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ENVIRONMENT

Robert Doughty Consultancy
Land off Crease Drove
Crowland, Peterborough

SUSTAINABLE DRAINAGE STATEMENT

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Robert Doughty Consultancy
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Crowland, Peterborough

SUSTAINABLE DRAINAGE STATEMENT

Birmingham
Livery Place, 35 Livery Street, Colmore Business
District, Birmingham, B3 2PB
T: 0121 233 3322

Leeds
Whitehall Waterfront, 2 Riverside Way, Leeds LS1
4EH
T: 0113 233 8000

London
11 Borough High Street
London
SE1 9SE
T: 020 74073879

Manchester
4th Floor Carvers Warehouse, 77 Dale Street
Manchester, M1 2HG
T: 0161 233 4260

Nottingham
Waterfront House, Station Street, Nottingham
NG2 3DQ
T: 0115 924 1100

DOCUMENT ISSUE RECORD

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1.0 INTRODUCTION

Site Details

- 1.1 This Sustainable Drainage Statement has been produced by BWB Consulting on behalf of Robert Doughty Consultancy in respect of a site located off Crease Drove, Crowland for residential development. A site location plan is included as **Figure 1.1**.

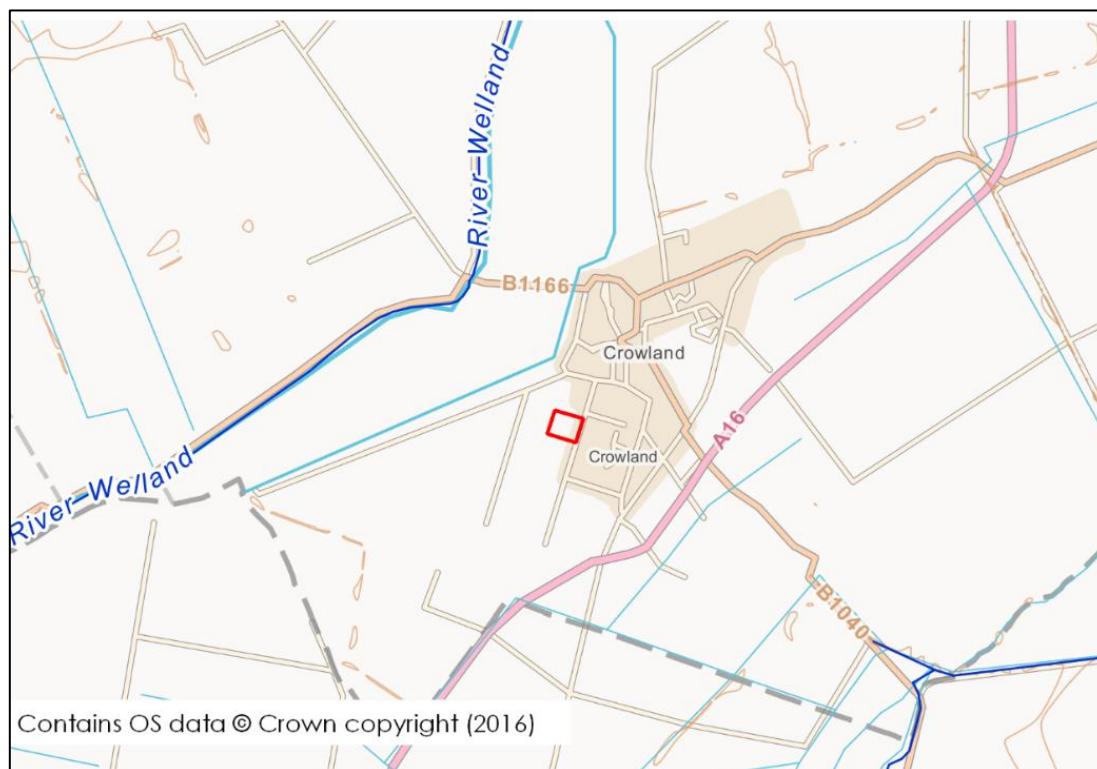


Figure 1.1 - Site Location

- 1.2 A Sustainable Drainage Statement sets out the principles of the drainage design for the development and summarises the reasoning behind the chosen design. This includes justification of specific flow rates, volumes of attenuation and the level of treatment provided to runoff.
- 1.3 A Flood Risk Assessment has been developed for the site (reference CDR-BWB-EWE-XX-RP-EN-0001) and this Sustainable Drainage Statement accompanies this overarching document. The proposed development is to be submitted to South Holland District Council for a planning application and the details in this strategy are based upon the submitted scheme.
- 1.4 The existing 3.3ha site is currently arable land, which is considered to be greenfield from a drainage perspective.
- 1.5 A proposed site development masterplan is included as **Appendix 1**.

Table 1.1 - Existing Site Details

Site Name	Land off Crease Drove, Crowland
Location	Crease Drove, Crowland, Peterborough, PE6 0BN
NGR (approx.)	523642, 309594
Application Site Area (ha)	3.3ha
Development Type	Residential dwellings
Local Planning Authority	South Holland District Council
Lead Local Flood Authority	Lincolnshire County Council
Sewerage Undertaker	Anglian Water
Internal Drainage Board	North Level District

SuDS Guidance

- 1.6 The LLFA do not have any specific SuDS guidance or standards to inform planning applications and in the absence of further information, the Non-Statutory Technical Standards for Sustainable Drainage Systems¹ as published by DEFRA have been utilised to inform the strategy.
- 1.7 The current proposals allow for an area of open space to the centre of the development, however there is currently no spatial allowance to create green corridors throughout the site. An illustrative layout is included as **Appendix 1**.
- 1.8 **Table 1.2** summarises the findings of this document with discussion and explanation of the points expanded upon in **Section 2.0**.

