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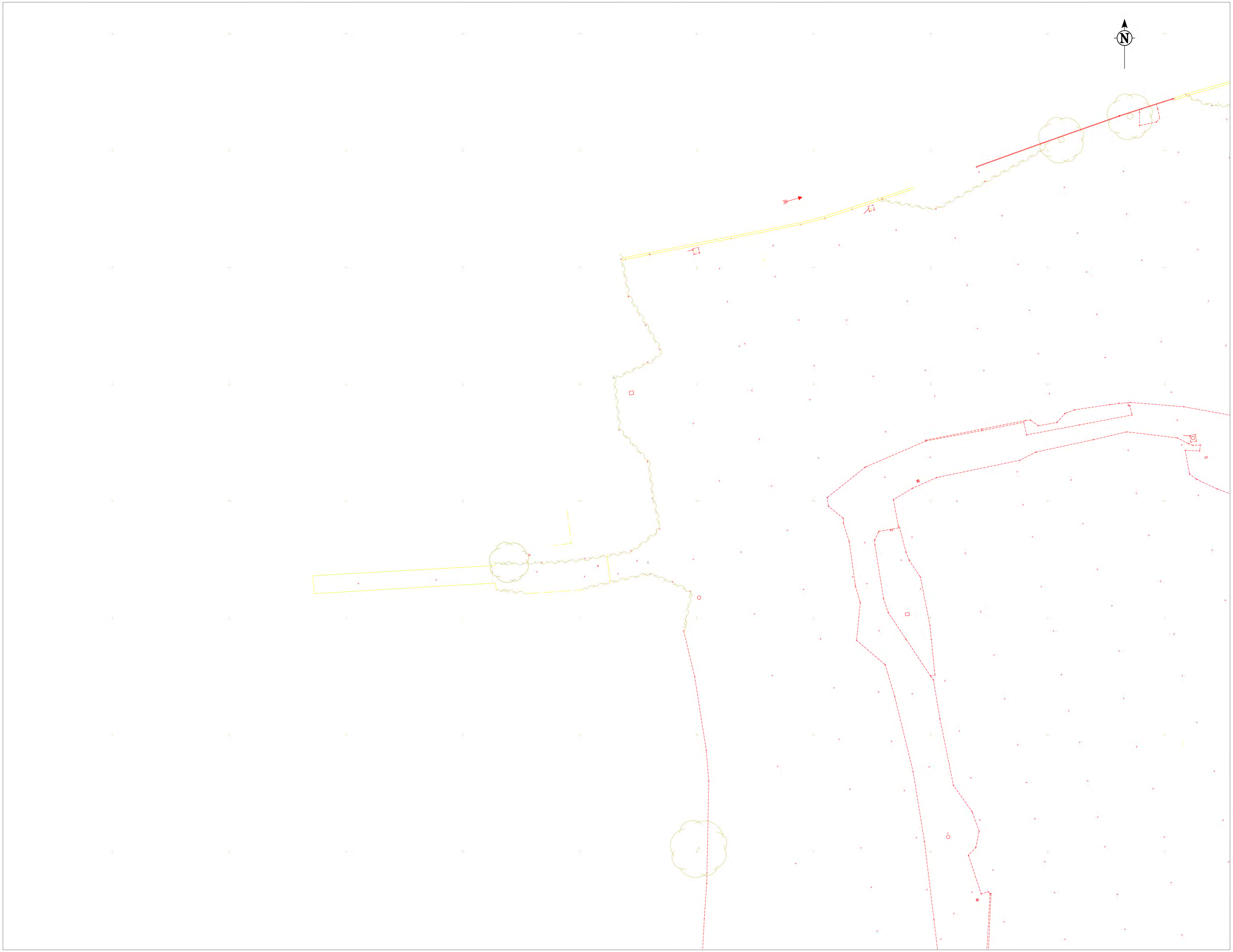

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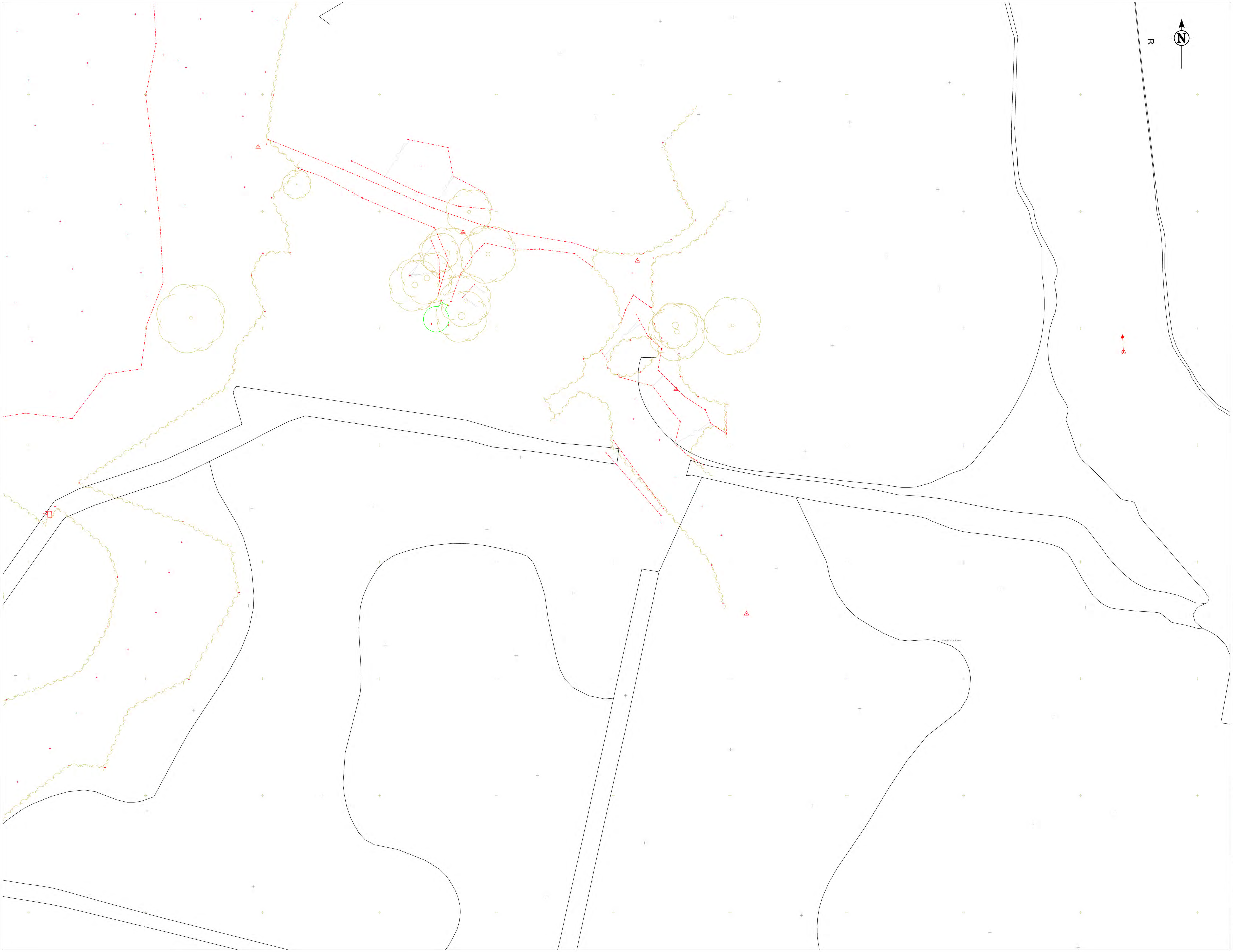

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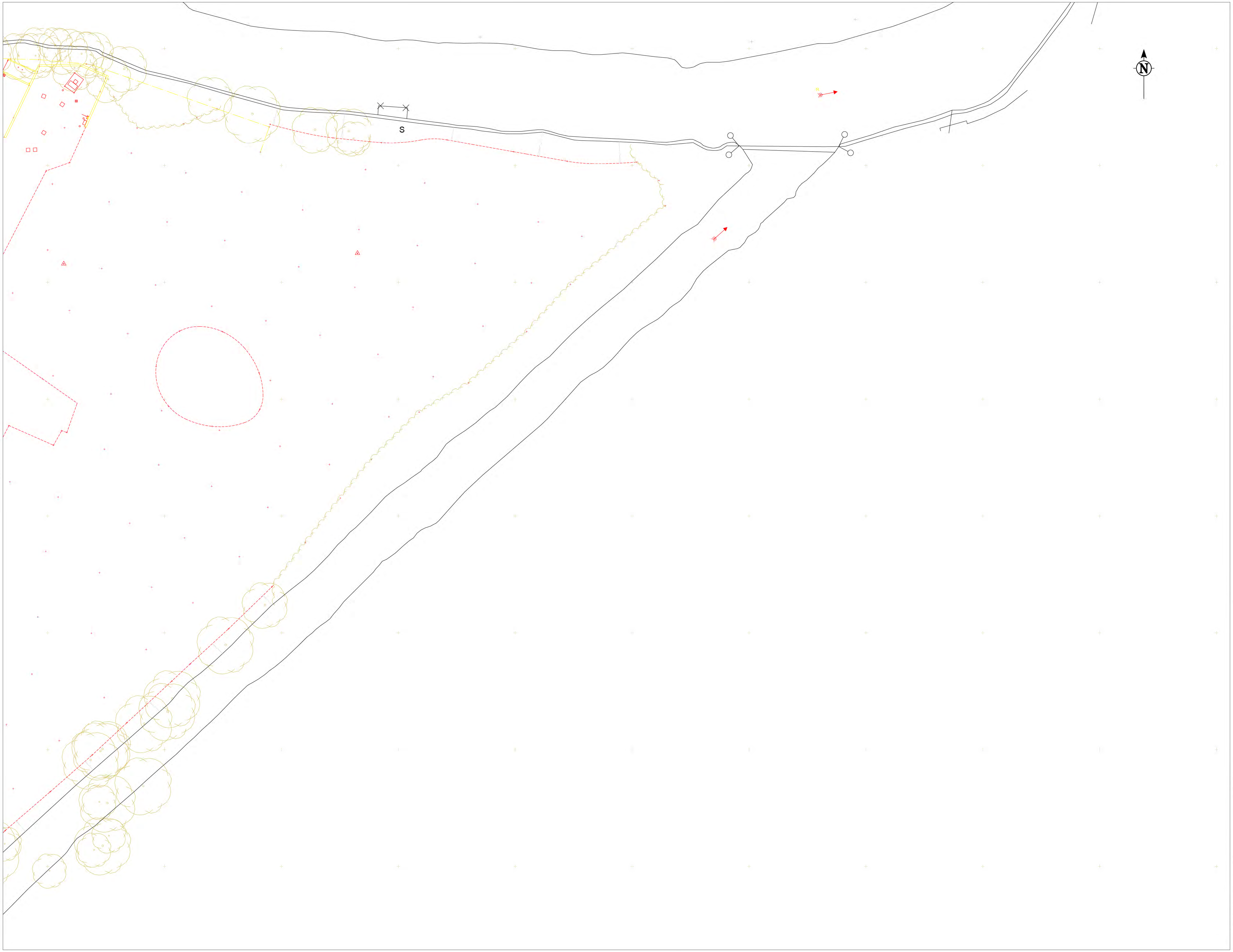

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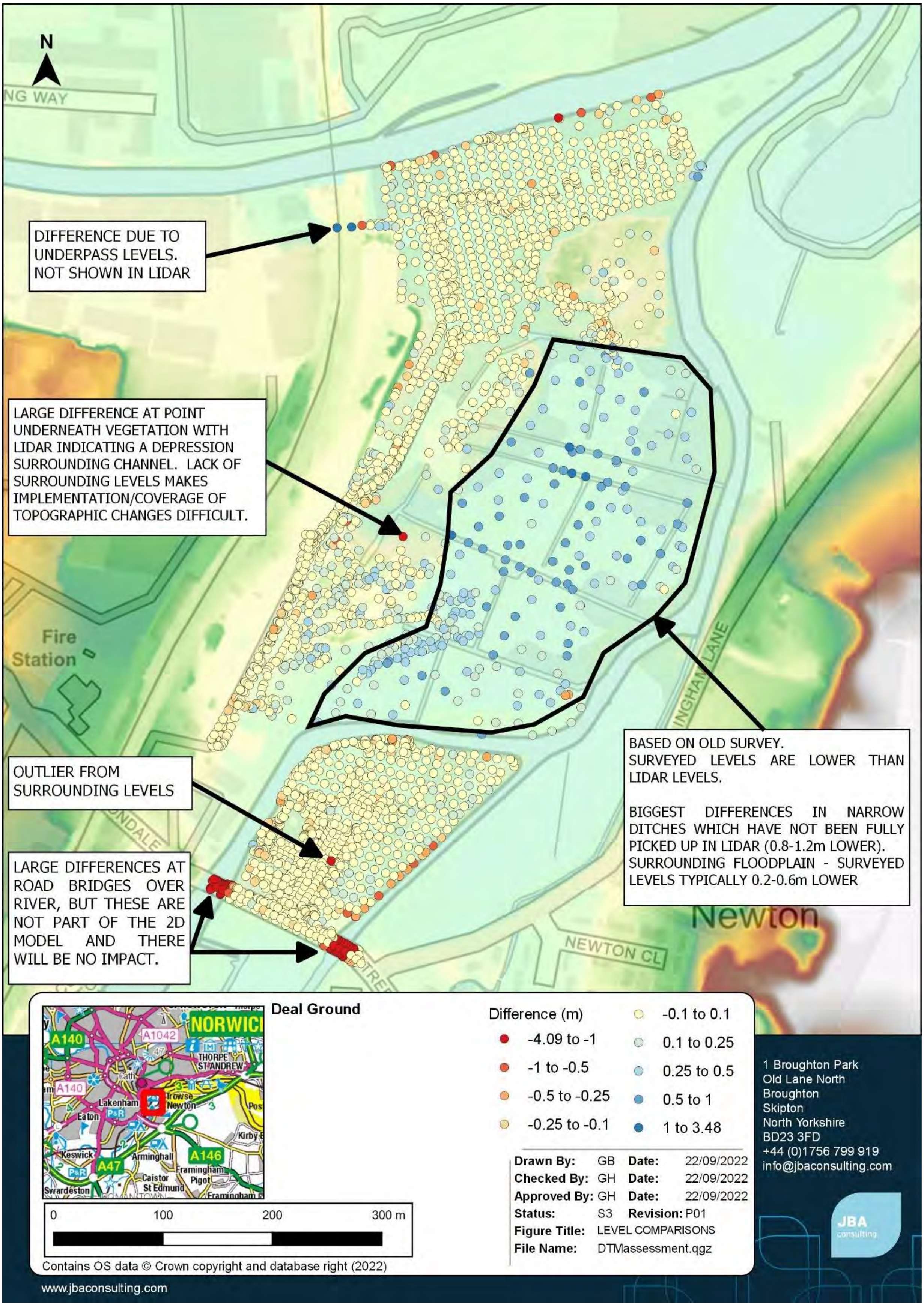
D.2 LiDAR Comparison



RECORD OF MEETING

1 Background and Context

2 Highway Drainage (adoptable)

3 Wensum Edge

4 Fen Village

5 Yare Newton

6 General Discussion

[redacted]

GH explained that [redacted]

POST-MEETING NOTE: use of a subsoiler is an established method for dealing with soil compaction and 'hardpan'. Such methods could be included within the Construction Management Plan and used to improve drainage within 'green' areas following construction activities.

[redacted]

POST-MEETING NOTE: an allowance for urban creep would ordinarily only apply to residential elements of a development. SL to confirm NCC's policy position and requirements

[redacted]

POST-MEETING NOTE: Noting that the NPPF Annex 3 classifies car-parks as 'less vulnerable', it would be helpful if NCC could confirm (i) its formal policy position on the design and siting of car-parking areas (for both residential and commercial uses) within flood risk areas and (ii) the policy/guidance/standards that underpin NCC's advice/requirements.

[redacted]

RECORD OF MEETING

[redacted]

F Ground Investigation

G Hydraulic Modelling

Technical note summarising hydraulic model information for EA review.

JBA consulting

Hydraulic Modelling Technical Report

Draft (S3-P01)

June 2023

Prepared for:
Serruys Property Company Ltd

www.jbaconsulting.com

Document Status

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Prepared by	Peter Barber MEng Analyst
Reviewed by	Gavin Hodson BSc FdSc Chartered Analyst
Authorised by	Gavin Hodson BSc FdSc Chartered Analyst

Contents

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1 Model Build

1.1 Overview

The model developed as part of this study is a combination of two Environment Agency (EA) models that have been truncated and merged to form one site specific model. These two models are:

- The Wensum (Norwich) Model (CH2M, 2017)
- The Broadlands Environmental Services Limited (BESL) model (Jacobs & CH2M, 2019)

This report documents decisions made in regard to model set up and assumptions made in the modelling process.

1.2 Wensum Model - CH2M 2017

The Wensum model starts is Drayton (617759,313244) and ends at downstream of Norwich (628663,307535). The start of the Wensum model is 1D only which and includes the River Tud. The model becomes a 1D | 2D model from Mile Cross Bridge (621737, 309873) until the downstream boundary of the model located immediately downstream of the A47.

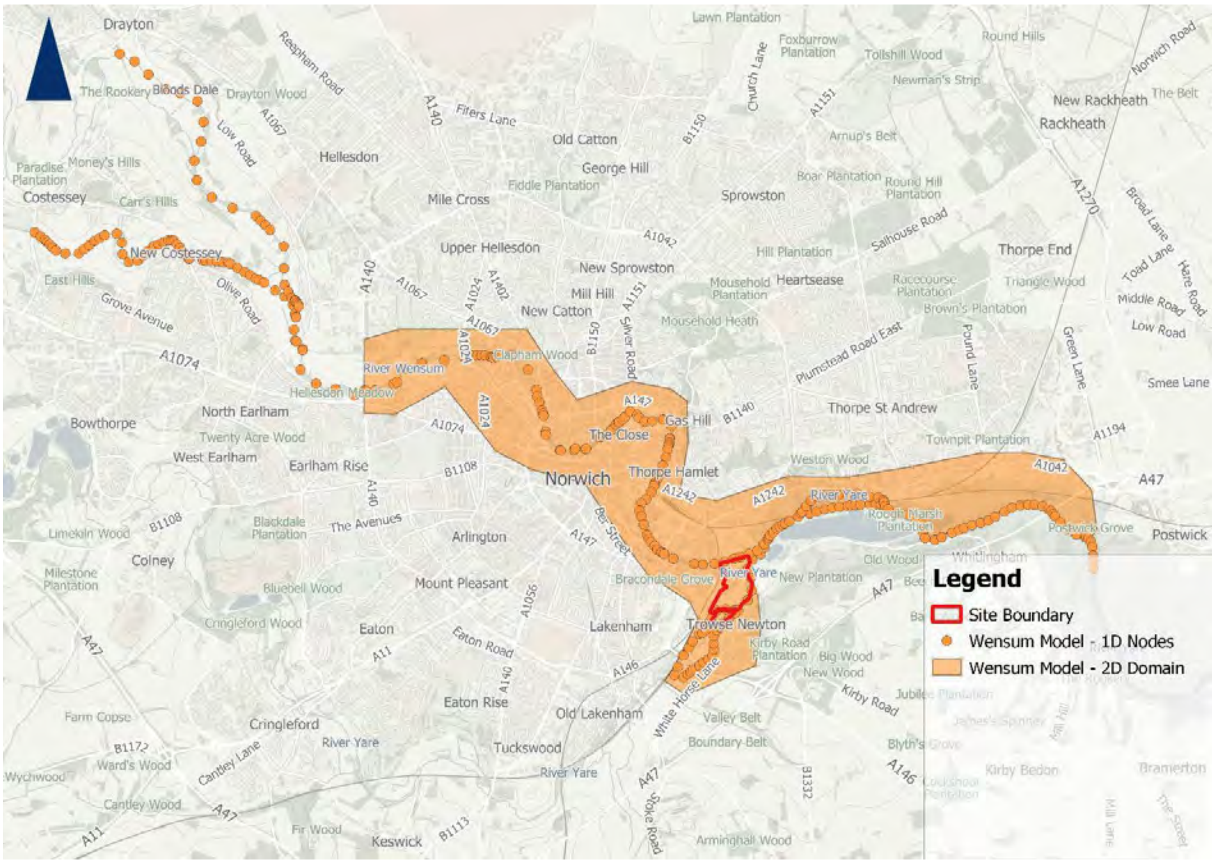


Figure 1-1: Wensum Model - CH2M, 2017 - Extent

1.2.1 Model Review - Wensum 2017

A detailed model review has been conducted and is provided in the supporting documentation named "2022s0896-Norwich_Techincal_Review_V1.0". The key model issues have been highlighted below:

- Model instability in the upper reaches of River Wensum – located well away from the subject site.
- Out-of-date LIDAR – 2009/11 LIDAR in existing model.
- The positioning of 1D-2D connections is not necessarily along channel bank tops.
- Incorrect schematisation of some bridge decks in model which have been included in both the 1D and 2D domains.
- Widespread use of 0.03 roughness across the 2D floodplain which is not necessarily realistic.
- Missing flow route connection between Whittingham Little and Great Broad.

1.2.2 Model Updates - Wensum 2017

The model extends much further upstream along the Wensum than is required for this site-specific study. Therefore, model truncation is desirable to reduce run times (originally 40 hours for the entire model) and the removal of model instability associated with the 1D model build in the upper reaches of the River Wensum. A review of the existing model outputs has found that high ground at Carrow Road (to the west of the development site) acts a barrier to flow. With flow confined to the Carrow Road bridge, this provides a suitable location to truncate the model where flows can easily be extracted.

As stated in the model review, the existing model uses out-of-date LIDAR (2009/11). This will be updated to use the newer 2015 LIDAR.

1.3 Broadlands Environmental Services Limited - Jacobs & CH2M 2019

The BESL model represents much of the north-east coast of east Anglia. Much of the Broadlands system is below sea level, the model included many man-made defences, drainage structures as well as the main watercourses: Ant, Bure, Chet, Thurne, Waveney and Yare. The Broadland water levels are tidally dominated and features large storage areas.

The BESL model was incorporated into this study to accurately represent the tidal downstream boundary. The Wensum 2017 downstream boundary did not account for the large amount of tidal storage. By using the BESL model in conjunction with the Wensum model the tidal impact at the site can be better represented and allow for comparison with gauge data at Reedham.

Figure 1-2: BESL Model - Jacobs & CH2m, 2019 - Extent

1.3.1 Model Review - BESL 2019

A brief model review was performed. Model updates were conducted recently by Jacobs and CH2M in 2019. The key review findings are highlighted below:

- Bank top levels compare well with latest topographical survey.
- Model stability is within tolerance.

- Implementation of hydrology climate change allowances is unconventional, and the methods used are not detailed in the supplied report.

1.3.2 Model Updates - BESL 2019

The BESL model covers a large portion of the Broadlands system that is not required for this modelling study. The model was truncated at the upstream node Y30200D and the downstream node Y10000d. The upstream node was truncated here to provide continuance from the Wensum model. The downstream node was terminated at Y10000d as it provides comparison with gauge data at Reedham level gauge.

1.4 Site Specific Model - JBA 2023

The site-specific model is a merger of the Wensum model and BESL model. Figure 1-3 shows the 1D model data sources and extent of the Norwich model. The model also contains the model updates that have been previously discussed in section 1.2.2 and 1.3.2.

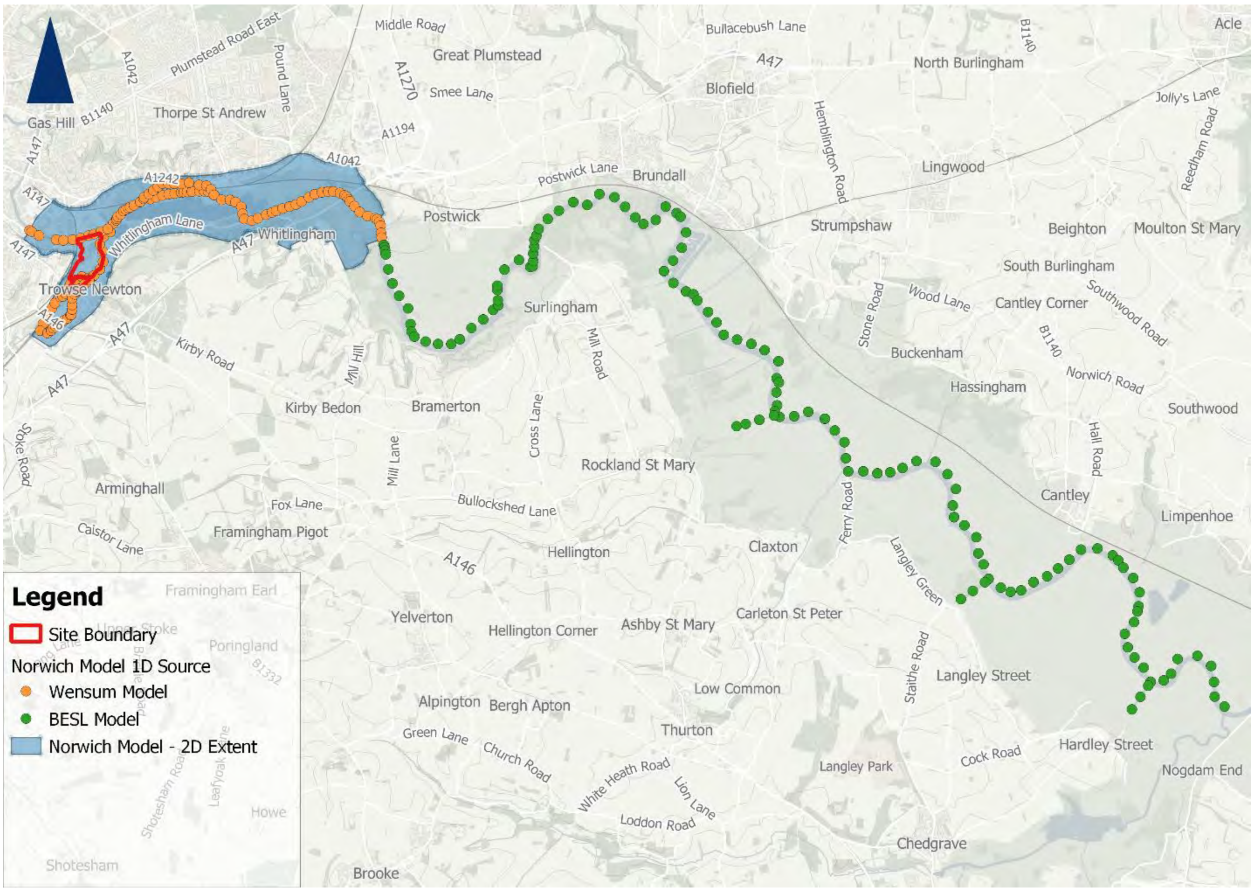


Figure 1-3: Norwich Model - JBA 2023 - 1D Model Node Source

1.5 Proposed Development

The proposed development is shown in Figure 1-4. The development will involve ground raising for development areas, the inclusion flood compensatory storage, and the addition of a road bridge across the River Yare.

The development will require the addition of four culverts, Figure 1-4 shows the location and a summary is shown in Table 1-1. There will be two at the north of the site, to maintain the flow route from the Bottle kiln to the Wensum. And two culverts either side of the proposed bridge that connects Deal Ground and May Gurney. The culverts at the bridge maintain conveyance through the bridge.

Table 1-1: Norwich Model - JBA 2023 - Proposed Culverts

Culvert Location	Upstream Invert level (mAOD)	Downstream Invert level (mAOD)	Size (width x height) (m)
Bridge (Left Bank)	1.22	1.21	7.50 x 2.70
Bridge (Right Bank)	1.82	1.81	7.50 x 0.97
DG Culvert North	1.21	1.20	0.6 (diameter)
DG culvert South	1.22	1.21	0.6 (diameter)

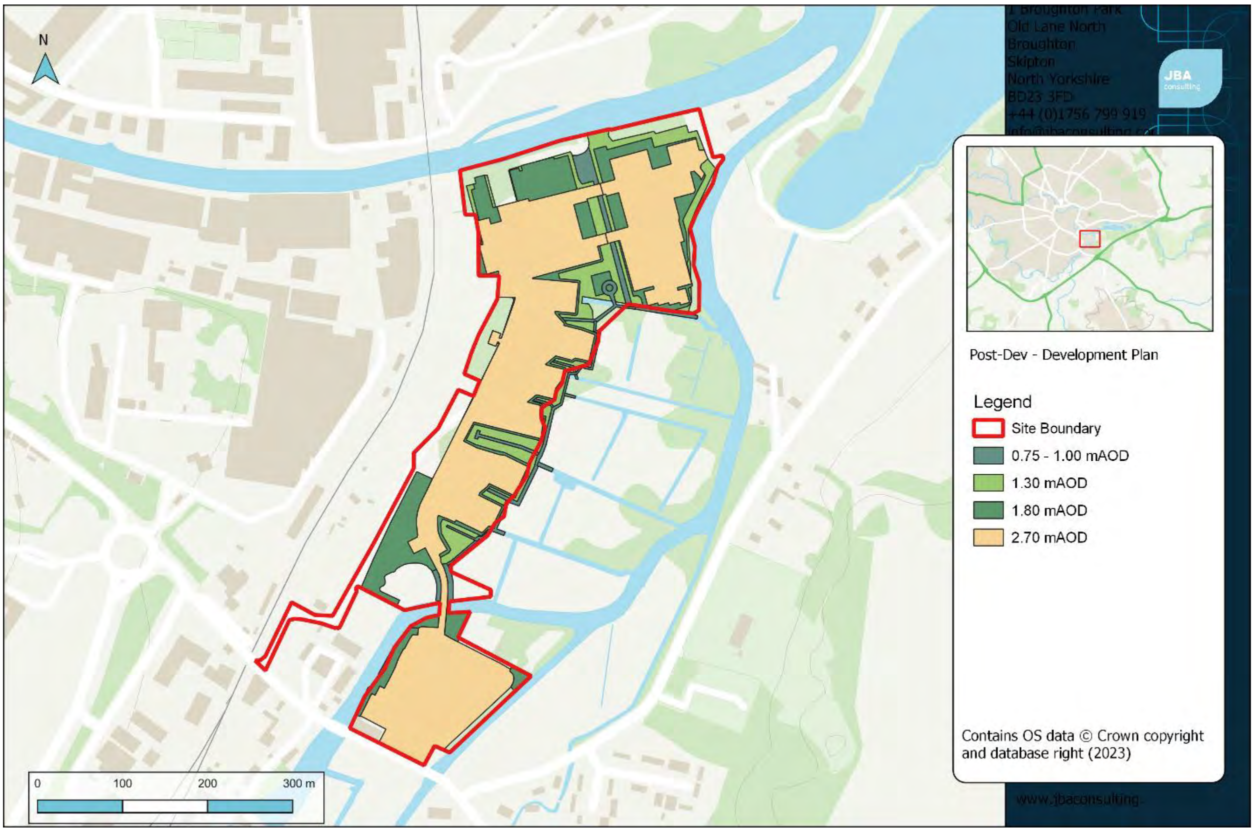


Figure 1-4: Norwich Model - JBA, 2023 - Deal Ground Proposed development

The baseline LiDAR and development plan LiDAR are compared in Figure 1-5. It can be seen where the land raising activities have occurred, as well as the storage space gained.

