainage will be offered for adoption, due to Kirklees Councils Highway department not allowed structures over 900mm in size, it is proposed to provide the attenuation in the form of a tank under the private driveway. (See Appendix F for drainage layout).

**4.10. Foul Drainage**

4.11. The foul drainage is proposed to connect into the public foul sewer located in the adjacent field.

## 5. SUDS Elements

5.1. All new surface water drainage systems should implement SUDS features where reasonably possible, these features are incorporated to offer benefits in Water Quality, Water Quantity, Amenity and Biodiversity. Below we have considered each SUDS element and determined it use within this particular development.

| COMPONENT | SUITABILITY | REASON |
|---|---|---|
| Green Roof | X | Roof structure not suitable. |
| Blue Roof | X | Roof structure not suitable. |
| Infiltration Systems | X | Not suitable due to levels. |
| Proprietary Treatment Systems | ✓ | Flow control device to be utilised. |
| Filter Strips | X | Not suitable due to levels. |
| Filter Drains | X | Not suitable due to levels. |
| Swales | X | Not suitable due to levels. |
| Bioretention Systems | X | Insufficient land available. |
| Trees | ✓ | Trees are included on the layout |
| Rain Garden | X | Layout not suitable for the use of rain gardens |
| Pervious Pavements | X | Not suitable due to levels. |
| Attenuation Storage Tanks | ✓ | Tanks proposed in front gardens for attenuation. |
| Detention Basins | X | Insufficient land available. |
| Ponds and Wetlands | X | Insufficient land available. |

# 6. SUDS Operations and Maintenance

6.1. Responsibility of the adopted drainage system, flow control and attenuation tank will be with Yorkshire Water post adoption, however during construction and up to the point of adoption the developer will be responsible for the operation and maintenance of the drainage system and its various SUDS elements.

6.2. The convention drainage system, consisting of standard manholes and pipework, are maintained by sub-contractors using specialist machinery to clear gullies, pipework and storage zones of rubbish and sediment. The frequency of this task is determined by the need, this can be identified by a reduced flow through the pipework, water surcharging or the visible sight of sediment or buildup in the manholes.

6.3. Across the adoptable drainage system corrective maintenance should be undertaken on an ad hoc basis defendant on need, these task should include:

- Repair to access chambers / manhole covers
- Jetting and clearing of blockages
- Repair any broken pipes, manhole sections, step irons

6.4. Beyond the convention drainage manholes and pipework, the adoptable system also has a Flow Control manhole and a concrete attenuation tank that requires routine inspection and maintenance as outlined below.

**FLOW CONTROL MANHOLE – HYDROBRAKE UNIT AND PENSTOCK**

| MAINTENANCE SCHEDULE | REQUIRED ACTION | FREQUENCY |
|---|---|---|
| Regular Maintenance | Vacuum clean the sump in the manhole. | Annually |
| | Inspect pipework for silt accumulation and jet-vac clean. | Annually |
| | Clean spindle threads on penstock by hosing down with clean water, then apply grease to the spindle. | Every 6 months |
| | All other moving parts should be lightly oiled / greased. | As required. |
| Remedial Actions | Repair / rehabilitate inlets, outlets and vents. | As required. |
| | Replace hydrobrake unit should it become damage and fail to operate. | As required. |
| | Anytime the hydrobrake unit is removed then new neoprene seals should be installed. | As required. |
| Monitoring | Check that flow control manhole is emptying, there should be little or no water after consecutive days of dry weather. | Twice in the first year, once after heavy rainfall, and then once after consecutive days of dry weather. After that annual inspections. |
| | The hydrobrake has one moving part which is the bypass gate, and the penstock has a gate operated by a rising spindle, both elements should be opened and closed to check their operation. | Every 3 months |
| | Check for any leakages between the hydrobrake / penstock units and the concrete mounting block. | Annually |
| | Check tightness of all fixing bolts. | Annually |
| | Whilst the penstock is in the fully open position, inspect the seals and the sealing surface. | Annually |

6.5. The above is scheduled maintenance, additional inspections and cleaning of the hydrobrake chamber should be undertaken in the event of a failure or after every extreme flood event.

6.6. Access is provided to the tank via the private shared driveway to plots 3-5, maintenance vehicles can safely pull off the public highway and park over the tank to undertake maintenance / remedial works.

6.7. Most inspections and maintenance operations can be undertaken from above ground, man entry into the tank should be avoided whenever possible, however if this is unavoidable then there are 2 access chambers on the tank that can be used.

6.8. Anyone entering the attenuation tank should be suitable trained in confined spaces, they should never undertake solo inspections, and they should utilise a fall arrest harness attached to a tripod mounted over the manhole.

6.9. See Appendix H for the Hydrobrake technical data and company brochure.

**CONCRETE ATTENUATION TANK – CARLOW CONCRETE**

| MAINTENANCE SCHEDULE | REQUIRED ACTION | FREQUENCY |
|---|---|---|
| Regular Maintenance | Inspect and identify areas that are not operating correctly. If required take remedial action. | Monthly for the first 3 months and then annually. |
| | Jet clean the inside of the tank for sediment removal | Annually |
| Remedial Actions | Repair / rehabilitate inlets, outlets and vents. | As required. |
| Monitoring | Inspect / check all inlets, outlets and vents to ensure that they are in good condition and operating as designed. | Annually |

6.10. The above is scheduled maintenance, additional inspections and cleaning of the tank should be undertaken in the event of a failure or after every extreme flood event.

6.11. Access is provided to the tank via the private shared driveway to plots 3-5, maintenance vehicles can safely pull off the public highway and park over the tank to undertake maintenance / remedial works.

6.12. Most inspections and maintenance operations can be undertaken from above ground, man entry into the tank should be avoided whenever possible, however if this is unavoidable then there are 2 access chambers on the tank that can be used.

6.13. Anyone entering the attenuation tank should be suitable trained in confined spaces, they should never undertake solo inspections, and they should utilise a fall arrest harness attached to a tripod mounted over the manhole.

## 7. Post Adoption SUDS Operations and Maintenance

7.1. The above operation and maintenance requirements are a minimum guidance and as it is noted above both of these SUDS features are to be adopted by Yorkshire Water who will have their own maintenance schedule that we have faith will be concise and robust to maintain their own assets.

7.2. In addition, it is expected that Yorkshire Water will have a standard set of Risk Assessments and Health & Safety guidance on the maintenance of all of their drainage assets to ensure a safe working environment for their employees when undertaking such tasks.

7.3. In the event of a blockage or asset failure then Yorkshire Water should be contacted who will then be responsible for the timely repair of the failure and reinstating the asset to its working status.

## 8. Flood Exceedance Events

8.1. Although the surface water drainage has been designed to accommodate the 1 in 100 year + 45% climate change rainfall event with no flooding, we have to consider events that exceed this and what happens to any flooding that may occur.

8.2. To illustrate this event, we have produced a Flood Exceedance Layout plan (See Appendix G for layout) and from this we can see that flood would occur at manhole (S4) and then would downhill, this mimics how the site would operate pre-development as per the original contours of the site.

# 9. Conclusion

9.1. Advant Engineers were commissioned by Barnes Homes Ltd to undertake a Drainage Strategy for the proposed residential development at Halifax Road in Hartshead Moor. This report will be provided as supporting documentation as part of a planning application.

9.2. The site currently forms part of the garden to No 916 Halifax Road and therefore Greenfield runoff rates apply.

9.3. It is proposed to discharge the surface water to the public surface water sewer in the adjacent field 3.5 l/s and to accommodate the 1 in 100 year + 45% climate change rainfall event on site.

9.4. Foul drainage is to be discharged to the public foul sewer located in the adjacent field.

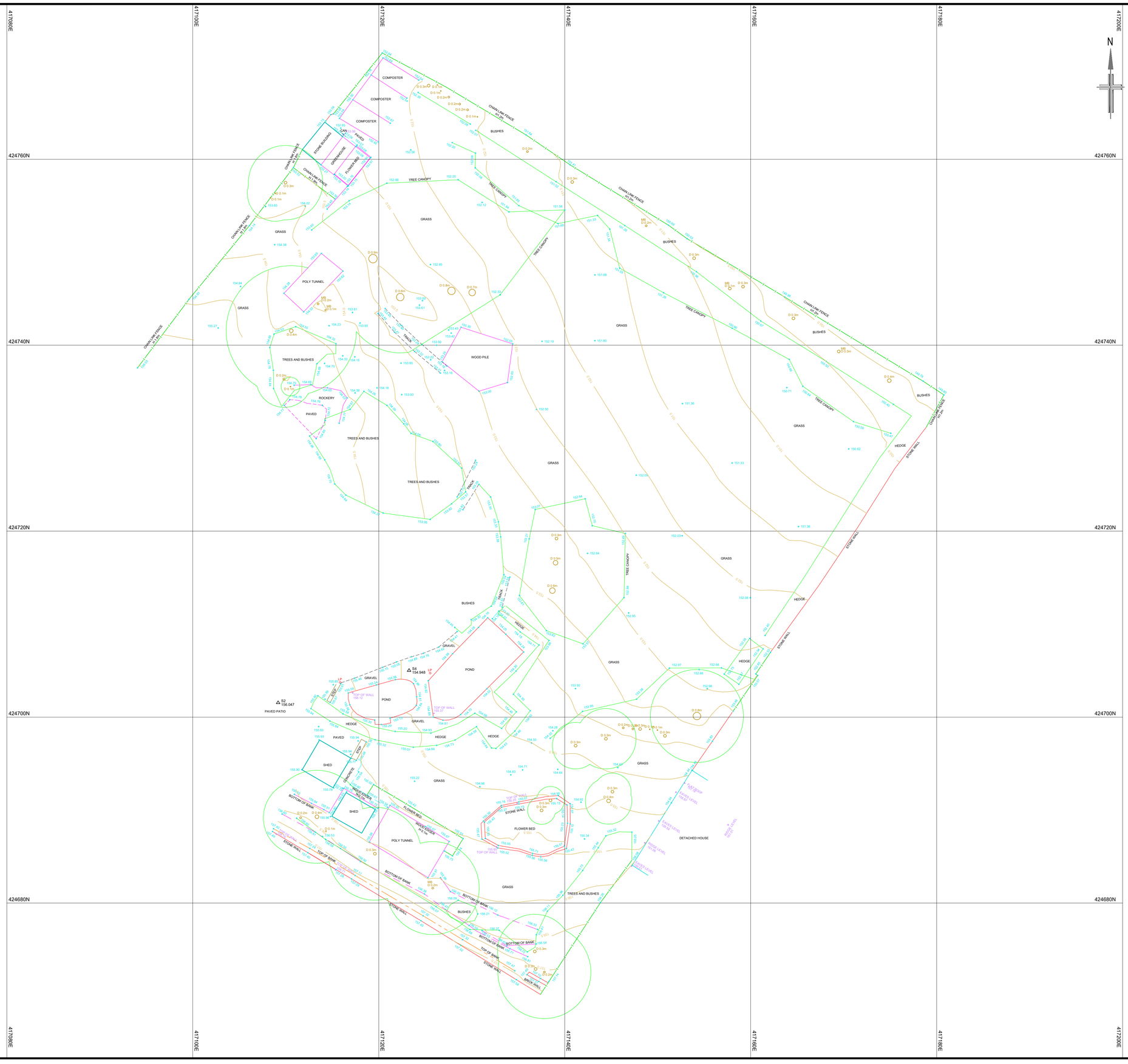
9.5. All public surface water/foul water drainage should be designed in accordance with the Water Authority and Sewers for Adoption.

9.6. All private surface water and surface water/foul water drainage should be designed in accordance with the current Building Regulations Part H.

