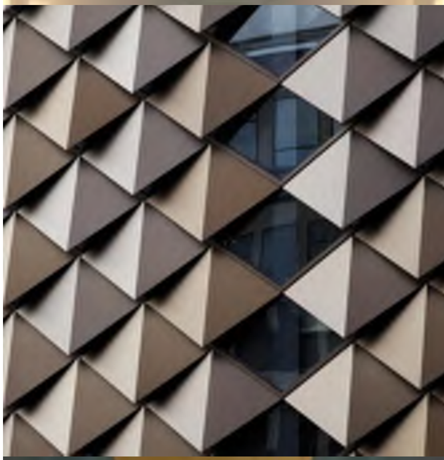

# St Andrew the Apostle School, London

## Flood Risk Assessment and Drainage Strategy Report

Curtins Ref: 072661-CUR-ZZ-XX-RP-C-0002

Revision: V02

Issue Date: 17 May 2021

Client Name: Bowmer & Kirkland

Client Address: Southern Regional Office, 1230 Arlington Business Park, Theale, Reading, RG7 4SA.


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| Rev | Description | Issued by | Checked | Date |
|---|---|---|---|---|
| V01 | Planning Issue | AS | WH | 09/04/21 |
| V02 | Revised to suit client team comments | RW | WH | 17/05/2021 |

This report has been prepared for the sole benefit, use, and information of the client. The liability of Curtins Consulting Limited with respect to the information contained in the report will not extend to any third party.

| Author | Signature | Date |
|---|---|---|
| **Alicja Smolen**<br>MSc (Hons)<br>Project Engineer | | 09/04/21 |

| Reviewed and Authorised | Signature | Date |
|---|---|---|
| **Wayne Howland**<br>BSc (Hons) CEng MIStructE<br>Associate | | 09/04/21 |

# Table of contents

# 1.0 Introduction

## 1.1 Project Background

Curtins has been appointed by Bowmer & Kirkland to provide a Drainage Strategy Report for the proposed school development located on the 1.9 ha land in Barnet, London, N11 1GN.

The site is currently occupied by buildings of miscellaneous use, office blocks, multi storey car park, in addition to the St Andrews school which is currently located in a converted office building.

This document will be used in support of a planning application to provide a 4 storey main school block with a basement car park and rooftop MUGA, a separate single storey sports block, associated infrastructure and landscaped areas. The Flood Risk Assessment (FRA) for the site was previously produced by Awcock Ward Partnership (AWP) in December 2015. This document has been produced to reflect the changes to the previously proposed drainage design and subsequently supersedes the drainage strategy provided in the AWP report.

Flood Risk Assessment produced by AWP is included in Appendix K.

Proposals contained in or forming part of this report, represent the design intent and may be subject to alteration or adjustment in completing the detailed design for this project. Where such adjustments are undertaken as part of the detailed design and are deemed a material deviation from the intent contained in this document, prior approval shall be obtained from the relevant authority in advance of commencing such works.

# 2.0 Surface Water

## 2.1 National Guidelines

The aim of the surface water drainage proposals is to focus on the capture and management the surface water within the site boundary, to prevent any likelihood of flooding to the proposed development, adjacent sites and infrastructure.

General national guidance for the design of the surface water drainage systems include the following:

- National Planning Policy Framework (NPPF)
- Non-Statutory Technical Standards for Sustainable Drainage Systems, DEFRA, March 2015
- Written Ministerial Statement regarding Sustainable Drainage (HCWS161)
- The SUDS Manual – C753, CIRIA Industry Best Practice Guidance
- Flood Risk Planning Practice Guidance
- Building Regulations Part H

The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes to the volume and rate of surface runoff from development sites, and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new developments.

Building Regulations 2010 Requirement H3 stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of hierarchy:

I. Discharge into the ground;
II. Discharge to a surface water body;
III. Discharge to a surface water sewer;
IV. Discharge to a combined sewer where there are absolutely no other options and only where agreed in advance with the relevant sewage undertaker.

The site details are as follows:

- Site Address (approximate)– Building 5, North London Business Park, London N11 1GN
- National Grid Reference (approximate) – X(Easting) 528227, Y(Northing) 193443
- Altitude – 53.5m AoD (South West) 47.5m AoD (North East)
- Sewerage Undertaker – Thames Water
- Lead Local Flood Authority – London Borough of Barnet

A location plan of the existing site is shown below:


Figure 1 – Location Plan_ Blue – school development boundary (approximate)

This Report forms the Drainage Strategy for the site, including the necessary attenuation requirements.

The proposed site layout is included in Appendix A.

**Discharge into the ground**

The following report was issued to Curtins as a part of the ISP and Feasibility Study documentation:

- 15_07932_OUT-APP_13.1_PHASE_1_GEO-REPORT_I1-3259264 (WSP Environmental, December 2007)

The document reported that the site is underlaid by the London Clay Formation (unproductive aquifer) with no reported geological faults within the site boundary. No superficial deposits were recorded beneath the site; however, land south of the site is reported to be underlaid by the Dollis Hill Gravel Member.

Extracts from GEO Report are included in Appendix B.

The FRA produced by AWP suggested that the underlying geology is likely to be unsuitable for infiltration into the ground, as the site suffers from the “impeded drainage”.

Based on the above, the use of a large scale soakaway type drainage is not considered viable and the on-site attenuation system as a primary method has been proposed.

**Discharge into a surface water body**

The nearest surface water body is the existing pond adjacent to the development boundary to the west.

The pond has been reported to be used as an attenuation feature for the whole/majority of the Business Park. However, the catchment areas that feed into the pond are unknown and it is unclear what the open waterbody may withstand during the large storm events. The only information to hand regarding the existing drainage network, are the as-built records identified within the FRA (By AWP in December 2015), which only identify drains taken from Thames Water sewer records. Furthermore, it is noted in the FRA that there are no flow control devices from the pond to the public sewer, therefore it is anticipated that the peak flows are unrestricted. In view of the above, surface water discharge from the school site to the existing pond is not considered suitable.

The second nearest natural watercourse to the site is Pymmes Brook which is approximately 515m east of the development. With Brunswick Park Road, residential properties and a cemetery between the site and the brook, a connection here is not considered suitable.

**Discharge into a surface water sewer**

In accordance with the hierarchical approach outlined in the Building Regulations Part H, it is proposed to discharge surface water from the development to the Thames Water public surface water network. The nearest viable connection to the existing network is located on the site close to the eastern boundary MH Reference: 2401. It is proposed to connect into the existing sewers via the proposed diversion route which ultimately discharges into MH 2401.

The sewer records are included in Appendix C.

## 2.2 Flood Risk

The following reports were issued to Curtins as part of the Tender documentation:

- Flood Risk Assessment (December 2015, AWP)

This report was submitted to the Local Authority as a part of an outline planning application made by Comer Homes Group for the wider masterplan development.

The report concludes that the site is in Flood Zone 1 and is not at risk of flooding.

## 2.3 Proposed Surface Water Design

The development site covers an area of approximately 1.9 ha. The estimated impermeable area of the development is 1.4 ha.

Development creep is not considered applicable for this site. If the site is ever expanded and the impermeable area increased, such scheme would go through the usual design and planning process, with an appropriate drainage strategy, which would include additional attenuation and flow control.

The surface water runoff from site will be positively drained and discharged to the public surface water sewer (MH 2401) located within the eastern part of the site.

A S106 application will be required for the proposed connection to the public sewer.

There are two existing surface water public sewers, one 375mm dia. And 600mm dia., crossing the site and in their current location will be running underneath the proposed building footprint. It is proposed to divert the 375mm sewer north into the 600mm sewer, the combined sewers will then be diverted around the north and east of the site back to their original connection point close to the eastern boundary of the site.

The Wallingford runoff tool, and the ICP SUDS calculator in Microdrainage, were used to estimate Greenfield runoff rates for the site. The $Q_{BAR}$ rates were 8.7 l/s and 12 l/s, respectively. The conservative discharge rate of 8.7l/s has been proposed for the design.

The summary sheets for Greenfield runoff rates are included in Appendix D.

The following Sustainable Drainage Systems (SuDS) have been proposed:

- Permeable parking
- Permeable MUGAs
- Filter drains
- Below ground attenuation tank
- Rain Gardens/bio-retention area
- Pocket soakaways

The Microdrainage Network module was used to determine the size of the attenuation required for the site. The majority of the proposed parking within the site will be provided utilising a permeable surface with a wrapped stone subbase. The subbase will provide water quality improvement and surface water storage. The MUGA will also utilise a permeable surface and storage within the subbase. Filter drains and rain gardens have been proposed to provide extra treatment system and an element of storage. The minor hardstanding areas such as the pedestrian footpath etc. to be served by the local pocket soakaway. The primary volume control for the site is provided via the two below ground geo-cellular storage tanks.

Due to the project specification/parameters/school operational requirements, it is not possible to provide any significant above ground attenuation feature, such as a swale/basin/pond.

The Surface Water Drainage Layout is included in Appendix E.

The surface water system has been designed to accommodate a 1 in 100 year plus 40% allowance for climate change storm event. The drainage has been designed to accommodate all of the flow during a 1 in 30 year storm event below ground.

The outputs for the 1 year, 30 year and 100 year plus climate change events are included in Appendix F.

For events greater than 100 year plus 40% climate change, a Flow Exceedance Plan is provided in Appendix G. The site levels have been designed to shed runoff away from the building in the event of exceedance flows, therefore it is considered unlikely that exceedance events will affect the proposed building.

**Water Quality**

The new SuDS Manual (CIRIA C753, November 2015) introduced a slightly different approach compared to the previous version for the water quality management of surface water. The manual describes risks posed by the surface water runoff to the receiving environment as a function of:

- The pollution hazard at a particular site (i.e. the pollution source);
- The effectiveness of the SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels (i.e. the pollutant pathway); and,
- The sensitivity of the receiving environment (the environmental receptor).

In accordance with the SuDS Manual, the site is classified as presenting a low pollutant hazard level in vehicular areas (car parking). In order to ensure water quality improvement permeable subbase to the parking bays is proposed. In addition to this filter drainage/rain garden are provided at other locations.

An outline Operations and Maintenance Manual is included in Appendix H.

# 3.0 Foul Water

The foul water network will be a gravity fed system, connecting to the existing Thames Water public sewer in Brunswick Park Road near the sites eastern boundary.

Through a pre-development enquiry and an ongoing pre planning correspondence with Thames Water, we have received a confirmation that there is adequate capacity within the public sewer network to accept the foul and surface water flows from the development.

The construction of the outfall will be subject to S106 approval with Thames Water.

The sewer records are included in Appendix C.

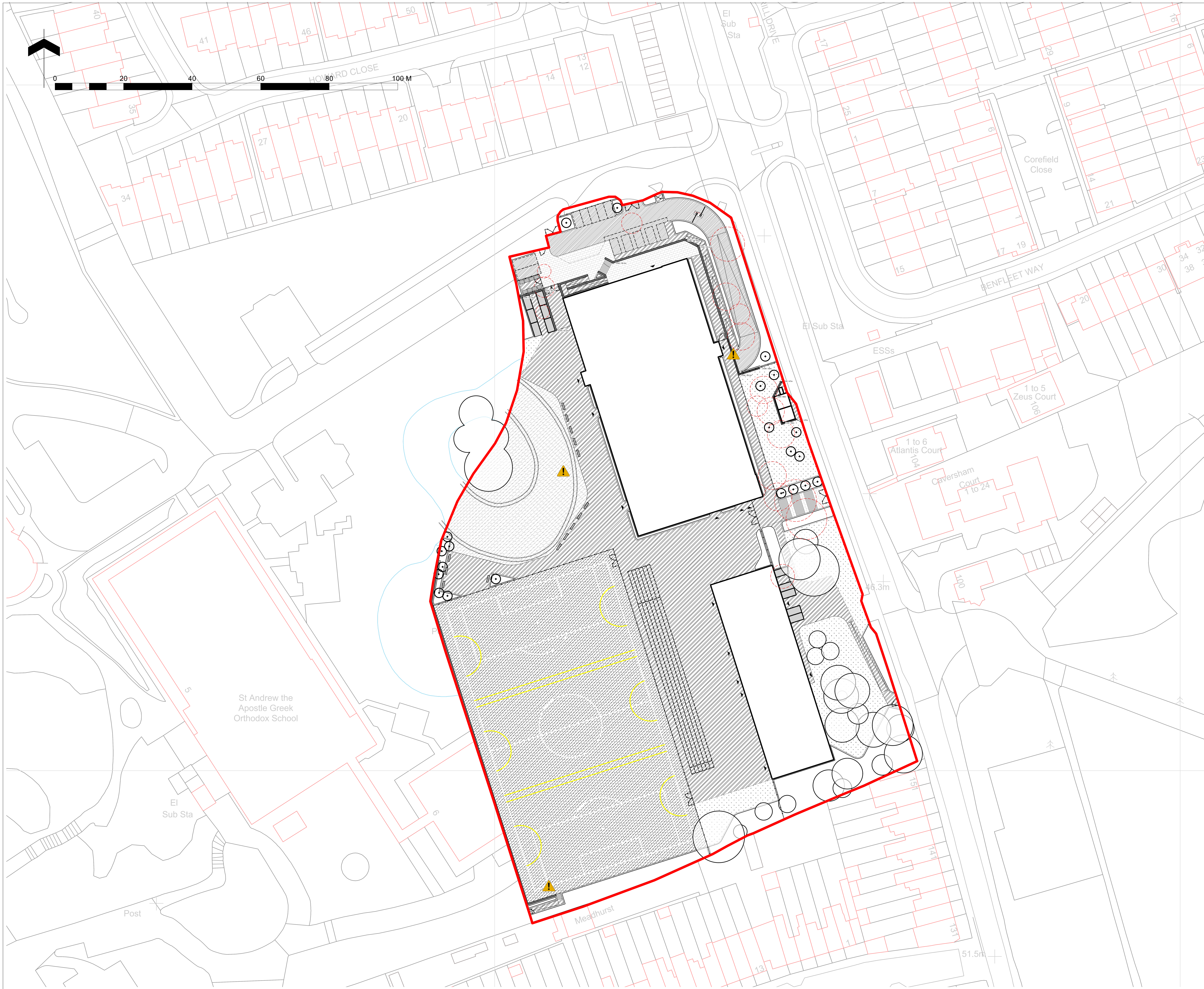
The STW pre-development enquiry response is included in Appendix J.

The Foul Water Drainage Layout is included in Appendix I.

# 4.0 Appendices

| | |
|---|---|
| **Appendix A** | **Proposed Layout** |
| **Appendix B** | **Phase I Geo Investigation Report Extracts** |
| **Appendix C** | **Sewer Records** |
| **Appendix D** | **Greenfield runoff rates** |
| **Appendix E** | **Surface Water Drainage Layout** |
| **Appendix F** | **Attenuation Calculation – 1, 30 and 100 year + 40% climate change** |
| **Appendix G** | **Flow Exceedance Plan** |
| **Appendix H** | **Outline Operations and Maintenance Manual** |
| **Appendix I** | **Foul Water Drainage Layout** |
| **Appendix J** | **STW Correspondence** |
| **Appendix K** | **Flood Risk Assessment (AWP, 2015)** |

## Appendix A Proposed Layout




KEY

| | |
|---|---|
| | Planning Application Boundary |
| | Proposed Building |
| | Existing Building to be demolished |
| | Existing Tree |
| | Existing Tree to be removed |

**Planning**

| | |
|---|---|
| | Proposed Tree<br>Refer to Planting Plan |
| | Grass Seed<br>Refer to Planting Plan |
| | Amenity Planting<br>Refer to Planting Plan |
| | Meadow Planting<br>Refer to Planting Plan |

**Paving**

| | |
|---|---|
| | Pedestrian Tarmac<br>To Engineer's Specification |
| | Vehicular Tarmac<br>To Engineer's Specification |
| | Concrete Block Paving<br>Specification TBC |
| | Artificial Sport Turf<br>Specification TBC |

**Furniture**

| | |
|---|---|
| | Steps and Handrails<br>Specification TBC |
| | Bench<br>Specification TBC |
| | Cycle Shelter<br>Specification TBC |

**Fencing and Structures**

| | |
|---|---|
| | Existing Fencing Retained |
| | Proposed Fencing<br>Refer to Fencing General Arrangement for details |
| | Proposed Gates<br>Refer to Fencing General Arrangement for details |
| | Brick Wall<br>Specification TBC |
| | Vehicle Barrier<br>Specification TBC |

| REV | DATE | DESCRIPTION |
|---|---|---|
| P01 | 03/03/2021 | Issued for Draft Contractors Proposals |

RESIDUAL PROJECT RISKS

Refer to
FS0200-ALA-00-XX-RR-L-0001_Risk Register and
FS0200-ALA-00-XX-RR-L-0002_Residual Risk Assessment for further details.

| ID | RISK | MITIGATION | Date Mitigated |
|---|---|---|---|
| | | | |

CLIENT

Department for Education

CONTRACTOR

BOWMER KIRKLAND

CONSULTANT ALA

ares LANDSCAPE ARCHITECTS

PROJECT

St Andrew the Apostle Greek Orthodox School

DRAWING TITLE

Landscape General Arrangement

DRAWING PURPOSE

DRAFT CP

| DRAWN BY | DATE | CHK'D BY | SCALE | MEDIA |
|---|---|---|---|---|
| CW | 03.03.2021 | CW | 1:500 | A1 |

CONTRACT DRAWING REFERENCE (AS REQUIRED)

| PROJECT - ORIGINATOR - ZONE - LEVEL - TYPE - ROLE - NUMBER | REVISION |
|---|---|
| FS0200-ALA-XX-XX-DR-L-0002 | P01 |

# Appendix B Phase I Geo Investigation Report Extracts

# Groundsure Enviroinsight

| | |
|---|---|
| Address: | NORTH LONDON BUSINESS PARK & OAKLEY ROAD SOUTH, BARNET, N11 1HR |
| Date: | 26 Nov 2015 |
| Reference: | HMD-411-2612457 |
| Client: | Ruddlesden Geotechnical |


| | |
|---|---|
| Aerial Photograph Capture date: | 28-Apr-2013 |
| Grid Reference: | 528088,193479 |
| Site Size: | 16.50ha |

Report Reference: HMD-411-2612457
Client Reference: 14477

# 5. Geology

## 5.1 Artificial Ground and Made Ground

Database searched and no data found.

The database has been searched on site, including a 50m buffer.

## 5.2 Superficial Ground and Drift Geology

The database has been searched on site, including a 50m buffer.

| Lex Code | Description | Rock Type |
|---|---|---|
| DHGR | DOLLIS HILL GRAVEL MEMBER | SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME] |

## 5.3 Bedrock and Solid Geology

The database has been searched on site, including a 50m buffer.

| Lex Code | Description | Rock Type |
|---|---|---|
| LC-CLSISA | LONDON CLAY FORMATION | CLAY, SILT AND SAND |

(Derived from the BGS 1:50,000 Digital Geological Map of Great Britain)

# 6.Hydrogeology and Hydrology

## 6.1 Aquifer within Superficial Deposits

Are there records of strata classification within the superficial geology at or in proximity to the property? Yes

From 1 April 2010, the Environment Agency's Groundwater Protection Policy has been using aquifer designations consistent with the Water Framework Directive. For further details on the designation and interpretation of this information, please refer to the Groundsure Enviroinsight User Guide.

The following aquifer records are shown on the Aquifer within Superficial Geology Map (6a):

| ID | Distance (m) | Direction | Designation | Description |
|---|---|---|---|---|
| 1 | 0 | On Site | Secondary A | Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers |
| 2 | 302 | E | Secondary A | Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers |
| 3 | 389 | W | Secondary A | Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers |

## 6.2 Aquifer within Bedrock Deposits

Are there records of strata classification within the bedrock geology at or in proximity to the property? Yes

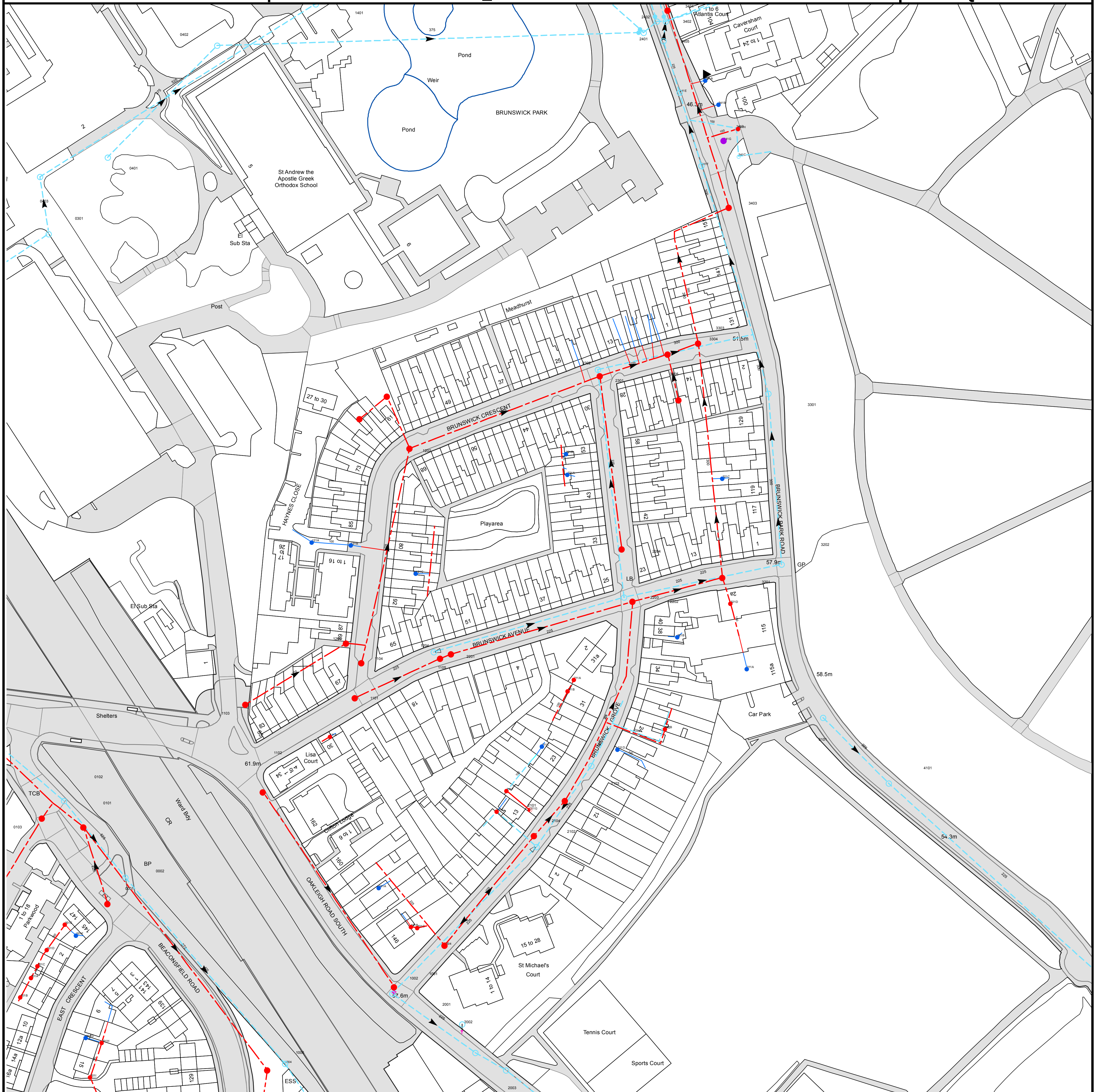
From 1 April 2010, the Environment Agency's Groundwater Protection Policy has been using aquifer designations consistent with the Water Framework Directive. For further details on the designation and interpretation of this information, please refer to the Groundsure Enviroinsight User Guide.

The following aquifer records are shown on the Aquifer within Bedrock Geology Map (6b):

| ID | Distance (m) | Direction | Designation | Description |
|---|---|---|---|---|
| 1 | 0 | On Site | Unproductive | These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow |

## Appendix C Sewer Records

| Asset Location Search Sewer Map - ALS/ALS Standard/2021_4345666 | TQ2893SW |
|---|---|




The width of the displayed area is 500m and the centre of the map is located at OS coordinates 528250,193250

**The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.**

## Appendix D Greenfield runoff rates

# Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

| | |
|---|---|
| Calculated by: | Alicja Smolen |
| Site name: | St Andrew |
| Site location: | N11 1BF |

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: | 51.62579° N |
| Longitude: | 0.14853° W |
| Reference: | 845200535 |
| Date: | Apr 09 2021 13:56 |

## Runoff estimation approach

IH124

## Site characteristics

Total site area (ha): 1.9

## 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): | 670 | 670 |
| Hydrological region: | 6 | 6 |
| Growth curve factor 1 year: | 0.85 | 0.85 |
| Growth curve factor 30 years: | 2.3 | 2.3 |
| Growth curve factor 100 years: | 3.19 | 3.19 |
| Growth curve factor 200 years: | 3.74 | 3.74 |

## 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): | 8.71 | 8.71 |
| 1 in 1 year (l/s): | 7.41 | 7.41 |
| 1 in 30 years (l/s): | 20.04 | 20.04 |
| 1 in 100 year (l/s): | 27.8 | 27.8 |
| 1 in 200 years (l/s): | 32.59 | 32.59 |

## Appendix E Surface Water Drainage Layout


# SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION UNUSUAL SIGNIFICANT HAZARDS

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

CONSTRUCTION
1. MAXIMUM LOADING ABOVE THE TANK NOT TO BE EXCEEDED. MAXIMUM LOADING AS PER MANUFACTURER SPECIFICATION.
2. CONNECTION TO LIVE SEWER. EXCAVATION MUST BE TAKEN WITH CARE AND PROTECTION MEASURES MUST BE ARRANGED PRIOR TO CONSTRUCTION.
3. EXISTING LIVE DRAINAGE CONNECTION TO BE PROTECTED DURING THE CONSTRUCTION

MAINTENANCE / CLEANING
1. MAXIMUM LOADING ABOVE THE TANK NOT TO BE EXCEEDED. MAXIMUM LOADING AS PER MANUFACTURER SPECIFICATION.
2.
3.

## GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
3. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
4. 4.FOR GENERAL NOTES REFER TO CURTINS DRAWING "FS02000-CUR-ZZ-ZZ-DR-C-0100_GENERAL INFRASTRUCTURE NOTES".

## KEY

- PROPOSED SURFACE WATER DRAINAGE
- SURFACE WATER DRAINAGE DIVERSION
- EXISTING SURFACE WATER SEWER
- RAIN GARDEN
- ATTENUATION SUB-BASE (CAR PARKING)
- POCKET SOAKAWAY
- ATTENUATION TANK
- PROPOSED PERMEABLE MUGA CONSTRUCTION TO BE DESIGNED BY SPECIALIST
- FILTER DRAIN WITH PERFORATED PIPE
- DIFFUSER UNIT
- LINEAR CHANNEL DRAIN WITH SUMP UNIT AT OUTFALL
- CONCRETE DISHED CHANNEL
- BEANY KERB
- DRAINAGE TO BE ABANDONED

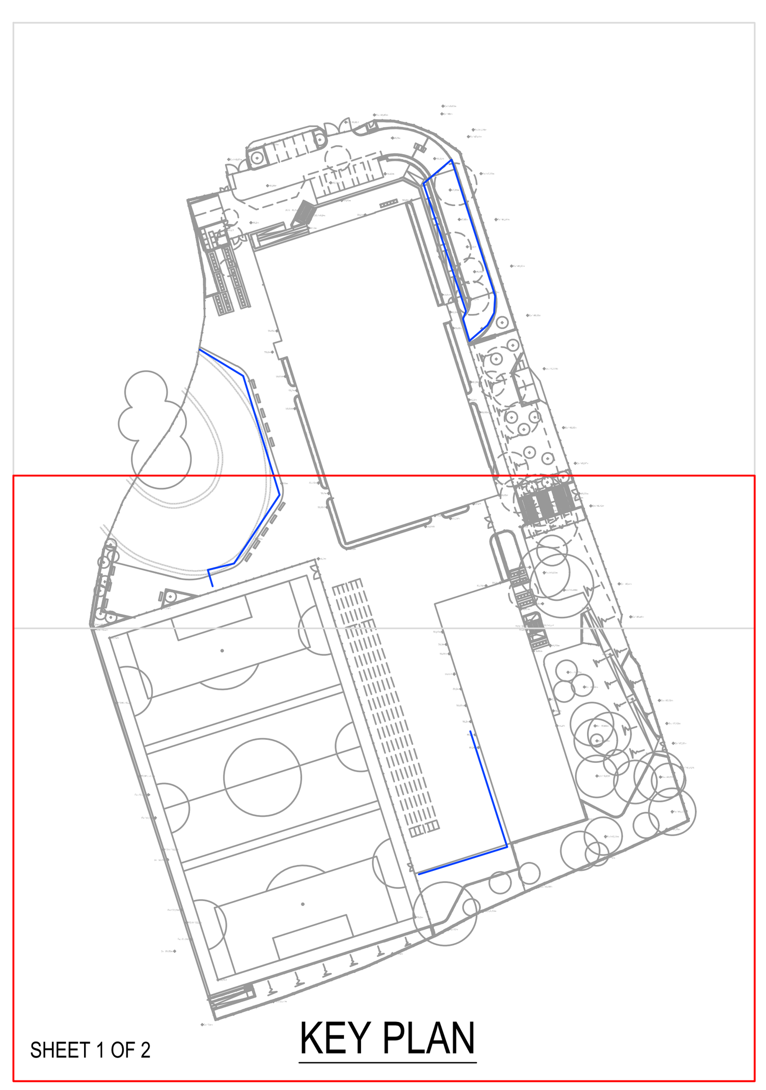
## DESIGN NOTES

1. SIPHONIC DOWN PIPES ARE SHOWN INDICATIVELY AT THIS STAGE. TO BE CONFIRMED BY SPECIALIST. FINAL DOWN PIPE POSITIONS MAY AFFECT THE FINAL DRAINAGE DESIGN.
2. COVER LEVELS ARE BASED ON ARES DRAWING FS0200-ALA-XX-XX-M2-L-0001 LANDSCAPE LAYOUT RECEIVED 29.03.21. SUBJECT TO CHANGE FOLLOWING RECEIPT OF DETAILED LEVELS DESIGN.
3. CURRENT ATTENUATION VOLUMES ARE BASED ON THE CURRENT IMPERMEABLE AREAS (1.4ha)
4. DRAINAGE DESIGN AND DISCHARGE RATE SUBJECT TO APPROVAL FROM THE LLFA AND THAMES WATER.
5. ALL GULLY/CHANNEL DRAIN CONNECTIONS TO BE 150mmØ.
6. ALL CATCHPITS TO HAVE A MINIMUM SUMP OF 300mm BELOW INVERT.
7. ALL PERMEABLE PARKING BAYS AND MUGA SUBBASE STORAGE TO INCORPORATE A MINIMUM OF 350mm SUB-BASE STORAGE.
8. ALL MANHOLE COVERS TO BE CLASS D400 UNLESS SITUATION WITHIN NONE TRAFFICKED AREAS.
9. INVERT AND COVER LEVELS OF EXISTING SEWERS ASSUMED, TO BE CONFIRMED BY CONTRACTOR PRIOR TO CONSTRUCTION.
10. ALL EXISTING SURFACE WATER RUNS WITHIN THE SITE BOUNDARY TO BE SURVEYED BEFORE THE CONSTRUCTION AND ANY ABANDONING WORKS.
11. PLEASE REFER TO DESIGNER'S HAZARD REGISTER - FS0200-CUR-XX-XX-RR-S-0001

## TO BE READ IN CONJUNCTION WITH:

DRAWING TO BE READ IN CONJUNCTION WITH:
- FS0200-CUR-ZZ-ZZ-DR-C-9031_SURFACE WATER DRAINAGE LAYOUT SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9040_FOUL WATER DRAINAGE LAYOUT SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9041_FOUL WATER DRAINAGE LAYOUT SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9051_DRAINAGE CONSTRUCTION DETAILS SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9052_DRAINAGE CONSTRUCTION DETAILS SHEET 2 OF 2

| Rev: | Description: | Date: | By: | Chkd: |
|---|---|---|---|---|
| P04 | ISSUED FOR PLANNING | 09.04.21 | JW | AS |
| P03 | UPDATED TO SUIT SIDE WIDE UTILITY SURVEY | 09.03.21 | EMC | WH |
| P02 | DRAFT CP ISSUE | 26.02.21 | EMC | RW |
| P01 | PRELIMINARY ISSUE | 19.02.21 | EMC | RW |




KEY PLAN


curtins
56 The Ropewalk, Nottingham, NG1 5DW
0115 941 5551
nottingham@curtins.com
www.curtins.com



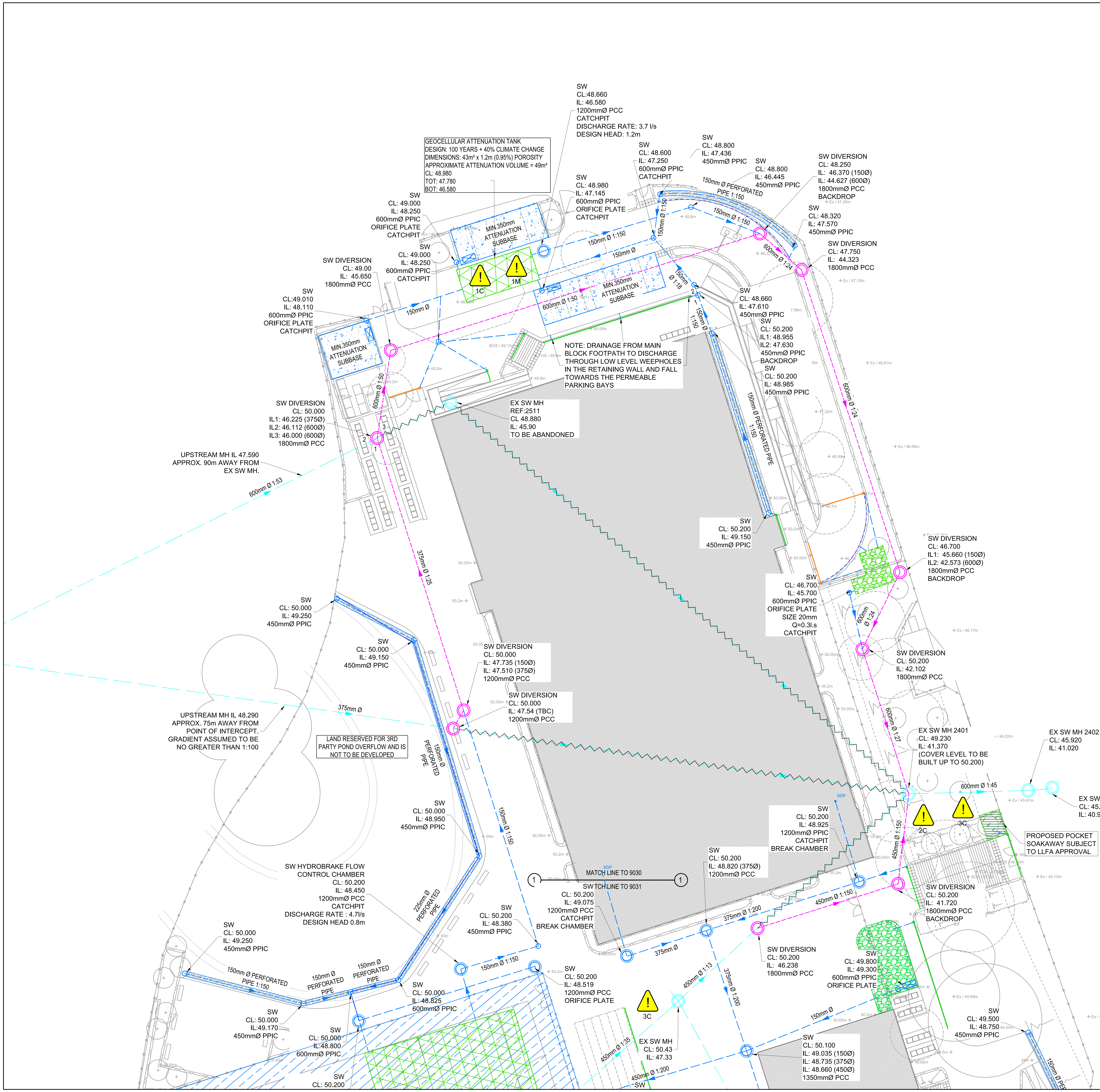

Status:
PRELIMINARY

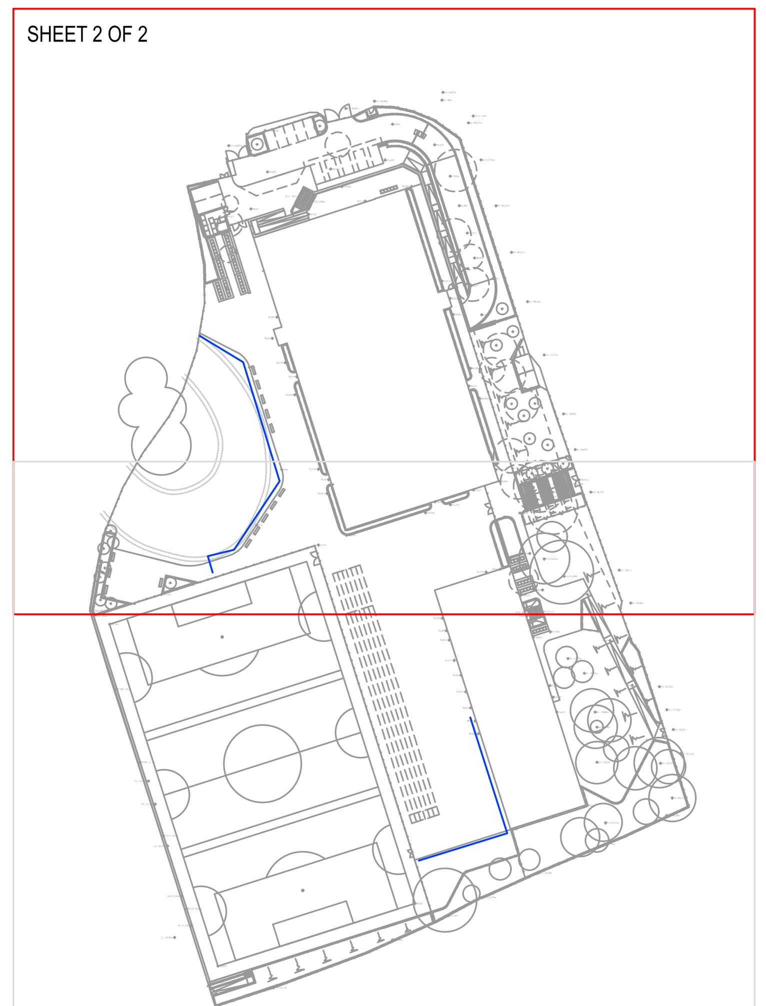
Project:
ST ANDREW THE APOSTLE, BARNET

Drg Title:
SURFACE WATER DRAINAGE LAYOUT SHEET 1 OF 2

| Size: | Date: | Drawn By: | Designed By: | Checked By: |
|---|---|---|---|---|
| A1 | 19.02.21 | EMC | RW | RW |
| Scale: 1:250 | | | | |

| Project No: | Originator: | Volume: | Level: | Type: | Role: | Category / Number: | Rev: |
|---|---|---|---|---|---|---|---|
| FS0200 - | CUR - | ZZ - | ZZ - | DR - | C - | 9030 | - P04 |




KEY PLAN

## GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
3. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
4. 4.FOR GENERAL NOTES REFER TO CURTINS DRAWING "FS02000-CUR-ZZ-ZZ-DR-C-0100_GENERAL INFRASTRUCTURE NOTES".

## KEY

- PROPOSED SURFACE WATER DRAINAGE
- SURFACE WATER DRAINAGE DIVERSION
- EXISTING SURFACE WATER SEWER
- RAIN GARDEN
- ATTENUATION SUB-BASE (CAR PARKING)
- POCKET SOAKAWAY
- ATTENUATION TANK
- PROPOSED PERMEABLE MUGA CONSTRUCTION TO BE DESIGNED BY SPECIALIST
- FILTER DRAIN WITH PERFORATED PIPE
- DIFFUSER UNIT
- LINEAR CHANNEL DRAIN WITH SUMP UNIT AT OUTFALL
- CONCRETE DISHED CHANNEL
- BEANY KERB
- DRAINAGE TO BE ABANDONED

## DESIGN NOTES

1. SIPHONIC DOWN PIPES ARE SHOWN INDICATIVELY AT THIS STAGE. TO BE CONFIRMED BY SPECIALIST. FINAL DOWN PIPE POSITIONS MAY AFFECT THE FINAL DRAINAGE DESIGN.
2. COVER LEVELS ARE BASED ON ARES DRAWING FS0200-ALA-XX-XX-M2-L-0001 LANDSCAPE LAYOUT RECEIVED 29.03.21. SUBJECT TO CHANGE FOLLOWING RECEIPT OF DETAILED LEVELS DESIGN.
3. CURRENT ATTENUATION VOLUMES ARE BASED ON THE CURRENT IMPERMEABLE AREAS (1.4ha)
4. DRAINAGE DESIGN AND DISCHARGE RATE SUBJECT TO APPROVAL FROM THE LLFA AND THAMES WATER.
5. ALL GULLY/CHANNEL DRAIN CONNECTIONS TO BE 150mmØ.
6. ALL CATCHPITS TO HAVE A MINIMUM SUMP OF 300mm BELOW INVERT.
7. ALL PERMEABLE PARKING BAYS AND MUGA SUBBASE STORAGE TO INCORPORATE A MINIMUM OF 350mm SUB-BASE STORAGE.
8. ALL MANHOLE COVERS TO BE CLASS D400 UNLESS SITUATION WITHIN NONE TRAFFICKED AREAS.
9. INVERT AND COVER LEVELS OF EXISTING SEWERS ASSUMED, TO BE CONFIRMED BY CONTRACTOR PRIOR TO CONSTRUCTION.
10. ALL EXISTING SURFACE WATER RUNS WITHIN THE SITE BOUNDARY TO BE SURVEYED BEFORE THE CONSTRUCTION AND ANY ABANDONING WORKS.
11. PLEASE REFER TO DESIGNER'S HAZARD REGISTER - FS0200-CUR-XX-XX-RR-S-0001

## TO BE READ IN CONJUNCTION WITH:

- FS0200-CUR-ZZ-ZZ-DR-C-9030_SURFACE WATER DRAINAGE LAYOUT SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9040_FOUL WATER DRAINAGE LAYOUT SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9041_FOUL WATER DRAINAGE LAYOUT SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9051_DRAINAGE CONSTRUCTION DETAILS SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9052_DRAINAGE CONSTRUCTION DETAILS SHEET 2 OF 2

| Rev: | Description: | Date: | By: | Chkd: |
|---|---|---|---|---|
| P04 | ISSUED FOR PLANNING | 09.04.21 | JW | AS |
| P03 | UPDATED TO SUIT SIDE WIDE UTILITY SURVEY | 09.03.21 | EMC | WH |
| P02 | DRAFT CP ISSUE | 26.02.21 | EMC | RW |
| P01 | PRELIMINARY ISSUE | 19.02.21 | EMC | RW |

## SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION UNUSUAL SIGNIFICANT HAZARDS

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT. IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

CONSTRUCTION
1. MAXIMUM LOADING ABOVE THE TANK NOT TO BE EXCEEDED. MAXIMUM LOADING AS PER MANUFACTURER SPECIFICATION.
2. CONNECTION TO LIVE SEWER. EXCAVATION MUST BE TAKEN WITH CARE AND PROTECTION MEASURES MUST BE ARRANGED PRIOR TO CONSTRUCTION.
3. EXISTING LIVE DRAINAGE CONNECTION TO BE PROTECTED DURING THE CONSTRUCTION

MAINTENANCE / CLEANING
1. MAXIMUM LOADING ABOVE THE TANK NOT TO BE EXCEEDED. MAXIMUM LOADING AS PER MANUFACTURER SPECIFICATION.
2.
3.

