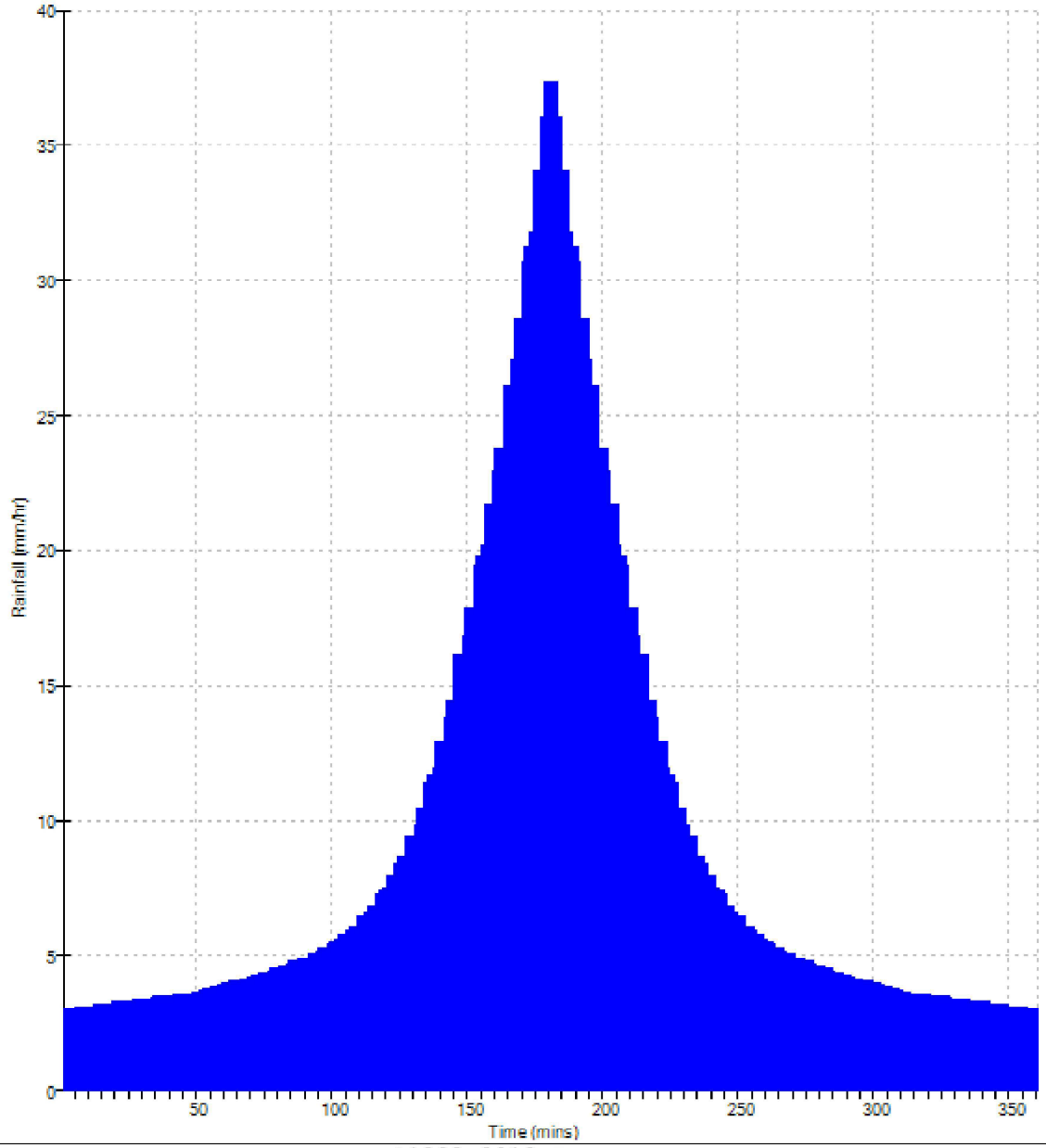
Rainfall profile

Storm duration (mins) 360

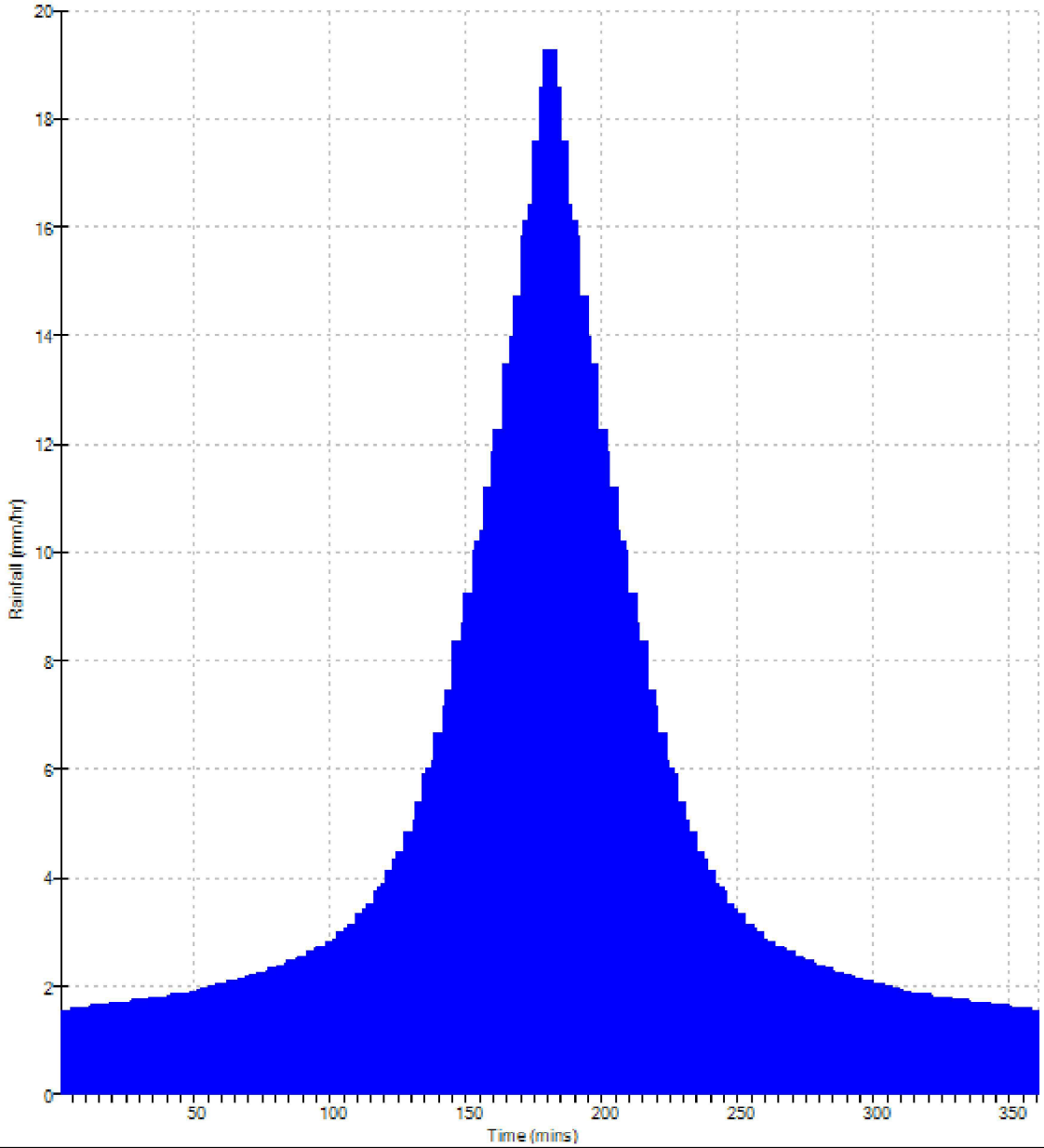
FEH Data	
FEH Rainfall Version	2013
Site Location GB	360097 438896
Data Type	Point
Peak Intensity (mm/hr)	37.369
Ave. Intensity (mm/hr)	9.533
Return Period (years)	30.0



Rainfall profile

Storm duration (mins) 360

FEH Data	
FEH Rainfall Version	2013
Site Location GB	360097 438896
Data Type	Point
Peak Intensity (mm/hr)	19.275
Ave. Intensity (mm/hr)	4.917
Return Period (years)	2.0



Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	18.800
Ratio R	0.281
Areal Reduction Factor	1.00
Area (ha)	6.236
SAAR (mm)	1219
CWI	123.855
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	51.35
Greenfield Runoff Volume (m^3)	2178.681

Greenfield Runoff Volume

FSR Data

Return Period (years)	1
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	18.800
Ratio R	0.281
Areal Reduction Factor	1.00
Area (ha)	6.236
SAAR (mm)	1219
CWI	123.855
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	46.71
Greenfield Runoff Volume (m^3)	710.686

APPENDIX K: PRELIMINARY PROPOSED DRAINAGE PLANS

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SITE: CHIPPINGS LANE, LONGRIDGE
REF: HYD371
REV: 0
DATE: 08/11/18

BETTS HYDRO CONSULTING ENGINEERS

EXISTING DRAINAGE SITUATION

LEGEND

- Phase 1
- Phase 2 & 3

Existing Drainage Features

- Topography
- Ordinary Watercourse
- Ponds

Existing Sewer Networks

- Public Surface Water Sewer
- Public Foul Water Sewer
- Foul Water Pumping Station