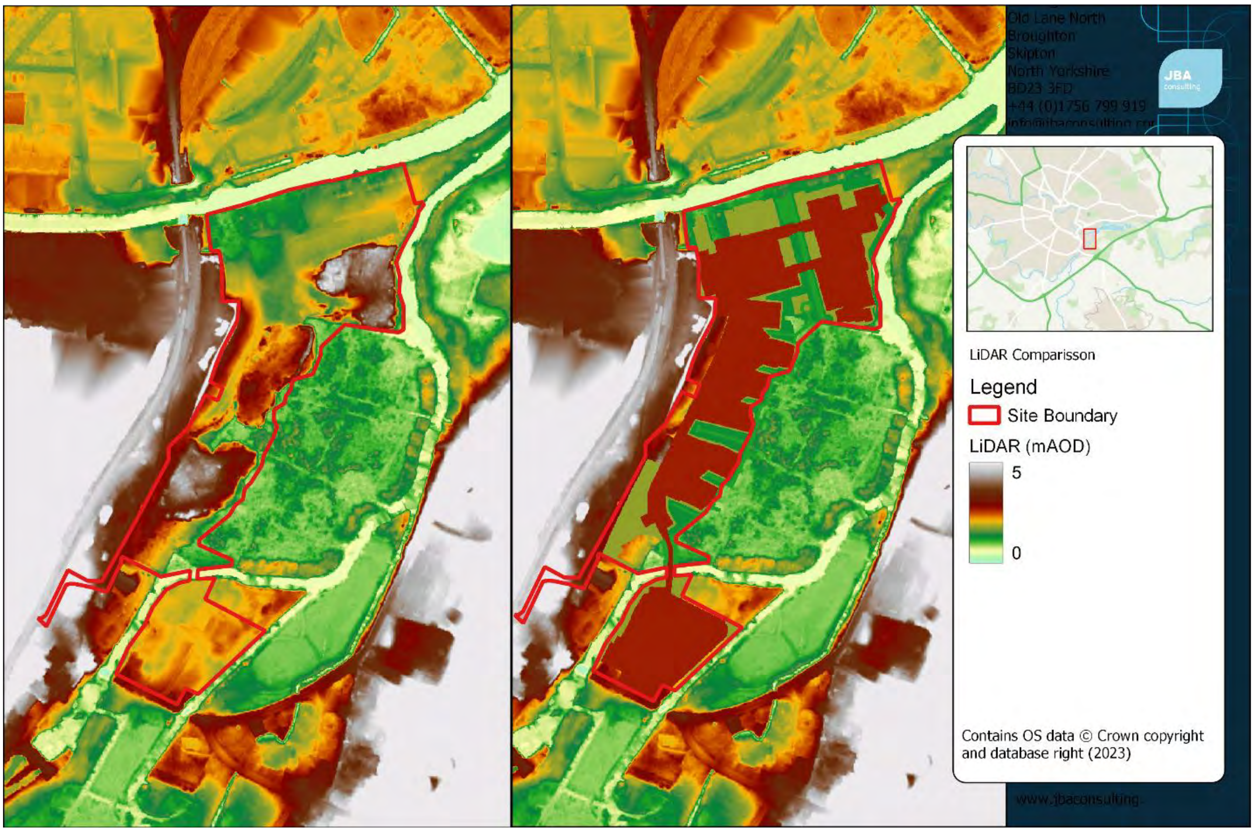


Figure 1-5: Norwich Model - JBA, 2023 - Deal Ground LiDAR Comparison

1.6 Model Run Record

Table 1-2 shows a complete model run list for the Norwich Model. The fluvial AEP indicates the input event for all the fluvial model inflows. The DSBDY has been calculated by using the Norfolk Broads model (BESL). The fluvial and tidal AEP listed in Table 1-2 show the input values for the downstream boundary.

Table 1-2: Model Simulation Record

Primary Scenario	Fluvial AEP	DSBDY Event (Fluvial AEP | Tidal event)
Baseline	3.3%	5% | MHWS
	3.3% + 11% CC	5% + 11%CC | MHWS + CC
	1.0%	1.0% | MHWS
	1.0% + 11% CC	1.0% +11%CC | MHWS + CC
	0.1%	0.1% | MHWS
	0.1% + 11% CC	0.1% + 11%CC | MHWS + CC
MP_F_001	3.3%	5% | MHWS
	3.3% + 11% CC	5% + 11%CC | MHWS + CC
	1.0%	1.0% | MHWS
	1.0% + 11% CC	1.0% +11%CC | MHWS + CC
	0.1%	0.1% | MHWS
	0.1% + 11%CC	0.1% + 11%CC | MHWS + CC

2 Model Boundary Conditions

2.1 Overview

The 1D model has ten boundary conditions in total, which can be divided into four categories:

Wensum Model inflows - There are six inflows along the truncated Wensum model. The inflows at WE1227d and YARF1_550d are the upstream inflows of the Wensum and Yare rivers, respectively, where the upstream of the original model was truncated. The remaining four inflows are lateral inflows, representing incoming water from other sources.

Wensum BESL Model Border - Due to the combination of a 1D|2D model into a 1D only model, an additional boundary condition was required to transfer the mass of water in the 2D floodplain into the downstream 1D model boundary.

BESL Model Inflows - These are the two remaining Yare inflows present in the original BESL model between the point of upstream truncation (Y30200U) and downstream truncation (Y10000).

BESL Downstream Boundary - This is the downstream model boundary located upstream of Reedham, just before the confluence with the River Chet.

Table 2-1 summarises the inflows, and Figure 2-1 shows the location of the model nodes.

Table 2-1: Model Boundary Conditions - Summary

Category	Boundary Name	Boundary Type	Location (NGR Reference)
Wensum Model Inflows	WE1227d	QT	Carrow Road Bridge (623903, 307741)
Wensum Model Inflows	YARF1_550d	QT	Loddon Road Bridge (A146) (624007, 306386)
Wensum Model Inflows	Y5int	Lateral ReFH QT	YAN6913 (624238, 306752) YAN5955 (624889, 307314)
Wensum Model Inflows	N4	Lateral ReFH QT	YAN5134 (625166, 308010) YAN4200 (625989, 308270)
Wensum Model Inflows	N6	Lateral ReFH QT	YAN2894 (626988, 307924) YAN1803 (628034, 308282)

Category	Boundary Name	Boundary Type	Location (NGR Reference)
Wensum Model Inflows	N7	Lateral ReFH QT	YAN1607 (628222, 308206) YAN0817 (628724, 307707)
Wensum Model / BESL	YAN0726ND	HT BDY	Wensum model / BESL model border (628446, 307336)
BESL Inflows	YARE1	FEH QT	Y22400U (632822, 307088)
BESL Inflows	YARE2	FEH QT	SD6LD (634064, 305542)
BESL Downstream Boundary	Y10000d	HTBDY	Upstream of Reedham (640046, 301255)

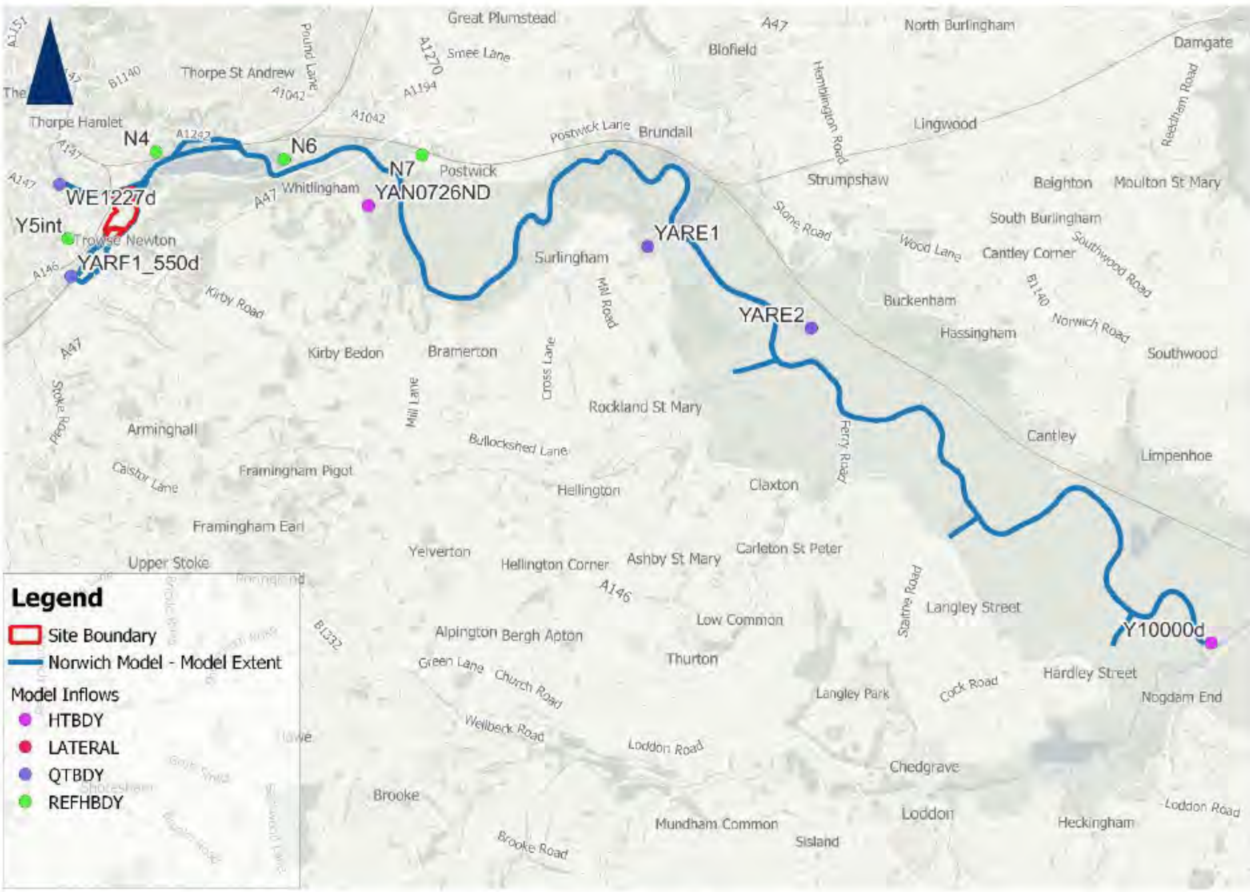


Figure 2-1: Model Boundary Conditions Location Plan

2.2 Climate Change Allowances

The River Wensum and River Yare are located within the Broadlands River Management Catchment. To estimate the fluvial model inflows for the catchment's lifetime, the central value from the 2080s epoch was used. The climate change allowances are shown in Table 2-2.

Table 2-2: Climate Change Allowances

Epoch	Central	Higher	Upper
2020s	8%	14%	27%
2050s	3%	10%	27%
2080s	11%	20%	44%

The tidal climate change allowances have remained unchanged from the Jacobs BESL model.

2.3 Model Inflows - Norwich

The lateral inflows (Y5int, N4, N6, and N7) have been configured with a ReFH flow-time boundary, which is applied to lateral inflow across multiple nodes. This approach has remained unchanged from the original Wensum model.

As for the inflows at WE1227d and YARF1_550d, they are flow time boundaries (QT) and represent the upstream inflows of the Wensum and Yare rivers, respectively. Two approaches have been taken to find the upstream model inflow values. One approach involves extracting the model flow-time series results from the node at the point of truncation in the full Wensum model, while the other approach uses the ReFH2 method.

2.3.1 Wensum Model 2017 Model Inflows

This approach involves extracting the flow-time series data from the WE1227d and YARF1_550d nodes from the original model, which utilizes the existing hydrology. These flows were updated as part of the 2017 assessment.

2.3.2 ReFH2 Approach

2.3.2.1 Catchment Descriptors

The hydrology has been calculated using an Urban ReFH2 approach. The catchment descriptors were captured from the FEH web application at the inflow node locations. A summary of key catchment descriptors is shown in Table 2-3.

The two catchments exhibit many similarities; both have high BFIHOST values, which are indicative of chalk catchments. At this stage in the rivers' reach, the Wensum catchment covers a much larger area than the Yare catchment.

Table 2-3: ReFH2 Approach - Key Catchment Descriptors

Catchment Descriptors	WE1227d	YARF1_550d
Area (km2)	673	278
URBEXT	0.032	0.032
SAAR (mm)	666	632
BFIHOST	0.689	0.547
DPLBAR (km)	47.61	30
DPSBAR (m/km)	20.6	19.5

2.3.2.2 Storm Duration Analysis

The critical storm duration can be defined as 'The duration of rainfall event likely to cause the highest peak flows or levels at a particular location, for a specified return period event' (CIRIA, 2015).

The storm duration of 1% AEP rainfall events have been compared for each catchment in Figure 2-2 and Figure 2-3. The storm durations that yield the peak flow are 62 hours for the Wensum catchment and 42 hours for the Yare catchment. However, the storm duration with the greatest peak flows may not necessarily cause the greatest flooding impact. This is because some catchments are more sensitive to volume, such as those with large floodplain storage, and therefore a longer storm duration would result in more water in the catchment.

The chosen model storm duration is the 62-hour storm duration for both catchments. Both catchments will be modelled with the same storm duration due to the equidistant location of the confluence from both inflow locations. This means that both watercourses will peak together at the confluence near the site, providing a conservative estimated of flooding.

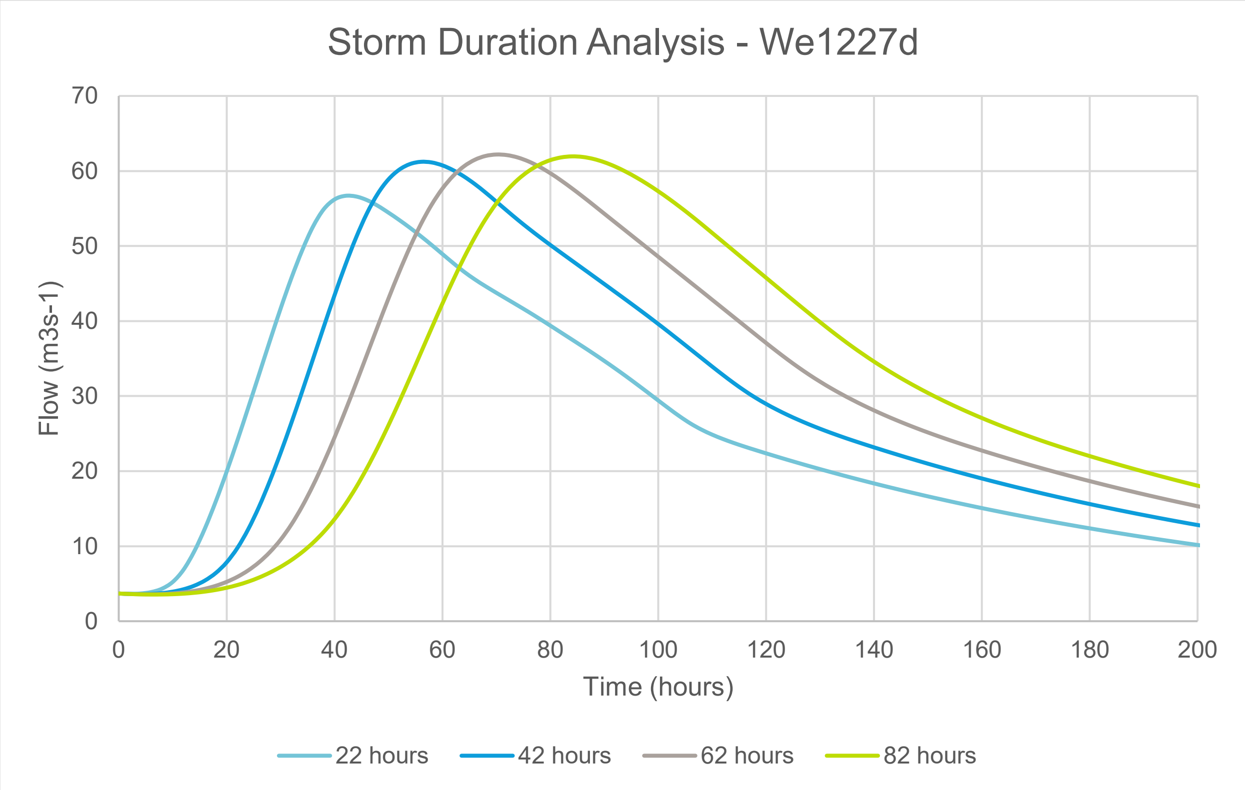


Figure 2-2: Storm Duration Analysis - WE1227d - 1% AEP

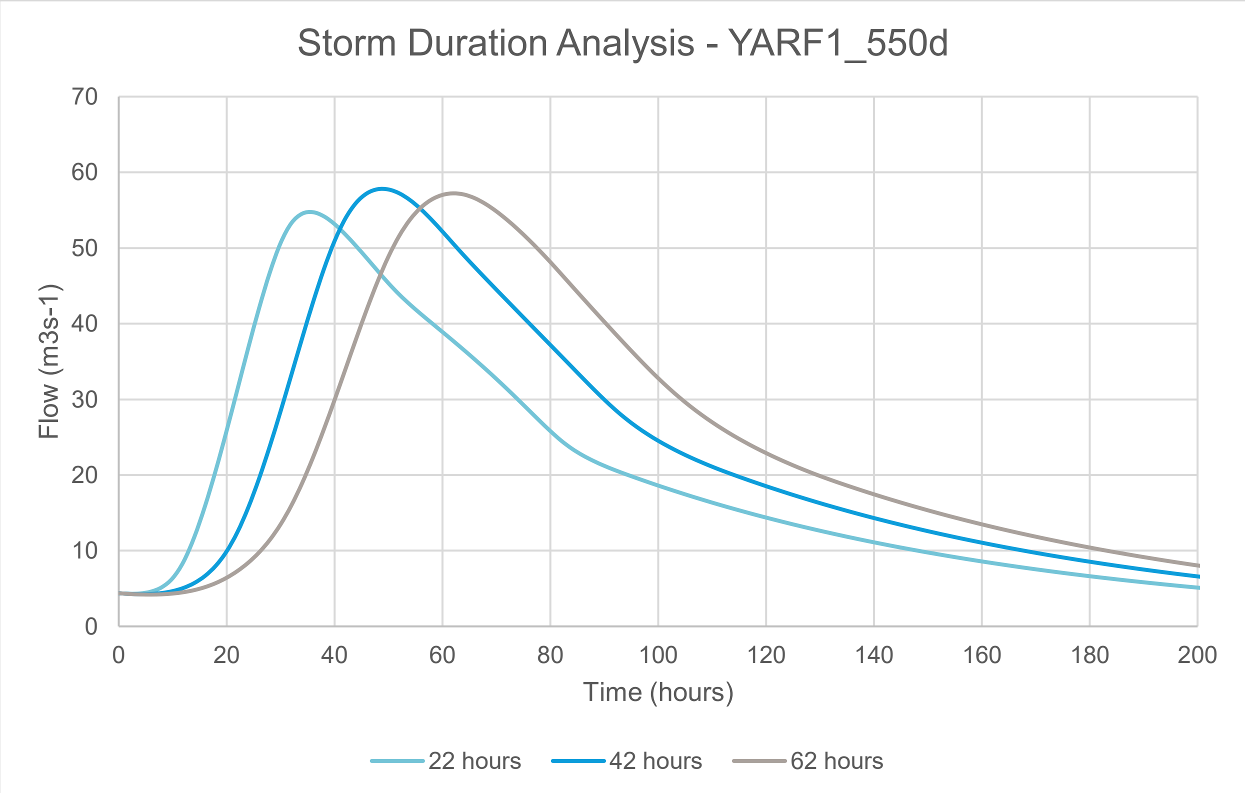


Figure 2-3: Storm Duration Analysis - YARF1_550d - 1% AEP

2.3.2.3 ReFH2 Model Inflows

The ReFH2 Model inflows are shown in Figure 2-4 and Figure 2-5. The Wensum shows the higher peaks, which is expected given the higher catchment area.

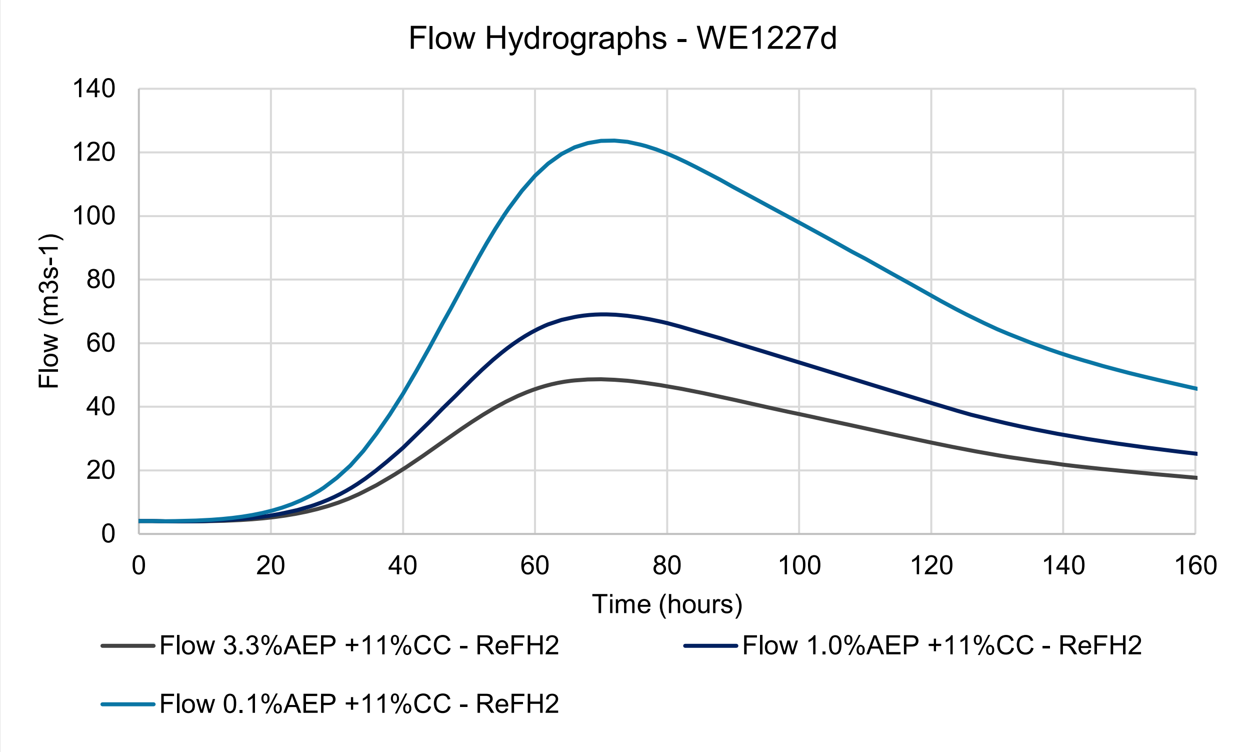


Figure 2-4: ReFH2 62-Hour Model Inflows - WE1227d

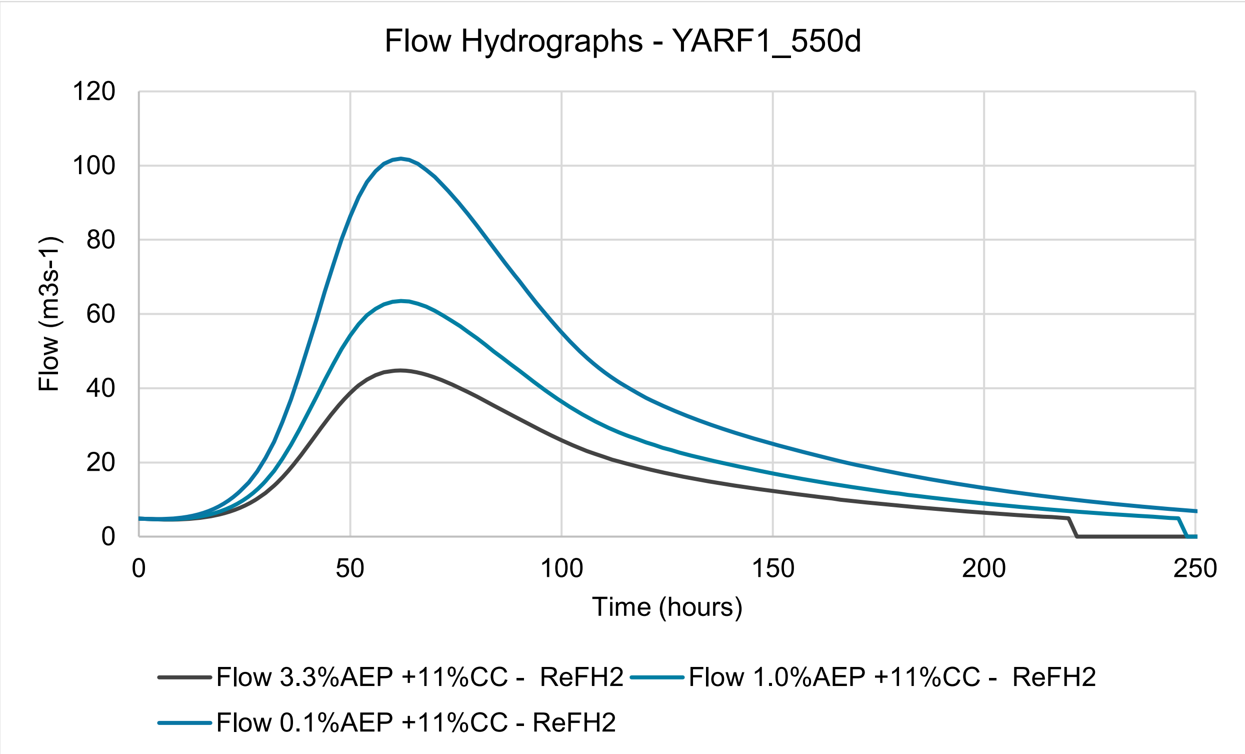


Figure 2-5: ReFH2 62-Hour Model Inflows - YARF1_550d

2.3.3 Method Comparison

The two methods have been plotted together in Figure 2-6 and Figure 2-7, as well as a comparison of peak flows in Table 2-4.

The two approaches to the Wensum inflow, yield similar peak values in low % AEP events but the ReFH2 produces lower peak flows in higher % AEP events. This shows that the growth curves used to create both flows are different but converge near the 1.0% and 0.1% AEP events. The two approaches show very different shapes, the ReFH2 approach shows a very smooth rising and falling limb. Whereas the other method shows a much flatter flow peak and longer period. This due to the hydrographs being extracted from the model and the influence of the downstream boundary is felt. Hence the oscillations at the start and end of the hydrograph.

The two approaches to the Yare inflow, show the opposite peak flow relationship to the Wensum. The Yare shows similar peak values in High % AEP events, and very different peak flows in low % AEP events. Both methods show similar shapes, except for the initial small "hump" in the model extracted flow curves.