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Birmingham • Bristol • Cambridge • Cardiff • Douglas • Dublin • Edinburgh • Glasgow • Kendal • Leeds • Liverpool • London • Manchester • Nottingham

Status: PRELIMINARY

Project: ST ANDREW THE APOSTLE, BARNET

Drg Title: SURFACE WATER DRAINAGE LAYOUT SHEET 2 OF 2

| Size: | Date: | Drawn By: | Designed By: | Checked By: |
|---|---|---|---|---|
| A1 | 19.02.21 | EMC | RW | RW |
| Scale: 1:250 | | | | |

| Project No: | Originator: | Volume: | Level: | Type: | Role: | Category / Number: | Rev: |
|---|---|---|---|---|---|---|---|
| FS0200 - | CUR - | ZZ - | ZZ - | DR - | C - | 9031 | - P04 |

**Appendix F Attenuation Calculation – 1, 30 and 100 year + 40% climate change**

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

| | | | |
|---|---|---|---|
| Return Period (years) | 100 | PIMP (%) | 100 |
| M5-60 (mm) | 20.000 | Add Flow / Climate Change (%) | 0 |
| Ratio R | 0.448 | Minimum Backdrop Height (m) | 0.200 |
| Maximum Rainfall (mm/hr) | 50 | Maximum Backdrop Height (m) | 1.500 |
| Maximum Time of Concentration (mins) | 30 | Min Design Depth for Optimisation (m) | 1.200 |
| Foul Sewage (l/s/ha) | 0.000 | Min Vel for Auto Design only (m/s) | 1.00 |
| Volumetric Runoff Coeff. | 0.750 | Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits

### Time Area Diagram for Storm

| Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|---|---|
| 0-4 | 0.139 | 4-8 | 0.842 | 8-12 | 0.414 |

Total Area Contributing (ha) = 1.395

Total Pipe Volume (m³) = 46.020

### 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) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 21.217 | 0.105 | 202.1 | 0.169 | 4.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | 🔒 |
| 2.000 | 10.897 | 0.255 | 42.7 | 0.153 | 4.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | 🔒 |
| 1.001 | 16.773 | 0.085 | 197.3 | 0.000 | 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 | 4.28 | 48.925 | 0.169 | 0.0 | 0.0 | 0.0 | 1.27 | 140.4 | 22.9 |
| 2.000 | 50.00 | 4.07 | 49.075 | 0.153 | 0.0 | 0.0 | 0.0 | 2.78 | 306.9 | 20.7 |
| 1.001 | 50.00 | 4.50 | 48.820 | 0.322 | 0.0 | 0.0 | 0.0 | 1.29 | 142.1 | 43.6 |

## 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) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.000 | 50.504 | 0.589 | 85.7 | 0.180 | 4.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | 🔒 |
| 3.001 | 31.435 | 0.340 | 92.5 | 0.127 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | 🔒 |
| 4.000 | 22.202 | 0.340 | 65.3 | 0.000 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 1.002 | 22.268 | 0.110 | 202.4 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | 🔒 |
| 1.003 | 12.197 | 0.100 | 122.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | 🔒 |
| 5.000 | 64.771 | 0.488 | 132.7 | 0.086 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | 🔒 |
| 6.000 | 21.793 | 0.370 | 58.9 | 0.023 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 7.000 | 103.501 | 0.260 | 398.1 | 0.500 | 4.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | 🔒 |
| 7.001 | 19.108 | 0.096 | 199.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | 🔒 |
| 5.001 | 22.778 | 0.005 | 4555.6 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | 🔒 |
| 1.004 | 16.100 | 0.001 | 16100.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | 🔒 |
| 1.005 | 63.528 | 6.629 | 9.6 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 8.000 | 32.307 | 1.540 | 21.0 | 0.000 | 4.00 | 0.0 | 0.600 | o | 150 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 3.000 | 50.00 | 4.43 | 49.669 | 0.180 | 0.0 | 0.0 | 0.0 | 1.96 | 216.3 | 24.4 |
| 3.001 | 50.00 | 4.71 | 49.075 | 0.307 | 0.0 | 0.0 | 0.0 | 1.88 | 208.2 | 41.6 |
| 4.000 | 50.00 | 4.30 | 49.300 | 0.000 | 0.0 | 0.0 | 0.0 | 1.25 | 22.0 | 0.0 |
| 1.002 | 50.00 | 4.97 | 48.660 | 0.629 | 0.0 | 0.0 | 0.0 | 1.43 | 226.7 | 85.2 |
| 1.003 | 50.00 | 5.08 | 48.550 | 0.629 | 0.0 | 0.0 | 0.0 | 1.84 | 292.6 | 85.2 |
| 5.000 | 50.00 | 4.95 | 49.250 | 0.086 | 0.0 | 0.0 | 0.0 | 1.13 | 45.1 | 11.6 |
| 6.000 | 50.00 | 4.28 | 49.250 | 0.023 | 0.0 | 0.0 | 0.0 | 1.31 | 23.2 | 3.1 |
| 7.000 | 50.00 | 5.91 | 48.779 | 0.500 | 0.0 | 0.0 | 0.0 | 0.90 | 99.6 | 67.7 |
| 7.001 | 50.00 | 6.16 | 48.519 | 0.500 | 0.0 | 0.0 | 0.0 | 1.28 | 141.4 | 67.7 |
| 5.001 | 50.00 | 8.22 | 48.455 | 0.609 | 0.0 | 0.0 | 0.0 | 0.18 | 7.3« | 82.5 |
| 1.004 | 50.00 | 9.99 | 48.450 | 1.238 | 0.0 | 0.0 | 0.0 | 0.15 | 24.0« | 167.6 |
| 1.005 | 50.00 | 10.32 | 48.449 | 1.238 | 0.0 | 0.0 | 0.0 | 3.27 | 57.9« | 167.6 |
| 8.000 | 50.00 | 4.24 | 49.150 | 0.000 | 0.0 | 0.0 | 0.0 | 2.21 | 39.0 | 0.0 |

## 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) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.001 | 6.754 | 0.360 | 18.8 | 0.024 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 9.000 | 12.348 | 0.320 | 38.6 | 0.012 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 8.002 | 21.310 | 0.670 | 31.8 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 10.000 | 4.126 | 0.030 | 137.5 | 0.018 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 10.001 | 5.699 | 1.620 | 3.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 11.000 | 6.324 | 0.040 | 158.1 | 0.007 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 11.001 | 18.060 | 1.260 | 14.3 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 12.000 | 11.636 | 1.670 | 7.0 | 0.035 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 13.000 | 13.341 | 0.355 | 37.6 | 0.031 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 13.001 | 6.241 | 0.565 | 11.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 8.003 | 7.066 | 0.001 | 7066.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 8.004 | 86.310 | 4.759 | 18.1 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 14.000 | 6.534 | 0.044 | 150.0 | 0.030 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | 🔒 |
| 14.001 | 6.534 | 3.836 | 1.7 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 8.001 | 50.00 | 4.29 | 47.610 | 0.024 | 0.0 | 0.0 | 0.0 | 2.34 | 41.3 | 3.2 |
| 9.000 | 50.00 | 4.13 | 47.570 | 0.012 | 0.0 | 0.0 | 0.0 | 1.63 | 28.7 | 1.6 |
| 8.002 | 50.00 | 4.49 | 47.250 | 0.036 | 0.0 | 0.0 | 0.0 | 1.79 | 31.7 | 4.9 |
| 10.000 | 50.00 | 4.08 | 48.230 | 0.018 | 0.0 | 0.0 | 0.0 | 0.86 | 15.1 | 2.4 |
| 10.001 | 50.00 | 4.10 | 48.200 | 0.018 | 0.0 | 0.0 | 0.0 | 5.41 | 95.6 | 2.4 |
| 11.000 | 50.00 | 4.13 | 48.150 | 0.007 | 0.0 | 0.0 | 0.0 | 0.80 | 14.1 | 0.9 |
| 11.001 | 50.00 | 4.24 | 48.110 | 0.007 | 0.0 | 0.0 | 0.0 | 2.67 | 47.3 | 0.9 |
| 12.000 | 50.00 | 4.05 | 48.250 | 0.035 | 0.0 | 0.0 | 0.0 | 3.84 | 67.9 | 4.7 |
| 13.000 | 50.00 | 4.14 | 47.500 | 0.031 | 0.0 | 0.0 | 0.0 | 1.65 | 29.1 | 4.2 |
| 13.001 | 50.00 | 4.17 | 47.145 | 0.031 | 0.0 | 0.0 | 0.0 | 3.05 | 53.9 | 4.2 |
| 8.003 | 50.00 | 5.55 | 46.580 | 0.127 | 0.0 | 0.0 | 0.0 | 0.11 | 2.0« | 17.2 |
| 8.004 | 50.00 | 6.16 | 46.579 | 0.127 | 0.0 | 0.0 | 0.0 | 2.38 | 42.0 | 17.2 |
| 14.000 | 50.00 | 4.13 | 45.700 | 0.030 | 0.0 | 0.0 | 0.0 | 0.82 | 14.5 | 4.1 |
| 14.001 | 50.00 | 4.15 | 45.656 | 0.030 | 0.0 | 0.0 | 0.0 | 7.78 | 137.6 | 4.1 |

## 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) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.006 | 16.022 | 0.028 | 572.2 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.006 | 50.00 | 10.96 | 41.820 | 1.395 | 0.0 | 0.0 | 0.0 | 0.41 | 7.3« | 188.9 |

## Area Summary for Storm

| Pipe Number | PIMP Type | PIMP Name | PIMP (%) | Gross Area (ha) | Imp. Area (ha) | Pipe Total (ha) |
|---|---|---|---|---|---|---|
| 1.000 | - | - | 100 | 0.169 | 0.169 | 0.169 |
| 2.000 | - | - | 100 | 0.153 | 0.153 | 0.153 |
| 1.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 3.000 | - | - | 100 | 0.180 | 0.180 | 0.180 |
| 3.001 | - | - | 100 | 0.127 | 0.127 | 0.127 |
| 4.000 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.002 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.003 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 5.000 | - | - | 100 | 0.086 | 0.086 | 0.086 |
| 6.000 | - | - | 100 | 0.023 | 0.023 | 0.023 |
| 7.000 | - | - | 100 | 0.500 | 0.500 | 0.500 |
| 7.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 5.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.004 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.005 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 8.000 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 8.001 | - | - | 100 | 0.024 | 0.024 | 0.024 |
| 9.000 | - | - | 100 | 0.012 | 0.012 | 0.012 |
| 8.002 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 10.000 | - | - | 100 | 0.018 | 0.018 | 0.018 |
| 10.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 11.000 | - | - | 100 | 0.007 | 0.007 | 0.007 |
| 11.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 12.000 | - | - | 100 | 0.035 | 0.035 | 0.035 |
| 13.000 | - | - | 100 | 0.031 | 0.031 | 0.031 |
| 13.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 8.003 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 8.004 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 14.000 | - | - | 100 | 0.030 | 0.030 | 0.030 |
| 14.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.006 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| | | | | Total | Total | Total |
| | | | | 1.395 | 1.395 | 1.395 |

## Free Flowing Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 1.006 | | 49.230 | 41.792 | 41.792 | 0 | 0 |

## Online Controls for Storm

### Orifice Manhole: 15, DS/PN: 7.001, Volume (m³): 13.7

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 48.519

### Hydro-Brake® Optimum Manhole: 12, DS/PN: 1.004, Volume (m³): 5.1

| | |
|---|---|
| Unit Reference | MD-SHE-0105-4700-0800-4700 |
| Design Head (m) | 0.800 |
| Design Flow (l/s) | 4.7 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 105 |
| Invert Level (m) | 48.450 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| **Control Points** | **Head (m)** | **Flow (l/s)** |
|---|---|---|
| Design Point (Calculated) | 0.800 | 4.7 |
| Flush-Flo™ | 0.241 | 4.7 |
| Kick-Flo® | 0.534 | 3.9 |
| Mean Flow over Head Range | - | 4.1 |

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)** |
|---|---|---|---|---|---|---|---|
| 0.100 | 3.6 | 1.200 | 5.7 | 3.000 | 8.7 | 7.000 | 13.0 |
| 0.200 | 4.7 | 1.400 | 6.1 | 3.500 | 9.4 | 7.500 | 13.5 |
| 0.300 | 4.7 | 1.600 | 6.5 | 4.000 | 10.0 | 8.000 | 13.9 |
| 0.400 | 4.5 | 1.800 | 6.9 | 4.500 | 10.6 | 8.500 | 14.3 |
| 0.500 | 4.2 | 2.000 | 7.2 | 5.000 | 11.1 | 9.000 | 14.7 |
| 0.600 | 4.1 | 2.200 | 7.5 | 5.500 | 11.6 | 9.500 | 15.1 |
| 0.800 | 4.7 | 2.400 | 7.8 | 6.000 | 12.1 | | |
| 1.000 | 5.2 | 2.600 | 8.2 | 6.500 | 12.6 | | |

### Orifice Manhole: 21, DS/PN: 10.001, Volume (m³): 1.0

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 48.200

### Orifice Manhole: 23, DS/PN: 11.001, Volume (m³): 1.1

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 48.110

## Orifice Manhole: 25, DS/PN: 13.001, Volume (m³): 2.3

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 47.145

## Hydro-Brake® Optimum Manhole: 20, DS/PN: 8.003, Volume (m³): 3.4

| | |
|---|---|
| Unit Reference | MD-SHE-0088-3700-1200-3700 |
| Design Head (m) | 1.200 |
| Design Flow (l/s) | 3.7 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 88 |
| Invert Level (m) | 46.580 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| **Control Points** | **Head (m)** | **Flow (l/s)** |
|---|---|---|
| Design Point (Calculated) | 1.200 | 3.7 |
| Flush-Flo™ | 0.361 | 3.7 |
| Kick-Flo® | 0.743 | 3.0 |
| Mean Flow over Head Range | - | 3.2 |

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)** |
|---|---|---|---|---|---|---|---|
| 0.100 | 2.7 | 1.200 | 3.7 | 3.000 | 5.7 | 7.000 | 8.4 |
| 0.200 | 3.5 | 1.400 | 4.0 | 3.500 | 6.1 | 7.500 | 8.7 |
| 0.300 | 3.7 | 1.600 | 4.2 | 4.000 | 6.5 | 8.000 | 9.0 |
| 0.400 | 3.7 | 1.800 | 4.5 | 4.500 | 6.9 | 8.500 | 9.3 |
| 0.500 | 3.6 | 2.000 | 4.7 | 5.000 | 7.2 | 9.000 | 9.5 |
| 0.600 | 3.5 | 2.200 | 4.9 | 5.500 | 7.5 | 9.500 | 9.8 |
| 0.800 | 3.1 | 2.400 | 5.1 | 6.000 | 7.9 | | |
| 1.000 | 3.4 | 2.600 | 5.3 | 6.500 | 8.2 | | |

## Orifice Manhole: 30, DS/PN: 14.001, Volume (m³): 1.3

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 45.656

## Storage Structures for Storm

### Porous Car Park Manhole: 15, DS/PN: 7.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00000 | Width (m) | 90.0 |
| Membrane Percolation (mm/hr) | 1000 | Length (m) | 55.0 |
| Max Percolation (l/s) | 1375.0 | Slope (1:X) | 200.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 48.857 | Cap Volume Depth (m) | 0.350 |

### Cellular Storage Manhole: 12, DS/PN: 1.004

| | | | |
|---|---|---|---|
| Invert Level (m) | 48.450 | Safety Factor | 2.0 |
| Infiltration Coefficient Base (m/hr) | 0.00000 | Porosity | 0.95 |
| Infiltration Coefficient Side (m/hr) | 0.00000 | | |

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 655.0 | 0.0 | 0.801 | 0.0 | 0.0 |
| 0.800 | 655.0 | 0.0 | | | |

### Porous Car Park Manhole: 21, DS/PN: 10.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00000 | Width (m) | 12.0 |
| Membrane Percolation (mm/hr) | 1000 | Length (m) | 4.8 |
| Max Percolation (l/s) | 16.0 | Slope (1:X) | 60.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 48.200 | Cap Volume Depth (m) | 0.350 |

### Porous Car Park Manhole: 23, DS/PN: 11.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00000 | Width (m) | 4.8 |
| Membrane Percolation (mm/hr) | 1000 | Length (m) | 4.8 |
| Max Percolation (l/s) | 6.4 | Slope (1:X) | 60.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 48.110 | Cap Volume Depth (m) | 0.350 |

### Porous Car Park Manhole: 25, DS/PN: 13.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00000 | Width (m) | 16.5 |
| Membrane Percolation (mm/hr) | 1000 | Length (m) | 4.8 |
| Max Percolation (l/s) | 22.0 | Slope (1:X) | 60.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 47.145 | Cap Volume Depth (m) | 0.350 |

## Cellular Storage Manhole: 20, DS/PN: 8.003

| | | | |
|---|---|---|---|
| Invert Level (m) | 46.580 | Safety Factor | 2.0 |
| Infiltration Coefficient Base (m/hr) | 0.00000 | Porosity | 0.95 |
| Infiltration Coefficient Side (m/hr) | 0.00000 | | |

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 43.0 | 45.0 | 1.201 | 0.0 | 87.0 |
| 1.200 | 43.0 | 87.0 | | | |

## Porous Car Park Manhole: 30, DS/PN: 14.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00000 | Width (m) | 10.0 |
| Membrane Percolation (mm/hr) | 1000 | Length (m) | 20.0 |
| Max Percolation (l/s) | 55.6 | Slope (1:X) | 1000.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 45.656 | Cap Volume Depth (m) | 0.350 |

## 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 | 2.000 |
| 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 Storage Structures | 7 |
| Number of Online Controls | 7 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Ratio R | 0.447 |
| Region | England and Wales | Cv (Summer) | 0.750 |
| M5-60 (mm) | 20.100 | Cv (Winter) | 0.840 |

| | | | |
|---|---|---|---|
| Margin for Flood Risk Warning (mm) | 300.0 | DVD Status | OFF |
| Analysis Timestep | Fine | Inertia Status | OFF |
| DTS Status | ON | | |

| | |
|---|---|
| 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, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 15 Winter | 1 | +0% | 100/15 Summer | | | |
| 2.000 | 2 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| 1.001 | 2 | 15 Winter | 1 | +0% | 30/15 Summer | | | |
| 3.000 | 4 | 15 Winter | 1 | +0% | 100/15 Summer | | | |
| 3.001 | 5 | 15 Winter | 1 | +0% | 100/15 Summer | | | |
| 4.000 | 6 | 360 Winter | 1 | +0% | 100/15 Summer | | | |
| 1.002 | 3 | 15 Winter | 1 | +0% | 30/15 Summer | | | |
| 1.003 | 4 | 15 Winter | 1 | +0% | 30/15 Summer | | | |
| 5.000 | 12 | 15 Winter | 1 | +0% | 100/15 Summer | | | |
| 6.000 | 13 | 15 Winter | 1 | +0% | | | | |
| 7.000 | 14 | 15 Winter | 1 | +0% | 30/15 Summer | 100/15 Summer | | |
| 7.001 | 15 | 1440 Winter | 1 | +0% | 1/15 Summer | | | |
| 5.001 | 13 | 15 Winter | 1 | +0% | 1/15 Summer | | | |
| 1.004 | 12 | 480 Winter | 1 | +0% | 100/60 Summer | | | |
| 1.005 | 13 | 480 Winter | 1 | +0% | | | | |
| 8.000 | 17 | 360 Winter | 1 | +0% | | | | |
| 8.001 | 18 | 15 Winter | 1 | +0% | | | | |
| 9.000 | 19 | 15 Summer | 1 | +0% | | | | |
| 8.002 | 19 | 15 Winter | 1 | +0% | | | | |

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

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 49.051 | -0.249 | 0.000 | 0.22 | | 26.0 | OK | |
| 2.000 | 2 | 49.161 | -0.289 | 0.000 | 0.12 | | 23.8 | OK | |
| 1.001 | 2 | 48.993 | -0.202 | 0.000 | 0.43 | | 49.2 | OK | |
| 3.000 | 4 | 49.762 | -0.282 | 0.000 | 0.14 | | 27.7 | OK | |
| 3.001 | 5 | 49.198 | -0.252 | 0.000 | 0.23 | | 42.9 | OK | |
| 4.000 | 6 | 49.300 | -0.150 | 0.000 | 0.00 | | 0.0 | OK | |
| 1.002 | 3 | 48.884 | -0.226 | 0.000 | 0.49 | | 92.1 | OK | |
| 1.003 | 4 | 48.780 | -0.220 | 0.000 | 0.51 | | 90.6 | OK | |
| 5.000 | 12 | 49.335 | -0.140 | 0.000 | 0.31 | | 13.4 | OK | |
| 6.000 | 13 | 49.290 | -0.110 | 0.000 | 0.16 | | 3.6 | OK | |
| 7.000 | 14 | 49.051 | -0.103 | 0.000 | 0.67 | | 64.3 | OK | 4 |
| 7.001 | 15 | 49.023 | 0.129 | 0.000 | 0.00 | | 0.6 | SURCHARGED | |
| 5.001 | 13 | 48.701 | 0.021 | 0.000 | 1.55 | | 15.8 | SURCHARGED | |
| 1.004 | 12 | 48.606 | -0.294 | 0.000 | 0.06 | | 3.5 | OK | |
| 1.005 | 13 | 48.473 | -0.126 | 0.000 | 0.06 | | 3.5 | OK | |
| 8.000 | 17 | 49.150 | -0.150 | 0.000 | 0.00 | | 0.0 | OK | |
| 8.001 | 18 | 47.639 | -0.121 | 0.000 | 0.08 | | 2.9 | OK | |
| 9.000 | 19 | 47.596 | -0.124 | 0.000 | 0.07 | | 1.9 | OK | |
| 8.002 | 19 | 47.290 | -0.110 | 0.000 | 0.16 | | 4.8 | OK | |

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

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) |
|---|---|---|---|---|---|---|---|---|---|
| 10.000 | 20 | 60 Winter | 1 | +0% | 30/30 Summer | | | | 48.303 |
| 10.001 | 21 | 60 Winter | 1 | +0% | 30/15 Summer | | | | 48.303 |
| 11.000 | 21 | 30 Winter | 1 | +0% | 100/15 Summer | | | | 48.185 |
| 11.001 | 23 | 30 Winter | 1 | +0% | 30/60 Winter | | | | 48.184 |
| 12.000 | 22 | 15 Winter | 1 | +0% | | | | | 48.280 |
| 13.000 | 23 | 15 Summer | 1 | +0% | 100/30 Winter | | | | 47.543 |
| 13.001 | 25 | 30 Winter | 1 | +0% | 30/15 Summer | | | | 47.250 |
| 8.003 | 20 | 60 Winter | 1 | +0% | 30/15 Summer | | | | 46.716 |
| 8.004 | 24 | 60 Winter | 1 | +0% | | | | | 46.604 |
| 14.000 | 29 | 15 Summer | 1 | +0% | 100/15 Summer | | | | 45.764 |
| 14.001 | 30 | 240 Winter | 1 | +0% | 100/15 Winter | | | | 45.717 |
| 1.006 | 17 | 120 Winter | 1 | +0% | 30/15 Winter | | | | 41.934 |

| PN | US/MH Name | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|
| 10.000 | 20 | -0.077 | 0.000 | 0.12 | | 1.3 | OK | |
| 10.001 | 21 | -0.047 | 0.000 | 0.00 | | 0.3 | OK | |
| 11.000 | 21 | -0.115 | 0.000 | 0.06 | | 0.8 | OK | |
| 11.001 | 23 | -0.076 | 0.000 | 0.00 | | 0.2 | OK | |
| 12.000 | 22 | -0.120 | 0.000 | 0.09 | | 5.4 | OK | |
| 13.000 | 23 | -0.107 | 0.000 | 0.18 | | 4.8 | OK | |
| 13.001 | 25 | -0.045 | 0.000 | 0.02 | | 1.0 | OK | |
| 8.003 | 20 | -0.014 | 0.000 | 0.38 | | 2.8 | OK | |
| 8.004 | 24 | -0.125 | 0.000 | 0.07 | | 2.8 | OK | |
| 14.000 | 29 | -0.086 | 0.000 | 0.38 | | 4.7 | OK | |
| 14.001 | 30 | -0.089 | 0.000 | 0.00 | | 0.2 | OK | |
| 1.006 | 17 | -0.036 | 0.000 | 0.94 | | 6.0 | OK | |

## 30 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 | 2.000 |
| 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 Storage Structures | 7 |
| Number of Online Controls | 7 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Ratio R | 0.447 |
| Region | England and Wales | Cv (Summer) | 0.750 |
| M5-60 (mm) | 20.100 | Cv (Winter) | 0.840 |

| | | | |
|---|---|---|---|
| Margin for Flood Risk Warning (mm) | 300.0 | DVD Status | OFF |
| Analysis Timestep | Fine | Inertia Status | OFF |
| DTS Status | ON | | |

| | |
|---|---|
| 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, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| 2.000 | 2 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| 1.001 | 2 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| 3.000 | 4 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| 3.001 | 5 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| 4.000 | 6 | 360 Winter | 30 | +0% | 100/15 Summer | | | |
| 1.002 | 3 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| 1.003 | 4 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| 5.000 | 12 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| 6.000 | 13 | 15 Winter | 30 | +0% | | | | |
| 7.000 | 14 | 15 Winter | 30 | +0% | 30/15 Summer | 100/15 Summer | | |
| 7.001 | 15 | 2160 Winter | 30 | +0% | 1/15 Summer | | | |
| 5.001 | 13 | 15 Winter | 30 | +0% | 1/15 Summer | | | |
| 1.004 | 12 | 360 Winter | 30 | +0% | 100/60 Summer | | | |
| 1.005 | 13 | 360 Winter | 30 | +0% | | | | |
| 8.000 | 17 | 360 Winter | 30 | +0% | | | | |
| 8.001 | 18 | 15 Winter | 30 | +0% | | | | |
| 9.000 | 19 | 15 Summer | 30 | +0% | | | | |
| 8.002 | 19 | 15 Summer | 30 | +0% | | | | |

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

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1.000 | 1 | 49.266 | -0.034 | 0.000 | 0.49 | | 58.6 | OK | |
| 2.000 | 2 | 49.253 | -0.197 | 0.000 | 0.29 | | 56.9 | OK | |
| 1.001 | 2 | 49.232 | 0.037 | 0.000 | 0.91 | | 103.9 | SURCHARGED | |
| 3.000 | 4 | 49.821 | -0.224 | 0.000 | 0.34 | | 68.2 | OK | |
| 3.001 | 5 | 49.292 | -0.158 | 0.000 | 0.62 | | 114.5 | OK | |
| 4.000 | 6 | 49.300 | -0.150 | 0.000 | 0.00 | | 0.0 | OK | |
| 1.002 | 3 | 49.162 | 0.052 | 0.000 | 1.13 | | 210.1 | SURCHARGED | |
| 1.003 | 4 | 49.021 | 0.021 | 0.000 | 1.18 | | 211.1 | SURCHARGED | |
| 5.000 | 12 | 49.396 | -0.079 | 0.000 | 0.74 | | 32.1 | OK | |
| 6.000 | 13 | 49.316 | -0.084 | 0.000 | 0.40 | | 8.8 | OK | |
| 7.000 | 14 | 49.791 | 0.637 | 0.000 | 1.58 | | 151.8 | SURCHARGED | 4 |
| 7.001 | 15 | 49.131 | 0.237 | 0.000 | 0.01 | | 0.6 | SURCHARGED | |
| 5.001 | 13 | 48.824 | 0.144 | 0.000 | 3.78 | | 38.7 | SURCHARGED | |
| 1.004 | 12 | 48.809 | -0.091 | 0.000 | 0.08 | | 4.7 | OK | |
| 1.005 | 13 | 48.478 | -0.121 | 0.000 | 0.08 | | 4.7 | OK | |
| 8.000 | 17 | 49.150 | -0.150 | 0.000 | 0.00 | | 0.0 | OK | |
| 8.001 | 18 | 47.662 | -0.098 | 0.000 | 0.26 | | 9.2 | OK | |
| 9.000 | 19 | 47.612 | -0.108 | 0.000 | 0.18 | | 4.6 | OK | |
| 8.002 | 19 | 47.322 | -0.078 | 0.000 | 0.46 | | 13.8 | OK | |

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

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) |
|---|---|---|---|---|---|---|---|---|---|
| 10.000 | 20 | 120 Winter | 30 | +0% | 30/30 Summer | | | | 48.422 |
| 10.001 | 21 | 120 Winter | 30 | +0% | 30/15 Summer | | | | 48.421 |
| 11.000 | 21 | 60 Winter | 30 | +0% | 100/15 Summer | | | | 48.261 |
| 11.001 | 23 | 60 Winter | 30 | +0% | 30/60 Winter | | | | 48.260 |
| 12.000 | 22 | 15 Winter | 30 | +0% | | | | | 48.297 |
| 13.000 | 23 | 15 Winter | 30 | +0% | 100/30 Winter | | | | 47.570 |
| 13.001 | 25 | 60 Winter | 30 | +0% | 30/15 Summer | | | | 47.374 |
| 8.003 | 20 | 60 Winter | 30 | +0% | 30/15 Summer | | | | 46.936 |
| 8.004 | 24 | 60 Winter | 30 | +0% | | | | | 46.609 |
| 14.000 | 29 | 15 Summer | 30 | +0% | 100/15 Summer | | | | 45.815 |
| 14.001 | 30 | 180 Winter | 30 | +0% | 100/15 Winter | | | | 45.795 |
| 1.006 | 17 | 120 Winter | 30 | +0% | 30/15 Winter | | | | 41.980 |

| PN | US/MH Name | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|
| 10.000 | 20 | 0.042 | 0.000 | 0.16 | | 1.8 | SURCHARGED | |
| 10.001 | 21 | 0.071 | 0.000 | 0.00 | | 0.4 | SURCHARGED | |
| 11.000 | 21 | -0.039 | 0.000 | 0.09 | | 1.1 | OK | |
| 11.001 | 23 | 0.000 | 0.000 | 0.01 | | 0.3 | SURCHARGED | |
| 12.000 | 22 | -0.103 | 0.000 | 0.22 | | 13.4 | OK | |
| 13.000 | 23 | -0.080 | 0.000 | 0.45 | | 11.8 | OK | |
| 13.001 | 25 | 0.079 | 0.000 | 0.03 | | 1.5 | SURCHARGED | |
| 8.003 | 20 | 0.206 | 0.000 | 0.50 | | 3.7 | SURCHARGED | |
| 8.004 | 24 | -0.120 | 0.000 | 0.09 | | 3.7 | OK | |
| 14.000 | 29 | -0.035 | 0.000 | 0.94 | | 11.5 | OK | |
| 14.001 | 30 | -0.011 | 0.000 | 0.00 | | 0.3 | OK | |
| 1.006 | 17 | 0.010 | 0.000 | 1.34 | | 8.6 | SURCHARGED | |

## 100 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 2.000
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 Storage Structures 7
Number of Online Controls 7 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.447
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

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, 0, 40

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 15 Winter | 100 | +40% | 100/15 Summer | | | |
| 2.000 | 2 | 15 Winter | 100 | +40% | 100/15 Summer | | | |
| 1.001 | 2 | 15 Winter | 100 | +40% | 30/15 Summer | | | |
| 3.000 | 4 | 15 Winter | 100 | +40% | 100/15 Summer | | | |
| 3.001 | 5 | 15 Winter | 100 | +40% | 100/15 Summer | | | |
| 4.000 | 6 | 15 Winter | 100 | +40% | 100/15 Summer | | | |
| 1.002 | 3 | 15 Winter | 100 | +40% | 30/15 Summer | | | |
| 1.003 | 4 | 15 Winter | 100 | +40% | 30/15 Summer | | | |
| 5.000 | 12 | 15 Winter | 100 | +40% | 100/15 Summer | | | |
| 6.000 | 13 | 15 Winter | 100 | +40% | | | | |
| 7.000 | 14 | 15 Winter | 100 | +40% | 30/15 Summer | 100/15 Summer | | |
| 7.001 | 15 | 2880 Winter | 100 | +40% | 1/15 Summer | | | |
| 5.001 | 13 | 600 Winter | 100 | +40% | 1/15 Summer | | | |
| 1.004 | 12 | 600 Winter | 100 | +40% | 100/60 Summer | | | |
| 1.005 | 13 | 600 Summer | 100 | +40% | | | | |
| 8.000 | 17 | 360 Winter | 100 | +40% | | | | |
| 8.001 | 18 | 15 Winter | 100 | +40% | | | | |
| 9.000 | 19 | 15 Winter | 100 | +40% | | | | |
| 8.002 | 19 | 120 Winter | 100 | +40% | | | | |

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

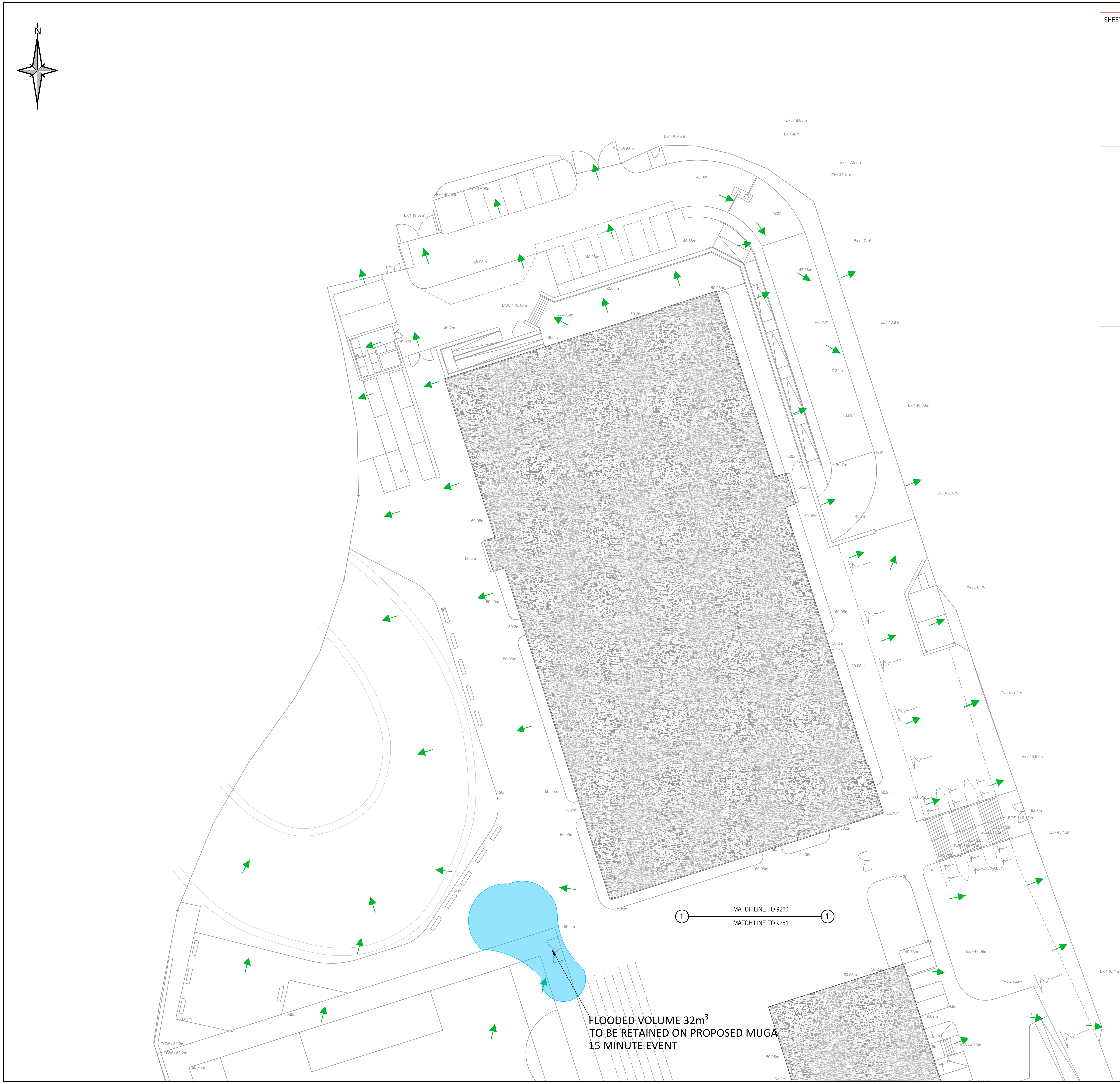
| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 49.974 | 0.674 | 0.000 | 0.84 | | 99.6 | FLOOD RISK | |
| 2.000 | 2 | 49.940 | 0.490 | 0.000 | 0.45 | | 89.5 | FLOOD RISK | |
| 1.001 | 2 | 49.902 | 0.707 | 0.000 | 1.65 | | 188.0 | FLOOD RISK | |
| 3.000 | 4 | 50.126 | 0.081 | 0.000 | 0.57 | | 114.1 | SURCHARGED | |
| 3.001 | 5 | 49.972 | 0.522 | 0.000 | 0.92 | | 169.3 | FLOOD RISK | |
| 4.000 | 6 | 49.670 | 0.220 | 0.000 | 0.14 | | 2.8 | FLOOD RISK | |
| 1.002 | 3 | 49.675 | 0.565 | 0.000 | 1.88 | | 350.9 | SURCHARGED | |
| 1.003 | 4 | 49.274 | 0.274 | 0.000 | 1.98 | | 352.9 | SURCHARGED | |
| 5.000 | 12 | 49.775 | 0.300 | 0.000 | 1.18 | | 51.6 | FLOOD RISK | |
| 6.000 | 13 | 49.345 | -0.055 | 0.000 | 0.73 | | 16.0 | OK | |
| 7.000 | 14 | 50.223 | 1.069 | 23.032 | 2.13 | | 204.2 | FLOOD | 4 |
| 7.001 | 15 | 49.290 | 0.396 | 0.000 | 0.01 | | 0.7 | SURCHARGED | |
| 5.001 | 13 | 49.161 | 0.481 | 0.000 | 0.59 | | 6.1 | SURCHARGED | |
| 1.004 | 12 | 49.159 | 0.259 | 0.000 | 0.08 | | 4.7 | SURCHARGED | |
| 1.005 | 13 | 48.478 | -0.121 | 0.000 | 0.08 | | 4.7 | OK | |
| 8.000 | 17 | 49.150 | -0.150 | 0.000 | 0.00 | | 0.0 | OK | |
| 8.001 | 18 | 47.683 | -0.077 | 0.000 | 0.48 | | 16.7 | OK | |
| 9.000 | 19 | 47.628 | -0.092 | 0.000 | 0.32 | | 8.3 | OK | |
| 8.002 | 19 | 47.395 | -0.005 | 0.000 | 0.24 | | 7.0 | OK | |

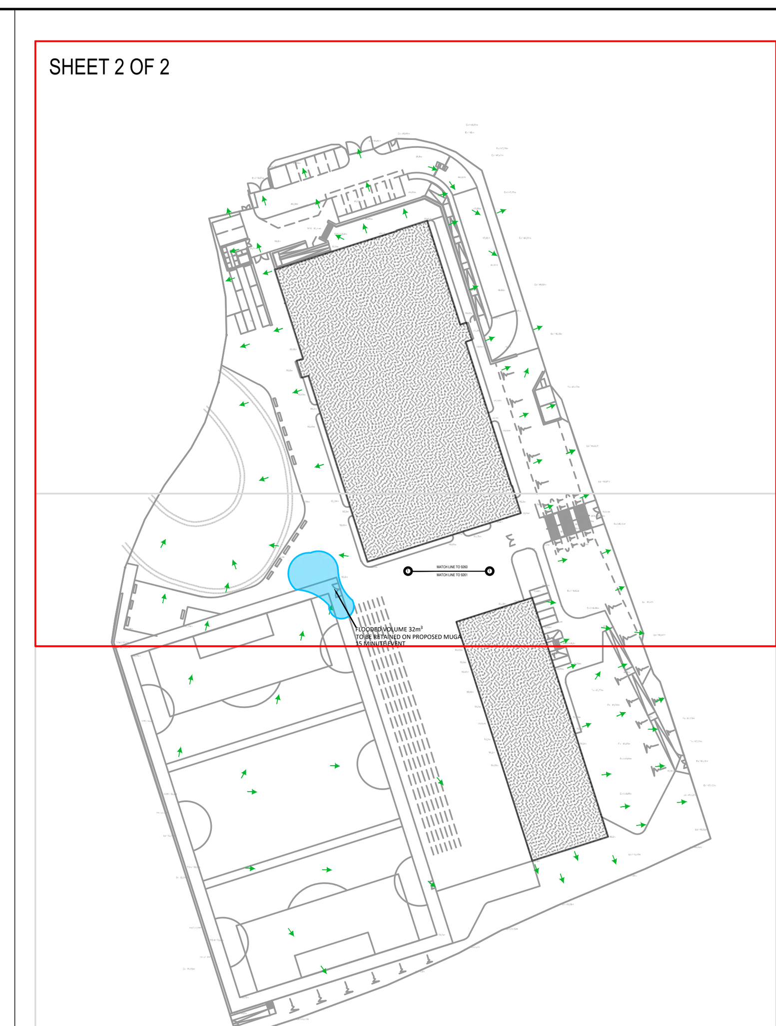
## 100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) |
|---|---|---|---|---|---|---|---|---|---|
| 10.000 | 20 | 120 Winter | 100 | +40% | 30/30 Summer | | | | 48.738 |
| 10.001 | 21 | 120 Winter | 100 | +40% | 30/15 Summer | | | | 48.737 |
| 11.000 | 21 | 60 Winter | 100 | +40% | 100/15 Summer | | | | 48.389 |
| 11.001 | 23 | 60 Winter | 100 | +40% | 30/60 Winter | | | | 48.387 |
| 12.000 | 22 | 15 Winter | 100 | +40% | | | | | 48.315 |
| 13.000 | 23 | 60 Winter | 100 | +40% | 100/30 Winter | | | | 47.812 |
| 13.001 | 25 | 60 Winter | 100 | +40% | 30/15 Summer | | | | 47.802 |
| 8.003 | 20 | 120 Winter | 100 | +40% | 30/15 Summer | | | | 47.390 |
| 8.004 | 24 | 30 Summer | 100 | +40% | | | | | 46.609 |
| 14.000 | 29 | 15 Summer | 100 | +40% | 100/15 Summer | | | | 45.926 |
| 14.001 | 30 | 240 Winter | 100 | +40% | 100/15 Winter | | | | 45.918 |
| 1.006 | 17 | 180 Winter | 100 | +40% | 30/15 Winter | | | | 41.981 |

| PN | US/MH Name | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|
| 10.000 | 20 | 0.358 | 0.000 | 0.30 | | 3.3 | FLOOD RISK | |
| 10.001 | 21 | 0.387 | 0.000 | 0.01 | | 0.6 | FLOOD RISK | |
| 11.000 | 21 | 0.089 | 0.000 | 0.17 | | 2.0 | SURCHARGED | |
| 11.001 | 23 | 0.127 | 0.000 | 0.01 | | 0.4 | SURCHARGED | |
| 12.000 | 22 | -0.085 | 0.000 | 0.40 | | 24.3 | OK | |
| 13.000 | 23 | 0.162 | 0.000 | 0.38 | | 10.2 | SURCHARGED | |
| 13.001 | 25 | 0.507 | 0.000 | 0.05 | | 2.5 | SURCHARGED | |
| 8.003 | 20 | 0.660 | 0.000 | 0.50 | | 3.7 | SURCHARGED | |
| 8.004 | 24 | -0.120 | 0.000 | 0.09 | | 3.7 | OK | |
| 14.000 | 29 | 0.076 | 0.000 | 1.70 | | 20.8 | SURCHARGED | |
| 14.001 | 30 | 0.112 | 0.000 | 0.00 | | 0.4 | SURCHARGED | |
| 1.006 | 17 | 0.011 | 0.000 | 1.35 | | 8.7 | SURCHARGED | |

## Appendix G Flow Exceedance Plan




KEY PLAN

## GENERAL NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
3. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
4. FOR GENERAL NOTES REFER TO CURTINS DRAWING "DR-C-9000_GENERAL INFRASTRUCTURE NOTES".

## TO BE READ IN CONJUNCTION WITH:

DRAWING TO BE READ IN CONJUNCTION WITH:
- FS0200-CUR-ZZ-ZZ-DR-C-9030_SURFACE WATER DRAINAGE LAYOUT SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9031_SURFACE WATER DRAINAGE LAYOUT SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9051_DRAINAGE CONSTRUCTION DETAILS SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9052_DRAINAGE CONSTRUCTION DETAILS SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9261_FLOOD EXCEEDENCE PLAN SHEET 2 OF 2

KEY

EXCEEDANCE FLOW DIRECTION FOR EVENTS UP TO 1 IN 100 YEAR + 50CC

| Rev: | Description: | Date: | By: | Chkd: |
|---|---|---|---|---|
| P01 | ISSUED FOR PLANNING | 09/04/21 | JW | AS |

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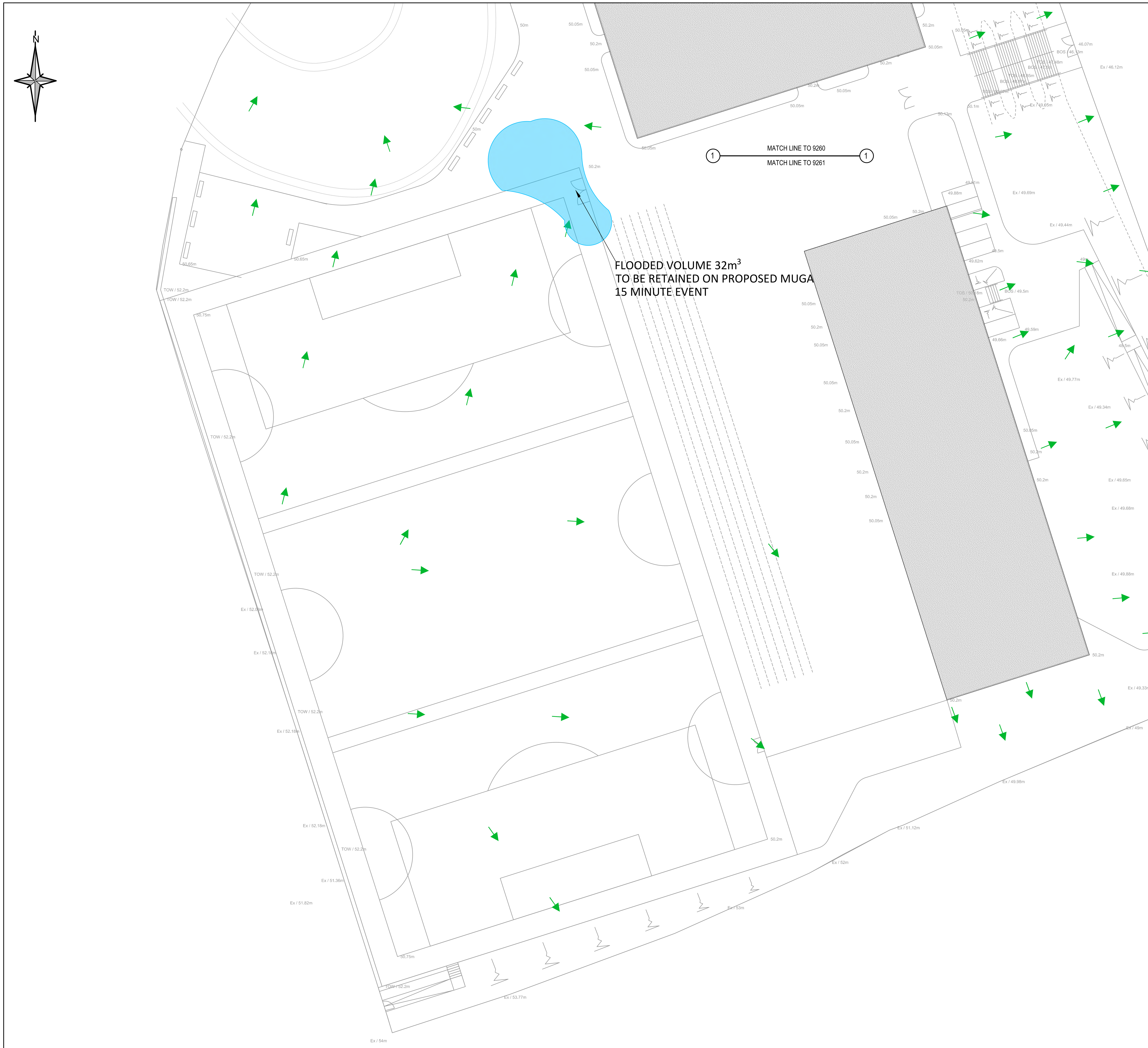
Status: PRELIMINARY

Project: ST ANDREW THE APOSTLE, BARNET

Drg Title: FLOOD EXCEEDENCE PLAN SHEET 1 OF 2

| Size: | Date: | Drawn By: | Designed By: | Checked By: |
|---|---|---|---|---|
| A1 | 09.04.21 | JW | AS | AS |
| Scale: 1:250 | | | | |

| Project No: | Originator: | Volume: | Level: | Type: | Role: | Category / Number: | Rev: |
|---|---|---|---|---|---|---|---|
| FS0200 | CUR | 01 | ZZ | DR | C | 9260 | P01 |




## GENERAL NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
3. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
4. FOR GENERAL NOTES REFER TO CURTINS DRAWING "DR-C-9000_GENERAL INFRASTRUCTURE NOTES".