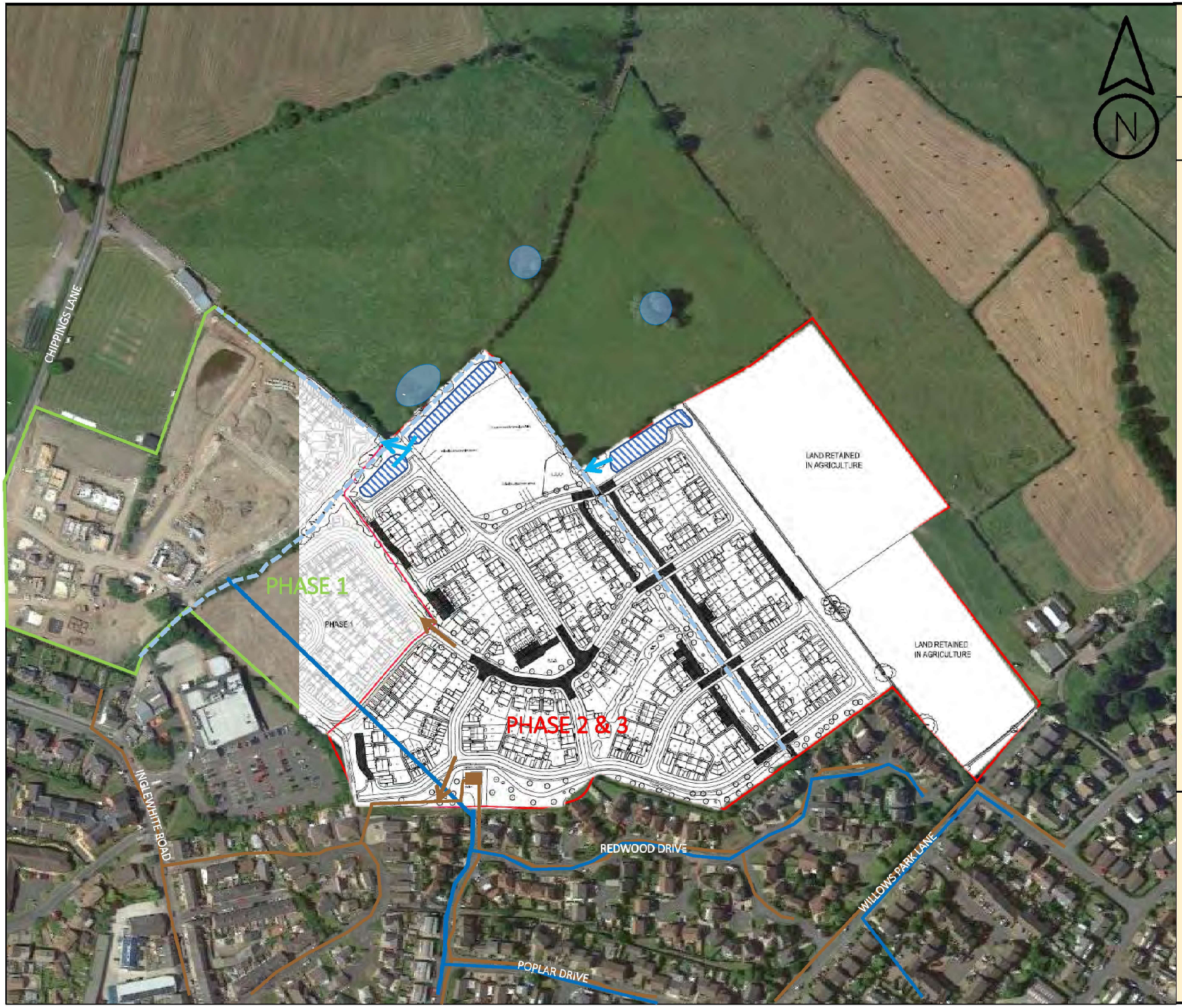
FURTHER NOTES:

This drawing is not a drainage 'design' it is a preliminary drainage strategy showing existing sewer locations.

No hydraulic simulation or assessment of these proposals has been undertaken.

Proposed points of connection to the existing watercourse and sewer require invert levels to be accurately established. Refer to proposed drainage plan.

Surcharging of the proposed outfall will require modelling to satisfy the requirements of united utilities along with full hydraulic analysis.



SITE: CHIPPINGS LANE, LONGRIDGE
REF: HYD371
REV: 0
DATE: 08/11/2018

BETTS HYDRO CONSULTING ENGINEERS

PRELIMINARY DRAINAGE STRATEGY PLAN

LEGEND

- Phase 1
- Phase 2 & 3

Existing Drainage Features

- Ordinary Watercourse
- Ponds

Existing Sewer Networks

- Public Surface Water Sewer
- Public Foul Water Sewer
- Foul Water Pumping Station

Proposed Drainage Connections

- SuDS/Attenuation
- Surface Water Drainage Connection
- Foul Water Drainage Connection(s)

FURTHER NOTES:

This drawing is not a drainage 'design' it is a preliminary drainage strategy showing existing sewer locations.