# 10. References

10.1. CIRIA C753 The SuDS Manual

# APPENDIX A
# TOPOGRAPHICAL SURVEY




## Notes

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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 S2

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 |
|---|---|---|---|
| S2 | 417109.177 | 424701.547 | 156.047 |
| S4 | 417123.260 | 424705.019 | 154.948 |

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
AHURU HOMES LIMITED
LEEDS

Site
WARREN COTTAGE, 916 HALIFAX ROAD
SCHOLES, CLECKHEATON

Title
TOPOGRAPHICAL
SURVEY

| | | | |
|---|---|---|---|
| Surveyed | SB, JM, AH | Drawn | SB |
| Check | KZ | Date | 29/10/2021 |
| Scale | 1:200 | Job No | P21-01350 |
| Sheet Size | A1 | Rev | 01 |

DWG Ref

| Project Number | Origin | Zone | Level | Desc | Type | Role | Sheet |
|---|---|---|---|---|---|---|---|
| P21-01350 | MET | EXT | XX | TOP | M2 | G | 001 |

# APPENDIX B
## PROPOSED LAYOUT

# Proposed Site Plan

1 : 200

SCALE 1:200

0 2m 4m 6m 8m 10m


**CLIENT**

**Barnes Homes**

**PROJECT**

**Land adjacent to 916 Halifax Road**
**Hartshead Moor**
**Cleckheaton**
**BD19 6LR**

**DRAWING TITLE**

**PROPOSED SITE PLAN**

**STATUS**

**S0**

| Proj Ref | Origin | Zone | Level | Type | Role | Num | Status | Rev |
|---|---|---|---|---|---|---|---|---|
| 24005 | - BAS | - 00 | -XX | - DR | - A | -00100 | -S0 | - P4 |

| Sheet | Scale | Issue Date | Drwn by | Ckd by |
|---|---|---|---|---|
| A1 | 1 : 200 | 11-02-24 | WD | AB |

**HOUSE KEY:**

**PLOT 1**:
2 bed bungalow
no garage
GEA: 89m²

**PLOT 2**:
2 bed dormer bungalow
integral garage
GEA: 100m²

**PLOT 3/4**:
2 bed semi
no garage
GEA: 44m² per dwelling

**PLOT 5**:
4/5 bed detached
integral garage
GEA: 89m²

**PLOT 6/7**:
4 bed detached
integral garage
GEA: 79m²

**PLOT 8**:
4 bed detached
no garage (3 bed if integral garage)
GEA: 70m²

**PLOT 9**:
4 bed detached
integral garage
GEA: 69m²

**PLOT 10**:
4 bed detached
integral garage
GEA: 69m²

**PLOT 11**:
2 bed bungalow
no garage
GEA: 89m²

| REV | DESCRIPTION | DATE | DRAWN |
|---|---|---|---|
| P4 | Drawing updated. | 19-08-24 | |
| P3 | Drawing updated. | 18-07-24 | |
| P2 | Drawing updated. | 25-03-24 | |
| P1 | Drawing updated. | 11-03-24 | |
| P0 | First Issue. | 04-02-24 | |

**ISSUE/REVISION HISTORY**


BARNES ARCHITECTURAL SERVICES

Unit 19, Victoria Spring Business Park
Liversedge, West Yorkshire WF15 6BU


**NOTES**

Do not scale from this drawing. Only figured dimensions are to be taken from this drawing. Contractor must verify all dimensions on site before commencing any work or shop drawings. Report any discrepancies to the architect before commencing work. If this drawing exceeds the quantities taken in any way the architects are to be informed before the work is initiated. Work within the Construction (Design & Management) Regulations 2015 is not to start until a Health and Safety Plan has been produced. This drawing is copyright and must not be reproduced without consent of BARNES ARCHITECTURAL SERVICES.

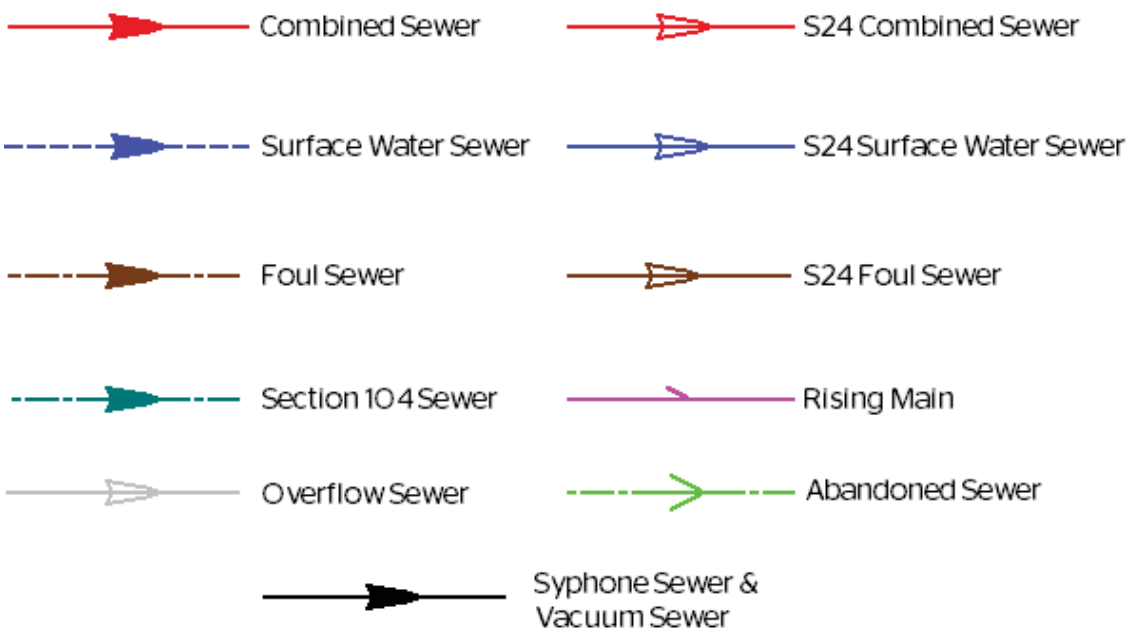
**DRAWING STATUS/TYPE KEY**

| | | | |
|---|---|---|---|
| **S0** | Feasibility | **S2** | Sketch |
| **L** | Landscape | **D4** | Construction |
| **S4** | Planning | **Z** | Marketing |
| **B** | Building Survey | **B3** | As Built |
| **D2** | Tender | **Z** | Tenant |
| **OS** | Ordnance Survey | | |

# APPENDIX C
# SEWER RECORDS

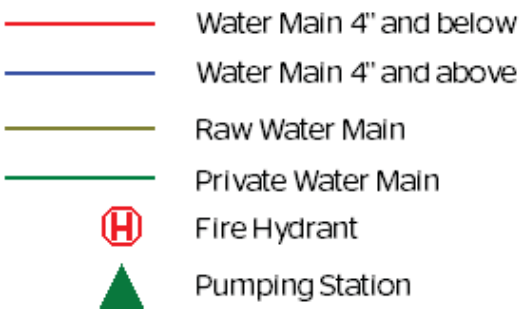
# Property Identfier

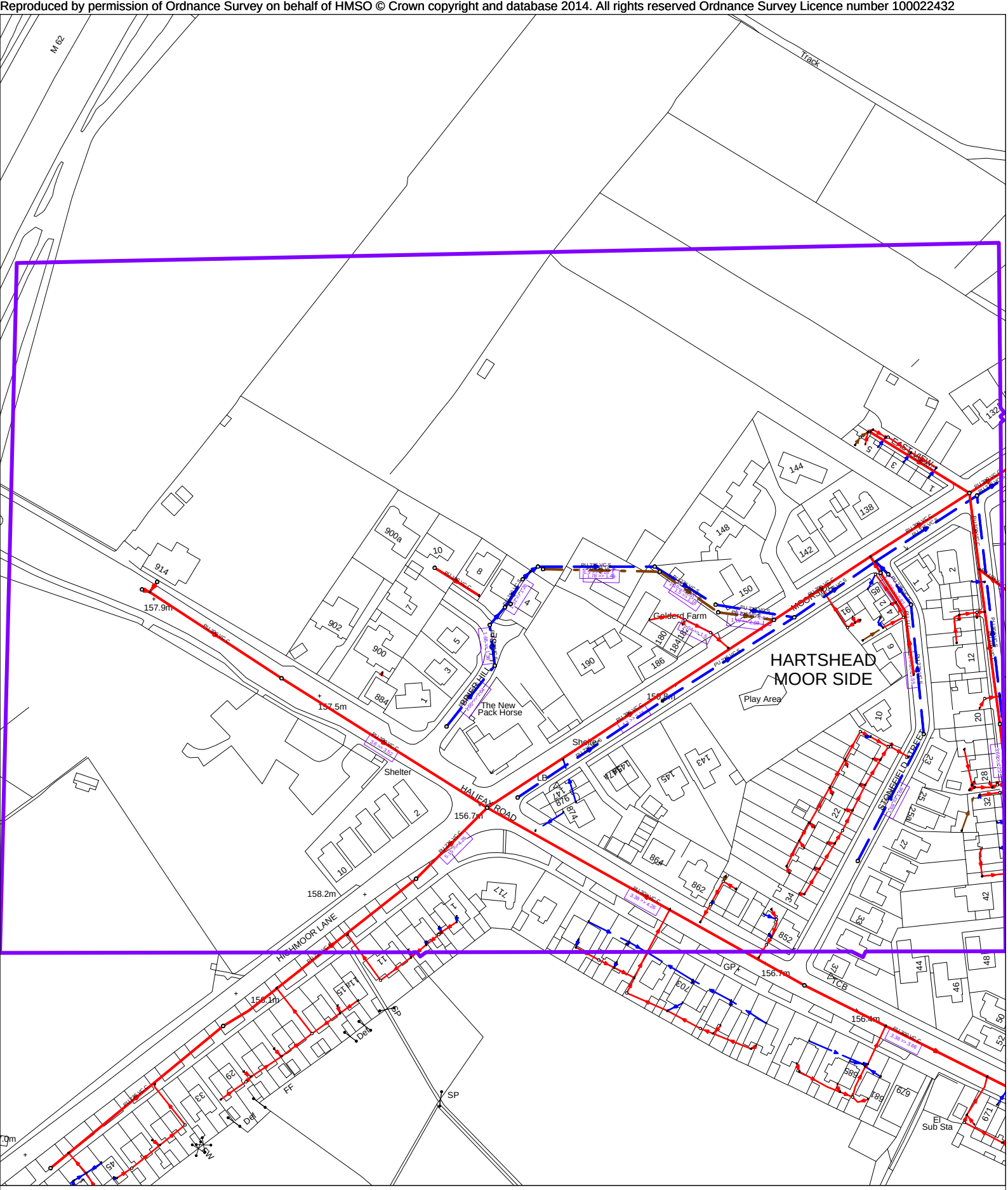

# Sewer Legend




Please note that the direction of flow arrows may not always appear depending on the scale of the map.

# Water Legend






Public Waste Water Network 27/10/2022 21:44:58 OS Grid Coordinates: 417025 : 424461 Map Name : SE1724SW svcGISSafeMovePD

# APPENDIX D
# GREENFIELD CALCULATION

Print | Close Report

# Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

| | |
|---|---|
| Calculated by: | Michael Micklethwaite |
| Site name: | Halifax Road |
| Site location: | Scholes |

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

**Site Details**

| | |
|---|---|
| Latitude: | 53.71897° N |
| Longitude: | 1.74245° W |
| Reference: | 3559631573 |
| Date: | Nov 03 2022 11:29 |

**Runoff estimation approach** IH124

**Site characteristics**

Total site area (ha): 0.423

**Methodology**

| | |
|---|---|
| $Q_{BAR}$ estimation method: | Calculate from SPR and SAAR |
| SPR estimation method: | Calculate from SOIL type |

| Soil characteristics | Default | Edited |
|---|---|---|
| SOIL type: | 4 | 4 |
| HOST class: | N/A | N/A |
| SPR/SPRHOST: | 0.47 | 0.47 |

| Hydrological characteristics | Default | Edited |
|---|---|---|
| SAAR (mm): | 779 | 779 |
| Hydrological region: | 3 | 3 |
| Growth curve factor 1 year: | 0.86 | 0.86 |
| Growth curve factor 30 years: | 1.75 | 1.75 |
| Growth curve factor 100 years: | 2.08 | 2.08 |
| Growth curve factor 200 years: | 2.37 | 2.37 |

**Notes**

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

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

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

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

**(3) Is SPR/SPRHOST ≤ 0.3?**

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

| Greenfield runoff rates | Default | Edited |
|---|---|---|
| $Q_{BAR}$ (l/s): | 2.31 | 2.31 |
| 1 in 1 year (l/s): | 1.99 | 1.99 |
| 1 in 30 years (l/s): | 4.05 | 4.05 |
| 1 in 100 year (l/s): | 4.81 | 4.81 |
| 1 in 200 years (l/s): | 5.49 | 5.49 |

# APPENDIX E
## SURFACE WATER CALCULATIONS

## Design Settings

| | | | |
|---|---|---|---|
| Rainfall Methodology | FSR | Maximum Time of Concentration (mins) | 5.00 |
| Return Period (years) | 1 | Maximum Rainfall (mm/hr) | 80.0 |
| Additional Flow (%) | 0 | Minimum Velocity (m/s) | 1.00 |
| FSR Region | England and Wales | Connection Type | Level Soffits |
| M5-60 (mm) | 20.000 | Minimum Backdrop Height (m) | 1.000 |
| Ratio-R | 0.400 | Preferred Cover Depth (m) | 1.200 |
| CV | 0.750 | Include Intermediate Ground | ✓ |
| Time of Entry (mins) | 5.00 | Enforce best practice design rules | x |

## 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 |

## Tank 1800 Link Type

| | | | |
|---|---|---|---|
| Shape | Closed Rectangular | Auto Increment (mm) | 500 |
| Barrels | 1 | Follow Ground | x |
| Height (mm) | 1800 | | |