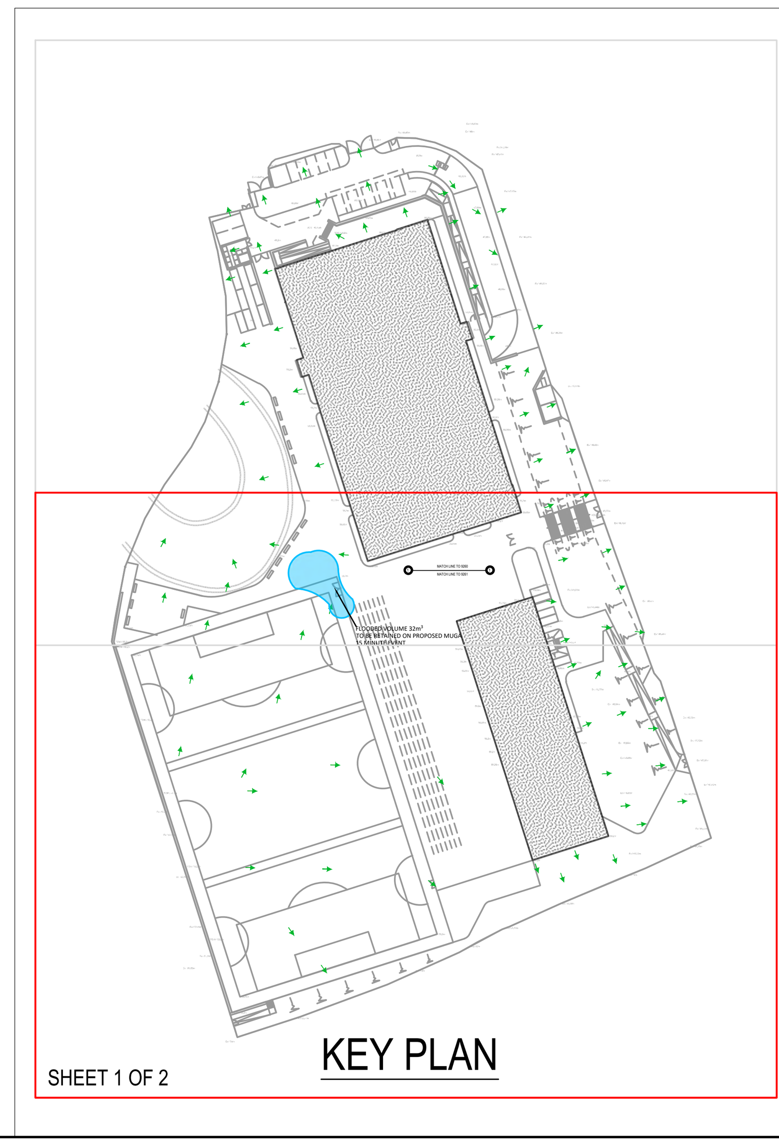
## TO BE READ IN CONJUNCTION WITH:

DRAWING TO BE READ IN CONJUNCTION WITH:

- FS0200-CUR-ZZ-ZZ-DR-C-9030_SURFACE WATER DRAINAGE LAYOUT SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9031_SURFACE WATER DRAINAGE LAYOUT SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9051_DRAINAGE CONSTRUCTION DETAILS SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9052_DRAINAGE CONSTRUCTION DETAILS SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9260_FLOOD EXCEEDENCE PLAN SHEET 1 OF 2

KEY

EXCEEDANCE FLOW DIRECTION FOR EVENTS UP TO 1 IN 100 YEAR + 50CC




KEY PLAN

| Rev: | Description: | Date: | By: | Chkd: |
|---|---|---|---|---|
| P01 | ISSUED FOR PLANNING | 09/04/21 | JW | AS |

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Status: PRELIMINARY

Project: ST ANDREW THE APOSTLE, BARNET

Drg Title: FLOOD EXCEEDENCE PLAN SHEET 2 OF 2

| Size: | Date: | Drawn By: | Designed By: | Checked By: |
|---|---|---|---|---|
| A1 | 09.04.21 | JW | AS | AS |
| Scale: 1:250 | | | | |

| Project No: | Originator: | Volume: | Level: | Type: | Role: | Category / Number: | Rev: |
|---|---|---|---|---|---|---|---|
| 072661 | CUR | 01 | ZZ | DR | C | 9261 | P01 |

## Appendix H Outline Operations and Maintenance Manual

# St Andrew the Apostle School, London

## SuDS Operations and Maintenance Manual

Curtins Ref: 072661-CUR-ZZ-XX-RP-C-0003

Revision: V01

Issue Date: 09 April 2021

Client Name: Bowmer and Kirkland

Client Address: Southern Regional Office, 1230 Arlington Business Park, Theale, Reading, RG7 4SA

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| Rev | Description | Issued by | Checked | Date |
|---|---|---|---|---|
| P01 | Planning Issue | AS | WH | 09/04/21 |

This report has been prepared for the sole benefit, use, and information for the client. The liability of Curtins Consulting Limited with respect to the information contained in the report will not extend to any third party.

| Author | Signature | Date |
|---|---|---|
| **Alicja Smolen**<br>MSc (Hons)<br>Project Engineer | | 09/04/21 |

| Reviewed | Signature | Date |
|---|---|---|
| **Wayne Howland**<br>BSc (Hons) CEng MIStructE<br>Associate | | 09/04/21 |

# Table of contents

# 1.0 Introduction

## 1.1 Project Background

Curtins Consulting Limited has been appointed by Bowmer and Kirkland to prepare a SuDS Operations and Maintenance Manual to supplement Drainage Strategy produced by Curtins. Document reference: 072661-CUR-ZZ-XX-RP-C-0002.

Particular reference is paid to the inspection, aftercare and maintenance of SuDs drainage features as part of this manual in order to demonstrate to the LLFA or adopting authority the effectiveness and longevity of the SuDs features designed within the scheme as opposed to the standard Building Regulations local and domestic drainage and/or the main discharge drainage connections to ‘Sewers for Adoption’ standards.

This report is based on current best practice guidance as described in the SuDS Manual, CIRIA, C753.

Proposals contained or forming part of this report represent the design intent and may be subject to alteration or adjustment in completing the detailed design for this project. Where such adjustments are undertaken as part of the detailed design and are deemed a material derivation from the intent contained in this document, prior approval shall be obtained from the relevant authority in advance of commencing such works.

## 1.2 Scope of O&M Manual

This manual is intended to give an overview of the operation and maintenance for SuDS features included with the drainage strategy and in relation to typical details only. Where proprietary products are specified the manufacturer’s instructions and recommendations should be followed in priority to this document unless specifically noted otherwise due to project constraints.

The recommended operations and frequencies are typical only and should be more frequent initially to ensure that there are no unforeseen issues with the operation and then adjusted to suit the site requirements.

Maintenance responsibility for the system is expected to revert to the DfE and the St Andrew the Apostle School management teams at the end of the contractor’s defects liability period.

# 2.0 Pipes

## 2.1 Location and Description

Pipes are the main conveyance across the site as shown on drainage drawings;

- FS0200-CUR-ZZ-ZZ-DR-C-9030-P02_Surface Water Drainage Layout Sheet 1 of 2
- FS0200-CUR-ZZ-ZZ-DR-C-9031-P02_Surface Water Drainage Layout Sheet 2 of 2

Pipes are proprietary products and the materials can vary across the site and as such where used the manufacturer's recommendations should be followed. Regardless of the product used, the pipes will be fully compliant with the Curtins' drainage specification.

## 2.2 Operation

They are intended to be dry except for during rainfall events. These have been designed to be self-cleansing for smaller diameter pipes, and for larger diameters the risk is reduced due to the overall pipe size.

Access for maintenance is provided through access chambers, manholes, rodding plates and rodding eyes.

## 2.3 Inspection and Maintenance Regime

Regular inspection and maintenance is important to identify areas which may have been obstructed/clogged and may not be draining correctly thus exposing the development to a greater level of flood risk. Maintenance responsibility for the pipes should be placed with the DfE and the St Andrew the Apostle School management teams

Sediment/material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols, as run-off is taken from potentially contaminated areas such as car parks/service yards.

 

| Maintenance Schedule | Required Action | Frequency |
|---|---|---|
| Monitoring (to be undertaken more regularly within the first year of operation and adjusted as required) | Initial inspection should be provided as post construction CCTV survey. | N/A |
| | Inspect for evidence of poor operation via water level in chambers. If required, take remedial action. | 3-monthly, 48 hours after large storms. |
| Occasional maintenance | Check and remove large vegetation growth near pipe runs. | 6 monthly |
| Remedial actions | Rod through poorly performing runs as initial remediation. | As required. |
| | If continued poor performance jet and CCTV survey poorly performing runs. | As required. |
| | Seek advice as to remediation techniques suitable for the type of performance issue and location. | As required If above does not improve performance. |

# 3.0 Permeable Pavements

## 3.1 Location and Description

Permeable paving is being used in parking bays in the car park areas as shown on surface water drainage drawings;

- FS0200-CUR-ZZ-ZZ-DR-C-9030-P02_Surface Water Drainage Layout Sheet 1 of 2
- FS0200-CUR-ZZ-ZZ-DR-C-9031-P02_Surface Water Drainage Layout Sheet 2 of 2

The permeable pavement has been designed in accordance with CIRIA C753.

Permeable pavements contain proprietary products and as such, the manufacturer's recommendations should be followed where used.

## 3.2 Operation

Permeable pavements are an efficient means of managing surface water runoff close to its source – intercepting runoff, reducing the volume and frequency of runoff, and providing a treatment medium.

The surface has been designed to be porous or to contain gaps where rain can flow through the upper construction layers in to the voided stone which makes up the sub-base.

## 3.3 Inspection and Maintenance Regime

Regular inspection and maintenance is important for the effective operation of the pervious pavement. Maintenance responsibility for the pipes should be placed with the DfE and the St Andrew the Apostle School management teams.

Sediment/material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols, as run-off is taken from potentially contaminated areas such as car parks/service yards.

# 4.0 Diffuser Units

## 4.1 Location and Description

Diffuser units are being used in parking bays in the car park areas as shown on surface water drainage drawings;

FS0200-CUR-ZZ-ZZ-DR-C-9030-P02_Surface Water Drainage Layout Sheet 1 of 2
FS0200-CUR-ZZ-ZZ-DR-C-9031-P02_Surface Water Drainage Layout Sheet 2 of 2

Diffuser units are proprietary products and as such, the manufacturer's recommendations and maintenance plan should be followed where used. For full maintenance details please see details provided by the manufacturer.

## 4.2 Operation

The subbase below the permeable pavement is sloped towards the diffuser units, the units are ideal for shallow attenuation and contribute towards the treatment.

## 4.3 Inspection and Maintenance Regime

Regular inspection and maintenance is important for the effective operation of the diffuser unit. Maintenance responsibility for the pipes should be placed with the DfE and the St Andrew the Apostle School management teams.

Sediment/material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols, as run-off is taken from potentially contaminated areas such as car parks/service yards.

# 5.0 Attenuation Tank (Geocellular Units)

## 5.1 Location and Description

There are two geocellular attenuation tanks located to the north and south-west of the main building, as shown on surface water drainage drawings:

- FS0200-CUR-ZZ-ZZ-DR-C-9030-P02_Surface Water Drainage Layout Sheet 1 of 2
- FS0200-CUR-ZZ-ZZ-DR-C-9031-P02_Surface Water Drainage Layout Sheet 2 of 2

The tank has/will be designed in accordance with CIRIA C697.

Geocellular units are proprietary products and therefore manufacturer's recommendations should also be taken in to consideration. Additionally different manufacturers may have different connection types and arrangements which will need to be taken in to consideration.

## 5.2 Operation

The attenuation tank is intended to be the surface water storage feature to attenuate the discharge from the site up to and including the 1 in 100 year plus 40% climate change event. The tank is intended to be empty between rainfall events.

## 5.3 Inspection and Maintenance Regime

Regular inspection and maintenance is important for the effective operation of attenuation tanks as designed. Maintenance responsibility for the pipes should be placed with the DfE and the St Andrew the Apostle School management teams.

As the feature is buried a regularly inspection regime is very important to ensure the correction functionality of the surface water drainage network.

Sediment\material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols, especially where run-off is taken from potentially contaminated areas such as car parks/service yards.

| Maintenance Schedule | Required Action | Frequency |
|---|---|---|
| Monitoring (to be undertaken more regularly within the first year of operation and adjusted as required) | Inspect inlets, outlets and overflows for blockages, and clear if required. If faults persist jetting and CCTV survey may be required. | Monthly and after large storms. |
| | Check penstocks and other mechanical devices (if present). | Half yearly. |
| | Inspect ventilation cowl (if present) | Monthly and after large storms. |
| Regular maintenance\inspection | Inspect and identify any areas that are not operating correctly. If required, take remedial action. | Monthly for 3 months, then six monthly |
| | Debris removal from catchment surface (where may cause risks to performance) | Monthly |
| | Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary. | Monthly (and after large storms) |
| | Remove sediment from pre-treatment structures | Annually (or as required after heavy rainfall events) |
| Remedial actions | Repair/rehabilitation of inlets, outlet, overflows and vents. | As required. |

# 6.0 Filter Strips, French Drains

## 6.1 Location and Description

Filter drains are located throughout the site, as shown on surface water drainage strategy drawing:

- FS0200-CUR-ZZ-ZZ-DR-C-9030-P02_Surface Water Drainage Layout Sheet 1 of 2
- FS0200-CUR-ZZ-ZZ-DR-C-9031-P02_Surface Water Drainage Layout Sheet 2 of 2

The features have/will be designed in accordance with CIRIA C697.

## 6.2 Operation

The filter strips/French drains are intended to be the surface water conveyance, water quality and attenuation storage features. These features are intended to be dry except during rainfall events.

The surface water should permeate through the upper layer of the feature in to the permeable stone below. The water is then collected and conveyed in the perforate pipe within the aggregate trench.

Access for maintenance has been provided through access chambers and rodding points.

## 6.3 Inspection and Maintenance Regime

Regular inspection and maintenance is important for the effective operation of the features. Maintenance responsibility for the features and their surrounding area should be placed with the DfE and the St Andrew the Apostle School management teams.

Plant management, to achieve the required habitat/appearance, should be specified clearly in a maintenance schedule by the landscape architect planned to coincide with other site wide maintenance operations.

Sediment\material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols, especially where run-off is taken from potentially contaminated areas such as car parks/service yards.

| Maintenance Schedule | Required Action | Frequency |
| --- | --- | --- |
| Monitoring (to be undertaken more regularly within the first year of operation and adjusted as required) | Inspect feature surface to identify evidence of erosion, compaction, ponding, sedimentation and contamination | Half yearly and after large storms. |
| | Check feature surface for even gradients | Half yearly |
| | Inspect gravel diaphragm trench upstream of filter strip for clogging | Half yearly. |
| | Inspect silt accumulation rates and establish appropriate removal frequencies. | Half yearly. |
| Regular maintenance\inspection | Litter and debris removal | Monthly or as required |
| | Grass cutting (to maintain grass height within landscape architect's specified design range) | To be confirmed by Landscape Architect [Monthly (during growing season) or as required] |
| | Manage other vegetation and remove nuisance plants/dead growth. | Monthly (at start, then as required). |
| | Remove sediment from main channel. | Annually (or as required after heavy rainfall events) |
| Occasional maintenance | Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where possible. | Annually, or as required. As per landscape architect's specification. |
| | Re-seed areas of poor vegetation growth (seed mix to landscape architect's specification). | Annually, or as required. As per landscape architect's specification |
| Remedial actions | Repair of erosion or other damage by re-seeding or re-turfing. Soil | As required. |

| | | |
|---|---|---|
| | reinforcement such as coir matting should be used and staked in accordance with manufacturer's instructions. | |
| | Realignment of flow channel/dished surface. | As required. |
| | Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface | As required. |
| | Re-level uneven surfaces and reinstate design levels. This may be required as part of sediment removal. | As required. |

# 7.0 Flow Control Chambers

## 7.1 Location and Description

The flow control chambers are located immediately downstream of the attenuation tanks, as shown on surface water drainage strategy drawing:

- FS0200-CUR-ZZ-ZZ-DR-C-9030-P02_Surface Water Drainage Layout Sheet 1 of 2
- FS0200-CUR-ZZ-ZZ-DR-C-9031-P02_Surface Water Drainage Layout Sheet 2 of 2

Flow control chambers are proprietary products and the manufacturer's recommendations should be followed. Regardless of the actual flow control used it will be fully compliant with the Curtins drainage specification.

## 7.2 Operation

Flow control chambers are intended to restrict the surface water runoff discharge rate from the site to a designed rate utilising techniques such as an orifice plate, vortex separator or mechanical float control.

## 7.3 Inspection and Maintenance Regime

Regular inspection and maintenance is important to identify areas which may have been obstructed/clogged and may not be drain efficiently, thus exposing the development to a greater level of flood risk.

Maintenance responsibility for the pipes should be placed with the DfE and the St Andrew the Apostle School management teams.

A recommended schedule is detailed in the table below.

| **Maintenance Schedule** | **Required Action** | **Frequency** |
|---|---|---|
| Monitoring (to be undertaken more regularly within the first year of operation and adjusted as required) | Initial inspection should be provided using a post construction CCTV survey. | N/A |
| | Inspect for evidence of poor operation via water level in chambers. If required take remedial action. | 3-monthly, 48 hours after large storms. |

| | | |
|---|---|---|
| Occasional maintenance | Check and remove large vegetation growth near pipe runs. | 6 monthly |
| Remedial actions | Open penstock where poor performance is identified. Inspect and rectify any issues found. | As required. |
| | If continued poor performance, jet and CCTV survey. | As required. |
| | Seek advice as to remediation techniques suitable for the type of performance issue and location. | As required If above does not improve performance. |

# 8.0 Rain Gardens and Tree Pits

## 8.1 Location and Description

The features are used in various locations throughout the proposed drainage system, as shown on surface water drainage drawings;

- FS0200-CUR-ZZ-ZZ-DR-C-9030-P02_Surface Water Drainage Layout Sheet 1 of 2
- FS0200-CUR-ZZ-ZZ-DR-C-9031-P02_Surface Water Drainage Layout Sheet 2 of 2

The features have been/will be designed in accordance with CIRIA C753.

## 8.2 Operation

The rain gardens and tree pits are intended to be a combination of surface water conveyance, water quality and attenuation storage features. They are particularly effective in delivering interception and can also provide biodiversity.

Engineered soils and/or HDPE crates are used to provide the necessary attenuation volume and water quality improvement. In the case of rain gardens, the choice of vegetation can also improve water quality and evapotranspiration levels. The tree pits will be supplemented by perforated carrier drains laid horizontal, with outlet inspection chambers including an orifice control to maximise the attenuation volume. Permeable membrane should be used around carrier drains to ensure that fines do not get washed downstream and clog up the wider drainage system. In areas near structures, impermeable liners are included to prevent water from infiltrating.

## 8.3 Inspection and Maintenance Regime

Regular inspection and maintenance is important for the effective operation of the features.

The tree pits have outlet inspection chambers to facilitate visual inspection of the operation and efficacy of the network, particularly in respect of fines potentially clogging up the system. Both features will require appropriate maintenance to strike the correct balance between leaf litter for vegetation nutrients and ensuring that the engineering properties are maintained.

In the longer term, the upper soil layer of the tree pit, and the rain gardens will require soil replacement. The project arboriculturalist will be able to advise on this matter.

| Maintenance Schedule | Required Action | Frequency |
|---|---|---|
| Regular maintenance\inspection | Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain to determine if maintenance is necessary | Quarterly |
| | Check operation of underdrains by inspection of flows after rain | Bianually |
| | Inspect inlets and outlets for blockages | Quarterly |
| Regular maintenance | Remove litter and surface debris and weeds | Quarterly (more frequently for aesthetic reasons) |
| | Remove sediment, litter and debris build-up from around inlets | Quarterly |
| Occasional maintenance | Infill any holes or scour in the filter medium, improve erosion protection if required | As required and as per landscape architect's specification. |
| | Clear water inlet points and soil aeration vents | Biannually |
| | Repair minor accumulations of silt by raking away surface mulch or scarifying surface of medium | As required. |
| Remedial actions | Remove and replace filter medium and vegetation above | As required. |

# 9.0 Our Locations

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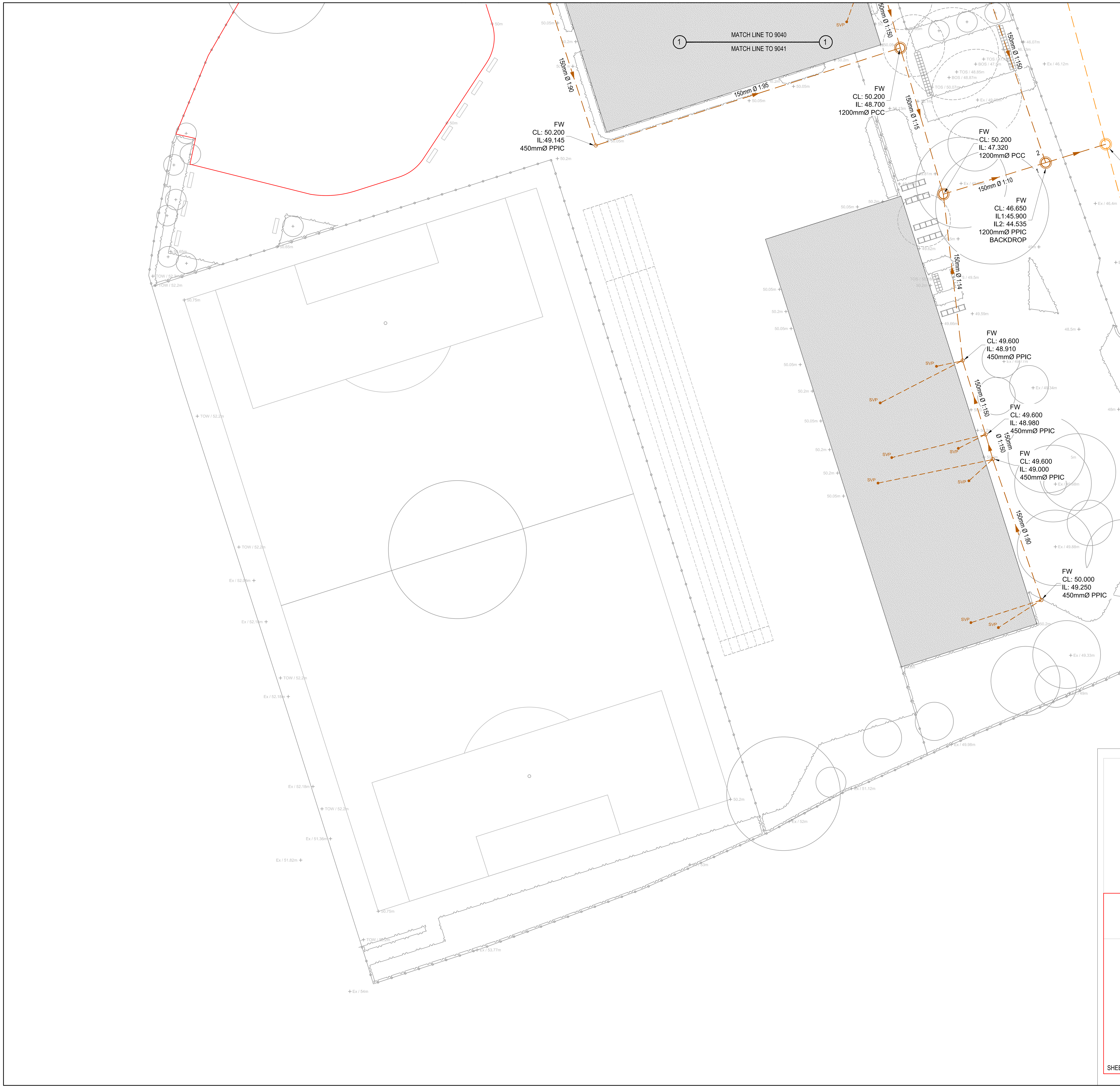
## Appendix I Foul Water Drainage Layout




## SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION UNUSUAL SIGNIFICANT HAZARDS

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## GENERAL NOTES

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4. FOR GENERAL NOTES REFER TO CURTINS DRAWING "FS02000-CUR-ZZ-ZZ-DR-C-0100_GENERAL INFRASTRUCTURE NOTES".

## KEY

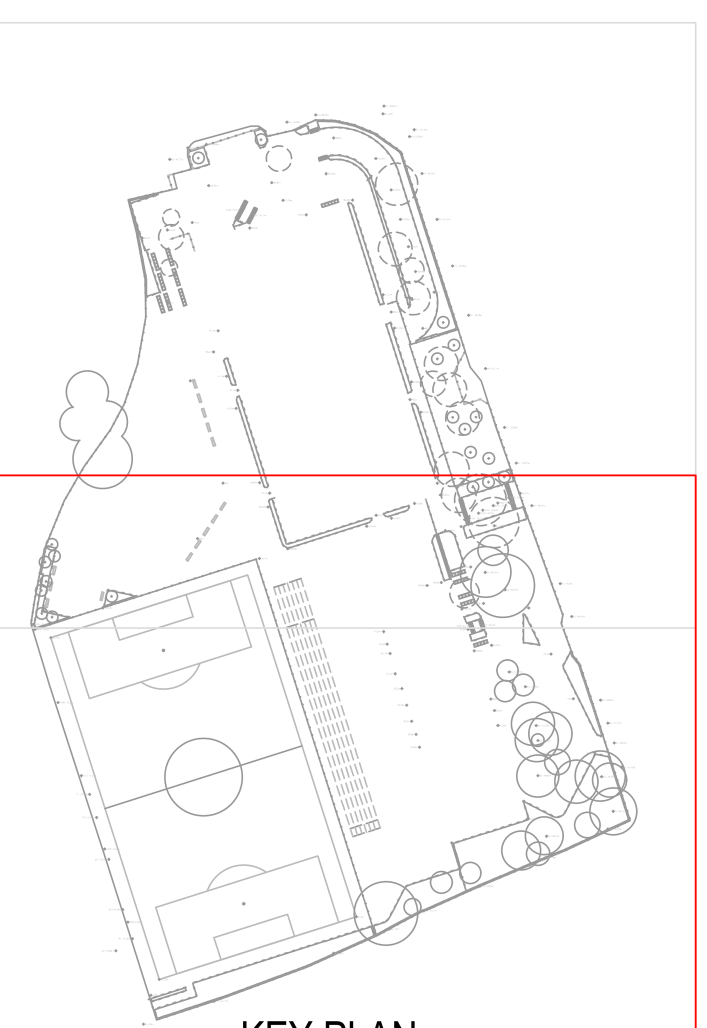
PROPOSED FOUL WATER DRAINAGE
EXISTING FOUL WATER DRAINAGE (APPROXIMATE LOCATION)
SVP PROPOSED INTERNAL FOUL WATER CONNECTION POINT TO ABOVE GROUND

## DESIGN NOTES

1. FOUL WATER CONNECTION SUBJECT TO S106 AGREEMENT WITH THAMES WATER
2. EXISTING FOUL WATER SEWER BASED ON SEWER MAPS RECEIVED 29.03.21
3. FOUL WATER POP UPS ARE ASSUMED AND LOCATIONS ARE TO BE CONFIRMED BY M&E/ARCHITECT DURING DETAILED DESIGN
4. COVER LEVELS ASSUMED AT THIS STAGE, FOLLOWING THE DETAILED LANDSCAPING DESIGN.
5. ALL SVP CONNECTION PIPES ARE ASSUMED TO BE 100mmØ. 150mmØ CONNECTIONS WILL UPSIZE THE MANHOLE.
6. ALL MANHOLE COVERS TO BE D400 UNLESS SITUATION WITHIN A NON-TRAFFICKED AREA.
7. REQUIREMENT FOR CAST IRON DRAINAGE TO RECEIVE HOT FLOWS TO BE CONFIRMED BY KITCHEN SPECIALIST.
8. DILUTION TRAPS TO BE PROVIDED ON ALL CLASSROOM SINKS.
9. INVERT AND COVER LEVELS OF EXISTING SEWERS ARE ASSUMED, TO BE CONFIRMED BY CONTRACTOR PRIOR TO CONSTRUCTION
10. PLEASE REFER TO DESIGNER'S HAZARD REGISTER - FS0200-CUR-XX-XX-RR-S-0001

## TO BE READ IN CONJUNCTION WITH:

DRAWING TO BE READ IN CONJUNCTION WITH:
- FS0200-CUR-ZZ-ZZ-DR-C-9031_SURFACE WATER DRAINAGE LAYOUT SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9040_FOUL WATER DRAINAGE LAYOUT SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9041_FOUL WATER DRAINAGE LAYOUT SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9051_DRAINAGE CONSTRUCTION DETAILS SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9052_DRAINAGE CONSTRUCTION DETAILS SHEET 2 OF 2



SHEET 1 OF 2

KEY PLAN

| Rev: | Description: | Date: | By: | Chkd: |
|---|---|---|---|---|
| P03 | ISSUED FOR PLANNING | 09.04.21 | JW | AS |
| P02 | DRAFT CP ISSUE | 26.02.21 | EMC | RW |
| P01 | PRELIMINARY ISSUE | 19.02.20 | EMC | RW |

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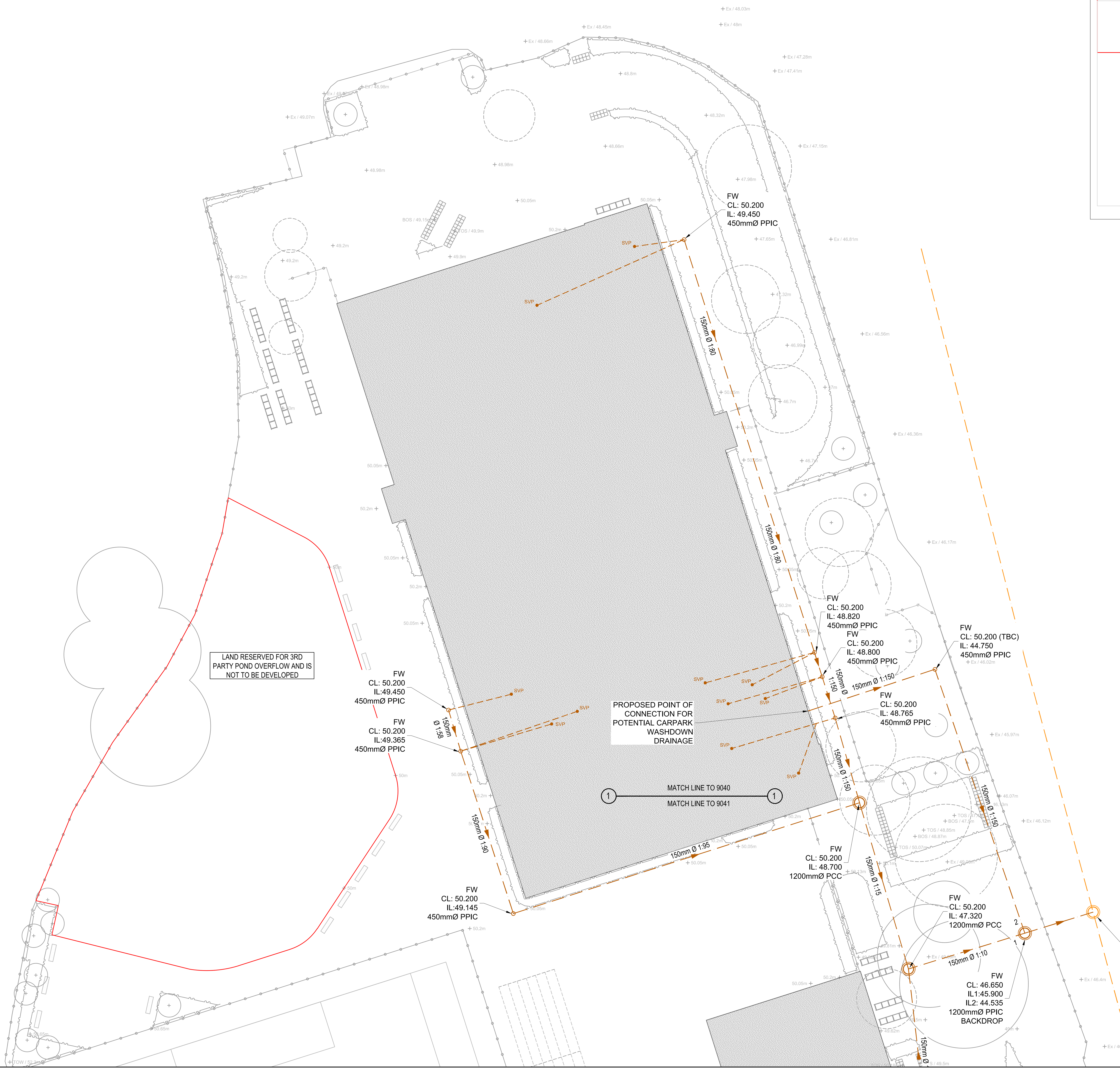
Status: PRELIMINARY

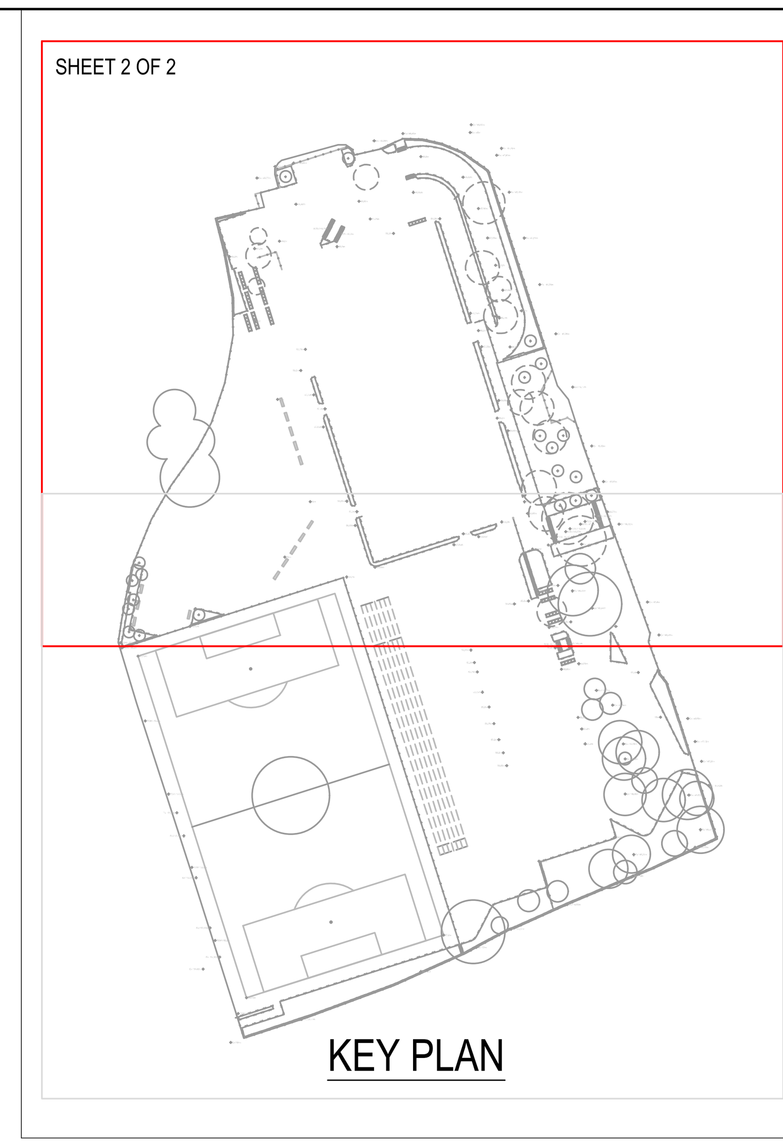
Project: ST ANDREW THE APOSTLE, BARNET

Drg Title: FOUL WATER DRAINAGE LAYOUT SHEET 1 OF 2

| Size: | Date: | Drawn By: | Designed By: | Checked By: |
|---|---|---|---|---|
| A1 | 19.01.21 | EMC | RW | RW |
| Scale: 1:250 | | | | |

| Project No: | Originator: | Volume: | Level: | Type: | Role: | Category / Number: | Rev: |
|---|---|---|---|---|---|---|---|
| FS0200 | CUR | ZZ | ZZ | DR | C | 9040 | P03 |

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## TO BE READ IN CONJUNCTION WITH:

DRAWING TO BE READ IN CONJUNCTION WITH:

- FS0200-CUR-ZZ-ZZ-DR-C-9040_FOUL WATER DRAINAGE LAYOUT SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9030_SURFACE WATER DRAINAGE LAYOUT SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9031_SURFACE WATER DRAINAGE LAYOUT SHEET 2 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9051_DRAINAGE CONSTRUCTION DETAILS SHEET 1 OF 2
- FS0200-CUR-ZZ-ZZ-DR-C-9052_DRAINAGE CONSTRUCTION DETAILS SHEET 2 OF 2

## SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION UNUSUAL SIGNIFICANT HAZARDS

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Status: PRELIMINARY

Project: ST ANDREW THE APOSTLE, BARNET

Drg Title: FOUL WATER DRAINAGE LAYOUT SHEET 2 OF 2

| Size: | Date: | Drawn By: | Designed By: | Checked By: |
|---|---|---|---|---|
| A1 | 19.02.21 | EMC | RW | RW |
| Scale: 1:250 | | | | |

| Project No: | Originator: | Volume: | Level: | Type: | Role: | Category / Number: | Rev: |
|---|---|---|---|---|---|---|---|
| FS0200 | CUR | ZZ | ZZ | DR | C | 9041 | P03 |

## Appendix J STW & LLFA Correspondence

WONDERFUL ON TAP

SEVERN TRENT

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Nottingham
NG1 5DW

**Severn Trent Water Ltd**
Leicester Water Centre
Gorse Hill
Anstey
Leicester
LE7 7GU

Tel: 02477 716843

www.stwater.co.uk
net.dev.east@severntrent.co.uk

Contact: Asif Mussa

Your ref:
Our ref: 8462461

FAO Robin Wells

26th February 2021

Dear Mr Wells

**Proposed School Development (1500 pupils & 1 swimming pool) Land at: West Coventry Academy, Nutbrook Avenue, Coventry (428030,278489).**

I refer to your Development Enquiry Request submitted in respect of the above site. Please find enclosed the sewer records that are included in the fee together with the Supplementary Guidance Notes (SGN) referred to below.

**Public Sewers in Site – Required Protection**
According to our sewer records there are no public sewers within the site boundary. Due to a change in legislation on 1 October 2011 there may also be former private sewers on the site which have transferred to the responsibility of Severn Trent Water Ltd, which are not shown on the statutory sewer records, but are located in your client's land. These sewers would have protective strips that we will not allow to be built over. If such sewers are identified to be present on the site, please contact us for further guidance.

**Foul Water Drainage**
The enclosed sewer record extract shows a 150mm diameter public foul water sewer in Hornbeam Drive. Your plans show that manhole 8208 is the preferred connection point. Flows generated from swimming pool backwash will require a trade effluent discharge consent from our Commercial Services team, if it will be open to the public. You will find all information relating trade effluent on our website:
https://www.stwater.co.uk/businesses/trade-effluent/trade-effluent-consent/

From the information you have provided and our desktop assessment, we feel that sewer modelling will be required. This will enable us to ensure that we fully understand the impact of your

proposals on our network.
Based on our current assessment of the risk and the information you have provided so far, we would like to commence the modelling once the site has progressed through the planning process.

In a change to our previous process, we no longer charge developers for the hydraulic modelling service. We will liaise with you over time with regard to the outcome of our investigations and any impact that may have on the Planning status, occupation, or phasing of the site. However while we can provide a brief summary of our findings if you need us to, we will no longer provide the full external capacity assessment report.

Please inform us as and when planning has progressed as this will help determine how quick we carry out the modelling exercise. In the meantime the site will be added to our modelling tracker and reviewed regularly until the site can be progressed for sewer modelling.

**Surface Water Drainage**

Under the terms of Section H of the Building Regulations 2000, the disposal of surface water by means of soakaways should be considered as the primary method. If this is not practical and no watercourse is available as an alternative, the use of sewerage should be considered. In addition, other sustainable drainage methods should also be explored before a discharge to the public sewerage system is considered.

In the event that following testing, it is demonstrated that soakaways would not be possible on the site; satisfactory evidence will need to be submitted. The evidence should be either percolation test results or a statement from the SI consultant (extract or a supplementary letter). This would satisfy SGN1 (enclosed).
In this scenario, a surface water connection to the available public sewer would be acceptable subject to formal S106 approval (see later) with the discharge rate requested to be restricted in accordance with SGN2 (Brownfield site). Please note the following comments.

Subject to the above, you will need to demonstrate how the site is currently drained if indeed it is positively drained; identifying which impermeable areas drain to which pipeline and the connections/outfalls to the public sewerage system identified.

Ideally, a drainage survey of the existing site is required; in the case of multiple connections the survey needs to also identify which impervious areas drain to which pipeline. When this information is made available a decision will be made on the permitted surface water discharge.

**New Connections**

For any new connections (including the re-use of existing connections) to the public sewerage system, you will need to submit a Section 106 application form. Our New Connections department are responsible for handling all such enquiries and applications. To contact them for an application form and associated guidance notes please call 0800 7076600 or download from www.stwater.co.uk.

Please quote 8462461 in any future correspondence (including e-mails) with STW Limited. Please note that 'Development Enquiry' responses are only valid for 6 months from the date of this letter.

Yours sincerely,

Asif Mussa
Wholesale Operations - Asset Protection (East)

## Appendix K Flood Risk Assessment (AWP, 2015)

# Proposed Redevelopment of North London Business Park (Royal Brunswick Park)

Comer Homes Group

## Environmental Statement Appendix 12.1

## Flood Risk Assessment

# Proposed Redevelopment of North London Business Park (Royal Brunswick Park)

## Environmental Statement Appendix 12.1

## Flood Risk Assessment

| | |
|---|---|
| Job Title | Proposed Redevelopment of North London Business Park (Royal Brunswick Park) |
| Project Number | 0031 |
| Date | 17 December 2015 |
| Client | Comer Homes Group |
| Prepared by | G Jane |
| Checked by | C Yalden |
| Authorised by | R Ward |
| File Reference | p:\0031 royal brunswick park\c documents\reports\0031 royal brunswick park - fra.docx |

Kensington Court
Woodwater Park
Pynes Hill
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EX2 5TY
Tel: 01392 409007
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# Contents

# 1 Introduction

1.1. This site-specific Flood Risk Assessment (FRA) has been prepared on behalf of Comer Homes Group by Awcock Ward Partnership (AWP) to assess the potential flood risks that may affect the hybrid application for the redevelopment of North London Business Park to provide a mixed use development of up to 1,200 dwellings, 3,214sqm office space, 1,153sqm retail space, 510sqm community space, 300sqm nursery and a 1,050 pupil capacity school.

1.2. The mixed use development will be delivered across a number of phases. The detailed application covers Phase 1 of the site, which includes the school site and 376 new residential dwellings, whilst the remaining phases of development will be covered by an outline application.

1.3. This FRA has been prepared to *“identify and assess the risks of all forms of flooding to and from the development and demonstrate how these flood risks will be managed so that the development remains safe throughout its lifetime, taking climate change into account”* as required by the National Planning Policy Framework (NPPF).

National Planning Policy Framework

1.4. The NPPF and the accompanying National Planning Practice Guidance (NPPG) were published by the Department for Communities and Local Government in March 2012 and March 2014 respectively. As a consequence PPS25 “Development and Flood Risk” was replaced, although its key elements were retained.

Structure and limitations of this FRA

1.5. This site-specific FRA has been written in accordance with the guidance set by the NPPF and NPPG, using the information that is currently available.

1.6. The report has been structured to describe the existing site parameters, the proposed development and to offer a Surface Water Management Plan (SWMP), indicating how surface water runoff can be managed so that it does not increase flood risk within the downstream catchment.

1.7. It is important to note that this FRA does not attempt to present a final design of the surface water drainage system nor the most value engineered design. This will be left until the detailed design stage when further work can be undertaken and all other types of systems can be evaluated. This evaluation will also need to include other assessments, including health and safety, CDM etc.

## Consultation

1.8. To scope any site specific or catchment specific flood risks or drainage requirements we have engaged with Barnet Council, as the Lead Local Flood Authority, and Thames Water's Development Engineer and Technical Coordinator.

1.9. Furthermore, a public consultation was held which provided an opportunity for members of the public to review the proposals and share any thoughts or concerns relating to the existing site or the outline drainage strategy.

1.10. The output of the above consultation process has helped to inform the FRA and the inherent Surface Water Management Plan (SWMP).

## Reference

1.11. This FRA has been prepared by reference to the following documents:

- National Planning Policy Framework (March 2012);
- National Planning Practice Guidance (March 2014);
- The London Plan (March 2015);
- Barnet's Surface Water Management Plan (October 2011);
- North London SFRA (August 2008);
- Groundsure Enviroinsight report (November 2015);
- CIRIA Guide 753 'The SuDS Manual';
- Thames Water's Asset Record Plans; and
- Environment Agency mapping.

# 2 Existing Site

Site location

2.1. The existing site is located off Brunswick Park Road in East Barnet, at national grid reference TQ 280 934. Figure 1 below shows the extents of the application site.


*Figure 1 – Site Location Plan*

Existing land uses

2.2. The existing site comprises a series of operational uses within the North London Business Park site. The site comprises a number of buildings, internal access roads and car parking, with areas of undeveloped green space to the east and north.

2.3. Within the eastern green space there is an existing attenuation pond which receives runoff from the existing brownfield site.

Surrounding land use

2.4. The site is bordered by residential development to the north and south, Brunswick Park Road and further residential development to the east, and a railway line to the west, with residential development beyond.

Topographic survey

2.5. A topographic survey has been undertaken and indicates that the existing site generally falls towards its most easterly extents, from a high point of approximately 72m above ordnance datum (AOD) at its north-western corner, to a low point of approximately 48m AOD near the south-east corner.

2.6. A copy of the existing site survey has been included as drawing 0031-XS-001 within Appendix A of this report.

Existing flood risk

2.7. An extract of the EA's 'Flood Map for Planning' for the East Barnet area is reproduced below as Figure 2. This mapping shows the site to be wholly within 'Flood Zone 1 – Low Risk' from fluvial flooding. This means that the site located is not at risk of flooding from fluvial sources in up to the 1 in 1000 year return period flood (<0.1%).

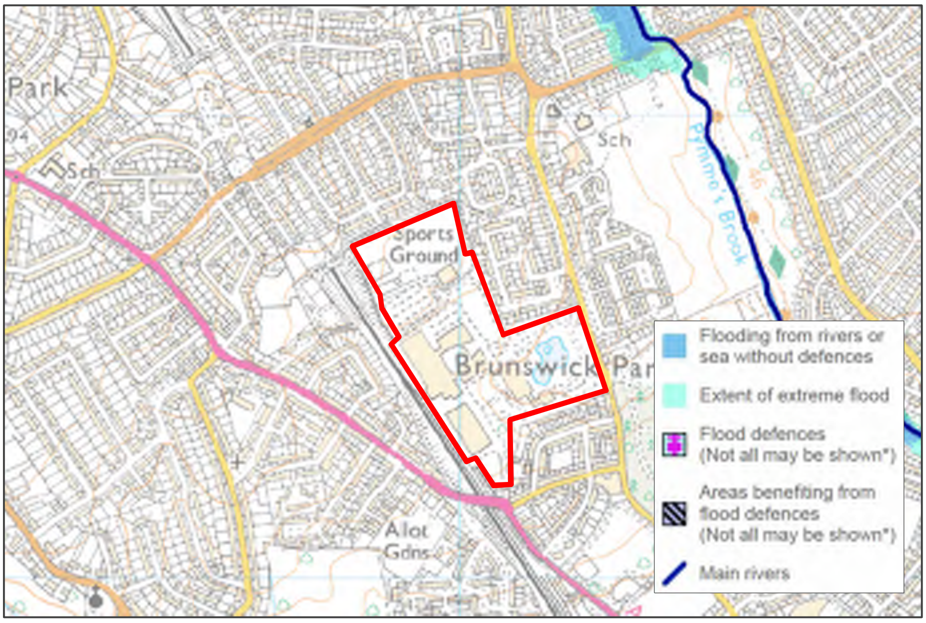



*Figure 2 – Flood Map for Planning*

2.8. A copy of the EA's 'Flooding from Surface Water' map has been reproduced as Figure 3. This mapping is based on LIDAR data and indicates the typical conveyance routes of concentrated surface water runoff.


*Figure 3 – Flooding from Surface Water*

2.9. This mapping extract highlights the location of the existing attenuation pond and indicates that any overland exceedance routes within the site follow the existing road network, before crossing the green landscaped areas towards the pond.

Existing site drainage / drainage infrastructure

2.10. The existing drainage regime is typical of an existing brownfield site. A number of private and adoptable surface and foul water networks have been identified.

2.11. Thames Water's (TW) asset records indicate public surface and foul sewerage networks beneath Brunswick Park Road to the east of the site. The records also illustrate that surface water sewers run west to east beneath the site towards Brunswick Park Road.

2.12. Historic drainage records (including as-built plans) identify existing private surface and foul water networks serving the site.

2.13. The records indicate that storm flows are conveyed to the existing attenuation pond, with a positive discharge to the public surface water sewer beneath Brunswick Park Road.

2.14. Similarly, the records indicate on-site private foul water drains routing to the public foul water sewers beneath Brunswick Park Road.

2.15. The existing alignments of adoptable sewers within the site and its local vicinity have been identified on the site survey drawing (ref. 0031-XS-001) included within Appendix A of this report.

Ground conditions

2.16. A desk-top assessment has been undertaken using the DEFRA Soilscape dataset and is included within Appendix B of this report.

2.17. The desktop assessment indicates that the soils underlying the site suffer from "impeded drainage" and on this basis the use of infiltration features has been disregarded. Instead the proposed drainage strategy will utilise on-site attenuation with restricted discharges to the existing downstream receptors.

# 3 Proposed Development

3.1. The proposed development comprises the redevelopment of the North London Business Park to provide a mixed use development of up to 1,200 dwellings, 3,214sqm office space, 1,153sqm retail space, 510sqm community space, 300sqm nursery and a 1,050 pupil capacity school.

3.2. The mixed use development will be delivered across a number of phases. The detailed application covers Phase 1 of the site, which includes the school site and 376 new residential dwellings, whilst the remaining phases of development will be covered by an outline application.

3.3. The scheme also comprises internal access roads, garaging and parking and associated landscaping, drainage and engineering works.