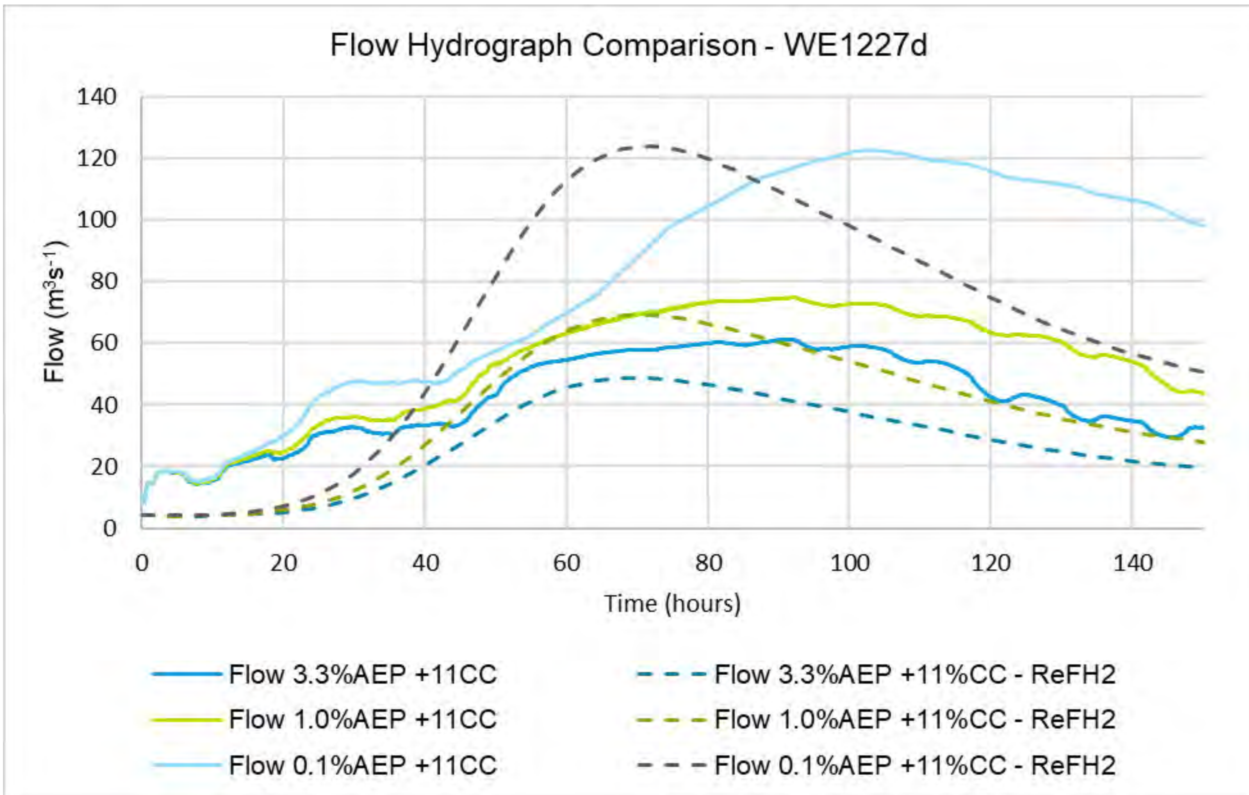


Figure 2-6: Model Flow Method Comparison - WE1227d

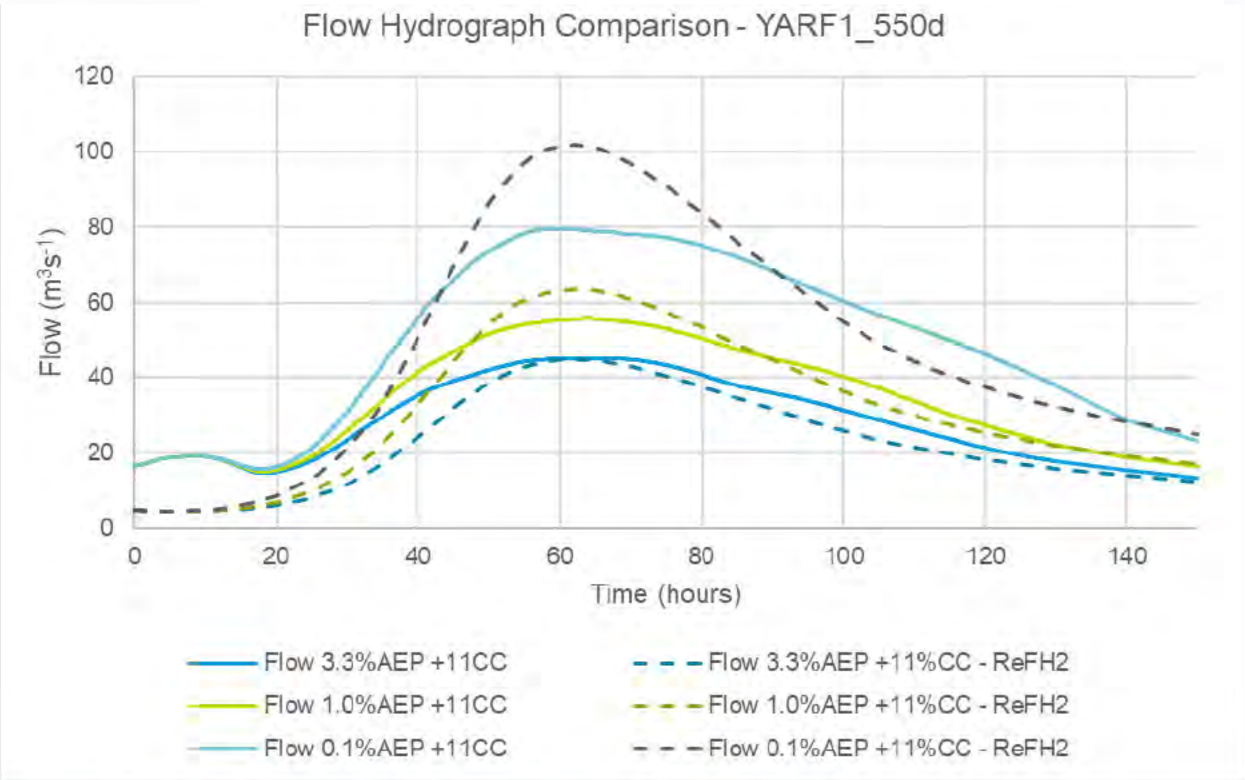


Figure 2-7: Model Flow Method Comparison - YARF1_550d

Table 2-4: Peak Flow comparison

% AEP	WE1227d Flows (m3s-1)		YARF1_550d Flows (m3s-1)	
	Model 2017	ReFH2 62h	Model 2017	ReFH2 62h
3.30	55.04	43.83	40.70	40.36
3.3 + 11%CC	61.09	48.66	45.18	44.80
1.00	67.28	62.19	50.52	57.22
1.0 + 11%CC	74.68	69.03	56.08	63.51
0.10	110.33	111.44	71.72	91.79
0.1 + 115CC	122.46	123.70	79.61	101.89

2.4 Wensum Model - BESL Model

The truncated Wensum model is a 1D|2D model. Where the Wensum model blends into the BESL model there is water in the 2D Floodplain. The BESL model is 1D only, the water in the 2D floodplain must be inputted into the 1D model.

This has been achieved by using a TUFLOW Type SX 2d boundary condition on the border between the two models. The SX boundary intakes the water into the 2D floodplain and connects it to a 1D node, called YAN0726ND. YAN0726ND is represented as a 1D Head Time (HT) Boundary that inputs the 2D flow into the 1D BESL model. This ensure the mass balance is conserved. YAN0726ND is not rated to AEPs, as it is dependent on the movement of water in the 2D floodplain.

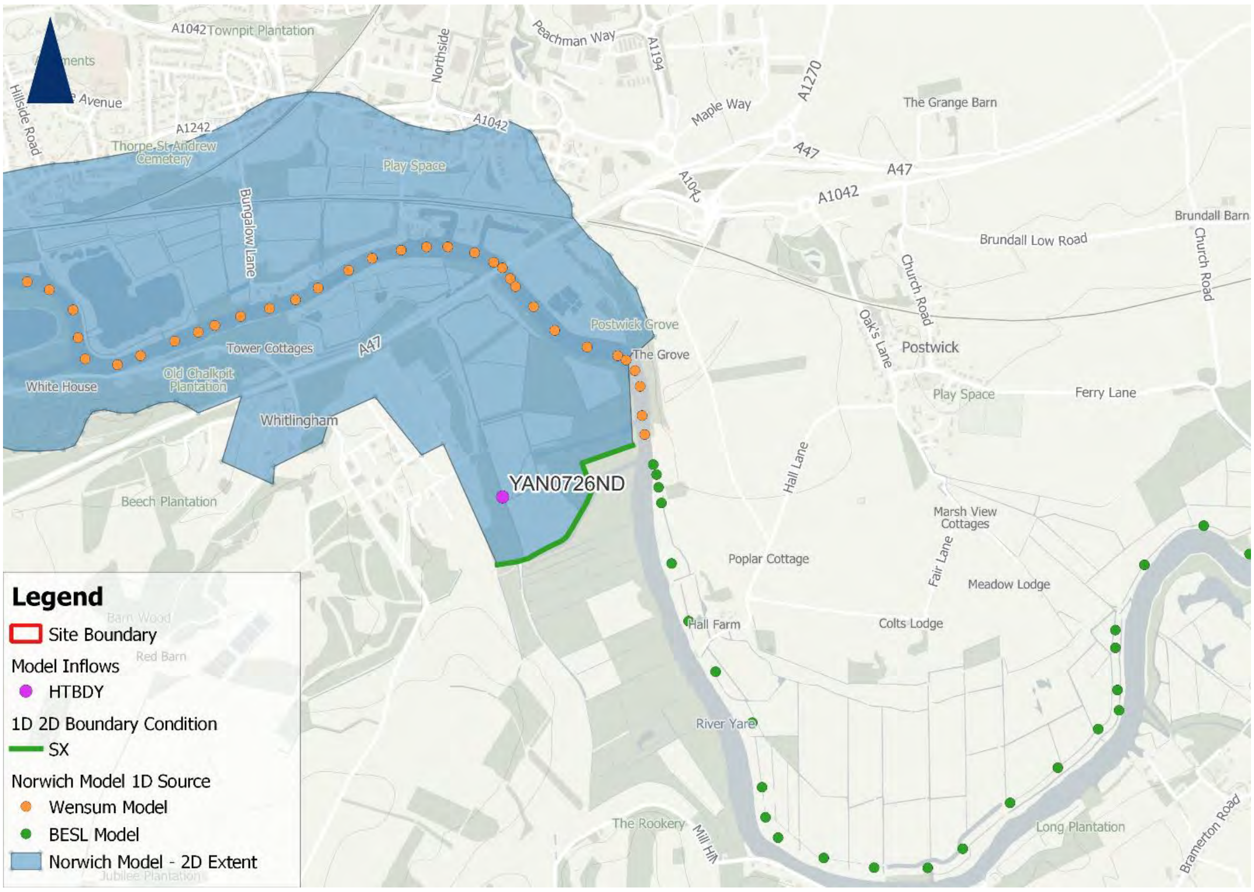


Figure 2-8: Wensum / BESL Model Border - SX Boundary Condition

2.5 BESL Inflows - Yare

The original BESL model covers a large area and contains many inflows. When the model was truncated the only inflows that remained are Yare_1 and Yare_2. These inflows are FEH QT boundaries and are identical because they contain the same FEH catchment descriptors. The model inflow peak values are shown in Table 2-5.

Table 2-5: BESL Inflows - Peak Flows (m3s-1)

Event	Yare 1 Peak Flow (m3s-1)	Yare 2 Peak Flow (m3s-1)
3.3% AEP	11.99	11.99
3.3% AEP +11%CC	13.30	13.30
1.0% AEP	16.85	16.85
1.0% AEP +11%CC	18.70	18.70
0.1% AEP	32.52	32.52
0.1%AEP +11%CC	36.10	36.10

2.6 BESL Downstream Boundary - Reedham

The downstream boundary is located 2.1km upstream of the village of Reedham, where the Yare meets the River Chet. The downstream boundary is a normal depth boundary to represent the tidal influence of the catchment.

The downstream boundary was calculated by running the original Jacobs and CH2M (2020) BESL model and extracting the stage-time series data at the Y10000d node. Inflows in the Jacobs and CH2M BESL model were updated to represent current climate change adjustments in the Broadlands River Management catchment. Table 2-6 shows the peak stage and Figure 2-9 show the stage-time data Y10000d for each event.

The events are detailed as "Fluvial %AEP | Tidal event ".

A fluvial 5% AEP event was run in place of a 3.3%AEP event. This is because the original model was not run for a 3.3% AEP event and due to the complex nature of the model hydrology it was not possible to create one.

Table 2-6: Peak Stage

Event	Peak Stage (mAOD)
5.0% AEP | MHWS	1.06
5.0% AEP + 11%CC | MHWS CC	1.60
1.0% AEP | MHWS	1.12
1.0% AEP + 11%CC | MHWS CC	1.63
0.1% AEP | MHWS	1.36
0.1% AEP + 11%CC | MHWS CC	1.84

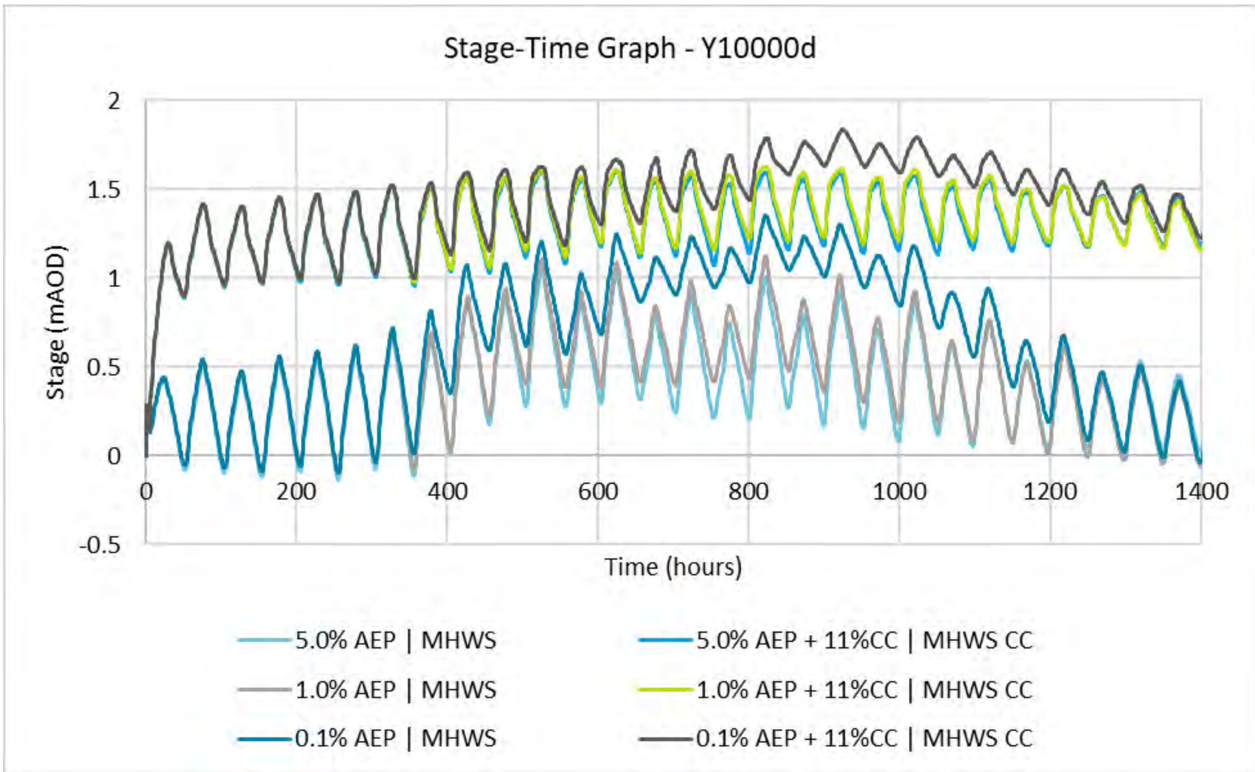


Figure 2-9: Stage-Time Graph - Y10000d

3 Model Performance

3.1 Overview

Sensitivity Testing is an essential part of the model build process. Sensitivity testing determines the impact of key model parameters on the model results and stability. The model parameters tested in this study are Manning's roughness and Downstream boundary level.

3.2 Model Sensitivity Analysis

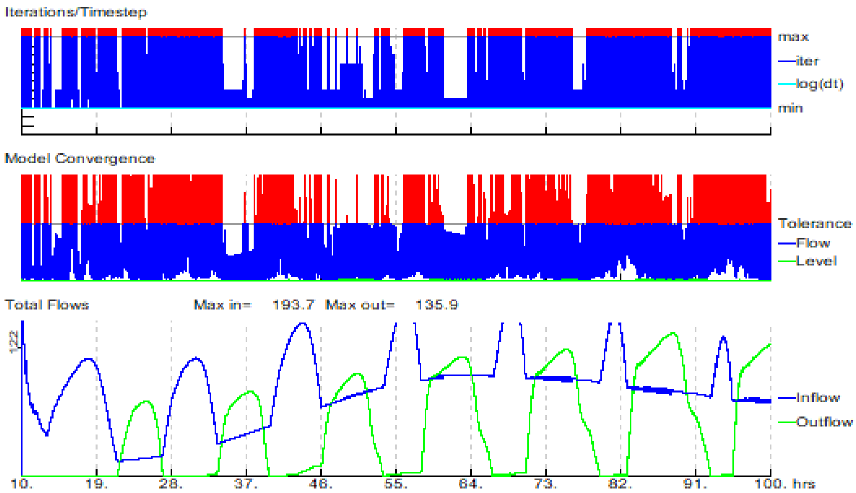
Sensitivity to flow and downstream boundary undertaken as part of the modelling process. Further tests to be agreed as part of EA review process.

3.3 Model Stability

3.3.1 1D Model Convergence

Figure 3-1 and Figure 3-2 show the Flood Modeller iteration and convergence plots for both the 3.3% AEP + 11%CC and the 1% AEP +11%CC events. The 1D model shows poor convergence, requiring high numbers of iterations of to reach a solution.

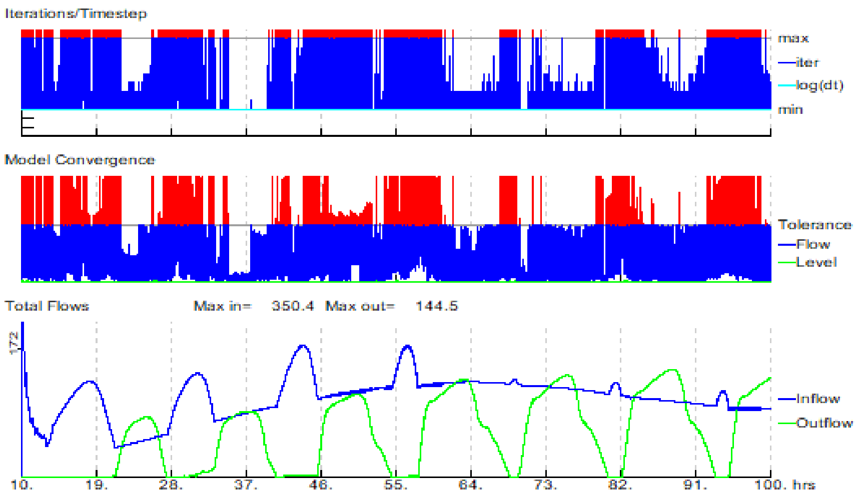
The stabilities issues are caused by the tidal downstream boundary and the large 2D storage areas. The downstream boundary controls the model level and causes fluctuations in the model flow series. The large amount of water in the 2D floodplain is due to the vast low lying storage areas in the catchment. This water is slow moving and "sits" on the 1D/2D boundary creating small oscillations between the two domains.



Datafile: ...\R3_WENSUM_NORWICH_BASELINE_2022_BESL_V5.DAT
Results: ..._BESL_-_BASELINE_-_3-3AEP_11CC_MHSWCC_62H.zzl
Ran at 11:31:37 on 21/03/2023
Ended at 04:47:53 on 22/03/2023
Start Time: 10.000 hrs
End Time: 100.000 hrs
Timestep: 1.0 secs

Current Model Time: 100.00 hrs
Percent Complete: 100 %

Figure 3-1: Model Stability Analysis - 3.3% AEP + 11%CC 1D Summary



Datafile: ...\R3_WENSUM_NORWICH_BASELINE_2022_BESL_V5.DAT
Results: ...CH_BESL_-_BASELINE_-_1AEP_11CC_MHSWCC_62H.zzl
Ran at 16:42:29 on 20/03/2023
Ended at 17:51:01 on 21/03/2023
Start Time: 10.000 hrs
End Time: 100.000 hrs
Timestep: 1.0 secs

Current Model Time: 100.00 hrs
Percent Complete: 100 %

Figure 3-2: Model Stability Analysis - 1.0% AEP + 11%CC 1D Summary

3.3.2 Model Stability Parameter Adjustments

In order improve model stability several 1D and 2D parameters have been adjusted. The parameters that have been changed from default are listed in Table 3-1. These values have been used in selective runs where model instability led to no solution being found.

Table 3-1: Model Stability Parameter Adjustments

Parameter	Default	Adjusted	Comment
Alpha (1D)	0.7	0.5	Alpha is an under-relaxation parameter. It determines the weighting of the result towards the previous iteration, therefore increasing its value towards 1 will improve mass conservation.
Theta (1D)	0.9	0.5	Theta is a Preissmann box weighting factor. A value of 1.0 gives a fully implicit numerical scheme. Allowed range 0.5-1.0
Pivotal Choice (1D)	0.1	0.5	Specifies the degree of matrix pivoting away from non-zero values. A value of zero would result in no solution being found. In "noisy" models this value may need adjusting where the matrix values are oscillating near zero.
Min/Max Iterations (1D)	3/11	6/18	The minimum and maximum number of iterations impacts the number of iterations in which the model will process to find a solution. It is recommended to change these values in conjunction with Alpha and Theta.
HX - A (Form Loss Coefficient) (2D)	0.0	0.5	Applies a form loss coefficient to the HX line at the specified location. This can be useful for 1D/2D models where additional energy losses are needed to model the flow between a river (1D) and the floodplain (2D).

3.3.3 Cumulative Mass Error

Another indication of model stability is cumulative mass error. Typically, during a stable model run the cumulative mass error will have a value of ±1%. Figure 3-3 shows the mass balance recorded during the model run for the 3.3% AEP +11%CC and 1% AEP + 11%CC events. Both events are within the EA recommended tolerance. The 1% AEP + 11%CC event shows a high initial spike in mass error due to high stage initial conditions; this causes water to immediately enter the 2D floodplain. Because this occurs at the start of the model, where there is little water present in the entire model, this represents a significant percentage causing a large spike.

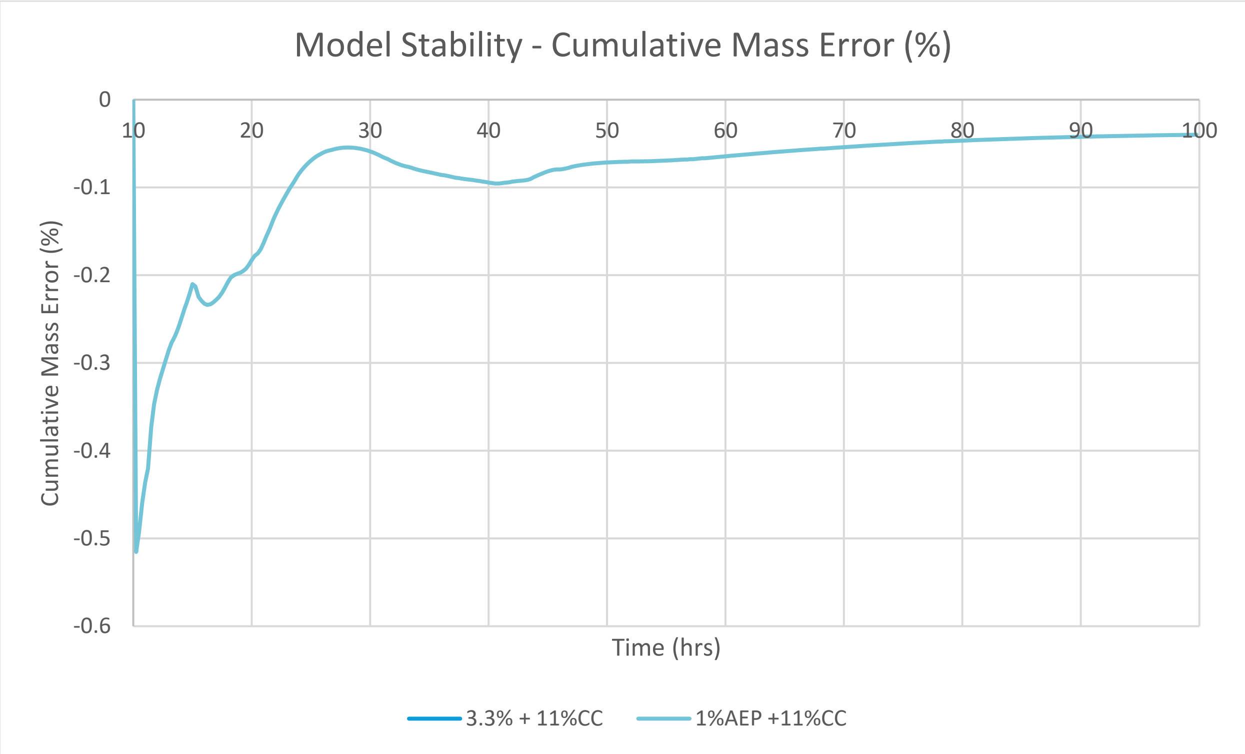


Figure 3-3: Model Stability Analysis - Cumulative Mass Error (%)

3.3.4 2D Volume

The output dVol measures the change in volume present in the 2D domain. Figure 3-4 shows the 2d volume recorded during the model run for the 3.3% AEP +11%CC and 1% AEP + 11%CC events. The volume mimics the time series of the tidal downstream boundary. The curves are gradual due to the slow movement of water between the 1D and 2D boundary.

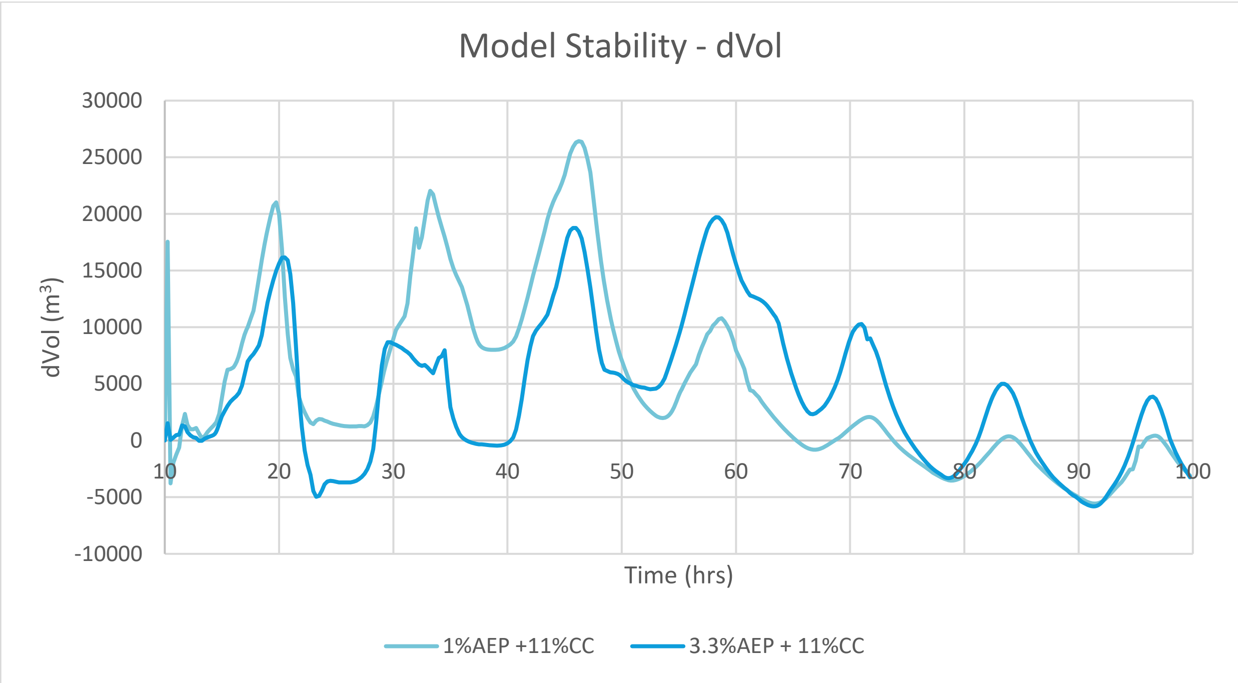


Figure 3-4: Model Stability Analysis - dVol

4 Model Files

4.1 1D Model Files

The core 1D Model files are shown in Table 4-1. The return period or AEP is represented by a place holder "X".

Table 4-1: 1D Model Files

File type		File Name
Data File (.DAT)	Baseline	R4_Wensum_Norwich_BESL_ 2023_Baseline-001.dat
	Post-Development	R4_Wensum_Norwich_BESL_ 2023_MP_F_001-001.dat
Event file (.IED)	Wensum & Norwich Inflows	R3_"X"%AEP_NORWICH-62hSD
	BESL Inflows	Yare_"X"yr_47hr_PH0
	Downstream Boundary - Present Day	R3-Y10000d- "X"AEP_11CC_MHWSCC.ied
	Downstream Boundary - Climate Change	R3-Y10000d-"X"AEP_MHWS.ied
Initial conditions (.IIC)		R3_N_BESL_-_MP_F_001_3- 3AEPCC-H-P-T-3h.iic
Results (.ZZL)	Baseline	R4_001_NORWICH_BESL_- _BASELINE_"X"AEP_MHSW(CC).zzl
	Post-Development	R4_001_NORWICH_BESL_- _MP_F_002_"X"AEP_MHSW(CC).zzl

4.2 2D Model Files

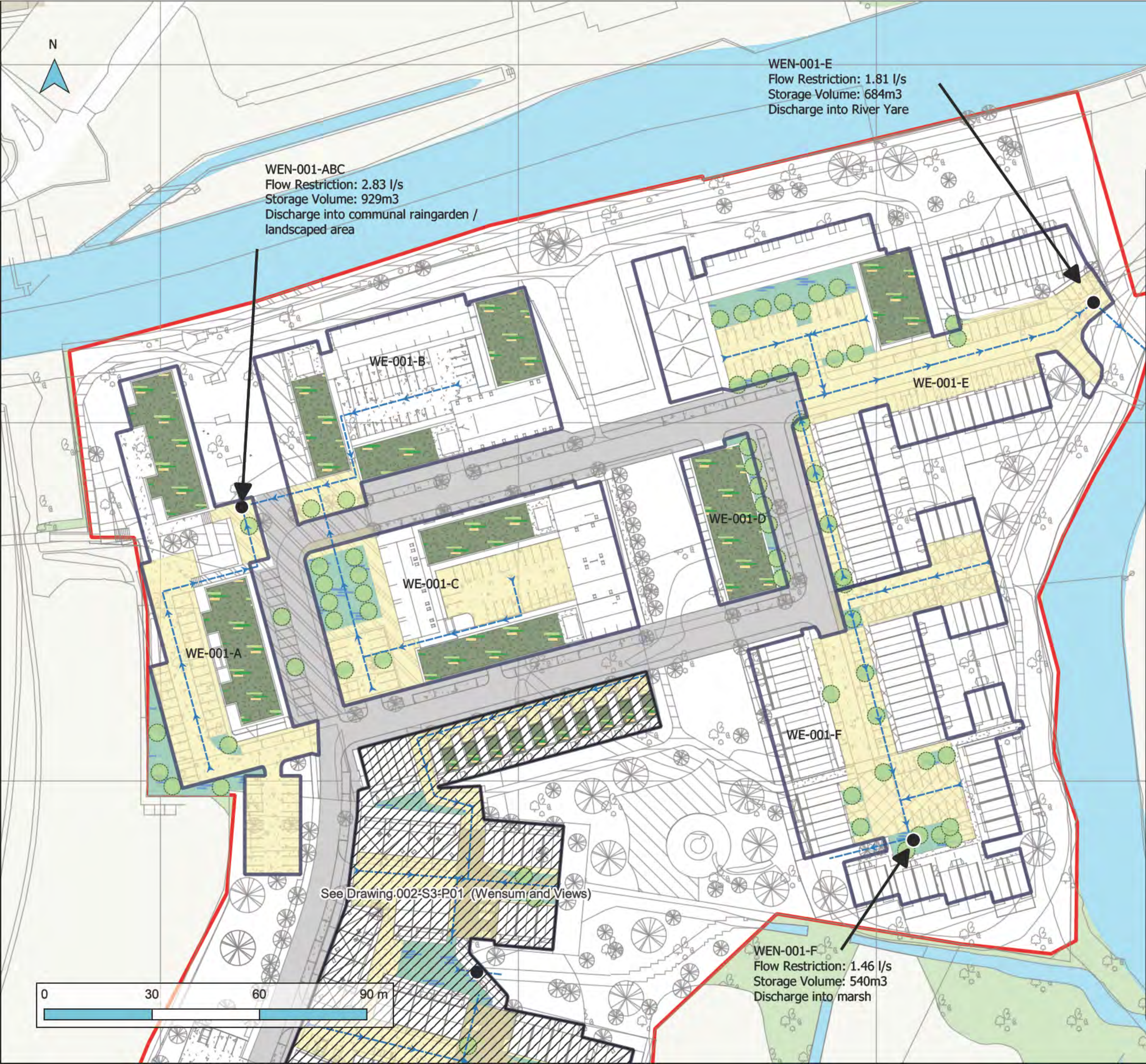
The core 2D model files are shown in Table 4-2.