Table 1.2 - SDS Summary

Outfall Location	Watercourse
Existing Site Peak Runoff Rate	4.5 l/s
Infiltration Rate	N/A
Existing Runoff Volume (100yr RP 6 hour Storm)	616.7m ³
Proposed Runoff Volume (100yr RP 6 hour Storm)	431.7m ³
Long Term Storage	N/A
Proposed Site Peak Runoff Rate	5l/s
Proposed Storage Volume	2450m ³
Flow Control Type	Vortex
SuDS Features	Swales & Attenuation Basin
Maintenance Responsibility	Management Company
LLFA/EA/WC/IDB Guidance	Non-statutory Technical Standards for Sustainable Drainage

¹ 2015, DEFRA. Non-statutory technical standards for sustainable drainage systems

2.0 DRAINAGE STRATEGY

Existing Site Runoff

Runoff Volume

- 2.1 To analyse existing Greenfield Runoff volume, the entire area of the existing site has been calculated as contributing to surface runoff, to replicate existing conditions.
- 2.2 Volume of runoff for proposed developments is compared for a 100 year return period, 6 hour storm. As the existing site is greenfield, this volume has been calculated using the Source Control module within Micro Drainage to be 616.7m³, results are included within **Appendix 2**.

Runoff Rate

- 2.3 The existing site will be considered greenfield as there are currently no positive drainage connections serving the site and it is wholly permeable.
- 2.4 An assessment of the existing runoff rates has been undertaken using the ICP SUDS calculation method within Micro Drainage and they are summarised in **Table 2.1**. Calculations are included within **Appendix 3**.

Proposed Site Runoff

Runoff Volume

- 2.5 At present, the exact area of landscaping and open areas within the site is not known. These areas would be reduced from the total development area, as they are classed as not contributing to surface runoff. For the purpose of this calculation, it is to be estimated that 70% of the development will consist of impermeable area, which equates to 2.31ha.
- 2.6 The proposed runoff volume can be derived using an average rainfall intensity of 12.1mm/hr as calculated using FEH rainfall data within Micro Drainage, and multiplied by the site area. The proposed runoff volume takes into account the additional impermeable area, as a result of the development against existing greenfield conditions. The rainfall profile (**Appendix 4**), and the calculated volume is as follows;

$$\text{Average Rainfall Intensity } 12.1 \text{ (mm/hr)} \times 6 \text{ (hours)} \times \text{Site Area } 2.31 \text{ (ha)} \times 10 = \text{Runoff Volume } 1677(\text{m}^3)$$

Runoff Rate

- 2.7 In order to comply with the Non-Statutory Technical Standards for Sustainable Drainage Systems, runoff should not exceed existing greenfield rates for the 1 and 100 year return period events and recommends a restriction to greenfield runoff rates (QBAR) if viable.
- 2.8 Therefore a discharge rate from site should not exceed the "greenfield runoff rate", where practicable. In this case it is recommended that surface water discharge post-development should be restricted to an equivalent QBAR rate of 4.5l/s. Post-

development discharge rates will be restricted as shown in **Table 2.1** for all storms up to the 100 year + 40% climate change storm.

- 2.9 As the volume of runoff has been calculated to increase post development, it is necessary to comply with the volume control criterion as per requirements S4-S6 of the Non-Statutory Technical Standards (otherwise known as long term storage). It is necessary to either prevent any excess volume from leaving the site or otherwise discharge it *“at a rate which does not adversely affect flood risk”* which is taken to be no more than;

- The pre development 1-year peak flow rate OR
- The mean annual flow rate Q_{bar} OR
- 2l/s/ha

- 2.10 As the proposed runoff rates are to be restricted to Q_{bar} value, there is no requirement to provide long term storage.

- 2.11 The proposed runoff rate for the site is therefore 3.9/s for the 1 year return period and 4.5l/s for all other storm events up to and including the 100 year event including a 40% allowance for climate change – as summarised in **Table 2.2**.

- 2.12 A control structure limiting flows to less than 5l/s would be impractically small and prone to blockage, it is therefore proposed to adopt a fixed discharge rate of 5l/s. This is in-line with DEFRA and EA recommendations². Therefore, a revised proposed runoff rate of **5l/s** is acceptable for return periods of 30, 100 and 100+CC return periods

Site Runoff Summary

- 2.13 The following tables summarise the calculated runoff volumes and rates for the proposed development.

Table 2.1 - Existing and Proposed Runoff Volumes

Existing Volume (m ³)	Proposed Volume (m ³)	Difference (m ³)
617	1677	1060.3

Table 2.2 - Existing & Proposed Runoff Rates

Return Period (Yr.)	Existing Runoff Rate (l/s)	Proposed Runoff Rate (l/s)
1	3.9	3.9
Q_{bar}	4.5	5
30	10.9	5
100	16.1	5
100 + 20% CC	19.3	5

² 2013, Kellagher. Preliminary rainfall runoff management for developments – Technical Report. W5-074/A/TR/1, Revision E. Environment Agency / Defra.

Drainage Hierarchy

- 2.14 A preferential hierarchy for discharge of surface water exists which states that surface water should be disposed of in the following order of preference;

- *Infiltration via soakaways*
- *Watercourse*
- *Surface Water Sewer*
- *Combined Water Sewer*

- 2.15 A topographic survey of the existing site has been undertaken and is included as **Appendix 5**. This shows that there are no existing drainage features within the site boundary and runoff is therefore considered to leave the site via natural process of runoff and infiltration. There is an IDB managed watercourse to the western boundary of the site, to which the Anglian Water SW sewer discharges to. However, it is not known the volume of surface water specifically from the site that enters this watercourse at source.