3.4. A copy of the proposed masterplan for the development is provided within Appendix C of this report.

## Vulnerability

3.5. In accordance with the NPPG, the most vulnerable form of development being promoted is the residential elements, which are classified as “More Vulnerable”. However as the scheme is entirely within ‘Flood Zone 1 – Low Risk’, Table 3 in the NPPG concludes that residential use is appropriate for this site.

## Sequential Test

3.6. The site is located within ‘Flood Zone 1 – Low Risk’ and would therefore pass the Sequential Test, as there are no competing sites with a lower flood risk classification.

## Cross sections and finished levels

3.7. It is anticipated that the existing ground profile will be modified locally to reflect the requirements of the new development.

3.8. Any future level design should aim to minimise the extent of any re-profiling works and wherever possible should look to retain existing watershed catchments.

### Safe access and egress

3.9. The full extents of the site and all roads surrounding the site are within 'Flood Zone 1 – Low Risk' and hence access and egress for motorised and non-motorised vehicles will not be affected during any fluvial flood events.

### Climate change impacts

3.10. The NPPF requires that the impact of climate change be considered. The NPPG states "In making an assessment of the impacts of climate change on flooding from the land, rivers and sea as part of a flood risk assessment, the sensitivity ranges in Table 5 may provide an appropriate precautionary response to the uncertainty about climate change impacts on rainfall intensities, river flow, wave height and wind speed."

3.11. Table 5 in the former Technical Guidance to the NPPF detailed the latest UKCIP climate change predictions on future weather conditions: peak rainfall is predicted to increase by approximately 30% during the next 100 years and river flows will increase by approximately 20% over the same period. A copy of this table can be seen below as Figure 4.

| Parameter | 1990 to 2025 | 2025 to 2055 | 2055 to 2085 | 2085 to 2115 |
|---|---|---|---|---|
| Peak rainfall intensity | +5% | +10% | +20% | +30% |
| Peak river flow | +10% | +20% | | |
| Offshore wind speed | +5% | | +10% | |
| Extreme wave height | +5% | | +10% | |

*Figure 4 – Recommended national precautionary ranges*

3.12. The on-site attenuation has been sized to offer flood protection for the development and its downstream catchment throughout its 100 year design life, with an allowance for the predicted effects of climate change.

# 4 Surface Water Management Plan

Existing surface water runoff

4.1. Surface water runoff generated by the existing brownfield site is predominantly routed towards the on-site attenuation pond. The as-built drainage records identify piped connections between this pond and the Thames Water surface water sewer beneath Brunswick Park Road; the records do not identify any form of hydraulic control indicating that peak flows are likely to be unrestricted.

4.2. In line with the requirements of the London Plan (Policy 5.13), the proposed development must ensure that future discharges are restricted to the equivalent greenfield runoff rates, providing a significant level of betterment over the existing scenario and thus reducing flood risk within the downstream catchment.

4.3. The MicroDrainage Source Control module has been used to assess the equivalent greenfield runoff rates for the site. In accordance with best practice, the assessment is based on the IH 124 methodology.

4.4. A copy of this assessment can be seen within Appendix D of this report, with the results summarised in Table 1 below.

| Return Period | Greenfield Runoff Rates (l/s) | | | | | |
|---|---|---|---|---|---|---|
| | Ph1 | Ph2 | Ph3 | Ph4 | Ph5 | TOTAL |
| 2 year | 21.5 | 16.3 | 4.6 | 10.0 | 10.9 | 63.3 |
| 30 year | 46.0 | 41.7 | 11.4 | 26.0 | 27.8 | 152.9 |
| 100 year | 75.5 | 57.2 | 15.9 | 36.0 | 38.1 | 222.7 |

*Table 1 – Greenfield Runoff Rates*

Surface Water Strategy

4.5. The surface water strategy for the site has been developed to respect the masterplan, accounting for runoff in up to the 100 year (+30% climate change) critical storm event.

4.6. A review of the proposed masterplan in conjunction with the alignment of Thames Water's existing surface water sewers has identified potential conflicts. Through consultation with Thames Water we have received confirmation that a build-over agreement will not be acceptable and that asset protection should be secured through suitable diversionary works.

4.7. A diversion corridor has been agreed with Thames Water and will be implemented by the proposed development to ensure that those served by the existing networks will be uninterrupted. It is proposed to unify the two existing Thames Water sewers with a single diversion sewer of equal hydraulic capacity.

4.8. The Soilscape desktop assessment indicates that the soils underlying the site suffer from “impeded drainage” and on this basis the use of infiltration features has been disregarded. Instead, the surface water strategy for the proposed development will comprise a network of:

- Adoptable and non-adoptable underground pipework;
- Rainwater harvesting systems;
- SuDS Attenuation Pond;
- Cellular Storage;
- Hydraulic controls; and,
- Overland exceedance measures.

Phase 1 Strategy (Detailed Application)

4.9. The proposed school site will benefit from its own on-site attenuation system, whilst the balance of Phase 1 will be served by a private communal drainage network.

4.10. Runoff generated by the school site will be intercepted by new private storm drainage which will convey flows to a cellular storage attenuation feature, with greenfield discharge to the Thames Water surface water sewers beneath Brunswick Park Road.

4.11. Roof level runoff from residential buildings within Phase 1 will feed into rainwater harvesting tanks. These tanks will seek to intercept the first 5mm of runoff for re-use for toilet flushing, thus reducing the level of pollutants being discharged to downstream surface water sewers and reducing potable water demand throughout the development.

4.12. Beyond the capacity of the rainwater harvesting tanks, any further inflow of runoff will overflow to an external storm drainage network which will route flows to the on-site attenuation pond.

4.13. Whilst they share a similar location within the site, the proposed attenuation pond will replace the existing pond and form part of a wider Public Open Space. The pond will provide water quality enhancement whilst also offering ecological and biodiversity benefits.

4.14. The outflow from the pond will be restricted to the equivalent greenfield runoff rate for the respective catchment and will discharge to the Thames Water surface water sewers beneath Brunswick Park Road.

4.15. Thames Water have confirmed through a pre-application enquiry that they agree with the principles of the proposed drainage strategy. A copy of this correspondence is included within Appendix F of this report.

4.16. The drawing included in Appendix E (reference 0031-PDL-100) shows a Preliminary Drainage Layout for the Phase 1 site, including the proposed diversion of Thames Water's sewers.

<u>Phase 2-5 Strategy (Outline Application)</u>

4.17. The surface water strategy for each future phase of development will include rainwater harvesting with on-site attenuation to restrict any residual flows to the equivalent greenfield runoff rate.

4.18. Restricted flows will be discharged to the Phase 1 network, passing through the pond before outfalling to the Thames Water surface water sewers beneath Brunswick Park Road.

4.19. The drawing included in Appendix E (reference 0031-PDL-200) shows the Preliminary Drainage Layout for the later development phases.

Attenuation storage volumes

4.20. The MicroDrainage Source Control module has been used to determine the storage requirements for each phase of the proposed development.

4.21. The output of these models can be seen within Appendix D of this report, with the results summarised in Table 2:

| Proposed Storage Feature | Proposed 100yr+30% Volume ($m^3$) |
|---|---|
| Phase 1 Attenuation Pond | 768 |
| Phase 1 School Attenuation | 356 |
| Phase 2 Attenuation | 920 |
| Phase 3 Attenuation | 160 |
| Phase 4 Attenuation | 722 |
| Phase 5 Attenuation | 799 |
| Total | 3725 |

*Table 2 – Attenuation Storage Requirements*

4.22. The drawing included in Appendix E (reference 0031-PDL-101) shows the proposed arrangement of the Phase 1 attenuation pond.

4.23. The attenuation pond includes a permanently wet base with 1m depth of available storage above. The available storage will be split between two stages, the first 600mm depth caters for runoff from storms up to the 5 year return period (20% of occurrence in any given year), whilst runoff up to the 100 year return period ( with 30% allowance for climate change) will be attenuated within a wider storage area, to a depth of 250mm, leaving 150mm of freeboard for exceedance storage.

Exceedance events

4.24. It is considered that the proposed drainage network will offer a significant level of betterment when compared to the existing site. The scheme will restrict the peak rate of discharge to the equivalent greenfield rates and will be designed to cater for runoff from all storms up to the 100 year return period, with 30% allowance for climate change.

4.25. During exceedance events, beyond the schemes 100 year design life, surface water runoff will overflow from the aforementioned systems and wherever possible will be directed away from buildings, towards areas of public open space. Any residual overland flows will then be routed towards the attenuation pond, as per the pre-development scenario.

Proposed foul water strategy

4.26. The existing site is served by private foul drains which can be diverted to accommodate the proposed development. Any diversionary works will retain the existing points of connectivity with Thames Waters public foul sewerage network beneath Brunswick Park Road.

4.27. Foul flows generated by the proposed development will be intercepted by new private foul networks within the site, prior to being discharged to Thames Waters public foul sewerage network beneath Brunswick Park Road.

4.28. The proposed development includes a series of basement car parks. Given that these areas are not exposed to rainfall it is considered that any drainage requirements will be limited to potential wash-down, spillages or other potential contaminants. It is therefore proposed to utilise private package pumps to transfer any basement drainage to the external foul water network.

4.29. A pre-development capacity enquiry has been submitted to Thames Water. The enquiry seeks to establish whether the existing points of connectivity can be retained for the proposed development, otherwise it will outline alternative points of adequacy or potential reinforcement requirements to accommodate any increased foul flows.

4.30. The drawings included within Appendix E (reference 0031-PDL-100 and 200) show the proposed foul drainage arrangements for the detailed and outline application sites.

Maintenance

4.31. The on-site sewer diversions will be designed in accordance with Sewers for Adoption (SfA) and will be offered to Thames Water for adoption.

4.32. All private drainage and SuDS features will be designed in accordance with Building Regulations Part H and CIRIA C753 and will become the responsibility of a 3rd party Management Company, or each respective homeowner / landlord / building management company.

# 5 Miscellaneous Issues

Construction issues

5.1. It is good practice to offer a Construction Environmental Management Plan (CEMP) to allow the construction and phasing of drainage works to be closely monitored. Prior to the commencement of construction, the contractor will produce a CEMP and agree it with the EA / LLFA.

5.2. Any facilities for the storage of oils, fuels or chemicals need to be situated in suitable bunded bases that will be equivalent to at least the volume of the tank plus 10%.

Residual flood risks

5.3. It has been established that the proposed developable area is wholly within ‘Flood Zone 1 – Low Risk’. There is no habitable development within Flood Zones 2 or 3. There are therefore no residual flood risks with regard to high risk flood zones.

5.4. Safe access and egress has been identified.

Health and safety

5.5. Until such time as the hazards relating to the site or location are known, we are unable to confirm that our recommendations will be acceptable in terms of safe buildability / maintainability.

5.6. Under the CDM Regulations, adequate information about the site must be provided by the client in order to allow the potential hazards to be reviewed by the designer, and avoidance / mitigation measures taken where reasonably practicable.

# 6 Mitigation, Conclusions and Recommendations

## Mitigation

6.1. The proposed development has been assessed in line with the NPPF, to allow the planning application to be progressed and to show that the development can be undertaken in an acceptable manner from a flood risk perspective.

6.2. In line with policy requirements the proposed development will restrict runoff from the site to the equivalent greenfield runoff rates. This will enable a significant reduction in surface water runoff being discharged off-site, freeing up capacity within Thames Waters surface water sewers and thus reducing flood risk within the downstream catchment.

6.3. The proposed drainage strategy promotes the use of rainwater harvesting. This will reduce the demand for potable water supply and will help to capture the first 5mm of runoff, reducing the level of pollutants being discharged off-site.

6.4. The inclusion of a SuDS attenuation pond will offer water quality enhancement as well as other ecological and biodiversity benefits.

6.5. Exceedance flows beyond the 100 year plus 30% critical storm event will be routed towards convenient holding points within the confines of the development area, away from properties and primary access routes.

6.6. Foul flows from the development will discharge to the existing foul sewerage network beneath Brunswick Park Road, retaining existing drainage connections wherever possible.

## Conclusions

6.7. The proposed development has been assessed in line with the NPPF and other relevant policies, to allow the planning application to be progressed and to show that the development can be undertaken in an acceptable manner from a flood risk perspective.

This Flood Risk Assessment has been assessed in line with the NPPF. It is concluded that the development can be undertaken in a sustainable manner with the ability to provide a significant reduction in flood risk to existing properties in the downstream catchment.

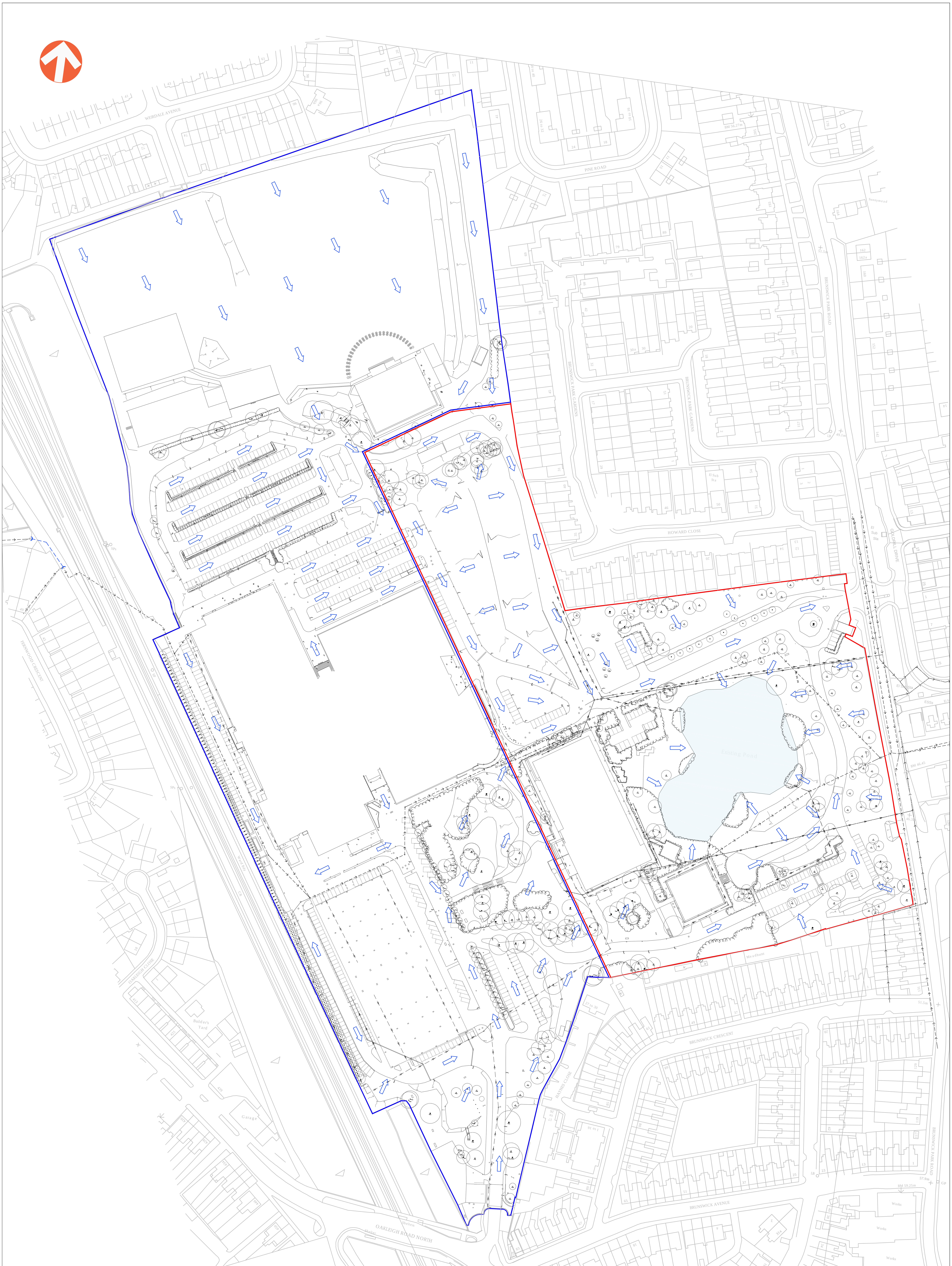
The FRA does not attempt to present a final design of the surface water system. Detailed design of the surface water network and inherent features will commence upon approval of the outline strategy and will include assessments due to further site investigations, health and safety, CDM etc.

Recommendations

6.8. As the development will be safe from flooding for its design life and will reduce flood risk to properties in the downstream catchment, it is recommended that the Local Planning Authority confirm they have no objections to the proposed development.

# Appendices

# Appendix A – Topographic Survey




**General Key**

| | |
|---|---|
| Red line | Phase 1 Boundary (Detailed Application) |
| Blue line | Phase 2-5 Boundary (Outline Application) |

**Existing Drainage**

| | |
|---|---|
| - → — — → — — | Thames Water Surface Water Sewer |
| ——→—·—— | Thames Water Foul Water Sewer |
| ⇨ | Overland Flood Flow Route |

**Notes**

1. Topographic survey undertaken by B.W Surveys on 06/03/2007.
2. Alignment of existing drainage taken from Thames Water asset record plans and historical as-built drainage records.

| REV | DATE | DESCRIPTION | BY | CHK | APD |
|---|---|---|---|---|---|
| A | 16.12.2015 | INITIAL ISSUE | JR | CPY | RPW |

CLIENT:
COMER HOMES GROUP

DRAWING STATUS:
FOR INFORMATION ONLY

PROJECT:
ROYAL BRUNSWICK PARK

TITLE:
EXISTING TOPOGRAPHIC SURVEY

| PROJECT No: | DRAWING No: | REV: |
|---|---|---|
| 0031 | XS-001 | A |

SCALE @ A1: 0 — 1:1000 — 50 metres

DESIGN BY:
awp awcockward partnership

Awcock Ward Partnership, Kensington Court, Woodwater Park, Pynes Hill, Exeter, EX2 5TY
Tel: 01392 409007 Web: www.awpexeter.com

# Appendix B – Soilscape Report

# 0031 - Royal Brunswick Park - Site Check Map



## Legend

Projection = OSGB36
xmin = 525400
ymin = 192200
xmax = 530200
ymax = 194900
Map produced by MAGIC on 30 November, 2015.

Site Check Report Report generated on Mon Nov 30 2015
**You selected the location:** Centroid Grid Ref: TQ280935
The following features have been found in your search area:

**Soilscape (England)**

| | |
|---|---|
| **Reference** | 18 |
| **Name** | SLOWLY PERMEABLE SEASONALLY WET SLIGHTLY ACID BUT BASE-RICH LOAMY AND CLAYEY SOILS |
| **Main Surface Texture Class** | LOAMY |
| **Natural Drainage Type** | IMPEDED DRAINAGE |
| **Natural Fertility** | MODERATE |
| **Characteristic Semi-natural Habitats** | LOWLAND SEASONALLY WET PASTURES AND WOODLANDS |
| **Main Land Cover** | GRASSLAND AND ARABLE SOME WOODLAND |
| **Hyperlink** | /Metadata_for_magic/soilscape_summary.pdf |

# Appendix C – Proposed Masterplan


NOTES:

This drawing is the copyright of Hyland Edgar Driver. It must not be copied or reproduced without written consent. Only figured dimensions are to be taken from this drawing. All contractors must visit the site and be responsible for taking and checking all dimensions related to the works shown on this drawing.

SAFETY, HEALTH AND ENVIRONMENT INFORMATION

Unusual residual hazards / risks, based on experienced and competent contractors working to approved method statements.

UNUSUAL RISKS

| | |
|---|---|
| Construction: | Unusual Risks (list)/No unusual risks |
| Operations: | Unusual Risks (list)/No unusual risks |
| Maintenance: | Unusual Risks (list)/No unusual risks |
| Dismantling/Demolition: | Unusual Risks (list)/No unusual risks |

REVISIONS

REVISIONS

| DATE | DRAWN BY | CHECKED BY |
|---|---|---|
| 24.08.15 | EHdM | DC |

DRAWING STATUS: PLANNING

SCALE at A1/A3: 1:1000

PROJECT: Royal Brunswick Park

DRAWING TITLE: Illustrative Landscape Masterplan

DRAWING NUMBER: HED-1140-RBP-LA-0001

REVISION: P00

CLIENT: COMER GROUP

H | E | D

Hyland Edgar Driver
**Landscape Architects & Urban Designers**
London & Winchester

Waterloo Court 10 Theed Street London SE1 8ST t. 020 7803 9636
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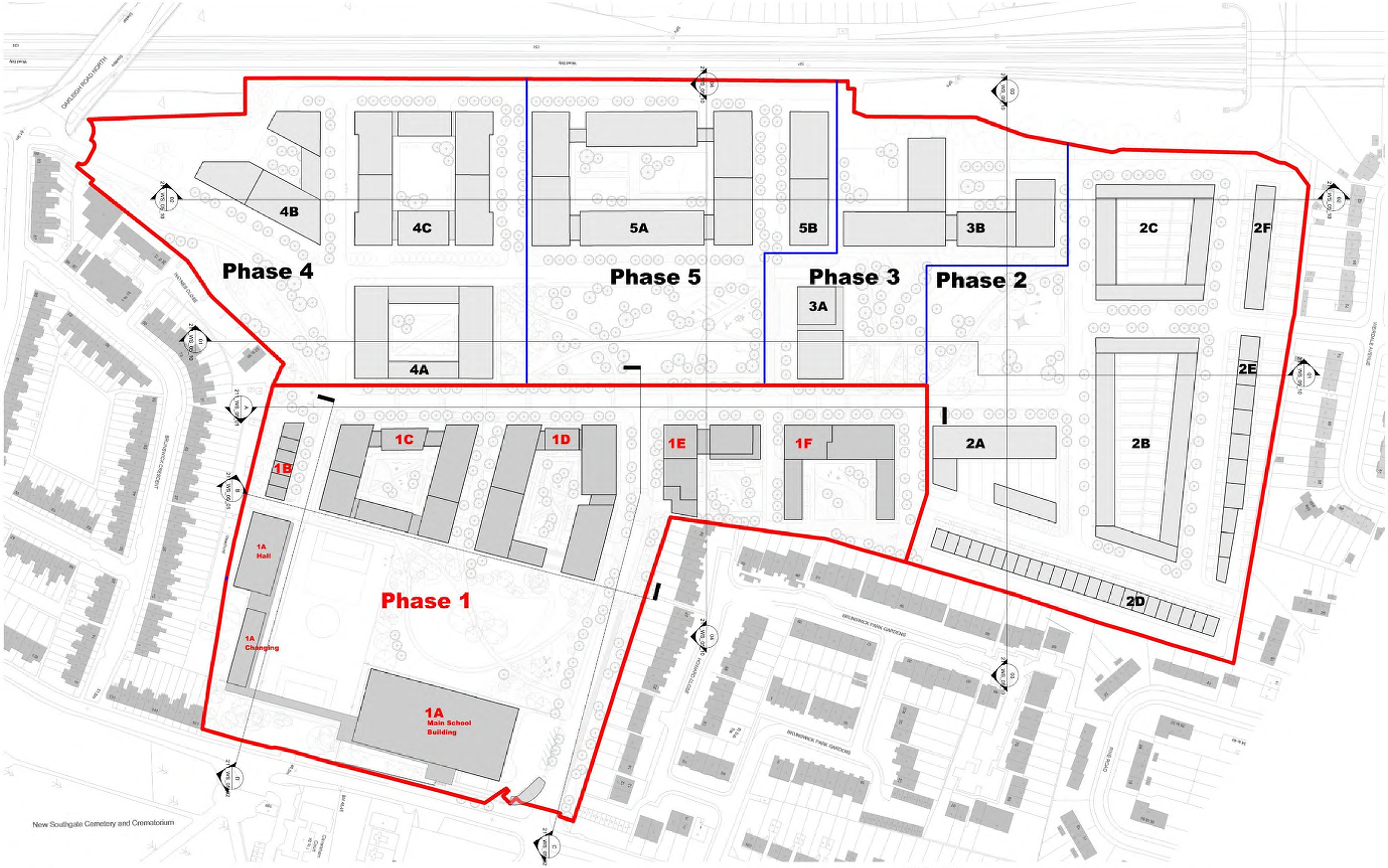



**General Notes**

1. Developmentment Zones (within which development can occur) and public open spaces are identified on drawing number 211_WS_02_01
2. Access and circulation routes are identified on Drawing number 211_WS_02_02.
3. Landscape treatments are identified on drawing number 211_WS_02_03
4. Allowable uses at ground floor frontages are identified on Drawing number 211_WS_02_04
4. Allowable uses at ground floor frontages are idnetified on Drawing number 211_WS_02_04
5. Allowable horizontal limits of deviations are identified on Drawing number 211_WS_02_05
6. Proposed site ground levels and allowable vertical deviations are identified on Drawing number 211_WS_02_06
7. Heights and allowable vertical deviations are identified on Drawing number 211_WS_02_07
8. Basement extents and allowable horizontal and vertical deviation are identified on drawing number 211_WS_02_08

**Additional Notes**

1. Refer to Section 5 of the Design Principles Document for further guidance on the Development Zone.
2. Refer to section 4 of the Design Principles Document for further guidance on the Public Open Space Zones, access routes typologies , and landscaping treatments of streets and spaces.
3. Refer to section 3 of the Design Principles Document for further guidance on the streets and circulation routes.

**Legend**

Planning Application Boundary

Detailed Application Zone Blocks

Phase 1 — Detailed Application Zone Reference

1A — Detailed Application Zone Block Reference

NOTES:

| REV. | DATE: | DETAILS: | INITIALS: |
| --- | --- | --- | --- |

NORTH POINT:

KEY PLAN:

PLUSARCHITECTURE

Exchequer Chambers, Exchequer Street, Dublin 2, Ireland. W: www.plusarchitecture.ie T: 353 (0) 1 521 3378

| | | | |
| --- | --- | --- | --- |
| PROJECT: North London Business Park | PROJECT: 211 | DATE: 14/12/15 | |
| CLIENT: The Corner Group | DRAWING NO.: 211_WS_02_09 | REVISION NO. | |
| TITLE: Site Plan | DRAWN BY: DW | SCALE AT A1 : 1 : 1000 | |
| ISSUE TYPE: Planning | CHECKED BY: DT | SCALE AT A3 : 1 : 2000 | |

# Appendix D – MicroDrainage Output

ICP SUDS Mean Annual Flood

Input

| | | | | | |
|---|---|---|---|---|---|
| Return Period (years) | 2 | SAAR (mm) | 700 | Urban | 0.000 |
| Area (ha) | 1.000 | Soil | 0.450 | Region Number | Region 6 |

| **Results** | **l/s** |
|---|---|
| QBAR Rural | 4.4 |
| QBAR Urban | 4.4 |
| Q2 years | 3.9 |
| Q1 year | 3.7 |
| Q30 years | 10.0 |
| Q100 years | 14.0 |

## Summary of Results for 2 year Return Period

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 49.267 | 0.267 | 19.4 | 0.0 | 19.4 | 142.9 | O K |
| 30 min Summer | 49.321 | 0.321 | 19.4 | 0.0 | 19.4 | 175.0 | O K |
| 60 min Summer | 49.359 | 0.359 | 19.4 | 0.0 | 19.4 | 198.2 | O K |
| 120 min Summer | 49.374 | 0.374 | 19.4 | 0.0 | 19.4 | 207.8 | O K |
| 180 min Summer | 49.374 | 0.374 | 19.4 | 0.0 | 19.4 | 208.1 | O K |
| 240 min Summer | 49.369 | 0.369 | 19.4 | 0.0 | 19.4 | 204.6 | O K |
| 360 min Summer | 49.350 | 0.350 | 19.4 | 0.0 | 19.4 | 192.6 | O K |
| 480 min Summer | 49.326 | 0.326 | 19.4 | 0.0 | 19.4 | 178.0 | O K |
| 600 min Summer | 49.302 | 0.302 | 19.4 | 0.0 | 19.4 | 163.6 | O K |
| 720 min Summer | 49.279 | 0.279 | 19.4 | 0.0 | 19.4 | 150.2 | O K |
| 960 min Summer | 49.241 | 0.241 | 19.3 | 0.0 | 19.3 | 127.8 | O K |
| 1440 min Summer | 49.193 | 0.193 | 18.4 | 0.0 | 18.4 | 100.4 | O K |
| 2160 min Summer | 49.161 | 0.161 | 14.8 | 0.0 | 14.8 | 82.9 | O K |
| 2880 min Summer | 49.142 | 0.142 | 12.4 | 0.0 | 12.4 | 72.6 | O K |
| 4320 min Summer | 49.120 | 0.120 | 9.4 | 0.0 | 9.4 | 60.8 | O K |
| 5760 min Summer | 49.106 | 0.106 | 7.7 | 0.0 | 7.7 | 53.6 | O K |
| 7200 min Summer | 49.097 | 0.097 | 6.6 | 0.0 | 6.6 | 48.7 | O K |
| 8640 min Summer | 49.089 | 0.089 | 5.7 | 0.0 | 5.7 | 45.0 | O K |
| 10080 min Summer | 49.084 | 0.084 | 5.1 | 0.0 | 5.1 | 42.0 | O K |
| 15 min Winter | 49.298 | 0.298 | 19.4 | 0.0 | 19.4 | 161.0 | O K |
| 30 min Winter | 49.358 | 0.358 | 19.4 | 0.0 | 19.4 | 198.0 | O K |
| 60 min Winter | 49.403 | 0.403 | 19.4 | 0.0 | 19.4 | 226.2 | O K |
| 120 min Winter | 49.420 | 0.420 | 19.4 | 0.0 | 19.4 | 237.1 | O K |
| 180 min Winter | 49.416 | 0.416 | 19.4 | 0.0 | 19.4 | 234.2 | O K |
| 240 min Winter | 49.405 | 0.405 | 19.4 | 0.0 | 19.4 | 227.2 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 41.734 | 0.0 | 150.7 | 0.0 | 18 |
| 30 min Summer | 26.594 | 0.0 | 192.9 | 0.0 | 32 |
| 60 min Summer | 16.285 | 0.0 | 238.9 | 0.0 | 60 |
| 120 min Summer | 9.752 | 0.0 | 286.4 | 0.0 | 96 |
| 180 min Summer | 7.183 | 0.0 | 316.5 | 0.0 | 130 |
| 240 min Summer | 5.773 | 0.0 | 339.3 | 0.0 | 164 |
| 360 min Summer | 4.234 | 0.0 | 373.4 | 0.0 | 230 |
| 480 min Summer | 3.389 | 0.0 | 398.7 | 0.0 | 296 |
| 600 min Summer | 2.851 | 0.0 | 419.2 | 0.0 | 362 |
| 720 min Summer | 2.475 | 0.0 | 436.8 | 0.0 | 422 |
| 960 min Summer | 1.980 | 0.0 | 465.7 | 0.0 | 540 |
| 1440 min Summer | 1.445 | 0.0 | 509.5 | 0.0 | 766 |
| 2160 min Summer | 1.055 | 0.0 | 559.8 | 0.0 | 1124 |
| 2880 min Summer | 0.844 | 0.0 | 596.8 | 0.0 | 1496 |
| 4320 min Summer | 0.616 | 0.0 | 652.2 | 0.0 | 2204 |
| 5760 min Summer | 0.492 | 0.0 | 697.4 | 0.0 | 2936 |
| 7200 min Summer | 0.414 | 0.0 | 732.7 | 0.0 | 3672 |
| 8640 min Summer | 0.359 | 0.0 | 762.7 | 0.0 | 4408 |
| 10080 min Summer | 0.319 | 0.0 | 788.3 | 0.0 | 5136 |
| 15 min Winter | 41.734 | 0.0 | 169.1 | 0.0 | 18 |
| 30 min Winter | 26.594 | 0.0 | 216.4 | 0.0 | 32 |
| 60 min Winter | 16.285 | 0.0 | 267.7 | 0.0 | 60 |
| 120 min Winter | 9.752 | 0.0 | 320.9 | 0.0 | 114 |
| 180 min Winter | 7.183 | 0.0 | 354.7 | 0.0 | 140 |
| 240 min Winter | 5.773 | 0.0 | 380.3 | 0.0 | 178 |

## Summary of Results for 2 year Return Period

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 360 min Winter | 49.371 | 0.371 | 19.4 | 0.0 | 19.4 | 206.2 | O K |
| 480 min Winter | 49.333 | 0.333 | 19.4 | 0.0 | 19.4 | 182.4 | O K |
| 600 min Winter | 49.296 | 0.296 | 19.4 | 0.0 | 19.4 | 159.9 | O K |
| 720 min Winter | 49.262 | 0.262 | 19.4 | 0.0 | 19.4 | 140.1 | O K |
| 960 min Winter | 49.211 | 0.211 | 19.0 | 0.0 | 19.0 | 110.5 | O K |
| 1440 min Winter | 49.167 | 0.167 | 15.6 | 0.0 | 15.6 | 86.5 | O K |
| 2160 min Winter | 49.138 | 0.138 | 11.8 | 0.0 | 11.8 | 70.5 | O K |
| 2880 min Winter | 49.121 | 0.121 | 9.6 | 0.0 | 9.6 | 61.5 | O K |
| 4320 min Winter | 49.101 | 0.101 | 7.1 | 0.0 | 7.1 | 51.0 | O K |
| 5760 min Winter | 49.089 | 0.089 | 5.7 | 0.0 | 5.7 | 44.9 | O K |
| 7200 min Winter | 49.081 | 0.081 | 4.8 | 0.0 | 4.8 | 40.7 | O K |
| 8640 min Winter | 49.075 | 0.075 | 4.2 | 0.0 | 4.2 | 37.6 | O K |
| 10080 min Winter | 49.071 | 0.071 | 3.7 | 0.0 | 3.7 | 35.2 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 360 min Winter | 4.234 | 0.0 | 418.5 | 0.0 | 252 |
| 480 min Winter | 3.389 | 0.0 | 446.7 | 0.0 | 320 |
| 600 min Winter | 2.851 | 0.0 | 469.8 | 0.0 | 384 |
| 720 min Winter | 2.475 | 0.0 | 489.4 | 0.0 | 442 |
| 960 min Winter | 1.980 | 0.0 | 521.9 | 0.0 | 550 |
| 1440 min Winter | 1.445 | 0.0 | 571.0 | 0.0 | 780 |
| 2160 min Winter | 1.055 | 0.0 | 627.2 | 0.0 | 1144 |
| 2880 min Winter | 0.844 | 0.0 | 668.7 | 0.0 | 1500 |
| 4320 min Winter | 0.616 | 0.0 | 730.9 | 0.0 | 2208 |
| 5760 min Winter | 0.492 | 0.0 | 781.2 | 0.0 | 2944 |
| 7200 min Winter | 0.414 | 0.0 | 820.7 | 0.0 | 3672 |
| 8640 min Winter | 0.359 | 0.0 | 854.4 | 0.0 | 4408 |
| 10080 min Winter | 0.319 | 0.0 | 883.4 | 0.0 | 5120 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +0 |

## Time Area Diagram

Total Area (ha) 1.970

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 1.970 |

## Model Details

Storage is Online Cover Level (m) 50.000

## Tank or Pond Structure

Invert Level (m) 49.000

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 487.0 | 0.600 | 720.0 | 0.601 | 1650.0 | 1.000 | 1879.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0202-1950-0500-1950 |
| Design Head (m) | 0.500 |
| Design Flow (l/s) | 19.5 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 202 |
| Invert Level (m) | 49.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.500 | 19.4 | Kick-Flo® | 0.428 | 18.0 |
| Flush-Flo™ | 0.282 | 19.4 | Mean Flow over Head Range | - | 14.5 |

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 | 6.9 | 0.800 | 24.3 | 2.000 | 37.7 | 4.000 | 52.7 | 7.000 | 69.0 |
| 0.200 | 18.8 | 1.000 | 27.0 | 2.200 | 39.4 | 4.500 | 55.8 | 7.500 | 71.4 |
| 0.300 | 19.4 | 1.200 | 29.4 | 2.400 | 41.1 | 5.000 | 58.7 | 8.000 | 73.8 |
| 0.400 | 18.5 | 1.400 | 31.7 | 2.600 | 42.7 | 5.500 | 61.0 | 8.500 | 76.1 |
| 0.500 | 19.4 | 1.600 | 33.8 | 3.000 | 45.8 | 6.000 | 63.8 | 9.000 | 78.3 |
| 0.600 | 21.1 | 1.800 | 35.8 | 3.500 | 49.4 | 6.500 | 66.4 | 9.500 | 80.5 |

## Orifice Overflow Control

Diameter (m) 0.210 Discharge Coefficient 0.600 Invert Level (m) 49.500

## Summary of Results for 30 year Return Period (+10%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 49.527 | 0.527 | 19.9 | 0.5 | 20.4 | 308.3 | O K |
| 30 min Summer | 49.613 | 0.613 | 21.4 | 8.8 | 30.1 | 380.2 | O K |
| 60 min Summer | 49.643 | 0.643 | 21.8 | 13.1 | 35.0 | 430.7 | O K |
| 120 min Summer | 49.654 | 0.654 | 22.0 | 14.5 | 36.6 | 448.6 | O K |
| 180 min Summer | 49.654 | 0.654 | 22.0 | 14.5 | 36.6 | 449.1 | O K |
| 240 min Summer | 49.651 | 0.651 | 22.0 | 14.2 | 36.1 | 443.7 | O K |
| 360 min Summer | 49.640 | 0.640 | 21.8 | 12.8 | 34.6 | 426.0 | O K |
| 480 min Summer | 49.629 | 0.629 | 21.6 | 11.3 | 32.9 | 407.1 | O K |
| 600 min Summer | 49.618 | 0.618 | 21.4 | 9.7 | 31.2 | 389.1 | O K |
| 720 min Summer | 49.608 | 0.608 | 21.3 | 8.0 | 29.3 | 372.8 | O K |
| 960 min Summer | 49.580 | 0.580 | 20.8 | 4.3 | 25.1 | 345.3 | O K |
| 1440 min Summer | 49.499 | 0.499 | 19.4 | 0.0 | 19.4 | 289.3 | O K |
| 2160 min Summer | 49.358 | 0.358 | 19.4 | 0.0 | 19.4 | 197.8 | O K |
| 2880 min Summer | 49.259 | 0.259 | 19.4 | 0.0 | 19.4 | 138.2 | O K |
| 4320 min Summer | 49.181 | 0.181 | 17.2 | 0.0 | 17.2 | 94.2 | O K |
| 5760 min Summer | 49.155 | 0.155 | 14.1 | 0.0 | 14.1 | 79.7 | O K |
| 7200 min Summer | 49.138 | 0.138 | 11.9 | 0.0 | 11.9 | 70.7 | O K |
| 8640 min Summer | 49.126 | 0.126 | 10.3 | 0.0 | 10.3 | 64.3 | O K |
| 10080 min Summer | 49.117 | 0.117 | 9.1 | 0.0 | 9.1 | 59.5 | O K |
| 15 min Winter | 49.580 | 0.580 | 20.8 | 4.3 | 25.1 | 345.5 | O K |
| 30 min Winter | 49.640 | 0.640 | 21.8 | 12.8 | 34.6 | 426.1 | O K |
| 60 min Winter | 49.675 | 0.675 | 22.4 | 17.7 | 40.1 | 485.1 | O K |
| 120 min Winter | 49.686 | 0.686 | 22.5 | 19.7 | 42.2 | 504.0 | O K |
| 180 min Winter | 49.686 | 0.686 | 22.5 | 19.6 | 42.1 | 502.9 | O K |
| 240 min Winter | 49.680 | 0.680 | 22.4 | 18.6 | 41.1 | 493.5 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 87.227 | 0.0 | 318.3 | 0.3 | 18 |
| 30 min Summer | 55.777 | 0.0 | 407.9 | 16.8 | 32 |
| 60 min Summer | 34.065 | 0.0 | 501.4 | 47.1 | 62 |
| 120 min Summer | 20.201 | 0.0 | 595.0 | 77.3 | 100 |
| 180 min Summer | 14.736 | 0.0 | 651.2 | 90.8 | 132 |
| 240 min Summer | 11.736 | 0.0 | 691.6 | 96.2 | 166 |
| 360 min Summer | 8.483 | 0.0 | 750.0 | 92.4 | 234 |
| 480 min Summer | 6.739 | 0.0 | 794.4 | 78.9 | 304 |
| 600 min Summer | 5.634 | 0.0 | 830.1 | 64.3 | 372 |
| 720 min Summer | 4.865 | 0.0 | 860.2 | 50.3 | 440 |
| 960 min Summer | 3.858 | 0.0 | 909.5 | 24.4 | 578 |
| 1440 min Summer | 2.780 | 0.0 | 982.5 | 0.0 | 864 |
| 2160 min Summer | 2.001 | 0.0 | 1062.9 | 0.0 | 1216 |
| 2880 min Summer | 1.584 | 0.0 | 1121.5 | 0.0 | 1552 |
| 4320 min Summer | 1.138 | 0.0 | 1207.8 | 0.0 | 2208 |
| 5760 min Summer | 0.900 | 0.0 | 1275.6 | 0.0 | 2936 |
| 7200 min Summer | 0.750 | 0.0 | 1328.4 | 0.0 | 3672 |
| 8640 min Summer | 0.646 | 0.0 | 1372.7 | 0.0 | 4408 |
| 10080 min Summer | 0.569 | 0.0 | 1410.3 | 0.0 | 5136 |
| 15 min Winter | 87.227 | 0.0 | 356.9 | 4.6 | 18 |
| 30 min Winter | 55.777 | 0.0 | 457.3 | 35.0 | 32 |
| 60 min Winter | 34.065 | 0.0 | 561.8 | 74.1 | 60 |
| 120 min Winter | 20.201 | 0.0 | 666.6 | 113.4 | 100 |
| 180 min Winter | 14.736 | 0.0 | 729.6 | 130.9 | 138 |
| 240 min Winter | 11.736 | 0.0 | 774.8 | 138.0 | 176 |

## Summary of Results for 30 year Return Period (+10%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 360 min Winter | 49.664 | 0.664 | 22.2 | 15.9 | 38.1 | 466.2 | O K |
| 480 min Winter | 49.647 | 0.647 | 21.9 | 13.7 | 35.6 | 438.0 | O K |
| 600 min Winter | 49.632 | 0.632 | 21.7 | 11.7 | 33.4 | 411.9 | O K |
| 720 min Winter | 49.618 | 0.618 | 21.4 | 9.6 | 31.1 | 388.9 | O K |
| 960 min Winter | 49.589 | 0.589 | 21.0 | 5.3 | 26.3 | 352.0 | O K |
| 1440 min Winter | 49.476 | 0.476 | 19.4 | 0.0 | 19.4 | 273.6 | O K |
| 2160 min Winter | 49.268 | 0.268 | 19.4 | 0.0 | 19.4 | 143.3 | O K |
| 2880 min Winter | 49.187 | 0.187 | 17.9 | 0.0 | 17.9 | 97.4 | O K |
| 4320 min Winter | 49.147 | 0.147 | 13.1 | 0.0 | 13.1 | 75.6 | O K |
| 5760 min Winter | 49.127 | 0.127 | 10.4 | 0.0 | 10.4 | 64.8 | O K |
| 7200 min Winter | 49.114 | 0.114 | 8.7 | 0.0 | 8.7 | 57.8 | O K |
| 8640 min Winter | 49.105 | 0.105 | 7.5 | 0.0 | 7.5 | 52.8 | O K |
| 10080 min Winter | 49.097 | 0.097 | 6.6 | 0.0 | 6.6 | 48.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 360 min Winter | 8.483 | 0.0 | 840.2 | 137.1 | 252 |
| 480 min Winter | 6.739 | 0.0 | 889.9 | 123.8 | 324 |
| 600 min Winter | 5.634 | 0.0 | 930.0 | 103.0 | 396 |
| 720 min Winter | 4.865 | 0.0 | 963.7 | 81.4 | 466 |
| 960 min Winter | 3.858 | 0.0 | 1018.9 | 39.2 | 614 |
| 1440 min Winter | 2.780 | 0.0 | 1100.8 | 0.0 | 920 |
| 2160 min Winter | 2.001 | 0.0 | 1190.6 | 0.0 | 1232 |
| 2880 min Winter | 1.584 | 0.0 | 1256.2 | 0.0 | 1504 |
| 4320 min Winter | 1.138 | 0.0 | 1353.2 | 0.0 | 2208 |
| 5760 min Winter | 0.900 | 0.0 | 1428.8 | 0.0 | 2936 |
| 7200 min Winter | 0.750 | 0.0 | 1488.0 | 0.0 | 3672 |
| 8640 min Winter | 0.646 | 0.0 | 1537.7 | 0.0 | 4408 |
| 10080 min Winter | 0.569 | 0.0 | 1580.1 | 0.0 | 5136 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 30 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +10 |

## Time Area Diagram

Total Area (ha) 1.970

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 1.970 |

## Model Details

Storage is Online Cover Level (m) 50.000

## Tank or Pond Structure

Invert Level (m) 49.000

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 487.0 | 0.600 | 720.0 | 0.601 | 1650.0 | 1.000 | 1879.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0202-1950-0500-1950 |
| Design Head (m) | 0.500 |
| Design Flow (l/s) | 19.5 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 202 |
| Invert Level (m) | 49.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.500 | 19.4 | Kick-Flo® | 0.428 | 18.0 |
| Flush-Flo™ | 0.282 | 19.4 | Mean Flow over Head Range | - | 14.5 |

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 | 6.9 | 0.800 | 24.3 | 2.000 | 37.7 | 4.000 | 52.7 | 7.000 | 69.0 |
| 0.200 | 18.8 | 1.000 | 27.0 | 2.200 | 39.4 | 4.500 | 55.8 | 7.500 | 71.4 |
| 0.300 | 19.4 | 1.200 | 29.4 | 2.400 | 41.1 | 5.000 | 58.7 | 8.000 | 73.8 |
| 0.400 | 18.5 | 1.400 | 31.7 | 2.600 | 42.7 | 5.500 | 61.0 | 8.500 | 76.1 |
| 0.500 | 19.4 | 1.600 | 33.8 | 3.000 | 45.8 | 6.000 | 63.8 | 9.000 | 78.3 |
| 0.600 | 21.1 | 1.800 | 35.8 | 3.500 | 49.4 | 6.500 | 66.4 | 9.500 | 80.5 |