Table 4-2: 2D Model Files

File Type	File Name
Tuflow Control file (.tcf)	R4_NORWICH_~s1~_~e1~_001.tcf
Tuflow Boundary Controller (.tbc)	R4_Wensum_Norwich_2023.tbc
Tuflow Geometry Controller (.tbc)	R4_Wensum_Norwich_2023.tgc
Tuflow Material File (.tmf)	R4_Wensum_Norwich_2023.tmf
Digital terrain Model (DTM)	Norwich_DTM-2021_Merge.asc

H SuDS

H.1 General Arrangement Drawings



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JBA consulting

SuDS Strategy - Wensum Edge

Legend

- Site Boundary
- Drainage Zones
- Master Plan
- Hydrobrake
- Drainage
- Tree Pits
- Rain Garden / Pond
- Green Roof
- Underground Storage

All volumes 1%AEP +CC45%

Drawing to be read in conjunction with Appendix H in FRA (DEALG-JBAU-XX-XX-FRA-0001-S3-P01)

Drawn By:	PB	Date:	15/06/2023	Scale:
Checked By:	GH	Date:	15/06/2023	1:1,000
Approved By:	GH	Date:	15/06/2023	Original at
Status:	S1	Revision:	P01	
Figure Title:	SuDS Strategy - Wensum Edge			
File Name:	0-JBAU-00-00-MX-Z-0002-Dealground Figures PB.qgz			

1 Broughton Park
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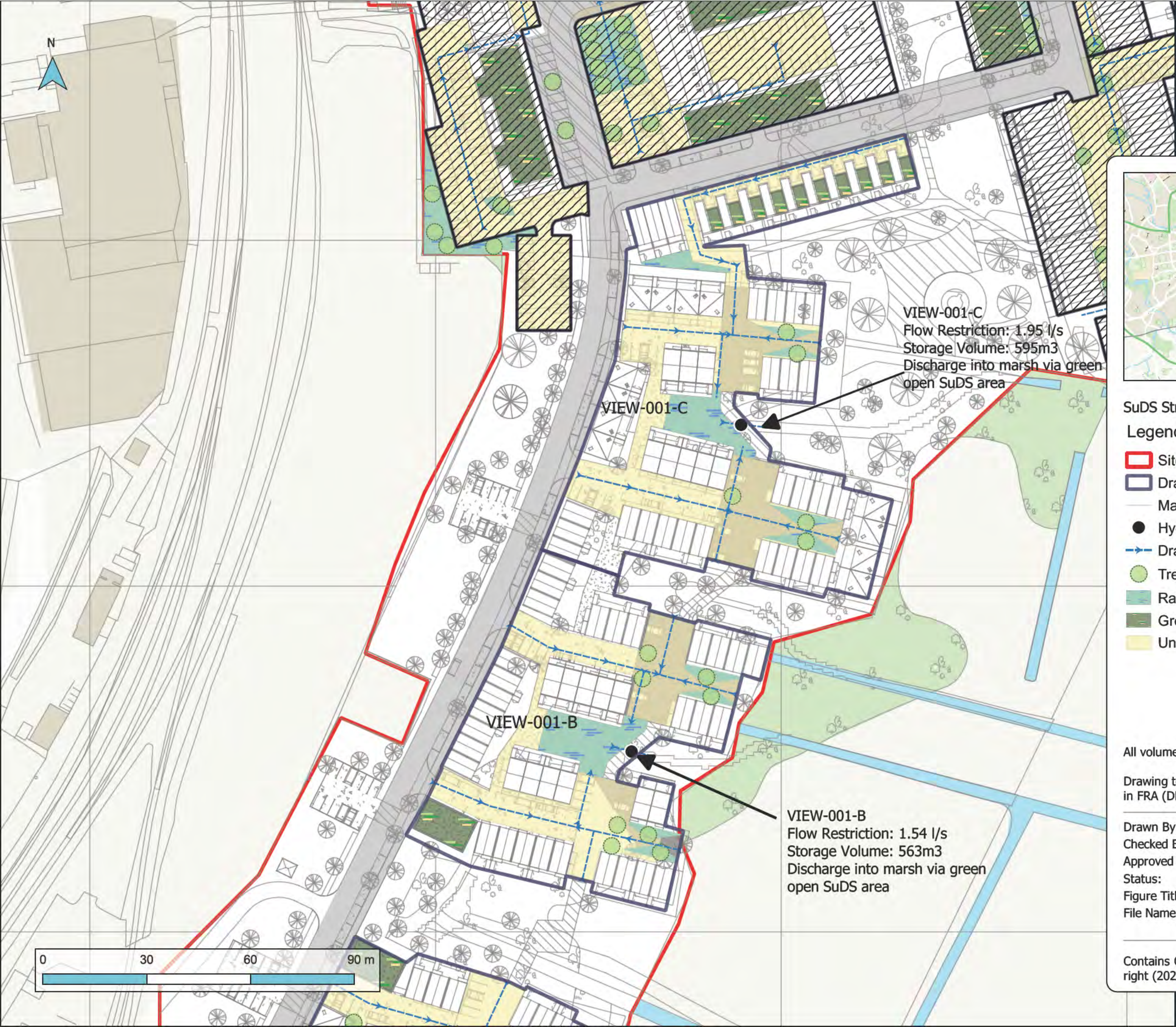
+44 (0)1756 799 919
info@jbaconsulting.com



SuDS Strategy - The View (North)

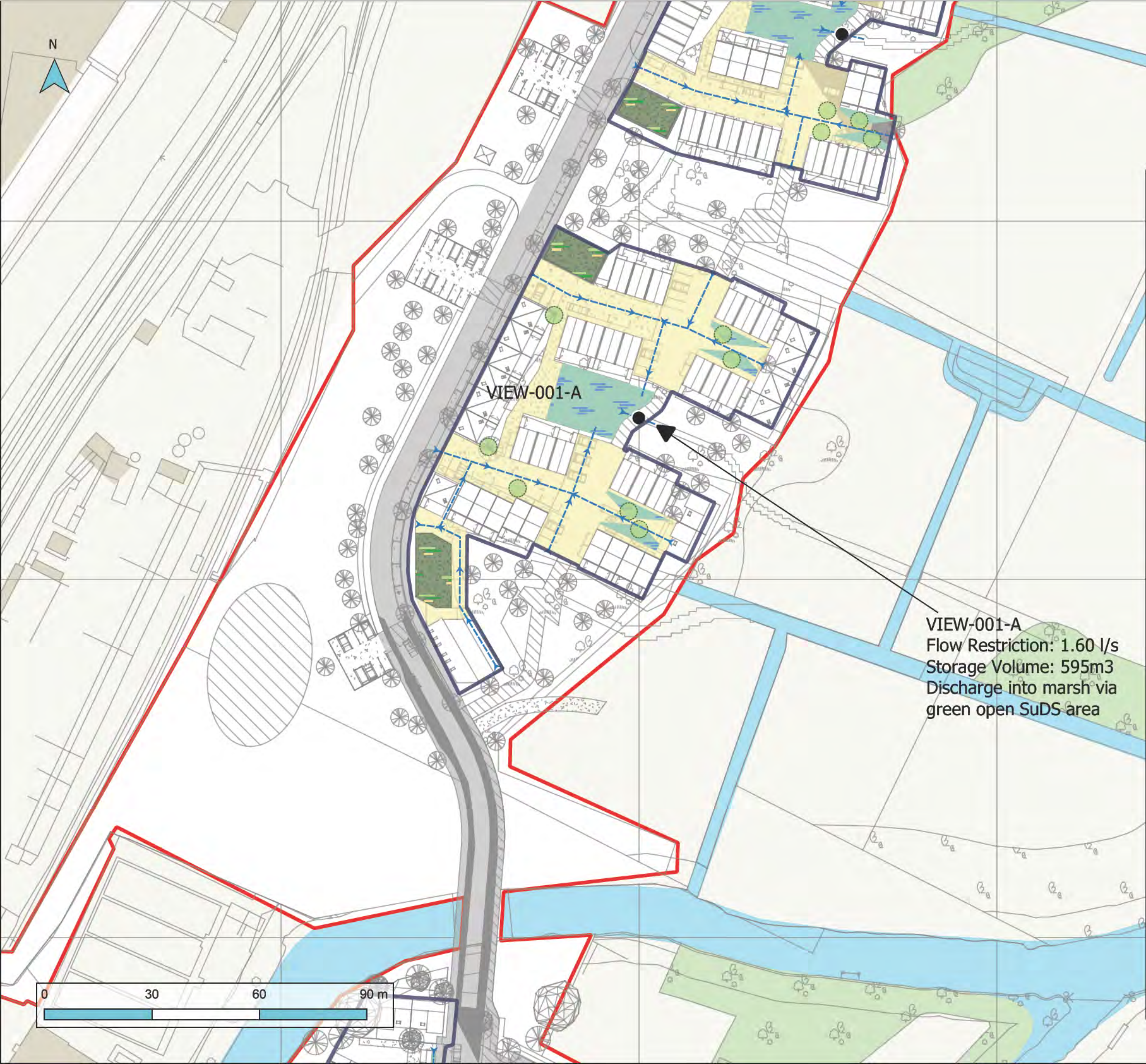
Legend

- Site Boundary
- Drainage Zones
- Master Plan
- Hydrobrake
- Drainage
- Tree Pits
- Rain Garden / Pond
- Green Roof
- Underground Storage

All volumes 1%AEP +CC45%

Drawing to be read in conjunction with Appendix H in FRA (DEALG-JBAU-XX-XX-FRA-0001-S3-P01)

Drawn By:	PB	Date:	15/06/2023	Scale:
Checked By:	GH	Date:	15/06/2023	1:1,000
Approved By:	GH	Date:	15/06/2023	Original at
Status:	S1	Revision:	P01	
Figure Title:	SuDS Strategy - The Views (North)			
File Name:	0-JBAU-00-00-MX-Z-0002-Dealground Figures PB.qgz			



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SuDS Strategy - The View (South)

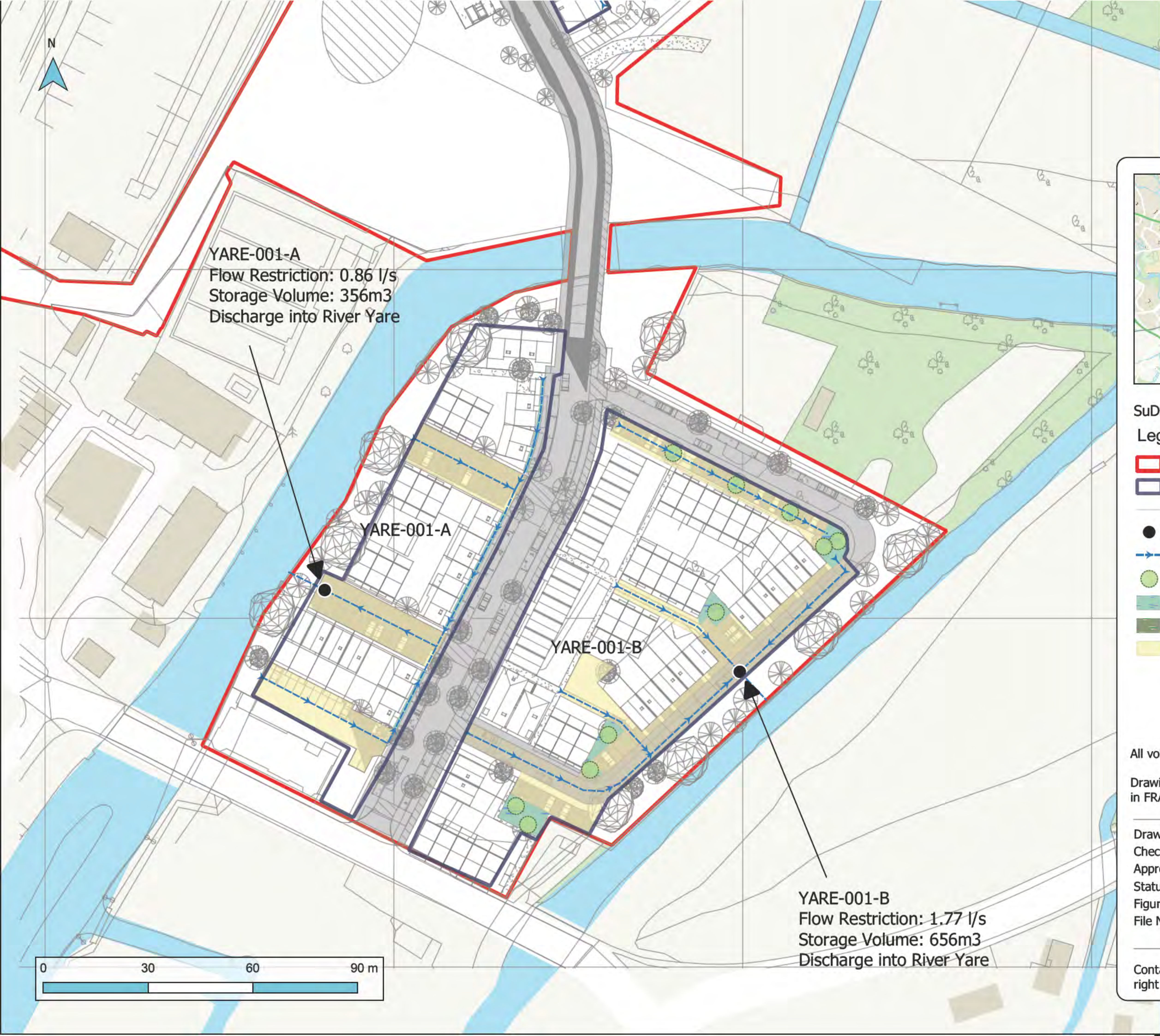
Legend

- Site Boundary
- Drainage Zones
- Master Plan
- Hydrobrake
- Drainage
- Tree Pits
- Rain Garden / Pond
- Green Roof
- Underground Storage

All Volumes 1% AEP + CC 45%

Drawing to be read in conjunction with Appendix H in FRA (DEALG-JBAU-XX-XX-FRA-0001-S3-P01)

Drawn By:	PB	Date: 15/06/2023	Scale:
Checked By:	GH	Date: 15/06/2023	1:1,000
Approved By:	GH	Date: 15/06/2023	Original at
Status:	S1	Revision: P01	
Figure Title:	SuDS Strategy - The Views (South)		
File Name:	0-JBAU-00-00-MX-Z-0002-Dealground Figures PB.qgz		



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SuDS Strategy - Yare edge

Legend

- Site Boundary
- Drainage Zones
- Master Plan
- Hydrobrake
- Drainage
- Tree Pits
- Rain Garden / Pond
- Green Roof
- Underground Storage

All volumes 1%AEp +CC45%

Drawing to be read in conjunction with Appendix H in FRA (DEALG-JBAU-XX-XX-FRA-0001-S3-P01)

Drawn By:	PB	Date:	15/06/2023	Scale:
Checked By:	GH	Date:	15/06/2023	1:1,000
Approved By:	GH	Date:	15/06/2023	Original at
Status:	S1	Revision:	P01	
Figure Title:	SuDS Strategy - Yare edge			
File Name:	0-JBAU-00-00-MX-Z-0002-Dealground Figures PB.qgz			

SUDS - MicroDrainage Summary Table

Project Title:	Dealground
Project Code:	2022-0896
Date:	15/06/2023
Prepared by:	Adam Odell
Reviewed by:	Gavin Hodson
BIM reference:	DEALG-XX-XX-SUDS-TBL-001-S3-P01

This table contains estimated storage depths, volumes and critical storm durations for 1% AEP + CC45% and 3.3% AEP + 45% CC.

Calculations were completed using MicroDrainage Version 2020.1

								3.33% AEP + CC45%			1% AEP + CC45%	
Area	Imp Area (ha)	Urban Creep Adjustion (10%)	Discharge rate (l/s)	Urban creep Justification	Available area m^2	Indicative Ground levels (mAOD)	Volume m^3	Storage Depth (m)	Critical Storm (mins)	Volume m^3	Storage Depth (m)	Critical Storm (mins)
Wensum Edge												
WEN-001-ABC	0.85	n/a	2.21	No (Whole area considered impermeable)	3234.00	3	641.1	0.668	1440	928.9	0.986	1440
WEN-001-D	0.09	n/a	0.22	No (Whole area considered impermeable)								
WEN-001-E	0.63	0.70	1.81	Yes (residential area with green space)	2718.00	3	491.5	0.603	2880	684.2	0.84	2880
WEN-001-F	0.51	0.56	1.46	Yes (residential area with green space)	2037.00	3.2	389.1	0.683	2880	540.1	0.885	2880
The Views												
V EW-001-A	0.61	n/a	1.60	No (Whole area considered impermeable)	2425.00	3	428.2	0.589	2880	595.2	0.819	2880
V EW-001-B	0.59	n/a	1.53	No (Whole area considered impermeable)	1953.00	3	405.5	0.693	2880	563.1	0.963	2880
V EW-001-C	0.75	n/a	1.95	No (Whole area considered impermeable)	2665.00	3	515.5	0.643	2880	719	0.899	2880
Yare Edge												
YARE-001-A	0.33	0.36	0.86	Yes (residential area with green space)	1281.927	3	258.7	0.684	2880	356	0.924	2880
YARE-001-B	0.62	0.68	1.77	Yes (residential area with green space)	2307.652	3	472.7	0.67	2880	656.6	0.931	2880

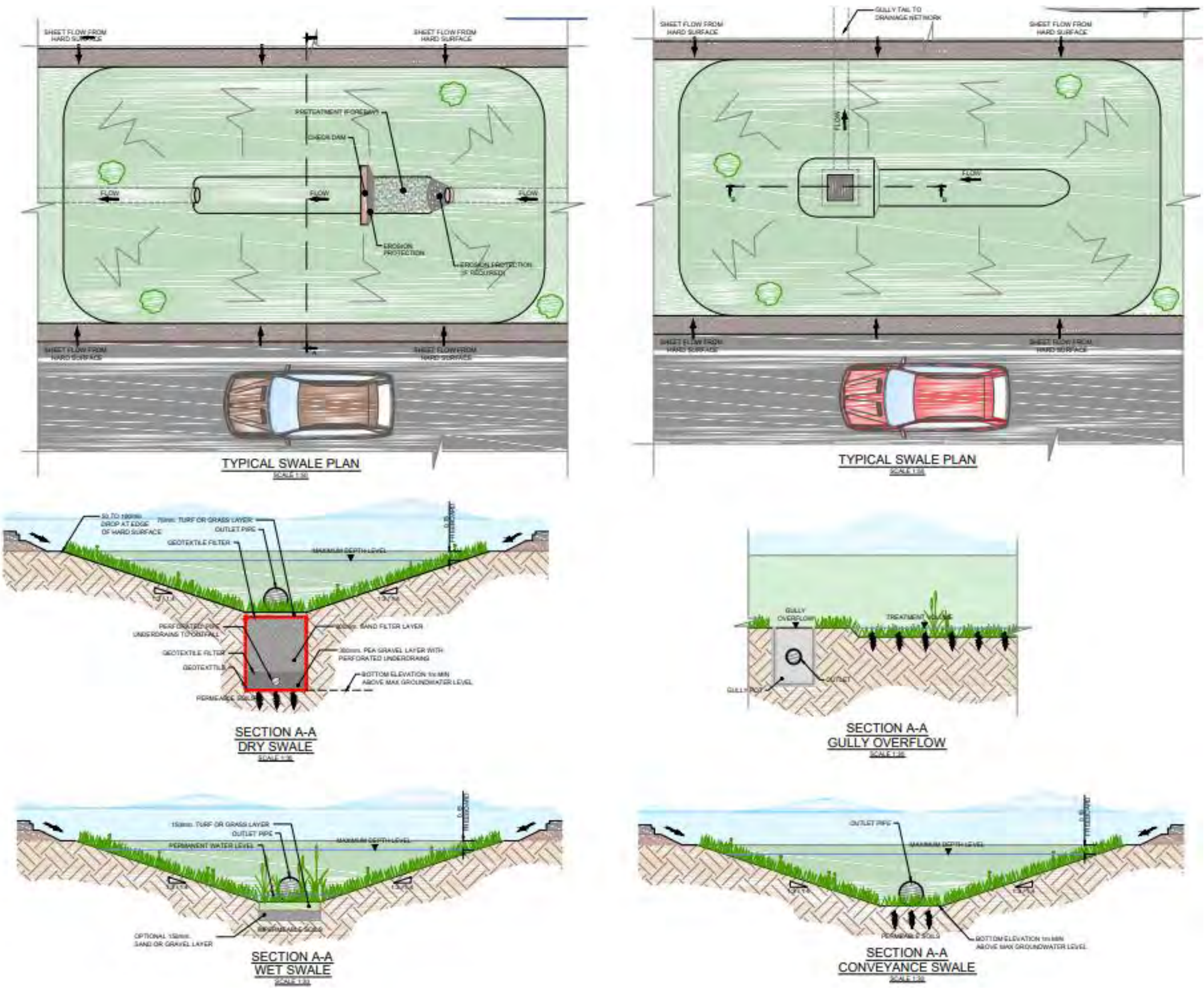
Additonal Notes

1. Full MicroDrainage printouts are provided in Appedix H of the FRA and Surface Water Management Strategy document
2. Table should be read in conjuction with the following drawings:
    a) DEALG-XX-XX-SUDS-DRG-001-S3-P01 (Wensum Edge SUDS Strategy)
    b) DEALG-XX-XX-SUDS-DRG-002-S3-P01 (The Views North SUDS Strategy)
    c) DEALG-XX-XX-SUDS-DRG-003-S3-P01 (The Views South SUDS Strategy)
    d) DEALG-XX-XX-SUDS-DRG-004-S3-P01 (Yare Edge SUDS Strategy)

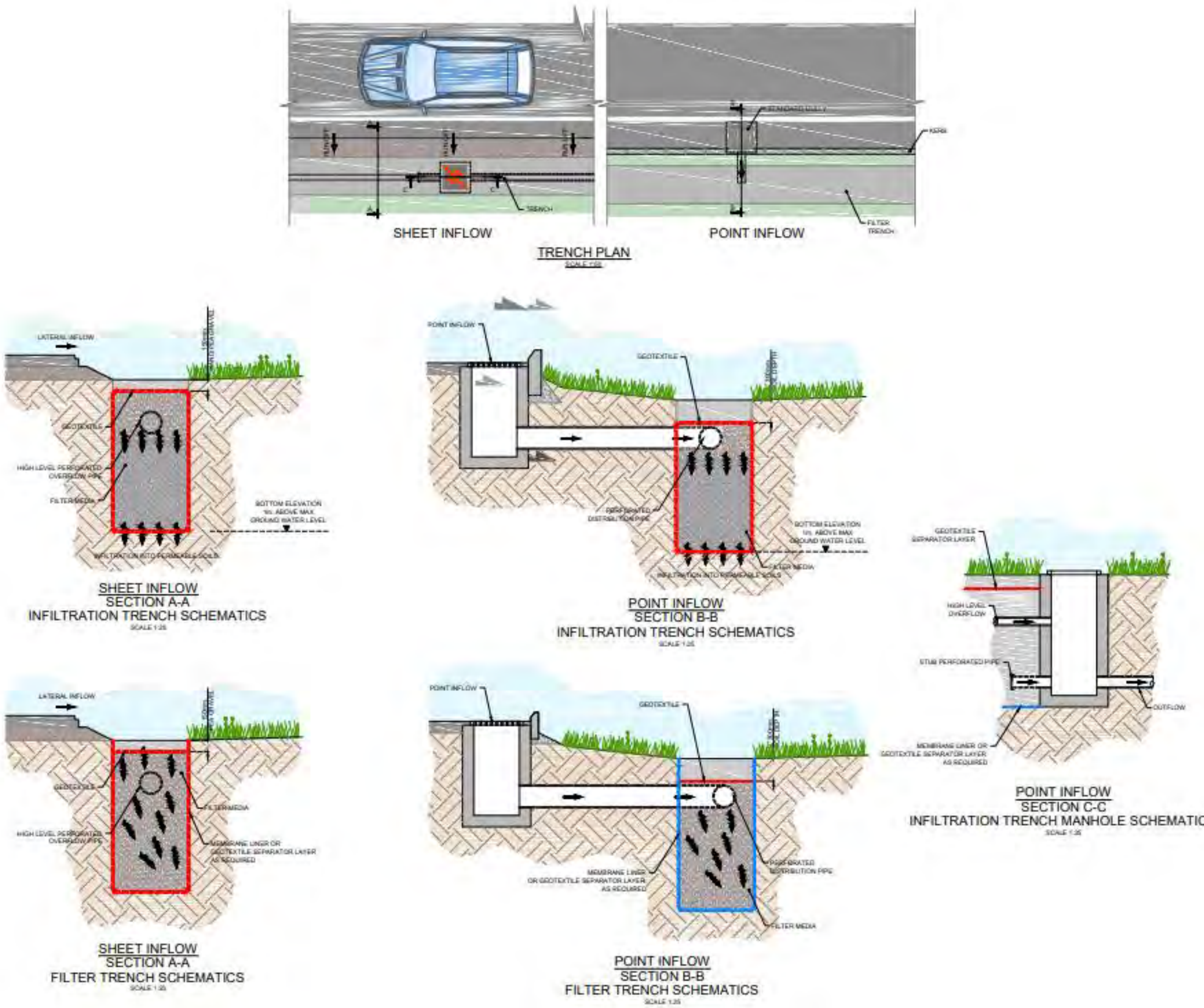
3) Volumes calculated using source control module and can be considered convservative as addtional storage provided in green space is currently not confirmed
4) Runoff rates based on 2.6 l/s/ha

H.2 Typical details

Swales are to be sued across the proposed development (Yare Edge and adopted highway) in both traditional and engineered form. H2-A and H2-B demonstrates how swales could be configured.

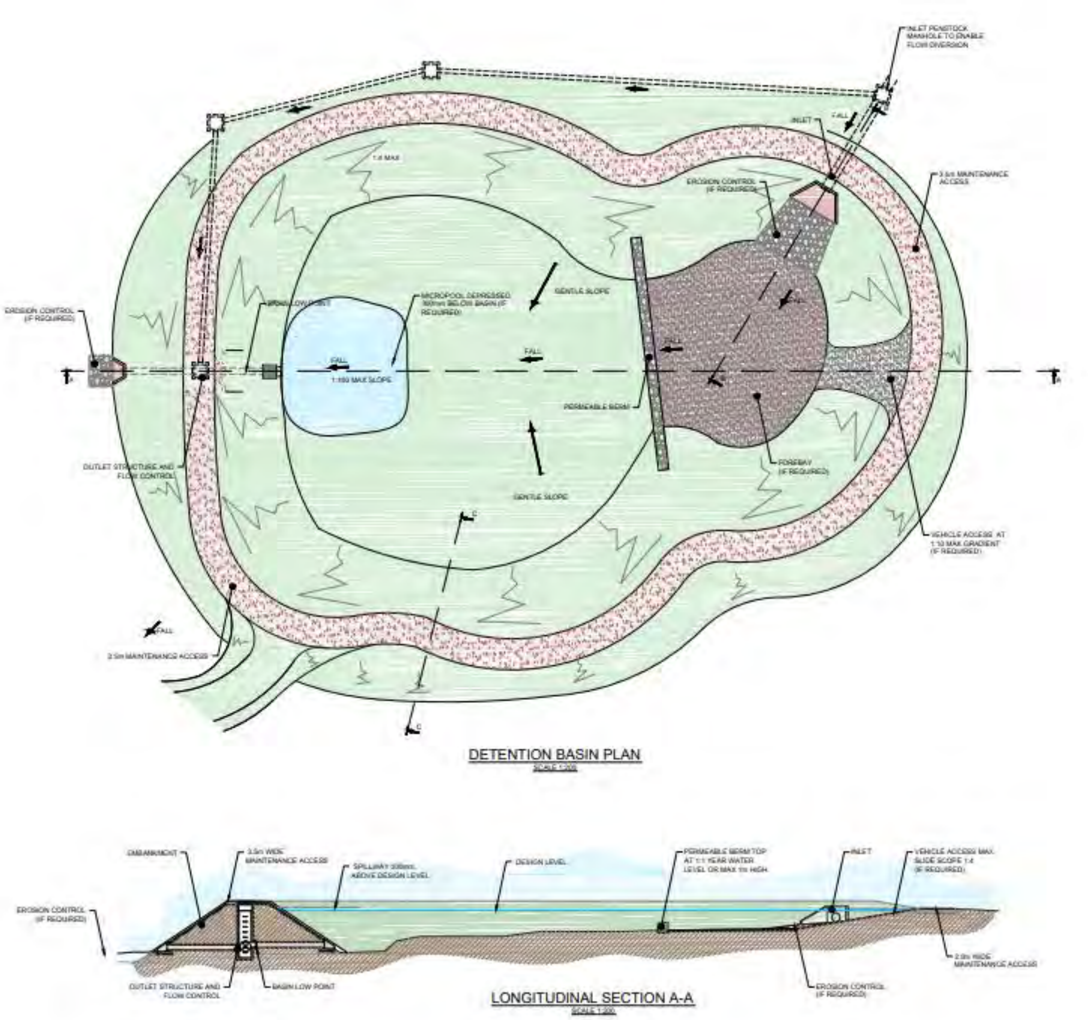


H2-A - Typical swale details



H2-B - Typical filter strip / Engineered swale details

Within the Views the communal areas will also provide a SuDS benefitting acting as a raingarden / detention basin. Permeable paving will be connected to these features before discharging into the CWS. H2-C provides an example of a detention basin. This feature will be enhanced with landscape and planting in the setting of the Views.