Infiltration via soakaways

- 2.16 Given the increase in impermeable area and concentration of development of the scheme, it is impractical for drainage to be infiltrated into the existing ground as soakaways should be located a minimum of 5m from buildings, trees and adopted highways. As part of this FRA, there has been no infiltration testing carried out. Given the reported underlying geology infiltration is unlikely to be a suitable means of discharge, and so this report is based on the assumption of discharge to the nearby watercourses.

Watercourse

- 2.17 Outfall to a watercourse is the next most preferable option for discharge of surface water. As the existing surface water sewer directly discharges into the existing drainage ditch (watercourse in this instance), which runs adjacent to the site. Direct discharge into this IDB managed watercourse would be subject to consent and approval from the North Level District IDB, however under correspondence for the FRA, the IDB expressed no constraints or disapprovals for discharging directly into this.
- 2.18 Given levels across the site, it is likely that a pumped solution would be required to drain parts of the site to the watercourse. The southeast corner of the site is at ~1.6m AOD, while the ditch invert level is at 0.5m AOD. Shallow surface swales could be used to route water from the southeast to the watercourse, but may require further land take.

Surface Water Sewer

- 2.19 The presence of a significant network of adopted sewers, as shown on the Anglian Water sewer records included as **Appendix 6** would appear to demonstrate that the surrounding area drains to these. The eastern boundary of the site is at a lower level than the west, and so a gravity connection to the watercourse on the western boundary may not be sustainable when allowing for the relevant cover levels, gradients and route. An alternative solution would be to drain the site to the Anglian Water sewer

network, connecting to existing manhole reference 6751, a 150mm diameter surface water sewer located outside the north easterly corner of the site.

- 2.20 Again, a pumped solution may be necessary given the invert level of the sewer at this location (~1.78m AOD).
- 2.21 Anglian Water correspondence states that (once evidence is provided that the project is to comply with the surface water hierarchy) then 'a connection point may be made to manhole 6751 in Crease Drove at NGR TF2266309741 at a rate of 8.08 l/s.' Proposed run off rates identified within this report are lower, and therefore acceptable for this.
- 2.22 A S106 (Water Industry Act 1991) application should be made to Anglian Water for approval prior to the connection being made. As connection to a sewer is shown to be the most preferred option, approval at a restricted rate will be acceptable.

Attenuation Requirements

- 2.23 Since the proposed discharge rate is less than the rate that would ordinarily be generated by the proposed development, storage will be required to balance the difference between the runoff generated and limited discharge rate.
- 2.24 Using a restriction of 5l/s, the volume of attenuation required for the site has been calculated for storm events up to the 100 year + 40% storm.
- 2.25 In accordance with the NPPF the development must demonstrate that potential effects of climate change are taken into account. Based upon the anticipated lifetime of the development an allowance of 40% has been applied in line with the latest climate change allowances outline by the Environment Agency.
- 2.26 Best practice would be to assess both FSR and FEH rainfall data simulations. A simulation has been run using Micro Drainage and the results are summarised in **Table 2.3** and calculations included as **Appendix 7**.

Table 2.3 - Attenuation Requirements

Rainfall Method	Critical Storm	Maximum Volume (m ³)
FSR	1440 min Winter	1775
FEH	2880 min Winter	2450

- 2.27 A minimum of 2450m³ of attenuation will be provided to cater for the maximum anticipated run-off volume for all storm durations up to the 1 in 100 year return period storm, including a 40% climate change allowance.

Long Term Storage

- 2.28 As discussed within paragraph **1.17** long term storage is not required due to meeting outlying criteria.
- 2.29 As discussed in paragraph **1.20**, restricting flows to below 5l/s is impractical and this is recognised in the BREEAM assessment guidance (Pol 03, Compliance Note CN18) which states;

"For the surface water run off credits, where the limiting discharge flow rate would require a flow rate of less than 5 l/s at a discharge point, a flow rate of up to 5 l/s may be used where required to reduce the risk of blockage. Discharge points are points of discharge into rivers, streams, ditches, drains, cuts, culverts, dykes, sluices, sewers and passages through which water flows."

- 2.30 Given this, it is proposed not to restrict additional flow as it would require the rate to be reduced below 5l/s. This is a function of the small size of the site and is a commonly accepted occurrence, and should therefore not preclude the site being shown to comply with the relevant criteria.

Sustainable Drainage Systems

- 2.31 It is recommended that at detailed design (reserved matters), the layout incorporates conveyance swales which intercept surface water flows from the development providing an initial form of treatment. Flows are then conveyed to an attenuation basin (currently shown within the central public open space) that will provide different forms of treatment. This will provide suitable treatment to surface water flows before final outfall at a restricted rate of 5l/s.
- 2.32 Lincolnshire County Council encourages developments which accord with the principles of sustainability in design, including appropriate measures to minimise the impact of surface water drainage
- 2.33 An indicative surface water layout for the development is shown on BWB Dwg No. CDR-BWB-HDG-00-DR-PD-0001 which is included as **Appendix 8**.

Maintenance

- 2.34 Any specialist or proprietary products that are specified at detailed design will have a manufacturer specific maintenance regime which will be included within the documents for the associated product.
- 2.35 Unless adopted by Derbyshire County Council, it is likely that a management company will adopt the SuDS features, and maintenance of these, including vegetation maintenance, trash screen clearing and regular outfall inspections will be detailed in the Operation and Maintenance manual for the site.
- 2.36 All drainage features will be located in open areas which are readily accessible.

3.0 FOUL WATER DRAINAGE STRATEGY

- 3.1 As a result of a Anglian Water Pre-Development enquiry, it is suggested that there is foul water capacity within the existing Crowland Water Recycling Centre.
- 3.2 The existing FW is located north of the site, within the Monks Meadow cul-de-sac. It is envisaged that a connection can be made to the existing system at this location.
- 3.3 Existing sewer levels indicate that foul water drainage from the site can be gravity fed, with no requirement for pumping needed. A connection will need to be made to the foul network at manhole 6704, as downstream of this point the network conveys via a pressurised rising main.
- 3.4 Once an assessment has been undertaken a suitable point of connection can be agreed through further consultation with Anglian Water.