**Available Diameters (mm)**

500

## Nodes

| Name | Area (ha) | T of E (mins) | Cover Level (m) | Diameter (mm) | Easting (m) | Northing (m) | Depth (m) |
|---|---|---|---|---|---|---|---|
| S1 | 0.074 | 5.00 | 155.178 | 1350 | 417129.253 | 424707.595 | 2.828 |
| S2 | 0.066 | 5.00 | 153.496 | 1350 | 417132.786 | 424731.129 | 3.196 |
| S3 | 0.083 | 5.00 | 153.695 | 1500 | 417140.390 | 424726.183 | 3.495 |
| S4 | | | 152.679 | 2400 | 417156.035 | 424716.763 | 2.579 |
| S5 | | | 152.450 | 1350 | 417162.427 | 424712.793 | 2.450 |
| S6 | | | 152.450 | 1350 | 417168.887 | 424723.290 | 2.550 |
| S7 | | | 150.249 | 1350 | 417176.090 | 424734.364 | 1.449 |
| S8 | | | 149.600 | 1350 | 417179.925 | 424740.640 | 1.250 |
| S9 | | | 149.600 | 1350 | 417217.040 | 424718.750 | 1.500 |
| TANK1 | | 5.00 | 153.700 | 1200 | 417109.974 | 424754.445 | 3.300 |
| TANK2 | | | 153.696 | 1200 | 417124.877 | 424740.830 | 3.346 |

## 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 | S1 | S3 | 21.669 | 0.600 | 152.350 | 150.500 | 1.850 | 11.7 | 150 | 5.00 | 54.7 |
| 2.000 | S2 | S3 | 9.071 | 0.600 | 150.300 | 150.200 | 0.100 | 90.7 | 300 | 5.00 | 54.7 |
| 1.001 | S3 | S4 | 18.262 | 0.600 | 150.200 | 150.100 | 0.100 | 182.6 | 300 | 5.00 | 54.7 |
| 1.002 | S4 | S5 | 7.525 | 0.600 | 150.100 | 150.000 | 0.100 | 75.3 | 225 | 5.00 | 54.7 |
| 1.003 | S5 | S6 | 12.325 | 0.600 | 150.000 | 149.900 | 0.100 | 123.3 | 225 | 5.00 | 54.7 |
| 1.004 | S6 | S7 | 13.210 | 0.600 | 149.900 | 148.800 | 1.100 | 12.0 | 225 | 5.00 | 54.7 |
| 1.005 | S7 | S8 | 7.355 | 0.600 | 148.800 | 148.350 | 0.450 | 16.3 | 225 | 5.00 | 54.7 |
| 1.006 | S8 | S9 | 43.089 | 0.600 | 148.350 | 148.100 | 0.250 | 172.4 | 225 | 5.00 | 54.7 |
| 1.000_1 | TANK1 | TANK2 | 20.550 | 0.600 | 150.400 | 150.350 | 0.050 | 411.0 | 2400 | 5.00 | 54.7 |
| 1.001_1 | TANK2 | S2 | 12.516 | 0.600 | 150.350 | 150.300 | 0.050 | 250.3 | 300 | 5.00 | 54.7 |

| 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 | 2.960 | 52.3 | 11.0 | 2.678 | 3.045 | 0.074 | 0.0 | 47 | 2.352 |
| 2.000 | 1.651 | 116.7 | 9.8 | 2.896 | 3.195 | 0.066 | 0.0 | 58 | 1.014 |
| 1.001 | 1.160 | 82.0 | 33.1 | 3.195 | 2.279 | 0.223 | 0.0 | 132 | 1.098 |
| 1.002 | 1.509 | 60.0 | 33.1 | 2.354 | 2.225 | 0.223 | 0.0 | 119 | 1.543 |
| 1.003 | 1.176 | 46.8 | 33.1 | 2.225 | 2.325 | 0.223 | 0.0 | 140 | 1.273 |
| 1.004 | 3.796 | 150.9 | 33.1 | 2.325 | 1.224 | 0.223 | 0.0 | 72 | 3.066 |
| 1.005 | 3.252 | 129.3 | 33.1 | 1.224 | 1.025 | 0.223 | 0.0 | 77 | 2.725 |
| 1.006 | 0.993 | 39.5 | 33.1 | 1.025 | 1.275 | 0.223 | 0.0 | 158 | 1.108 |
| 1.000_1 | 2.558 | 11051.1 | 0.0 | 1.500 | 1.546 | 0.000 | 0.0 | 0 | 0.000 |
| 1.001_1 | 0.989 | 69.9 | 0.0 | 3.046 | 2.896 | 0.000 | 0.0 | 0 | 0.000 |

## 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 | 21.669 | 11.7 | 150 | Circular | 155.178 | 152.350 | 2.678 | 153.695 | 150.500 | 3.045 |
| 2.000 | 9.071 | 90.7 | 300 | Circular | 153.496 | 150.300 | 2.896 | 153.695 | 150.200 | 3.195 |
| 1.001 | 18.262 | 182.6 | 300 | Circular | 153.695 | 150.200 | 3.195 | 152.679 | 150.100 | 2.279 |
| 1.002 | 7.525 | 75.3 | 225 | Circular | 152.679 | 150.100 | 2.354 | 152.450 | 150.000 | 2.225 |
| 1.003 | 12.325 | 123.3 | 225 | Circular | 152.450 | 150.000 | 2.225 | 152.450 | 149.900 | 2.325 |
| 1.004 | 13.210 | 12.0 | 225 | Circular | 152.450 | 149.900 | 2.325 | 150.249 | 148.800 | 1.224 |
| 1.005 | 7.355 | 16.3 | 225 | Circular | 150.249 | 148.800 | 1.224 | 149.600 | 148.350 | 1.025 |
| 1.006 | 43.089 | 172.4 | 225 | Circular | 149.600 | 148.350 | 1.025 | 149.600 | 148.100 | 1.275 |

| Link | US Node | Dia (mm) | Node Type | MH Type | DS Node | Dia (mm) | Node Type | MH Type |
|---|---|---|---|---|---|---|---|---|
| 1.000 | S1 | 1350 | Manhole | Adoptable | S3 | 1500 | Manhole | Adoptable |
| 2.000 | S2 | 1350 | Manhole | Adoptable | S3 | 1500 | Manhole | Adoptable |
| 1.001 | S3 | 1500 | Manhole | Adoptable | S4 | 2400 | Manhole | Adoptable |
| 1.002 | S4 | 2400 | Manhole | Adoptable | S5 | 1350 | Manhole | Adoptable |
| 1.003 | S5 | 1350 | Manhole | Adoptable | S6 | 1350 | Manhole | Adoptable |
| 1.004 | S6 | 1350 | Manhole | Adoptable | S7 | 1350 | Manhole | Adoptable |
| 1.005 | S7 | 1350 | Manhole | Adoptable | S8 | 1350 | Manhole | Adoptable |
| 1.006 | S8 | 1350 | Manhole | Adoptable | S9 | 1350 | Manhole | Adoptable |

## 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_1 | 20.550 | 411.0 | 2400 | Tank 1800 | 153.700 | 150.400 | 1.500 | 153.696 | 150.350 | 1.546 |
| 1.001_1 | 12.516 | 250.3 | 300 | Circular | 153.696 | 150.350 | 3.046 | 153.496 | 150.300 | 2.896 |

| Link | US Node | Dia (mm) | Node Type | MH Type | DS Node | Dia (mm) | Node Type | MH Type |
|---|---|---|---|---|---|---|---|---|
| 1.000_1 | TANK1 | 1200 | Manhole | Adoptable | TANK2 | 1200 | Manhole | Adoptable |
| 1.001_1 | TANK2 | 1200 | Manhole | Adoptable | S2 | 1350 | Manhole | Adoptable |

## Manhole Schedule

| Node | Easting (m) | Northing (m) | CL (m) | Depth (m) | Dia (mm) | Connections | Link | IL (m) | Dia (mm) |
|---|---|---|---|---|---|---|---|---|---|
| S1 | 417129.253 | 424707.595 | 155.178 | 2.828 | 1350 | 0 | 1.000 | 152.350 | 150 |
| S2 | 417132.786 | 424731.129 | 153.496 | 3.196 | 1350 | 1 | 1.001_1 | 150.300 | 300 |
| | | | | | | 0 | 2.000 | 150.300 | 300 |
| S3 | 417140.390 | 424726.183 | 153.695 | 3.495 | 1500 | 1 | 1.000 | 150.500 | 150 |
| | | | | | | 2 | 2.000 | 150.200 | 300 |
| | | | | | | 0 | 1.001 | 150.200 | 300 |
| S4 | 417156.035 | 424716.763 | 152.679 | 2.579 | 2400 | 1 | 1.001 | 150.100 | 300 |
| | | | | | | 0 | 1.002 | 150.100 | 225 |
| S5 | 417162.427 | 424712.793 | 152.450 | 2.450 | 1350 | 1 | 1.002 | 150.000 | 225 |
| | | | | | | 0 | 1.003 | 150.000 | 225 |
| S6 | 417168.887 | 424723.290 | 152.450 | 2.550 | 1350 | 1 | 1.003 | 149.900 | 225 |
| | | | | | | 0 | 1.004 | 149.900 | 225 |
| S7 | 417176.090 | 424734.364 | 150.249 | 1.449 | 1350 | 1 | 1.004 | 148.800 | 225 |
| | | | | | | 0 | 1.005 | 148.800 | 225 |
| S8 | 417179.925 | 424740.640 | 149.600 | 1.250 | 1350 | 1 | 1.005 | 148.350 | 225 |
| | | | | | | 0 | 1.006 | 148.350 | 225 |
| S9 | 417217.040 | 424718.750 | 149.600 | 1.500 | 1350 | 1 | 1.006 | 148.100 | 225 |
| TANK1 | 417109.974 | 424754.445 | 153.700 | 3.300 | 1200 | 0 | 1.000_1 | 150.400 | 2400 |

## Manhole Schedule

| Node | Easting (m) | Northing (m) | CL (m) | Depth (m) | Dia (mm) | Connections | Link | IL (m) | Dia (mm) |
|---|---|---|---|---|---|---|---|---|---|
| TANK2 | 417124.877 | 424740.830 | 153.696 | 3.346 | 1200 | 1 | 1.000_1 | 150.350 | 2400 |
| | | | | | | 0 | 1.001_1 | 150.350 | 300 |

## Simulation Settings

| | | | |
|---|---|---|---|
| Rainfall Methodology | FSR | Analysis Speed | Detailed |
| Rainfall Events | Singular | Skip Steady State | x |
| FSR Region | England and Wales | Drain Down Time (mins) | 1440 |
| M5-60 (mm) | 20.000 | Additional Storage (m³/ha) | 0.0 |
| Ratio-R | 0.400 | Starting Level (m) | |
| Summer CV | 0.750 | Check Discharge Rate(s) | x |
| Winter CV | 0.840 | 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 |
| 30 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 |
| 100 | 45 | 0 | 0 |

## Node S4 Online Hydro-Brake® Control

| | | | |
|---|---|---|---|
| Flap Valve | x | Objective | (HE) Minimise upstream storage |
| Replaces Downstream Link | ✓ | Sump Available | ✓ |
| Invert Level (m) | 150.100 | Product Number | CTL-SHE-0072-3500-2500-3500 |
| Design Depth (m) | 2.500 | Min Outlet Diameter (m) | 0.100 |
| Design Flow (l/s) | 3.5 | Min Node Diameter (mm) | 1200 |

## Other (defaults)

| | | | | | |
|---|---|---|---|---|---|
| Entry Loss (manhole) | 0.250 | Entry Loss (junction) | 0.000 | Apply Recommended Losses | x |
| Exit Loss (manhole) | 0.250 | Exit Loss (junction) | 0.000 | Flood Risk (m) | 0.300 |

## Rainfall

| Event | Peak Intensity (mm/hr) | Average Intensity (mm/hr) | Event | Peak Intensity (mm/hr) | Average Intensity (mm/hr) |
|---|---|---|---|---|---|
| 1 year 15 minute summer | 109.521 | 30.991 | 1 year 240 minute summer | 18.475 | 4.882 |
| 1 year 15 minute winter | 76.857 | 30.991 | 1 year 240 minute winter | 12.274 | 4.882 |
| 1 year 30 minute summer | 71.439 | 20.215 | 1 year 360 minute summer | 14.169 | 3.646 |
| 1 year 30 minute winter | 50.133 | 20.215 | 1 year 360 minute winter | 9.210 | 3.646 |
| 1 year 60 minute summer | 48.435 | 12.800 | 1 year 480 minute summer | 11.185 | 2.956 |
| 1 year 60 minute winter | 32.179 | 12.800 | 1 year 480 minute winter | 7.431 | 2.956 |
| 1 year 120 minute summer | 30.053 | 7.942 | 1 year 600 minute summer | 9.182 | 2.511 |
| 1 year 120 minute winter | 19.966 | 7.942 | 1 year 600 minute winter | 6.274 | 2.511 |
| 1 year 180 minute summer | 23.233 | 5.979 | 1 year 720 minute summer | 8.203 | 2.199 |
| 1 year 180 minute winter | 15.102 | 5.979 | 1 year 720 minute winter | 5.513 | 2.199 |