H2-C - Typical Detention basin details

Other SuDS elements such as Green roofs and underground storage will be provided following feedback from LLFA.

H.3 Storage Calculations

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 3455 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	2.341	0.341	0.0	1.5	0.0	1.5	247.9	O K
30 min Summer	2.381	0.381	0.0	1.5	0.0	1.5	277.0	O K
60 min Summer	2.425	0.425	0.0	1.5	0.0	1.5	308.5	O K
120 min Summer	2.471	0.471	0.0	1.5	0.0	1.5	342.0	O K
180 min Summer	2.498	0.498	0.0	1.5	0.0	1.5	361.9	O K
240 min Summer	2.517	0.517	0.0	1.5	0.0	1.5	376.0	O K
360 min Summer	2.543	0.543	0.0	1.5	0.0	1.5	394.9	O K
480 min Summer	2.560	0.560	0.0	1.5	0.0	1.5	407.1	O K
600 min Summer	2.572	0.572	0.0	1.5	0.0	1.5	415.5	O K
720 min Summer	2.580	0.580	0.0	1.5	0.0	1.5	421.2	O K
960 min Summer	2.615	0.615	0.0	1.5	0.0	1.5	446.7	O K
1440 min Summer	2.658	0.658	0.0	1.5	0.0	1.5	478.1	O K
2160 min Summer	2.688	0.688	0.0	1.5	0.0	1.5	500.1	O K
2880 min Summer	2.697	0.697	0.0	1.5	0.0	1.5	506.8	O K
4320 min Summer	2.647	0.647	0.0	1.5	0.0	1.5	469.9	O K
5760 min Summer	2.602	0.602	0.0	1.5	0.0	1.5	437.7	O K
7200 min Summer	2.561	0.561	0.0	1.5	0.0	1.5	407.8	O K
8640 min Summer	2.519	0.519	0.0	1.5	0.0	1.5	377.0	O K
10080 min Summer	2.478	0.478	0.0	1.5	0.0	1.5	347.3	O K
15 min Winter	2.389	0.389	0.0	1.5	0.0	1.5	282.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	228.747	0.0	125.6	0.0	27
30 min Summer	127.487	0.0	125.1	0.0	42
60 min Summer	71.052	0.0	244.8	0.0	72
120 min Summer	39.599	0.0	244.8	0.0	130
180 min Summer	28.130	0.0	241.7	0.0	190
240 min Summer	22.070	0.0	237.9	0.0	250
360 min Summer	15.678	0.0	230.4	0.0	370
480 min Summer	12.300	0.0	224.4	0.0	488
600 min Summer	10.190	0.0	219.4	0.0	608
720 min Summer	8.738	0.0	215.0	0.0	728
960 min Summer	7.123	0.0	206.0	0.0	966
1440 min Summer	5.340	0.0	197.1	0.0	1444
2160 min Summer	4.004	0.0	425.6	0.0	2160
2880 min Summer	3.264	0.0	409.7	0.0	2740
4320 min Summer	2.296	0.0	376.1	0.0	3412
5760 min Summer	1.789	0.0	732.1	0.0	4152
7200 min Summer	1.474	0.0	741.7	0.0	4976
8640 min Summer	1.258	0.0	743.3	0.0	5792
10080 min Summer	1.101	0.0	729.9	0.0	6464
15 min Winter	228.747	0.0	125.5	0.0	27

Summary of Results for 100 year Return Period (+45%)

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
30 min Winter	2.435	0.435	0.0	1.5	0.0	1.5	315.8	O K
60 min Winter	2.484	0.484	0.0	1.5	0.0	1.5	351.8	O K
120 min Winter	2.537	0.537	0.0	1.5	0.0	1.5	390.4	O K
180 min Winter	2.569	0.569	0.0	1.5	0.0	1.5	413.5	O K
240 min Winter	2.591	0.591	0.0	1.5	0.0	1.5	429.8	O K
360 min Winter	2.622	0.622	0.0	1.5	0.0	1.5	451.8	O K
480 min Winter	2.642	0.642	0.0	1.5	0.0	1.5	466.3	O K
600 min Winter	2.655	0.655	0.0	1.5	0.0	1.5	476.3	O K
720 min Winter	2.665	0.665	0.0	1.5	0.0	1.5	483.5	O K
960 min Winter	2.707	0.707	0.0	1.5	0.0	1.5	513.6	Flood Risk
1440 min Winter	2.760	0.760	0.0	1.5	0.0	1.5	552.3	Flood Risk
2160 min Winter	2.801	0.801	0.0	1.5	0.0	1.5	582.5	Flood Risk
2880 min Winter	2.819	0.819	0.0	1.5	0.0	1.5	595.2	Flood Risk
4320 min Winter	2.755	0.755	0.0	1.5	0.0	1.5	548.8	Flood Risk
5760 min Winter	2.702	0.702	0.0	1.5	0.0	1.5	509.8	Flood Risk
7200 min Winter	2.649	0.649	0.0	1.5	0.0	1.5	471.6	O K
8640 min Winter	2.597	0.597	0.0	1.5	0.0	1.5	433.7	O K
10080 min Winter	2.543	0.543	0.0	1.5	0.0	1.5	394.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	127.487	0.0	123.7	0.0	41
60 min Winter	71.052	0.0	245.8	0.0	70
120 min Winter	39.599	0.0	238.6	0.0	130
180 min Winter	28.130	0.0	232.3	0.0	188
240 min Winter	22.070	0.0	227.8	0.0	246
360 min Winter	15.678	0.0	221.5	0.0	364
480 min Winter	12.300	0.0	217.1	0.0	482
600 min Winter	10.190	0.0	213.7	0.0	598
720 min Winter	8.738	0.0	210.8	0.0	716
960 min Winter	7.123	0.0	208.0	0.0	950
1440 min Winter	5.340	0.0	209.6	0.0	1414
2160 min Winter	4.004	0.0	431.2	0.0	2096
2880 min Winter	3.264	0.0	423.7	0.0	2748
4320 min Winter	2.296	0.0	401.4	0.0	3588
5760 min Winter	1.789	0.0	822.3	0.0	4432
7200 min Winter	1.474	0.0	809.2	0.0	5336
8640 min Winter	1.258	0.0	774.6	0.0	6304
10080 min Winter	1.101	0.0	745.6	0.0	7176

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.610

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.203	4	8	0.203	8	12	0.203

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	32.3
Membrane Percolation (mm/hr)	1000	Length (m)	75.0
Max Percolation (l/s)	672.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0060-1600-1000-1600
Design Head (m)	1.000
Design Flow (l/s)	1.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	60
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	1.6
Flush-Flo™	0.262	1.5
Kick-Flo®	0.531	1.2
Mean Flow over Head Range	-	1.3

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)**
0.100	1.3	1.200	1.7	3.000	2.6	7.000	3.9
0.200	1.5	1.400	1.9	3.500	2.8	7.500	4.0
0.300	1.5	1.600	2.0	4.000	3.0	8.000	4.2
0.400	1.4	1.800	2.1	4.500	3.2	8.500	4.3
0.500	1.3	2.000	2.2	5.000	3.3	9.000	4.4
0.600	1.3	2.200	2.3	5.500	3.5	9.500	4.5
0.800	1.4	2.400	2.4	6.000	3.6		
1.000	1.6	2.600	2.5	6.500	3.8		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 3284 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	2.413	0.413	0.0	1.5	0.0	1.5	241.6	O K
30 min Summer	2.461	0.461	0.0	1.5	0.0	1.5	269.8	O K
60 min Summer	2.513	0.513	0.0	1.5	0.0	1.5	300.4	O K
120 min Summer	2.569	0.569	0.0	1.5	0.0	1.5	332.7	O K
180 min Summer	2.602	0.602	0.0	1.5	0.0	1.5	351.9	O K
240 min Summer	2.624	0.624	0.0	1.5	0.0	1.5	365.2	O K
360 min Summer	2.654	0.654	0.0	1.5	0.0	1.5	382.9	O K
480 min Summer	2.673	0.673	0.0	1.5	0.0	1.5	394.0	O K
600 min Summer	2.686	0.686	0.0	1.5	0.0	1.5	401.4	O K
720 min Summer	2.694	0.694	0.0	1.5	0.0	1.5	406.3	O K
960 min Summer	2.734	0.734	0.0	1.5	0.0	1.5	429.2	Flood Risk
1440 min Summer	2.781	0.781	0.0	1.5	0.0	1.5	456.7	Flood Risk
2160 min Summer	2.810	0.810	0.0	1.5	0.0	1.5	473.9	Flood Risk
2880 min Summer	2.818	0.818	0.0	1.5	0.0	1.5	478.5	Flood Risk
4320 min Summer	2.756	0.756	0.0	1.5	0.0	1.5	442.3	Flood Risk
5760 min Summer	2.703	0.703	0.0	1.5	0.0	1.5	411.4	Flood Risk
7200 min Summer	2.655	0.655	0.0	1.5	0.0	1.5	383.4	O K
8640 min Summer	2.611	0.611	0.0	1.5	0.0	1.5	357.4	O K
10080 min Summer	2.568	0.568	0.0	1.5	0.0	1.5	332.4	O K
15 min Winter	2.471	0.471	0.0	1.5	0.0	1.5	275.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	228.747	0.0	124.1	0.0	27
30 min Summer	127.487	0.0	121.9	0.0	42
60 min Summer	71.052	0.0	240.4	0.0	72
120 min Summer	39.599	0.0	234.7	0.0	132
180 min Summer	28.130	0.0	230.0	0.0	190
240 min Summer	22.070	0.0	226.5	0.0	250
360 min Summer	15.678	0.0	221.3	0.0	370
480 min Summer	12.300	0.0	217.4	0.0	488
600 min Summer	10.190	0.0	214.3	0.0	608
720 min Summer	8.738	0.0	211.5	0.0	728
960 min Summer	7.123	0.0	208.4	0.0	966
1440 min Summer	5.340	0.0	209.5	0.0	1444
2160 min Summer	4.004	0.0	434.2	0.0	2160
2880 min Summer	3.264	0.0	422.8	0.0	2564
4320 min Summer	2.296	0.0	393.6	0.0	3280
5760 min Summer	1.789	0.0	719.5	0.0	4040
7200 min Summer	1.474	0.0	732.1	0.0	4896
8640 min Summer	1.258	0.0	733.9	0.0	5712
10080 min Summer	1.101	0.0	712.8	0.0	6560
15 min Winter	228.747	0.0	121.9	0.0	27

Summary of Results for 100 year Return Period (+45%)

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
30 min Winter	2.526	0.526	0.0	1.5	0.0	1.5	307.4	O K
60 min Winter	2.585	0.585	0.0	1.5	0.0	1.5	342.2	O K
120 min Winter	2.648	0.648	0.0	1.5	0.0	1.5	379.2	O K
180 min Winter	2.686	0.686	0.0	1.5	0.0	1.5	401.3	O K
240 min Winter	2.712	0.712	0.0	1.5	0.0	1.5	416.7	Flood Risk
360 min Winter	2.748	0.748	0.0	1.5	0.0	1.5	437.4	Flood Risk
480 min Winter	2.771	0.771	0.0	1.5	0.0	1.5	450.7	Flood Risk
600 min Winter	2.786	0.786	0.0	1.5	0.0	1.5	459.9	Flood Risk
720 min Winter	2.797	0.797	0.0	1.5	0.0	1.5	466.2	Flood Risk
960 min Winter	2.844	0.844	0.0	1.5	0.0	1.5	493.9	Flood Risk
1440 min Winter	2.904	0.904	0.0	1.5	0.0	1.5	528.7	Flood Risk
2160 min Winter	2.947	0.947	0.0	1.5	0.0	1.5	554.2	Flood Risk
2880 min Winter	2.963	0.963	0.0	1.6	0.0	1.6	563.1	Flood Risk
4320 min Winter	2.884	0.884	0.0	1.5	0.0	1.5	517.4	Flood Risk
5760 min Winter	2.818	0.818	0.0	1.5	0.0	1.5	478.7	Flood Risk
7200 min Winter	2.755	0.755	0.0	1.5	0.0	1.5	441.4	Flood Risk
8640 min Winter	2.693	0.693	0.0	1.5	0.0	1.5	405.7	O K
10080 min Winter	2.634	0.634	0.0	1.5	0.0	1.5	371.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	127.487	0.0	116.8	0.0	41
60 min Winter	71.052	0.0	235.0	0.0	70
120 min Winter	39.599	0.0	228.3	0.0	130
180 min Winter	28.130	0.0	224.7	0.0	188
240 min Winter	22.070	0.0	222.4	0.0	246
360 min Winter	15.678	0.0	219.4	0.0	364
480 min Winter	12.300	0.0	217.7	0.0	482
600 min Winter	10.190	0.0	216.8	0.0	598
720 min Winter	8.738	0.0	216.3	0.0	716
960 min Winter	7.123	0.0	220.4	0.0	948
1440 min Winter	5.340	0.0	223.1	0.0	1408
2160 min Winter	4.004	0.0	446.4	0.0	2080
2880 min Winter	3.264	0.0	445.8	0.0	2736
4320 min Winter	2.296	0.0	423.0	0.0	3424
5760 min Winter	1.789	0.0	814.5	0.0	4336
7200 min Winter	1.474	0.0	816.2	0.0	5264
8640 min Winter	1.258	0.0	784.0	0.0	6216
10080 min Winter	1.101	0.0	741.1	0.0	7072

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.590

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.197	4	8	0.197	8	12	0.197

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	26.0
Membrane Percolation (mm/hr)	1000	Length (m)	75.0
Max Percolation (l/s)	541.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0059-1590-1000-1590
Design Head (m)	1.000
Design Flow (l/s)	1.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	59
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	1.6
Flush-Flo™	0.262	1.5
Kick-Flo®	0.531	1.2
Mean Flow over Head Range	-	1.3

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)
0.100	1.3	1.200	1.7	3.000	2.6	7.000	3.9
0.200	1.5	1.400	1.9	3.500	2.8	7.500	4.0
0.300	1.5	1.600	2.0	4.000	3.0	8.000	4.2
0.400	1.4	1.800	2.1	4.500	3.2	8.500	4.3
0.500	1.3	2.000	2.2	5.000	3.3	9.000	4.4
0.600	1.3	2.200	2.3	5.500	3.5	9.500	4.5
0.800	1.4	2.400	2.4	6.000	3.6		
1.000	1.6	2.600	2.5	6.500	3.8		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 3134 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	2.383	0.383	0.0	1.9	0.0	1.9	306.2	O K
30 min Summer	2.427	0.427	0.0	1.9	0.0	1.9	341.9	O K
60 min Summer	2.476	0.476	0.0	1.9	0.0	1.9	380.5	O K
120 min Summer	2.527	0.527	0.0	1.9	0.0	1.9	421.3	O K
180 min Summer	2.557	0.557	0.0	1.9	0.0	1.9	445.5	O K
240 min Summer	2.578	0.578	0.0	1.9	0.0	1.9	462.4	O K
360 min Summer	2.606	0.606	0.0	1.9	0.0	1.9	485.1	O K
480 min Summer	2.624	0.624	0.0	1.9	0.0	1.9	499.5	O K
600 min Summer	2.637	0.637	0.0	1.9	0.0	1.9	509.2	O K
720 min Summer	2.645	0.645	0.0	1.9	0.0	1.9	515.7	O K
960 min Summer	2.682	0.682	0.0	1.9	0.0	1.9	545.8	O K
1440 min Summer	2.728	0.728	0.0	1.9	0.0	1.9	582.1	Flood Risk
2160 min Summer	2.757	0.757	0.0	1.9	0.0	1.9	605.6	Flood Risk
2880 min Summer	2.765	0.765	0.0	1.9	0.0	1.9	611.7	Flood Risk
4320 min Summer	2.706	0.706	0.0	1.9	0.0	1.9	564.5	Flood Risk
5760 min Summer	2.654	0.654	0.0	1.9	0.0	1.9	522.9	O K
7200 min Summer	2.604	0.604	0.0	1.9	0.0	1.9	483.0	O K
8640 min Summer	2.552	0.552	0.0	1.9	0.0	1.9	441.6	O K
10080 min Summer	2.507	0.507	0.0	1.9	0.0	1.9	405.3	O K
15 min Winter	2.436	0.436	0.0	1.9	0.0	1.9	349.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	228.747	0.0	165.9	0.0	27
30 min Summer	127.487	0.0	165.6	0.0	42
60 min Summer	71.052	0.0	320.4	0.0	72
120 min Summer	39.599	0.0	323.0	0.0	130
180 min Summer	28.130	0.0	320.1	0.0	190
240 min Summer	22.070	0.0	316.0	0.0	250
360 min Summer	15.678	0.0	306.9	0.0	370
480 min Summer	12.300	0.0	299.1	0.0	488
600 min Summer	10.190	0.0	292.5	0.0	608
720 min Summer	8.738	0.0	286.8	0.0	728
960 min Summer	7.123	0.0	274.2	0.0	966
1440 min Summer	5.340	0.0	260.1	0.0	1444
2160 min Summer	4.004	0.0	565.4	0.0	2160
2880 min Summer	3.264	0.0	543.2	0.0	2628
4320 min Summer	2.296	0.0	496.2	0.0	3332
5760 min Summer	1.789	0.0	909.8	0.0	4096
7200 min Summer	1.474	0.0	927.2	0.0	4904
8640 min Summer	1.258	0.0	938.7	0.0	5624
10080 min Summer	1.101	0.0	939.5	0.0	6368
15 min Winter	228.747	0.0	166.2	0.0	27

Summary of Results for 100 year Return Period (+45%)

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
30 min Winter	2.487	0.487	0.0	1.9	0.0	1.9	389.7	O K
60 min Winter	2.542	0.542	0.0	1.9	0.0	1.9	433.8	O K
120 min Winter	2.601	0.601	0.0	1.9	0.0	1.9	480.8	O K
180 min Winter	2.636	0.636	0.0	1.9	0.0	1.9	509.0	O K
240 min Winter	2.661	0.661	0.0	1.9	0.0	1.9	528.7	O K
360 min Winter	2.694	0.694	0.0	1.9	0.0	1.9	555.2	O K
480 min Winter	2.715	0.715	0.0	1.9	0.0	1.9	572.3	Flood Risk
600 min Winter	2.730	0.730	0.0	1.9	0.0	1.9	584.0	Flood Risk
720 min Winter	2.740	0.740	0.0	1.9	0.0	1.9	592.2	Flood Risk
960 min Winter	2.785	0.785	0.0	1.9	0.0	1.9	628.0	Flood Risk
1440 min Winter	2.841	0.841	0.0	1.9	0.0	1.9	673.1	Flood Risk
2160 min Winter	2.883	0.883	0.0	1.9	0.0	1.9	706.6	Flood Risk
2880 min Winter	2.899	0.899	0.0	1.9	0.0	1.9	719.0	Flood Risk
4320 min Winter	2.824	0.824	0.0	1.9	0.0	1.9	659.2	Flood Risk
5760 min Winter	2.760	0.760	0.0	1.9	0.0	1.9	608.3	Flood Risk
7200 min Winter	2.698	0.698	0.0	1.9	0.0	1.9	558.1	O K
8640 min Winter	2.635	0.635	0.0	1.9	0.0	1.9	507.6	O K
10080 min Winter	2.564	0.564	0.0	1.9	0.0	1.9	450.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	127.487	0.0	164.0	0.0	41
60 min Winter	71.052	0.0	324.6	0.0	70
120 min Winter	39.599	0.0	317.1	0.0	130
180 min Winter	28.130	0.0	309.1	0.0	188
240 min Winter	22.070	0.0	303.3	0.0	246
360 min Winter	15.678	0.0	294.9	0.0	364
480 min Winter	12.300	0.0	288.8	0.0	482
600 min Winter	10.190	0.0	284.0	0.0	598
720 min Winter	8.738	0.0	279.9	0.0	716
960 min Winter	7.123	0.0	274.2	0.0	950
1440 min Winter	5.340	0.0	274.7	0.0	1410
2160 min Winter	4.004	0.0	570.6	0.0	2084
2880 min Winter	3.264	0.0	556.6	0.0	2740
4320 min Winter	2.296	0.0	524.3	0.0	3468
5760 min Winter	1.789	0.0	1031.1	0.0	4384
7200 min Winter	1.474	0.0	1040.7	0.0	5328
8640 min Winter	1.258	0.0	1023.5	0.0	6232
10080 min Winter	1.101	0.0	1007.2	0.0	7064

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.750

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.250	4	8	0.250	8	12	0.250

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	30.3
Membrane Percolation (mm/hr)	1000	Length (m)	88.0
Max Percolation (l/s)	740.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0
Flush-Flo™	0.296	1.9
Kick-Flo®	0.599	1.6
Mean Flow over Head Range	-	1.7

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	1.6	1.200	2.2	3.000	3.3	7.000	4.9
0.200	1.9	1.400	2.3	3.500	3.5	7.500	5.1
0.300	1.9	1.600	2.5	4.000	3.8	8.000	5.2
0.400	1.9	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.8	2.000	2.7	5.000	4.2	9.000	5.5
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.7
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.7		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 3626 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	2.252	0.252	0.0	2.2	0.0	2.2	242.0	O K
30 min Summer	2.336	0.336	0.0	2.2	0.0	2.2	322.1	O K
60 min Summer	2.420	0.420	0.0	2.2	0.0	2.2	403.5	O K
120 min Summer	2.512	0.512	0.0	2.2	0.0	2.2	491.9	O K
180 min Summer	2.579	0.579	0.0	2.2	0.0	2.2	555.6	O K
240 min Summer	2.630	0.630	0.0	2.2	0.0	2.2	605.1	O K
360 min Summer	2.704	0.704	0.0	2.2	0.0	2.2	675.8	Flood Risk
480 min Summer	2.753	0.753	0.0	2.2	0.0	2.2	722.7	Flood Risk
600 min Summer	2.786	0.786	0.0	2.2	0.0	2.2	754.6	Flood Risk
720 min Summer	2.809	0.809	0.0	2.2	0.0	2.2	776.8	Flood Risk
960 min Summer	2.835	0.835	0.0	2.2	0.0	2.2	802.1	Flood Risk
1440 min Summer	2.850	0.850	0.0	2.2	0.0	2.2	816.3	Flood Risk
2160 min Summer	2.834	0.834	0.0	2.2	0.0	2.2	800.4	Flood Risk
2880 min Summer	2.803	0.803	0.0	2.2	0.0	2.2	770.5	Flood Risk
4320 min Summer	2.746	0.746	0.0	2.2	0.0	2.2	715.7	Flood Risk
5760 min Summer	2.699	0.699	0.0	2.2	0.0	2.2	671.0	O K
7200 min Summer	2.661	0.661	0.0	2.2	0.0	2.2	634.1	O K
8640 min Summer	2.625	0.625	0.0	2.2	0.0	2.2	599.7	O K
10080 min Summer	2.589	0.589	0.0	2.2	0.0	2.2	565.7	O K
15 min Winter	2.285	0.285	0.0	2.2	0.0	2.2	273.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	163.329	0.0	170.8	0.0	27
30 min Summer	107.213	0.0	183.7	0.0	42
60 min Summer	66.819	0.0	349.4	0.0	72
120 min Summer	40.799	0.0	365.3	0.0	130
180 min Summer	30.824	0.0	360.4	0.0	190
240 min Summer	25.274	0.0	348.8	0.0	250
360 min Summer	19.000	0.0	330.0	0.0	370
480 min Summer	15.410	0.0	320.1	0.0	490
600 min Summer	13.024	0.0	314.5	0.0	608
720 min Summer	11.309	0.0	311.3	0.0	728
960 min Summer	8.976	0.0	308.6	0.0	966
1440 min Summer	6.404	0.0	304.9	0.0	1444
2160 min Summer	4.519	0.0	631.1	0.0	2160
2880 min Summer	3.522	0.0	606.5	0.0	2796
4320 min Summer	2.481	0.0	557.8	0.0	3424
5760 min Summer	1.941	0.0	1111.9	0.0	4208
7200 min Summer	1.614	0.0	1132.5	0.0	5040
8640 min Summer	1.393	0.0	1127.0	0.0	5872
10080 min Summer	1.234	0.0	1095.4	0.0	6568
15 min Winter	163.329	0.0	178.2	0.0	27

Summary of Results for 100 year Return Period (+45%)

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
30 min Winter	2.378	0.378	0.0	2.2	0.0	2.2	363.0	O K
60 min Winter	2.473	0.473	0.0	2.2	0.0	2.2	454.5	O K
120 min Winter	2.577	0.577	0.0	2.2	0.0	2.2	554.3	O K
180 min Winter	2.653	0.653	0.0	2.2	0.0	2.2	626.5	O K
240 min Winter	2.711	0.711	0.0	2.2	0.0	2.2	682.2	Flood Risk
360 min Winter	2.794	0.794	0.0	2.2	0.0	2.2	761.9	Flood Risk
480 min Winter	2.849	0.849	0.0	2.2	0.0	2.2	815.3	Flood Risk
600 min Winter	2.888	0.888	0.0	2.2	0.0	2.2	852.1	Flood Risk
720 min Winter	2.915	0.915	0.0	2.2	0.0	2.2	878.0	Flood Risk
960 min Winter	2.946	0.946	0.0	2.2	0.0	2.2	908.5	Flood Risk
1440 min Winter	2.968	0.968	0.0	2.2	0.0	2.2	928.9	Flood Risk
2160 min Winter	2.956	0.956	0.0	2.2	0.0	2.2	917.9	Flood Risk
2880 min Winter	2.928	0.928	0.0	2.2	0.0	2.2	891.0	Flood Risk
4320 min Winter	2.858	0.858	0.0	2.2	0.0	2.2	823.9	Flood Risk
5760 min Winter	2.802	0.802	0.0	2.2	0.0	2.2	769.8	Flood Risk
7200 min Winter	2.752	0.752	0.0	2.2	0.0	2.2	722.3	Flood Risk
8640 min Winter	2.706	0.706	0.0	2.2	0.0	2.2	677.6	Flood Risk
10080 min Winter	2.661	0.661	0.0	2.2	0.0	2.2	634.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	107.213	0.0	186.1	0.0	41
60 min Winter	66.819	0.0	363.9	0.0	70
120 min Winter	40.799	0.0	363.1	0.0	130
180 min Winter	30.824	0.0	347.0	0.0	188
240 min Winter	25.274	0.0	334.5	0.0	246
360 min Winter	19.000	0.0	322.4	0.0	364
480 min Winter	15.410	0.0	319.3	0.0	482
600 min Winter	13.024	0.0	320.9	0.0	600
720 min Winter	11.309	0.0	324.2	0.0	718
960 min Winter	8.976	0.0	326.5	0.0	952
1440 min Winter	6.404	0.0	322.7	0.0	1416
2160 min Winter	4.519	0.0	640.4	0.0	2100
2880 min Winter	3.522	0.0	622.7	0.0	2764
4320 min Winter	2.481	0.0	590.7	0.0	3896
5760 min Winter	1.941	0.0	1229.1	0.0	4448
7200 min Winter	1.614	0.0	1206.1	0.0	5400
8640 min Winter	1.393	0.0	1154.5	0.0	6312
10080 min Winter	1.234	0.0	1104.9	0.0	7264

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 624621 307427 TG 24621 07427
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.850

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.283	4	8	0.283	8	12	0.283

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	32.0
Membrane Percolation (mm/hr)	1000	Length (m)	100.0
Max Percolation (l/s)	888.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0070-2200-1000-2200
Design Head (m)	1.000
Design Flow (l/s)	2.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	70
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	2.2
Flush-Flo™	0.307	2.2
Kick-Flo®	0.625	1.8
Mean Flow over Head Range	-	1.9

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)**
0.100	1.8	1.200	2.4	3.000	3.6	7.000	5.4
0.200	2.1	1.400	2.6	3.500	3.9	7.500	5.6
0.300	2.2	1.600	2.7	4.000	4.2	8.000	5.8
0.400	2.2	1.800	2.9	4.500	4.4	8.500	5.9
0.500	2.1	2.000	3.0	5.000	4.6	9.000	6.1
0.600	1.9	2.200	3.2	5.500	4.8	9.500	6.3
0.800	2.0	2.400	3.3	6.000	5.0		
1.000	2.2	2.600	3.4	6.500	5.2		