No hydraulic simulation or assessment of these proposals has been undertaken.

Proposed points of connection to the existing watercourse and sewer require invert levels to be accurately established. Refer to proposed drainage plan.

Surcharging of the proposed outfall will require modelling to satisfy the requirements of united utilities along with full hydraulic analysis.

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APPENDIX L: STORMWATER STORAGE ESTIMATES

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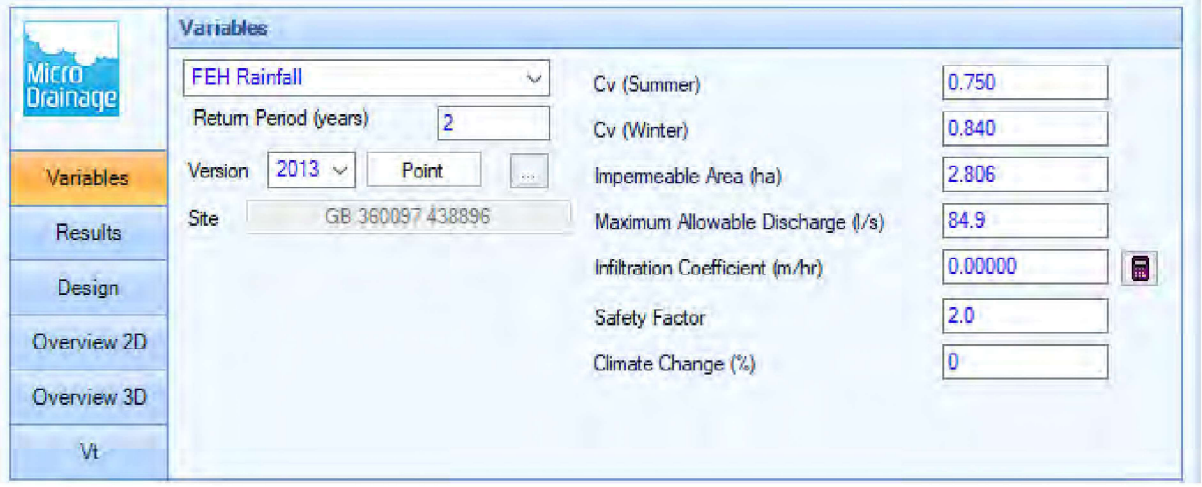
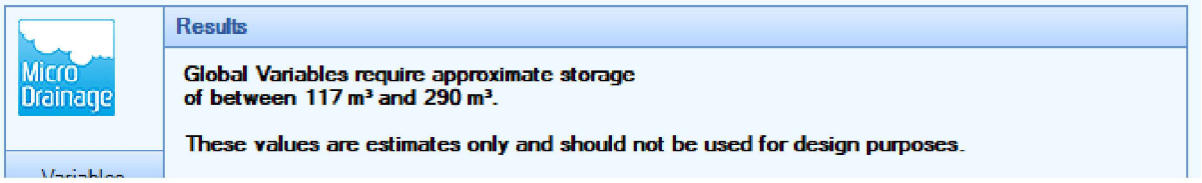
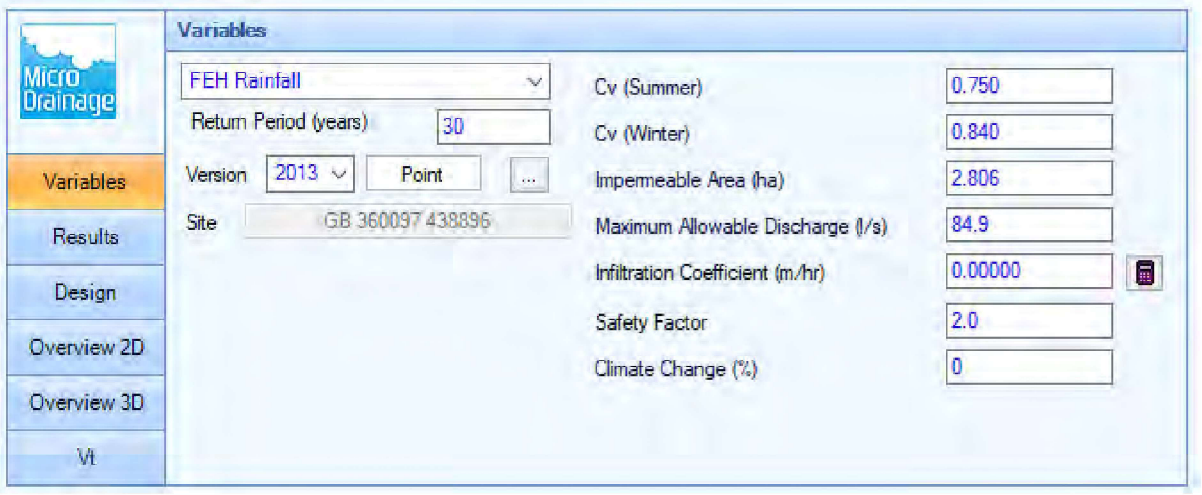
QUICK STORAGE ESTIMATES — CHIPPINGS LANE, LONGRIDGE