## Rainfall

| Event | Peak Intensity (mm/hr) | Average Intensity (mm/hr) | Event | Peak Intensity (mm/hr) | Average Intensity (mm/hr) |
|---|---|---|---|---|---|
| 1 year 960 minute summer | 6.768 | 1.782 | 100 year 240 minute summer | 54.269 | 14.342 |
| 1 year 960 minute winter | 4.483 | 1.782 | 100 year 240 minute winter | 36.055 | 14.342 |
| 1 year 1440 minute summer | 4.949 | 1.326 | 100 year 360 minute summer | 40.484 | 10.418 |
| 1 year 1440 minute winter | 3.326 | 1.326 | 100 year 360 minute winter | 26.315 | 10.418 |
| 30 year 15 minute summer | 268.706 | 76.035 | 100 year 480 minute summer | 31.414 | 8.302 |
| 30 year 15 minute winter | 188.566 | 76.035 | 100 year 480 minute winter | 20.871 | 8.302 |
| 30 year 30 minute summer | 174.929 | 49.499 | 100 year 600 minute summer | 25.431 | 6.956 |
| 30 year 30 minute winter | 122.757 | 49.499 | 100 year 600 minute winter | 17.376 | 6.956 |
| 30 year 60 minute summer | 116.589 | 30.811 | 100 year 720 minute summer | 22.452 | 6.017 |
| 30 year 60 minute winter | 77.459 | 30.811 | 100 year 720 minute winter | 15.089 | 6.017 |
| 30 year 120 minute summer | 70.438 | 18.615 | 100 year 960 minute summer | 18.166 | 4.784 |
| 30 year 120 minute winter | 46.797 | 18.615 | 100 year 960 minute winter | 12.033 | 4.784 |
| 30 year 180 minute summer | 53.298 | 13.715 | 100 year 1440 minute summer | 12.896 | 3.456 |
| 30 year 180 minute winter | 34.645 | 13.715 | 100 year 1440 minute winter | 8.667 | 3.456 |
| 30 year 240 minute summer | 41.604 | 10.995 | 100 year +45% CC 15 minute summer | 505.670 | 143.087 |
| 30 year 240 minute winter | 27.641 | 10.995 | 100 year +45% CC 15 minute winter | 354.856 | 143.087 |
| 30 year 360 minute summer | 31.221 | 8.034 | 100 year +45% CC 30 minute summer | 332.000 | 93.944 |
| 30 year 360 minute winter | 20.295 | 8.034 | 100 year +45% CC 30 minute winter | 232.982 | 93.944 |
| 30 year 480 minute summer | 24.324 | 6.428 | 100 year +45% CC 60 minute summer | 222.268 | 58.739 |
| 30 year 480 minute winter | 16.160 | 6.428 | 100 year +45% CC 60 minute winter | 147.669 | 58.739 |
| 30 year 600 minute summer | 19.756 | 5.404 | 100 year +45% CC 120 minute summer | 134.215 | 35.469 |
| 30 year 600 minute winter | 13.498 | 5.404 | 100 year +45% CC 120 minute winter | 89.169 | 35.469 |
| 30 year 720 minute summer | 17.490 | 4.687 | 100 year +45% CC 180 minute summer | 101.219 | 26.047 |
| 30 year 720 minute winter | 11.754 | 4.687 | 100 year +45% CC 180 minute winter | 65.795 | 26.047 |
| 30 year 960 minute summer | 14.215 | 3.743 | 100 year +45% CC 240 minute summer | 78.690 | 20.795 |
| 30 year 960 minute winter | 9.416 | 3.743 | 100 year +45% CC 240 minute winter | 52.280 | 20.795 |
| 30 year 1440 minute summer | 10.161 | 2.723 | 100 year +45% CC 360 minute summer | 58.701 | 15.106 |
| 30 year 1440 minute winter | 6.829 | 2.723 | 100 year +45% CC 360 minute winter | 38.157 | 15.106 |
| 100 year 15 minute summer | 348.738 | 98.681 | 100 year +45% CC 480 minute summer | 45.550 | 12.038 |
| 100 year 15 minute winter | 244.728 | 98.681 | 100 year +45% CC 480 minute winter | 30.262 | 12.038 |
| 100 year 30 minute summer | 228.965 | 64.789 | 100 year +45% CC 600 minute summer | 36.875 | 10.086 |
| 100 year 30 minute winter | 160.677 | 64.789 | 100 year +45% CC 600 minute winter | 25.195 | 10.086 |
| 100 year 60 minute summer | 153.288 | 40.510 | 100 year +45% CC 720 minute summer | 32.556 | 8.725 |
| 100 year 60 minute winter | 101.841 | 40.510 | 100 year +45% CC 720 minute winter | 21.879 | 8.725 |
| 100 year 120 minute summer | 92.562 | 24.461 | 100 year +45% CC 960 minute summer | 26.340 | 6.936 |
| 100 year 120 minute winter | 61.496 | 24.461 | 100 year +45% CC 960 minute winter | 17.448 | 6.936 |
| 100 year 180 minute summer | 69.806 | 17.964 | 100 year +45% CC 1440 minute summer | 18.700 | 5.012 |
| 100 year 180 minute winter | 45.376 | 17.964 | 100 year +45% CC 1440 minute winter | 12.567 | 5.012 |

**Results for 1 year Critical Storm Duration. Lowest mass balance: 99.52%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | S1 | 10 | 152.395 | 0.045 | 10.4 | 0.0650 | 0.0000 | OK |
| 60 minute winter | S2 | 58 | 150.582 | 0.282 | 13.4 | 0.4034 | 0.0000 | OK |
| 60 minute winter | S3 | 58 | 150.582 | 0.382 | 11.5 | 0.6745 | 0.0000 | SURCHARGED |
| 60 minute winter | S4 | 60 | 150.582 | 0.482 | 6.3 | 2.1788 | 0.0000 | SURCHARGED |
| 15 minute summer | S5 | 55 | 150.037 | 0.037 | 2.3 | 0.0531 | 0.0000 | OK |
| 15 minute summer | S6 | 56 | 149.920 | 0.020 | 2.3 | 0.0281 | 0.0000 | OK |
| 15 minute summer | S7 | 56 | 148.821 | 0.021 | 2.3 | 0.0302 | 0.0000 | OK |
| 60 minute summer | S8 | 125 | 148.387 | 0.037 | 2.3 | 0.0534 | 0.0000 | OK |
| 60 minute summer | S9 | 125 | 148.137 | 0.037 | 2.3 | 0.0000 | 0.0000 | OK |
| | | | | | | | | |
| 60 minute winter | TANK1 | 60 | 150.582 | 0.182 | 8.7 | 0.2056 | 0.0000 | OK |
| 60 minute winter | TANK2 | 59 | 150.582 | 0.232 | 13.0 | 0.2622 | 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 | S1 | 1.000 | S3 | 10.3 | 2.246 | 0.197 | 0.1024 | |
| 60 minute winter | S2 | 2.000 | S3 | -8.6 | 0.275 | -0.074 | 0.6310 | |
| 60 minute winter | S3 | 1.001 | S4 | 6.3 | 0.610 | 0.077 | 1.2860 | |
| 60 minute winter | S4 | Hydro-Brake® | S5 | 2.3 | | | | |
| 15 minute summer | S5 | 1.003 | S6 | 2.3 | 0.812 | 0.050 | 0.0366 | |
| 15 minute summer | S6 | 1.004 | S7 | 2.3 | 1.329 | 0.016 | 0.0233 | |
| 15 minute summer | S7 | 1.005 | S8 | 2.3 | 1.334 | 0.018 | 0.0226 | |
| 60 minute summer | S8 | 1.006 | S9 | 2.3 | 0.548 | 0.059 | 0.1840 | 21.4 |
| | | | | | | | | |
| 60 minute winter | TANK1 | 1.000_1 | TANK2 | -8.7 | -0.086 | -0.001 | 10.1957 | |
| 60 minute winter | TANK2 | 1.001_1 | S2 | -13.0 | -0.506 | -0.186 | 0.7955 | |

**Results for 30 year Critical Storm Duration. Lowest mass balance: 99.52%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | S1 | 10 | 152.424 | 0.074 | 25.6 | 0.1058 | 0.0000 | OK |
| 120 minute winter | S2 | 118 | 151.204 | 0.904 | 19.6 | 1.2942 | 0.0000 | SURCHARGED |
| 120 minute winter | S3 | 118 | 151.204 | 1.004 | 17.0 | 1.7747 | 0.0000 | SURCHARGED |
| 120 minute winter | S4 | 118 | 151.204 | 1.104 | 4.2 | 4.9956 | 0.0000 | SURCHARGED |
| 120 minute winter | S5 | 120 | 150.038 | 0.038 | 2.4 | 0.0539 | 0.0000 | OK |
| 120 minute winter | S6 | 120 | 149.920 | 0.020 | 2.4 | 0.0284 | 0.0000 | OK |
| 15 minute winter | S7 | 5 | 148.822 | 0.022 | 2.3 | 0.0308 | 0.0000 | OK |
| 120 minute winter | S8 | 120 | 148.388 | 0.038 | 2.4 | 0.0541 | 0.0000 | OK |
| 120 minute winter | S9 | 120 | 148.138 | 0.037 | 2.4 | 0.0000 | 0.0000 | OK |
| 120 minute winter | TANK1 | 118 | 151.205 | 0.804 | 9.6 | 0.9099 | 0.0000 | OK |
| 120 minute winter | TANK2 | 118 | 151.205 | 0.854 | 19.0 | 0.9664 | 0.0000 | SURCHARGED |

| 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 | S1 | 1.000 | S3 | 25.5 | 2.455 | 0.487 | 0.2844 | |
| 120 minute winter | S2 | 2.000 | S3 | -12.5 | 0.284 | -0.107 | 0.6388 | |
| 120 minute winter | S3 | 1.001 | S4 | 4.2 | 0.582 | 0.051 | 1.2860 | |
| 120 minute winter | S4 | Hydro-Brake® | S5 | 2.4 | | | | |
| 120 minute winter | S5 | 1.003 | S6 | 2.4 | 0.818 | 0.051 | 0.0373 | |
| 120 minute winter | S6 | 1.004 | S7 | 2.4 | 1.339 | 0.016 | 0.0238 | |
| 15 minute winter | S7 | 1.005 | S8 | 2.3 | 1.364 | 0.018 | 0.0226 | |
| 120 minute winter | S8 | 1.006 | S9 | 2.4 | 0.553 | 0.061 | 0.1876 | 69.7 |
| 120 minute winter | TANK1 | 1.000_1 | TANK2 | -9.6 | -0.040 | -0.001 | 40.9109 | |
| 120 minute winter | TANK2 | 1.001_1 | S2 | -19.0 | -0.288 | -0.272 | 0.8814 | |

**Results for 100 year Critical Storm Duration. Lowest mass balance: 99.52%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | S1 | 10 | 152.437 | 0.087 | 33.2 | 0.1239 | 0.0000 | OK |
| 180 minute winter | S2 | 176 | 151.569 | 1.269 | 18.7 | 1.8161 | 0.0000 | SURCHARGED |
| 180 minute winter | S3 | 176 | 151.569 | 1.369 | 16.4 | 2.4192 | 0.0000 | SURCHARGED |
| 180 minute winter | S4 | 176 | 151.569 | 1.469 | 3.8 | 6.6455 | 0.0000 | SURCHARGED |
| 180 minute winter | S5 | 176 | 150.040 | 0.040 | 2.7 | 0.0574 | 0.0000 | OK |
| 180 minute winter | S6 | 176 | 149.921 | 0.021 | 2.7 | 0.0302 | 0.0000 | OK |
| 180 minute winter | S7 | 176 | 148.823 | 0.023 | 2.7 | 0.0325 | 0.0000 | OK |
| 180 minute winter | S8 | 176 | 148.390 | 0.040 | 2.7 | 0.0577 | 0.0000 | OK |
| 180 minute winter | S9 | 176 | 148.140 | 0.040 | 2.7 | 0.0000 | 0.0000 | OK |
| 180 minute winter | TANK1 | 176 | 151.569 | 1.169 | 9.1 | 1.3224 | 0.0000 | OK |
| 180 minute winter | TANK2 | 176 | 151.569 | 1.219 | 18.2 | 1.3789 | 0.0000 | SURCHARGED |