Orifice Overflow Control

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 3.000

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 3419 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	2.350	0.350	0.0	1.7	0.0	1.7	284.7	O K
30 min Summer	2.390	0.390	0.0	1.7	0.0	1.7	318.1	O K
60 min Summer	2.435	0.435	0.0	1.7	0.0	1.7	354.3	O K
120 min Summer	2.482	0.482	0.0	1.7	0.0	1.7	392.7	O K
180 min Summer	2.510	0.510	0.0	1.7	0.0	1.7	415.5	O K
240 min Summer	2.530	0.530	0.0	1.7	0.0	1.7	431.5	O K
360 min Summer	2.556	0.556	0.0	1.7	0.0	1.7	453.1	O K
480 min Summer	2.573	0.573	0.0	1.7	0.0	1.7	467.1	O K
600 min Summer	2.585	0.585	0.0	1.7	0.0	1.7	476.8	O K
720 min Summer	2.593	0.593	0.0	1.7	0.0	1.7	483.4	O K
960 min Summer	2.630	0.630	0.0	1.7	0.0	1.7	512.9	O K
1440 min Summer	2.674	0.674	0.0	1.7	0.0	1.7	549.3	O K
2160 min Summer	2.706	0.706	0.0	1.7	0.0	1.7	574.9	Flood Risk
2880 min Summer	2.715	0.715	0.0	1.7	0.0	1.7	582.9	Flood Risk
4320 min Summer	2.663	0.663	0.0	1.7	0.0	1.7	540.1	O K
5760 min Summer	2.617	0.617	0.0	1.7	0.0	1.7	502.6	O K
7200 min Summer	2.573	0.573	0.0	1.7	0.0	1.7	467.0	O K
8640 min Summer	2.528	0.528	0.0	1.7	0.0	1.7	429.8	O K
10080 min Summer	2.487	0.487	0.0	1.7	0.0	1.7	396.8	O K
15 min Winter	2.399	0.399	0.0	1.7	0.0	1.7	324.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	228.747	0.0	145.3	0.0	27
30 min Summer	127.487	0.0	145.0	0.0	42
60 min Summer	71.052	0.0	283.0	0.0	72
120 min Summer	39.599	0.0	284.0	0.0	130
180 min Summer	28.130	0.0	281.4	0.0	190
240 min Summer	22.070	0.0	277.8	0.0	250
360 min Summer	15.678	0.0	270.2	0.0	370
480 min Summer	12.300	0.0	262.9	0.0	488
600 min Summer	10.190	0.0	256.8	0.0	608
720 min Summer	8.738	0.0	251.4	0.0	728
960 min Summer	7.123	0.0	239.5	0.0	966
1440 min Summer	5.340	0.0	226.3	0.0	1444
2160 min Summer	4.004	0.0	491.5	0.0	2160
2880 min Summer	3.264	0.0	472.0	0.0	2744
4320 min Summer	2.296	0.0	432.2	0.0	3416
5760 min Summer	1.789	0.0	840.9	0.0	4160
7200 min Summer	1.474	0.0	853.2	0.0	4976
8640 min Summer	1.258	0.0	858.2	0.0	5712
10080 min Summer	1.101	0.0	844.9	0.0	6456
15 min Winter	228.747	0.0	145.6	0.0	27

Summary of Results for 100 year Return Period (+45%)

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
30 min Winter	2.445	0.445	0.0	1.7	0.0	1.7	362.7	O K
60 min Winter	2.496	0.496	0.0	1.7	0.0	1.7	404.0	O K
120 min Winter	2.550	0.550	0.0	1.7	0.0	1.7	448.1	O K
180 min Winter	2.583	0.583	0.0	1.7	0.0	1.7	474.7	O K
240 min Winter	2.606	0.606	0.0	1.7	0.0	1.7	493.4	O K
360 min Winter	2.637	0.637	0.0	1.7	0.0	1.7	518.8	O K
480 min Winter	2.657	0.657	0.0	1.7	0.0	1.7	535.4	O K
600 min Winter	2.671	0.671	0.0	1.7	0.0	1.7	546.9	O K
720 min Winter	2.681	0.681	0.0	1.7	0.0	1.7	555.2	O K
960 min Winter	2.724	0.724	0.0	1.7	0.0	1.7	589.8	Flood Risk
1440 min Winter	2.779	0.779	0.0	1.7	0.0	1.7	634.5	Flood Risk
2160 min Winter	2.822	0.822	0.0	1.7	0.0	1.7	669.4	Flood Risk
2880 min Winter	2.840	0.840	0.0	1.7	0.0	1.7	684.2	Flood Risk
4320 min Winter	2.774	0.774	0.0	1.7	0.0	1.7	630.8	Flood Risk
5760 min Winter	2.719	0.719	0.0	1.7	0.0	1.7	585.6	Flood Risk
7200 min Winter	2.664	0.664	0.0	1.7	0.0	1.7	541.1	O K
8640 min Winter	2.610	0.610	0.0	1.7	0.0	1.7	496.6	O K
10080 min Winter	2.550	0.550	0.0	1.7	0.0	1.7	448.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	127.487	0.0	143.8	0.0	41
60 min Winter	71.052	0.0	285.6	0.0	70
120 min Winter	39.599	0.0	279.3	0.0	130
180 min Winter	28.130	0.0	271.8	0.0	188
240 min Winter	22.070	0.0	266.1	0.0	246
360 min Winter	15.678	0.0	258.1	0.0	364
480 min Winter	12.300	0.0	252.3	0.0	482
600 min Winter	10.190	0.0	247.8	0.0	600
720 min Winter	8.738	0.0	244.1	0.0	716
960 min Winter	7.123	0.0	238.7	0.0	950
1440 min Winter	5.340	0.0	239.1	0.0	1414
2160 min Winter	4.004	0.0	495.9	0.0	2096
2880 min Winter	3.264	0.0	485.1	0.0	2748
4320 min Winter	2.296	0.0	458.8	0.0	3632
5760 min Winter	1.789	0.0	945.0	0.0	4440
7200 min Winter	1.474	0.0	932.5	0.0	5344
8640 min Winter	1.258	0.0	896.5	0.0	6312
10080 min Winter	1.101	0.0	874.6	0.0	7168

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.700

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.233	4	8	0.233	8	12	0.233

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	21.9
Membrane Percolation (mm/hr)	1000	Length (m)	124.0
Max Percolation (l/s)	754.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0063-1800-1000-1800
Design Head (m)	1.000
Design Flow (l/s)	1.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	63
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	1.8
Flush-Flo™	0.280	1.7
Kick-Flo®	0.565	1.4
Mean Flow over Head Range	-	1.5

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)
0.100	1.5	1.200	2.0	3.000	3.0	7.000	4.4
0.200	1.7	1.400	2.1	3.500	3.2	7.500	4.6
0.300	1.7	1.600	2.2	4.000	3.4	8.000	4.7
0.400	1.7	1.800	2.3	4.500	3.6	8.500	4.8
0.500	1.6	2.000	2.5	5.000	3.8	9.000	5.0
0.600	1.4	2.200	2.6	5.500	3.9	9.500	5.1
0.800	1.6	2.400	2.7	6.000	4.1		
1.000	1.8	2.600	2.8	6.500	4.3		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 3366 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	2.375	0.375	0.0	1.4	0.0	1.4	228.5	O K
30 min Summer	2.418	0.418	0.0	1.4	0.0	1.4	255.2	O K
60 min Summer	2.466	0.466	0.0	1.4	0.0	1.4	284.2	O K
120 min Summer	2.516	0.516	0.0	1.4	0.0	1.4	315.0	O K
180 min Summer	2.546	0.546	0.0	1.4	0.0	1.4	333.3	O K
240 min Summer	2.567	0.567	0.0	1.4	0.0	1.4	346.2	O K
360 min Summer	2.595	0.595	0.0	1.4	0.0	1.4	363.2	O K
480 min Summer	2.613	0.613	0.0	1.4	0.0	1.4	374.1	O K
600 min Summer	2.625	0.625	0.0	1.4	0.0	1.4	381.4	O K
720 min Summer	2.633	0.633	0.0	1.4	0.0	1.4	386.3	O K
960 min Summer	2.670	0.670	0.0	1.4	0.0	1.4	408.7	O K
1440 min Summer	2.715	0.715	0.0	1.4	0.0	1.4	436.1	O K
2160 min Summer	2.744	0.744	0.0	1.4	0.0	1.4	454.1	O K
2880 min Summer	2.753	0.753	0.0	1.4	0.0	1.4	459.2	O K
4320 min Summer	2.697	0.697	0.0	1.4	0.0	1.4	425.3	O K
5760 min Summer	2.649	0.649	0.0	1.4	0.0	1.4	396.0	O K
7200 min Summer	2.606	0.606	0.0	1.4	0.0	1.4	369.4	O K
8640 min Summer	2.564	0.564	0.0	1.4	0.0	1.4	344.3	O K
10080 min Summer	2.524	0.524	0.0	1.4	0.0	1.4	319.5	O K
15 min Winter	2.427	0.427	0.0	1.4	0.0	1.4	260.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	228.747	0.0	116.2	0.0	27
30 min Summer	127.487	0.0	114.8	0.0	42
60 min Summer	71.052	0.0	226.1	0.0	72
120 min Summer	39.599	0.0	222.2	0.0	132
180 min Summer	28.130	0.0	217.1	0.0	190
240 min Summer	22.070	0.0	213.2	0.0	250
360 min Summer	15.678	0.0	207.4	0.0	370
480 min Summer	12.300	0.0	203.1	0.0	488
600 min Summer	10.190	0.0	199.5	0.0	608
720 min Summer	8.738	0.0	196.5	0.0	728
960 min Summer	7.123	0.0	191.6	0.0	966
1440 min Summer	5.340	0.0	190.3	0.0	1444
2160 min Summer	4.004	0.0	399.7	0.0	2160
2880 min Summer	3.264	0.0	387.8	0.0	2628
4320 min Summer	2.296	0.0	359.4	0.0	3332
5760 min Summer	1.789	0.0	678.0	0.0	4096
7200 min Summer	1.474	0.0	688.1	0.0	4904
8640 min Summer	1.258	0.0	686.4	0.0	5784
10080 min Summer	1.101	0.0	666.2	0.0	6560
15 min Winter	228.747	0.0	115.0	0.0	27

Summary of Results for 100 year Return Period (+45%)

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
30 min Winter	2.477	0.477	0.0	1.4	0.0	1.4	290.9	O K
60 min Winter	2.531	0.531	0.0	1.4	0.0	1.4	324.0	O K
120 min Winter	2.589	0.589	0.0	1.4	0.0	1.4	359.2	O K
180 min Winter	2.623	0.623	0.0	1.4	0.0	1.4	380.3	O K
240 min Winter	2.648	0.648	0.0	1.4	0.0	1.4	395.1	O K
360 min Winter	2.680	0.680	0.0	1.4	0.0	1.4	415.0	O K
480 min Winter	2.702	0.702	0.0	1.4	0.0	1.4	428.0	O K
600 min Winter	2.716	0.716	0.0	1.4	0.0	1.4	436.9	O K
720 min Winter	2.726	0.726	0.0	1.4	0.0	1.4	443.2	O K
960 min Winter	2.771	0.771	0.0	1.4	0.0	1.4	470.1	O K
1440 min Winter	2.827	0.827	0.0	1.4	0.0	1.4	504.3	O K
2160 min Winter	2.869	0.869	0.0	1.4	0.0	1.4	530.1	O K
2880 min Winter	2.885	0.885	0.0	1.4	0.0	1.4	540.1	O K
4320 min Winter	2.815	0.815	0.0	1.4	0.0	1.4	497.1	O K
5760 min Winter	2.756	0.756	0.0	1.4	0.0	1.4	461.0	O K
7200 min Winter	2.698	0.698	0.0	1.4	0.0	1.4	426.0	O K
8640 min Winter	2.643	0.643	0.0	1.4	0.0	1.4	392.1	O K
10080 min Winter	2.588	0.588	0.0	1.4	0.0	1.4	358.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	127.487	0.0	111.7	0.0	41
60 min Winter	71.052	0.0	222.1	0.0	70
120 min Winter	39.599	0.0	214.6	0.0	130
180 min Winter	28.130	0.0	210.3	0.0	188
240 min Winter	22.070	0.0	207.4	0.0	246
360 min Winter	15.678	0.0	203.5	0.0	364
480 min Winter	12.300	0.0	201.0	0.0	482
600 min Winter	10.190	0.0	199.3	0.0	598
720 min Winter	8.738	0.0	198.1	0.0	716
960 min Winter	7.123	0.0	200.4	0.0	950
1440 min Winter	5.340	0.0	202.8	0.0	1412
2160 min Winter	4.004	0.0	409.2	0.0	2084
2880 min Winter	3.264	0.0	407.0	0.0	2740
4320 min Winter	2.296	0.0	386.1	0.0	3468
5760 min Winter	1.789	0.0	765.1	0.0	4384
7200 min Winter	1.474	0.0	758.5	0.0	5328
8640 min Winter	1.258	0.0	725.1	0.0	6232
10080 min Winter	1.101	0.0	687.3	0.0	7160

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.560

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.187	4	8	0.187	8	12	0.187

Model Details

Storage is Online Cover Level (m) 3.200

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	24.5
Membrane Percolation (mm/hr)	1000	Length (m)	83.0
Max Percolation (l/s)	564.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0058-1500-1000-1500
Design Head (m)	1.000
Design Flow (l/s)	1.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	58
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	1.5
Flush-Flo™	0.253	1.4
Kick-Flo®	0.515	1.1
Mean Flow over Head Range	-	1.2

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	1.2	1.200	1.6	3.000	2.5	7.000	3.7
0.200	1.4	1.400	1.7	3.500	2.7	7.500	3.8
0.300	1.4	1.600	1.9	4.000	2.8	8.000	3.9
0.400	1.3	1.800	2.0	4.500	3.0	8.500	4.0
0.500	1.2	2.000	2.0	5.000	3.1	9.000	4.1
0.600	1.2	2.200	2.1	5.500	3.3	9.500	4.2
0.800	1.4	2.400	2.2	6.000	3.4		
1.000	1.5	2.600	2.3	6.500	3.5		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 3919 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	2.390	0.390	0.0	0.7	0.0	0.7	147.3	O K
30 min Summer	2.435	0.435	0.0	0.7	0.0	0.7	164.6	O K
60 min Summer	2.485	0.485	0.0	0.7	0.0	0.7	183.4	O K
120 min Summer	2.538	0.538	0.0	0.7	0.0	0.7	203.3	O K
180 min Summer	2.569	0.569	0.0	0.7	0.0	0.7	215.2	O K
240 min Summer	2.591	0.591	0.0	0.7	0.0	0.7	223.6	O K
360 min Summer	2.621	0.621	0.0	0.7	0.0	0.7	234.8	O K
480 min Summer	2.641	0.641	0.0	0.7	0.0	0.7	242.1	O K
600 min Summer	2.654	0.654	0.0	0.7	0.0	0.7	247.1	O K
720 min Summer	2.663	0.663	0.0	0.7	0.0	0.7	250.6	O K
960 min Summer	2.703	0.703	0.0	0.8	0.0	0.8	265.6	Flood Risk
1440 min Summer	2.752	0.752	0.0	0.8	0.0	0.8	284.4	Flood Risk
2160 min Summer	2.788	0.788	0.0	0.8	0.0	0.8	297.9	Flood Risk
2880 min Summer	2.800	0.800	0.0	0.8	0.0	0.8	302.4	Flood Risk
4320 min Summer	2.746	0.746	0.0	0.8	0.0	0.8	282.0	Flood Risk
5760 min Summer	2.700	0.700	0.0	0.8	0.0	0.8	264.7	Flood Risk
7200 min Summer	2.660	0.660	0.0	0.7	0.0	0.7	249.3	O K
8640 min Summer	2.623	0.623	0.0	0.7	0.0	0.7	235.4	O K
10080 min Summer	2.589	0.589	0.0	0.7	0.0	0.7	222.5	O K
15 min Winter	2.444	0.444	0.0	0.7	0.0	0.7	167.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	228.747	0.0	58.4	0.0	27
30 min Summer	127.487	0.0	55.3	0.0	42
60 min Summer	71.052	0.0	114.4	0.0	72
120 min Summer	39.599	0.0	112.2	0.0	132
180 min Summer	28.130	0.0	111.4	0.0	190
240 min Summer	22.070	0.0	111.0	0.0	250
360 min Summer	15.678	0.0	111.0	0.0	370
480 min Summer	12.300	0.0	111.6	0.0	488
600 min Summer	10.190	0.0	112.4	0.0	608
720 min Summer	8.738	0.0	112.7	0.0	728
960 min Summer	7.123	0.0	114.9	0.0	966
1440 min Summer	5.340	0.0	116.0	0.0	1444
2160 min Summer	4.004	0.0	230.8	0.0	2160
2880 min Summer	3.264	0.0	232.8	0.0	2692
4320 min Summer	2.296	0.0	219.5	0.0	3376
5760 min Summer	1.789	0.0	429.3	0.0	4144
7200 min Summer	1.474	0.0	416.2	0.0	4968
8640 min Summer	1.258	0.0	393.4	0.0	5792
10080 min Summer	1.101	0.0	368.2	0.0	6568
15 min Winter	228.747	0.0	55.2	0.0	27

Summary of Results for 100 year Return Period (+45%)

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
30 min Winter	2.496	0.496	0.0	0.7	0.0	0.7	187.5	O K
60 min Winter	2.552	0.552	0.0	0.7	0.0	0.7	208.8	O K
120 min Winter	2.613	0.613	0.0	0.7	0.0	0.7	231.6	O K
180 min Winter	2.649	0.649	0.0	0.7	0.0	0.7	245.4	O K
240 min Winter	2.675	0.675	0.0	0.8	0.0	0.8	255.0	O K
360 min Winter	2.710	0.710	0.0	0.8	0.0	0.8	268.2	Flood Risk
480 min Winter	2.733	0.733	0.0	0.8	0.0	0.8	276.9	Flood Risk
600 min Winter	2.749	0.749	0.0	0.8	0.0	0.8	283.0	Flood Risk
720 min Winter	2.760	0.760	0.0	0.8	0.0	0.8	287.4	Flood Risk
960 min Winter	2.808	0.808	0.0	0.8	0.0	0.8	305.5	Flood Risk
1440 min Winter	2.870	0.870	0.0	0.8	0.0	0.8	328.9	Flood Risk
2160 min Winter	2.919	0.919	0.0	0.9	0.0	0.9	347.6	Flood Risk
2880 min Winter	2.942	0.942	0.0	0.9	0.0	0.9	356.0	Flood Risk
4320 min Winter	2.875	0.875	0.0	0.8	0.0	0.8	330.6	Flood Risk
5760 min Winter	2.820	0.820	0.0	0.8	0.0	0.8	309.8	Flood Risk
7200 min Winter	2.767	0.767	0.0	0.8	0.0	0.8	289.9	Flood Risk
8640 min Winter	2.717	0.717	0.0	0.8	0.0	0.8	270.9	Flood Risk
10080 min Winter	2.669	0.669	0.0	0.8	0.0	0.8	252.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	127.487	0.0	54.0	0.0	41
60 min Winter	71.052	0.0	112.8	0.0	70
120 min Winter	39.599	0.0	112.6	0.0	130
180 min Winter	28.130	0.0	113.6	0.0	188
240 min Winter	22.070	0.0	115.0	0.0	246
360 min Winter	15.678	0.0	117.6	0.0	364
480 min Winter	12.300	0.0	119.0	0.0	482
600 min Winter	10.190	0.0	119.8	0.0	598
720 min Winter	8.738	0.0	120.1	0.0	716
960 min Winter	7.123	0.0	122.3	0.0	950
1440 min Winter	5.340	0.0	123.1	0.0	1412
2160 min Winter	4.004	0.0	247.1	0.0	2096
2880 min Winter	3.264	0.0	248.8	0.0	2744
4320 min Winter	2.296	0.0	234.4	0.0	3548
5760 min Winter	1.789	0.0	455.5	0.0	4392
7200 min Winter	1.474	0.0	436.4	0.0	5336
8640 min Winter	1.258	0.0	415.5	0.0	6232
10080 min Winter	1.101	0.0	394.5	0.0	7160

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.360

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.120	4	8	0.120	8	12	0.120

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	14.0
Membrane Percolation (mm/hr)	1000	Length (m)	90.0
Max Percolation (l/s)	350.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0044-9000-1000-9000
Design Head (m)	1.000
Design Flow (l/s)	0.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	44
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	0.9
Flush-Flo™	0.194	0.7
Kick-Flo®	0.394	0.6
Mean Flow over Head Range	-	0.7

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	0.7	1.200	1.0	3.000	1.5	7.000	2.2
0.200	0.7	1.400	1.0	3.500	1.6	7.500	2.2
0.300	0.7	1.600	1.1	4.000	1.7	8.000	2.3
0.400	0.6	1.800	1.2	4.500	1.8	8.500	2.4
0.500	0.7	2.000	1.2	5.000	1.9	9.000	2.4
0.600	0.7	2.200	1.3	5.500	1.9	9.500	2.5
0.800	0.8	2.400	1.3	6.000	2.0		
1.000	0.9	2.600	1.4	6.500	2.1		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 3338 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	2.394	0.394	0.0	1.7	0.0	1.7	278.0	O K
30 min Summer	2.440	0.440	0.0	1.7	0.0	1.7	310.4	O K
60 min Summer	2.490	0.490	0.0	1.7	0.0	1.7	345.6	O K
120 min Summer	2.543	0.543	0.0	1.7	0.0	1.7	382.9	O K
180 min Summer	2.574	0.574	0.0	1.7	0.0	1.7	405.2	O K
240 min Summer	2.596	0.596	0.0	1.7	0.0	1.7	420.8	O K
360 min Summer	2.626	0.626	0.0	1.7	0.0	1.7	441.5	O K
480 min Summer	2.644	0.644	0.0	1.7	0.0	1.7	454.7	O K
600 min Summer	2.657	0.657	0.0	1.7	0.0	1.7	463.6	O K
720 min Summer	2.666	0.666	0.0	1.7	0.0	1.7	469.6	O K
960 min Summer	2.704	0.704	0.0	1.7	0.0	1.7	496.9	Flood Risk
1440 min Summer	2.751	0.751	0.0	1.7	0.0	1.7	530.2	Flood Risk
2160 min Summer	2.783	0.783	0.0	1.7	0.0	1.7	552.3	Flood Risk
2880 min Summer	2.791	0.791	0.0	1.7	0.0	1.7	558.4	Flood Risk
4320 min Summer	2.733	0.733	0.0	1.7	0.0	1.7	516.9	Flood Risk
5760 min Summer	2.682	0.682	0.0	1.7	0.0	1.7	481.0	O K
7200 min Summer	2.635	0.635	0.0	1.7	0.0	1.7	448.2	O K
8640 min Summer	2.591	0.591	0.0	1.7	0.0	1.7	416.8	O K
10080 min Summer	2.544	0.544	0.0	1.7	0.0	1.7	383.8	O K
15 min Winter	2.449	0.449	0.0	1.7	0.0	1.7	316.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	228.747	0.0	143.0	0.0	27
30 min Summer	127.487	0.0	141.6	0.0	42
60 min Summer	71.052	0.0	278.1	0.0	72
120 min Summer	39.599	0.0	275.2	0.0	132
180 min Summer	28.130	0.0	269.3	0.0	190
240 min Summer	22.070	0.0	264.2	0.0	250
360 min Summer	15.678	0.0	256.6	0.0	370
480 min Summer	12.300	0.0	250.8	0.0	488
600 min Summer	10.190	0.0	246.0	0.0	608
720 min Summer	8.738	0.0	241.9	0.0	728
960 min Summer	7.123	0.0	234.6	0.0	966
1440 min Summer	5.340	0.0	230.7	0.0	1444
2160 min Summer	4.004	0.0	489.2	0.0	2160
2880 min Summer	3.264	0.0	473.4	0.0	2632
4320 min Summer	2.296	0.0	437.2	0.0	3332
5760 min Summer	1.789	0.0	825.2	0.0	4096
7200 min Summer	1.474	0.0	838.3	0.0	4912
8640 min Summer	1.258	0.0	839.7	0.0	5792
10080 min Summer	1.101	0.0	825.9	0.0	6560
15 min Winter	228.747	0.0	141.9	0.0	27

Summary of Results for 100 year Return Period (+45%)

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
30 min Winter	2.501	0.501	0.0	1.7	0.0	1.7	353.8	O K
60 min Winter	2.558	0.558	0.0	1.7	0.0	1.7	393.9	O K
120 min Winter	2.619	0.619	0.0	1.7	0.0	1.7	436.8	O K
180 min Winter	2.655	0.655	0.0	1.7	0.0	1.7	462.3	O K
240 min Winter	2.681	0.681	0.0	1.7	0.0	1.7	480.3	O K
360 min Winter	2.715	0.715	0.0	1.7	0.0	1.7	504.5	Flood Risk
480 min Winter	2.737	0.737	0.0	1.7	0.0	1.7	520.2	Flood Risk
600 min Winter	2.753	0.753	0.0	1.7	0.0	1.7	531.1	Flood Risk
720 min Winter	2.763	0.763	0.0	1.7	0.0	1.7	538.7	Flood Risk
960 min Winter	2.810	0.810	0.0	1.7	0.0	1.7	571.4	Flood Risk
1440 min Winter	2.869	0.869	0.0	1.7	0.0	1.7	613.0	Flood Risk
2160 min Winter	2.913	0.913	0.0	1.7	0.0	1.7	644.4	Flood Risk
2880 min Winter	2.931	0.931	0.0	1.7	0.0	1.7	656.6	Flood Risk
4320 min Winter	2.856	0.856	0.0	1.7	0.0	1.7	604.1	Flood Risk
5760 min Winter	2.793	0.793	0.0	1.7	0.0	1.7	559.9	Flood Risk
7200 min Winter	2.733	0.733	0.0	1.7	0.0	1.7	516.9	Flood Risk
8640 min Winter	2.673	0.673	0.0	1.7	0.0	1.7	475.1	O K
10080 min Winter	2.614	0.614	0.0	1.7	0.0	1.7	433.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	127.487	0.0	138.6	0.0	41
60 min Winter	71.052	0.0	275.4	0.0	70
120 min Winter	39.599	0.0	265.5	0.0	130
180 min Winter	28.130	0.0	259.6	0.0	188
240 min Winter	22.070	0.0	255.6	0.0	246
360 min Winter	15.678	0.0	250.2	0.0	364
480 min Winter	12.300	0.0	246.5	0.0	482
600 min Winter	10.190	0.0	243.7	0.0	598
720 min Winter	8.738	0.0	241.6	0.0	716
960 min Winter	7.123	0.0	242.8	0.0	950
1440 min Winter	5.340	0.0	245.9	0.0	1412
2160 min Winter	4.004	0.0	498.8	0.0	2084
2880 min Winter	3.264	0.0	493.6	0.0	2744
4320 min Winter	2.296	0.0	468.9	0.0	3500
5760 min Winter	1.789	0.0	931.5	0.0	4384
7200 min Winter	1.474	0.0	926.4	0.0	5328
8640 min Winter	1.258	0.0	887.9	0.0	6232
10080 min Winter	1.101	0.0	846.1	0.0	7160

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.680

Time (mins) From:	**To:**	**Area (ha)**	**Time (mins) From:**	**To:**	**Area (ha)**	**Time (mins) From:**	**To:**	**Area (ha)**
0	4	0.227	4	8	0.227	8	12	0.227

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	21.0
Membrane Percolation (mm/hr)	1000	Length (m)	112.0
Max Percolation (l/s)	653.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0063-1770-1000-1770
Design Head (m)	1.000
Design Flow (l/s)	1.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	63
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	1.8
Flush-Flo™	0.277	1.7
Kick-Flo®	0.562	1.4
Mean Flow over Head Range	-	1.5

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)**
0.100	1.5	1.200	2.0	3.000	3.0	7.000	4.4
0.200	1.7	1.400	2.1	3.500	3.2	7.500	4.6
0.300	1.7	1.600	2.2	4.000	3.4	8.000	4.7
0.400	1.7	1.800	2.3	4.500	3.6	8.500	4.8
0.500	1.6	2.000	2.5	5.000	3.8	9.000	5.0
0.600	1.4	2.200	2.6	5.500	3.9	9.500	5.1
0.800	1.6	2.400	2.7	6.000	4.1		
1.000	1.8	2.600	2.8	6.500	4.3		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 30 year Return Period (+45%)

Half Drain Time : 2441 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	2.219	0.219	0.0	1.5	0.0	1.5	159.1	O K
30 min Summer	2.250	0.250	0.0	1.5	0.0	1.5	182.0	O K
60 min Summer	2.285	0.285	0.0	1.5	0.0	1.5	207.2	O K
120 min Summer	2.322	0.322	0.0	1.5	0.0	1.5	234.3	O K
180 min Summer	2.345	0.345	0.0	1.5	0.0	1.5	250.4	O K
240 min Summer	2.360	0.360	0.0	1.5	0.0	1.5	261.6	O K
360 min Summer	2.381	0.381	0.0	1.5	0.0	1.5	276.6	O K
480 min Summer	2.393	0.393	0.0	1.5	0.0	1.5	286.0	O K
600 min Summer	2.402	0.402	0.0	1.5	0.0	1.5	292.1	O K
720 min Summer	2.407	0.407	0.0	1.5	0.0	1.5	296.1	O K
960 min Summer	2.433	0.433	0.0	1.5	0.0	1.5	314.4	O K
1440 min Summer	2.463	0.463	0.0	1.5	0.0	1.5	336.5	O K
2160 min Summer	2.484	0.484	0.0	1.5	0.0	1.5	351.7	O K
2880 min Summer	2.494	0.494	0.0	1.5	0.0	1.5	359.3	O K
4320 min Summer	2.455	0.455	0.0	1.5	0.0	1.5	330.8	O K
5760 min Summer	2.419	0.419	0.0	1.5	0.0	1.5	304.7	O K
7200 min Summer	2.386	0.386	0.0	1.5	0.0	1.5	280.4	O K
8640 min Summer	2.355	0.355	0.0	1.5	0.0	1.5	257.8	O K
10080 min Summer	2.326	0.326	0.0	1.5	0.0	1.5	236.8	O K
15 min Winter	2.251	0.251	0.0	1.5	0.0	1.5	182.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	151.060	0.0	114.2	0.0	27
30 min Summer	85.910	0.0	119.6	0.0	41
60 min Summer	48.858	0.0	192.3	0.0	72
120 min Summer	27.786	0.0	215.3	0.0	130
180 min Summer	19.974	0.0	226.6	0.0	190
240 min Summer	15.803	0.0	232.4	0.0	250
360 min Summer	11.359	0.0	235.8	0.0	368
480 min Summer	8.987	0.0	234.9	0.0	488
600 min Summer	7.494	0.0	232.9	0.0	606
720 min Summer	6.460	0.0	230.3	0.0	726
960 min Summer	5.310	0.0	224.1	0.0	964
1440 min Summer	4.029	0.0	209.4	0.0	1442
2160 min Summer	3.056	0.0	431.4	0.0	1976
2880 min Summer	2.513	0.0	419.7	0.0	2368
4320 min Summer	1.789	0.0	388.6	0.0	3068
5760 min Summer	1.405	0.0	570.6	0.0	3856
7200 min Summer	1.166	0.0	584.9	0.0	4616
8640 min Summer	1.000	0.0	595.0	0.0	5440
10080 min Summer	0.879	0.0	601.1	0.0	6160
15 min Winter	151.060	0.0	120.0	0.0	27