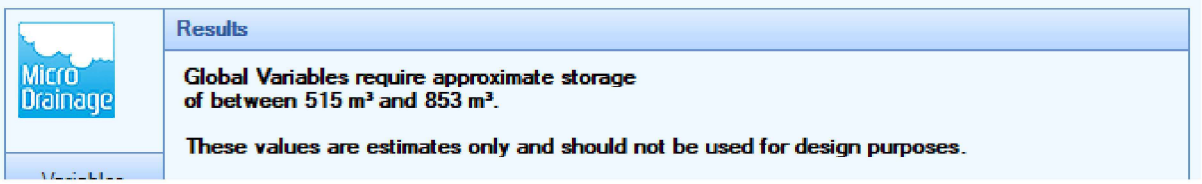
1 YEAR RETURN PERIOD STORM EVENT



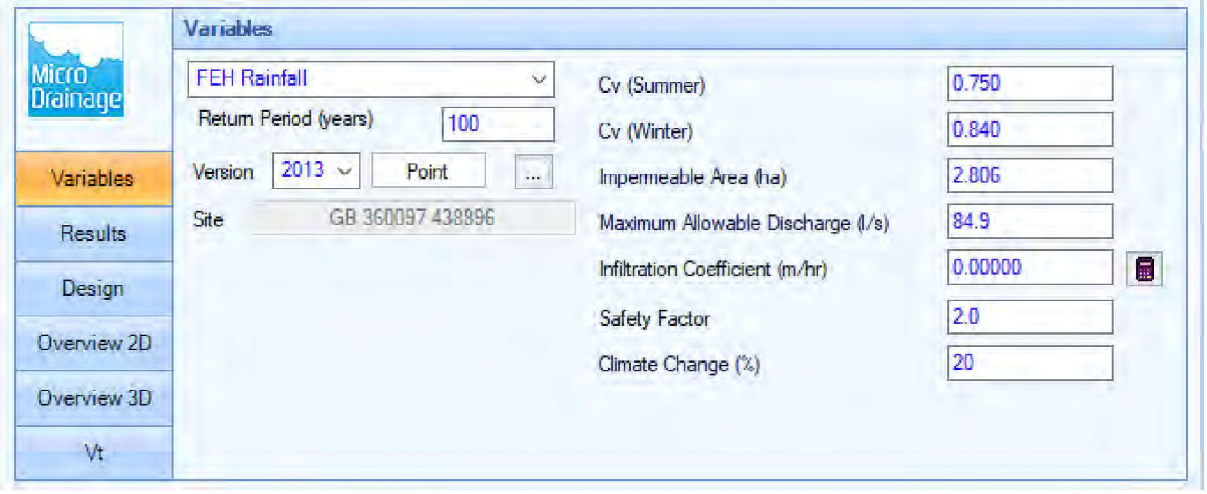


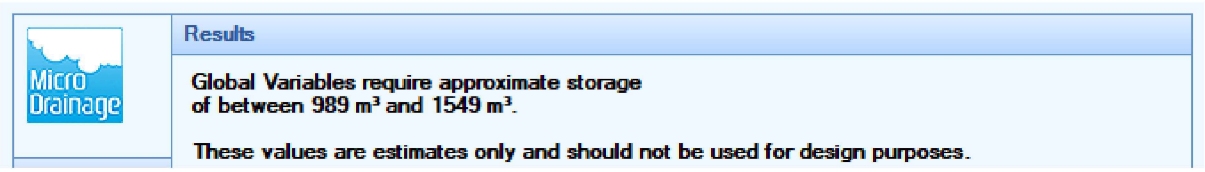
30 YEAR RETURN PERIOD STORM EVENT



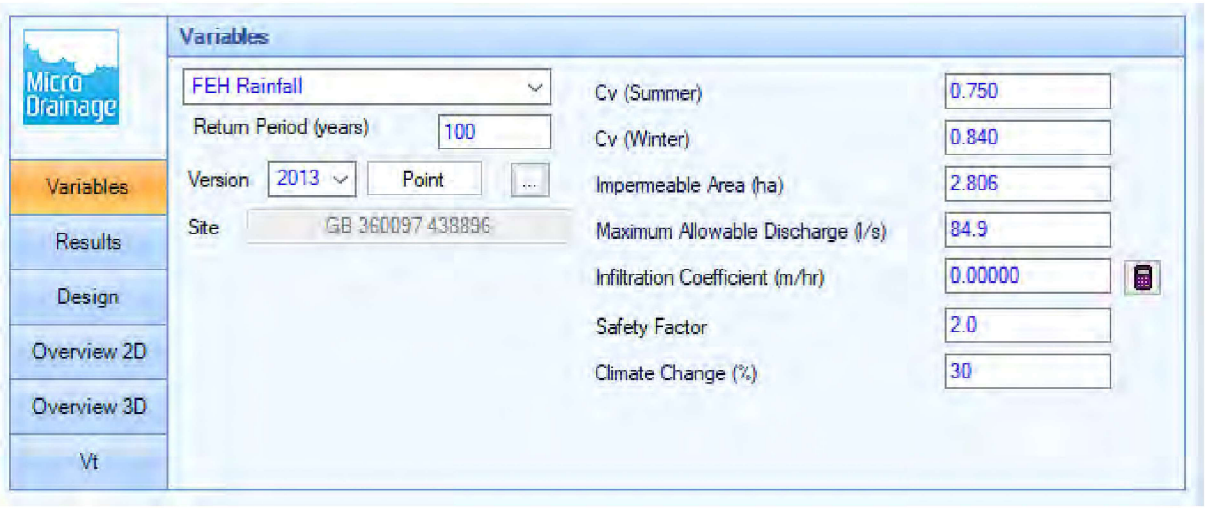