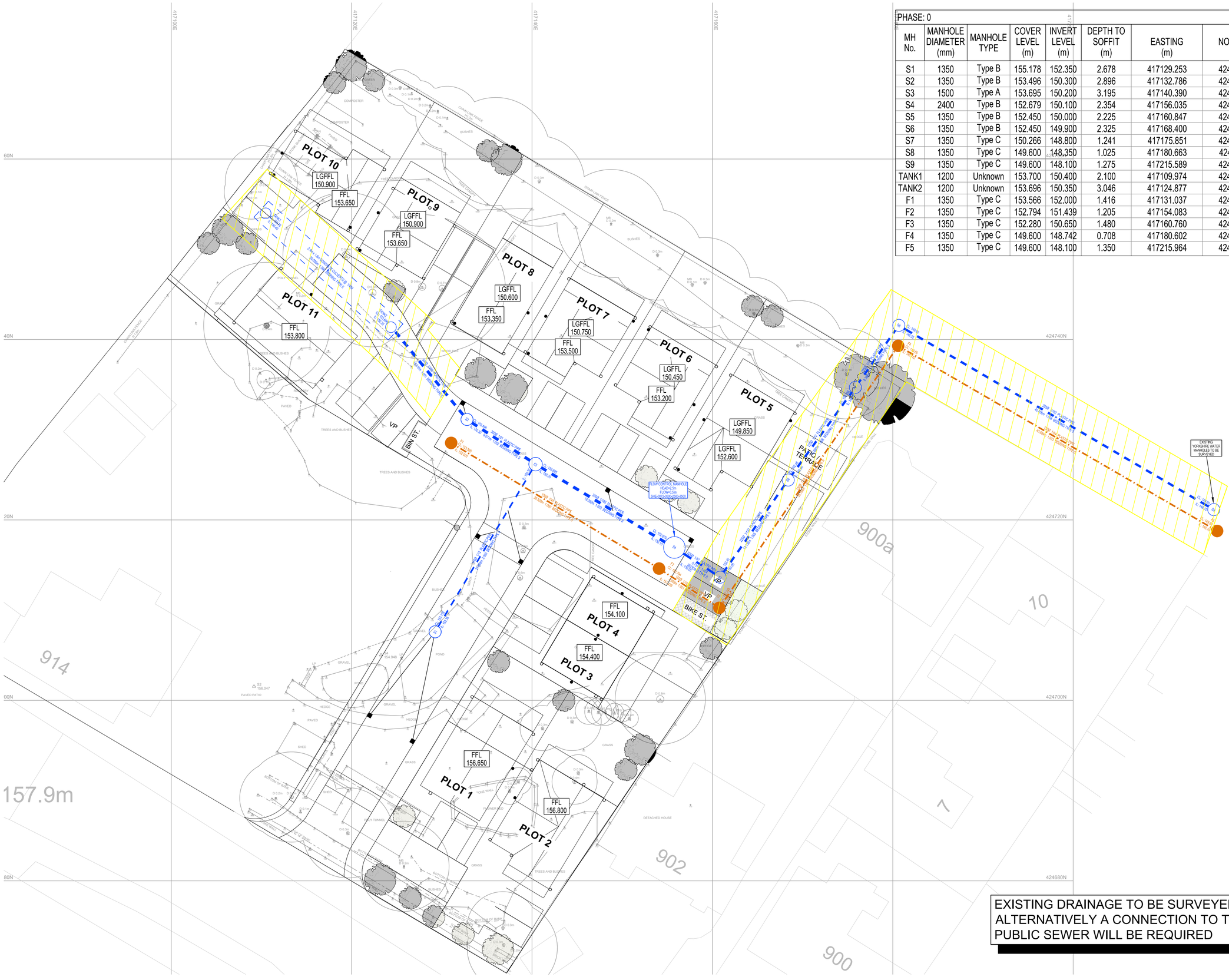
| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | S1 | 1.000 | S3 | 33.1 | 2.381 | 0.632 | 0.3048 | |
| 180 minute winter | S2 | 2.000 | S3 | -11.8 | 0.277 | -0.101 | 0.6388 | |
| 180 minute winter | S3 | 1.001 | S4 | 3.8 | 0.538 | 0.046 | 1.2860 | |
| 180 minute winter | S4 | Hydro-Brake® | S5 | 2.7 | | | | |
| 180 minute winter | S5 | 1.003 | S6 | 2.7 | 0.851 | 0.059 | 0.0409 | |
| 180 minute winter | S6 | 1.004 | S7 | 2.7 | 1.391 | 0.018 | 0.0261 | |
| 180 minute winter | S7 | 1.005 | S8 | 2.7 | 0.957 | 0.021 | 0.0253 | |
| 180 minute winter | S8 | 1.006 | S9 | 2.7 | 0.574 | 0.069 | 0.2058 | 101.0 |
| 180 minute winter | TANK1 | 1.000_1 | TANK2 | -9.1 | -0.019 | -0.001 | 58.8980 | |
| 180 minute winter | TANK2 | 1.001_1 | S2 | -18.2 | -0.258 | -0.260 | 0.8814 | |

**Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 99.52%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | S1 | 11 | 152.700 | 0.350 | 48.2 | 0.5014 | 0.0000 | SURCHARGED |
| 240 minute winter | S2 | 232 | 152.669 | 2.369 | 21.8 | 3.3897 | 0.0000 | SURCHARGED |
| 240 minute winter | S3 | 232 | 152.669 | 2.469 | 19.1 | 4.3622 | 0.0000 | SURCHARGED |
| 240 minute winter | S4 | 232 | 152.669 | 2.568 | 5.0 | 11.6198 | 0.0000 | FLOOD RISK |
| 240 minute winter | S5 | 232 | 150.046 | 0.045 | 3.6 | 0.0651 | 0.0000 | OK |
| 240 minute winter | S6 | 232 | 149.924 | 0.024 | 3.6 | 0.0342 | 0.0000 | OK |
| 240 minute winter | S7 | 232 | 148.826 | 0.026 | 3.6 | 0.0367 | 0.0000 | OK |
| 240 minute winter | S8 | 232 | 148.396 | 0.046 | 3.6 | 0.0655 | 0.0000 | OK |
| 240 minute winter | S9 | 232 | 148.145 | 0.045 | 3.5 | 0.0000 | 0.0000 | OK |
| 240 minute winter | TANK1 | 232 | 152.669 | 2.269 | 10.6 | 2.5659 | 0.0000 | SURCHARGED |
| 240 minute winter | TANK2 | 232 | 152.669 | 2.319 | 21.2 | 2.6225 | 0.0000 | SURCHARGED |

| 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 | S1 | 1.000 | S3 | 44.1 | 2.584 | 0.842 | 0.3815 | |
| 240 minute winter | S2 | 2.000 | S3 | -13.7 | 0.276 | -0.117 | 0.6388 | |
| 240 minute winter | S3 | 1.001 | S4 | 5.0 | 0.552 | 0.061 | 1.2860 | |
| 240 minute winter | S4 | Hydro-Brake® | S5 | 3.6 | | | | |
| 240 minute winter | S5 | 1.003 | S6 | 3.6 | 0.919 | 0.076 | 0.0491 | |
| 240 minute winter | S6 | 1.004 | S7 | 3.6 | 1.504 | 0.024 | 0.0313 | |
| 240 minute winter | S7 | 1.005 | S8 | 3.6 | 0.992 | 0.027 | 0.0304 | |
| 240 minute winter | S8 | 1.006 | S9 | 3.5 | 0.620 | 0.090 | 0.2469 | 156.0 |
| 240 minute winter | TANK1 | 1.000_1 | TANK2 | -10.6 | 0.011 | -0.001 | 88.8170 | |
| 240 minute winter | TANK2 | 1.001_1 | S2 | -21.2 | -0.301 | -0.303 | 0.8814 | |

# APPENDIX F
# DRAINAGE LAYOUT




| PHASE: 0 | | | | | | | |
|---|---|---|---|---|---|---|---|
| MH No. | MANHOLE DIAMETER (mm) | MANHOLE TYPE | COVER LEVEL (m) | INVERT LEVEL (m) | DEPTH TO SOFFIT (m) | EASTING (m) | NORTHING (m) |
| S1 | 1350 | Type B | 155.178 | 152.350 | 2.678 | 417129.253 | 424707.595 |
| S2 | 1350 | Type B | 153.496 | 150.300 | 2.896 | 417132.786 | 424731.129 |
| S3 | 1500 | Type A | 153.695 | 150.200 | 3.195 | 417140.390 | 424726.183 |
| S4 | 2400 | Type B | 152.679 | 150.100 | 2.354 | 417156.035 | 424716.763 |
| S5 | 1350 | Type B | 152.450 | 150.000 | 2.225 | 417160.847 | 424713.650 |
| S6 | 1350 | Type B | 152.450 | 149.900 | 2.325 | 417168.400 | 424724.422 |
| S7 | 1350 | Type C | 150.266 | 148.800 | 1.241 | 417175.851 | 424734.690 |
| S8 | 1350 | Type C | 149.600 | 148.350 | 1.025 | 417180.663 | 424741.561 |
| S9 | 1350 | Type C | 149.600 | 148.100 | 1.275 | 417215.589 | 424721.144 |
| TANK1 | 1200 | Unknown | 153.700 | 150.400 | 2.100 | 417109.974 | 424754.445 |
| TANK2 | 1200 | Unknown | 153.696 | 150.350 | 3.046 | 417124.877 | 424740.830 |
| F1 | 1350 | Type C | 153.566 | 152.000 | 1.416 | 417131.037 | 424728.538 |
| F2 | 1350 | Type C | 152.794 | 151.439 | 1.205 | 417154.083 | 424714.609 |
| F3 | 1350 | Type C | 152.280 | 150.650 | 1.480 | 417160.760 | 424710.260 |
| F4 | 1350 | Type C | 149.600 | 148.742 | 0.708 | 417180.602 | 424739.296 |
| F5 | 1350 | Type C | 149.600 | 148.100 | 1.350 | 417215.964 | 424718.778 |

EXISTING DRAINAGE TO BE SURVEYED, ALTERNATIVELY A CONNECTION TO THE PUBLIC SEWER WILL BE REQUIRED

NOTES

1. THIS DRAWING IS PRODUCED FOR USE IN THIS PROJECT ONLY AND MAY NOT BE USED FOR ANY OTHER PURPOSE. THE CONSULTING ENGINEERS ACCEPT NO LIABILITY FOR THE USE OF THIS DRAWING OTHER THAN THE PURPOSE FOR WHICH IT WAS INTENDED IN CONNECTION WITH THIS PROJECT AS RECORDED ON THE TITLE BLOCK FIELDS 'PURPOSE FOR ISSUE' AND 'FILE STATUS CODE'.
2. THIS DRAWING MAY NOT BE REPRODUCED IN ANY FORM WITHOUT PRIOR WRITTEN AGREEMENT FROM ADVANT ENGINEERS.
3. DO NOT SCALE FROM THE DRAWING, USE WRITTEN DIMENSIONS ONLY.
4. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
5. DISCREPANCIES MUST BE REPORTED BACK TO THE ENGINEER PRIOR TO CONSTRUCTION.
6. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ADVANT ENGINEERS DRAWINGS AND SPECIFICATIONS.

KEY

PROP S104 SW SEWER

PROP S104 FW SEWER

SEWER EASEMENT

N

| REV | | BY | DATE |
|---|---|---|---|
| A | INITIAL ISSUE | MJM | 23.10.24 |
| REV | AMENDMENTS | BY | DATE |

FOR COMMENT

| STATUS | CHK'D |
|---|---|
| PRELIMINARY | MJM |
| FOR COMMENT | MJM |
| FOR APPROVAL | |
| FOR CONSTRUCTION | |
| AS BUILT | |

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leeds@advantengineers.co.uk

CLIENT
BARNES HOMES

CONTRACT
HALIFAX ROAD
HARTSHEAD MOOR

TITLE
S104 DRAINAGE LAYOUT

| DRAWN | MJM | CHK'D | MJM |
|---|---|---|---|
| SCALE | 1:200 @ A1 | DATE | 23.10.24 |

| JOB No | DRG No | REV |
|---|---|---|
| 22091 | 104 | A |

# APPENDIX G
# FLOOD EXCEEDANCE PLAN

NOTES

1. THIS DRAWING IS PRODUCED FOR USE IN THIS PROJECT ONLY AND MAY NOT BE USED FOR ANY OTHER PURPOSE. THE CONSULTING ENGINEERS ACCEPT NO LIABILITY FOR THE USE OF THIS DRAWING OTHER THAN THE PURPOSE FOR WHICH IT WAS INTENDED IN CONNECTION WITH THIS PROJECT AS RECORDED ON THE TITLE BLOCK FIELDS 'PURPOSE FOR ISSUE' AND 'FILE STATUS CODE'.
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5. DISCREPANCIES MUST BE REPORTED BACK TO THE ENGINEER PRIOR TO CONSTRUCTION.
6. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ADVANT ENGINEERS DRAWINGS AND SPECIFICATIONS.