Summary of Results for 30 year Return Period (+45%)

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
30 min Winter	2.286	0.286	0.0	1.5	0.0	1.5	208.2	O K
60 min Winter	2.326	0.326	0.0	1.5	0.0	1.5	236.9	O K
120 min Winter	2.369	0.369	0.0	1.5	0.0	1.5	268.0	O K
180 min Winter	2.394	0.394	0.0	1.5	0.0	1.5	286.7	O K
240 min Winter	2.413	0.413	0.0	1.5	0.0	1.5	299.9	O K
360 min Winter	2.437	0.437	0.0	1.5	0.0	1.5	317.7	O K
480 min Winter	2.453	0.453	0.0	1.5	0.0	1.5	329.3	O K
600 min Winter	2.464	0.464	0.0	1.5	0.0	1.5	337.3	O K
720 min Winter	2.472	0.472	0.0	1.5	0.0	1.5	342.9	O K
960 min Winter	2.504	0.504	0.0	1.5	0.0	1.5	366.1	O K
1440 min Winter	2.546	0.546	0.0	1.5	0.0	1.5	397.1	O K
2160 min Winter	2.578	0.578	0.0	1.5	0.0	1.5	419.8	O K
2880 min Winter	2.589	0.589	0.0	1.5	0.0	1.5	428.2	O K
4320 min Winter	2.538	0.538	0.0	1.5	0.0	1.5	390.7	O K
5760 min Winter	2.484	0.484	0.0	1.5	0.0	1.5	351.8	O K
7200 min Winter	2.433	0.433	0.0	1.5	0.0	1.5	314.8	O K
8640 min Winter	2.386	0.386	0.0	1.5	0.0	1.5	280.3	O K
10080 min Winter	2.342	0.342	0.0	1.5	0.0	1.5	248.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	85.910	0.0	123.0	0.0	41
60 min Winter	48.858	0.0	215.4	0.0	70
120 min Winter	27.786	0.0	234.5	0.0	128
180 min Winter	19.974	0.0	240.1	0.0	186
240 min Winter	15.803	0.0	241.1	0.0	246
360 min Winter	11.359	0.0	239.7	0.0	362
480 min Winter	8.987	0.0	236.8	0.0	480
600 min Winter	7.494	0.0	233.4	0.0	596
720 min Winter	6.460	0.0	229.8	0.0	714
960 min Winter	5.310	0.0	220.3	0.0	946
1440 min Winter	4.029	0.0	201.1	0.0	1406
2160 min Winter	3.056	0.0	430.7	0.0	2080
2880 min Winter	2.513	0.0	412.0	0.0	2716
4320 min Winter	1.789	0.0	379.1	0.0	3416
5760 min Winter	1.405	0.0	651.4	0.0	4264
7200 min Winter	1.166	0.0	668.4	0.0	5112
8640 min Winter	1.000	0.0	680.4	0.0	5888
10080 min Winter	0.879	0.0	687.0	0.0	6664

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.610

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.203	4	8	0.203	8	12	0.203

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	32.3
Membrane Percolation (mm/hr)	1000	Length (m)	75.0
Max Percolation (l/s)	672.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0060-1600-1000-1600
Design Head (m)	1.000
Design Flow (l/s)	1.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	60
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	1.6
Flush-Flo™	0.262	1.5
Kick-Flo®	0.531	1.2
Mean Flow over Head Range	-	1.3

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)**
0.100	1.3	1.200	1.7	3.000	2.6	7.000	3.9
0.200	1.5	1.400	1.9	3.500	2.8	7.500	4.0
0.300	1.5	1.600	2.0	4.000	3.0	8.000	4.2
0.400	1.4	1.800	2.1	4.500	3.2	8.500	4.3
0.500	1.3	2.000	2.2	5.000	3.3	9.000	4.4
0.600	1.3	2.200	2.3	5.500	3.5	9.500	4.5
0.800	1.4	2.400	2.4	6.000	3.6		
1.000	1.6	2.600	2.5	6.500	3.8		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 30 year Return Period (+45%)

Half Drain Time : 2340 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	2.266	0.266	0.0	1.5	0.0	1.5	155.8	O K
30 min Summer	2.304	0.304	0.0	1.5	0.0	1.5	177.9	O K
60 min Summer	2.346	0.346	0.0	1.5	0.0	1.5	202.2	O K
120 min Summer	2.390	0.390	0.0	1.5	0.0	1.5	228.3	O K
180 min Summer	2.417	0.417	0.0	1.5	0.0	1.5	243.7	O K
240 min Summer	2.435	0.435	0.0	1.5	0.0	1.5	254.5	O K
360 min Summer	2.459	0.459	0.0	1.5	0.0	1.5	268.8	O K
480 min Summer	2.475	0.475	0.0	1.5	0.0	1.5	277.8	O K
600 min Summer	2.485	0.485	0.0	1.5	0.0	1.5	283.7	O K
720 min Summer	2.492	0.492	0.0	1.5	0.0	1.5	287.5	O K
960 min Summer	2.523	0.523	0.0	1.5	0.0	1.5	305.8	O K
1440 min Summer	2.561	0.561	0.0	1.5	0.0	1.5	328.0	O K
2160 min Summer	2.582	0.582	0.0	1.5	0.0	1.5	340.6	O K
2880 min Summer	2.591	0.591	0.0	1.5	0.0	1.5	345.8	O K
4320 min Summer	2.544	0.544	0.0	1.5	0.0	1.5	318.2	O K
5760 min Summer	2.495	0.495	0.0	1.5	0.0	1.5	289.5	O K
7200 min Summer	2.451	0.451	0.0	1.5	0.0	1.5	263.7	O K
8640 min Summer	2.411	0.411	0.0	1.5	0.0	1.5	240.5	O K
10080 min Summer	2.375	0.375	0.0	1.5	0.0	1.5	219.3	O K
15 min Winter	2.304	0.304	0.0	1.5	0.0	1.5	178.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	151.060	0.0	117.2	0.0	27
30 min Summer	85.910	0.0	121.2	0.0	41
60 min Summer	48.858	0.0	192.8	0.0	72
120 min Summer	27.786	0.0	216.1	0.0	130
180 min Summer	19.974	0.0	227.6	0.0	190
240 min Summer	15.803	0.0	232.9	0.0	250
360 min Summer	11.359	0.0	234.6	0.0	368
480 min Summer	8.987	0.0	232.6	0.0	488
600 min Summer	7.494	0.0	229.6	0.0	606
720 min Summer	6.460	0.0	226.2	0.0	726
960 min Summer	5.310	0.0	216.2	0.0	964
1440 min Summer	4.029	0.0	197.8	0.0	1442
2160 min Summer	3.056	0.0	422.5	0.0	2052
2880 min Summer	2.513	0.0	409.0	0.0	2392
4320 min Summer	1.789	0.0	371.7	0.0	3124
5760 min Summer	1.405	0.0	560.2	0.0	3880
7200 min Summer	1.166	0.0	575.7	0.0	4624
8640 min Summer	1.000	0.0	587.3	0.0	5448
10080 min Summer	0.879	0.0	595.4	0.0	6160
15 min Winter	151.060	0.0	121.6	0.0	27

Summary of Results for 30 year Return Period (+45%)

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
30 min Winter	2.347	0.347	0.0	1.5	0.0	1.5	203.2	O K
60 min Winter	2.395	0.395	0.0	1.5	0.0	1.5	231.0	O K
120 min Winter	2.446	0.446	0.0	1.5	0.0	1.5	260.9	O K
180 min Winter	2.477	0.477	0.0	1.5	0.0	1.5	279.0	O K
240 min Winter	2.499	0.499	0.0	1.5	0.0	1.5	291.7	O K
360 min Winter	2.528	0.528	0.0	1.5	0.0	1.5	309.1	O K
480 min Winter	2.548	0.548	0.0	1.5	0.0	1.5	320.5	O K
600 min Winter	2.561	0.561	0.0	1.5	0.0	1.5	328.3	O K
720 min Winter	2.570	0.570	0.0	1.5	0.0	1.5	333.6	O K
960 min Winter	2.607	0.607	0.0	1.5	0.0	1.5	355.2	O K
1440 min Winter	2.652	0.652	0.0	1.5	0.0	1.5	381.7	O K
2160 min Winter	2.684	0.684	0.0	1.5	0.0	1.5	400.0	O K
2880 min Winter	2.693	0.693	0.0	1.5	0.0	1.5	405.5	O K
4320 min Winter	2.635	0.635	0.0	1.5	0.0	1.5	371.2	O K
5760 min Winter	2.577	0.577	0.0	1.5	0.0	1.5	337.5	O K
7200 min Winter	2.512	0.512	0.0	1.5	0.0	1.5	299.8	O K
8640 min Winter	2.448	0.448	0.0	1.5	0.0	1.5	262.2	O K
10080 min Winter	2.392	0.392	0.0	1.5	0.0	1.5	229.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	85.910	0.0	123.5	0.0	41
60 min Winter	48.858	0.0	216.1	0.0	70
120 min Winter	27.786	0.0	234.7	0.0	128
180 min Winter	19.974	0.0	238.3	0.0	188
240 min Winter	15.803	0.0	237.5	0.0	246
360 min Winter	11.359	0.0	232.7	0.0	362
480 min Winter	8.987	0.0	227.3	0.0	480
600 min Winter	7.494	0.0	222.5	0.0	598
720 min Winter	6.460	0.0	218.3	0.0	714
960 min Winter	5.310	0.0	209.1	0.0	944
1440 min Winter	4.029	0.0	197.8	0.0	1402
2160 min Winter	3.056	0.0	429.6	0.0	2060
2880 min Winter	2.513	0.0	414.2	0.0	2684
4320 min Winter	1.789	0.0	380.2	0.0	3336
5760 min Winter	1.405	0.0	638.7	0.0	4272
7200 min Winter	1.166	0.0	656.8	0.0	5184
8640 min Winter	1.000	0.0	670.6	0.0	5960
10080 min Winter	0.879	0.0	680.1	0.0	6664

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.590

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.197	4	8	0.197	8	12	0.197

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	26.0
Membrane Percolation (mm/hr)	1000	Length (m)	75.0
Max Percolation (l/s)	541.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0059-1590-1000-1590
Design Head (m)	1.000
Design Flow (l/s)	1.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	59
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	1.6
Flush-Flo™	0.262	1.5
Kick-Flo®	0.531	1.2
Mean Flow over Head Range	-	1.3

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)
0.100	1.3	1.200	1.7	3.000	2.6	7.000	3.9
0.200	1.5	1.400	1.9	3.500	2.8	7.500	4.0
0.300	1.5	1.600	2.0	4.000	3.0	8.000	4.2
0.400	1.4	1.800	2.1	4.500	3.2	8.500	4.3
0.500	1.3	2.000	2.2	5.000	3.3	9.000	4.4
0.600	1.3	2.200	2.3	5.500	3.5	9.500	4.5
0.800	1.4	2.400	2.4	6.000	3.6		
1.000	1.6	2.600	2.5	6.500	3.8		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 30 year Return Period (+45%)

Half Drain Time : 2217 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	2.246	0.246	0.0	1.9	0.0	1.9	197.1	O K
30 min Summer	2.281	0.281	0.0	1.9	0.0	1.9	225.2	O K
60 min Summer	2.320	0.320	0.0	1.9	0.0	1.9	256.0	O K
120 min Summer	2.361	0.361	0.0	1.9	0.0	1.9	289.0	O K
180 min Summer	2.386	0.386	0.0	1.9	0.0	1.9	308.5	O K
240 min Summer	2.402	0.402	0.0	1.9	0.0	1.9	321.9	O K
360 min Summer	2.425	0.425	0.0	1.9	0.0	1.9	339.7	O K
480 min Summer	2.438	0.438	0.0	1.9	0.0	1.9	350.5	O K
600 min Summer	2.447	0.447	0.0	1.9	0.0	1.9	357.4	O K
720 min Summer	2.452	0.452	0.0	1.9	0.0	1.9	361.7	O K
960 min Summer	2.478	0.478	0.0	1.9	0.0	1.9	382.7	O K
1440 min Summer	2.509	0.509	0.0	1.9	0.0	1.9	407.0	O K
2160 min Summer	2.529	0.529	0.0	1.9	0.0	1.9	423.3	O K
2880 min Summer	2.539	0.539	0.0	1.9	0.0	1.9	430.9	O K
4320 min Summer	2.493	0.493	0.0	1.9	0.0	1.9	394.5	O K
5760 min Summer	2.451	0.451	0.0	1.9	0.0	1.9	360.9	O K
7200 min Summer	2.412	0.412	0.0	1.9	0.0	1.9	329.9	O K
8640 min Summer	2.377	0.377	0.0	1.9	0.0	1.9	301.4	O K
10080 min Summer	2.344	0.344	0.0	1.9	0.0	1.9	275.1	O K
15 min Winter	2.282	0.282	0.0	1.9	0.0	1.9	225.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	151.060	0.0	148.4	0.0	27
30 min Summer	85.910	0.0	156.9	0.0	41
60 min Summer	48.858	0.0	241.5	0.0	72
120 min Summer	27.786	0.0	272.1	0.0	130
180 min Summer	19.974	0.0	289.0	0.0	190
240 min Summer	15.803	0.0	299.1	0.0	248
360 min Summer	11.359	0.0	307.8	0.0	368
480 min Summer	8.987	0.0	308.7	0.0	486
600 min Summer	7.494	0.0	307.0	0.0	606
720 min Summer	6.460	0.0	304.3	0.0	724
960 min Summer	5.310	0.0	297.4	0.0	964
1440 min Summer	4.029	0.0	279.3	0.0	1440
2160 min Summer	3.056	0.0	556.2	0.0	1868
2880 min Summer	2.513	0.0	557.4	0.0	2280
4320 min Summer	1.789	0.0	518.3	0.0	2988
5760 min Summer	1.405	0.0	707.9	0.0	3800
7200 min Summer	1.166	0.0	726.8	0.0	4552
8640 min Summer	1.000	0.0	740.7	0.0	5360
10080 min Summer	0.879	0.0	749.8	0.0	6152
15 min Winter	151.060	0.0	157.4	0.0	27

Summary of Results for 30 year Return Period (+45%)

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
30 min Winter	2.322	0.322	0.0	1.9	0.0	1.9	257.3	O K
60 min Winter	2.366	0.366	0.0	1.9	0.0	1.9	292.5	O K
120 min Winter	2.413	0.413	0.0	1.9	0.0	1.9	330.4	O K
180 min Winter	2.441	0.441	0.0	1.9	0.0	1.9	353.0	O K
240 min Winter	2.461	0.461	0.0	1.9	0.0	1.9	368.9	O K
360 min Winter	2.488	0.488	0.0	1.9	0.0	1.9	390.2	O K
480 min Winter	2.505	0.505	0.0	1.9	0.0	1.9	403.8	O K
600 min Winter	2.516	0.516	0.0	1.9	0.0	1.9	413.0	O K
720 min Winter	2.524	0.524	0.0	1.9	0.0	1.9	419.2	O K
960 min Winter	2.558	0.558	0.0	1.9	0.0	1.9	446.3	O K
1440 min Winter	2.602	0.602	0.0	1.9	0.0	1.9	481.8	O K
2160 min Winter	2.634	0.634	0.0	1.9	0.0	1.9	507.1	O K
2880 min Winter	2.643	0.643	0.0	1.9	0.0	1.9	514.5	O K
4320 min Winter	2.579	0.579	0.0	1.9	0.0	1.9	463.1	O K
5760 min Winter	2.516	0.516	0.0	1.9	0.0	1.9	413.0	O K
7200 min Winter	2.457	0.457	0.0	1.9	0.0	1.9	365.8	O K
8640 min Winter	2.403	0.403	0.0	1.9	0.0	1.9	322.3	O K
10080 min Winter	2.353	0.353	0.0	1.9	0.0	1.9	282.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	85.910	0.0	161.9	0.0	41
60 min Winter	48.858	0.0	272.1	0.0	70
120 min Winter	27.786	0.0	300.9	0.0	128
180 min Winter	19.974	0.0	312.4	0.0	186
240 min Winter	15.803	0.0	316.2	0.0	246
360 min Winter	11.359	0.0	316.2	0.0	362
480 min Winter	8.987	0.0	313.3	0.0	480
600 min Winter	7.494	0.0	309.5	0.0	596
720 min Winter	6.460	0.0	305.2	0.0	712
960 min Winter	5.310	0.0	293.9	0.0	944
1440 min Winter	4.029	0.0	269.5	0.0	1404
2160 min Winter	3.056	0.0	571.0	0.0	2076
2880 min Winter	2.513	0.0	549.0	0.0	2708
4320 min Winter	1.789	0.0	514.2	0.0	3332
5760 min Winter	1.405	0.0	808.0	0.0	4160
7200 min Winter	1.166	0.0	830.4	0.0	5040
8640 min Winter	1.000	0.0	847.1	0.0	5800
10080 min Winter	0.879	0.0	858.5	0.0	6568

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.750

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.250	4	8	0.250	8	12	0.250

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	30.3
Membrane Percolation (mm/hr)	1000	Length (m)	88.0
Max Percolation (l/s)	740.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0
Flush-Flo™	0.296	1.9
Kick-Flo®	0.599	1.6
Mean Flow over Head Range	-	1.7

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	1.6	1.200	2.2	3.000	3.3	7.000	4.9
0.200	1.9	1.400	2.3	3.500	3.5	7.500	5.1
0.300	1.9	1.600	2.5	4.000	3.8	8.000	5.2
0.400	1.9	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.8	2.000	2.7	5.000	4.2	9.000	5.5
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.7
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.7		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 30 year Return Period (+45%)

Half Drain Time : 2446 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	2.190	0.190	0.0	2.1	0.0	2.1	182.6	O K
30 min Summer	2.251	0.251	0.0	2.2	0.0	2.2	241.0	O K
60 min Summer	2.313	0.313	0.0	2.2	0.0	2.2	300.5	O K
120 min Summer	2.379	0.379	0.0	2.2	0.0	2.2	363.9	O K
180 min Summer	2.421	0.421	0.0	2.2	0.0	2.2	404.1	O K
240 min Summer	2.452	0.452	0.0	2.2	0.0	2.2	433.5	O K
360 min Summer	2.494	0.494	0.0	2.2	0.0	2.2	474.5	O K
480 min Summer	2.523	0.523	0.0	2.2	0.0	2.2	502.3	O K
600 min Summer	2.543	0.543	0.0	2.2	0.0	2.2	521.4	O K
720 min Summer	2.557	0.557	0.0	2.2	0.0	2.2	534.8	O K
960 min Summer	2.573	0.573	0.0	2.2	0.0	2.2	549.8	O K
1440 min Summer	2.577	0.577	0.0	2.2	0.0	2.2	554.3	O K
2160 min Summer	2.555	0.555	0.0	2.2	0.0	2.2	532.6	O K
2880 min Summer	2.532	0.532	0.0	2.2	0.0	2.2	510.3	O K
4320 min Summer	2.493	0.493	0.0	2.2	0.0	2.2	473.1	O K
5760 min Summer	2.460	0.460	0.0	2.2	0.0	2.2	441.2	O K
7200 min Summer	2.432	0.432	0.0	2.2	0.0	2.2	414.5	O K
8640 min Summer	2.407	0.407	0.0	2.2	0.0	2.2	391.0	O K
10080 min Summer	2.385	0.385	0.0	2.2	0.0	2.2	370.0	O K
15 min Winter	2.215	0.215	0.0	2.1	0.0	2.1	206.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	125.894	0.0	141.5	0.0	27
30 min Summer	81.693	0.0	170.2	0.0	41
60 min Summer	50.606	0.0	278.4	0.0	72
120 min Summer	30.710	0.0	329.3	0.0	130
180 min Summer	22.879	0.0	350.4	0.0	190
240 min Summer	18.538	0.0	356.7	0.0	250
360 min Summer	13.736	0.0	357.0	0.0	368
480 min Summer	11.075	0.0	352.6	0.0	488
600 min Summer	9.342	0.0	346.8	0.0	608
720 min Summer	8.112	0.0	340.7	0.0	726
960 min Summer	6.457	0.0	328.9	0.0	966
1440 min Summer	4.636	0.0	308.6	0.0	1442
2160 min Summer	3.298	0.0	646.7	0.0	2008
2880 min Summer	2.590	0.0	631.0	0.0	2284
4320 min Summer	1.851	0.0	583.2	0.0	3028
5760 min Summer	1.467	0.0	834.8	0.0	3808
7200 min Summer	1.233	0.0	869.0	0.0	4616
8640 min Summer	1.075	0.0	899.7	0.0	5448
10080 min Summer	0.961	0.0	925.7	0.0	6248
15 min Winter	125.894	0.0	155.7	0.0	27

Summary of Results for 30 year Return Period (+45%)

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
30 min Winter	2.283	0.283	0.0	2.2	0.0	2.2	272.2	O K
60 min Winter	2.353	0.353	0.0	2.2	0.0	2.2	339.1	O K
120 min Winter	2.428	0.428	0.0	2.2	0.0	2.2	410.6	O K
180 min Winter	2.475	0.475	0.0	2.2	0.0	2.2	456.3	O K
240 min Winter	2.510	0.510	0.0	2.2	0.0	2.2	489.8	O K
360 min Winter	2.560	0.560	0.0	2.2	0.0	2.2	537.3	O K
480 min Winter	2.594	0.594	0.0	2.2	0.0	2.2	570.0	O K
600 min Winter	2.618	0.618	0.0	2.2	0.0	2.2	593.3	O K
720 min Winter	2.636	0.636	0.0	2.2	0.0	2.2	610.1	O K
960 min Winter	2.656	0.656	0.0	2.2	0.0	2.2	630.0	O K
1440 min Winter	2.668	0.668	0.0	2.2	0.0	2.2	641.1	O K
2160 min Winter	2.653	0.653	0.0	2.2	0.0	2.2	627.2	O K
2880 min Winter	2.625	0.625	0.0	2.2	0.0	2.2	600.4	O K
4320 min Winter	2.566	0.566	0.0	2.2	0.0	2.2	543.7	O K
5760 min Winter	2.517	0.517	0.0	2.2	0.0	2.2	496.4	O K
7200 min Winter	2.474	0.474	0.0	2.2	0.0	2.2	454.7	O K
8640 min Winter	2.434	0.434	0.0	2.2	0.0	2.2	416.9	O K
10080 min Winter	2.399	0.399	0.0	2.2	0.0	2.2	382.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	81.693	0.0	177.5	0.0	41
60 min Winter	50.606	0.0	309.5	0.0	70
120 min Winter	30.710	0.0	352.8	0.0	128
180 min Winter	22.879	0.0	361.4	0.0	188
240 min Winter	18.538	0.0	361.8	0.0	246
360 min Winter	13.736	0.0	355.7	0.0	364
480 min Winter	11.075	0.0	346.7	0.0	480
600 min Winter	9.342	0.0	337.2	0.0	598
720 min Winter	8.112	0.0	328.2	0.0	716
960 min Winter	6.457	0.0	314.5	0.0	950
1440 min Winter	4.636	0.0	295.1	0.0	1408
2160 min Winter	3.298	0.0	643.4	0.0	2080
2880 min Winter	2.590	0.0	622.0	0.0	2716
4320 min Winter	1.851	0.0	586.6	0.0	3328
5760 min Winter	1.467	0.0	940.9	0.0	4208
7200 min Winter	1.233	0.0	980.0	0.0	5048
8640 min Winter	1.075	0.0	1014.5	0.0	5888
10080 min Winter	0.961	0.0	1041.7	0.0	6752

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 624621 307427 TG 24621 07427
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.850

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.283	4	8	0.283	8	12	0.283

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	32.0
Membrane Percolation (mm/hr)	1000	Length (m)	100.0
Max Percolation (l/s)	888.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0070-2200-1000-2200
Design Head (m)	1.000
Design Flow (l/s)	2.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	70
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	2.2
Flush-Flo™	0.307	2.2
Kick-Flo®	0.625	1.8
Mean Flow over Head Range	-	1.9

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)**
0.100	1.8	1.200	2.4	3.000	3.6	7.000	5.4
0.200	2.1	1.400	2.6	3.500	3.9	7.500	5.6
0.300	2.2	1.600	2.7	4.000	4.2	8.000	5.8
0.400	2.2	1.800	2.9	4.500	4.4	8.500	5.9
0.500	2.1	2.000	3.0	5.000	4.6	9.000	6.1
0.600	1.9	2.200	3.2	5.500	4.8	9.500	6.3
0.800	2.0	2.400	3.3	6.000	5.0		
1.000	2.2	2.600	3.4	6.500	5.2		

Orifice Overflow Control

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 3.000

Summary of Results for 30 year Return Period (+45%)

Half Drain Time : 2413 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	2.225	0.225	0.0	1.7	0.0	1.7	182.9	O K
30 min Summer	2.257	0.257	0.0	1.7	0.0	1.7	209.2	O K
60 min Summer	2.292	0.292	0.0	1.7	0.0	1.7	238.1	O K
120 min Summer	2.330	0.330	0.0	1.7	0.0	1.7	269.2	O K
180 min Summer	2.353	0.353	0.0	1.7	0.0	1.7	287.6	O K
240 min Summer	2.369	0.369	0.0	1.7	0.0	1.7	300.5	O K
360 min Summer	2.390	0.390	0.0	1.7	0.0	1.7	317.6	O K
480 min Summer	2.403	0.403	0.0	1.7	0.0	1.7	328.3	O K
600 min Summer	2.412	0.412	0.0	1.7	0.0	1.7	335.3	O K
720 min Summer	2.417	0.417	0.0	1.7	0.0	1.7	339.8	O K
960 min Summer	2.443	0.443	0.0	1.7	0.0	1.7	360.5	O K
1440 min Summer	2.473	0.473	0.0	1.7	0.0	1.7	385.4	O K
2160 min Summer	2.494	0.494	0.0	1.7	0.0	1.7	402.3	O K
2880 min Summer	2.504	0.504	0.0	1.7	0.0	1.7	410.9	O K
4320 min Summer	2.465	0.465	0.0	1.7	0.0	1.7	379.0	O K
5760 min Summer	2.429	0.429	0.0	1.7	0.0	1.7	349.2	O K
7200 min Summer	2.395	0.395	0.0	1.7	0.0	1.7	321.5	O K
8640 min Summer	2.363	0.363	0.0	1.7	0.0	1.7	295.6	O K
10080 min Summer	2.334	0.334	0.0	1.7	0.0	1.7	271.7	O K
15 min Winter	2.257	0.257	0.0	1.7	0.0	1.7	209.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	151.060	0.0	131.1	0.0	27
30 min Summer	85.910	0.0	137.7	0.0	41
60 min Summer	48.858	0.0	220.5	0.0	72
120 min Summer	27.786	0.0	247.0	0.0	130
180 min Summer	19.974	0.0	260.4	0.0	190
240 min Summer	15.803	0.0	267.4	0.0	250
360 min Summer	11.359	0.0	272.1	0.0	368
480 min Summer	8.987	0.0	271.5	0.0	486
600 min Summer	7.494	0.0	269.5	0.0	606
720 min Summer	6.460	0.0	266.7	0.0	726
960 min Summer	5.310	0.0	260.0	0.0	964
1440 min Summer	4.029	0.0	243.9	0.0	1442
2160 min Summer	3.056	0.0	499.0	0.0	1932
2880 min Summer	2.513	0.0	488.9	0.0	2336
4320 min Summer	1.789	0.0	451.8	0.0	3032
5760 min Summer	1.405	0.0	655.6	0.0	3816
7200 min Summer	1.166	0.0	672.1	0.0	4616
8640 min Summer	1.000	0.0	683.9	0.0	5440
10080 min Summer	0.879	0.0	691.0	0.0	6160
15 min Winter	151.060	0.0	138.2	0.0	27

Summary of Results for 30 year Return Period (+45%)