## Orifice Overflow Control

Diameter (m) 0.210 Discharge Coefficient 0.600 Invert Level (m) 49.500

## Summary of Results for 100 year Return Period (+30%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 49.668 | 0.668 | 22.2 | 16.4 | 38.6 | 472.5 | O K |
| 30 min Summer | 49.734 | 0.734 | 23.3 | 28.3 | 51.6 | 585.2 | Flood Risk |
| 60 min Summer | 49.778 | 0.778 | 23.9 | 36.6 | 60.5 | 662.2 | Flood Risk |
| 120 min Summer | 49.793 | 0.793 | 24.2 | 39.4 | 63.6 | 688.8 | Flood Risk |
| 180 min Summer | 49.794 | 0.794 | 24.2 | 39.5 | 63.7 | 689.6 | Flood Risk |
| 240 min Summer | 49.788 | 0.788 | 24.1 | 38.5 | 62.6 | 680.2 | Flood Risk |
| 360 min Summer | 49.772 | 0.772 | 23.8 | 35.4 | 59.2 | 650.8 | Flood Risk |
| 480 min Summer | 49.754 | 0.754 | 23.6 | 32.1 | 55.7 | 620.8 | Flood Risk |
| 600 min Summer | 49.738 | 0.738 | 23.3 | 29.2 | 52.5 | 592.3 | Flood Risk |
| 720 min Summer | 49.723 | 0.723 | 23.1 | 26.3 | 49.4 | 566.3 | Flood Risk |
| 960 min Summer | 49.697 | 0.697 | 22.7 | 21.5 | 44.3 | 521.2 | O K |
| 1440 min Summer | 49.655 | 0.655 | 22.0 | 14.7 | 36.7 | 450.2 | O K |
| 2160 min Summer | 49.611 | 0.611 | 21.3 | 8.4 | 29.8 | 376.8 | O K |
| 2880 min Summer | 49.557 | 0.557 | 20.4 | 2.2 | 22.6 | 329.2 | O K |
| 4320 min Summer | 49.351 | 0.351 | 19.4 | 0.0 | 19.4 | 193.6 | O K |
| 5760 min Summer | 49.222 | 0.222 | 19.1 | 0.0 | 19.1 | 117.0 | O K |
| 7200 min Summer | 49.182 | 0.182 | 17.3 | 0.0 | 17.3 | 94.6 | O K |
| 8640 min Summer | 49.162 | 0.162 | 15.0 | 0.0 | 15.0 | 83.8 | O K |
| 10080 min Summer | 49.149 | 0.149 | 13.3 | 0.0 | 13.3 | 76.5 | O K |
| 15 min Winter | 49.701 | 0.701 | 22.8 | 22.3 | 45.1 | 529.3 | Flood Risk |
| 30 min Winter | 49.775 | 0.775 | 23.9 | 36.0 | 59.8 | 656.5 | Flood Risk |
| 60 min Winter | 49.826 | 0.826 | 24.6 | 43.2 | 67.9 | 746.5 | Flood Risk |
| 120 min Winter | 49.842 | 0.842 | 24.9 | 44.8 | 69.7 | 775.8 | Flood Risk |
| 180 min Winter | 49.840 | 0.840 | 24.8 | 44.6 | 69.5 | 771.5 | Flood Risk |
| 240 min Winter | 49.830 | 0.830 | 24.7 | 43.6 | 68.3 | 752.8 | Flood Risk |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 133.985 | 0.0 | 490.7 | 52.2 | 18 |
| 30 min Summer | 86.337 | 0.0 | 633.4 | 122.7 | 32 |
| 60 min Summer | 52.933 | 0.0 | 780.1 | 202.4 | 60 |
| 120 min Summer | 31.380 | 0.0 | 925.3 | 278.8 | 94 |
| 180 min Summer | 22.833 | 0.0 | 1010.0 | 315.2 | 128 |
| 240 min Summer | 18.130 | 0.0 | 1069.4 | 333.5 | 162 |
| 360 min Summer | 13.031 | 0.0 | 1153.1 | 343.7 | 230 |
| 480 min Summer | 10.316 | 0.0 | 1217.2 | 339.3 | 298 |
| 600 min Summer | 8.601 | 0.0 | 1268.4 | 324.7 | 366 |
| 720 min Summer | 7.410 | 0.0 | 1311.4 | 302.5 | 434 |
| 960 min Summer | 5.854 | 0.0 | 1381.2 | 259.7 | 568 |
| 1440 min Summer | 4.194 | 0.0 | 1483.9 | 188.1 | 824 |
| 2160 min Summer | 3.001 | 0.0 | 1594.7 | 95.3 | 1212 |
| 2880 min Summer | 2.364 | 0.0 | 1675.1 | 20.0 | 1616 |
| 4320 min Summer | 1.688 | 0.0 | 1792.5 | 0.0 | 2340 |
| 5760 min Summer | 1.328 | 0.0 | 1882.6 | 0.0 | 2992 |
| 7200 min Summer | 1.102 | 0.0 | 1952.7 | 0.0 | 3672 |
| 8640 min Summer | 0.946 | 0.0 | 2011.1 | 0.0 | 4408 |
| 10080 min Summer | 0.831 | 0.0 | 2060.5 | 0.0 | 5136 |
| 15 min Winter | 133.985 | 0.0 | 550.0 | 80.6 | 18 |
| 30 min Winter | 86.337 | 0.0 | 709.8 | 168.4 | 32 |
| 60 min Winter | 52.933 | 0.0 | 874.0 | 263.8 | 60 |
| 120 min Winter | 31.380 | 0.0 | 1036.6 | 353.5 | 98 |
| 180 min Winter | 22.833 | 0.0 | 1131.5 | 398.1 | 136 |
| 240 min Winter | 18.130 | 0.0 | 1198.0 | 422.8 | 174 |

## Summary of Results for 100 year Return Period (+30%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 360 min Winter | 49.802 | 0.802 | 24.3 | 40.9 | 65.2 | 704.4 | Flood Risk |
| 480 min Winter | 49.777 | 0.777 | 23.9 | 36.4 | 60.3 | 660.9 | Flood Risk |
| 600 min Winter | 49.755 | 0.755 | 23.6 | 32.2 | 55.8 | 621.6 | Flood Risk |
| 720 min Winter | 49.735 | 0.735 | 23.3 | 28.5 | 51.8 | 586.7 | Flood Risk |
| 960 min Winter | 49.701 | 0.701 | 22.8 | 22.3 | 45.0 | 528.5 | Flood Risk |
| 1440 min Winter | 49.649 | 0.649 | 21.9 | 13.9 | 35.8 | 440.5 | O K |
| 2160 min Winter | 49.598 | 0.598 | 21.1 | 6.3 | 27.4 | 358.5 | O K |
| 2880 min Winter | 49.494 | 0.494 | 19.4 | 0.0 | 19.4 | 286.1 | O K |
| 4320 min Winter | 49.205 | 0.205 | 18.9 | 0.0 | 18.9 | 107.2 | O K |
| 5760 min Winter | 49.165 | 0.165 | 15.3 | 0.0 | 15.3 | 85.1 | O K |
| 7200 min Winter | 49.145 | 0.145 | 12.7 | 0.0 | 12.7 | 74.3 | O K |
| 8640 min Winter | 49.131 | 0.131 | 11.0 | 0.0 | 11.0 | 67.1 | O K |
| 10080 min Winter | 49.121 | 0.121 | 9.6 | 0.0 | 9.6 | 61.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 360 min Winter | 13.031 | 0.0 | 1291.7 | 440.5 | 246 |
| 480 min Winter | 10.316 | 0.0 | 1363.5 | 437.9 | 318 |
| 600 min Winter | 8.601 | 0.0 | 1420.9 | 423.8 | 386 |
| 720 min Winter | 7.410 | 0.0 | 1469.1 | 401.2 | 456 |
| 960 min Winter | 5.854 | 0.0 | 1547.3 | 340.7 | 594 |
| 1440 min Winter | 4.194 | 0.0 | 1662.3 | 232.2 | 864 |
| 2160 min Winter | 3.001 | 0.0 | 1786.3 | 84.2 | 1256 |
| 2880 min Winter | 2.364 | 0.0 | 1876.4 | 0.0 | 1756 |
| 4320 min Winter | 1.688 | 0.0 | 2008.1 | 0.0 | 2288 |
| 5760 min Winter | 1.328 | 0.0 | 2108.7 | 0.0 | 2944 |
| 7200 min Winter | 1.102 | 0.0 | 2187.2 | 0.0 | 3672 |
| 8640 min Winter | 0.946 | 0.0 | 2252.7 | 0.0 | 4408 |
| 10080 min Winter | 0.831 | 0.0 | 2308.3 | 0.0 | 5144 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +30 |

## Time Area Diagram

Total Area (ha) 1.970

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 1.970 |

## Model Details

Storage is Online Cover Level (m) 50.000

## Tank or Pond Structure

Invert Level (m) 49.000

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 487.0 | 0.600 | 720.0 | 0.601 | 1650.0 | 1.000 | 1879.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0202-1950-0500-1950 |
| Design Head (m) | 0.500 |
| Design Flow (l/s) | 19.5 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 202 |
| Invert Level (m) | 49.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.500 | 19.4 | Kick-Flo® | 0.428 | 18.0 |
| Flush-Flo™ | 0.282 | 19.4 | Mean Flow over Head Range | - | 14.5 |

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 | 6.9 | 0.800 | 24.3 | 2.000 | 37.7 | 4.000 | 52.7 | 7.000 | 69.0 |
| 0.200 | 18.8 | 1.000 | 27.0 | 2.200 | 39.4 | 4.500 | 55.8 | 7.500 | 71.4 |
| 0.300 | 19.4 | 1.200 | 29.4 | 2.400 | 41.1 | 5.000 | 58.7 | 8.000 | 73.8 |
| 0.400 | 18.5 | 1.400 | 31.7 | 2.600 | 42.7 | 5.500 | 61.0 | 8.500 | 76.1 |
| 0.500 | 19.4 | 1.600 | 33.8 | 3.000 | 45.8 | 6.000 | 63.8 | 9.000 | 78.3 |
| 0.600 | 21.1 | 1.800 | 35.8 | 3.500 | 49.4 | 6.500 | 66.4 | 9.500 | 80.5 |

## Orifice Overflow Control

Diameter (m) 0.210 Discharge Coefficient 0.600 Invert Level (m) 49.500

## Summary of Results for 2 year Return Period

Half Drain Time : 442 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 99.139 | 0.139 | 0.0 | 2.1 | 0.0 | 2.1 | 49.5 | O K |
| 30 min Summer | 99.175 | 0.175 | 0.0 | 2.1 | 0.0 | 2.1 | 62.4 | O K |
| 60 min Summer | 99.209 | 0.209 | 0.0 | 2.1 | 0.0 | 2.1 | 74.5 | O K |
| 120 min Summer | 99.240 | 0.240 | 0.0 | 2.1 | 0.0 | 2.1 | 85.4 | O K |
| 180 min Summer | 99.254 | 0.254 | 0.0 | 2.1 | 0.0 | 2.1 | 90.4 | O K |
| 240 min Summer | 99.261 | 0.261 | 0.0 | 2.1 | 0.0 | 2.1 | 92.9 | O K |
| 360 min Summer | 99.265 | 0.265 | 0.0 | 2.1 | 0.0 | 2.1 | 94.3 | O K |
| 480 min Summer | 99.264 | 0.264 | 0.0 | 2.1 | 0.0 | 2.1 | 94.0 | O K |
| 600 min Summer | 99.262 | 0.262 | 0.0 | 2.1 | 0.0 | 2.1 | 93.2 | O K |
| 720 min Summer | 99.258 | 0.258 | 0.0 | 2.1 | 0.0 | 2.1 | 92.1 | O K |
| 960 min Summer | 99.250 | 0.250 | 0.0 | 2.1 | 0.0 | 2.1 | 89.2 | O K |
| 1440 min Summer | 99.231 | 0.231 | 0.0 | 2.1 | 0.0 | 2.1 | 82.1 | O K |
| 2160 min Summer | 99.199 | 0.199 | 0.0 | 2.1 | 0.0 | 2.1 | 71.1 | O K |
| 2880 min Summer | 99.171 | 0.171 | 0.0 | 2.1 | 0.0 | 2.1 | 61.0 | O K |
| 4320 min Summer | 99.128 | 0.128 | 0.0 | 2.1 | 0.0 | 2.1 | 45.6 | O K |
| 5760 min Summer | 99.101 | 0.101 | 0.0 | 2.0 | 0.0 | 2.0 | 36.0 | O K |
| 7200 min Summer | 99.087 | 0.087 | 0.0 | 1.9 | 0.0 | 1.9 | 31.0 | O K |
| 8640 min Summer | 99.078 | 0.078 | 0.0 | 1.7 | 0.0 | 1.7 | 27.8 | O K |
| 10080 min Summer | 99.071 | 0.071 | 0.0 | 1.5 | 0.0 | 1.5 | 25.4 | O K |
| 15 min Winter | 99.156 | 0.156 | 0.0 | 2.1 | 0.0 | 2.1 | 55.6 | O K |
| 30 min Winter | 99.197 | 0.197 | 0.0 | 2.1 | 0.0 | 2.1 | 70.1 | O K |
| 60 min Winter | 99.236 | 0.236 | 0.0 | 2.1 | 0.0 | 2.1 | 83.9 | O K |
| 120 min Winter | 99.271 | 0.271 | 0.0 | 2.1 | 0.0 | 2.1 | 96.5 | O K |
| 180 min Winter | 99.288 | 0.288 | 0.0 | 2.1 | 0.0 | 2.1 | 102.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 41.734 | 0.0 | 47.5 | 0.0 | 19 |
| 30 min Summer | 26.594 | 0.0 | 61.2 | 0.0 | 33 |
| 60 min Summer | 16.285 | 0.0 | 77.7 | 0.0 | 62 |
| 120 min Summer | 9.752 | 0.0 | 93.2 | 0.0 | 122 |
| 180 min Summer | 7.183 | 0.0 | 103.1 | 0.0 | 182 |
| 240 min Summer | 5.773 | 0.0 | 110.6 | 0.0 | 240 |
| 360 min Summer | 4.234 | 0.0 | 121.7 | 0.0 | 342 |
| 480 min Summer | 3.389 | 0.0 | 130.0 | 0.0 | 394 |
| 600 min Summer | 2.851 | 0.0 | 136.7 | 0.0 | 454 |
| 720 min Summer | 2.475 | 0.0 | 142.3 | 0.0 | 520 |
| 960 min Summer | 1.980 | 0.0 | 151.8 | 0.0 | 654 |
| 1440 min Summer | 1.445 | 0.0 | 165.8 | 0.0 | 924 |
| 2160 min Summer | 1.055 | 0.0 | 184.0 | 0.0 | 1320 |
| 2880 min Summer | 0.844 | 0.0 | 196.1 | 0.0 | 1700 |
| 4320 min Summer | 0.616 | 0.0 | 213.8 | 0.0 | 2416 |
| 5760 min Summer | 0.492 | 0.0 | 229.7 | 0.0 | 3064 |
| 7200 min Summer | 0.414 | 0.0 | 241.2 | 0.0 | 3752 |
| 8640 min Summer | 0.359 | 0.0 | 250.9 | 0.0 | 4496 |
| 10080 min Summer | 0.319 | 0.0 | 258.9 | 0.0 | 5152 |
| 15 min Winter | 41.734 | 0.0 | 53.5 | 0.0 | 18 |
| 30 min Winter | 26.594 | 0.0 | 68.7 | 0.0 | 33 |
| 60 min Winter | 16.285 | 0.0 | 87.1 | 0.0 | 62 |
| 120 min Winter | 9.752 | 0.0 | 104.6 | 0.0 | 120 |
| 180 min Winter | 7.183 | 0.0 | 115.6 | 0.0 | 178 |

## Summary of Results for 2 year Return Period

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.298 | 0.298 | 0.0 | 2.1 | 0.0 | 2.1 | 106.1 | O K |
| 360 min Winter | 99.305 | 0.305 | 0.0 | 2.1 | 0.0 | 2.1 | 108.7 | O K |
| 480 min Winter | 99.304 | 0.304 | 0.0 | 2.1 | 0.0 | 2.1 | 108.1 | O K |
| 600 min Winter | 99.298 | 0.298 | 0.0 | 2.1 | 0.0 | 2.1 | 106.2 | O K |
| 720 min Winter | 99.293 | 0.293 | 0.0 | 2.1 | 0.0 | 2.1 | 104.5 | O K |
| 960 min Winter | 99.281 | 0.281 | 0.0 | 2.1 | 0.0 | 2.1 | 100.0 | O K |
| 1440 min Winter | 99.250 | 0.250 | 0.0 | 2.1 | 0.0 | 2.1 | 88.9 | O K |
| 2160 min Winter | 99.201 | 0.201 | 0.0 | 2.1 | 0.0 | 2.1 | 71.5 | O K |
| 2880 min Winter | 99.158 | 0.158 | 0.0 | 2.1 | 0.0 | 2.1 | 56.4 | O K |
| 4320 min Winter | 99.102 | 0.102 | 0.0 | 2.0 | 0.0 | 2.0 | 36.4 | O K |
| 5760 min Winter | 99.082 | 0.082 | 0.0 | 1.8 | 0.0 | 1.8 | 29.1 | O K |
| 7200 min Winter | 99.071 | 0.071 | 0.0 | 1.5 | 0.0 | 1.5 | 25.1 | O K |
| 8640 min Winter | 99.063 | 0.063 | 0.0 | 1.3 | 0.0 | 1.3 | 22.5 | O K |
| 10080 min Winter | 99.058 | 0.058 | 0.0 | 1.2 | 0.0 | 1.2 | 20.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 5.773 | 0.0 | 124.0 | 0.0 | 236 |
| 360 min Winter | 4.234 | 0.0 | 136.5 | 0.0 | 348 |
| 480 min Winter | 3.389 | 0.0 | 145.7 | 0.0 | 454 |
| 600 min Winter | 2.851 | 0.0 | 153.2 | 0.0 | 498 |
| 720 min Winter | 2.475 | 0.0 | 159.5 | 0.0 | 564 |
| 960 min Winter | 1.980 | 0.0 | 170.1 | 0.0 | 714 |
| 1440 min Winter | 1.445 | 0.0 | 185.8 | 0.0 | 1010 |
| 2160 min Winter | 1.055 | 0.0 | 206.2 | 0.0 | 1424 |
| 2880 min Winter | 0.844 | 0.0 | 219.8 | 0.0 | 1788 |
| 4320 min Winter | 0.616 | 0.0 | 239.8 | 0.0 | 2424 |
| 5760 min Winter | 0.492 | 0.0 | 257.3 | 0.0 | 3104 |
| 7200 min Winter | 0.414 | 0.0 | 270.3 | 0.0 | 3792 |
| 8640 min Winter | 0.359 | 0.0 | 281.2 | 0.0 | 4496 |
| 10080 min Winter | 0.319 | 0.0 | 290.3 | 0.0 | 5240 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +0 |

## Time Area Diagram

Total Area (ha) 0.650

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 0.650 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 375.0 | 0.0 | 1.000 | 375.0 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0076-2100-0500-2100 |
| Design Head (m) | 0.500 |
| Design Flow (l/s) | 2.1 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 76 |
| Invert Level (m) | 99.000 |
| Minimum Outlet Pipe Diameter (mm) | 100 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.500 | 2.1 | Kick-Flo® | 0.345 | 1.8 |
| Flush-Flo™ | 0.150 | 2.1 | Mean Flow over Head Range | - | 1.8 |

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 | 2.0 | 0.800 | 2.6 | 2.000 | 4.0 | 4.000 | 5.5 | 7.000 | 7.2 |
| 0.200 | 2.1 | 1.000 | 2.9 | 2.200 | 4.1 | 4.500 | 5.8 | 7.500 | 7.4 |
| 0.300 | 1.9 | 1.200 | 3.1 | 2.400 | 4.3 | 5.000 | 6.1 | 8.000 | 7.7 |
| 0.400 | 1.9 | 1.400 | 3.4 | 2.600 | 4.5 | 5.500 | 6.4 | 8.500 | 7.9 |
| 0.500 | 2.1 | 1.600 | 3.6 | 3.000 | 4.8 | 6.000 | 6.6 | 9.000 | 8.1 |
| 0.600 | 2.3 | 1.800 | 3.8 | 3.500 | 5.1 | 6.500 | 6.9 | 9.500 | 8.4 |

## Orifice Overflow Control

Diameter (m) 0.045 Discharge Coefficient 0.600 Invert Level (m) 99.500

## Summary of Results for 30 year Return Period (+10%)

Half Drain Time : 915 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 99.294 | 0.294 | 0.0 | 2.1 | 0.0 | 2.1 | 104.8 | O K |
| 30 min Summer | 99.374 | 0.374 | 0.0 | 2.1 | 0.0 | 2.1 | 133.3 | O K |
| 60 min Summer | 99.451 | 0.451 | 0.0 | 2.1 | 0.0 | 2.1 | 160.6 | O K |
| 120 min Summer | 99.521 | 0.521 | 0.0 | 2.1 | 0.1 | 2.3 | 185.4 | O K |
| 180 min Summer | 99.553 | 0.553 | 0.0 | 2.2 | 0.7 | 2.8 | 197.0 | O K |
| 240 min Summer | 99.568 | 0.568 | 0.0 | 2.2 | 0.9 | 3.1 | 202.5 | O K |
| 360 min Summer | 99.578 | 0.578 | 0.0 | 2.2 | 1.0 | 3.2 | 206.0 | O K |
| 480 min Summer | 99.576 | 0.576 | 0.0 | 2.2 | 1.0 | 3.2 | 205.3 | O K |
| 600 min Summer | 99.573 | 0.573 | 0.0 | 2.2 | 1.0 | 3.2 | 204.2 | O K |
| 720 min Summer | 99.570 | 0.570 | 0.0 | 2.2 | 0.9 | 3.1 | 203.0 | O K |
| 960 min Summer | 99.562 | 0.562 | 0.0 | 2.2 | 0.8 | 3.0 | 200.1 | O K |
| 1440 min Summer | 99.544 | 0.544 | 0.0 | 2.2 | 0.5 | 2.7 | 193.6 | O K |
| 2160 min Summer | 99.512 | 0.512 | 0.0 | 2.1 | 0.0 | 2.2 | 182.3 | O K |
| 2880 min Summer | 99.473 | 0.473 | 0.0 | 2.1 | 0.0 | 2.1 | 168.6 | O K |
| 4320 min Summer | 99.401 | 0.401 | 0.0 | 2.1 | 0.0 | 2.1 | 143.0 | O K |
| 5760 min Summer | 99.327 | 0.327 | 0.0 | 2.1 | 0.0 | 2.1 | 116.4 | O K |
| 7200 min Summer | 99.260 | 0.260 | 0.0 | 2.1 | 0.0 | 2.1 | 92.5 | O K |
| 8640 min Summer | 99.207 | 0.207 | 0.0 | 2.1 | 0.0 | 2.1 | 73.7 | O K |
| 10080 min Summer | 99.166 | 0.166 | 0.0 | 2.1 | 0.0 | 2.1 | 59.0 | O K |
| 15 min Winter | 99.330 | 0.330 | 0.0 | 2.1 | 0.0 | 2.1 | 117.5 | O K |
| 30 min Winter | 99.420 | 0.420 | 0.0 | 2.1 | 0.0 | 2.1 | 149.5 | O K |
| 60 min Winter | 99.506 | 0.506 | 0.0 | 2.1 | 0.0 | 2.1 | 180.2 | O K |
| 120 min Winter | 99.582 | 0.582 | 0.0 | 2.2 | 1.0 | 3.3 | 207.3 | O K |
| 180 min Winter | 99.617 | 0.617 | 0.0 | 2.3 | 1.3 | 3.6 | 219.6 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 87.227 | 0.0 | 101.2 | 0.0 | 19 |
| 30 min Summer | 55.777 | 0.0 | 128.7 | 0.0 | 34 |
| 60 min Summer | 34.065 | 0.0 | 163.6 | 0.0 | 64 |
| 120 min Summer | 20.201 | 0.0 | 194.1 | 0.2 | 122 |
| 180 min Summer | 14.736 | 0.0 | 212.3 | 2.9 | 182 |
| 240 min Summer | 11.736 | 0.0 | 225.4 | 6.0 | 242 |
| 360 min Summer | 8.483 | 0.0 | 244.3 | 10.4 | 360 |
| 480 min Summer | 6.739 | 0.0 | 258.6 | 13.3 | 450 |
| 600 min Summer | 5.634 | 0.0 | 269.9 | 15.0 | 506 |
| 720 min Summer | 4.865 | 0.0 | 279.3 | 15.7 | 570 |
| 960 min Summer | 3.858 | 0.0 | 294.1 | 14.7 | 700 |
| 1440 min Summer | 2.780 | 0.0 | 310.6 | 7.9 | 994 |
| 2160 min Summer | 2.001 | 0.0 | 349.5 | 0.4 | 1452 |
| 2880 min Summer | 1.584 | 0.0 | 368.6 | 0.0 | 1872 |
| 4320 min Summer | 1.138 | 0.0 | 396.5 | 0.0 | 2684 |
| 5760 min Summer | 0.900 | 0.0 | 420.5 | 0.0 | 3464 |
| 7200 min Summer | 0.750 | 0.0 | 437.8 | 0.0 | 4184 |
| 8640 min Summer | 0.646 | 0.0 | 452.1 | 0.0 | 4848 |
| 10080 min Summer | 0.569 | 0.0 | 464.0 | 0.0 | 5544 |
| 15 min Winter | 87.227 | 0.0 | 113.3 | 0.0 | 19 |
| 30 min Winter | 55.777 | 0.0 | 142.9 | 0.0 | 33 |
| 60 min Winter | 34.065 | 0.0 | 183.3 | 0.0 | 62 |
| 120 min Winter | 20.201 | 0.0 | 217.4 | 6.2 | 120 |
| 180 min Winter | 14.736 | 0.0 | 237.9 | 12.6 | 178 |

## Summary of Results for 30 year Return Period (+10%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.635 | 0.635 | 0.0 | 2.3 | 1.4 | 3.7 | 226.1 | O K |
| 360 min Winter | 99.648 | 0.648 | 0.0 | 2.4 | 1.5 | 3.8 | 230.8 | O K |
| 480 min Winter | 99.648 | 0.648 | 0.0 | 2.4 | 1.5 | 3.8 | 230.8 | O K |
| 600 min Winter | 99.642 | 0.642 | 0.0 | 2.3 | 1.5 | 3.8 | 228.7 | O K |
| 720 min Winter | 99.638 | 0.638 | 0.0 | 2.3 | 1.4 | 3.8 | 227.4 | O K |
| 960 min Winter | 99.627 | 0.627 | 0.0 | 2.3 | 1.4 | 3.7 | 223.5 | O K |
| 1440 min Winter | 99.599 | 0.599 | 0.0 | 2.3 | 1.2 | 3.4 | 213.3 | O K |
| 2160 min Winter | 99.558 | 0.558 | 0.0 | 2.2 | 0.7 | 2.9 | 198.7 | O K |
| 2880 min Winter | 99.520 | 0.520 | 0.0 | 2.1 | 0.1 | 2.2 | 185.2 | O K |
| 4320 min Winter | 99.416 | 0.416 | 0.0 | 2.1 | 0.0 | 2.1 | 148.2 | O K |
| 5760 min Winter | 99.299 | 0.299 | 0.0 | 2.1 | 0.0 | 2.1 | 106.7 | O K |
| 7200 min Winter | 99.205 | 0.205 | 0.0 | 2.1 | 0.0 | 2.1 | 73.0 | O K |
| 8640 min Winter | 99.140 | 0.140 | 0.0 | 2.1 | 0.0 | 2.1 | 49.8 | O K |
| 10080 min Winter | 99.103 | 0.103 | 0.0 | 2.0 | 0.0 | 2.0 | 36.5 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 11.736 | 0.0 | 252.6 | 17.2 | 236 |
| 360 min Winter | 8.483 | 0.0 | 273.7 | 23.4 | 348 |
| 480 min Winter | 6.739 | 0.0 | 289.6 | 27.5 | 454 |
| 600 min Winter | 5.634 | 0.0 | 302.2 | 30.2 | 508 |
| 720 min Winter | 4.865 | 0.0 | 312.7 | 31.9 | 566 |
| 960 min Winter | 3.858 | 0.0 | 329.0 | 33.2 | 722 |
| 1440 min Winter | 2.780 | 0.0 | 345.7 | 29.6 | 1028 |
| 2160 min Winter | 2.001 | 0.0 | 391.5 | 14.5 | 1496 |
| 2880 min Winter | 1.584 | 0.0 | 412.9 | 1.6 | 2016 |
| 4320 min Winter | 1.138 | 0.0 | 443.9 | 0.0 | 2900 |
| 5760 min Winter | 0.900 | 0.0 | 471.0 | 0.0 | 3688 |
| 7200 min Winter | 0.750 | 0.0 | 490.4 | 0.0 | 4328 |
| 8640 min Winter | 0.646 | 0.0 | 506.6 | 0.0 | 4928 |
| 10080 min Winter | 0.569 | 0.0 | 520.1 | 0.0 | 5448 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 30 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +10 |

## Time Area Diagram

Total Area (ha) 0.650

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 0.650 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 375.0 | 0.0 | 1.000 | 375.0 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0076-2100-0500-2100 |
| Design Head (m) | 0.500 |
| Design Flow (l/s) | 2.1 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 76 |
| Invert Level (m) | 99.000 |
| Minimum Outlet Pipe Diameter (mm) | 100 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.500 | 2.1 | Kick-Flo® | 0.345 | 1.8 |
| Flush-Flo™ | 0.150 | 2.1 | Mean Flow over Head Range | - | 1.8 |

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 | 2.0 | 0.800 | 2.6 | 2.000 | 4.0 | 4.000 | 5.5 | 7.000 | 7.2 |
| 0.200 | 2.1 | 1.000 | 2.9 | 2.200 | 4.1 | 4.500 | 5.8 | 7.500 | 7.4 |
| 0.300 | 1.9 | 1.200 | 3.1 | 2.400 | 4.3 | 5.000 | 6.1 | 8.000 | 7.7 |
| 0.400 | 1.9 | 1.400 | 3.4 | 2.600 | 4.5 | 5.500 | 6.4 | 8.500 | 7.9 |
| 0.500 | 2.1 | 1.600 | 3.6 | 3.000 | 4.8 | 6.000 | 6.6 | 9.000 | 8.1 |
| 0.600 | 2.3 | 1.800 | 3.8 | 3.500 | 5.1 | 6.500 | 6.9 | 9.500 | 8.4 |

## Orifice Overflow Control

Diameter (m) 0.045 Discharge Coefficient 0.600 Invert Level (m) 99.500

## Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 1222 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 99.454 | 0.454 | 0.0 | 2.1 | 0.0 | 2.1 | 161.7 | O K |
| 30 min Summer | 99.580 | 0.580 | 0.0 | 2.2 | 1.0 | 3.3 | 206.8 | O K |
| 60 min Summer | 99.699 | 0.699 | 0.0 | 2.4 | 1.8 | 4.2 | 249.0 | O K |
| 120 min Summer | 99.802 | 0.802 | 0.0 | 2.6 | 2.2 | 4.8 | 285.7 | Flood Risk |
| 180 min Summer | 99.848 | 0.848 | 0.0 | 2.7 | 2.4 | 5.1 | 301.9 | Flood Risk |
| 240 min Summer | 99.869 | 0.869 | 0.0 | 2.7 | 2.5 | 5.2 | 309.6 | Flood Risk |
| 360 min Summer | 99.880 | 0.880 | 0.0 | 2.7 | 2.5 | 5.2 | 313.6 | Flood Risk |
| 480 min Summer | 99.876 | 0.876 | 0.0 | 2.7 | 2.5 | 5.2 | 312.2 | Flood Risk |
| 600 min Summer | 99.871 | 0.871 | 0.0 | 2.7 | 2.5 | 5.2 | 310.4 | Flood Risk |
| 720 min Summer | 99.865 | 0.865 | 0.0 | 2.7 | 2.5 | 5.2 | 308.2 | Flood Risk |
| 960 min Summer | 99.850 | 0.850 | 0.0 | 2.7 | 2.4 | 5.1 | 302.9 | Flood Risk |
| 1440 min Summer | 99.814 | 0.814 | 0.0 | 2.6 | 2.3 | 4.9 | 290.1 | Flood Risk |
| 2160 min Summer | 99.759 | 0.759 | 0.0 | 2.5 | 2.1 | 4.6 | 270.4 | Flood Risk |
| 2880 min Summer | 99.710 | 0.710 | 0.0 | 2.5 | 1.8 | 4.3 | 253.0 | Flood Risk |
| 4320 min Summer | 99.635 | 0.635 | 0.0 | 2.3 | 1.4 | 3.7 | 226.2 | O K |
| 5760 min Summer | 99.581 | 0.581 | 0.0 | 2.2 | 1.0 | 3.3 | 206.9 | O K |
| 7200 min Summer | 99.544 | 0.544 | 0.0 | 2.2 | 0.5 | 2.7 | 193.7 | O K |
| 8640 min Summer | 99.500 | 0.500 | 0.0 | 2.1 | 0.0 | 2.1 | 178.0 | O K |
| 10080 min Summer | 99.441 | 0.441 | 0.0 | 2.1 | 0.0 | 2.1 | 157.3 | O K |
| 15 min Winter | 99.509 | 0.509 | 0.0 | 2.1 | 0.0 | 2.1 | 181.2 | O K |
| 30 min Winter | 99.650 | 0.650 | 0.0 | 2.4 | 1.5 | 3.9 | 231.5 | O K |
| 60 min Winter | 99.784 | 0.784 | 0.0 | 2.6 | 2.2 | 4.7 | 279.3 | Flood Risk |
| 120 min Winter | 99.901 | 0.901 | 0.0 | 2.7 | 2.6 | 5.3 | 321.1 | Flood Risk |
| 180 min Winter | 99.955 | 0.955 | 0.0 | 2.8 | 2.8 | 5.6 | 340.2 | Flood Risk |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 133.985 | 0.0 | 151.9 | 0.0 | 19 |
| 30 min Summer | 86.337 | 0.0 | 177.5 | 5.0 | 34 |
| 60 min Summer | 52.933 | 0.0 | 254.5 | 22.8 | 64 |
| 120 min Summer | 31.380 | 0.0 | 301.8 | 43.2 | 122 |
| 180 min Summer | 22.833 | 0.0 | 329.3 | 55.1 | 182 |
| 240 min Summer | 18.130 | 0.0 | 348.4 | 63.2 | 242 |
| 360 min Summer | 13.031 | 0.0 | 375.1 | 73.9 | 360 |
| 480 min Summer | 10.316 | 0.0 | 395.3 | 81.3 | 430 |
| 600 min Summer | 8.601 | 0.0 | 410.9 | 86.7 | 488 |
| 720 min Summer | 7.410 | 0.0 | 423.5 | 90.6 | 550 |
| 960 min Summer | 5.854 | 0.0 | 441.3 | 95.7 | 676 |
| 1440 min Summer | 4.194 | 0.0 | 445.3 | 99.2 | 954 |
| 2160 min Summer | 3.001 | 0.0 | 524.7 | 94.5 | 1364 |
| 2880 min Summer | 2.364 | 0.0 | 550.8 | 80.8 | 1784 |
| 4320 min Summer | 1.688 | 0.0 | 586.9 | 56.6 | 2592 |
| 5760 min Summer | 1.328 | 0.0 | 620.7 | 34.4 | 3400 |
| 7200 min Summer | 1.102 | 0.0 | 643.7 | 12.6 | 4256 |
| 8640 min Summer | 0.946 | 0.0 | 662.7 | 0.0 | 5184 |
| 10080 min Summer | 0.831 | 0.0 | 678.4 | 0.0 | 5952 |
| 15 min Winter | 133.985 | 0.0 | 165.3 | 0.0 | 19 |
| 30 min Winter | 86.337 | 0.0 | 188.5 | 14.3 | 33 |
| 60 min Winter | 52.933 | 0.0 | 285.2 | 36.7 | 62 |
| 120 min Winter | 31.380 | 0.0 | 338.0 | 61.0 | 120 |
| 180 min Winter | 22.833 | 0.0 | 368.7 | 75.2 | 178 |

## Summary of Results for 100 year Return Period (+30%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.982 | 0.982 | 0.0 | 2.8 | 2.9 | 5.7 | 349.8 | Flood Risk |
| 360 min Winter | 100.000 | 1.000 | 0.0 | 2.9 | 2.9 | 5.8 | 356.2 | Flood Risk |
| 480 min Winter | 99.999 | 0.999 | 0.0 | 2.9 | 2.9 | 5.8 | 355.9 | Flood Risk |
| 600 min Winter | 99.988 | 0.988 | 0.0 | 2.9 | 2.9 | 5.7 | 352.1 | Flood Risk |
| 720 min Winter | 99.981 | 0.981 | 0.0 | 2.8 | 2.9 | 5.7 | 349.4 | Flood Risk |
| 960 min Winter | 99.961 | 0.961 | 0.0 | 2.8 | 2.8 | 5.6 | 342.4 | Flood Risk |
| 1440 min Winter | 99.910 | 0.910 | 0.0 | 2.7 | 2.6 | 5.4 | 324.2 | Flood Risk |
| 2160 min Winter | 99.831 | 0.831 | 0.0 | 2.6 | 2.3 | 5.0 | 296.1 | Flood Risk |
| 2880 min Winter | 99.762 | 0.762 | 0.0 | 2.5 | 2.1 | 4.6 | 271.6 | Flood Risk |
| 4320 min Winter | 99.659 | 0.659 | 0.0 | 2.4 | 1.6 | 3.9 | 234.8 | O K |
| 5760 min Winter | 99.589 | 0.589 | 0.0 | 2.3 | 1.1 | 3.3 | 209.9 | O K |
| 7200 min Winter | 99.544 | 0.544 | 0.0 | 2.2 | 0.5 | 2.7 | 193.8 | O K |
| 8640 min Winter | 99.480 | 0.480 | 0.0 | 2.1 | 0.0 | 2.1 | 171.1 | O K |
| 10080 min Winter | 99.392 | 0.392 | 0.0 | 2.1 | 0.0 | 2.1 | 139.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 18.130 | 0.0 | 390.0 | 84.8 | 236 |
| 360 min Winter | 13.031 | 0.0 | 419.7 | 97.5 | 348 |
| 480 min Winter | 10.316 | 0.0 | 441.9 | 106.6 | 454 |
| 600 min Winter | 8.601 | 0.0 | 458.8 | 113.2 | 542 |
| 720 min Winter | 7.410 | 0.0 | 472.0 | 118.2 | 568 |
| 960 min Winter | 5.854 | 0.0 | 487.8 | 125.0 | 722 |
| 1440 min Winter | 4.194 | 0.0 | 487.7 | 130.8 | 1024 |
| 2160 min Winter | 3.001 | 0.0 | 587.8 | 129.2 | 1468 |
| 2880 min Winter | 2.364 | 0.0 | 617.1 | 118.0 | 1900 |
| 4320 min Winter | 1.688 | 0.0 | 656.7 | 83.8 | 2724 |
| 5760 min Winter | 1.328 | 0.0 | 695.2 | 50.6 | 3568 |
| 7200 min Winter | 1.102 | 0.0 | 721.0 | 16.6 | 4472 |
| 8640 min Winter | 0.946 | 0.0 | 742.5 | 0.0 | 5536 |
| 10080 min Winter | 0.831 | 0.0 | 760.3 | 0.0 | 6360 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +30 |

## Time Area Diagram

Total Area (ha) 0.650

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 0.650 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 375.0 | 0.0 | 1.000 | 375.0 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0076-2100-0500-2100 |
| Design Head (m) | 0.500 |
| Design Flow (l/s) | 2.1 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 76 |
| Invert Level (m) | 99.000 |
| Minimum Outlet Pipe Diameter (mm) | 100 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.500 | 2.1 | Kick-Flo® | 0.345 | 1.8 |
| Flush-Flo™ | 0.150 | 2.1 | Mean Flow over Head Range | - | 1.8 |

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 | 2.0 | 0.800 | 2.6 | 2.000 | 4.0 | 4.000 | 5.5 | 7.000 | 7.2 |
| 0.200 | 2.1 | 1.000 | 2.9 | 2.200 | 4.1 | 4.500 | 5.8 | 7.500 | 7.4 |
| 0.300 | 1.9 | 1.200 | 3.1 | 2.400 | 4.3 | 5.000 | 6.1 | 8.000 | 7.7 |
| 0.400 | 1.9 | 1.400 | 3.4 | 2.600 | 4.5 | 5.500 | 6.4 | 8.500 | 7.9 |
| 0.500 | 2.1 | 1.600 | 3.6 | 3.000 | 4.8 | 6.000 | 6.6 | 9.000 | 8.1 |
| 0.600 | 2.3 | 1.800 | 3.8 | 3.500 | 5.1 | 6.500 | 6.9 | 9.500 | 8.4 |

## Orifice Overflow Control

Diameter (m) 0.045 Discharge Coefficient 0.600 Invert Level (m) 99.500

## Summary of Results for 2 year Return Period

Half Drain Time : 154 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 98.339 | 0.339 | 0.0 | 16.3 | 0.0 | 16.3 | 161.2 | O K |
| 30 min Summer | 98.420 | 0.420 | 0.0 | 16.3 | 0.0 | 16.3 | 199.4 | O K |
| 60 min Summer | 98.486 | 0.486 | 0.0 | 16.3 | 0.0 | 16.3 | 231.0 | O K |
| 120 min Summer | 98.519 | 0.519 | 0.0 | 16.3 | 0.0 | 16.3 | 246.7 | O K |
| 180 min Summer | 98.522 | 0.522 | 0.0 | 16.3 | 0.0 | 16.3 | 247.9 | O K |
| 240 min Summer | 98.518 | 0.518 | 0.0 | 16.3 | 0.0 | 16.3 | 246.0 | O K |
| 360 min Summer | 98.499 | 0.499 | 0.0 | 16.3 | 0.0 | 16.3 | 236.9 | O K |
| 480 min Summer | 98.470 | 0.470 | 0.0 | 16.3 | 0.0 | 16.3 | 223.5 | O K |
| 600 min Summer | 98.439 | 0.439 | 0.0 | 16.3 | 0.0 | 16.3 | 208.4 | O K |
| 720 min Summer | 98.408 | 0.408 | 0.0 | 16.3 | 0.0 | 16.3 | 193.7 | O K |
| 960 min Summer | 98.351 | 0.351 | 0.0 | 16.3 | 0.0 | 16.3 | 166.7 | O K |
| 1440 min Summer | 98.263 | 0.263 | 0.0 | 16.3 | 0.0 | 16.3 | 125.0 | O K |
| 2160 min Summer | 98.190 | 0.190 | 0.0 | 15.8 | 0.0 | 15.8 | 90.3 | O K |
| 2880 min Summer | 98.163 | 0.163 | 0.0 | 13.6 | 0.0 | 13.6 | 77.3 | O K |
| 4320 min Summer | 98.134 | 0.134 | 0.0 | 10.5 | 0.0 | 10.5 | 63.7 | O K |
| 5760 min Summer | 98.118 | 0.118 | 0.0 | 8.6 | 0.0 | 8.6 | 55.9 | O K |
| 7200 min Summer | 98.107 | 0.107 | 0.0 | 7.3 | 0.0 | 7.3 | 50.6 | O K |
| 8640 min Summer | 98.098 | 0.098 | 0.0 | 6.3 | 0.0 | 6.3 | 46.8 | O K |
| 10080 min Summer | 98.092 | 0.092 | 0.0 | 5.7 | 0.0 | 5.7 | 43.7 | O K |
| 15 min Winter | 98.382 | 0.382 | 0.0 | 16.3 | 0.0 | 16.3 | 181.5 | O K |
| 30 min Winter | 98.475 | 0.475 | 0.0 | 16.3 | 0.0 | 16.3 | 225.5 | O K |
| 60 min Winter | 98.550 | 0.550 | 0.0 | 16.3 | 0.0 | 16.3 | 261.4 | O K |
| 120 min Winter | 98.592 | 0.592 | 0.0 | 16.3 | 0.0 | 16.3 | 281.0 | O K |
| 180 min Winter | 98.590 | 0.590 | 0.0 | 16.3 | 0.0 | 16.3 | 280.1 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 41.734 | 0.0 | 167.9 | 0.0 | 18 |
| 30 min Summer | 26.594 | 0.0 | 214.8 | 0.0 | 32 |
| 60 min Summer | 16.285 | 0.0 | 265.7 | 0.0 | 62 |
| 120 min Summer | 9.752 | 0.0 | 318.5 | 0.0 | 116 |
| 180 min Summer | 7.183 | 0.0 | 352.1 | 0.0 | 144 |
| 240 min Summer | 5.773 | 0.0 | 377.4 | 0.0 | 176 |
| 360 min Summer | 4.234 | 0.0 | 415.3 | 0.0 | 246 |
| 480 min Summer | 3.389 | 0.0 | 443.4 | 0.0 | 314 |
| 600 min Summer | 2.851 | 0.0 | 466.3 | 0.0 | 380 |
| 720 min Summer | 2.475 | 0.0 | 485.8 | 0.0 | 442 |
| 960 min Summer | 1.980 | 0.0 | 518.0 | 0.0 | 568 |
| 1440 min Summer | 1.445 | 0.0 | 566.8 | 0.0 | 806 |
| 2160 min Summer | 1.055 | 0.0 | 622.5 | 0.0 | 1128 |
| 2880 min Summer | 0.844 | 0.0 | 663.7 | 0.0 | 1496 |
| 4320 min Summer | 0.616 | 0.0 | 725.3 | 0.0 | 2204 |
| 5760 min Summer | 0.492 | 0.0 | 775.4 | 0.0 | 2936 |
| 7200 min Summer | 0.414 | 0.0 | 814.6 | 0.0 | 3672 |
| 8640 min Summer | 0.359 | 0.0 | 848.0 | 0.0 | 4408 |
| 10080 min Summer | 0.319 | 0.0 | 876.6 | 0.0 | 5136 |
| 15 min Winter | 41.734 | 0.0 | 188.4 | 0.0 | 18 |
| 30 min Winter | 26.594 | 0.0 | 240.9 | 0.0 | 32 |
| 60 min Winter | 16.285 | 0.0 | 297.8 | 0.0 | 60 |
| 120 min Winter | 9.752 | 0.0 | 356.9 | 0.0 | 116 |
| 180 min Winter | 7.183 | 0.0 | 394.5 | 0.0 | 164 |

## Summary of Results for 2 year Return Period

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 98.582 | 0.582 | 0.0 | 16.3 | 0.0 | 16.3 | 276.6 | O K |
| 360 min Winter | 98.552 | 0.552 | 0.0 | 16.3 | 0.0 | 16.3 | 262.4 | O K |
| 480 min Winter | 98.511 | 0.511 | 0.0 | 16.3 | 0.0 | 16.3 | 242.8 | O K |
| 600 min Winter | 98.463 | 0.463 | 0.0 | 16.3 | 0.0 | 16.3 | 219.9 | O K |
| 720 min Winter | 98.413 | 0.413 | 0.0 | 16.3 | 0.0 | 16.3 | 196.1 | O K |
| 960 min Winter | 98.325 | 0.325 | 0.0 | 16.3 | 0.0 | 16.3 | 154.6 | O K |
| 1440 min Winter | 98.210 | 0.210 | 0.0 | 16.0 | 0.0 | 16.0 | 99.7 | O K |
| 2160 min Winter | 98.158 | 0.158 | 0.0 | 13.1 | 0.0 | 13.1 | 74.8 | O K |
| 2880 min Winter | 98.136 | 0.136 | 0.0 | 10.7 | 0.0 | 10.7 | 64.5 | O K |
| 4320 min Winter | 98.112 | 0.112 | 0.0 | 7.9 | 0.0 | 7.9 | 53.1 | O K |
| 5760 min Winter | 98.098 | 0.098 | 0.0 | 6.3 | 0.0 | 6.3 | 46.6 | O K |
| 7200 min Winter | 98.089 | 0.089 | 0.0 | 5.3 | 0.0 | 5.3 | 42.3 | O K |
| 8640 min Winter | 98.082 | 0.082 | 0.0 | 4.6 | 0.0 | 4.6 | 39.0 | O K |
| 10080 min Winter | 98.077 | 0.077 | 0.0 | 4.1 | 0.0 | 4.1 | 36.6 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 5.773 | 0.0 | 422.9 | 0.0 | 188 |
| 360 min Winter | 4.234 | 0.0 | 465.4 | 0.0 | 264 |
| 480 min Winter | 3.389 | 0.0 | 496.8 | 0.0 | 340 |
| 600 min Winter | 2.851 | 0.0 | 522.4 | 0.0 | 414 |
| 720 min Winter | 2.475 | 0.0 | 544.3 | 0.0 | 478 |
| 960 min Winter | 1.980 | 0.0 | 580.5 | 0.0 | 598 |
| 1440 min Winter | 1.445 | 0.0 | 635.1 | 0.0 | 810 |
| 2160 min Winter | 1.055 | 0.0 | 697.4 | 0.0 | 1144 |
| 2880 min Winter | 0.844 | 0.0 | 743.5 | 0.0 | 1500 |
| 4320 min Winter | 0.616 | 0.0 | 812.8 | 0.0 | 2208 |
| 5760 min Winter | 0.492 | 0.0 | 868.5 | 0.0 | 2944 |
| 7200 min Winter | 0.414 | 0.0 | 912.5 | 0.0 | 3664 |
| 8640 min Winter | 0.359 | 0.0 | 950.0 | 0.0 | 4408 |
| 10080 min Winter | 0.319 | 0.0 | 982.3 | 0.0 | 5120 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +0 |