4.0 SUMMARY

- 4.1 This statement and supporting appendices demonstrate that the drainage design for the development will comply with the relevant local and national standards, specifically the hierarchy of discharge, run-off rate and volume criterion.
- 4.2 The site will be restricted to greenfield run-off rates and will be provided up to the 100 year + 40% climate change event in the form of swales and an attenuation basin. The swale network combined with appropriate design of the final pond will provide treatment of flows. Outfall will be at a restricted rate of 5l/s to the ditch along the far western boundary commensurate with an equivalent greenfield runoff rate.

APPENDIX 1

Development Masterplan



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Rev.	By	Notes	Date

rdc Robert Doughty Consultancy 32 High Street, Helpingham © Steaford, Lincolnshire NG34 0RA Tel: 01529 421646 Fax: 01529 421358 Email: admin@rdc-landplan.co.uk Web: www.rdc-landplan.co.uk		
Client: J Woodroffe and others		
Project: Crease Drove, Crowland		
Drawing title: Masterplan		
Drawing No. 1163-2-MP02	Rev.	Drawn WW
Scale 1:1250@A2	Date 10/10/16	Checked LMS

All measurements should be checked against on site conditions and any discrepancies should be brought to the attention of the Robert Doughty Consultancy.

APPENDIX 2

Greenfield Runoff Volume Calculation

BWB Partnership		Page 1																																		
3-4 Kayes Walk Lace Market Nottingham NG1 1PY																																				
Date 13/01/2017 15:55 File	Designed by robert.ward Checked by																																			
Micro Drainage		Source Control 2015.1																																		
<u>Greenfield Runoff Volume</u> FEH Data <table> <tr> <td>Return Period (years)</td> <td>100</td> </tr> <tr> <td>Storm Duration (mins)</td> <td>360</td> </tr> <tr> <td>Site Location</td> <td>GB 523500 309750 TE 23500 09750</td> </tr> <tr> <td>C (1km)</td> <td>-0.023</td> </tr> <tr> <td>D1 (1km)</td> <td>0.309</td> </tr> <tr> <td>D2 (1km)</td> <td>0.315</td> </tr> <tr> <td>D3 (1km)</td> <td>0.214</td> </tr> <tr> <td>E (1km)</td> <td>0.313</td> </tr> <tr> <td>F (1km)</td> <td>2.482</td> </tr> <tr> <td>Areal Reduction Factor</td> <td>1.00</td> </tr> <tr> <td>Area (ha)</td> <td>3.300</td> </tr> <tr> <td>SAAR (mm)</td> <td>549</td> </tr> <tr> <td>CWI</td> <td>75.780</td> </tr> <tr> <td>SPR Host</td> <td>24.300</td> </tr> <tr> <td>URBEXT (1990)</td> <td>0.2633</td> </tr> </table> Results <table> <tr> <td>Percentage Runoff (%)</td> <td>25.72</td> </tr> <tr> <td>Greenfield Runoff Volume (m³)</td> <td>616.716</td> </tr> </table>			Return Period (years)	100	Storm Duration (mins)	360	Site Location	GB 523500 309750 TE 23500 09750	C (1km)	-0.023	D1 (1km)	0.309	D2 (1km)	0.315	D3 (1km)	0.214	E (1km)	0.313	F (1km)	2.482	Areal Reduction Factor	1.00	Area (ha)	3.300	SAAR (mm)	549	CWI	75.780	SPR Host	24.300	URBEXT (1990)	0.2633	Percentage Runoff (%)	25.72	Greenfield Runoff Volume (m³)	616.716
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Greenfield Runoff Volume (m³)	616.716																																			
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APPENDIX 3

Greenfield Runoff Rate Calculation

BWB Partnership		Page 1
3-4 Kayes Walk Lace Market Nottingham NG1 1PY		
Date 12/01/2017 14:11 File	Designed by robert.ward Checked by	
Micro Drainage Source Control 2015.1		

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	3.300	Urban	0.000
SAAR (mm)	550	Region Number	Region 5

Results l/s

QBAR Rural	4.5
QBAR Urban	4.5
Q100 years	16.1
Q1 year	3.9
Q30 years	10.9
Q100 years	16.1