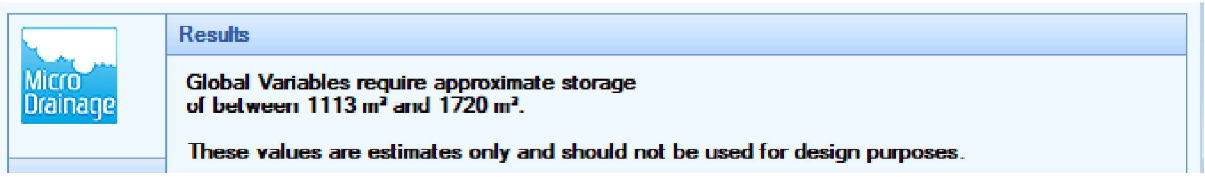
100 YEAR RETURN PERIOD STORM EVENT + 20% CLIMATE CHANGE



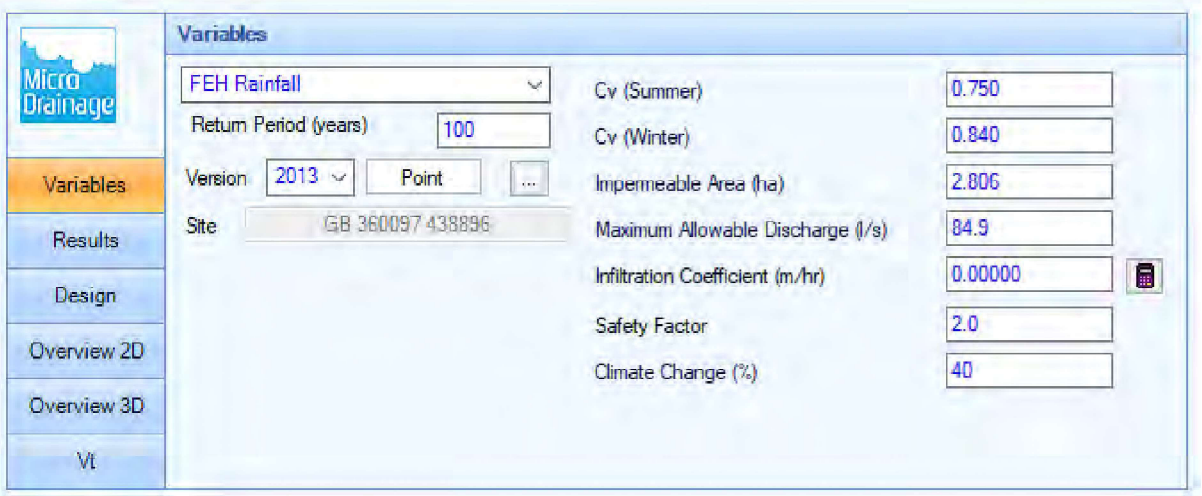


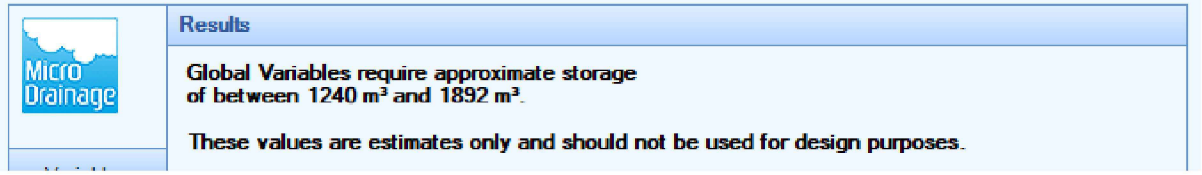
100 YEAR RETURN PERIOD STORM EVENT + 30% CLIMATE CHANGE