## Time Area Diagram

Total Area (ha) 2.190

| Time From: | (mins) To: | Area (ha) |
|---|---|---|
| 0 | 4 | 2.190 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 500.0 | 0.0 | 2.000 | 500.0 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0186-1640-0600-1640 |
| Design Head (m) | 0.600 |
| Design Flow (l/s) | 16.4 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 186 |
| Invert Level (m) | 98.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.600 | 16.3 | Kick-Flo® | 0.478 | 14.7 |
| Flush-Flo™ | 0.278 | 16.3 | Mean Flow over Head Range | - | 12.9 |

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 | 6.5 | 0.800 | 18.7 | 2.000 | 29.0 | 4.000 | 40.5 | 7.000 | 52.9 |
| 0.200 | 15.9 | 1.000 | 20.8 | 2.200 | 30.4 | 4.500 | 42.9 | 7.500 | 54.8 |
| 0.300 | 16.3 | 1.200 | 22.7 | 2.400 | 31.7 | 5.000 | 45.2 | 8.000 | 56.6 |
| 0.400 | 15.7 | 1.400 | 24.5 | 2.600 | 32.9 | 5.500 | 47.3 | 8.500 | 58.4 |
| 0.500 | 15.0 | 1.600 | 26.1 | 3.000 | 35.3 | 6.000 | 49.3 | 9.000 | 60.1 |
| 0.600 | 16.3 | 1.800 | 27.6 | 3.500 | 38.0 | 6.500 | 51.0 | 9.500 | 61.8 |

## Orifice Overflow Control

Diameter (m) 0.110 Discharge Coefficient 0.600 Invert Level (m) 98.600

## Summary of Results for 30 year Return Period (+10%)

Half Drain Time : 254 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 98.725 | 0.725 | 0.0 | 17.9 | 5.8 | 23.6 | 344.2 | O K |
| 30 min Summer | 98.893 | 0.893 | 0.0 | 19.7 | 12.3 | 32.1 | 424.2 | O K |
| 60 min Summer | 99.019 | 1.019 | 0.0 | 21.0 | 15.2 | 36.3 | 484.2 | O K |
| 120 min Summer | 99.070 | 1.070 | 0.0 | 21.5 | 16.3 | 37.8 | 508.1 | O K |
| 180 min Summer | 99.074 | 1.074 | 0.0 | 21.5 | 16.3 | 37.9 | 510.1 | O K |
| 240 min Summer | 99.064 | 1.064 | 0.0 | 21.4 | 16.2 | 37.6 | 505.6 | O K |
| 360 min Summer | 99.028 | 1.028 | 0.0 | 21.1 | 15.4 | 36.5 | 488.1 | O K |
| 480 min Summer | 98.986 | 0.986 | 0.0 | 20.7 | 14.5 | 35.2 | 468.2 | O K |
| 600 min Summer | 98.944 | 0.944 | 0.0 | 20.3 | 13.6 | 33.8 | 448.4 | O K |
| 720 min Summer | 98.905 | 0.905 | 0.0 | 19.9 | 12.6 | 32.5 | 429.9 | O K |
| 960 min Summer | 98.837 | 0.837 | 0.0 | 19.1 | 10.8 | 29.9 | 397.7 | O K |
| 1440 min Summer | 98.741 | 0.741 | 0.0 | 18.0 | 6.9 | 25.0 | 351.8 | O K |
| 2160 min Summer | 98.632 | 0.632 | 0.0 | 16.7 | 0.5 | 17.2 | 300.1 | O K |
| 2880 min Summer | 98.490 | 0.490 | 0.0 | 16.3 | 0.0 | 16.3 | 232.7 | O K |
| 4320 min Summer | 98.259 | 0.259 | 0.0 | 16.3 | 0.0 | 16.3 | 122.9 | O K |
| 5760 min Summer | 98.182 | 0.182 | 0.0 | 15.4 | 0.0 | 15.4 | 86.5 | O K |
| 7200 min Summer | 98.158 | 0.158 | 0.0 | 13.2 | 0.0 | 13.2 | 75.1 | O K |
| 8640 min Summer | 98.142 | 0.142 | 0.0 | 11.4 | 0.0 | 11.4 | 67.6 | O K |
| 10080 min Summer | 98.131 | 0.131 | 0.0 | 10.1 | 0.0 | 10.1 | 62.3 | O K |
| 15 min Winter | 98.810 | 0.810 | 0.0 | 18.8 | 10.0 | 28.8 | 384.9 | O K |
| 30 min Winter | 99.003 | 1.003 | 0.0 | 20.9 | 14.9 | 35.8 | 476.5 | O K |
| 60 min Winter | 99.151 | 1.151 | 0.0 | 22.3 | 17.8 | 40.1 | 546.8 | O K |
| 120 min Winter | 99.213 | 1.213 | 0.0 | 22.8 | 18.9 | 41.7 | 576.3 | O K |
| 180 min Winter | 99.212 | 1.212 | 0.0 | 22.8 | 18.8 | 41.7 | 575.5 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 87.227 | 0.0 | 354.1 | 7.7 | 18 |
| 30 min Summer | 55.777 | 0.0 | 453.8 | 41.9 | 32 |
| 60 min Summer | 34.065 | 0.0 | 557.6 | 80.6 | 62 |
| 120 min Summer | 20.201 | 0.0 | 661.7 | 118.1 | 104 |
| 180 min Summer | 14.736 | 0.0 | 724.1 | 137.0 | 134 |
| 240 min Summer | 11.736 | 0.0 | 769.1 | 147.6 | 168 |
| 360 min Summer | 8.483 | 0.0 | 833.9 | 156.2 | 236 |
| 480 min Summer | 6.739 | 0.0 | 883.3 | 154.1 | 306 |
| 600 min Summer | 5.634 | 0.0 | 923.0 | 143.0 | 374 |
| 720 min Summer | 4.865 | 0.0 | 956.5 | 130.4 | 440 |
| 960 min Summer | 3.858 | 0.0 | 1011.3 | 106.4 | 576 |
| 1440 min Summer | 2.780 | 0.0 | 1092.6 | 58.4 | 838 |
| 2160 min Summer | 2.001 | 0.0 | 1181.7 | 2.6 | 1260 |
| 2880 min Summer | 1.584 | 0.0 | 1246.9 | 0.0 | 1668 |
| 4320 min Summer | 1.138 | 0.0 | 1343.0 | 0.0 | 2292 |
| 5760 min Summer | 0.900 | 0.0 | 1418.2 | 0.0 | 2944 |
| 7200 min Summer | 0.750 | 0.0 | 1476.9 | 0.0 | 3672 |
| 8640 min Summer | 0.646 | 0.0 | 1526.2 | 0.0 | 4408 |
| 10080 min Summer | 0.569 | 0.0 | 1568.1 | 0.0 | 5136 |
| 15 min Winter | 87.227 | 0.0 | 397.0 | 21.9 | 18 |
| 30 min Winter | 55.777 | 0.0 | 508.7 | 64.7 | 32 |
| 60 min Winter | 34.065 | 0.0 | 624.7 | 110.6 | 60 |
| 120 min Winter | 20.201 | 0.0 | 741.3 | 155.2 | 114 |
| 180 min Winter | 14.736 | 0.0 | 811.2 | 178.0 | 140 |

## Summary of Results for 30 year Return Period (+10%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.194 | 1.194 | 0.0 | 22.7 | 18.5 | 41.2 | 567.1 | O K |
| 360 min Winter | 99.135 | 1.135 | 0.0 | 22.1 | 17.5 | 39.6 | 539.0 | O K |
| 480 min Winter | 99.071 | 1.071 | 0.0 | 21.5 | 16.3 | 37.8 | 508.7 | O K |
| 600 min Winter | 99.010 | 1.010 | 0.0 | 20.9 | 15.1 | 36.0 | 479.8 | O K |
| 720 min Winter | 98.955 | 0.955 | 0.0 | 20.4 | 13.8 | 34.2 | 453.5 | O K |
| 960 min Winter | 98.862 | 0.862 | 0.0 | 19.4 | 11.5 | 30.9 | 409.3 | O K |
| 1440 min Winter | 98.739 | 0.739 | 0.0 | 18.0 | 6.8 | 24.8 | 350.9 | O K |
| 2160 min Winter | 98.583 | 0.583 | 0.0 | 16.3 | 0.0 | 16.3 | 277.1 | O K |
| 2880 min Winter | 98.335 | 0.335 | 0.0 | 16.3 | 0.0 | 16.3 | 159.3 | O K |
| 4320 min Winter | 98.172 | 0.172 | 0.0 | 14.5 | 0.0 | 14.5 | 81.5 | O K |
| 5760 min Winter | 98.143 | 0.143 | 0.0 | 11.5 | 0.0 | 11.5 | 68.1 | O K |
| 7200 min Winter | 98.127 | 0.127 | 0.0 | 9.7 | 0.0 | 9.7 | 60.4 | O K |
| 8640 min Winter | 98.116 | 0.116 | 0.0 | 8.3 | 0.0 | 8.3 | 55.0 | O K |
| 10080 min Winter | 98.107 | 0.107 | 0.0 | 7.3 | 0.0 | 7.3 | 51.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 11.736 | 0.0 | 861.6 | 191.4 | 180 |
| 360 min Winter | 8.483 | 0.0 | 934.2 | 203.6 | 254 |
| 480 min Winter | 6.739 | 0.0 | 989.5 | 205.7 | 326 |
| 600 min Winter | 5.634 | 0.0 | 1034.0 | 198.9 | 398 |
| 720 min Winter | 4.865 | 0.0 | 1071.6 | 183.5 | 468 |
| 960 min Winter | 3.858 | 0.0 | 1132.9 | 148.5 | 604 |
| 1440 min Winter | 2.780 | 0.0 | 1223.9 | 74.3 | 880 |
| 2160 min Winter | 2.001 | 0.0 | 1323.7 | 0.0 | 1360 |
| 2880 min Winter | 1.584 | 0.0 | 1396.7 | 0.0 | 1676 |
| 4320 min Winter | 1.138 | 0.0 | 1504.6 | 0.0 | 2244 |
| 5760 min Winter | 0.900 | 0.0 | 1588.5 | 0.0 | 2944 |
| 7200 min Winter | 0.750 | 0.0 | 1654.3 | 0.0 | 3672 |
| 8640 min Winter | 0.646 | 0.0 | 1709.6 | 0.0 | 4408 |
| 10080 min Winter | 0.569 | 0.0 | 1756.8 | 0.0 | 5144 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 30 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +10 |

## Time Area Diagram

Total Area (ha) 2.190

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 2.190 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 500.0 | 0.0 | 2.000 | 500.0 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0186-1640-0600-1640 |
| Design Head (m) | 0.600 |
| Design Flow (l/s) | 16.4 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 186 |
| Invert Level (m) | 98.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.600 | 16.3 | Kick-Flo® | 0.478 | 14.7 |
| Flush-Flo™ | 0.278 | 16.3 | Mean Flow over Head Range | - | 12.9 |

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 | 6.5 | 0.800 | 18.7 | 2.000 | 29.0 | 4.000 | 40.5 | 7.000 | 52.9 |
| 0.200 | 15.9 | 1.000 | 20.8 | 2.200 | 30.4 | 4.500 | 42.9 | 7.500 | 54.8 |
| 0.300 | 16.3 | 1.200 | 22.7 | 2.400 | 31.7 | 5.000 | 45.2 | 8.000 | 56.6 |
| 0.400 | 15.7 | 1.400 | 24.5 | 2.600 | 32.9 | 5.500 | 47.3 | 8.500 | 58.4 |
| 0.500 | 15.0 | 1.600 | 26.1 | 3.000 | 35.3 | 6.000 | 49.3 | 9.000 | 60.1 |
| 0.600 | 16.3 | 1.800 | 27.6 | 3.500 | 38.0 | 6.500 | 51.0 | 9.500 | 61.8 |

## Orifice Overflow Control

Diameter (m) 0.110 Discharge Coefficient 0.600 Invert Level (m) 98.600

## Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 328 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 99.110 | 1.110 | 0.0 | 21.9 | 17.0 | 38.9 | 527.3 | O K |
| 30 min Summer | 99.387 | 1.387 | 0.0 | 24.3 | 21.6 | 46.0 | 658.9 | O K |
| 60 min Summer | 99.604 | 1.604 | 0.0 | 26.1 | 24.6 | 50.7 | 761.8 | O K |
| 120 min Summer | 99.700 | 1.700 | 0.0 | 26.8 | 25.8 | 52.7 | 807.3 | O K |
| 180 min Summer | 99.706 | 1.706 | 0.0 | 26.9 | 25.9 | 52.8 | 810.5 | Flood Risk |
| 240 min Summer | 99.691 | 1.691 | 0.0 | 26.8 | 25.7 | 52.5 | 803.3 | O K |
| 360 min Summer | 99.631 | 1.631 | 0.0 | 26.3 | 25.0 | 51.3 | 774.9 | O K |
| 480 min Summer | 99.564 | 1.564 | 0.0 | 25.8 | 24.1 | 49.9 | 742.9 | O K |
| 600 min Summer | 99.495 | 1.495 | 0.0 | 25.2 | 23.1 | 48.4 | 709.9 | O K |
| 720 min Summer | 99.428 | 1.428 | 0.0 | 24.7 | 22.2 | 46.9 | 678.3 | O K |
| 960 min Summer | 99.309 | 1.309 | 0.0 | 23.7 | 20.4 | 44.1 | 621.9 | O K |
| 1440 min Summer | 99.124 | 1.124 | 0.0 | 22.0 | 17.3 | 39.3 | 534.1 | O K |
| 2160 min Summer | 98.938 | 0.938 | 0.0 | 20.2 | 13.4 | 33.6 | 445.5 | O K |
| 2880 min Summer | 98.816 | 0.816 | 0.0 | 18.9 | 10.1 | 29.0 | 387.5 | O K |
| 4320 min Summer | 98.678 | 0.678 | 0.0 | 17.3 | 2.8 | 20.1 | 322.0 | O K |
| 5760 min Summer | 98.491 | 0.491 | 0.0 | 16.3 | 0.0 | 16.3 | 233.1 | O K |
| 7200 min Summer | 98.284 | 0.284 | 0.0 | 16.3 | 0.0 | 16.3 | 135.1 | O K |
| 8640 min Summer | 98.201 | 0.201 | 0.0 | 15.9 | 0.0 | 15.9 | 95.6 | O K |
| 10080 min Summer | 98.174 | 0.174 | 0.0 | 14.7 | 0.0 | 14.7 | 82.7 | O K |
| 15 min Winter | 99.245 | 1.245 | 0.0 | 23.1 | 19.4 | 42.5 | 591.5 | O K |
| 30 min Winter | 99.561 | 1.561 | 0.0 | 25.8 | 24.0 | 49.8 | 741.4 | O K |
| 60 min Winter | 99.812 | 1.812 | 0.0 | 27.7 | 27.2 | 54.8 | 860.7 | Flood Risk |
| 120 min Winter | 99.936 | 1.936 | 0.0 | 28.6 | 28.6 | 57.2 | 919.7 | Flood Risk |
| 180 min Winter | 99.929 | 1.929 | 0.0 | 28.5 | 28.5 | 57.0 | 916.2 | Flood Risk |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 133.985 | 0.0 | 545.8 | 83.4 | 18 |
| 30 min Summer | 86.337 | 0.0 | 704.3 | 154.6 | 33 |
| 60 min Summer | 52.933 | 0.0 | 867.4 | 227.3 | 62 |
| 120 min Summer | 31.380 | 0.0 | 1028.8 | 297.1 | 110 |
| 180 min Summer | 22.833 | 0.0 | 1123.0 | 333.5 | 140 |
| 240 min Summer | 18.130 | 0.0 | 1189.0 | 355.5 | 172 |
| 360 min Summer | 13.031 | 0.0 | 1282.0 | 379.4 | 240 |
| 480 min Summer | 10.316 | 0.0 | 1353.3 | 391.6 | 308 |
| 600 min Summer | 8.601 | 0.0 | 1410.3 | 395.8 | 376 |
| 720 min Summer | 7.410 | 0.0 | 1458.1 | 394.0 | 442 |
| 960 min Summer | 5.854 | 0.0 | 1535.7 | 368.7 | 578 |
| 1440 min Summer | 4.194 | 0.0 | 1649.9 | 313.7 | 836 |
| 2160 min Summer | 3.001 | 0.0 | 1773.0 | 240.1 | 1208 |
| 2880 min Summer | 2.364 | 0.0 | 1862.4 | 167.3 | 1584 |
| 4320 min Summer | 1.688 | 0.0 | 1993.1 | 32.4 | 2380 |
| 5760 min Summer | 1.328 | 0.0 | 2093.0 | 0.0 | 3224 |
| 7200 min Summer | 1.102 | 0.0 | 2170.9 | 0.0 | 3816 |
| 8640 min Summer | 0.946 | 0.0 | 2235.9 | 0.0 | 4416 |
| 10080 min Summer | 0.831 | 0.0 | 2291.0 | 0.0 | 5136 |
| 15 min Winter | 133.985 | 0.0 | 611.7 | 113.3 | 18 |
| 30 min Winter | 86.337 | 0.0 | 789.3 | 195.6 | 32 |
| 60 min Winter | 52.933 | 0.0 | 971.7 | 279.5 | 60 |
| 120 min Winter | 31.380 | 0.0 | 1152.5 | 360.6 | 116 |
| 180 min Winter | 22.833 | 0.0 | 1258.0 | 403.8 | 146 |

## Summary of Results for 100 year Return Period (+30%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.903 | 1.903 | 0.0 | 28.3 | 28.2 | 56.5 | 904.0 | Flood Risk |
| 360 min Winter | 99.811 | 1.811 | 0.0 | 27.7 | 27.2 | 54.8 | 860.0 | Flood Risk |
| 480 min Winter | 99.709 | 1.709 | 0.0 | 26.9 | 25.9 | 52.8 | 811.9 | Flood Risk |
| 600 min Winter | 99.609 | 1.609 | 0.0 | 26.1 | 24.7 | 50.8 | 764.1 | O K |
| 720 min Winter | 99.514 | 1.514 | 0.0 | 25.4 | 23.4 | 48.8 | 719.2 | O K |
| 960 min Winter | 99.349 | 1.349 | 0.0 | 24.0 | 21.0 | 45.1 | 640.8 | O K |
| 1440 min Winter | 99.105 | 1.105 | 0.0 | 21.8 | 16.9 | 38.8 | 525.1 | O K |
| 2160 min Winter | 98.883 | 0.883 | 0.0 | 19.6 | 12.1 | 31.7 | 419.2 | O K |
| 2880 min Winter | 98.759 | 0.759 | 0.0 | 18.3 | 8.1 | 26.4 | 360.4 | O K |
| 4320 min Winter | 98.571 | 0.571 | 0.0 | 16.3 | 0.0 | 16.3 | 271.3 | O K |
| 5760 min Winter | 98.225 | 0.225 | 0.0 | 16.1 | 0.0 | 16.1 | 107.0 | O K |
| 7200 min Winter | 98.168 | 0.168 | 0.0 | 14.2 | 0.0 | 14.2 | 79.9 | O K |
| 8640 min Winter | 98.149 | 0.149 | 0.0 | 12.2 | 0.0 | 12.2 | 70.8 | O K |
| 10080 min Winter | 98.136 | 0.136 | 0.0 | 10.7 | 0.0 | 10.7 | 64.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 18.130 | 0.0 | 1331.9 | 430.7 | 182 |
| 360 min Winter | 13.031 | 0.0 | 1436.1 | 461.3 | 258 |
| 480 min Winter | 10.316 | 0.0 | 1515.9 | 478.4 | 332 |
| 600 min Winter | 8.601 | 0.0 | 1579.8 | 486.3 | 404 |
| 720 min Winter | 7.410 | 0.0 | 1633.3 | 487.7 | 474 |
| 960 min Winter | 5.854 | 0.0 | 1720.3 | 472.8 | 608 |
| 1440 min Winter | 4.194 | 0.0 | 1848.1 | 396.8 | 866 |
| 2160 min Winter | 3.001 | 0.0 | 1985.9 | 283.2 | 1252 |
| 2880 min Winter | 2.364 | 0.0 | 2086.1 | 162.5 | 1616 |
| 4320 min Winter | 1.688 | 0.0 | 2232.7 | 0.0 | 2592 |
| 5760 min Winter | 1.328 | 0.0 | 2344.3 | 0.0 | 3112 |
| 7200 min Winter | 1.102 | 0.0 | 2431.6 | 0.0 | 3672 |
| 8640 min Winter | 0.946 | 0.0 | 2504.4 | 0.0 | 4400 |
| 10080 min Winter | 0.831 | 0.0 | 2566.4 | 0.0 | 5136 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +30 |

## Time Area Diagram

Total Area (ha) 2.190

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 2.190 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 500.0 | 0.0 | 2.000 | 500.0 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0186-1640-0600-1640 |
| Design Head (m) | 0.600 |
| Design Flow (l/s) | 16.4 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 186 |
| Invert Level (m) | 98.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.600 | 16.3 | Kick-Flo® | 0.478 | 14.7 |
| Flush-Flo™ | 0.278 | 16.3 | Mean Flow over Head Range | - | 12.9 |

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 | 6.5 | 0.800 | 18.7 | 2.000 | 29.0 | 4.000 | 40.5 | 7.000 | 52.9 |
| 0.200 | 15.9 | 1.000 | 20.8 | 2.200 | 30.4 | 4.500 | 42.9 | 7.500 | 54.8 |
| 0.300 | 16.3 | 1.200 | 22.7 | 2.400 | 31.7 | 5.000 | 45.2 | 8.000 | 56.6 |
| 0.400 | 15.7 | 1.400 | 24.5 | 2.600 | 32.9 | 5.500 | 47.3 | 8.500 | 58.4 |
| 0.500 | 15.0 | 1.600 | 26.1 | 3.000 | 35.3 | 6.000 | 49.3 | 9.000 | 60.1 |
| 0.600 | 16.3 | 1.800 | 27.6 | 3.500 | 38.0 | 6.500 | 51.0 | 9.500 | 61.8 |

## Orifice Overflow Control

Diameter (m) 0.110 Discharge Coefficient 0.600 Invert Level (m) 98.600

## Summary of Results for 2 year Return Period

Half Drain Time : 92 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 98.373 | 0.373 | 0.0 | 4.6 | 0.0 | 4.6 | 30.1 | O K |
| 30 min Summer | 98.453 | 0.453 | 0.0 | 4.6 | 0.0 | 4.6 | 36.6 | O K |
| 60 min Summer | 98.505 | 0.505 | 0.0 | 4.6 | 0.0 | 4.6 | 40.8 | O K |
| 120 min Summer | 98.507 | 0.507 | 0.0 | 4.6 | 0.0 | 4.6 | 41.0 | O K |
| 180 min Summer | 98.490 | 0.490 | 0.0 | 4.6 | 0.0 | 4.6 | 39.6 | O K |
| 240 min Summer | 98.464 | 0.464 | 0.0 | 4.6 | 0.0 | 4.6 | 37.5 | O K |
| 360 min Summer | 98.408 | 0.408 | 0.0 | 4.6 | 0.0 | 4.6 | 33.0 | O K |
| 480 min Summer | 98.355 | 0.355 | 0.0 | 4.6 | 0.0 | 4.6 | 28.6 | O K |
| 600 min Summer | 98.306 | 0.306 | 0.0 | 4.6 | 0.0 | 4.6 | 24.7 | O K |
| 720 min Summer | 98.264 | 0.264 | 0.0 | 4.6 | 0.0 | 4.6 | 21.3 | O K |
| 960 min Summer | 98.198 | 0.198 | 0.0 | 4.6 | 0.0 | 4.6 | 16.0 | O K |
| 1440 min Summer | 98.127 | 0.127 | 0.0 | 4.4 | 0.0 | 4.4 | 10.3 | O K |
| 2160 min Summer | 98.098 | 0.098 | 0.0 | 3.5 | 0.0 | 3.5 | 7.9 | O K |
| 2880 min Summer | 98.083 | 0.083 | 0.0 | 2.9 | 0.0 | 2.9 | 6.7 | O K |
| 4320 min Summer | 98.068 | 0.068 | 0.0 | 2.1 | 0.0 | 2.1 | 5.5 | O K |
| 5760 min Summer | 98.060 | 0.060 | 0.0 | 1.7 | 0.0 | 1.7 | 4.8 | O K |
| 7200 min Summer | 98.054 | 0.054 | 0.0 | 1.4 | 0.0 | 1.4 | 4.4 | O K |
| 8640 min Summer | 98.050 | 0.050 | 0.0 | 1.2 | 0.0 | 1.2 | 4.0 | O K |
| 10080 min Summer | 98.047 | 0.047 | 0.0 | 1.1 | 0.0 | 1.1 | 3.8 | O K |
| 15 min Winter | 98.421 | 0.421 | 0.0 | 4.6 | 0.0 | 4.6 | 34.0 | O K |
| 30 min Winter | 98.516 | 0.516 | 0.0 | 4.6 | 0.0 | 4.6 | 41.7 | O K |
| 60 min Winter | 98.577 | 0.577 | 0.0 | 4.6 | 0.0 | 4.6 | 46.6 | O K |
| 120 min Winter | 98.579 | 0.579 | 0.0 | 4.6 | 0.0 | 4.6 | 46.8 | O K |
| 180 min Winter | 98.556 | 0.556 | 0.0 | 4.6 | 0.0 | 4.6 | 44.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 41.734 | 0.0 | 33.1 | 0.0 | 18 |
| 30 min Summer | 26.594 | 0.0 | 42.2 | 0.0 | 32 |
| 60 min Summer | 16.285 | 0.0 | 51.8 | 0.0 | 60 |
| 120 min Summer | 9.752 | 0.0 | 62.1 | 0.0 | 98 |
| 180 min Summer | 7.183 | 0.0 | 68.6 | 0.0 | 130 |
| 240 min Summer | 5.773 | 0.0 | 73.5 | 0.0 | 164 |
| 360 min Summer | 4.234 | 0.0 | 80.9 | 0.0 | 230 |
| 480 min Summer | 3.389 | 0.0 | 86.4 | 0.0 | 294 |
| 600 min Summer | 2.851 | 0.0 | 90.8 | 0.0 | 356 |
| 720 min Summer | 2.475 | 0.0 | 94.6 | 0.0 | 416 |
| 960 min Summer | 1.980 | 0.0 | 100.9 | 0.0 | 530 |
| 1440 min Summer | 1.445 | 0.0 | 110.4 | 0.0 | 750 |
| 2160 min Summer | 1.055 | 0.0 | 121.0 | 0.0 | 1104 |
| 2880 min Summer | 0.844 | 0.0 | 129.0 | 0.0 | 1468 |
| 4320 min Summer | 0.616 | 0.0 | 141.2 | 0.0 | 2200 |
| 5760 min Summer | 0.492 | 0.0 | 150.6 | 0.0 | 2928 |
| 7200 min Summer | 0.414 | 0.0 | 158.2 | 0.0 | 3672 |
| 8640 min Summer | 0.359 | 0.0 | 164.8 | 0.0 | 4368 |
| 10080 min Summer | 0.319 | 0.0 | 170.5 | 0.0 | 5120 |
| 15 min Winter | 41.734 | 0.0 | 37.1 | 0.0 | 18 |
| 30 min Winter | 26.594 | 0.0 | 47.3 | 0.0 | 32 |
| 60 min Winter | 16.285 | 0.0 | 58.1 | 0.0 | 60 |
| 120 min Winter | 9.752 | 0.0 | 69.6 | 0.0 | 110 |
| 180 min Winter | 7.183 | 0.0 | 76.9 | 0.0 | 138 |

## Summary of Results for 2 year Return Period

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 98.522 | 0.522 | 0.0 | 4.6 | 0.0 | 4.6 | 42.2 | O K |
| 360 min Winter | 98.435 | 0.435 | 0.0 | 4.6 | 0.0 | 4.6 | 35.1 | O K |
| 480 min Winter | 98.349 | 0.349 | 0.0 | 4.6 | 0.0 | 4.6 | 28.2 | O K |
| 600 min Winter | 98.275 | 0.275 | 0.0 | 4.6 | 0.0 | 4.6 | 22.2 | O K |
| 720 min Winter | 98.215 | 0.215 | 0.0 | 4.6 | 0.0 | 4.6 | 17.4 | O K |
| 960 min Winter | 98.139 | 0.139 | 0.0 | 4.5 | 0.0 | 4.5 | 11.2 | O K |
| 1440 min Winter | 98.099 | 0.099 | 0.0 | 3.6 | 0.0 | 3.6 | 8.0 | O K |
| 2160 min Winter | 98.078 | 0.078 | 0.0 | 2.6 | 0.0 | 2.6 | 6.3 | O K |
| 2880 min Winter | 98.068 | 0.068 | 0.0 | 2.1 | 0.0 | 2.1 | 5.5 | O K |
| 4320 min Winter | 98.056 | 0.056 | 0.0 | 1.5 | 0.0 | 1.5 | 4.5 | O K |
| 5760 min Winter | 98.050 | 0.050 | 0.0 | 1.2 | 0.0 | 1.2 | 4.0 | O K |
| 7200 min Winter | 98.045 | 0.045 | 0.0 | 1.0 | 0.0 | 1.0 | 3.6 | O K |
| 8640 min Winter | 98.042 | 0.042 | 0.0 | 0.9 | 0.0 | 0.9 | 3.4 | O K |
| 10080 min Winter | 98.039 | 0.039 | 0.0 | 0.8 | 0.0 | 0.8 | 3.1 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 5.773 | 0.0 | 82.4 | 0.0 | 178 |
| 360 min Winter | 4.234 | 0.0 | 90.6 | 0.0 | 250 |
| 480 min Winter | 3.389 | 0.0 | 96.7 | 0.0 | 314 |
| 600 min Winter | 2.851 | 0.0 | 101.7 | 0.0 | 374 |
| 720 min Winter | 2.475 | 0.0 | 106.0 | 0.0 | 430 |
| 960 min Winter | 1.980 | 0.0 | 113.0 | 0.0 | 530 |
| 1440 min Winter | 1.445 | 0.0 | 123.7 | 0.0 | 750 |
| 2160 min Winter | 1.055 | 0.0 | 135.5 | 0.0 | 1104 |
| 2880 min Winter | 0.844 | 0.0 | 144.5 | 0.0 | 1468 |
| 4320 min Winter | 0.616 | 0.0 | 158.1 | 0.0 | 2176 |
| 5760 min Winter | 0.492 | 0.0 | 168.7 | 0.0 | 2920 |
| 7200 min Winter | 0.414 | 0.0 | 177.2 | 0.0 | 3672 |
| 8640 min Winter | 0.359 | 0.0 | 184.6 | 0.0 | 4416 |
| 10080 min Winter | 0.319 | 0.0 | 191.0 | 0.0 | 5120 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +0 |

## Time Area Diagram

Total Area (ha) 0.425

| Time From: | (mins) To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.425 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 85.0 | 0.0 | 2.000 | 85.0 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0106-4700-0700-4700 |
| Design Head (m) | 0.700 |
| Design Flow (l/s) | 4.7 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 106 |
| Invert Level (m) | 98.000 |
| 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) | 0.700 | 4.6 | Kick-Flo® | 0.477 | 3.9 |
| Flush-Flo™ | 0.211 | 4.6 | Mean Flow over Head Range | - | 4.0 |

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 | 3.6 | 0.800 | 4.9 | 2.000 | 7.6 | 4.000 | 10.5 | 7.000 | 13.7 |
| 0.200 | 4.6 | 1.000 | 5.5 | 2.200 | 7.9 | 4.500 | 11.1 | 7.500 | 14.1 |
| 0.300 | 4.5 | 1.200 | 6.0 | 2.400 | 8.2 | 5.000 | 11.7 | 8.000 | 14.6 |
| 0.400 | 4.3 | 1.400 | 6.4 | 2.600 | 8.6 | 5.500 | 12.2 | 8.500 | 15.1 |
| 0.500 | 4.0 | 1.600 | 6.8 | 3.000 | 9.2 | 6.000 | 12.7 | 9.000 | 15.5 |
| 0.600 | 4.3 | 1.800 | 7.2 | 3.500 | 9.8 | 6.500 | 13.2 | 9.500 | 15.9 |

## Orifice Overflow Control

Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 98.700

## Summary of Results for 30 year Return Period (+10%)

Half Drain Time : 161 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 98.808 | 0.808 | 0.0 | 5.0 | 2.1 | 7.0 | 65.2 | O K |
| 30 min Summer | 98.975 | 0.975 | 0.0 | 5.4 | 3.7 | 9.1 | 78.8 | O K |
| 60 min Summer | 99.072 | 1.072 | 0.0 | 5.6 | 4.4 | 10.0 | 86.6 | O K |
| 120 min Summer | 99.092 | 1.092 | 0.0 | 5.7 | 4.5 | 10.2 | 88.2 | O K |
| 180 min Summer | 99.073 | 1.073 | 0.0 | 5.6 | 4.4 | 10.0 | 86.6 | O K |
| 240 min Summer | 99.040 | 1.040 | 0.0 | 5.6 | 4.2 | 9.8 | 84.0 | O K |
| 360 min Summer | 98.972 | 0.972 | 0.0 | 5.4 | 3.7 | 9.1 | 78.5 | O K |
| 480 min Summer | 98.913 | 0.913 | 0.0 | 5.2 | 3.2 | 8.5 | 73.7 | O K |
| 600 min Summer | 98.863 | 0.863 | 0.0 | 5.1 | 2.7 | 7.8 | 69.7 | O K |
| 720 min Summer | 98.822 | 0.822 | 0.0 | 5.0 | 2.3 | 7.3 | 66.4 | O K |
| 960 min Summer | 98.760 | 0.760 | 0.0 | 4.8 | 1.0 | 5.8 | 61.4 | O K |
| 1440 min Summer | 98.601 | 0.601 | 0.0 | 4.6 | 0.0 | 4.6 | 48.5 | O K |
| 2160 min Summer | 98.327 | 0.327 | 0.0 | 4.6 | 0.0 | 4.6 | 26.4 | O K |
| 2880 min Summer | 98.183 | 0.183 | 0.0 | 4.6 | 0.0 | 4.6 | 14.8 | O K |
| 4320 min Summer | 98.108 | 0.108 | 0.0 | 3.9 | 0.0 | 3.9 | 8.7 | O K |
| 5760 min Summer | 98.088 | 0.088 | 0.0 | 3.1 | 0.0 | 3.1 | 7.1 | O K |
| 7200 min Summer | 98.078 | 0.078 | 0.0 | 2.6 | 0.0 | 2.6 | 6.3 | O K |
| 8640 min Summer | 98.070 | 0.070 | 0.0 | 2.2 | 0.0 | 2.2 | 5.7 | O K |
| 10080 min Summer | 98.065 | 0.065 | 0.0 | 2.0 | 0.0 | 2.0 | 5.3 | O K |
| 15 min Winter | 98.903 | 0.903 | 0.0 | 5.2 | 3.1 | 8.3 | 72.9 | O K |
| 30 min Winter | 99.098 | 1.098 | 0.0 | 5.7 | 4.6 | 10.3 | 88.7 | O K |
| 60 min Winter | 99.218 | 1.218 | 0.0 | 6.0 | 5.2 | 11.2 | 98.4 | O K |
| 120 min Winter | 99.237 | 1.237 | 0.0 | 6.0 | 5.3 | 11.4 | 99.9 | O K |
| 180 min Winter | 99.206 | 1.206 | 0.0 | 6.0 | 5.2 | 11.1 | 97.4 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 87.227 | 0.0 | 69.4 | 1.9 | 18 |
| 30 min Summer | 55.777 | 0.0 | 88.7 | 8.8 | 32 |
| 60 min Summer | 34.065 | 0.0 | 108.5 | 16.2 | 60 |
| 120 min Summer | 20.201 | 0.0 | 128.7 | 22.4 | 90 |
| 180 min Summer | 14.736 | 0.0 | 140.8 | 24.7 | 124 |
| 240 min Summer | 11.736 | 0.0 | 149.6 | 25.1 | 158 |
| 360 min Summer | 8.483 | 0.0 | 162.2 | 22.0 | 228 |
| 480 min Summer | 6.739 | 0.0 | 171.8 | 18.1 | 296 |
| 600 min Summer | 5.634 | 0.0 | 179.5 | 14.5 | 362 |
| 720 min Summer | 4.865 | 0.0 | 186.0 | 10.9 | 432 |
| 960 min Summer | 3.858 | 0.0 | 196.7 | 3.7 | 570 |
| 1440 min Summer | 2.780 | 0.0 | 212.5 | 0.0 | 852 |
| 2160 min Summer | 2.001 | 0.0 | 229.5 | 0.0 | 1192 |
| 2880 min Summer | 1.584 | 0.0 | 242.2 | 0.0 | 1524 |
| 4320 min Summer | 1.138 | 0.0 | 261.1 | 0.0 | 2204 |
| 5760 min Summer | 0.900 | 0.0 | 275.3 | 0.0 | 2936 |
| 7200 min Summer | 0.750 | 0.0 | 286.8 | 0.0 | 3672 |
| 8640 min Summer | 0.646 | 0.0 | 296.4 | 0.0 | 4400 |
| 10080 min Summer | 0.569 | 0.0 | 304.7 | 0.0 | 5072 |
| 15 min Winter | 87.227 | 0.0 | 77.7 | 5.0 | 18 |
| 30 min Winter | 55.777 | 0.0 | 99.4 | 13.7 | 31 |
| 60 min Winter | 34.065 | 0.0 | 121.5 | 22.5 | 58 |
| 120 min Winter | 20.201 | 0.0 | 144.2 | 30.2 | 94 |
| 180 min Winter | 14.736 | 0.0 | 157.7 | 33.3 | 132 |

## Summary of Results for 30 year Return Period (+10%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.157 | 1.157 | 0.0 | 5.8 | 4.9 | 10.8 | 93.4 | O K |
| 360 min Winter | 99.055 | 1.055 | 0.0 | 5.6 | 4.3 | 9.9 | 85.2 | O K |
| 480 min Winter | 98.970 | 0.970 | 0.0 | 5.4 | 3.7 | 9.1 | 78.3 | O K |
| 600 min Winter | 98.900 | 0.900 | 0.0 | 5.2 | 3.1 | 8.3 | 72.7 | O K |
| 720 min Winter | 98.844 | 0.844 | 0.0 | 5.1 | 2.5 | 7.6 | 68.2 | O K |
| 960 min Winter | 98.765 | 0.765 | 0.0 | 4.8 | 1.2 | 6.0 | 61.8 | O K |
| 1440 min Winter | 98.529 | 0.529 | 0.0 | 4.6 | 0.0 | 4.6 | 42.7 | O K |
| 2160 min Winter | 98.171 | 0.171 | 0.0 | 4.6 | 0.0 | 4.6 | 13.8 | O K |
| 2880 min Winter | 98.109 | 0.109 | 0.0 | 3.9 | 0.0 | 3.9 | 8.8 | O K |
| 4320 min Winter | 98.083 | 0.083 | 0.0 | 2.9 | 0.0 | 2.9 | 6.7 | O K |
| 5760 min Winter | 98.071 | 0.071 | 0.0 | 2.3 | 0.0 | 2.3 | 5.7 | O K |
| 7200 min Winter | 98.063 | 0.063 | 0.0 | 1.9 | 0.0 | 1.9 | 5.1 | O K |
| 8640 min Winter | 98.058 | 0.058 | 0.0 | 1.6 | 0.0 | 1.6 | 4.7 | O K |
| 10080 min Winter | 98.054 | 0.054 | 0.0 | 1.4 | 0.0 | 1.4 | 4.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 11.736 | 0.0 | 167.5 | 34.3 | 170 |
| 360 min Winter | 8.483 | 0.0 | 181.6 | 32.8 | 242 |
| 480 min Winter | 6.739 | 0.0 | 192.4 | 27.6 | 314 |
| 600 min Winter | 5.634 | 0.0 | 201.0 | 22.4 | 382 |
| 720 min Winter | 4.865 | 0.0 | 208.3 | 17.0 | 454 |
| 960 min Winter | 3.858 | 0.0 | 220.3 | 5.7 | 604 |
| 1440 min Winter | 2.780 | 0.0 | 238.0 | 0.0 | 922 |
| 2160 min Winter | 2.001 | 0.0 | 257.1 | 0.0 | 1188 |
| 2880 min Winter | 1.584 | 0.0 | 271.3 | 0.0 | 1472 |
| 4320 min Winter | 1.138 | 0.0 | 292.4 | 0.0 | 2188 |
| 5760 min Winter | 0.900 | 0.0 | 308.4 | 0.0 | 2904 |
| 7200 min Winter | 0.750 | 0.0 | 321.2 | 0.0 | 3584 |
| 8640 min Winter | 0.646 | 0.0 | 332.0 | 0.0 | 4400 |
| 10080 min Winter | 0.569 | 0.0 | 341.3 | 0.0 | 5128 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 30 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +10 |

## Time Area Diagram

Total Area (ha) 0.425

| Time (mins) From: | To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.425 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area ($m^2$) | Inf. Area ($m^2$) | Depth (m) | Area ($m^2$) | Inf. Area ($m^2$) |
|---|---|---|---|---|---|
| 0.000 | 85.0 | 0.0 | 2.000 | 85.0 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0106-4700-0700-4700 |
| Design Head (m) | 0.700 |
| Design Flow (l/s) | 4.7 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 106 |
| Invert Level (m) | 98.000 |
| 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) | 0.700 | 4.6 | Kick-Flo® | 0.477 | 3.9 |
| Flush-Flo™ | 0.211 | 4.6 | Mean Flow over Head Range | - | 4.0 |

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 | 3.6 | 0.800 | 4.9 | 2.000 | 7.6 | 4.000 | 10.5 | 7.000 | 13.7 |
| 0.200 | 4.6 | 1.000 | 5.5 | 2.200 | 7.9 | 4.500 | 11.1 | 7.500 | 14.1 |
| 0.300 | 4.5 | 1.200 | 6.0 | 2.400 | 8.2 | 5.000 | 11.7 | 8.000 | 14.6 |
| 0.400 | 4.3 | 1.400 | 6.4 | 2.600 | 8.6 | 5.500 | 12.2 | 8.500 | 15.1 |
| 0.500 | 4.0 | 1.600 | 6.8 | 3.000 | 9.2 | 6.000 | 12.7 | 9.000 | 15.5 |
| 0.600 | 4.3 | 1.800 | 7.2 | 3.500 | 9.8 | 6.500 | 13.2 | 9.500 | 15.9 |

## Orifice Overflow Control

Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 98.700

## Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 228 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 99.238 | 1.238 | 0.0 | 6.0 | 5.4 | 11.4 | 99.9 | O K |
| 30 min Summer | 99.520 | 1.520 | 0.0 | 6.6 | 6.7 | 13.3 | 122.8 | O K |
| 60 min Summer | 99.702 | 1.702 | 0.0 | 7.0 | 7.4 | 14.4 | 137.4 | Flood Risk |
| 120 min Summer | 99.749 | 1.749 | 0.0 | 7.1 | 7.6 | 14.7 | 141.2 | Flood Risk |
| 180 min Summer | 99.727 | 1.727 | 0.0 | 7.1 | 7.5 | 14.6 | 139.5 | Flood Risk |
| 240 min Summer | 99.678 | 1.678 | 0.0 | 7.0 | 7.3 | 14.3 | 135.5 | O K |
| 360 min Summer | 99.558 | 1.558 | 0.0 | 6.7 | 6.8 | 13.6 | 125.8 | O K |
| 480 min Summer | 99.451 | 1.451 | 0.0 | 6.5 | 6.4 | 12.9 | 117.2 | O K |
| 600 min Summer | 99.358 | 1.358 | 0.0 | 6.3 | 6.0 | 12.3 | 109.7 | O K |
| 720 min Summer | 99.278 | 1.278 | 0.0 | 6.1 | 5.6 | 11.7 | 103.2 | O K |
| 960 min Summer | 99.146 | 1.146 | 0.0 | 5.8 | 4.8 | 10.7 | 92.5 | O K |
| 1440 min Summer | 98.962 | 0.962 | 0.0 | 5.4 | 3.6 | 9.0 | 77.7 | O K |
| 2160 min Summer | 98.802 | 0.802 | 0.0 | 4.9 | 2.0 | 6.9 | 64.8 | O K |
| 2880 min Summer | 98.693 | 0.693 | 0.0 | 4.6 | 0.0 | 4.6 | 56.0 | O K |
| 4320 min Summer | 98.277 | 0.277 | 0.0 | 4.6 | 0.0 | 4.6 | 22.4 | O K |
| 5760 min Summer | 98.133 | 0.133 | 0.0 | 4.5 | 0.0 | 4.5 | 10.7 | O K |
| 7200 min Summer | 98.106 | 0.106 | 0.0 | 3.8 | 0.0 | 3.8 | 8.5 | O K |
| 8640 min Summer | 98.092 | 0.092 | 0.0 | 3.3 | 0.0 | 3.3 | 7.4 | O K |
| 10080 min Summer | 98.083 | 0.083 | 0.0 | 2.9 | 0.0 | 2.9 | 6.7 | O K |
| 15 min Winter | 99.390 | 1.390 | 0.0 | 6.4 | 6.1 | 12.5 | 112.2 | O K |
| 30 min Winter | 99.715 | 1.715 | 0.0 | 7.0 | 7.5 | 14.5 | 138.5 | Flood Risk |
| 60 min Winter | 99.934 | 1.934 | 0.0 | 7.4 | 8.2 | 15.7 | 156.2 | Flood Risk |
| 120 min Winter | 99.982 | 1.982 | 0.0 | 7.5 | 8.4 | 15.9 | 160.0 | Flood Risk |
| 180 min Winter | 99.942 | 1.942 | 0.0 | 7.5 | 8.3 | 15.7 | 156.9 | Flood Risk |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 133.985 | 0.0 | 106.6 | 18.0 | 18 |
| 30 min Summer | 86.337 | 0.0 | 137.4 | 32.5 | 32 |
| 60 min Summer | 52.933 | 0.0 | 168.7 | 46.8 | 60 |
| 120 min Summer | 31.380 | 0.0 | 200.0 | 59.8 | 92 |
| 180 min Summer | 22.833 | 0.0 | 218.3 | 65.7 | 126 |
| 240 min Summer | 18.130 | 0.0 | 231.1 | 68.6 | 160 |
| 360 min Summer | 13.031 | 0.0 | 249.1 | 70.2 | 228 |
| 480 min Summer | 10.316 | 0.0 | 263.0 | 69.0 | 296 |
| 600 min Summer | 8.601 | 0.0 | 274.1 | 64.4 | 362 |
| 720 min Summer | 7.410 | 0.0 | 283.4 | 60.1 | 426 |
| 960 min Summer | 5.854 | 0.0 | 298.5 | 52.4 | 556 |
| 1440 min Summer | 4.194 | 0.0 | 320.7 | 37.8 | 808 |
| 2160 min Summer | 3.001 | 0.0 | 344.3 | 16.0 | 1192 |
| 2880 min Summer | 2.364 | 0.0 | 361.7 | 0.0 | 1644 |
| 4320 min Summer | 1.688 | 0.0 | 387.2 | 0.0 | 2296 |
| 5760 min Summer | 1.328 | 0.0 | 406.3 | 0.0 | 2936 |
| 7200 min Summer | 1.102 | 0.0 | 421.5 | 0.0 | 3672 |
| 8640 min Summer | 0.946 | 0.0 | 434.1 | 0.0 | 4360 |
| 10080 min Summer | 0.831 | 0.0 | 445.0 | 0.0 | 5136 |
| 15 min Winter | 133.985 | 0.0 | 119.4 | 24.2 | 18 |
| 30 min Winter | 86.337 | 0.0 | 153.9 | 41.1 | 32 |
| 60 min Winter | 52.933 | 0.0 | 188.9 | 57.8 | 60 |
| 120 min Winter | 31.380 | 0.0 | 224.0 | 73.2 | 96 |
| 180 min Winter | 22.833 | 0.0 | 244.5 | 80.6 | 134 |