KEY

FLOOD EXCEEDANCE EVENT

FLOOD FLOW PATH

N

EXISTING DRAINAGE TO BE SURVEYED, ALTERNATIVELY A CONNECTION TO THE PUBLIC SEWER WILL BE REQUIRED

| REV | | BY | DATE |
|---|---|---|---|
| A | INITIAL ISSUE | MJM | 13.05.25 |
| REV | AMENDMENTS | BY | DATE |

FOR APPROVAL

| STATUS | | CHK'D |
|---|---|---|
| PRELIMINARY | | MJM |
| FOR COMMENT | | MJM |
| FOR APPROVAL | | MJM |
| FOR CONSTRUCTION | | |
| AS BUILT | | |

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leeds@advantengineers.co.uk

CLIENT
BARNES HOMES

CONTRACT
HALIFAX ROAD
HARTSHEAD MOOR

TITLE
FLOOD EXCEEDANCE
LAYOUT PLAN

| DRAWN | MJM | CHK'D | MJM |
|---|---|---|---|
| SCALE | 1:200 @ A1 | DATE | 13.05.25 |

| JOB No | DRG No | REV |
|---|---|---|
| 22091 | 113 | A |

# APPENDIX H
# HYDROBRAKE INFORMATION

## Technical Specification

| Control Point | Head (m) | Flow (l/s) |
|---|---|---|
| Primary Design | 2.500 | 3.500 |
| Flush-Flo™ | 0.317 | 2.334 |
| Kick-Flo® | 0.646 | 1.883 |
| Mean Flow | | 2.586 |

This Hydro-Brake® Optimum includes:

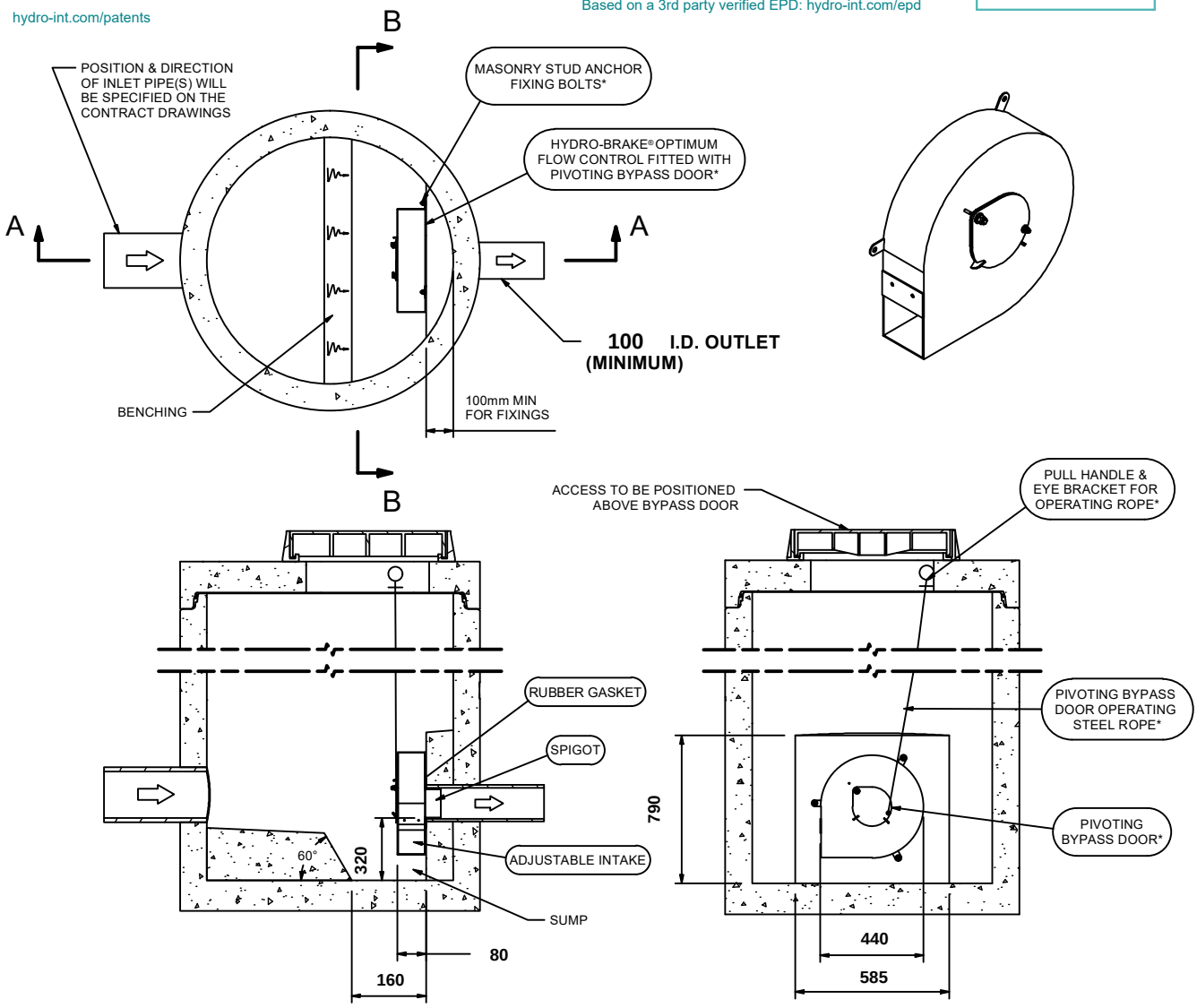
- •All in 3 mm Grade 304L stainless steel
- • Integral pivoting by-pass door allowing clear line of sight through to outlet, c/w operating rope
- • Media blasted for corrosion resistance
- • Variable flow rate post installation via adjustable inlet (if necessary)
- • Indicative Weight: 10 kg
- • Product Carbon Footprint: 44.14 kgCO2e

Based on a 3rd party verified EPD: hydro-int.com/epd

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 08/4596

wrc approved PT/503/0422 Valid: 01/04/2022 - 31/03/2027

hydro-int.com/patents




SECTION A-A

SECTION B-B

**IMPORTANT:**

LIMIT OF HYDRO INTERNATIONAL SUPPLY
THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED
HYDRO-BRAKE® IS A REGISTERED TRADEMARK FOR FLOW CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY HYDRO INTERNATIONAL

**THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.**

DESIGN ADVICE

The head/flow characteristics of this SHE-0072-3500-2500-3500 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.
**The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.**

Hydro International A CRH COMPANY

| | |
|---|---|
| DATE | 14/05/2025 04:26 |
| SITE | Halifax Road |
| DESIGNER | Michael Micklethwaite |
| REF | 22091 |

SHE-0072-3500-2500-3500

Hydro-Brake® Optimum



michael@advantengineers.co.uk

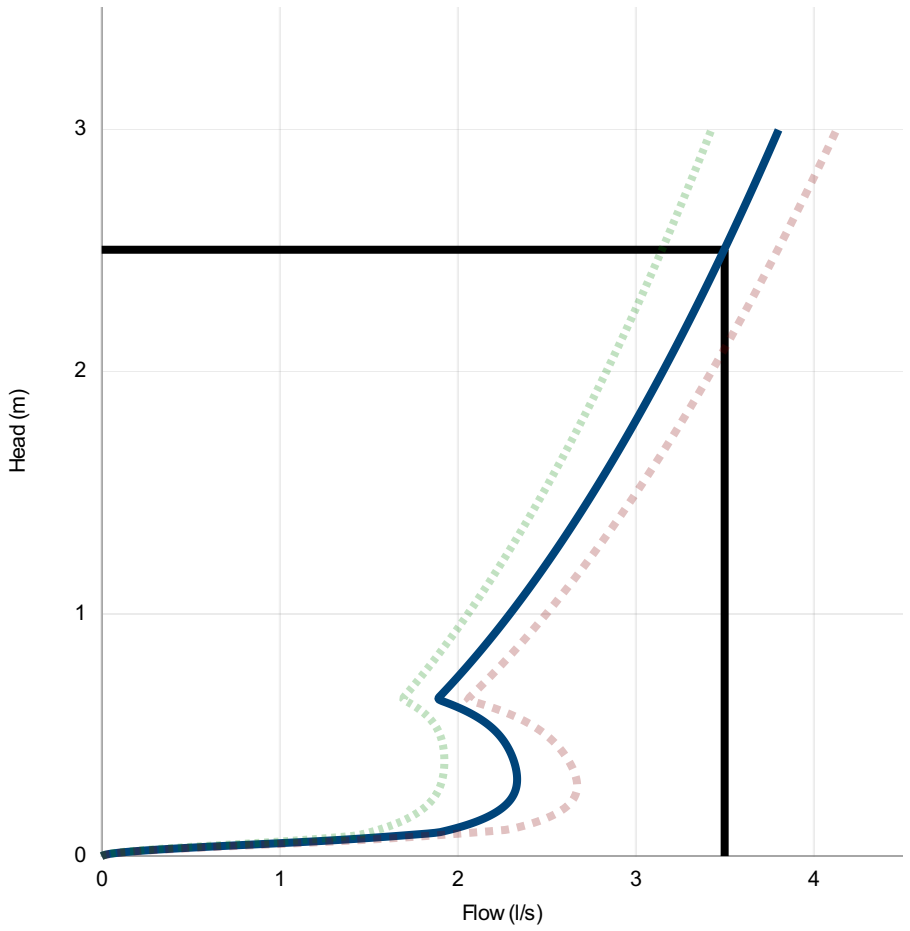
## Technical Specification

| | Original Setting | | Minimum Setting | | Maximum Setting | |
|---|---|---|---|---|---|---|
| **Control Point** | **Head (m)** | **Flow (l/s)** | **Head (m)** | **Flow (l/s)** | **Head (m)** | **Flow (l/s)** |
| Primary Design | 2.500 | 3.500 | 2.500 | 3.148 | 2.500 | 3.798 |
| Flush-Flo™ | 0.317 | 2.334 | 0.392 | 1.925 | 0.290 | 2.671 |
| Kick-Flo® | 0.646 | 1.883 | 0.646 | 1.687 | 0.644 | 2.051 |
| Mean Flow | | 2.586 | | 2.290 | | 2.835 |

BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE No 08/4596

wrc approved™
PT/503/0422
Valid: 01/04/2022 - 31/03/2027

hydro-int.com/patents




| Head (m) | Flow (l/s) |
|---|---|
| 0.000 | 0.000 |
| 0.086 | 1.713 |
| 0.172 | 2.196 |
| 0.259 | 2.318 |
| 0.345 | 2.331 |
| 0.431 | 2.294 |
| 0.517 | 2.210 |
| 0.603 | 2.032 |
| 0.690 | 1.940 |
| 0.776 | 2.046 |
| 0.862 | 2.146 |
| 0.948 | 2.240 |
| 1.034 | 2.331 |
| 1.121 | 2.418 |
| 1.207 | 2.501 |
| 1.293 | 2.581 |
| 1.379 | 2.658 |
| 1.466 | 2.733 |
| 1.552 | 2.806 |
| 1.638 | 2.877 |
| 1.724 | 2.945 |
| 1.810 | 3.012 |
| 1.897 | 3.078 |
| 1.983 | 3.141 |
| 2.069 | 3.204 |
| 2.155 | 3.265 |
| 2.241 | 3.325 |
| 2.328 | 3.383 |
| 2.414 | 3.441 |
| 2.500 | 3.497 |

DESIGN ADVICE

The head/flow characteristics of this SHE-0072-3500-2500-3500 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

! **The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.**

Hydro International
A CRH COMPANY

| | |
|---|---|
| DATE | 14/05/2025 04:26 |
| Site | Halifax Road |
| DESIGNER | Michael Micklethwaite |
| Ref | 22091 |

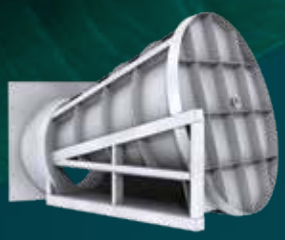
SHE-0072-3500-2500-3500

Hydro-Brake® Optimum

Hydro International
A CRH COMPANY

# The **Hydro-Brake®** Flow Control Series

**Hydro-Brake® Flood**



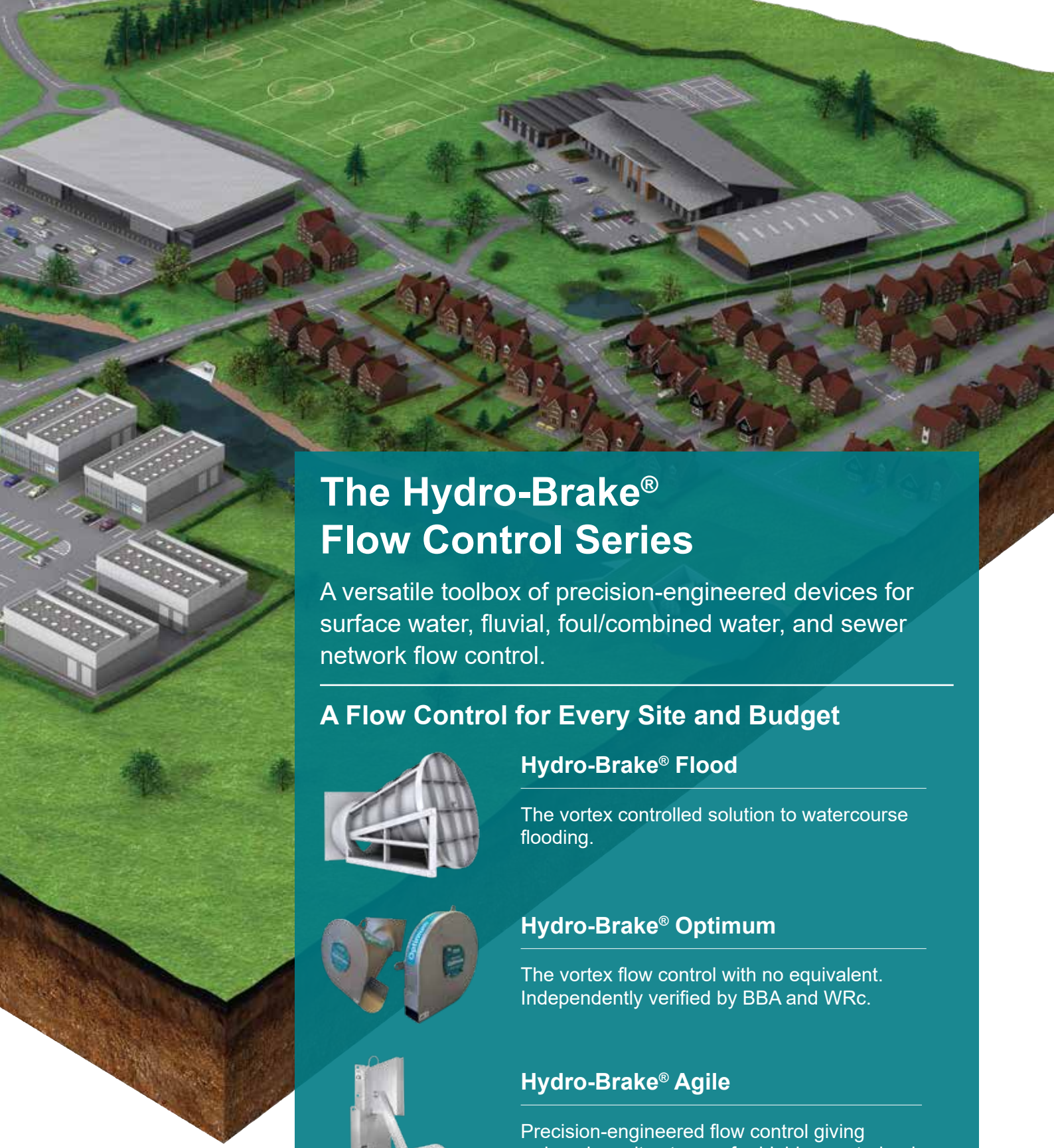
**Hydro-Brake® Optimum**

**Hydro-Brake® Agile**

**Hydro-Brake® Orifice**

## The element of control

Turning Water Around®



# The Hydro-Brake® Flow Control Series

A versatile toolbox of precision-engineered devices for surface water, fluvial, foul/combined water, and sewer network flow control.