100 YEAR RETURN PERIOD STORM EVENT + 40% CLIMATE CHANGE





APPENDIX M: TYPICAL SUDS DETAILS

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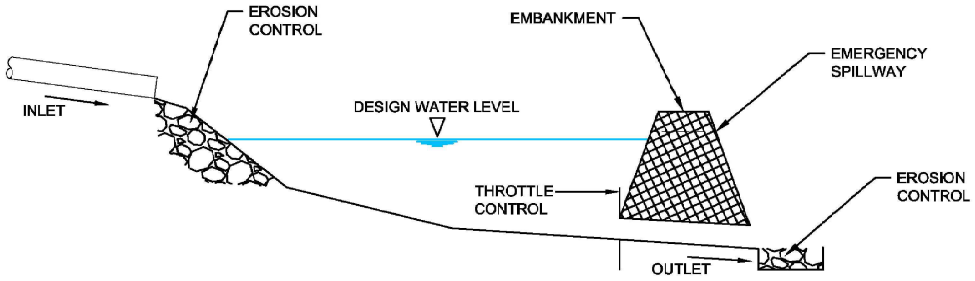
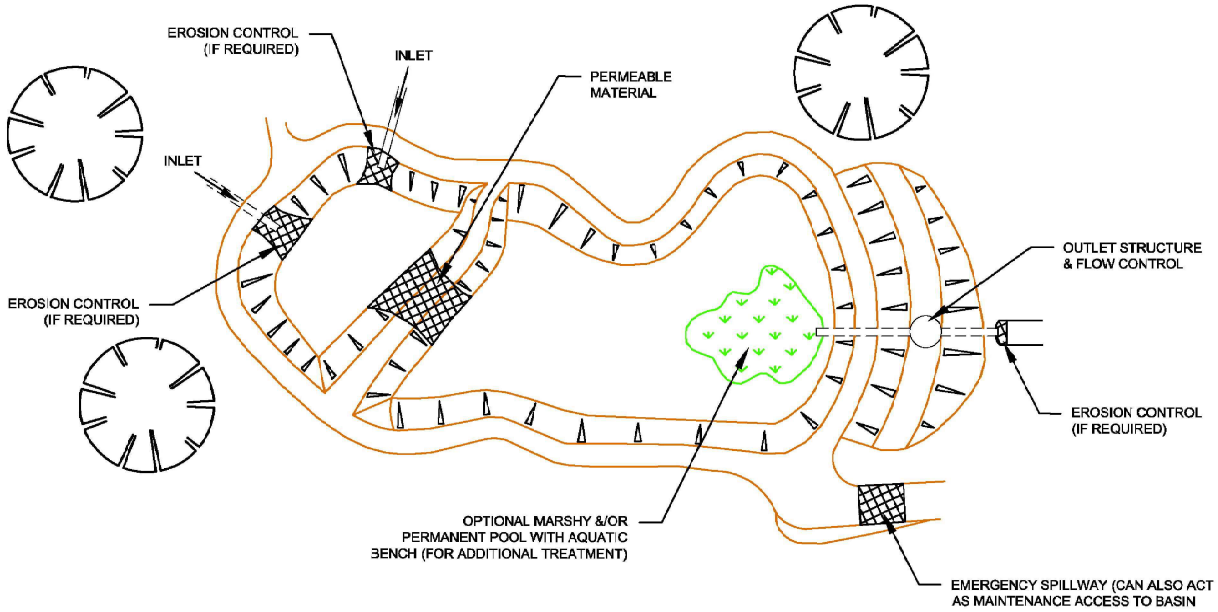
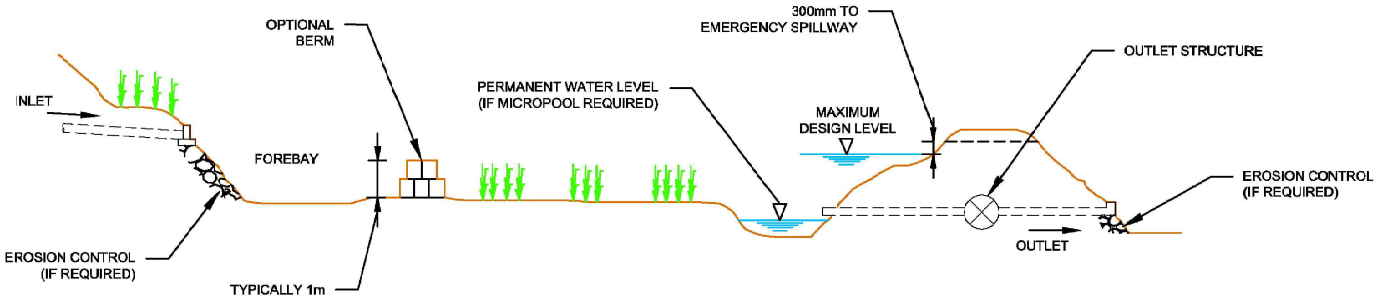