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APPENDIX 4

Rainfall Profile

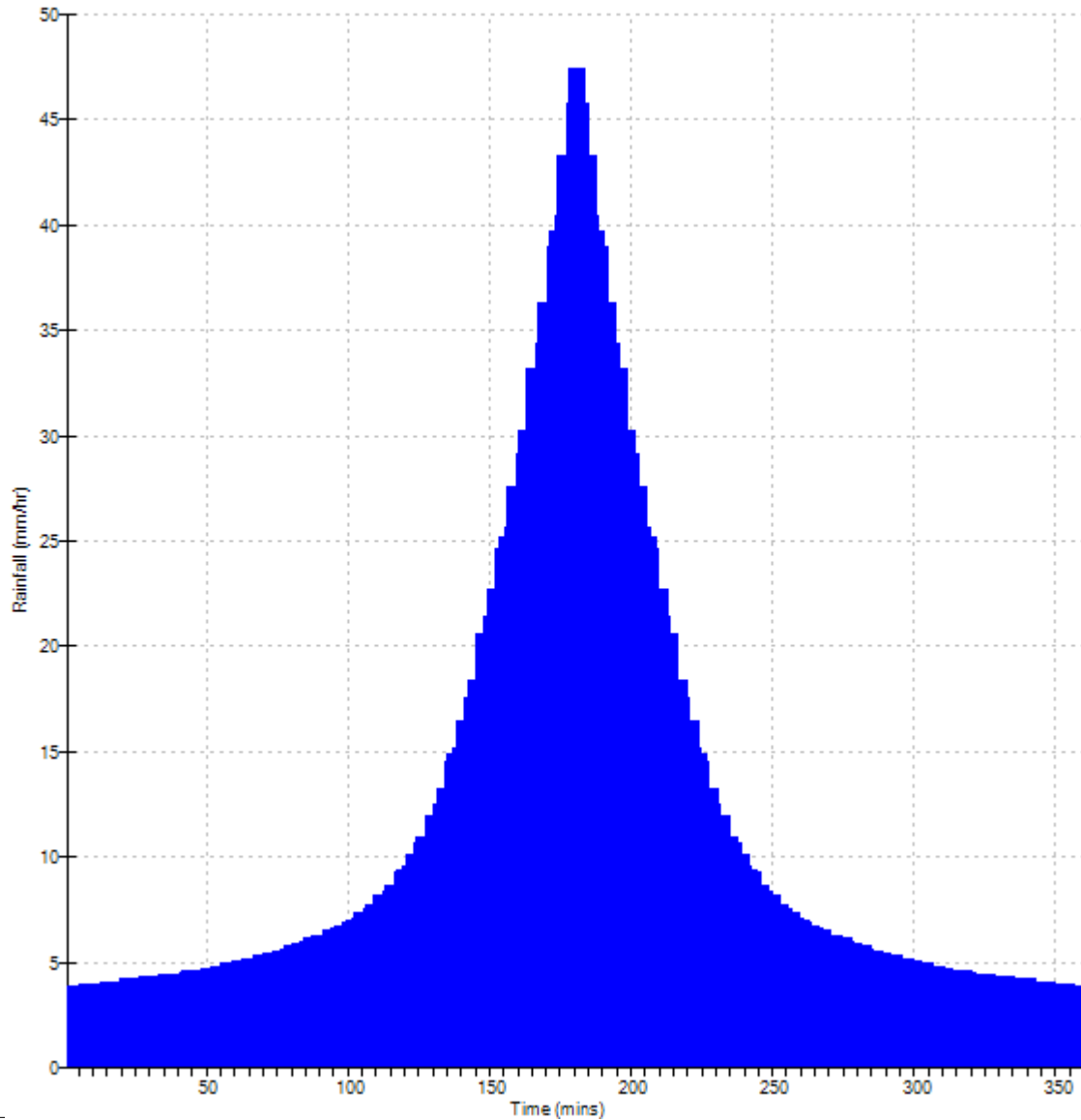
BWB Partnership		Page 1
3-4 Kayes Walk Lace Market Nottingham NG1 1PY		
Date 13/01/2017 16:20	Designed by robert.ward	
File	Checked by	
Micro Drainage		Source Control 2015.1