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
30 min Winter	2.294	0.294	0.0	1.7	0.0	1.7	239.2	O K
60 min Winter	2.334	0.334	0.0	1.7	0.0	1.7	272.2	O K
120 min Winter	2.378	0.378	0.0	1.7	0.0	1.7	307.8	O K
180 min Winter	2.404	0.404	0.0	1.7	0.0	1.7	329.2	O K
240 min Winter	2.423	0.423	0.0	1.7	0.0	1.7	344.3	O K
360 min Winter	2.448	0.448	0.0	1.7	0.0	1.7	364.7	O K
480 min Winter	2.464	0.464	0.0	1.7	0.0	1.7	378.0	O K
600 min Winter	2.475	0.475	0.0	1.7	0.0	1.7	387.0	O K
720 min Winter	2.483	0.483	0.0	1.7	0.0	1.7	393.3	O K
960 min Winter	2.515	0.515	0.0	1.7	0.0	1.7	419.6	O K
1440 min Winter	2.558	0.558	0.0	1.7	0.0	1.7	454.4	O K
2160 min Winter	2.591	0.591	0.0	1.7	0.0	1.7	481.6	O K
2880 min Winter	2.603	0.603	0.0	1.7	0.0	1.7	491.5	O K
4320 min Winter	2.547	0.547	0.0	1.7	0.0	1.7	445.6	O K
5760 min Winter	2.493	0.493	0.0	1.7	0.0	1.7	401.9	O K
7200 min Winter	2.442	0.442	0.0	1.7	0.0	1.7	360.0	O K
8640 min Winter	2.394	0.394	0.0	1.7	0.0	1.7	320.8	O K
10080 min Winter	2.349	0.349	0.0	1.7	0.0	1.7	284.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	85.910	0.0	141.9	0.0	41
60 min Winter	48.858	0.0	247.2	0.0	70
120 min Winter	27.786	0.0	269.8	0.0	128
180 min Winter	19.974	0.0	277.1	0.0	186
240 min Winter	15.803	0.0	278.6	0.0	246
360 min Winter	11.359	0.0	277.7	0.0	362
480 min Winter	8.987	0.0	274.8	0.0	480
600 min Winter	7.494	0.0	271.2	0.0	596
720 min Winter	6.460	0.0	267.3	0.0	712
960 min Winter	5.310	0.0	257.5	0.0	944
1440 min Winter	4.029	0.0	236.7	0.0	1406
2160 min Winter	3.056	0.0	500.3	0.0	2080
2880 min Winter	2.513	0.0	478.2	0.0	2716
4320 min Winter	1.789	0.0	446.9	0.0	3376
5760 min Winter	1.405	0.0	748.5	0.0	4216
7200 min Winter	1.166	0.0	768.1	0.0	5048
8640 min Winter	1.000	0.0	781.9	0.0	5880
10080 min Winter	0.879	0.0	789.7	0.0	6664

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.700

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.233	4	8	0.233	8	12	0.233

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	21.9
Membrane Percolation (mm/hr)	1000	Length (m)	124.0
Max Percolation (l/s)	754.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0063-1800-1000-1800
Design Head (m)	1.000
Design Flow (l/s)	1.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	63
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	1.8
Flush-Flo™	0.280	1.7
Kick-Flo®	0.565	1.4
Mean Flow over Head Range	-	1.5

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)**
0.100	1.5	1.200	2.0	3.000	3.0	7.000	4.4
0.200	1.7	1.400	2.1	3.500	3.2	7.500	4.6
0.300	1.7	1.600	2.2	4.000	3.4	8.000	4.7
0.400	1.7	1.800	2.3	4.500	3.6	8.500	4.8
0.500	1.6	2.000	2.5	5.000	3.8	9.000	5.0
0.600	1.4	2.200	2.6	5.500	3.9	9.500	5.1
0.800	1.6	2.400	2.7	6.000	4.1		
1.000	1.8	2.600	2.8	6.500	4.3		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 30 year Return Period (+45%)

Half Drain Time : 2405 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	2.241	0.241	0.0	1.4	0.0	1.4	147.0	O K
30 min Summer	2.275	0.275	0.0	1.4	0.0	1.4	168.0	O K
60 min Summer	2.313	0.313	0.0	1.4	0.0	1.4	191.1	O K
120 min Summer	2.354	0.354	0.0	1.4	0.0	1.4	215.9	O K
180 min Summer	2.378	0.378	0.0	1.4	0.0	1.4	230.6	O K
240 min Summer	2.395	0.395	0.0	1.4	0.0	1.4	240.9	O K
360 min Summer	2.417	0.417	0.0	1.4	0.0	1.4	254.6	O K
480 min Summer	2.431	0.431	0.0	1.4	0.0	1.4	263.1	O K
600 min Summer	2.441	0.441	0.0	1.4	0.0	1.4	268.8	O K
720 min Summer	2.447	0.447	0.0	1.4	0.0	1.4	272.5	O K
960 min Summer	2.475	0.475	0.0	1.4	0.0	1.4	289.5	O K
1440 min Summer	2.510	0.510	0.0	1.4	0.0	1.4	311.2	O K
2160 min Summer	2.534	0.534	0.0	1.4	0.0	1.4	325.7	O K
2880 min Summer	2.543	0.543	0.0	1.4	0.0	1.4	331.2	O K
4320 min Summer	2.497	0.497	0.0	1.4	0.0	1.4	303.2	O K
5760 min Summer	2.454	0.454	0.0	1.4	0.0	1.4	277.2	O K
7200 min Summer	2.416	0.416	0.0	1.4	0.0	1.4	253.8	O K
8640 min Summer	2.381	0.381	0.0	1.4	0.0	1.4	232.4	O K
10080 min Summer	2.348	0.348	0.0	1.4	0.0	1.4	212.6	O K
15 min Winter	2.276	0.276	0.0	1.4	0.0	1.4	168.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	151.060	0.0	108.3	0.0	27
30 min Summer	85.910	0.0	112.5	0.0	41
60 min Summer	48.858	0.0	180.3	0.0	72
120 min Summer	27.786	0.0	201.8	0.0	130
180 min Summer	19.974	0.0	212.2	0.0	190
240 min Summer	15.803	0.0	217.2	0.0	250
360 min Summer	11.359	0.0	219.2	0.0	368
480 min Summer	8.987	0.0	217.8	0.0	488
600 min Summer	7.494	0.0	215.3	0.0	606
720 min Summer	6.460	0.0	212.4	0.0	726
960 min Summer	5.310	0.0	204.8	0.0	964
1440 min Summer	4.029	0.0	187.8	0.0	1442
2160 min Summer	3.056	0.0	394.3	0.0	2100
2880 min Summer	2.513	0.0	380.3	0.0	2428
4320 min Summer	1.789	0.0	352.6	0.0	3120
5760 min Summer	1.405	0.0	528.1	0.0	3864
7200 min Summer	1.166	0.0	542.0	0.0	4624
8640 min Summer	1.000	0.0	552.3	0.0	5448
10080 min Summer	0.879	0.0	559.0	0.0	6168
15 min Winter	151.060	0.0	112.8	0.0	27

Summary of Results for 30 year Return Period (+45%)

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
30 min Winter	2.315	0.315	0.0	1.4	0.0	1.4	192.0	O K
60 min Winter	2.358	0.358	0.0	1.4	0.0	1.4	218.4	O K
120 min Winter	2.405	0.405	0.0	1.4	0.0	1.4	246.9	O K
180 min Winter	2.433	0.433	0.0	1.4	0.0	1.4	264.0	O K
240 min Winter	2.453	0.453	0.0	1.4	0.0	1.4	276.1	O K
360 min Winter	2.480	0.480	0.0	1.4	0.0	1.4	292.6	O K
480 min Winter	2.497	0.497	0.0	1.4	0.0	1.4	303.4	O K
600 min Winter	2.510	0.510	0.0	1.4	0.0	1.4	310.9	O K
720 min Winter	2.518	0.518	0.0	1.4	0.0	1.4	316.3	O K
960 min Winter	2.553	0.553	0.0	1.4	0.0	1.4	337.6	O K
1440 min Winter	2.597	0.597	0.0	1.4	0.0	1.4	363.9	O K
2160 min Winter	2.627	0.627	0.0	1.4	0.0	1.4	382.7	O K
2880 min Winter	2.638	0.638	0.0	1.4	0.0	1.4	389.1	O K
4320 min Winter	2.584	0.584	0.0	1.4	0.0	1.4	356.3	O K
5760 min Winter	2.531	0.531	0.0	1.4	0.0	1.4	323.9	O K
7200 min Winter	2.471	0.471	0.0	1.4	0.0	1.4	287.1	O K
8640 min Winter	2.415	0.415	0.0	1.4	0.0	1.4	253.3	O K
10080 min Winter	2.366	0.366	0.0	1.4	0.0	1.4	223.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	85.910	0.0	114.9	0.0	41
60 min Winter	48.858	0.0	201.9	0.0	70
120 min Winter	27.786	0.0	219.0	0.0	128
180 min Winter	19.974	0.0	223.0	0.0	186
240 min Winter	15.803	0.0	222.9	0.0	246
360 min Winter	11.359	0.0	219.9	0.0	362
480 min Winter	8.987	0.0	215.7	0.0	480
600 min Winter	7.494	0.0	211.2	0.0	598
720 min Winter	6.460	0.0	206.9	0.0	714
960 min Winter	5.310	0.0	196.4	0.0	946
1440 min Winter	4.029	0.0	183.2	0.0	1404
2160 min Winter	3.056	0.0	398.5	0.0	2072
2880 min Winter	2.513	0.0	382.9	0.0	2708
4320 min Winter	1.789	0.0	351.3	0.0	3372
5760 min Winter	1.405	0.0	602.3	0.0	4320
7200 min Winter	1.166	0.0	618.9	0.0	5120
8640 min Winter	1.000	0.0	631.0	0.0	5896
10080 min Winter	0.879	0.0	638.7	0.0	6672

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.560

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.187	4	8	0.187	8	12	0.187

Model Details

Storage is Online Cover Level (m) 3.200

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	24.5
Membrane Percolation (mm/hr)	1000	Length (m)	83.0
Max Percolation (l/s)	564.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0058-1500-1000-1500
Design Head (m)	1.000
Design Flow (l/s)	1.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	58
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	1.5
Flush-Flo™	0.253	1.4
Kick-Flo®	0.515	1.1
Mean Flow over Head Range	-	1.2

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	1.2	1.200	1.6	3.000	2.5	7.000	3.7
0.200	1.4	1.400	1.7	3.500	2.7	7.500	3.8
0.300	1.4	1.600	1.9	4.000	2.8	8.000	3.9
0.400	1.3	1.800	2.0	4.500	3.0	8.500	4.0
0.500	1.2	2.000	2.0	5.000	3.1	9.000	4.1
0.600	1.2	2.200	2.1	5.500	3.3	9.500	4.2
0.800	1.4	2.400	2.2	6.000	3.4		
1.000	1.5	2.600	2.3	6.500	3.5		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 30 year Return Period (+45%)

Half Drain Time : 3025 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	2.251	0.251	0.0	0.7	0.0	0.7	94.9	O K
30 min Summer	2.287	0.287	0.0	0.7	0.0	0.7	108.4	O K
60 min Summer	2.327	0.327	0.0	0.7	0.0	0.7	123.5	O K
120 min Summer	2.370	0.370	0.0	0.7	0.0	0.7	139.8	O K
180 min Summer	2.396	0.396	0.0	0.7	0.0	0.7	149.7	O K
240 min Summer	2.415	0.415	0.0	0.7	0.0	0.7	156.8	O K
360 min Summer	2.440	0.440	0.0	0.7	0.0	0.7	166.4	O K
480 min Summer	2.457	0.457	0.0	0.7	0.0	0.7	172.6	O K
600 min Summer	2.468	0.468	0.0	0.7	0.0	0.7	176.9	O K
720 min Summer	2.476	0.476	0.0	0.7	0.0	0.7	179.9	O K
960 min Summer	2.507	0.507	0.0	0.7	0.0	0.7	191.6	O K
1440 min Summer	2.545	0.545	0.0	0.7	0.0	0.7	206.0	O K
2160 min Summer	2.571	0.571	0.0	0.7	0.0	0.7	215.8	O K
2880 min Summer	2.582	0.582	0.0	0.7	0.0	0.7	220.0	O K
4320 min Summer	2.545	0.545	0.0	0.7	0.0	0.7	206.0	O K
5760 min Summer	2.511	0.511	0.0	0.7	0.0	0.7	193.2	O K
7200 min Summer	2.479	0.479	0.0	0.7	0.0	0.7	181.2	O K
8640 min Summer	2.449	0.449	0.0	0.7	0.0	0.7	169.7	O K
10080 min Summer	2.419	0.419	0.0	0.7	0.0	0.7	158.5	O K
15 min Winter	2.287	0.287	0.0	0.7	0.0	0.7	108.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	151.060	0.0	60.8	0.0	27
30 min Summer	85.910	0.0	61.1	0.0	42
60 min Summer	48.858	0.0	112.7	0.0	72
120 min Summer	27.786	0.0	118.0	0.0	130
180 min Summer	19.974	0.0	116.9	0.0	190
240 min Summer	15.803	0.0	115.1	0.0	250
360 min Summer	11.359	0.0	112.0	0.0	370
480 min Summer	8.987	0.0	109.5	0.0	488
600 min Summer	7.494	0.0	107.4	0.0	608
720 min Summer	6.460	0.0	105.6	0.0	726
960 min Summer	5.310	0.0	102.5	0.0	966
1440 min Summer	4.029	0.0	100.4	0.0	1442
2160 min Summer	3.056	0.0	213.7	0.0	2144
2880 min Summer	2.513	0.0	207.1	0.0	2476
4320 min Summer	1.789	0.0	190.7	0.0	3204
5760 min Summer	1.405	0.0	339.8	0.0	4032
7200 min Summer	1.166	0.0	347.8	0.0	4832
8640 min Summer	1.000	0.0	351.8	0.0	5704
10080 min Summer	0.879	0.0	347.4	0.0	6464
15 min Winter	151.060	0.0	61.3	0.0	27

Summary of Results for 30 year Return Period (+45%)

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
30 min Winter	2.328	0.328	0.0	0.7	0.0	0.7	123.9	O K
60 min Winter	2.373	0.373	0.0	0.7	0.0	0.7	141.1	O K
120 min Winter	2.423	0.423	0.0	0.7	0.0	0.7	159.8	O K
180 min Winter	2.453	0.453	0.0	0.7	0.0	0.7	171.2	O K
240 min Winter	2.474	0.474	0.0	0.7	0.0	0.7	179.3	O K
360 min Winter	2.504	0.504	0.0	0.7	0.0	0.7	190.4	O K
480 min Winter	2.523	0.523	0.0	0.7	0.0	0.7	197.8	O K
600 min Winter	2.537	0.537	0.0	0.7	0.0	0.7	203.0	O K
720 min Winter	2.547	0.547	0.0	0.7	0.0	0.7	206.8	O K
960 min Winter	2.584	0.584	0.0	0.7	0.0	0.7	220.8	O K
1440 min Winter	2.632	0.632	0.0	0.7	0.0	0.7	238.9	O K
2160 min Winter	2.669	0.669	0.0	0.8	0.0	0.8	252.9	O K
2880 min Winter	2.684	0.684	0.0	0.8	0.0	0.8	258.7	O K
4320 min Winter	2.637	0.637	0.0	0.7	0.0	0.7	240.7	O K
5760 min Winter	2.593	0.593	0.0	0.7	0.0	0.7	224.2	O K
7200 min Winter	2.550	0.550	0.0	0.7	0.0	0.7	207.8	O K
8640 min Winter	2.507	0.507	0.0	0.7	0.0	0.7	191.7	O K
10080 min Winter	2.465	0.465	0.0	0.7	0.0	0.7	175.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	85.910	0.0	60.7	0.0	41
60 min Winter	48.858	0.0	118.5	0.0	70
120 min Winter	27.786	0.0	116.4	0.0	130
180 min Winter	19.974	0.0	114.1	0.0	188
240 min Winter	15.803	0.0	112.4	0.0	246
360 min Winter	11.359	0.0	109.9	0.0	364
480 min Winter	8.987	0.0	108.2	0.0	480
600 min Winter	7.494	0.0	106.8	0.0	598
720 min Winter	6.460	0.0	105.8	0.0	714
960 min Winter	5.310	0.0	105.6	0.0	946
1440 min Winter	4.029	0.0	107.2	0.0	1406
2160 min Winter	3.056	0.0	218.7	0.0	2076
2880 min Winter	2.513	0.0	215.9	0.0	2712
4320 min Winter	1.789	0.0	205.0	0.0	3380
5760 min Winter	1.405	0.0	386.5	0.0	4320
7200 min Winter	1.166	0.0	392.9	0.0	5256
8640 min Winter	1.000	0.0	384.2	0.0	6144
10080 min Winter	0.879	0.0	364.7	0.0	7064

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.360

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.120	4	8	0.120	8	12	0.120

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	14.0
Membrane Percolation (mm/hr)	1000	Length (m)	90.0
Max Percolation (l/s)	350.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0044-9000-1000-9000
Design Head (m)	1.000
Design Flow (l/s)	0.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	44
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	0.9
Flush-Flo™	0.194	0.7
Kick-Flo®	0.394	0.6
Mean Flow over Head Range	-	0.7

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	0.7	1.200	1.0	3.000	1.5	7.000	2.2
0.200	0.7	1.400	1.0	3.500	1.6	7.500	2.2
0.300	0.7	1.600	1.1	4.000	1.7	8.000	2.3
0.400	0.6	1.800	1.2	4.500	1.8	8.500	2.4
0.500	0.7	2.000	1.2	5.000	1.9	9.000	2.4
0.600	0.7	2.200	1.3	5.500	1.9	9.500	2.5
0.800	0.8	2.400	1.3	6.000	2.0		
1.000	0.9	2.600	1.4	6.500	2.1		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

Summary of Results for 30 year Return Period (+45%)

Half Drain Time : 2371 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	2.254	0.254	0.0	1.7	0.0	1.7	179.1	O K
30 min Summer	2.290	0.290	0.0	1.7	0.0	1.7	204.6	O K
60 min Summer	2.330	0.330	0.0	1.7	0.0	1.7	232.6	O K
120 min Summer	2.372	0.372	0.0	1.7	0.0	1.7	262.7	O K
180 min Summer	2.398	0.398	0.0	1.7	0.0	1.7	280.5	O K
240 min Summer	2.415	0.415	0.0	1.7	0.0	1.7	293.0	O K
360 min Summer	2.439	0.439	0.0	1.7	0.0	1.7	309.4	O K
480 min Summer	2.453	0.453	0.0	1.7	0.0	1.7	319.7	O K
600 min Summer	2.463	0.463	0.0	1.7	0.0	1.7	326.4	O K
720 min Summer	2.469	0.469	0.0	1.7	0.0	1.7	330.8	O K
960 min Summer	2.498	0.498	0.0	1.7	0.0	1.7	351.1	O K
1440 min Summer	2.533	0.533	0.0	1.7	0.0	1.7	376.3	O K
2160 min Summer	2.559	0.559	0.0	1.7	0.0	1.7	394.2	O K
2880 min Summer	2.569	0.569	0.0	1.7	0.0	1.7	401.5	O K
4320 min Summer	2.519	0.519	0.0	1.7	0.0	1.7	366.2	O K
5760 min Summer	2.475	0.475	0.0	1.7	0.0	1.7	335.2	O K
7200 min Summer	2.435	0.435	0.0	1.7	0.0	1.7	307.0	O K
8640 min Summer	2.398	0.398	0.0	1.7	0.0	1.7	281.0	O K
10080 min Summer	2.364	0.364	0.0	1.7	0.0	1.7	257.2	O K
15 min Winter	2.290	0.290	0.0	1.7	0.0	1.7	204.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	151.060	0.0	132.2	0.0	27
30 min Summer	85.910	0.0	137.7	0.0	41
60 min Summer	48.858	0.0	219.3	0.0	72
120 min Summer	27.786	0.0	245.7	0.0	130
180 min Summer	19.974	0.0	259.0	0.0	190
240 min Summer	15.803	0.0	265.6	0.0	250
360 min Summer	11.359	0.0	269.1	0.0	368
480 min Summer	8.987	0.0	267.8	0.0	488
600 min Summer	7.494	0.0	265.2	0.0	606
720 min Summer	6.460	0.0	262.0	0.0	726
960 min Summer	5.310	0.0	253.6	0.0	964
1440 min Summer	4.029	0.0	234.6	0.0	1442
2160 min Summer	3.056	0.0	485.8	0.0	2100
2880 min Summer	2.513	0.0	469.0	0.0	2448
4320 min Summer	1.789	0.0	439.4	0.0	3076
5760 min Summer	1.405	0.0	643.1	0.0	3864
7200 min Summer	1.166	0.0	660.4	0.0	4616
8640 min Summer	1.000	0.0	673.1	0.0	5440
10080 min Summer	0.879	0.0	681.7	0.0	6160
15 min Winter	151.060	0.0	138.1	0.0	27

Summary of Results for 30 year Return Period (+45%)

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
30 min Winter	2.331	0.331	0.0	1.7	0.0	1.7	233.7	O K
60 min Winter	2.377	0.377	0.0	1.7	0.0	1.7	265.7	O K
120 min Winter	2.426	0.426	0.0	1.7	0.0	1.7	300.3	O K
180 min Winter	2.455	0.455	0.0	1.7	0.0	1.7	321.0	O K
240 min Winter	2.476	0.476	0.0	1.7	0.0	1.7	335.7	O K
360 min Winter	2.504	0.504	0.0	1.7	0.0	1.7	355.5	O K
480 min Winter	2.522	0.522	0.0	1.7	0.0	1.7	368.4	O K
600 min Winter	2.535	0.535	0.0	1.7	0.0	1.7	377.4	O K
720 min Winter	2.544	0.544	0.0	1.7	0.0	1.7	383.7	O K
960 min Winter	2.581	0.581	0.0	1.7	0.0	1.7	409.8	O K
1440 min Winter	2.627	0.627	0.0	1.7	0.0	1.7	442.1	O K
2160 min Winter	2.659	0.659	0.0	1.7	0.0	1.7	465.0	O K
2880 min Winter	2.670	0.670	0.0	1.7	0.0	1.7	472.7	O K
4320 min Winter	2.612	0.612	0.0	1.7	0.0	1.7	432.0	O K
5760 min Winter	2.553	0.553	0.0	1.7	0.0	1.7	390.2	O K
7200 min Winter	2.490	0.490	0.0	1.7	0.0	1.7	345.6	O K
8640 min Winter	2.433	0.433	0.0	1.7	0.0	1.7	305.3	O K
10080 min Winter	2.381	0.381	0.0	1.7	0.0	1.7	268.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	85.910	0.0	141.0	0.0	41
60 min Winter	48.858	0.0	245.8	0.0	70
120 min Winter	27.786	0.0	267.7	0.0	128
180 min Winter	19.974	0.0	273.7	0.0	186
240 min Winter	15.803	0.0	274.2	0.0	246
360 min Winter	11.359	0.0	271.5	0.0	362
480 min Winter	8.987	0.0	267.1	0.0	480
600 min Winter	7.494	0.0	262.3	0.0	596
720 min Winter	6.460	0.0	257.4	0.0	714
960 min Winter	5.310	0.0	243.9	0.0	946
1440 min Winter	4.029	0.0	225.7	0.0	1404
2160 min Winter	3.056	0.0	489.9	0.0	2076
2880 min Winter	2.513	0.0	470.3	0.0	2708
4320 min Winter	1.789	0.0	431.6	0.0	3376
5760 min Winter	1.405	0.0	733.3	0.0	4280
7200 min Winter	1.166	0.0	753.8	0.0	5112
8640 min Winter	1.000	0.0	768.9	0.0	5888
10080 min Winter	0.879	0.0	778.7	0.0	6664

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 624550 306900 TG 24550 06900
C (1km)	-0.024
D1 (1km)	0.267
D2 (1km)	0.400
D3 (1km)	0.243
E (1km)	0.308
F (1km)	2.475
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.850
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.680

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.227	4	8	0.227	8	12	0.227

Model Details

Storage is Online Cover Level (m) 3.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	21.0
Membrane Percolation (mm/hr)	1000	Length (m)	112.0
Max Percolation (l/s)	653.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0063-1770-1000-1770
Design Head (m)	1.000
Design Flow (l/s)	1.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	63
Invert Level (m)	2.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	1.8
Flush-Flo™	0.277	1.7
Kick-Flo®	0.562	1.4
Mean Flow over Head Range	-	1.5

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)**
0.100	1.5	1.200	2.0	3.000	3.0	7.000	4.4
0.200	1.7	1.400	2.1	3.500	3.2	7.500	4.6
0.300	1.7	1.600	2.2	4.000	3.4	8.000	4.7
0.400	1.7	1.800	2.3	4.500	3.6	8.500	4.8
0.500	1.6	2.000	2.5	5.000	3.8	9.000	5.0
0.600	1.4	2.200	2.6	5.500	3.9	9.500	5.1
0.800	1.6	2.400	2.7	6.000	4.1		
1.000	1.8	2.600	2.8	6.500	4.3		

Weir Overflow Control

Discharge Coef 0.100 Width (m) 0.600 Invert Level (m) 3.000

H.4 Treatment

Simple Index Approach tool (SIA) Results

Project Title	Dealground
Project Code	2022-0896
Date	12/06/2023
Prepared by	Adam Odei
Reviewed by	Gavin Hodson
BIM reference	DEALG-XX-XX-SUDS-TBL-001-S3-P01

This tab e shows the results of the S mple Index tool (SIA) developed by SEPA HR Wa lingford and Cir a. The SIA is described in Sect on 26.7.1 of the Mannual and this text should be referred too when interpreting the results of th s table.

Location	Pollution Hazard ndices				Aggregated Surface Water Po lution Mitigation Index			Combined Pollution Mitigation Indices			Sufficiency of Pollution Mitigation Indices		
	Hazard Level	Suspended Solids	Metals	Hydrocarbons	Total Suspended Solids	Metals	Hydrocarbons	Total Suspended Solids	Metals	Hydrocarbons	Suspended Solids	Metals	Hydrocarbons
View-001-A	Low	0.5	0.	0.	>0.95	0.95	0.95	>0.95	0.95	0.95	Suff cient	Suff cient	Sufficient
View-001-B	Low	0.5	0.	0.	>0.95	0.95	0.95	>0.95	0.95	0.95	Suff cient	Suff cient	Sufficient
View-001-C	Low	0.5	0.	0.	>0.95	0.95	0.95	>0.95	0.95	0.95	Suff cient	Suff cient	Sufficient
WE-001-A	Low	0.5	0.	0.	0.7	0.6	0.7	0.7	0.6	0.7	Suff cient	Suff cient	Sufficient
WE-001-B	Low	0.5	0.	0.	0.7	0.6	0.7	0.7	0.6	0.7	Suff cient	Suff cient	Sufficient
WE-001-C	Low	0.5	0.	0.	0.7	0.6	0.7	0.7	0.6	0.7	Suff cient	Suff cient	Sufficient
WE-001-D	Low	0.5	0.	0.	0.7	0.6	0.7	0.7	0.6	0.7	Suff cient	Suff cient	Sufficient
WE-001-E	Low	0.5	0.	0.	0.7	0.6	0.7	0.7	0.6	0.7	Suff cient	Suff cient	Sufficient
YE-001-A	Low	0.5	0.	0.	0.7	0.6	0.7	0.7	0.6	0.7	Suff cient	Suff cient	Sufficient
YE-001-B	Low	0.5	0.	0.	0.7	0.6	0.7	0.7	0.6	0.7	Suff cient	Suff cient	Sufficient
Highway-001	Medium	0.7	0.6	0.7	0.7	0.6	0.7	0.7	0.6	0.7	Suff cient	Suff cient	Sufficient
Highway-002	Medium	0.7	0.6	0.7	0.7	0.6	0.7	0.7	0.6	0.7	Suff cient	Suff cient	Sufficient

H.5 Maintenance

SUDS Maintenance Strategy

Dealground

June 2023

1 Introduction

This report identifies the SuDS maintenance plan for the 'Dealground' development, Norwich.

For the purpose of this report maintenance is referred to as:

1. Inspection required to identify asset performance to identify and plan maintenance needs.
2. Operation and maintenance of the drainage system

The SuDS features on site compromise of:

1. Pervious Paving
2. Green Roofs
3. Swales
4. Attenuation Storage Tanks
5. Bioretention Systems (rain gardens)
6. Inlet, Outlets and Inspection Chambers

The responsibility for the maintenance of SUDs is as following:

1. Where SuDS features are located within the curtilage of individual properties, maintenance responsibilities are completed by the homeowner. Any maintenance responsibilities for homeowners should be clearly outlined within property deeds.
2. The Management company, on behalf of the residents, is responsible for the maintenance of communal SuDS features.
3. The surface drainage system within the public highway, including both the attenuation tank and surface water pumping station, will be offered for adoption, who will be responsible for its maintenance.
4. Should Norfolk Country Council highways not adopt the road, then maintenance rests with the management company.

2 Maintenance Activities

2.1 Operation and Maintenance

Maintenance activities can be categorised as:

1. Regular maintenance (including inspections)
2. Occasional maintenance
3. Remedial maintenance

Regular maintenance tasks are to be carried on a predictable. This includes regular inspections/monitoring, and debris and litter removal.

Occasional maintenance task is required less frequently than regular tasks, but still periodically (e.g.filter replacement).

Remedial maintenances are required infrequently to rectify faults that are identified. Regular maintenance will reduce the likelihood of remedial maintenance. Therefore, remedial maintenance is likely to be unforeseen events that are difficult to predict and site specific. (e.g. erosion repairs, clearance of blockages).

The tables below show the maintenance plans for each of the SuDs features (CIRIA C753).

Table 2-1. Attenuation Storage Tank maintenance plan

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

Table 2-2. Pervious Paving maintenance plan

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site specific observations of clogging or manufacturers recommendations - pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As Required
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying	As required - once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As Required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a Hazard to users, and replace lost jointing material	As Required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging
Monitoring	Initial inspection	Monthly for three months after installation
	inspect for evidence of poor operation and or weed growth - if required, take remedial action	Three monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Table 2-3 Green Roof maintenance plan

Maintenance schedule	Required Action	Typical frequnecy
Regular inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	
	Inspect underside of roof for evidence of leakage	
Regular maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (ie year one), replace dead plants as required	Monthly (but usually responsibility of manufacturer)
	Post establishment, replace dead plants as required where (> 5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial Actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

Table 2-4. Swale Maintenance Schedule

Maintenance schedule	Required action	Typical frequency
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	
	Scarify and sp ke topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	
	Remove and dispose of oils or petrol residues using safe standard practices	

Table 2-5. Bioretention system Maintenance schedule

Maintenance Schedule	Required action	Typical frequency
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary.	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular maintenance	Remove litter surface debris and weeds	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter and debris build-up from around inlets or from forebays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years

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