## Summary of Results for 100 year Return Period (+30%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.868 | 1.868 | 0.0 | 7.3 | 8.0 | 15.3 | 150.8 | Flood Risk |
| 360 min Winter | 99.697 | 1.697 | 0.0 | 7.0 | 7.4 | 14.4 | 137.0 | O K |
| 480 min Winter | 99.544 | 1.544 | 0.0 | 6.7 | 6.8 | 13.5 | 124.7 | O K |
| 600 min Winter | 99.414 | 1.414 | 0.0 | 6.4 | 6.2 | 12.6 | 114.2 | O K |
| 720 min Winter | 99.305 | 1.305 | 0.0 | 6.2 | 5.7 | 11.9 | 105.4 | O K |
| 960 min Winter | 99.134 | 1.134 | 0.0 | 5.8 | 4.8 | 10.6 | 91.6 | O K |
| 1440 min Winter | 98.918 | 0.918 | 0.0 | 5.3 | 3.3 | 8.5 | 74.1 | O K |
| 2160 min Winter | 98.765 | 0.765 | 0.0 | 4.8 | 1.2 | 6.0 | 61.7 | O K |
| 2880 min Winter | 98.505 | 0.505 | 0.0 | 4.6 | 0.0 | 4.6 | 40.8 | O K |
| 4320 min Winter | 98.117 | 0.117 | 0.0 | 4.2 | 0.0 | 4.2 | 9.5 | O K |
| 5760 min Winter | 98.093 | 0.093 | 0.0 | 3.3 | 0.0 | 3.3 | 7.5 | O K |
| 7200 min Winter | 98.081 | 0.081 | 0.0 | 2.8 | 0.0 | 2.8 | 6.5 | O K |
| 8640 min Winter | 98.073 | 0.073 | 0.0 | 2.4 | 0.0 | 2.4 | 5.9 | O K |
| 10080 min Winter | 98.067 | 0.067 | 0.0 | 2.1 | 0.0 | 2.1 | 5.4 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 18.130 | 0.0 | 258.8 | 84.5 | 172 |
| 360 min Winter | 13.031 | 0.0 | 279.1 | 87.4 | 246 |
| 480 min Winter | 10.316 | 0.0 | 294.6 | 87.2 | 314 |
| 600 min Winter | 8.601 | 0.0 | 307.0 | 84.3 | 384 |
| 720 min Winter | 7.410 | 0.0 | 317.4 | 78.4 | 448 |
| 960 min Winter | 5.854 | 0.0 | 334.3 | 67.3 | 578 |
| 1440 min Winter | 4.194 | 0.0 | 359.2 | 44.5 | 836 |
| 2160 min Winter | 3.001 | 0.0 | 385.6 | 9.8 | 1256 |
| 2880 min Winter | 2.364 | 0.0 | 405.1 | 0.0 | 1760 |
| 4320 min Winter | 1.688 | 0.0 | 433.7 | 0.0 | 2204 |
| 5760 min Winter | 1.328 | 0.0 | 455.0 | 0.0 | 2928 |
| 7200 min Winter | 1.102 | 0.0 | 472.0 | 0.0 | 3672 |
| 8640 min Winter | 0.946 | 0.0 | 486.2 | 0.0 | 4400 |
| 10080 min Winter | 0.831 | 0.0 | 498.4 | 0.0 | 4976 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +30 |

## Time Area Diagram

Total Area (ha) 0.425

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 0.425 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 85.0 | 0.0 | 2.000 | 85.0 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0106-4700-0700-4700 |
| Design Head (m) | 0.700 |
| Design Flow (l/s) | 4.7 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 106 |
| Invert Level (m) | 98.000 |
| 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) | 0.700 | 4.6 | Kick-Flo® | 0.477 | 3.9 |
| Flush-Flo™ | 0.211 | 4.6 | Mean Flow over Head Range | - | 4.0 |

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 | 3.6 | 0.800 | 4.9 | 2.000 | 7.6 | 4.000 | 10.5 | 7.000 | 13.7 |
| 0.200 | 4.6 | 1.000 | 5.5 | 2.200 | 7.9 | 4.500 | 11.1 | 7.500 | 14.1 |
| 0.300 | 4.5 | 1.200 | 6.0 | 2.400 | 8.2 | 5.000 | 11.7 | 8.000 | 14.6 |
| 0.400 | 4.3 | 1.400 | 6.4 | 2.600 | 8.6 | 5.500 | 12.2 | 8.500 | 15.1 |
| 0.500 | 4.0 | 1.600 | 6.8 | 3.000 | 9.2 | 6.000 | 12.7 | 9.000 | 15.5 |
| 0.600 | 4.3 | 1.800 | 7.2 | 3.500 | 9.8 | 6.500 | 13.2 | 9.500 | 15.9 |

## Orifice Overflow Control

Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 98.700

## Summary of Results for 2 year Return Period

Half Drain Time : 189 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 98.331 | 0.331 | 0.0 | 10.0 | 0.0 | 10.0 | 121.8 | O K |
| 30 min Summer | 98.411 | 0.411 | 0.0 | 10.0 | 0.0 | 10.0 | 151.4 | O K |
| 60 min Summer | 98.481 | 0.481 | 0.0 | 10.0 | 0.0 | 10.0 | 177.1 | O K |
| 120 min Summer | 98.526 | 0.526 | 0.0 | 10.0 | 0.0 | 10.0 | 193.5 | O K |
| 180 min Summer | 98.531 | 0.531 | 0.0 | 10.0 | 0.0 | 10.0 | 195.3 | O K |
| 240 min Summer | 98.528 | 0.528 | 0.0 | 10.0 | 0.0 | 10.0 | 194.5 | O K |
| 360 min Summer | 98.515 | 0.515 | 0.0 | 10.0 | 0.0 | 10.0 | 189.4 | O K |
| 480 min Summer | 98.493 | 0.493 | 0.0 | 10.0 | 0.0 | 10.0 | 181.5 | O K |
| 600 min Summer | 98.467 | 0.467 | 0.0 | 10.0 | 0.0 | 10.0 | 171.8 | O K |
| 720 min Summer | 98.440 | 0.440 | 0.0 | 10.0 | 0.0 | 10.0 | 161.9 | O K |
| 960 min Summer | 98.389 | 0.389 | 0.0 | 10.0 | 0.0 | 10.0 | 143.0 | O K |
| 1440 min Summer | 98.300 | 0.300 | 0.0 | 10.0 | 0.0 | 10.0 | 110.6 | O K |
| 2160 min Summer | 98.210 | 0.210 | 0.0 | 10.0 | 0.0 | 10.0 | 77.3 | O K |
| 2880 min Summer | 98.162 | 0.162 | 0.0 | 9.8 | 0.0 | 9.8 | 59.6 | O K |
| 4320 min Summer | 98.128 | 0.128 | 0.0 | 7.7 | 0.0 | 7.7 | 47.3 | O K |
| 5760 min Summer | 98.111 | 0.111 | 0.0 | 6.4 | 0.0 | 6.4 | 41.0 | O K |
| 7200 min Summer | 98.100 | 0.100 | 0.0 | 5.4 | 0.0 | 5.4 | 36.9 | O K |
| 8640 min Summer | 98.092 | 0.092 | 0.0 | 4.8 | 0.0 | 4.8 | 33.9 | O K |
| 10080 min Summer | 98.086 | 0.086 | 0.0 | 4.2 | 0.0 | 4.2 | 31.6 | O K |
| 15 min Winter | 98.372 | 0.372 | 0.0 | 10.0 | 0.0 | 10.0 | 137.0 | O K |
| 30 min Winter | 98.464 | 0.464 | 0.0 | 10.0 | 0.0 | 10.0 | 170.9 | O K |
| 60 min Winter | 98.544 | 0.544 | 0.0 | 10.0 | 0.0 | 10.0 | 200.3 | O K |
| 120 min Winter | 98.597 | 0.597 | 0.0 | 10.0 | 0.0 | 10.0 | 219.9 | O K |
| 180 min Winter | 98.606 | 0.606 | 0.0 | 10.0 | 0.0 | 10.0 | 223.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 41.734 | 0.0 | 125.9 | 0.0 | 18 |
| 30 min Summer | 26.594 | 0.0 | 161.0 | 0.0 | 33 |
| 60 min Summer | 16.285 | 0.0 | 199.1 | 0.0 | 62 |
| 120 min Summer | 9.752 | 0.0 | 238.6 | 0.0 | 120 |
| 180 min Summer | 7.183 | 0.0 | 263.8 | 0.0 | 164 |
| 240 min Summer | 5.773 | 0.0 | 282.7 | 0.0 | 192 |
| 360 min Summer | 4.234 | 0.0 | 311.1 | 0.0 | 258 |
| 480 min Summer | 3.389 | 0.0 | 332.1 | 0.0 | 328 |
| 600 min Summer | 2.851 | 0.0 | 349.3 | 0.0 | 394 |
| 720 min Summer | 2.475 | 0.0 | 363.9 | 0.0 | 460 |
| 960 min Summer | 1.980 | 0.0 | 388.1 | 0.0 | 588 |
| 1440 min Summer | 1.445 | 0.0 | 424.6 | 0.0 | 836 |
| 2160 min Summer | 1.055 | 0.0 | 466.3 | 0.0 | 1172 |
| 2880 min Summer | 0.844 | 0.0 | 497.1 | 0.0 | 1500 |
| 4320 min Summer | 0.616 | 0.0 | 543.4 | 0.0 | 2208 |
| 5760 min Summer | 0.492 | 0.0 | 580.7 | 0.0 | 2936 |
| 7200 min Summer | 0.414 | 0.0 | 610.1 | 0.0 | 3672 |
| 8640 min Summer | 0.359 | 0.0 | 635.1 | 0.0 | 4408 |
| 10080 min Summer | 0.319 | 0.0 | 656.6 | 0.0 | 5136 |
| 15 min Winter | 41.734 | 0.0 | 141.3 | 0.0 | 18 |
| 30 min Winter | 26.594 | 0.0 | 180.6 | 0.0 | 32 |
| 60 min Winter | 16.285 | 0.0 | 223.1 | 0.0 | 62 |
| 120 min Winter | 9.752 | 0.0 | 267.4 | 0.0 | 118 |
| 180 min Winter | 7.183 | 0.0 | 295.5 | 0.0 | 172 |

## Summary of Results for 2 year Return Period

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 98.599 | 0.599 | 0.0 | 10.0 | 0.0 | 10.0 | 220.6 | O K |
| 360 min Winter | 98.579 | 0.579 | 0.0 | 10.0 | 0.0 | 10.0 | 213.3 | O K |
| 480 min Winter | 98.549 | 0.549 | 0.0 | 10.0 | 0.0 | 10.0 | 202.0 | O K |
| 600 min Winter | 98.513 | 0.513 | 0.0 | 10.0 | 0.0 | 10.0 | 188.9 | O K |
| 720 min Winter | 98.472 | 0.472 | 0.0 | 10.0 | 0.0 | 10.0 | 173.6 | O K |
| 960 min Winter | 98.389 | 0.389 | 0.0 | 10.0 | 0.0 | 10.0 | 143.0 | O K |
| 1440 min Winter | 98.257 | 0.257 | 0.0 | 10.0 | 0.0 | 10.0 | 94.6 | O K |
| 2160 min Winter | 98.157 | 0.157 | 0.0 | 9.6 | 0.0 | 9.6 | 57.8 | O K |
| 2880 min Winter | 98.131 | 0.131 | 0.0 | 7.9 | 0.0 | 7.9 | 48.1 | O K |
| 4320 min Winter | 98.105 | 0.105 | 0.0 | 5.9 | 0.0 | 5.9 | 38.8 | O K |
| 5760 min Winter | 98.092 | 0.092 | 0.0 | 4.7 | 0.0 | 4.7 | 33.8 | O K |
| 7200 min Winter | 98.083 | 0.083 | 0.0 | 4.0 | 0.0 | 4.0 | 30.5 | O K |
| 8640 min Winter | 98.076 | 0.076 | 0.0 | 3.5 | 0.0 | 3.5 | 28.2 | O K |
| 10080 min Winter | 98.071 | 0.071 | 0.0 | 3.1 | 0.0 | 3.1 | 26.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 5.773 | 0.0 | 316.8 | 0.0 | 220 |
| 360 min Winter | 4.234 | 0.0 | 348.6 | 0.0 | 276 |
| 480 min Winter | 3.389 | 0.0 | 372.1 | 0.0 | 354 |
| 600 min Winter | 2.851 | 0.0 | 391.3 | 0.0 | 430 |
| 720 min Winter | 2.475 | 0.0 | 407.7 | 0.0 | 504 |
| 960 min Winter | 1.980 | 0.0 | 434.8 | 0.0 | 634 |
| 1440 min Winter | 1.445 | 0.0 | 475.8 | 0.0 | 866 |
| 2160 min Winter | 1.055 | 0.0 | 522.3 | 0.0 | 1164 |
| 2880 min Winter | 0.844 | 0.0 | 556.9 | 0.0 | 1504 |
| 4320 min Winter | 0.616 | 0.0 | 608.9 | 0.0 | 2244 |
| 5760 min Winter | 0.492 | 0.0 | 650.4 | 0.0 | 2944 |
| 7200 min Winter | 0.414 | 0.0 | 683.4 | 0.0 | 3680 |
| 8640 min Winter | 0.359 | 0.0 | 711.5 | 0.0 | 4408 |
| 10080 min Winter | 0.319 | 0.0 | 735.8 | 0.0 | 5144 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +0 |

## Time Area Diagram

Total Area (ha) 1.640

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 1.640 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 387.5 | 0.0 | 2.000 | 387.5 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0151-1010-0650-1010 |
| Design Head (m) | 0.650 |
| Design Flow (l/s) | 10.1 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 151 |
| Invert Level (m) | 98.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.650 | 10.1 | Kick-Flo® | 0.483 | 8.7 |
| Flush-Flo™ | 0.239 | 10.0 | Mean Flow over Head Range | - | 8.3 |

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 | 5.4 | 0.800 | 11.1 | 2.000 | 17.1 | 4.000 | 23.8 | 7.000 | 31.1 |
| 0.200 | 10.0 | 1.000 | 12.3 | 2.200 | 17.9 | 4.500 | 25.2 | 7.500 | 32.2 |
| 0.300 | 10.0 | 1.200 | 13.4 | 2.400 | 18.7 | 5.000 | 26.6 | 8.000 | 33.3 |
| 0.400 | 9.6 | 1.400 | 14.4 | 2.600 | 19.4 | 5.500 | 27.8 | 8.500 | 34.3 |
| 0.500 | 8.9 | 1.600 | 15.4 | 3.000 | 20.8 | 6.000 | 29.0 | 9.000 | 35.3 |
| 0.600 | 9.7 | 1.800 | 16.3 | 3.500 | 22.4 | 6.500 | 30.1 | 9.500 | 36.3 |

## Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.650

## Summary of Results for 30 year Return Period (+10%)

Half Drain Time : 330 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 98.707 | 0.707 | 0.0 | 10.5 | 1.4 | 11.9 | 260.1 | O K |
| 30 min Summer | 98.877 | 0.877 | 0.0 | 11.6 | 7.2 | 18.8 | 323.0 | O K |
| 60 min Summer | 99.014 | 1.014 | 0.0 | 12.4 | 9.5 | 21.9 | 373.2 | O K |
| 120 min Summer | 99.082 | 1.082 | 0.0 | 12.8 | 10.5 | 23.3 | 398.1 | O K |
| 180 min Summer | 99.089 | 1.089 | 0.0 | 12.8 | 10.6 | 23.4 | 400.8 | O K |
| 240 min Summer | 99.085 | 1.085 | 0.0 | 12.8 | 10.6 | 23.4 | 399.3 | O K |
| 360 min Summer | 99.060 | 1.060 | 0.0 | 12.7 | 10.2 | 22.9 | 390.1 | O K |
| 480 min Summer | 99.027 | 1.027 | 0.0 | 12.5 | 9.7 | 22.2 | 378.2 | O K |
| 600 min Summer | 98.994 | 0.994 | 0.0 | 12.3 | 9.2 | 21.5 | 365.7 | O K |
| 720 min Summer | 98.960 | 0.960 | 0.0 | 12.1 | 8.7 | 20.8 | 353.5 | O K |
| 960 min Summer | 98.900 | 0.900 | 0.0 | 11.7 | 7.7 | 19.4 | 331.4 | O K |
| 1440 min Summer | 98.807 | 0.807 | 0.0 | 11.1 | 5.7 | 16.8 | 297.2 | O K |
| 2160 min Summer | 98.717 | 0.717 | 0.0 | 10.5 | 1.8 | 12.3 | 263.9 | O K |
| 2880 min Summer | 98.608 | 0.608 | 0.0 | 10.0 | 0.0 | 10.0 | 223.8 | O K |
| 4320 min Summer | 98.355 | 0.355 | 0.0 | 10.0 | 0.0 | 10.0 | 130.5 | O K |
| 5760 min Summer | 98.213 | 0.213 | 0.0 | 10.0 | 0.0 | 10.0 | 78.5 | O K |
| 7200 min Summer | 98.158 | 0.158 | 0.0 | 9.7 | 0.0 | 9.7 | 58.1 | O K |
| 8640 min Summer | 98.139 | 0.139 | 0.0 | 8.5 | 0.0 | 8.5 | 51.1 | O K |
| 10080 min Summer | 98.126 | 0.126 | 0.0 | 7.6 | 0.0 | 7.6 | 46.2 | O K |
| 15 min Winter | 98.790 | 0.790 | 0.0 | 11.0 | 5.2 | 16.2 | 291.0 | O K |
| 30 min Winter | 98.984 | 0.984 | 0.0 | 12.2 | 9.1 | 21.3 | 362.2 | O K |
| 60 min Winter | 99.142 | 1.142 | 0.0 | 13.1 | 11.3 | 24.4 | 420.3 | O K |
| 120 min Winter | 99.229 | 1.229 | 0.0 | 13.6 | 12.4 | 25.9 | 452.6 | O K |
| 180 min Winter | 99.232 | 1.232 | 0.0 | 13.6 | 12.4 | 26.0 | 453.4 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 87.227 | 0.0 | 265.3 | 1.2 | 19 |
| 30 min Summer | 55.777 | 0.0 | 339.8 | 24.1 | 33 |
| 60 min Summer | 34.065 | 0.0 | 417.7 | 54.0 | 62 |
| 120 min Summer | 20.201 | 0.0 | 495.6 | 84.0 | 118 |
| 180 min Summer | 14.736 | 0.0 | 542.3 | 99.7 | 144 |
| 240 min Summer | 11.736 | 0.0 | 576.0 | 109.0 | 176 |
| 360 min Summer | 8.483 | 0.0 | 624.6 | 118.1 | 244 |
| 480 min Summer | 6.739 | 0.0 | 661.5 | 120.7 | 314 |
| 600 min Summer | 5.634 | 0.0 | 691.3 | 117.3 | 382 |
| 720 min Summer | 4.865 | 0.0 | 716.4 | 109.1 | 450 |
| 960 min Summer | 3.858 | 0.0 | 757.3 | 92.0 | 586 |
| 1440 min Summer | 2.780 | 0.0 | 818.2 | 60.2 | 852 |
| 2160 min Summer | 2.001 | 0.0 | 885.0 | 14.7 | 1276 |
| 2880 min Summer | 1.584 | 0.0 | 933.9 | 0.0 | 1700 |
| 4320 min Summer | 1.138 | 0.0 | 1006.0 | 0.0 | 2380 |
| 5760 min Summer | 0.900 | 0.0 | 1062.1 | 0.0 | 3048 |
| 7200 min Summer | 0.750 | 0.0 | 1106.1 | 0.0 | 3672 |
| 8640 min Summer | 0.646 | 0.0 | 1143.0 | 0.0 | 4408 |
| 10080 min Summer | 0.569 | 0.0 | 1174.5 | 0.0 | 5136 |
| 15 min Winter | 87.227 | 0.0 | 297.4 | 9.4 | 18 |
| 30 min Winter | 55.777 | 0.0 | 380.9 | 41.5 | 32 |
| 60 min Winter | 34.065 | 0.0 | 467.9 | 77.4 | 60 |
| 120 min Winter | 20.201 | 0.0 | 555.2 | 113.1 | 116 |
| 180 min Winter | 14.736 | 0.0 | 607.6 | 132.2 | 148 |

## Summary of Results for 30 year Return Period (+10%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume ($m^3$) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.225 | 1.225 | 0.0 | 13.6 | 12.3 | 25.9 | 450.9 | O K |
| 360 min Winter | 99.185 | 1.185 | 0.0 | 13.3 | 11.8 | 25.2 | 436.2 | O K |
| 480 min Winter | 99.136 | 1.136 | 0.0 | 13.1 | 11.2 | 24.3 | 418.1 | O K |
| 600 min Winter | 99.085 | 1.085 | 0.0 | 12.8 | 10.6 | 23.4 | 399.4 | O K |
| 720 min Winter | 99.036 | 1.036 | 0.0 | 12.5 | 9.9 | 22.4 | 381.5 | O K |
| 960 min Winter | 98.951 | 0.951 | 0.0 | 12.0 | 8.6 | 20.6 | 349.9 | O K |
| 1440 min Winter | 98.824 | 0.824 | 0.0 | 11.2 | 6.1 | 17.3 | 303.5 | O K |
| 2160 min Winter | 98.711 | 0.711 | 0.0 | 10.5 | 1.6 | 12.1 | 261.8 | O K |
| 2880 min Winter | 98.543 | 0.543 | 0.0 | 10.0 | 0.0 | 10.0 | 200.0 | O K |
| 4320 min Winter | 98.203 | 0.203 | 0.0 | 10.0 | 0.0 | 10.0 | 74.8 | O K |
| 5760 min Winter | 98.141 | 0.141 | 0.0 | 8.6 | 0.0 | 8.6 | 51.8 | O K |
| 7200 min Winter | 98.121 | 0.121 | 0.0 | 7.2 | 0.0 | 7.2 | 44.7 | O K |
| 8640 min Winter | 98.110 | 0.110 | 0.0 | 6.3 | 0.0 | 6.3 | 40.3 | O K |
| 10080 min Winter | 98.101 | 0.101 | 0.0 | 5.5 | 0.0 | 5.5 | 37.2 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume ($m^3$) | Discharge Volume ($m^3$) | Overflow Volume ($m^3$) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 11.736 | 0.0 | 645.3 | 143.8 | 184 |
| 360 min Winter | 8.483 | 0.0 | 699.7 | 156.1 | 262 |
| 480 min Winter | 6.739 | 0.0 | 741.1 | 161.0 | 336 |
| 600 min Winter | 5.634 | 0.0 | 774.4 | 160.9 | 410 |
| 720 min Winter | 4.865 | 0.0 | 802.5 | 156.2 | 480 |
| 960 min Winter | 3.858 | 0.0 | 848.4 | 134.3 | 618 |
| 1440 min Winter | 2.780 | 0.0 | 916.5 | 87.7 | 894 |
| 2160 min Winter | 2.001 | 0.0 | 991.3 | 15.8 | 1360 |
| 2880 min Winter | 1.584 | 0.0 | 1046.1 | 0.0 | 1816 |
| 4320 min Winter | 1.138 | 0.0 | 1127.0 | 0.0 | 2376 |
| 5760 min Winter | 0.900 | 0.0 | 1189.6 | 0.0 | 2944 |
| 7200 min Winter | 0.750 | 0.0 | 1238.9 | 0.0 | 3672 |
| 8640 min Winter | 0.646 | 0.0 | 1280.3 | 0.0 | 4400 |
| 10080 min Winter | 0.569 | 0.0 | 1315.8 | 0.0 | 5144 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 30 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +10 |

## Time Area Diagram

Total Area (ha) 1.640

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 1.640 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 387.5 | 0.0 | 2.000 | 387.5 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0151-1010-0650-1010 |
| Design Head (m) | 0.650 |
| Design Flow (l/s) | 10.1 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 151 |
| Invert Level (m) | 98.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.650 | 10.1 | Kick-Flo® | 0.483 | 8.7 |
| Flush-Flo™ | 0.239 | 10.0 | Mean Flow over Head Range | - | 8.3 |

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 | 5.4 | 0.800 | 11.1 | 2.000 | 17.1 | 4.000 | 23.8 | 7.000 | 31.1 |
| 0.200 | 10.0 | 1.000 | 12.3 | 2.200 | 17.9 | 4.500 | 25.2 | 7.500 | 32.2 |
| 0.300 | 10.0 | 1.200 | 13.4 | 2.400 | 18.7 | 5.000 | 26.6 | 8.000 | 33.3 |
| 0.400 | 9.6 | 1.400 | 14.4 | 2.600 | 19.4 | 5.500 | 27.8 | 8.500 | 34.3 |
| 0.500 | 8.9 | 1.600 | 15.4 | 3.000 | 20.8 | 6.000 | 29.0 | 9.000 | 35.3 |
| 0.600 | 9.7 | 1.800 | 16.3 | 3.500 | 22.4 | 6.500 | 30.1 | 9.500 | 36.3 |

## Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.650

## Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 423 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 99.081 | 1.081 | 0.0 | 12.8 | 10.5 | 23.3 | 398.1 | O K |
| 30 min Summer | 99.359 | 1.359 | 0.0 | 14.2 | 13.8 | 28.0 | 500.3 | O K |
| 60 min Summer | 99.588 | 1.588 | 0.0 | 15.3 | 16.0 | 31.3 | 584.6 | O K |
| 120 min Summer | 99.715 | 1.715 | 0.0 | 15.9 | 17.1 | 33.0 | 631.5 | Flood Risk |
| 180 min Summer | 99.727 | 1.727 | 0.0 | 16.0 | 17.2 | 33.1 | 635.6 | Flood Risk |
| 240 min Summer | 99.719 | 1.719 | 0.0 | 15.9 | 17.1 | 33.0 | 632.8 | Flood Risk |
| 360 min Summer | 99.678 | 1.678 | 0.0 | 15.7 | 16.8 | 32.5 | 617.7 | O K |
| 480 min Summer | 99.627 | 1.627 | 0.0 | 15.5 | 16.3 | 31.8 | 599.0 | O K |
| 600 min Summer | 99.571 | 1.571 | 0.0 | 15.3 | 15.8 | 31.1 | 578.4 | O K |
| 720 min Summer | 99.514 | 1.514 | 0.0 | 15.0 | 15.3 | 30.3 | 557.5 | O K |
| 960 min Summer | 99.408 | 1.408 | 0.0 | 14.5 | 14.3 | 28.8 | 518.4 | O K |
| 1440 min Summer | 99.235 | 1.235 | 0.0 | 13.6 | 12.4 | 26.0 | 454.8 | O K |
| 2160 min Summer | 99.052 | 1.052 | 0.0 | 12.6 | 10.1 | 22.7 | 387.2 | O K |
| 2880 min Summer | 98.925 | 0.925 | 0.0 | 11.9 | 8.1 | 20.0 | 340.5 | O K |
| 4320 min Summer | 98.773 | 0.773 | 0.0 | 10.9 | 4.6 | 15.5 | 284.5 | O K |
| 5760 min Summer | 98.671 | 0.671 | 0.0 | 10.2 | 0.2 | 10.4 | 247.1 | O K |
| 7200 min Summer | 98.479 | 0.479 | 0.0 | 10.0 | 0.0 | 10.0 | 176.5 | O K |
| 8640 min Summer | 98.292 | 0.292 | 0.0 | 10.0 | 0.0 | 10.0 | 107.7 | O K |
| 10080 min Summer | 98.202 | 0.202 | 0.0 | 10.0 | 0.0 | 10.0 | 74.3 | O K |
| 15 min Winter | 99.213 | 1.213 | 0.0 | 13.5 | 12.2 | 25.7 | 446.5 | O K |
| 30 min Winter | 99.527 | 1.527 | 0.0 | 15.0 | 15.4 | 30.5 | 562.2 | O K |
| 60 min Winter | 99.790 | 1.790 | 0.0 | 16.2 | 17.7 | 33.9 | 659.0 | Flood Risk |
| 120 min Winter | 99.950 | 1.950 | 0.0 | 16.9 | 18.9 | 35.8 | 717.7 | Flood Risk |
| 180 min Winter | 99.961 | 1.961 | 0.0 | 17.0 | 19.0 | 36.0 | 722.1 | Flood Risk |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 133.985 | 0.0 | 408.7 | 55.7 | 18 |
| 30 min Summer | 86.337 | 0.0 | 527.3 | 111.3 | 33 |
| 60 min Summer | 52.933 | 0.0 | 649.7 | 168.8 | 62 |
| 120 min Summer | 31.380 | 0.0 | 770.5 | 224.8 | 120 |
| 180 min Summer | 22.833 | 0.0 | 841.0 | 254.8 | 152 |
| 240 min Summer | 18.130 | 0.0 | 890.4 | 273.4 | 182 |
| 360 min Summer | 13.031 | 0.0 | 960.1 | 294.9 | 248 |
| 480 min Summer | 10.316 | 0.0 | 1013.4 | 307.3 | 316 |
| 600 min Summer | 8.601 | 0.0 | 1056.1 | 313.6 | 386 |
| 720 min Summer | 7.410 | 0.0 | 1091.9 | 315.8 | 454 |
| 960 min Summer | 5.854 | 0.0 | 1150.1 | 310.2 | 588 |
| 1440 min Summer | 4.194 | 0.0 | 1235.4 | 270.9 | 852 |
| 2160 min Summer | 3.001 | 0.0 | 1327.8 | 219.8 | 1232 |
| 2880 min Summer | 2.364 | 0.0 | 1394.8 | 171.6 | 1612 |
| 4320 min Summer | 1.688 | 0.0 | 1492.7 | 75.5 | 2376 |
| 5760 min Summer | 1.328 | 0.0 | 1567.4 | 1.7 | 3240 |
| 7200 min Summer | 1.102 | 0.0 | 1625.8 | 0.0 | 4040 |
| 8640 min Summer | 0.946 | 0.0 | 1674.5 | 0.0 | 4584 |
| 10080 min Summer | 0.831 | 0.0 | 1715.8 | 0.0 | 5240 |
| 15 min Winter | 133.985 | 0.0 | 458.0 | 78.9 | 18 |
| 30 min Winter | 86.337 | 0.0 | 590.9 | 143.4 | 32 |
| 60 min Winter | 52.933 | 0.0 | 727.8 | 209.9 | 60 |
| 120 min Winter | 31.380 | 0.0 | 863.1 | 274.9 | 116 |
| 180 min Winter | 22.833 | 0.0 | 942.1 | 310.2 | 168 |

## Summary of Results for 100 year Return Period (+30%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.943 | 1.943 | 0.0 | 16.9 | 18.9 | 35.8 | 715.4 | Flood Risk |
| 360 min Winter | 99.881 | 1.881 | 0.0 | 16.6 | 18.4 | 35.0 | 692.5 | Flood Risk |
| 480 min Winter | 99.804 | 1.804 | 0.0 | 16.3 | 17.8 | 34.1 | 664.0 | Flood Risk |
| 600 min Winter | 99.721 | 1.721 | 0.0 | 15.9 | 17.1 | 33.1 | 633.5 | Flood Risk |
| 720 min Winter | 99.639 | 1.639 | 0.0 | 15.6 | 16.4 | 32.0 | 603.5 | O K |
| 960 min Winter | 99.490 | 1.490 | 0.0 | 14.9 | 15.1 | 29.9 | 548.4 | O K |
| 1440 min Winter | 99.254 | 1.254 | 0.0 | 13.7 | 12.6 | 26.3 | 461.5 | O K |
| 2160 min Winter | 99.021 | 1.021 | 0.0 | 12.4 | 9.7 | 22.1 | 375.9 | O K |
| 2880 min Winter | 98.877 | 0.877 | 0.0 | 11.6 | 7.2 | 18.8 | 322.8 | O K |
| 4320 min Winter | 98.733 | 0.733 | 0.0 | 10.6 | 2.5 | 13.1 | 269.8 | O K |
| 5760 min Winter | 98.491 | 0.491 | 0.0 | 10.0 | 0.0 | 10.0 | 180.8 | O K |
| 7200 min Winter | 98.202 | 0.202 | 0.0 | 10.0 | 0.0 | 10.0 | 74.5 | O K |
| 8640 min Winter | 98.148 | 0.148 | 0.0 | 9.1 | 0.0 | 9.1 | 54.6 | O K |
| 10080 min Winter | 98.132 | 0.132 | 0.0 | 8.0 | 0.0 | 8.0 | 48.6 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 18.130 | 0.0 | 997.5 | 332.7 | 190 |
| 360 min Winter | 13.031 | 0.0 | 1075.5 | 359.7 | 266 |
| 480 min Winter | 10.316 | 0.0 | 1135.2 | 376.2 | 342 |
| 600 min Winter | 8.601 | 0.0 | 1183.0 | 385.7 | 416 |
| 720 min Winter | 7.410 | 0.0 | 1223.1 | 390.4 | 486 |
| 960 min Winter | 5.854 | 0.0 | 1288.2 | 389.9 | 626 |
| 1440 min Winter | 4.194 | 0.0 | 1383.9 | 350.6 | 894 |
| 2160 min Winter | 3.001 | 0.0 | 1487.2 | 276.6 | 1276 |
| 2880 min Winter | 2.364 | 0.0 | 1562.3 | 199.8 | 1648 |
| 4320 min Winter | 1.688 | 0.0 | 1672.2 | 48.2 | 2508 |
| 5760 min Winter | 1.328 | 0.0 | 1755.6 | 0.0 | 3520 |
| 7200 min Winter | 1.102 | 0.0 | 1821.0 | 0.0 | 3888 |
| 8640 min Winter | 0.946 | 0.0 | 1875.5 | 0.0 | 4408 |
| 10080 min Winter | 0.831 | 0.0 | 1922.1 | 0.0 | 5136 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +30 |

## Time Area Diagram

Total Area (ha) 1.640

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 1.640 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 387.5 | 0.0 | 2.000 | 387.5 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0151-1010-0650-1010 |
| Design Head (m) | 0.650 |
| Design Flow (l/s) | 10.1 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 151 |
| Invert Level (m) | 98.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.650 | 10.1 | Kick-Flo® | 0.483 | 8.7 |
| Flush-Flo™ | 0.239 | 10.0 | Mean Flow over Head Range | - | 8.3 |

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 | 5.4 | 0.800 | 11.1 | 2.000 | 17.1 | 4.000 | 23.8 | 7.000 | 31.1 |
| 0.200 | 10.0 | 1.000 | 12.3 | 2.200 | 17.9 | 4.500 | 25.2 | 7.500 | 32.2 |
| 0.300 | 10.0 | 1.200 | 13.4 | 2.400 | 18.7 | 5.000 | 26.6 | 8.000 | 33.3 |
| 0.400 | 9.6 | 1.400 | 14.4 | 2.600 | 19.4 | 5.500 | 27.8 | 8.500 | 34.3 |
| 0.500 | 8.9 | 1.600 | 15.4 | 3.000 | 20.8 | 6.000 | 29.0 | 9.000 | 35.3 |
| 0.600 | 9.7 | 1.800 | 16.3 | 3.500 | 22.4 | 6.500 | 30.1 | 9.500 | 36.3 |

## Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.650

## Summary of Results for 2 year Return Period

Half Drain Time : 192 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 98.330 | 0.330 | 0.0 | 10.9 | 0.0 | 10.9 | 133.8 | O K |
| 30 min Summer | 98.410 | 0.410 | 0.0 | 10.9 | 0.0 | 10.9 | 166.5 | O K |
| 60 min Summer | 98.480 | 0.480 | 0.0 | 10.9 | 0.0 | 10.9 | 195.0 | O K |
| 120 min Summer | 98.524 | 0.524 | 0.0 | 10.9 | 0.0 | 10.9 | 213.0 | O K |
| 180 min Summer | 98.530 | 0.530 | 0.0 | 10.9 | 0.0 | 10.9 | 215.2 | O K |
| 240 min Summer | 98.528 | 0.528 | 0.0 | 10.9 | 0.0 | 10.9 | 214.6 | O K |
| 360 min Summer | 98.516 | 0.516 | 0.0 | 10.9 | 0.0 | 10.9 | 209.6 | O K |
| 480 min Summer | 98.496 | 0.496 | 0.0 | 10.9 | 0.0 | 10.9 | 201.5 | O K |
| 600 min Summer | 98.473 | 0.473 | 0.0 | 10.9 | 0.0 | 10.9 | 191.9 | O K |
| 720 min Summer | 98.446 | 0.446 | 0.0 | 10.9 | 0.0 | 10.9 | 181.1 | O K |
| 960 min Summer | 98.395 | 0.395 | 0.0 | 10.9 | 0.0 | 10.9 | 160.4 | O K |
| 1440 min Summer | 98.308 | 0.308 | 0.0 | 10.9 | 0.0 | 10.9 | 124.9 | O K |
| 2160 min Summer | 98.217 | 0.217 | 0.0 | 10.8 | 0.0 | 10.8 | 88.1 | O K |
| 2880 min Summer | 98.168 | 0.168 | 0.0 | 10.6 | 0.0 | 10.6 | 68.1 | O K |
| 4320 min Summer | 98.133 | 0.133 | 0.0 | 8.5 | 0.0 | 8.5 | 54.0 | O K |
| 5760 min Summer | 98.115 | 0.115 | 0.0 | 7.0 | 0.0 | 7.0 | 46.8 | O K |
| 7200 min Summer | 98.104 | 0.104 | 0.0 | 5.9 | 0.0 | 5.9 | 42.2 | O K |
| 8640 min Summer | 98.096 | 0.096 | 0.0 | 5.2 | 0.0 | 5.2 | 38.8 | O K |
| 10080 min Summer | 98.089 | 0.089 | 0.0 | 4.7 | 0.0 | 4.7 | 36.2 | O K |
| 15 min Winter | 98.371 | 0.371 | 0.0 | 10.9 | 0.0 | 10.9 | 150.6 | O K |
| 30 min Winter | 98.463 | 0.463 | 0.0 | 10.9 | 0.0 | 10.9 | 187.9 | O K |
| 60 min Winter | 98.542 | 0.542 | 0.0 | 10.9 | 0.0 | 10.9 | 220.1 | O K |
| 120 min Winter | 98.596 | 0.596 | 0.0 | 10.9 | 0.0 | 10.9 | 241.9 | O K |
| 180 min Winter | 98.605 | 0.605 | 0.0 | 10.9 | 0.0 | 10.9 | 245.8 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 41.734 | 0.0 | 138.0 | 0.0 | 18 |
| 30 min Summer | 26.594 | 0.0 | 176.5 | 0.0 | 33 |
| 60 min Summer | 16.285 | 0.0 | 218.4 | 0.0 | 62 |
| 120 min Summer | 9.752 | 0.0 | 261.8 | 0.0 | 120 |
| 180 min Summer | 7.183 | 0.0 | 289.4 | 0.0 | 162 |
| 240 min Summer | 5.773 | 0.0 | 310.2 | 0.0 | 192 |
| 360 min Summer | 4.234 | 0.0 | 341.3 | 0.0 | 258 |
| 480 min Summer | 3.389 | 0.0 | 364.4 | 0.0 | 326 |
| 600 min Summer | 2.851 | 0.0 | 383.2 | 0.0 | 396 |
| 720 min Summer | 2.475 | 0.0 | 399.2 | 0.0 | 462 |
| 960 min Summer | 1.980 | 0.0 | 425.8 | 0.0 | 588 |
| 1440 min Summer | 1.445 | 0.0 | 465.9 | 0.0 | 838 |
| 2160 min Summer | 1.055 | 0.0 | 511.7 | 0.0 | 1188 |
| 2880 min Summer | 0.844 | 0.0 | 545.5 | 0.0 | 1500 |
| 4320 min Summer | 0.616 | 0.0 | 596.2 | 0.0 | 2208 |
| 5760 min Summer | 0.492 | 0.0 | 637.3 | 0.0 | 2944 |
| 7200 min Summer | 0.414 | 0.0 | 669.6 | 0.0 | 3672 |
| 8640 min Summer | 0.359 | 0.0 | 697.0 | 0.0 | 4408 |
| 10080 min Summer | 0.319 | 0.0 | 720.5 | 0.0 | 5136 |
| 15 min Winter | 41.734 | 0.0 | 154.8 | 0.0 | 18 |
| 30 min Winter | 26.594 | 0.0 | 197.9 | 0.0 | 32 |
| 60 min Winter | 16.285 | 0.0 | 244.8 | 0.0 | 62 |
| 120 min Winter | 9.752 | 0.0 | 293.4 | 0.0 | 118 |
| 180 min Winter | 7.183 | 0.0 | 324.3 | 0.0 | 172 |

## Summary of Results for 2 year Return Period

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 98.599 | 0.599 | 0.0 | 10.9 | 0.0 | 10.9 | 243.1 | O K |
| 360 min Winter | 98.580 | 0.580 | 0.0 | 10.9 | 0.0 | 10.9 | 235.7 | O K |
| 480 min Winter | 98.551 | 0.551 | 0.0 | 10.9 | 0.0 | 10.9 | 223.8 | O K |
| 600 min Winter | 98.517 | 0.517 | 0.0 | 10.9 | 0.0 | 10.9 | 210.1 | O K |
| 720 min Winter | 98.480 | 0.480 | 0.0 | 10.9 | 0.0 | 10.9 | 195.0 | O K |
| 960 min Winter | 98.397 | 0.397 | 0.0 | 10.9 | 0.0 | 10.9 | 161.4 | O K |
| 1440 min Winter | 98.266 | 0.266 | 0.0 | 10.9 | 0.0 | 10.9 | 108.0 | O K |
| 2160 min Winter | 98.163 | 0.163 | 0.0 | 10.6 | 0.0 | 10.6 | 66.0 | O K |
| 2880 min Winter | 98.136 | 0.136 | 0.0 | 8.7 | 0.0 | 8.7 | 55.1 | O K |
| 4320 min Winter | 98.109 | 0.109 | 0.0 | 6.4 | 0.0 | 6.4 | 44.4 | O K |
| 5760 min Winter | 98.095 | 0.095 | 0.0 | 5.2 | 0.0 | 5.2 | 38.7 | O K |
| 7200 min Winter | 98.086 | 0.086 | 0.0 | 4.4 | 0.0 | 4.4 | 34.9 | O K |
| 8640 min Winter | 98.079 | 0.079 | 0.0 | 3.8 | 0.0 | 3.8 | 32.2 | O K |
| 10080 min Winter | 98.074 | 0.074 | 0.0 | 3.4 | 0.0 | 3.4 | 30.1 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 5.773 | 0.0 | 347.6 | 0.0 | 218 |
| 360 min Winter | 4.234 | 0.0 | 382.5 | 0.0 | 274 |
| 480 min Winter | 3.389 | 0.0 | 408.3 | 0.0 | 352 |
| 600 min Winter | 2.851 | 0.0 | 429.3 | 0.0 | 428 |
| 720 min Winter | 2.475 | 0.0 | 447.3 | 0.0 | 506 |
| 960 min Winter | 1.980 | 0.0 | 477.1 | 0.0 | 636 |
| 1440 min Winter | 1.445 | 0.0 | 522.1 | 0.0 | 868 |
| 2160 min Winter | 1.055 | 0.0 | 573.2 | 0.0 | 1164 |
| 2880 min Winter | 0.844 | 0.0 | 611.1 | 0.0 | 1504 |
| 4320 min Winter | 0.616 | 0.0 | 668.1 | 0.0 | 2244 |
| 5760 min Winter | 0.492 | 0.0 | 713.9 | 0.0 | 2944 |
| 7200 min Winter | 0.414 | 0.0 | 750.0 | 0.0 | 3672 |
| 8640 min Winter | 0.359 | 0.0 | 780.8 | 0.0 | 4408 |
| 10080 min Winter | 0.319 | 0.0 | 807.4 | 0.0 | 5064 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +0 |

## Time Area Diagram

Total Area (ha) 1.800

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 1.800 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 427.5 | 0.0 | 2.000 | 427.5 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0156-1090-0620-1090 |
| Design Head (m) | 0.620 |
| Design Flow (l/s) | 10.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 156 |
| Invert Level (m) | 98.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.620 | 10.9 | Kick-Flo® | 0.470 | 9.5 |
| Flush-Flo™ | 0.243 | 10.9 | Mean Flow over Head Range | - | 8.9 |

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 | 5.6 | 0.800 | 12.3 | 2.000 | 19.0 | 4.000 | 26.4 | 7.000 | 34.5 |
| 0.200 | 10.8 | 1.000 | 13.6 | 2.200 | 19.8 | 4.500 | 28.0 | 7.500 | 35.7 |
| 0.300 | 10.8 | 1.200 | 14.9 | 2.400 | 20.7 | 5.000 | 29.4 | 8.000 | 36.9 |
| 0.400 | 10.3 | 1.400 | 16.0 | 2.600 | 21.5 | 5.500 | 30.8 | 8.500 | 38.1 |
| 0.500 | 9.8 | 1.600 | 17.0 | 3.000 | 23.0 | 6.000 | 32.1 | 9.000 | 39.2 |
| 0.600 | 10.7 | 1.800 | 18.0 | 3.500 | 24.8 | 6.500 | 33.2 | 9.500 | 40.3 |

## Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.620

## Summary of Results for 30 year Return Period (+10%)

Half Drain Time : 329 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 98.703 | 0.703 | 0.0 | 11.5 | 2.5 | 14.1 | 285.3 | O K |
| 30 min Summer | 98.873 | 0.873 | 0.0 | 12.8 | 7.7 | 20.5 | 354.5 | O K |
| 60 min Summer | 99.010 | 1.010 | 0.0 | 13.7 | 9.9 | 23.6 | 410.2 | O K |
| 120 min Summer | 99.080 | 1.080 | 0.0 | 14.1 | 10.9 | 25.0 | 438.8 | O K |
| 180 min Summer | 99.088 | 1.088 | 0.0 | 14.2 | 11.0 | 25.2 | 441.8 | O K |
| 240 min Summer | 99.084 | 1.084 | 0.0 | 14.2 | 10.9 | 25.1 | 440.2 | O K |
| 360 min Summer | 99.060 | 1.060 | 0.0 | 14.0 | 10.6 | 24.6 | 430.3 | O K |
| 480 min Summer | 99.028 | 1.028 | 0.0 | 13.8 | 10.2 | 24.0 | 417.4 | O K |
| 600 min Summer | 98.994 | 0.994 | 0.0 | 13.6 | 9.7 | 23.3 | 403.6 | O K |
| 720 min Summer | 98.960 | 0.960 | 0.0 | 13.4 | 9.2 | 22.6 | 389.9 | O K |
| 960 min Summer | 98.899 | 0.899 | 0.0 | 13.0 | 8.2 | 21.1 | 365.0 | O K |
| 1440 min Summer | 98.801 | 0.801 | 0.0 | 12.3 | 6.2 | 18.5 | 325.5 | O K |
| 2160 min Summer | 98.707 | 0.707 | 0.0 | 11.6 | 2.7 | 14.3 | 287.1 | O K |
| 2880 min Summer | 98.613 | 0.613 | 0.0 | 10.9 | 0.0 | 10.9 | 249.0 | O K |
| 4320 min Summer | 98.369 | 0.369 | 0.0 | 10.9 | 0.0 | 10.9 | 149.9 | O K |
| 5760 min Summer | 98.224 | 0.224 | 0.0 | 10.8 | 0.0 | 10.8 | 90.8 | O K |
| 7200 min Summer | 98.164 | 0.164 | 0.0 | 10.6 | 0.0 | 10.6 | 66.5 | O K |
| 8640 min Summer | 98.144 | 0.144 | 0.0 | 9.3 | 0.0 | 9.3 | 58.5 | O K |
| 10080 min Summer | 98.130 | 0.130 | 0.0 | 8.3 | 0.0 | 8.3 | 53.0 | O K |
| 15 min Winter | 98.786 | 0.786 | 0.0 | 12.2 | 5.9 | 18.0 | 319.2 | O K |
| 30 min Winter | 98.979 | 0.979 | 0.0 | 13.5 | 9.5 | 23.0 | 397.7 | O K |
| 60 min Winter | 99.138 | 1.138 | 0.0 | 14.5 | 11.6 | 26.1 | 462.1 | O K |
| 120 min Winter | 99.228 | 1.228 | 0.0 | 15.0 | 12.7 | 27.7 | 498.9 | O K |
| 180 min Winter | 99.231 | 1.231 | 0.0 | 15.0 | 12.7 | 27.8 | 500.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 87.227 | 0.0 | 290.9 | 3.0 | 18 |
| 30 min Summer | 55.777 | 0.0 | 372.7 | 29.3 | 33 |
| 60 min Summer | 34.065 | 0.0 | 458.3 | 61.1 | 62 |
| 120 min Summer | 20.201 | 0.0 | 543.8 | 93.0 | 120 |
| 180 min Summer | 14.736 | 0.0 | 595.1 | 109.8 | 146 |
| 240 min Summer | 11.736 | 0.0 | 632.0 | 120.0 | 178 |
| 360 min Summer | 8.483 | 0.0 | 685.4 | 130.2 | 246 |
| 480 min Summer | 6.739 | 0.0 | 725.9 | 133.8 | 314 |
| 600 min Summer | 5.634 | 0.0 | 758.6 | 132.0 | 382 |
| 720 min Summer | 4.865 | 0.0 | 786.1 | 124.7 | 452 |
| 960 min Summer | 3.858 | 0.0 | 831.1 | 107.0 | 588 |
| 1440 min Summer | 2.780 | 0.0 | 897.8 | 74.3 | 852 |
| 2160 min Summer | 2.001 | 0.0 | 971.3 | 25.8 | 1256 |
| 2880 min Summer | 1.584 | 0.0 | 1024.9 | 0.0 | 1700 |
| 4320 min Summer | 1.138 | 0.0 | 1103.9 | 0.0 | 2420 |
| 5760 min Summer | 0.900 | 0.0 | 1165.7 | 0.0 | 3056 |
| 7200 min Summer | 0.750 | 0.0 | 1213.9 | 0.0 | 3672 |
| 8640 min Summer | 0.646 | 0.0 | 1254.4 | 0.0 | 4408 |
| 10080 min Summer | 0.569 | 0.0 | 1288.9 | 0.0 | 5136 |
| 15 min Winter | 87.227 | 0.0 | 326.1 | 13.3 | 18 |
| 30 min Winter | 55.777 | 0.0 | 417.8 | 47.7 | 32 |
| 60 min Winter | 34.065 | 0.0 | 513.4 | 85.7 | 60 |
| 120 min Winter | 20.201 | 0.0 | 609.2 | 123.6 | 116 |
| 180 min Winter | 14.736 | 0.0 | 666.7 | 143.9 | 152 |