Rainfall profile

Storm duration (mins) 360

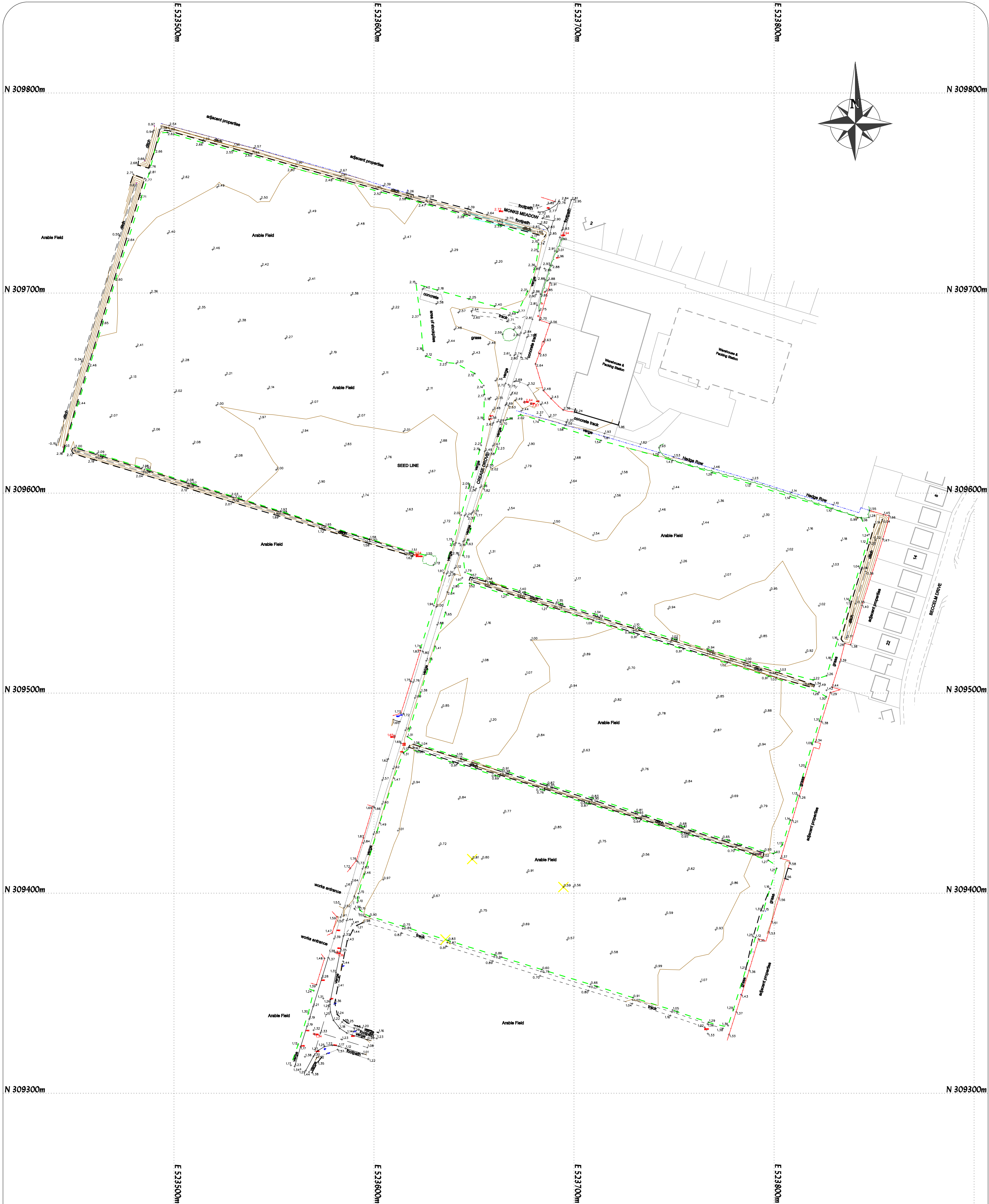
FEH Data

C (1km)	-0.023
D1 (1km)	0.309
D2 (1km)	0.315
D3 (1km)	0.214
E (1km)	0.313
F (1km)	2.482
Peak Intensity (mm/hr)	47.478
Ave. Intensity (mm/hr)	12.112
Return Period (years)	100



APPENDIX 5

Topographical Survey



TCS Topographical & Volumetric
Surveys Lee Fletcher
TCSurveysUK@gmail.com
Mobile: 07855 847595

ADC 
INFRASTRUCTURE

Client

- All Levels and Grid are correlated to OSNG and mAOD by using the national GNS network
- Contours are at 0.5 metre intervals with primary contours at 5.0m intervals.
- Key :
 - Ground Detail (Top & Toe of Banks) Site Boundary
 - Hedge Line
 - Edge of Crop
 - Fence Lines
 - Boundary, Presumed Line
 - Building
 - Edge of Track/Tarmac

- Contours
- Ordnance Survey (c) Crown Copyright 2015. All rights reserved. Licence number 100022432
- Road gullies
- Manhole (centre cover level)
- Fire Hydrant
- Lamp posts
- Sign posts
- Yellow Marker Pegs

Land off Crease Drove Crowland

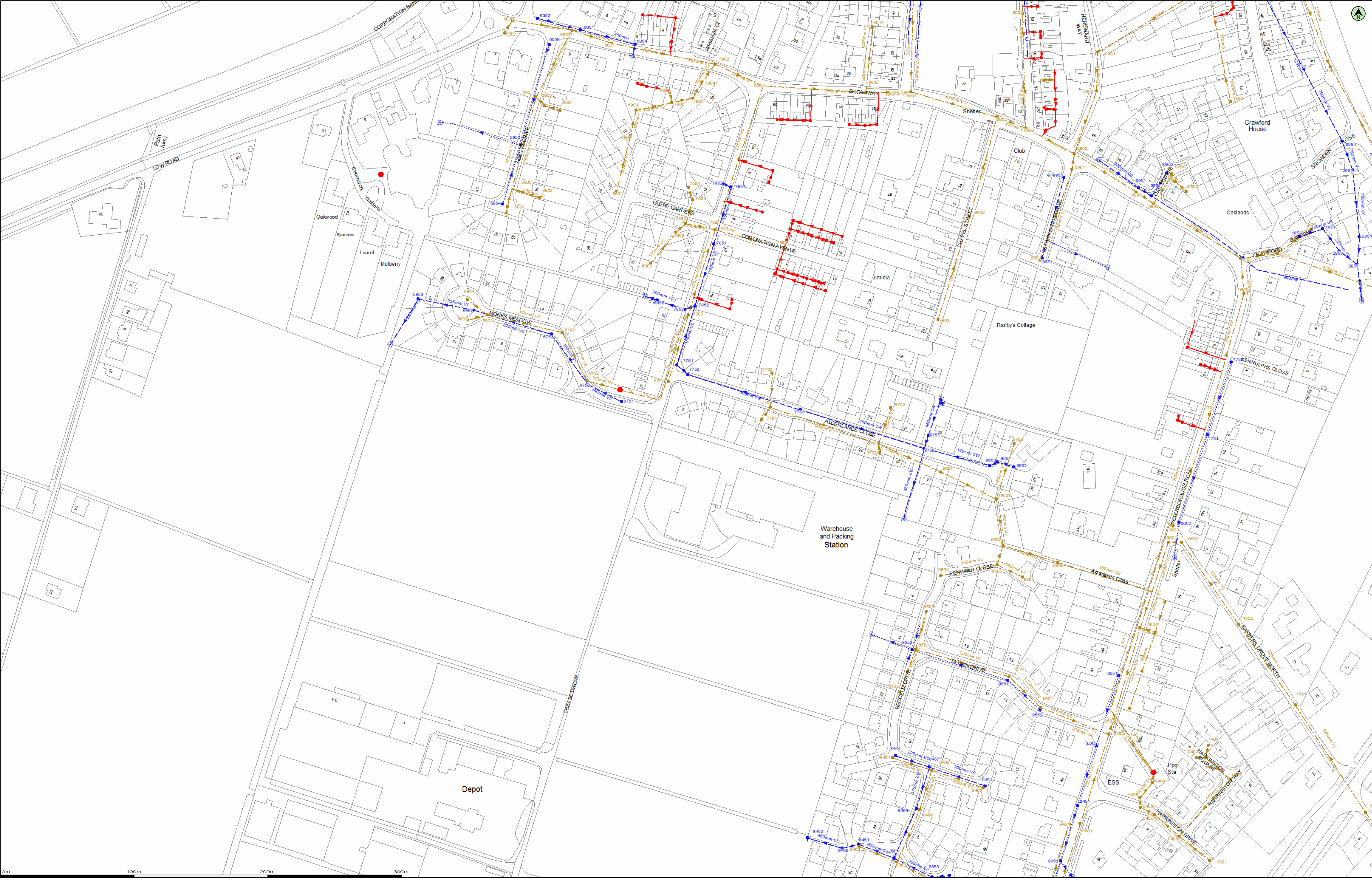
Location

Topographical Survey April 2016

Title		No'
Date : 9th April 2016	Revision	
Drawn by : LF		
Plan Size : A2		
Scales : 1/1250		
Drawing Ref : TCS/ADC/001-1		