## A Flow Control for Every Site and Budget



### Hydro-Brake® Flood

The vortex controlled solution to watercourse flooding.



### Hydro-Brake® Optimum

The vortex flow control with no equivalent. Independently verified by BBA and WRc.

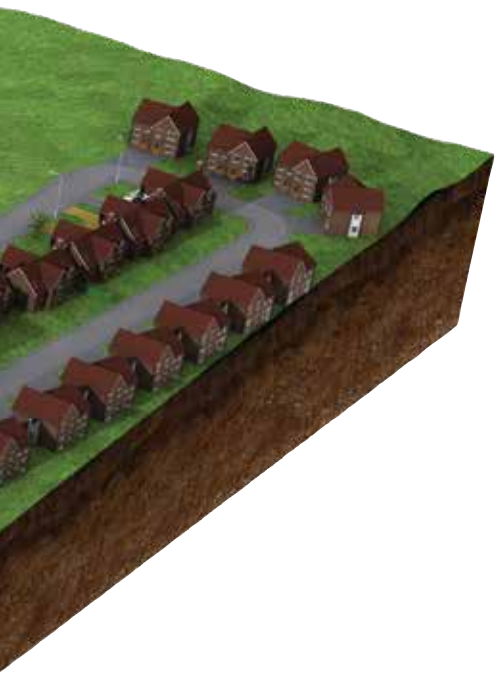


### Hydro-Brake® Agile

Precision-engineered flow control giving reduced on-site storage for highly constrained applications.

### Hydro-Brake® Orifice

The low cost option for unconstrained sites.



# The Element of Control

**Hydro International has set the highest standards in flow control technology during more than 40 years of specialist water engineering. When it comes to understanding, predicting and controlling the flow of water, Hydro works with scientific rigour.**

Our customers are constantly challenged to deliver imaginative solutions, despite tough commercial and physical constraints. Committed to precision in product development and manufacture, we partner with you to engineer the best-possible water management solutions.

Hydro International's unrivalled knowledge and outstanding technical design support give our customers complete reassurance of system performance and value.

**We give you the element of control.**

## Precision-Engineered for Reliable, Repeatable Performance

The Hydro-Brake® Flow Control Series offers a comprehensive choice for sustainable, performance-optimised attenuation and control whatever the project. Fully scalable and adaptable to your site conditions, there is no need to compromise on your project requirements.

All Hydro International flow controls are manufactured to the same exacting standards of quality. Tested, proven and independently accredited by regulatory bodies across the world, they offer the reassurance of reliable, repeatable performance.

## Technical Design Support

Faced with increasingly varied environmental and planning stipulations, engineers need to adapt their solutions accordingly and balance flow rates with storage requirements and optimise the drainage system performance over the duration of a storm. In these circumstances, Hydro International's expert design support can advise on the correct flow control selection and design.

A full range of technical services, including detailed hydraulic modelling, easy-to-use design tools and integration into industry-standard software, all help engineers to achieve optimum hydraulic performance.

## Buildable, Maintainable, Adoptable

Hydro International flow controls are designed and manufactured for ease of installation and reliable through-life performance with minimum intervention. Simple, predictable, low-maintenance regimes make them straightforward for management organisations to take on, and remove any concerns for adopting authorities.

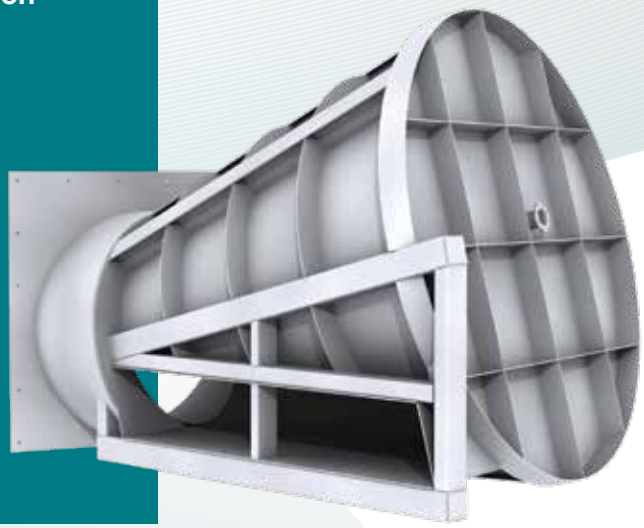
For peace of mind and to make maintenance easier and more cost effective Hydro-Logic® Smart Maintenance can be added to any of our flow control chambers. This sophisticated sensor and telemetry package enables remote, monitoring of water levels and alerts will be triggered when abnormal water level activity is detected.

# Hydro-Brake® Flood

**Hydro-Brake® Flood is a highly sustainable, precision-engineered vortex technology for preventing watercourse flooding.**

Hydro-Brake® Flood flow controls have been installed at the heart of low-maintenance, self-activating flood defences since the 1990s, and now protect more than 6,000 properties from an estimated £200m of flood damage in pioneering schemes across the UK.

**Watercourse flood prevention**



- ✓ No external power.
- ✓ No moving parts.
- ✓ Upstream flood storage minimised.
- ✓ Minimal maintenance.

## Bespoke, Precision Engineering

**Each Hydro-Brake® Flood is a bespoke solution that precisely manages watercourse flows, right up to major dams with pass forward flow rates of 30 m³/s. The same technology is used just as successfully in smaller, dispersed schemes.**

Each Hydro-Brake® Flood scheme is purpose-designed to optimise flow control performance characteristics and precisely calculate the amount of upstream storage required. Using Hydro-Brake® Flood vortex technology can reduce the volume of floodwater to be stored by up to 30% compared to fixed orifice controls.

## A Simple, Elegant Solution

**The internal geometry of Hydro-Brake® Flood is designed so that water can flow through it without restriction for as long as possible, minimising the upstream storage required. A self-activating vortex is created when the water reaches the pre-determined hydraulic head, holding back excess water, and releasing it at a controlled rate.**

## Expert Design and Manufacture

**Designing fluvial interventions, whether on a large or small scale, requires expert engineering and hydraulic modelling in line with the flood risk management strategy. Hydro International can support with detailed design using Computational Fluid Dynamics and structural design using Finite Element Analysis, scale testing and production of detailed design drawings and specifications.**

Hydro-Brake® Flood vortex flow controls are manufactured in high-grade stainless steel to be structurally fit-for-purpose, using modern production and control methods to ensure the design and performance objectives are delivered.

## Low Impact, Minimal Maintenance

**The Hydro-Brake® Flood has a large open area at all flow rates, resulting in a low risk of blockages. With no power or moving parts, the flow controls require minimal operational attention and maintenance.**

## Future-Proofed

**Hydro-Brake® Flood schemes can be designed to allow for future variances in fluvial flows. A facility for future adjustment to allow for climate change can be incorporated without necessitating new engineering or construction works.**

## Monitoring

**Flood alleviation at the fluvial level can be demonstrated to deliver a level of protection that is worth far more than the project costs. We can offer support and advice on post-installation monitoring of the value of the intervention.**

## Case Studies

### Flood Prevention Scheme Protects 1,750 Properties in Glasgow

Glasgow City Council's £53 m White Cart Water Flood Prevention scheme protects 1,750 properties in the south of the city. Normally a shallow river, White Cart Water is prone to flash flooding. As little as twelve hours of rain can cause water levels to rise by six metres.

New manufacturing and installation techniques were developed as part of the project that saw the world's five largest-ever Hydro-Brake® Flood vortex flow controls installed in 3 dams in the highlands above the city. The final scheme controls flow rates and velocities up to a 1 in 200 year flood event, with a 45% maximum reduction in peak flows, holding back more than 2.5 billion litres of floodwater in upstream storage areas that make best use of the natural environment.

### Vortex Technology Protects Northallerton Homes and Businesses

In the North Yorkshire town of Northallerton, a £3.1 million flood alleviation scheme is using Hydro-Brake® Flood technology to protect 170 homes and businesses. Two large Hydro-Brake® Flood vortex flow controls were installed in refurbished culverts on town's outskirts.

They enable excess water to be held back in specially-built flood storage basins. Before the scheme was built, excess floodwaters could overtop the watercourse in the agricultural land on its approach to the culverts sending flows to cause flooding in the east of the town. Hydro International carefully-sized the flow controls to minimise upstream storage requirements.

## Hydro-Brake® Flood Selection Criteria

| Suitability: | For rivers & watercourses; Flood storage reservoirs | | |
|---|---|---|---|
| Flow Range (l/s) | Head Range (m) | Ability to match greenfield discharge rate | On-site water storage requirement |
| 550 – 12,000 * | 1.5 – 10 * | n/a | Low |
| Moving Parts? | External Power? | Risk of blockage? | |
| No | No | Very low | |

* higher flows and heads may be possible (contact Hydro International to discuss)

# Hydro-Brake® Optimum

**The Hydro-Brake® Optimum is Hydro International's flagship passive flow control device and the most advanced vortex flow control available.**

Hydro-Brake® Optimum is the only vortex flow control for which the head and discharge relationship can be fine-tuned to optimise your design. Designers can size a Hydro-Brake® Optimum to achieve the perfect hydraulic performance curve and engineer the best possible passive flow control performance.


- Surface water management and SuDS
- Combined drainage systems and CSOs
- Watercourse flood prevention
- Sewer network optimisation
- Wastewater treatment plants

- ✓ No external energy source.
- ✓ No moving parts.
- ✓ Future-proof.
- ✓ Large outlet clearances prevent blockages.

## There is No Equivalent

**Hydro-Brake® Optimum dispenses with the need to choose from a range of sizes and types and instead offers built-in flexibility to size each unit for absolute fit. Each Hydro-Brake® Optimum is individually-sized, so you achieve performance without compromise for every project.**

## Maximise Storage Savings

**The increased hydraulic efficiency of the Hydro-Brake® Optimum means you can reduce on-site storage by up to 15% than if an alternative vortex control is used. With reduced storage, you can lower construction and excavation costs as well as saving project time and overall land-use.**

## Best Value for Every Project

**Selecting the superior performance of Hydro-Brake® Optimum does not mean a higher cost for your project. On the contrary, because your upstream storage can be fine-tuned to achieve the smallest volumes, construction, excavation and material costs are reduced.**

## Easy to Install

**Hydro-Brake® Optimum comes with a range of installation options and accessories to make construction and installation as simple as possible.**

## Setting the Standard

**The Hydro-Brake® Optimum is the culmination of more than 40 years of research and development by Hydro International, and the company continues to take an international lead in vortex technology and expertise. Hydro-Brake® Optimum is the only vortex flow control to be independently certified by BBA and WRc for the control of stormwater or combined flows.**

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 08/4596

wrc approved

## Minimal Maintenance

**With up to 20% larger outlet clearances compared to other vortex devices, there is significantly less risk of blockage with a Hydro-Brake® Optimum. With no power source or moving parts, it offers minimal, predictable maintenance.**

## Future-Proofed

**Standard, Hydraulically Efficient, Hydro-Brake® Optimum units are supplied with an adjustable inlet, allowing post-installation flow adjustments without the need to replace the whole device.**

## Flow Control Chamber

**A Hydro-Brake® Optimum flow control can be supplied prefitted in a precast reinforced concrete chamber. Custom options including high level emergency bypass, rodding pipe and removable units are also available.**

## Case Studies

### Tight Fit for New Homes

Engineers challenged to solve a “tight fit” surface water management challenge on a West Yorkshire housing development used the Hydro-Brake® Optimum Design Tool to calculate a solution that optimised the limited pipe storage area. Using conventional flow control devices would have required more back up storage than would fit in the space available, but by using Hydro-Brake® Optimum flood protection measures, challenging discharge limits were met for a 1 in 100 year storm.