## Summary of Results for 30 year Return Period (+10%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.225 | 1.225 | 0.0 | 15.0 | 12.6 | 27.7 | 497.4 | O K |
| 360 min Winter | 99.186 | 1.186 | 0.0 | 14.8 | 12.2 | 27.0 | 481.7 | O K |
| 480 min Winter | 99.137 | 1.137 | 0.0 | 14.5 | 11.6 | 26.1 | 461.9 | O K |
| 600 min Winter | 99.086 | 1.086 | 0.0 | 14.2 | 11.0 | 25.1 | 441.2 | O K |
| 720 min Winter | 99.037 | 1.037 | 0.0 | 13.9 | 10.3 | 24.2 | 421.3 | O K |
| 960 min Winter | 98.950 | 0.950 | 0.0 | 13.3 | 9.0 | 22.3 | 385.7 | O K |
| 1440 min Winter | 98.818 | 0.818 | 0.0 | 12.4 | 6.6 | 19.0 | 332.1 | O K |
| 2160 min Winter | 98.701 | 0.701 | 0.0 | 11.5 | 2.4 | 13.9 | 284.5 | O K |
| 2880 min Winter | 98.555 | 0.555 | 0.0 | 10.9 | 0.0 | 10.9 | 225.3 | O K |
| 4320 min Winter | 98.216 | 0.216 | 0.0 | 10.8 | 0.0 | 10.8 | 87.7 | O K |
| 5760 min Winter | 98.146 | 0.146 | 0.0 | 9.5 | 0.0 | 9.5 | 59.3 | O K |
| 7200 min Winter | 98.126 | 0.126 | 0.0 | 7.9 | 0.0 | 7.9 | 51.2 | O K |
| 8640 min Winter | 98.114 | 0.114 | 0.0 | 6.8 | 0.0 | 6.8 | 46.2 | O K |
| 10080 min Winter | 98.105 | 0.105 | 0.0 | 6.0 | 0.0 | 6.0 | 42.5 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 11.736 | 0.0 | 708.1 | 156.5 | 186 |
| 360 min Winter | 8.483 | 0.0 | 767.8 | 170.1 | 262 |
| 480 min Winter | 6.739 | 0.0 | 813.2 | 176.0 | 338 |
| 600 min Winter | 5.634 | 0.0 | 849.8 | 176.8 | 410 |
| 720 min Winter | 4.865 | 0.0 | 880.6 | 173.4 | 482 |
| 960 min Winter | 3.858 | 0.0 | 931.0 | 152.9 | 624 |
| 1440 min Winter | 2.780 | 0.0 | 1005.7 | 104.9 | 894 |
| 2160 min Winter | 2.001 | 0.0 | 1088.0 | 28.4 | 1340 |
| 2880 min Winter | 1.584 | 0.0 | 1148.0 | 0.0 | 1816 |
| 4320 min Winter | 1.138 | 0.0 | 1236.7 | 0.0 | 2380 |
| 5760 min Winter | 0.900 | 0.0 | 1305.6 | 0.0 | 2944 |
| 7200 min Winter | 0.750 | 0.0 | 1359.7 | 0.0 | 3672 |
| 8640 min Winter | 0.646 | 0.0 | 1405.2 | 0.0 | 4408 |
| 10080 min Winter | 0.569 | 0.0 | 1444.0 | 0.0 | 5136 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 30 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +10 |

## Time Area Diagram

Total Area (ha) 1.800

| Time (mins) From: | To: | Area (ha) |
|---|---|---|
| 0 | 4 | 1.800 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 427.5 | 0.0 | 2.000 | 427.5 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0156-1090-0620-1090 |
| Design Head (m) | 0.620 |
| Design Flow (l/s) | 10.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 156 |
| Invert Level (m) | 98.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.620 | 10.9 | Kick-Flo® | 0.470 | 9.5 |
| Flush-Flo™ | 0.243 | 10.9 | Mean Flow over Head Range | - | 8.9 |

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 | 5.6 | 0.800 | 12.3 | 2.000 | 19.0 | 4.000 | 26.4 | 7.000 | 34.5 |
| 0.200 | 10.8 | 1.000 | 13.6 | 2.200 | 19.8 | 4.500 | 28.0 | 7.500 | 35.7 |
| 0.300 | 10.8 | 1.200 | 14.9 | 2.400 | 20.7 | 5.000 | 29.4 | 8.000 | 36.9 |
| 0.400 | 10.3 | 1.400 | 16.0 | 2.600 | 21.5 | 5.500 | 30.8 | 8.500 | 38.1 |
| 0.500 | 9.8 | 1.600 | 17.0 | 3.000 | 23.0 | 6.000 | 32.1 | 9.000 | 39.2 |
| 0.600 | 10.7 | 1.800 | 18.0 | 3.500 | 24.8 | 6.500 | 33.2 | 9.500 | 40.3 |

## Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.620

## Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 426 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 min Summer | 99.076 | 1.076 | 0.0 | 14.1 | 10.8 | 25.0 | 437.2 | O K |
| 30 min Summer | 99.354 | 1.354 | 0.0 | 15.7 | 14.0 | 29.8 | 549.9 | O K |
| 60 min Summer | 99.585 | 1.585 | 0.0 | 17.0 | 16.2 | 33.2 | 643.7 | O K |
| 120 min Summer | 99.717 | 1.717 | 0.0 | 17.6 | 17.3 | 35.0 | 697.5 | Flood Risk |
| 180 min Summer | 99.730 | 1.730 | 0.0 | 17.7 | 17.4 | 35.1 | 702.5 | Flood Risk |
| 240 min Summer | 99.722 | 1.722 | 0.0 | 17.6 | 17.4 | 35.0 | 699.5 | Flood Risk |
| 360 min Summer | 99.683 | 1.683 | 0.0 | 17.5 | 17.1 | 34.5 | 683.5 | O K |
| 480 min Summer | 99.634 | 1.634 | 0.0 | 17.2 | 16.6 | 33.9 | 663.4 | O K |
| 600 min Summer | 99.579 | 1.579 | 0.0 | 16.9 | 16.2 | 33.1 | 641.2 | O K |
| 720 min Summer | 99.523 | 1.523 | 0.0 | 16.6 | 15.7 | 32.3 | 618.6 | O K |
| 960 min Summer | 99.417 | 1.417 | 0.0 | 16.1 | 14.7 | 30.7 | 575.6 | O K |
| 1440 min Summer | 99.243 | 1.243 | 0.0 | 15.1 | 12.9 | 28.0 | 504.9 | O K |
| 2160 min Summer | 99.056 | 1.056 | 0.0 | 14.0 | 10.6 | 24.6 | 428.7 | O K |
| 2880 min Summer | 98.924 | 0.924 | 0.0 | 13.1 | 8.6 | 21.7 | 375.4 | O K |
| 4320 min Summer | 98.760 | 0.760 | 0.0 | 12.0 | 5.2 | 17.2 | 308.7 | O K |
| 5760 min Summer | 98.666 | 0.666 | 0.0 | 11.2 | 0.9 | 12.2 | 270.5 | O K |
| 7200 min Summer | 98.504 | 0.504 | 0.0 | 10.9 | 0.0 | 10.9 | 204.5 | O K |
| 8640 min Summer | 98.309 | 0.309 | 0.0 | 10.9 | 0.0 | 10.9 | 125.4 | O K |
| 10080 min Summer | 98.214 | 0.214 | 0.0 | 10.8 | 0.0 | 10.8 | 86.8 | O K |
| 15 min Winter | 99.207 | 1.207 | 0.0 | 14.9 | 12.5 | 27.4 | 490.3 | O K |
| 30 min Winter | 99.522 | 1.522 | 0.0 | 16.6 | 15.6 | 32.3 | 618.0 | O K |
| 60 min Winter | 99.786 | 1.786 | 0.0 | 18.0 | 17.9 | 35.9 | 725.4 | Flood Risk |
| 120 min Winter | 99.951 | 1.951 | 0.0 | 18.7 | 19.2 | 37.9 | 792.4 | Flood Risk |
| 180 min Winter | 99.968 | 1.968 | 0.0 | 18.8 | 19.3 | 38.1 | 799.2 | Flood Risk |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 133.985 | 0.0 | 448.2 | 62.7 | 18 |
| 30 min Summer | 86.337 | 0.0 | 578.4 | 121.2 | 33 |
| 60 min Summer | 52.933 | 0.0 | 712.9 | 181.8 | 62 |
| 120 min Summer | 31.380 | 0.0 | 845.5 | 240.9 | 120 |
| 180 min Summer | 22.833 | 0.0 | 922.9 | 272.5 | 154 |
| 240 min Summer | 18.130 | 0.0 | 977.2 | 292.4 | 184 |
| 360 min Summer | 13.031 | 0.0 | 1053.6 | 315.5 | 250 |
| 480 min Summer | 10.316 | 0.0 | 1112.1 | 329.1 | 318 |
| 600 min Summer | 8.601 | 0.0 | 1159.0 | 336.4 | 386 |
| 720 min Summer | 7.410 | 0.0 | 1198.3 | 339.4 | 456 |
| 960 min Summer | 5.854 | 0.0 | 1262.1 | 336.3 | 588 |
| 1440 min Summer | 4.194 | 0.0 | 1355.7 | 297.5 | 852 |
| 2160 min Summer | 3.001 | 0.0 | 1457.2 | 244.4 | 1232 |
| 2880 min Summer | 2.364 | 0.0 | 1530.8 | 194.9 | 1612 |
| 4320 min Summer | 1.688 | 0.0 | 1638.2 | 96.0 | 2376 |
| 5760 min Summer | 1.328 | 0.0 | 1720.3 | 10.8 | 3224 |
| 7200 min Summer | 1.102 | 0.0 | 1784.3 | 0.0 | 4040 |
| 8640 min Summer | 0.946 | 0.0 | 1837.7 | 0.0 | 4592 |
| 10080 min Summer | 0.831 | 0.0 | 1883.0 | 0.0 | 5240 |
| 15 min Winter | 133.985 | 0.0 | 502.4 | 87.1 | 18 |
| 30 min Winter | 86.337 | 0.0 | 648.2 | 155.0 | 32 |
| 60 min Winter | 52.933 | 0.0 | 798.6 | 224.9 | 60 |
| 120 min Winter | 31.380 | 0.0 | 947.1 | 293.4 | 118 |
| 180 min Winter | 22.833 | 0.0 | 1033.8 | 330.7 | 170 |

## Summary of Results for 100 year Return Period (+30%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 240 min Winter | 99.948 | 1.948 | 0.0 | 18.7 | 19.2 | 37.9 | 791.3 | Flood Risk |
| 360 min Winter | 99.889 | 1.889 | 0.0 | 18.4 | 18.7 | 37.2 | 767.3 | Flood Risk |
| 480 min Winter | 99.815 | 1.815 | 0.0 | 18.1 | 18.1 | 36.2 | 737.0 | Flood Risk |
| 600 min Winter | 99.734 | 1.734 | 0.0 | 17.7 | 17.5 | 35.2 | 704.1 | Flood Risk |
| 720 min Winter | 99.653 | 1.653 | 0.0 | 17.3 | 16.8 | 34.1 | 671.4 | O K |
| 960 min Winter | 99.504 | 1.504 | 0.0 | 16.5 | 15.5 | 32.0 | 610.7 | O K |
| 1440 min Winter | 99.265 | 1.265 | 0.0 | 15.2 | 13.1 | 28.3 | 513.7 | O K |
| 2160 min Winter | 99.024 | 1.024 | 0.0 | 13.8 | 10.1 | 23.9 | 416.0 | O K |
| 2880 min Winter | 98.873 | 0.873 | 0.0 | 12.8 | 7.7 | 20.5 | 354.3 | O K |
| 4320 min Winter | 98.716 | 0.716 | 0.0 | 11.6 | 3.2 | 14.8 | 290.9 | O K |
| 5760 min Winter | 98.519 | 0.519 | 0.0 | 10.9 | 0.0 | 10.9 | 211.0 | O K |
| 7200 min Winter | 98.218 | 0.218 | 0.0 | 10.8 | 0.0 | 10.8 | 88.5 | O K |
| 8640 min Winter | 98.154 | 0.154 | 0.0 | 10.0 | 0.0 | 10.0 | 62.6 | O K |
| 10080 min Winter | 98.137 | 0.137 | 0.0 | 8.8 | 0.0 | 8.8 | 55.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 240 min Winter | 18.130 | 0.0 | 1094.6 | 354.7 | 192 |
| 360 min Winter | 13.031 | 0.0 | 1180.2 | 383.5 | 268 |
| 480 min Winter | 10.316 | 0.0 | 1245.8 | 401.5 | 344 |
| 600 min Winter | 8.601 | 0.0 | 1298.3 | 412.1 | 416 |
| 720 min Winter | 7.410 | 0.0 | 1342.3 | 417.7 | 490 |
| 960 min Winter | 5.854 | 0.0 | 1413.7 | 418.9 | 628 |
| 1440 min Winter | 4.194 | 0.0 | 1518.7 | 383.9 | 896 |
| 2160 min Winter | 3.001 | 0.0 | 1632.2 | 307.0 | 1280 |
| 2880 min Winter | 2.364 | 0.0 | 1714.6 | 228.4 | 1668 |
| 4320 min Winter | 1.688 | 0.0 | 1835.1 | 68.2 | 2468 |
| 5760 min Winter | 1.328 | 0.0 | 1926.8 | 0.0 | 3464 |
| 7200 min Winter | 1.102 | 0.0 | 1998.6 | 0.0 | 3896 |
| 8640 min Winter | 0.946 | 0.0 | 2058.4 | 0.0 | 4408 |
| 10080 min Winter | 0.831 | 0.0 | 2109.4 | 0.0 | 5136 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.446 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +30 |

## Time Area Diagram

Total Area (ha) 1.800

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 1.800 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 427.5 | 0.0 | 2.000 | 427.5 | 0.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0156-1090-0620-1090 |
| Design Head (m) | 0.620 |
| Design Flow (l/s) | 10.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 156 |
| Invert Level (m) | 98.000 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.620 | 10.9 | Kick-Flo® | 0.470 | 9.5 |
| Flush-Flo™ | 0.243 | 10.9 | Mean Flow over Head Range | - | 8.9 |

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 | 5.6 | 0.800 | 12.3 | 2.000 | 19.0 | 4.000 | 26.4 | 7.000 | 34.5 |
| 0.200 | 10.8 | 1.000 | 13.6 | 2.200 | 19.8 | 4.500 | 28.0 | 7.500 | 35.7 |
| 0.300 | 10.8 | 1.200 | 14.9 | 2.400 | 20.7 | 5.000 | 29.4 | 8.000 | 36.9 |
| 0.400 | 10.3 | 1.400 | 16.0 | 2.600 | 21.5 | 5.500 | 30.8 | 8.500 | 38.1 |
| 0.500 | 9.8 | 1.600 | 17.0 | 3.000 | 23.0 | 6.000 | 32.1 | 9.000 | 39.2 |
| 0.600 | 10.7 | 1.800 | 18.0 | 3.500 | 24.8 | 6.500 | 33.2 | 9.500 | 40.3 |

## Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.620

# Appendix E – Drainage Layout Drawings

Notes

1. The development is entirely located within Flood Zone 1 - Low Risk. It is therefore not at risk of flooding from fluvial sources in up to a 1 in 1000 year return period.
3. The proposed drainage strategy has been prepared in accordance with the National Planning Policy Framework (NPPF) and the supplementary Planning Practice Guidance (NPPG).
4. The Barnet Surface Water Management Plan identifies the site as being wholly located within Brunswick Park - Group2_030 Critical Drainage Area.
5. The site has been previously developed and is currently occupied by a business park and school, therefore the site can be classed as 'brownfield'.
6. In accordance with London Plan 'Policy 5.13 - Sustainable Drainage' and the North London Strategic Flood Risk Assessment, the discharge from the proposed development will be restricted back to undeveloped Greenfield run-off rates.
6. A desk top study has indicated that the site suffers from 'impeded drainage', therefore the drainage strategy utilises attenuation features with a restricted discharge, sized to cater for up to the 1 in 100 year storm.
7. Roof water from buildings and private areas of hard-standing (including the on-site road network) will be collected from downpipes, gutters and trapped gullies before being transferred via a private storm network towards on site attenuation features.
8. Rainwater harvesting will be provided throughout the development to reduce the volume of runoff being discharged and to capture the first 5mm of rainfall.
9. This Preliminary Drainage Layout drawing does not attempt to present a final design of the proposed drainage systems. Detailed design of the systems and any inherent features will commence on approval of the strategy and will include assessments due to further site investigations, health and safety, CDM etc.
10. We are currently liaising with Thames water to agree on a point of connection for both surface water and foul and confirm whether the existing sewerage networks have capacity to accommodate the development or to otherwise outline any offsite reinforcement requirements.
11. Any private drainage networks or features will be designed in accordance with Building Regulations Part H. The operation and maintenance of any communal private drainage will be undertaken via a third party management company.
12. Any adoptable drainage networks will be designed in accordance with Sewers for Adoption and will be handed to Thames Water for adoption.
13. The alignment of existing public drainage infrastructure is based on Thames Water asset record plans, as built survey information and topographic survey information.

Pre Development Runoff

In accordance with Policy 5.13 of The London Plan and the North London Strategic Flood Risk Assessment, the rate of runoff from the proposed brownfield development site will be restricted to replicate the pre-development greenfield scenario.

Given the proposed Phase 1 development area of only 5.5ha, the pre-development greenfield run-off rates have been assessed in accordance with the ICP SuDS Method, which is based on IH124, but for catchments of less than 50 ha.

Greenfield Runoff Rates

| Return Period | Greenfield Runoff Rate (l/s) |
|---|---|
| 2yr | 21.5 |
| 30yr | 55.0 |
| 100yr | 77.0 |

Proposed Phase 1 Drainage Features

School Site to independent Cellular Storage feature

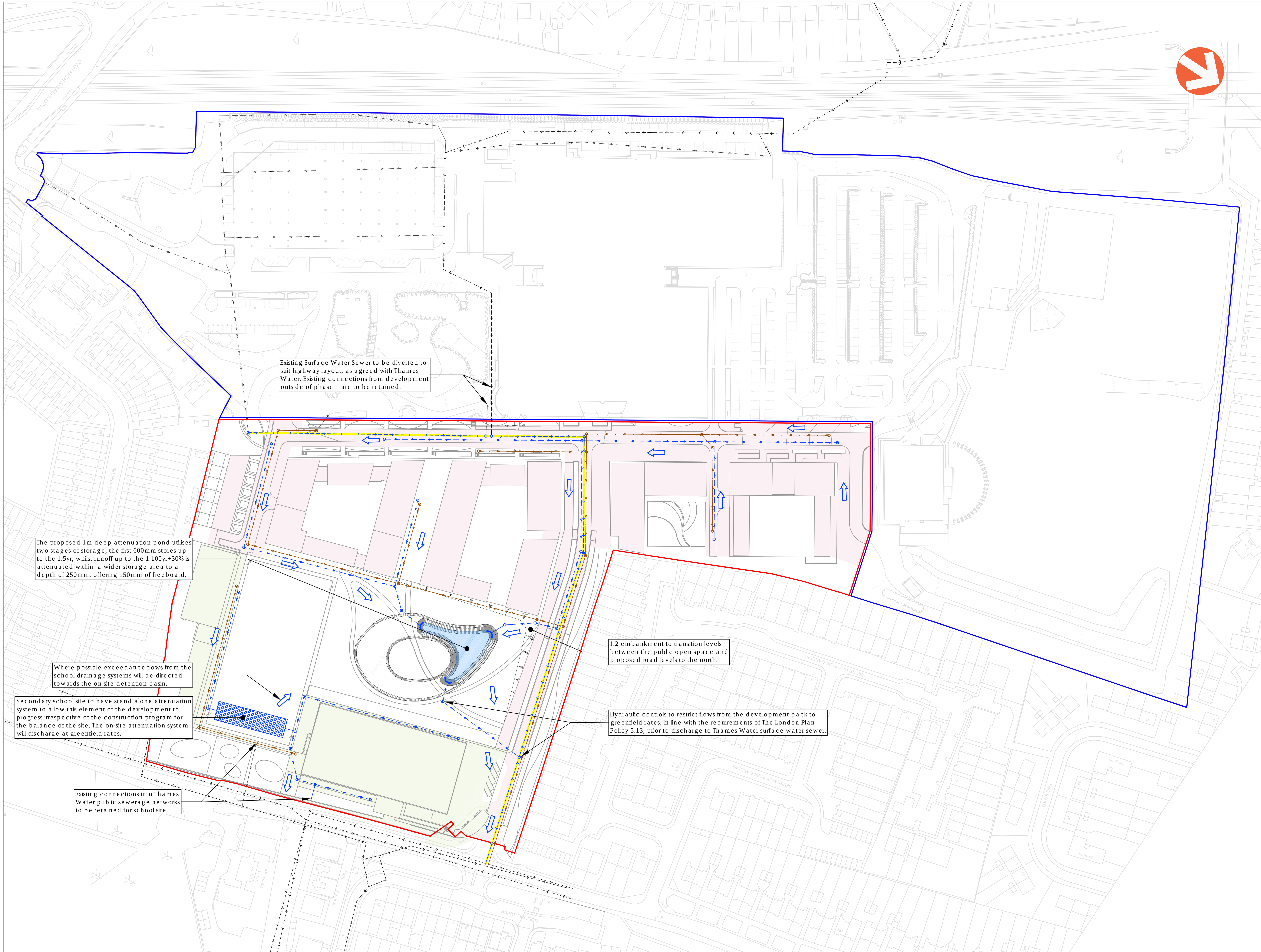
| | |
|---|---|
| Ownership | Private (Management Company) |
| Impermeable Catchment | 0.65 ha |
| Dimensions | 37.5 m x 10.0 m x 1.0 m deep |
| 100yr + 30% Volume | 356 m³ |

Balance of Phase 1 to proposed Detention Basin

| | |
|---|---|
| Ownership | Private (Management Company) |
| Impermeable Catchment | 1.97 ha |
| 100yr+30% Volume | 768 m³ (above permanent water) |
| 100yr+30% water level | 0.838 m (above permanent water) |

Future runoff rates

| Return Period | School Runoff (l/s) | Basin Discharge (l/s) | Total |
|---|---|---|---|
| 2yr | 2.1 | 19.4 | 21.5 |
| 30yr+10% | 3.8 | 42.2 | 46.0 |
| 100yr+30% | 5.8 | 69.7 | 75.5 |




Key

Detailed Application (Phase 1)
Outline Application Boundary

Existing Retained Drainage

Thames Water Foul Sewer
Thames Water Surface Water Sewer

Proposed Drainage

Impermeable Catchment (Phase 1)
Imp. Catchment (School)
Attenuation Pond
Cellular Storage Attenuation
Overland Flood Flow Route
Thames Water Sewer Diversion (indicative)
Private Surface Water Drain
Private Foul Water Drain

| REV | DATE | DESCRIPTION | BY | CHK | APD |
|---|---|---|---|---|---|
| A | 16.12.2015 | INITIAL ISSUE | AJH | CPY | RW |

CLIENT: COMER HOMES GROUP

DRAWING STATUS: PLANNING APPLICATION

PROJECT: ROYAL BRUNSWICK PARK

TITLE: PHASE 1 PRELIMINARY DRAINAGE LAYOUT

PROJECT No: 0031

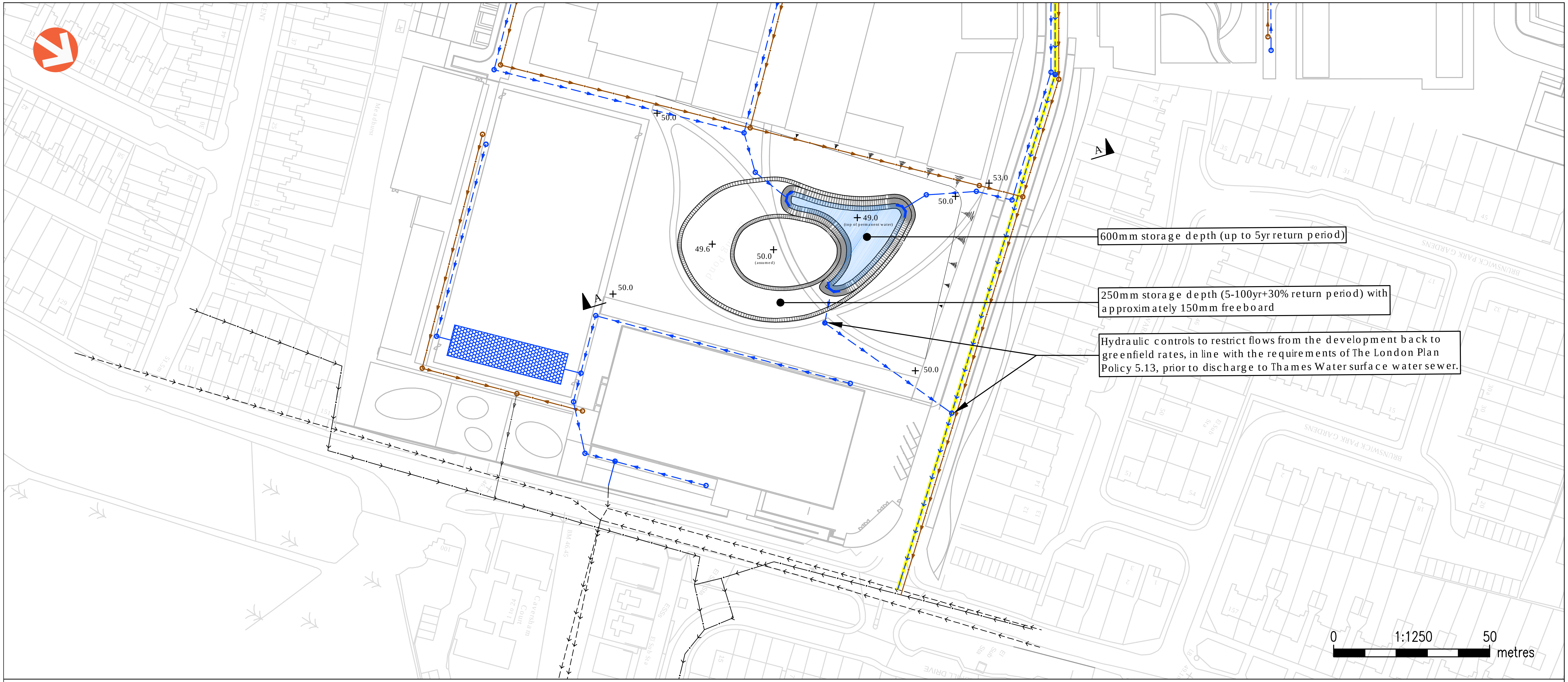
DRAWING No: PDL-100

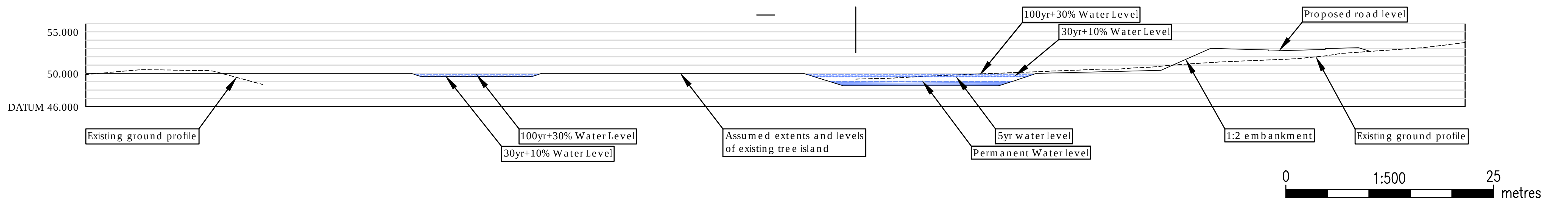
REV: A

SCALE @ A1: 0 1:1000 50 metres

DESIGN BY: awp awcockward partnership

Awcock Ward Partnership, Kensington Court, Woodwater Park, Pynes Hill, Exeter, EX2 5TY
Tel: 01392 409007 Web: www.awpexeter.com




Key

Existing Retained Drainage

Thames Water Foul Sewer

Thames Water Surface Water Sewer

Proposed Drainage

Attenuation Pond

Cellular Storage Attenuation

Thames Water Sewer Diversion (Indicative)

Private Surface Water Drain

Private Foul Water Drain

| REV | DATE | DESCRIPTION | BY | CHK | APD |
|---|---|---|---|---|---|
| A | 16.12.2015 | INITIAL ISSUE | GJ | CY | IDA |

CLIENT: COMER HOMES GROUP

DRAWING STATUS: PLANNING APPLICATION

PROJECT: ROYAL BRUNSWICK PARK

TITLE: PROPOSED DETENTION BASIN

PROJECT No: 0031

DRAWING No: PDL-101

REV: A

SCALE @ A3: AS SHOWN

awp awcockward partnership

Awcock Ward Partnership, Kensington Court, Woodwater Park, Pynes Hill, Exeter, EX2 5TY
Tel: 01392 409007 Web: www.awpexeter.com

Notes

1. The development is entirely located within Flood Zone 1 - Low Risk. It is therefore not at risk of flooding from fluvial sources in up to a 1 in 1000 year return period.
3. The proposed drainage strategy has been prepared in accordance with the National Planning Policy Framework (NPPF) and the supplementary Planning Practice Guidance (NPPG).
4. The Barnet Surface Water Management Plan identifies the site as being wholly located within Brunswick Park - Group2_030 Critical Drainage Area.
5. The site has been previously developed and is currently occupied by a business park and school, therefore the site can be classed as 'brownfield'.
6. In accordance with London Plan 'Policy 5.13 - Sustainable Drainage' and the North London Strategic Flood Risk Assessment, the discharge from the proposed development will be restricted back to undeveloped Greenfield run-off rates.
6. A desk top study has indicated that the site suffers from 'impeded drainage', therefore the drainage strategy utilises attenuation features with a restricted discharge, sized to cater for up to the 1 in 100 year storm.
7. Roof water from buildings and private areas of hard-standing (including the on-site road network) will be collected from downpipes, gutters and trapped gullies before being transferred via a private storm network towards on site attenuation features.
8. Rainwater harvesting will be provided throughout the development to reduce the volume of runoff being discharged and to capture the first 5mm of rainfall.
9. This Preliminary Drainage Layout drawing does not attempt to present a final design of the proposed drainage systems. Detailed design of the systems and any inherent features will commence on approval of the strategy and will include assessments due to further site investigations, health and safety, CDM etc.
10. We are currently liaising with Thames water to agree on a point of connection for both surface water and foul and confirm whether the existing sewerage networks have capacity to accommodate the development or to otherwise outline any offsite reinforcement requirements.
11. Any private drainage networks or features will be designed in accordance with Building Regulations Part H. The operation and maintenance of any communal private drainage will be undertaken via a third party management company.
12. Any adoptable drainage networks will be designed in accordance with Sewers for Adoption and will be handed to Thames Water for adoption.
13. The alignment of existing public drainage infrastructure is based on Thames Water asset record plans, as built survey information and topographic survey information.

Pre Development Runoff

In accordance with Policy 5.13 of The London Plan and the North London Strategic Flood Risk Assessment, the rate of runoff from the proposed brownfield development site will be restricted to replicate the pre-development greenfield scenario.

The pre-development greenfield run-off rates have been assessed in accordance with the ICP SuDS Method, which is based on IH124, but for catchments of less than 50 ha.

Greenfield Runoff Rates (l/s)

| Return Period | Ph2 | PH3 | PH4 | PH5 | Total |
|---|---|---|---|---|---|
| 2yr | 16.4 | 4.7 | 10.1 | 10.9 | 42.1 |
| 30yr | 42.0 | 12.0 | 26.0 | 28.0 | 108.0 |
| 100yr | 58.8 | 16.8 | 36.4 | 39.2 | 151.2 |

Proposed Attenuation Features

Phase 2

| | |
|---|---|
| Ownership | Private (Management Company) |
| Impermeable Catchment | 2.19 ha |
| Dimensions | 25.0 m x 20.0 m x 2.0 m deep |
| 100yr + 30% Volume | 920 m³ |

Phase 3

| | |
|---|---|
| Ownership | Private (Management Company) |
| Impermeable Catchment | 0.425 ha |
| Dimensions | 12.0 m x 7.0 m x 2.0 m deep |
| 100yr + 30% Volume | 160.0 m³ |

Phase 4a

| | |
|---|---|
| Ownership | Private (Management Company) |
| Impermeable Catchment | 0.32 ha |
| Dimensions | 15.5 m x 5.0 m x 2.0 m deep |
| 100yr + 30% Volume | 144 m³ |

Phase 4b&c

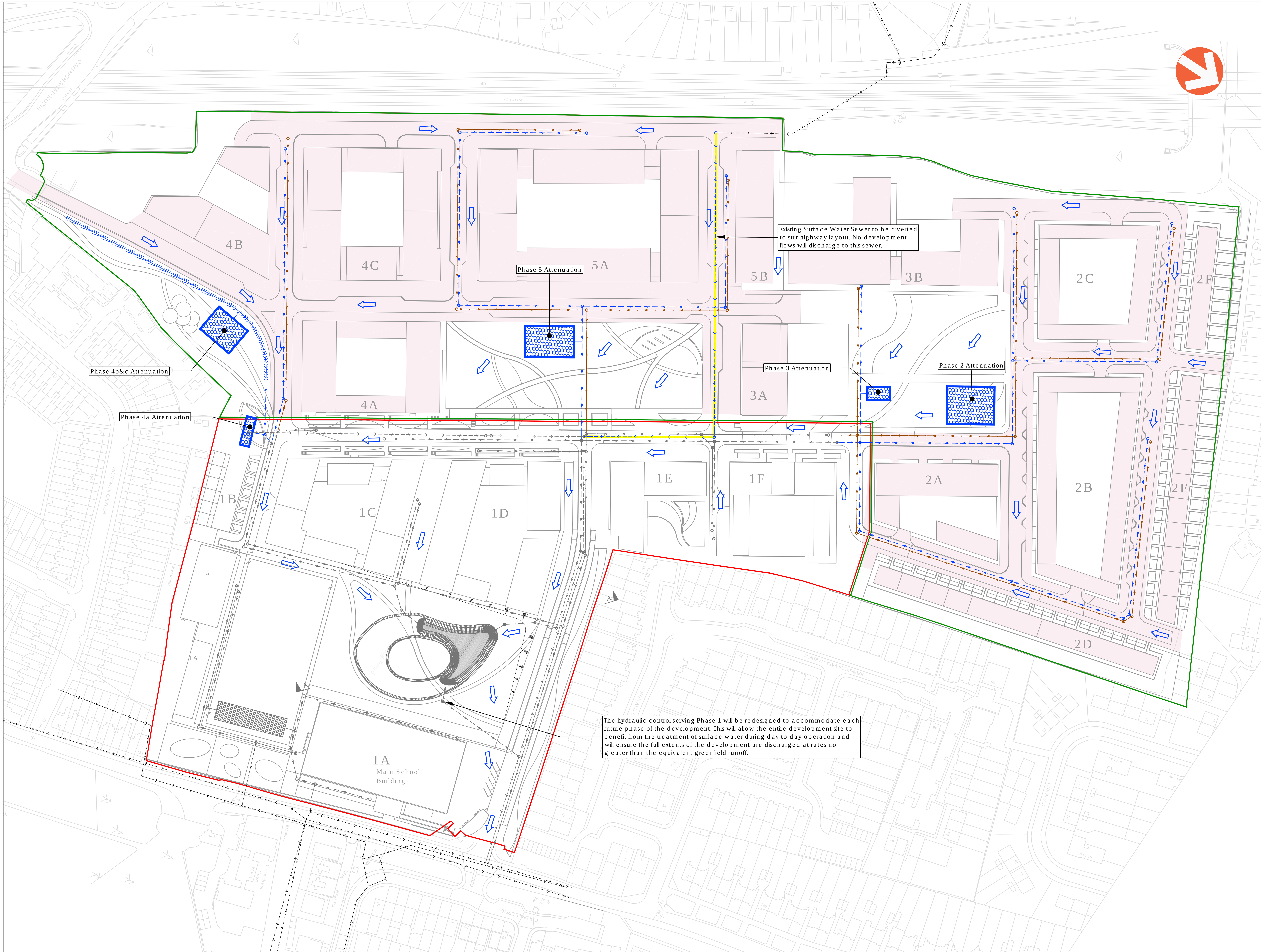
| | |
|---|---|
| Ownership | Private (Management Company) |
| Impermeable Catchment | 1.31 ha |
| Dimensions | 15.5 m x 20.0 m x 2.0 m deep |
| 100yr + 30% Volume | 578 m³ |

Phase 5

| | |
|---|---|
| Ownership | Private (Management Company) |
| Impermeable Catchment | 1.8 ha |
| Dimensions | 26.0 m x 16.5 m x 2.0 m deep |
| 100yr + 30% Volume | 799 m³ |

Future Runoff Rates

| Return Period | PH2 (l/s) | PH3 (l/s) | PH4 (l/s) | PH5 (l/s) | Total |
|---|---|---|---|---|---|
| 2yr | 16.3 | 4.6 | 10.0 | 10.9 | 41.8 |
| 30yr+10% | 41.7 | 11.4 | 26.0 | 27.8 | 106.9 |
| 100yr+30% | 57.2 | 15.9 | 36.0 | 38.1 | 147.2 |




Key

- Detailed Application (Phase 1)
- Outline Application Boundary

Existing Retained Drainage

- Thames Water Foul Sewer
- Thames Water Surface Water Sewer

Proposed Drainage

- Impermeable Catchment
- Cellular Storage Attenuation
- Overland Flood Flow Route
- Thames Water Sewer Diversion (indicative)
- Private Surface Water Drain
- Private Foul Water Drain

| REV | DATE | DESCRIPTION | BY | CHK | APD |
|---|---|---|---|---|---|
| A | 16.12.2015 | INITIAL ISSUE | GJ | CPY | RW |

CLIENT: COMER HOMES GROUP

DRAWING STATUS: PLANNING APPLICATION

PROJECT: ROYAL BRUNSWICK PARK

TITLE: PRELIMINARY DRAINAGE LAYOUT - FULL SITE

PROJECT No: 0031

DRAWING No: PDL-200

REV: A

SCALE @ A1: 0 1:1000 50 metres

DESIGN BY: awp awcockward partnership


Awcock Ward Partnership, Kensington Court, Woodwater Park, Pynes Hill, Exeter, EX2 5TY
Tel: 01392 409007 Web: www.awpexeter.com

# Appendix F – Thames Water Correspondence

## Chris Yalden

| | |
|---|---|
| From: | DEVELOPER.SERVICES@THAMESWATER.CO.UK |
| Sent: | 15 December 2015 08:32 |
| To: | Chris Yalden |
| Subject: | IRef:1013480825 RE: Royal Brunswick Park re-development scheme, Barnet - Outline SW Strategy |

Dear Chris,

Thank you for your email.

From the information you have provided, we have no issues with your reduction/attenuation measures.

Best regards

Shaun Picart

Thames Water - Development Engineer

0800 009 3921

Original Text

From: chris.yalden@awpexeter.com
To: DEVELOPER.SERVICES@THAMESWATER.CO.UK
CC:
Sent: 08.12.15 15:12:50
Subject: Royal Brunswick Park re-development scheme, Barnet - Outline SW Strategy

FAO Shaun Picart, Development Engineer
Chris Freeman, Technical Coordinator

Shaun, Chris,

We spoke with you both earlier this year with regard to the proposed school which forms Phase 1 of the 'Royal Brunswick Park re-development scheme', at Brunswick Park Road, Barnet (site formerly known as North London Business Park).

I would now like to seek your thoughts on our work-in-progress drainage strategy for the full redevelopment site. I am not seeking approval or final agreement as clearly you will need to review full details of the scheme, however I'm hoping your response will give us confidence that we're currently progressing in the right direction.

To remain compliant with local and regional policies the scheme will need to reduce the peak runoff from the brownfield site to the equivalent greenfield rates; offering a significant reduction and downstream betterment.

As-built records indicate connections between your existing surface water sewer and an existing on-site attenuation pond. In accordance with the London Plan Policy 5.13 Sustainable Drainage Hierarchy, we are keen to retain the function of this pond to provide on-site attenuation, with a controlled discharge to your network, at greenfield rates. The proposals would demonstrate a significant reduction in peak rate of runoff whilst also providing water quality enhancement and improved site management.

Can you please confirm that this outline drainage strategy is acceptable in principle?

With regards to foul flows, the proposals will generate an increased foul flow. We've completed a pre-development enquiry to establish whether this flow can be accommodated or whether any off-site reinforcement will be required – this will be submitted shortly.

I look forward to hearing from you in due course and welcome any discussions.

Best Regards,

Chris Yalden
Associate
MICE, IEng

Kensington Court, Woodwater Park, Pynes Hill, Exeter EX2 5TY

office: 01392 409007
direct dial: 01392 441066
Mobile: 07843 107790
email: chris.yalden@awpexeter.com
web: www.awpexeter.com

AWP is a regional engineering consultancy providing development planning and infrastructure services to developers and house builders across the south west.

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From: DEVELOPER.SERVICES@THAMESWATER.CO.UK [mailto:DEVELOPER.SERVICES@THAMESWATER.CO.UK]
Sent: 26 March 2015 11:14
To: Chris Yalden
Subject: RE: RE: IRef:1012416174 RE: Query relating to Buildover Agreement (Ref. 50039476-BN)

Dear Chris,

Thank you for your email.

I've reviewed your drawing, what you're proposing seems fine in principal.

We look forward to receiving your application including longitudinal drawings.

Best regards

Shaun Picart

Thames Water - Development Engineer

0800 009 3921

Original Text

From: chris.yalden@awpexeter.com
To: DEVELOPER.SERVICES@THAMESWATER.CO.UK
CC:
Sent: 19.03.15 10:05:57
Subject: RE: IRef:1012416174 RE: Query relating to Buildover Agreement (Ref. 50039476-BN)

FAO Chris Freeman, Technical Coordinator

RE: Application to build over a Class 3 and a Class 2 Public Sewer (Ref: 50039476-BN)
Site Address: Royal Brunswick Park, London, N14 5DU

Many thanks for your below email, received at the tail end of last year.

Given that Thames Water will not accept a build-over agreement and are making recommendations to divert the existing 375mm and 600mm diameter sewers, we have undertaken an assessment to define a possible diversion route. The output of this assessment can be seen on the attached Sketch Plan (ref. 0031-SK-101).

The deliverability of this potential diversion will be subject to existing sewer levels and capacity at the point of connection. There is a risk that the existing sewer beneath Brunswick Park Road will be too shallow / small to enable a connection and the diversion may need to include relaying of this system, downstream towards Caversham Court, where the public sewers turn and head east.

Pleas can you confirm whether the broad principles of this diversion are preferable to Thames Water, as opposed to the previously discussed build-over.

Best Regards,

Chris Yalden
Associate
MICE, IEng

Kensington Court, Woodwater Park, Pynes Hill, Exeter EX2 5TY

office: 01392 409007
direct dial: 01392 441066
email: chris.yalden@awpexeter.com
web: www.awpexeter.com



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From: DEVELOPER.SERVICES@THAMESWATER.CO.UK [mailto:DEVELOPER.SERVICES@THAMESWATER.CO.UK]
Sent: 30 December 2014 10:01
To: Chris Yalden
Cc: Gavin Swift; Ian Awcock
Subject: IRef:1012416174 RE: Query relating to Buildover Agreement (Ref. 50039476-BN)

Dear Mr Yalden,

Many thanks for your below email.

I have discussed your comments with our senior connections manager who is of the opinion that the Sewers For Adoption 6th Edition and specifically Table 2.1 which you mention is in it's principals referring to sewers in residential development land or in public roads and built-up domestic areas which due to the difficulty and complexities of cordoning off areas for open-cut trench works would make this type of access unlikely to be sought and given.

In areas such as parks and greenfield spaces however it is very likely that open-cut trenches would be used to repair sewers due to cost-effectiveness and simplicity of access even at 8 metres as tunnelling repairs would be significantly more costly.

It is for the above reasons and those previously mentioned that we are not able in this instance to allow these 2 sewers to be built over by this proposed development and we must request that an application be made under Section 185 of the Water Industry Act 1991 to divert the sewers around the proposed development.

Kind Regards

Chris Freeman

Technical Coordinator

Original Text

From: chris.yalden@awpexeter.com
To: developer.services@thameswater.co.uk
CC: Ian.Awcock@awpexeter.com ;gavin.swift@awpexeter.com
Sent: 18.12.14 15:05:39
Subject: Query relating to Buildover Agreement (Ref. 50039476-BN)

FAO Chris Freeman, Technical Coordinator

RE: Application to build over a Class 3 and a Class 2 Public Sewer (Ref: 50039476-BN)
Site Address: Royal Brunswick Park, London, N14 5DU

Many thanks for your response to our build-over application for the above scheme; I wanted to touch base with you to discuss the application in a little more detail but understand that you're out of office today.

We respect that it's likely a standard position for Thames Water to refuse Build Over Consent for developments located above large public sewers however in this case we wanted to ensure that consideration had been given to the fact the existing sewer is 8m deep. In accordance with Sewers for Adoption guidance (SfA 6th Edition, Table 2.1) any repair, maintenance or renewal of this network by open-cut methods is not anticipated. On this basis we had considered that a build over agreement would be permitted for this scheme as it would not impact on any future works associated to the underlying sewers.

We welcome your comments on the above.

Regards,

Chris Yalden

Principal Engineer
MICE, IEng

Kensington Court, Woodwater Park, Pynes Hill, Exeter EX2 5TY

office: 01392 409007
direct dial: 01392 441066
email: chris.yalden@awpexeter.com
web: www.awpexeter.com



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