APPENDIX 6

Anglian Water Sewer Records



(c) Crown copyright and database rights 2016 Ordnance Survey 100022432 Date: 30/11/16 Scale: 1:1250 Map Centre: 523713.309714 Data updated: 24/10/16 Our Ref: 206419 - 1 Wastewater Plan A1

This plan is provided by Anglian Water pursuant to its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2016 Ordnance Survey 100022432. This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other users of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

- | | | |
|--------------------------------|-----------|--------------------------------|
| Foul Sewer | — — — — — | Outfall |
| Surface Sewer | — — — — — | (Colour denotes effluent type) |
| Combined Sewer | — — — — — | Inlet |
| Final Effluent | — — — — — | (Colour denotes effluent type) |
| Rising Main | — — — — — | Manhole |
| (Colour denotes effluent type) | — — — — — | (Colour denotes effluent type) |
| Private Sewer | — — — — — | Sewage Treatment Works |
| (Colour denotes effluent type) | — — — — — | Pumping Station |
| Decommissioned Sewer | — — — — — | |
| (Colour denotes effluent type) | — — — — — | |

NTW2529	jessica.cooper@bwbconsulting.com



APPENDIX 7

MD Storage Simulation Results

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3-4 Kayes Walk Lace Market Nottingham NG1 1PY																																																																																																																																										
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<u>Summary of Results for 100 year Return Period (+40%)</u>																																																																																																																																										
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Micro Drainage		Source Control 2015.1			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	98.580	0.580	4.9	1029.5	O K
120 min Winter	98.692	0.692	4.9	1227.7	O K
180 min Winter	98.755	0.755	4.9	1340.3	O K
240 min Winter	98.798	0.798	4.9	1416.1	O K
360 min Winter	98.852	0.852	4.9	1512.8	O K
480 min Winter	98.890	0.890	4.9	1579.7	O K
600 min Winter	98.917	0.917	4.9	1628.2	O K
720 min Winter	98.938	0.938	4.9	1664.5	O K
960 min Winter	98.965	0.965	4.9	1713.1	O K
1440 min Winter	98.990	0.990	4.9	1756.4	O K
2160 min Winter	98.989	0.989	4.9	1756.2	O K
2880 min Winter	98.969	0.969	4.9	1720.0	O K
4320 min Winter	98.911	0.911	4.9	1617.0	O K
5760 min Winter	98.857	0.857	4.9	1520.5	O K
7200 min Winter	98.800	0.800	4.9	1420.0	O K
8640 min Winter	98.743	0.743	4.9	1318.1	O K
10080 min Winter	98.684	0.684	4.9	1213.5	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	53.779	0.0	819.4	70	
120 min Winter	32.300	0.0	786.8	130	
180 min Winter	23.685	0.0	764.7	188	
240 min Winter	18.910	0.0	752.2	246	
360 min Winter	13.666	0.0	739.1	364	
480 min Winter	10.856	0.0	732.9	482	
600 min Winter	9.077	0.0	730.8	598	
720 min Winter	7.839	0.0	731.8	716	
960 min Winter	6.216	0.0	737.1	950	
1440 min Winter	4.476	0.0	734.0	1410	
2160 min Winter	3.218	0.0	1473.4	2084	
2880 min Winter	2.544	0.0	1433.5	2736	
4320 min Winter	1.825	0.0	1366.0	3460	
5760 min Winter	1.440	0.0	2626.0	4376	
7200 min Winter	1.198	0.0	2687.6	5328	
8640 min Winter	1.030	0.0	2639.3	6232	
10080 min Winter	0.907	0.0	2531.6	7160	
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Micro Drainage Source Control 2015.1		

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 98.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1775.0	1.000	1775.0	1.001	0.0	2.000	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0105-5000-1000-5000

Design Head (m) 1.000

Design Flow (l/s) 5.0

Flush-Flo™ Calculated

Objective Minimise upstream storage

Diameter (mm) 105

Invert Level (m) 98.000

Minimum Outlet Pipe Diameter (mm) 150

Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.0
Flush-Flo™	0.295	4.9
Kick-Flo®	0.636	4.0
Mean Flow over Head Range	-	4.3

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	3.6	1.200	5.4	3.000	8.3	7.000	12.4
0.200	4.8	1.400	5.8	3.500	8.9	7.500	12.8
0.300	4.9	1.600	6.2	4.000	9.5	8.000	13.2
0.400	4.9	1.800	6.5	4.500	10.1	8.500	13.6
0.500	4.7	2.000	6.9	5.000	10.6	9.000	14.0
0.600	4.3	2.200	7.2	5.500	11.1	9.500	14.4
0.800	4.5	2.400	7.5	6.000	11.5		
1.000	5.0	2.600	7.8	6.500	12.0		