### ‘Optimum’ Savings for Developer with 21st Century Drainage

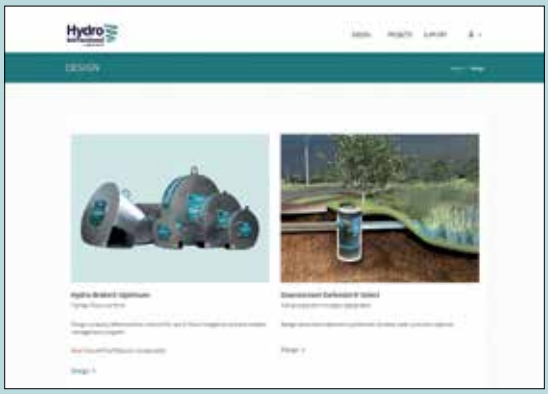
The first phase of Edinburgh City Council’s 21st Century Homes project, the Gracemount development showcases sustainable construction. A major feature of the drainage solution is Hydro International’s high performance Hydro-Brake Optimum® to control surface water which saved the developers over 30% in storage construction costs.

*Photo courtesy of Edinburgh City Council*

## Hydro-Brake® Optimum Selection Criteria

| Suitability: | Most sites, from very low to very high flow rates | | |
|---|---|---|---|
| Flow Range (l/s) | Head Range (m) | Ability to match greenfield discharge rate | On-site water storage requirement |
| 0.7 – 550 * | 0.4 – 4.0 | Very good | Low |
| Moving Parts? | External Power? | Risk of blockage? | |
| No | No | Very low | |

* lower flows may be possible (contact Hydro International to discuss)



## 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 option to design and customise our latest stormwater treatment separator, the Downstream Defender® Select.

hydro-int.design

**Hydro-Brake® Hotline: 01275 337937**
stormwater@hydro-int.com

# Hydro-Brake® Agile

**The Hydro-Brake® Agile flow control delivers precision engineering with best value for even the most constrained sites.**

The Hydro-Brake® Agile flow control is a float-activated flow control that maintains a constant discharge to deliver precise performance over a wide range of heads. It is ideally suited to applications with constrained discharge requirements or where the flood storage area available through attenuation is very limited.

Surface water management and SuDS

Watercourse flood prevention


- ✓ No external energy source.
- ✓ Rapid drain-down provides resilience to subsequent rainfall events.
- ✓ Future-proof – simple adjustments possible for future changes in operating conditions.
- ✓ Repeatable, predictable maintenance regime.

## Meet Stringent Discharge Consents

**Designing flood storage, whether above or below ground, is dependent on the rate at which excess water can be controlled and discharged. The Hydro-Brake® Agile flow control is the only flow control design that achieves a constant rate of discharge and therefore the minimum possible upstream storage.**

Whether controlling surface water on a housing development, or regulating flows in a wastewater treatment works, investment in a precision-engineered device can result in considerable savings in total project costs.

## Sustainable Solution

**The Hydro-Brake® Agile flow control provides sustainable control of flood storage without the need for external power sources or control circuits. Simple adjustments can be made to future-proof the device to allow for climate change.**

## Quality Manufacture

**The Hydro-Brake® Agile flow control is precision-engineered using high-grade stainless steel with long-life, durable components and CE marked in accordance with the EU Machinery Directive (2006/42/EC). Manufactured in the UK, the flow control can be transported quickly to site to meet project timescales.**

## Easy to Install and Maintain

**During dry weather periods, and especially during the first flush of a storm, the outlet area is at its largest, reducing the risk of blockages.**

In the event of a blockage, an integrated release mechanism can be operated from surface level, enabling the gate to be fully opened and returned to its operating position.

## Hydro-Brake® Agile Flow Control Chamber

**The Hydro-Brake® Agile flow control can be supplied pre-fitted in a precast reinforced concrete chamber for quick and easy installation on site.**

A range of outlet pipe sizes is also available to suit site requirements. Once lifted into position, the connecting pipework can be connected and a cover slab installed. To suit the location and invert required, the chamber depth can be easily varied with concrete rings.

## Example Solutions

### Constrained Space

For an urban in-fill housing project in a heavily-developed inner city area, the design team were keen to deliver an effective drainage strategy. However, there was limited space available, conflicting demands from new and existing services, and an existing drainage infrastructure with very limited capacity to accept additional flows.

Using a flow control that provided a near-constant discharge rate within the parameters of the available downstream capacity, the surface water was moved off-site as quickly and effectively as possible, enabling the on-site storage to be reduced to a level that could be accommodated in the heavily constrained space available.

### Constant Discharge

Providing temporary flood storage through attenuation was the solution to a known surface water flooding problem. A flow control was needed to limit flow to the existing drainage network, with the excess rainwater overflowing into an off-line attenuation tank. Implementation costs had to be kept to an absolute minimum or the project may not have been feasible. In addition, any surcharge to the upstream drainage network would have moved flooding to a different part of the catchment.

A constant discharge flow control was therefore used to pass forward an appropriate amount of flow at all times, minimising pressure on the upstream network and only putting floodwater into the attenuation structure when absolutely necessary.

## Hydro-Brake® Agile Selection Criteria

| Suitability: | Constrained sites with stringent discharge consents | | |
|---|---|---|---|
| Flow Range (l/s) | Head Range (m) | Ability to match greenfield discharge rate | On-site water storage requirement |
| 4.5 – 100 | 0.4 – 2.4 | Good | Very low |
| Moving Parts? | External Power? | Risk of blockage? | |
| Yes | No | Not suited to all sites | |

# Hydro-Brake® Orifice

**The Hydro-Brake® Orifice delivers cost-effective, precise, repeatable flow control and is suitable for unconstrained sites with generous discharge consents**

The Hydro-Brake® Orifice is a precision-cut orifice plate flow control, available in a broad range of configurations. A low-cost, low-complexity flow control, it is the ideal choice where there is minimal limitation on space available for on-site flood storage and attenuation, or where there are generous discharge consents.


Surface water management and SuDS

Watercourse flood prevention

Sewer network optimisation

## Flexible and Versatile

**Already trusted as part of Hydro International's family of precision-engineered flow control devices, the Hydro-Brake® Orifice can be designed and manufactured to meet a wide variety of configurations. With the Hydro-Brake® Orifice there is no need to compromise on your project needs.**

## Configured for Each Site

**Each Hydro-Brake® Orifice is manufactured to suit the precise hydraulic requirements specified for the application. Our experienced professional engineering team will work with you to understand the needs of your site and recommend the best solution.**

A wide variety of configurations and mounting options is available, for example integrated mesh guards, curve mount, pipe inserts and slide- or pivot-mounts. Hydro International can advise on sizing and flow rates and recommend the best solution for your site.

## Quality Manufacture

**The Hydro-Brake® Orifice is manufactured from high-grade stainless steel under strict Quality Assurance to the exacting methods and tolerances set out in the international standard BS EN ISO 5167-2: 2003.**

## Simple to Install

**The Hydro-Brake® Orifice is simple to install. It can also be supplied pre-fitted in a precast reinforced concrete chamber for 'plug-and-play' installation on site.**

## Resilience by Design

**The Hydro-Brake® Orifice can be supplied with integrated protection against the risk of blockages. Alternatively, the Hydro-Brake® Orifice can be mounted on moveable or removable structures to allow for manual intervention to drain the control chamber from surface level and clear any blockages that do occur.**

## Hydro-Brake® Orifice Selection Criteria

| Suitability: | Unconstrained sites with generous discharge consents | | |
|---|---|---|---|
| Flow Range (l/s) | Head Range (m) | Ability to match greenfield discharge rate | On-site water storage requirement |
| 2.5 – 100 * | 0.25 – 2.0 * | Not suited to all sites | Unconstrained |
| Moving Parts? | External Power? | Risk of blockage? | |
| No | No | Not suited to all sites | |

* flows and heads may be possible outside of these ranges (contact Hydro International to discuss)

# Hydro-Brake® Flow Control Series Selection Guide

**The Hydro-Brake® Flow Control Series is a versatile toolbox for surface water, fluvial, foul water, and sewer network flow control. No matter what the site and budget, every flow control offers the same precision-engineered performance.**

| Features | Hydro-Brake® Flood | Hydro-Brake® Optimum | Hydro-Brake® Agile | Hydro-Brake® Orifice |
|---|---|---|---|---|
| **Suitability** | For watercourses; Flood storage reservoirs | Most sites, from very low to very high flow rates | Constrained sites with stringent discharge consents | Unconstrained sites with generous discharge consents |
| **Flow Range (l/s) *** | 550 – 12,000 | 0.7 – 550 | 4.5 – 100 | 2.5 – 100 |
| **Head Range (m) *** | 1.5 – 10 | 0.4 – 4.0 | 0.4 – 2.4 | 0.25 – 2.0 |
| **Ability to Match Greenfield Discharge Rate** | n/a | Very good | Good | Not suited to all sites |
| **Moving Parts** | No | No | Yes | No |
| **Future Proof** | Option that can be designed in | Adjustable inlet fitted as standard on Hydraulically Efficient units | No | No |
| **External Power Requirement** | No | No | No | No |
| **Constant Discharge** | No | No | Yes | No |
| **On-site Storage** | Low | Low | Very low | Unconstrained |
| **Risk of Blockage** | Very low | Very low | Not suited to all sites | Not suited to all sites |

* flows and heads outside of these ranges may be possible (contact Hydro International to discuss)

## Expert Design Support

**No matter how big or small the project, Hydro International's professional engineers are on hand to provide free support to designers and specifiers to aid with the correct selection and configuration of Hydro flow controls for each project design.**

Our dedicated design support team advises on best-practice sizing, flow and storage calculations for the Hydro-Brake® Flow Control Series within your surface water, fluvial, sewer or wastewater plant design.

## Data, Insight and Analysis Services

**Our Hydro-Logic® smart monitoring equipment provides a remote data collection capability that delivers real-world climate, water level, water flow and water quality data in near real time.**

## Documentation

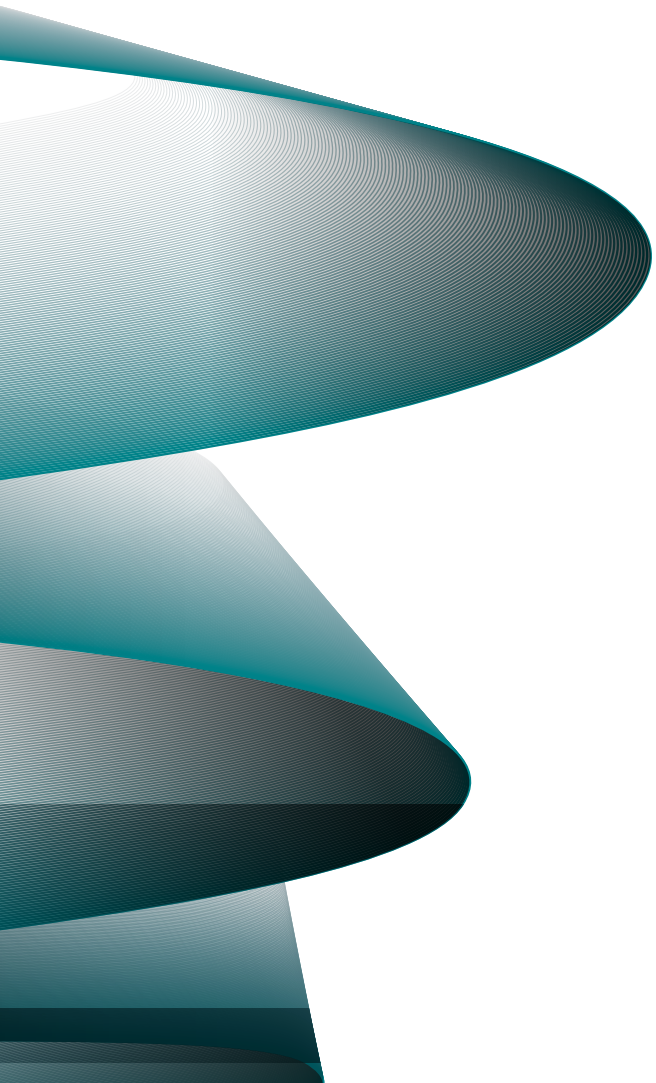
**Our dedicated design support team can assist with the output of hydraulic data to support your system design and dimensioned installation drawings, as well as advising on successful integration with other Hydro International water treatment and storage products.**

**Call the Hydro-Brake® Hotline 01275 337937 or email stormwater@hydro-int.com.**

Hydro International
A CRH COMPANY

## For Flow Control Product and Design Advice:

Tel: 01275 337937
Email: stormwater@hydro-int.com



# Hydro-Brake® Flow Control Series

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