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Micro Drainage		Source Control 2015.1				
<u>Summary of Results for 100 year Return Period (+40%)</u>						
Storm Event		Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer		98.375	0.375	4.9	918.9	O K
30 min Summer		98.431	0.431	4.9	1055.8	O K
60 min Summer		98.494	0.494	4.9	1210.8	O K
120 min Summer		98.565	0.565	4.9	1383.9	O K
180 min Summer		98.609	0.609	4.9	1493.0	O K
240 min Summer		98.642	0.642	4.9	1573.5	O K
360 min Summer		98.689	0.689	4.9	1688.7	O K
480 min Summer		98.722	0.722	4.9	1769.7	O K
600 min Summer		98.747	0.747	4.9	1830.7	O K
720 min Summer		98.767	0.767	4.9	1878.5	O K
960 min Summer		98.797	0.797	4.9	1951.5	O K
1440 min Summer		98.831	0.831	4.9	2035.2	O K
2160 min Summer		98.850	0.850	4.9	2081.4	O K
2880 min Summer		98.849	0.849	4.9	2079.7	O K
4320 min Summer		98.787	0.787	4.9	1927.8	O K
5760 min Summer		98.735	0.735	4.9	1801.6	O K
7200 min Summer		98.689	0.689	4.9	1688.9	O K
8640 min Summer		98.645	0.645	4.9	1581.3	O K
10080 min Summer		98.599	0.599	4.9	1468.4	O K
15 min Winter		98.420	0.420	4.9	1029.7	O K
30 min Winter		98.483	0.483	4.9	1183.4	O K
Storm Event		Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer		213.348	0.0	422.2	27	
30 min Summer		122.808	0.0	419.8	42	
60 min Summer		70.691	0.0	832.7	72	
120 min Summer		40.691	0.0	820.3	132	
180 min Summer		29.457	0.0	800.4	190	
240 min Summer		23.423	0.0	778.5	250	
360 min Summer		16.956	0.0	745.9	370	
480 min Summer		13.483	0.0	725.2	490	
600 min Summer		11.287	0.0	710.9	610	
720 min Summer		9.760	0.0	700.8	728	
960 min Summer		7.774	0.0	689.4	968	
1440 min Summer		5.642	0.0	684.8	1446	
2160 min Summer		4.094	0.0	1419.7	2164	
2880 min Summer		3.261	0.0	1377.8	2880	
4320 min Summer		2.272	0.0	1289.7	3676	
5760 min Summer		1.758	0.0	2748.3	4432	
7200 min Summer		1.440	0.0	2678.5	5184	
8640 min Summer		1.224	0.0	2578.2	5976	
10080 min Summer		1.067	0.0	2507.6	6752	
15 min Winter		213.348	0.0	422.0	27	
30 min Winter		122.808	0.0	415.9	41	
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Micro Drainage		Source Control 2015.1			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	98.554	0.554	4.9	1357.5	O K
120 min Winter	98.634	0.634	4.9	1553.3	O K
180 min Winter	98.684	0.684	4.9	1677.0	O K
240 min Winter	98.721	0.721	4.9	1767.7	O K
360 min Winter	98.775	0.775	4.9	1898.0	O K
480 min Winter	98.812	0.812	4.9	1990.4	O K
600 min Winter	98.841	0.841	4.9	2060.7	O K
720 min Winter	98.864	0.864	4.9	2116.3	O K
960 min Winter	98.899	0.899	4.9	2202.5	O K
1440 min Winter	98.941	0.941	4.9	2305.4	O K
2160 min Winter	98.968	0.968	4.9	2372.0	O K
2880 min Winter	98.974	0.974	4.9	2385.6	O K
4320 min Winter	98.907	0.907	4.9	2223.1	O K
5760 min Winter	98.842	0.842	4.9	2063.8	O K
7200 min Winter	98.786	0.786	4.9	1926.7	O K
8640 min Winter	98.732	0.732	4.9	1792.9	O K
10080 min Winter	98.677	0.677	4.9	1659.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	70.691	0.0	828.3	70	
120 min Winter	40.691	0.0	794.8	130	
180 min Winter	29.457	0.0	764.8	188	
240 min Winter	23.423	0.0	746.4	248	
360 min Winter	16.956	0.0	726.0	366	
480 min Winter	13.483	0.0	717.0	482	
600 min Winter	11.287	0.0	714.9	600	
720 min Winter	9.760	0.0	717.7	718	
960 min Winter	7.774	0.0	724.8	952	
1440 min Winter	5.642	0.0	723.8	1418	
2160 min Winter	4.094	0.0	1451.0	2104	
2880 min Winter	3.261	0.0	1440.1	2776	
4320 min Winter	2.272	0.0	1370.9	4064	
5760 min Winter	1.758	0.0	2866.7	4608	
7200 min Winter	1.440	0.0	2749.6	5488	
8640 min Winter	1.224	0.0	2622.6	6408	
10080 min Winter	1.067	0.0	2504.1	7368	
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Micro Drainage Source Control 2015.1		

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 98.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	2450.0	1.000	2450.0	1.001	0.0	2.000	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0105-5000-1000-5000

Design Head (m) 1.000

Design Flow (l/s) 5.0

Flush-Flo™ Calculated

Objective Minimise upstream storage

Diameter (mm) 105

Invert Level (m) 98.000

Minimum Outlet Pipe Diameter (mm) 150

Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.0
Flush-Flo™	0.295	4.9
Kick-Flo®	0.636	4.0
Mean Flow over Head Range	-	4.3

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	3.6	1.200	5.4	3.000	8.3	7.000	12.4
0.200	4.8	1.400	5.8	3.500	8.9	7.500	12.8
0.300	4.9	1.600	6.2	4.000	9.5	8.000	13.2
0.400	4.9	1.800	6.5	4.500	10.1	8.500	13.6
0.500	4.7	2.000	6.9	5.000	10.6	9.000	14.0
0.600	4.3	2.200	7.2	5.500	11.1	9.500	14.4
0.800	4.5	2.400	7.5	6.000	11.5		
1.000	5.0	2.600	7.8	6.500	12.0		

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APPENDIX 8

Indicative Surface Water Layout

BWB