SCHEMATIC OF DETENTION BASIN PROFILE



PLAN VIEW



ELEVATION

DO NOT SCALE

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
Unit 5, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288173 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT: TYPICAL SUDS DETAIL

TITLE: DETENTION BASINS

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	110	A

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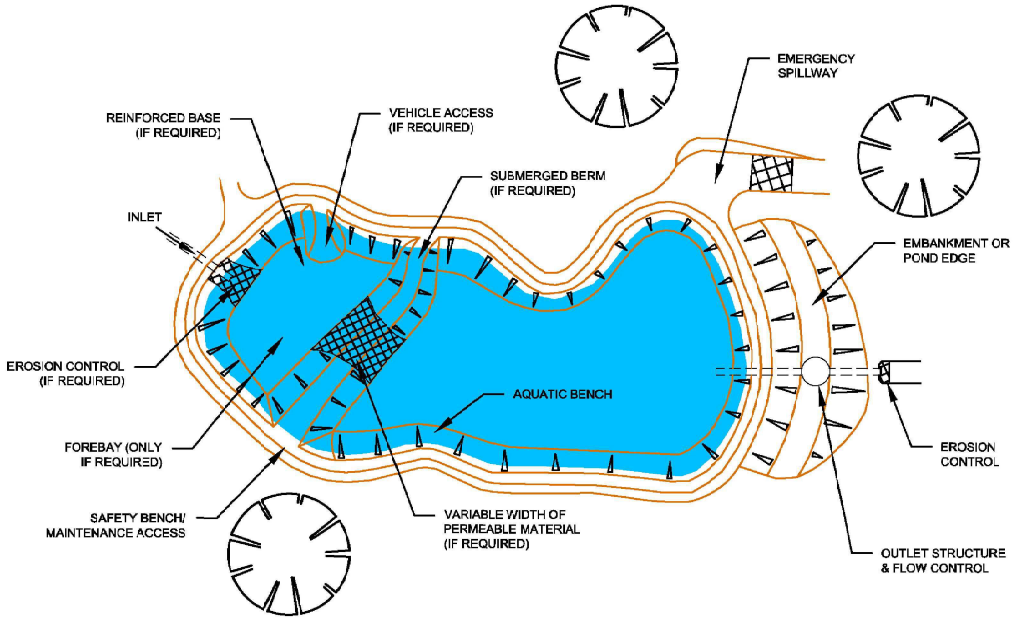
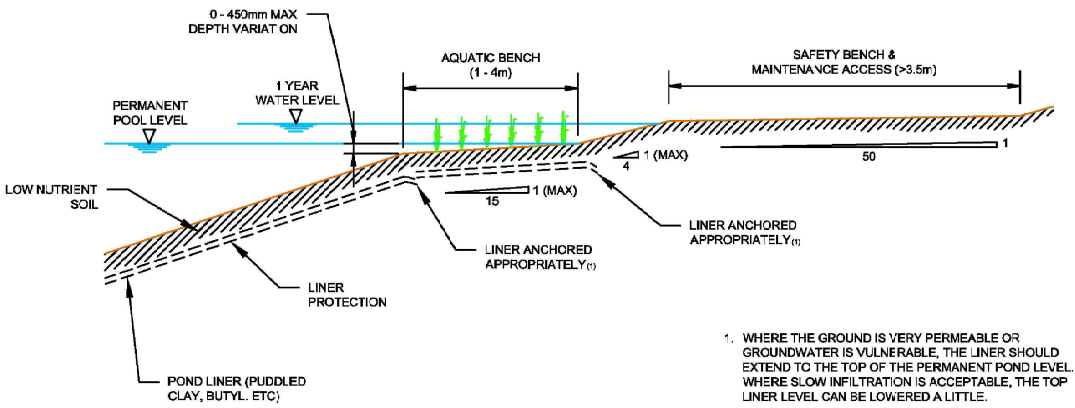
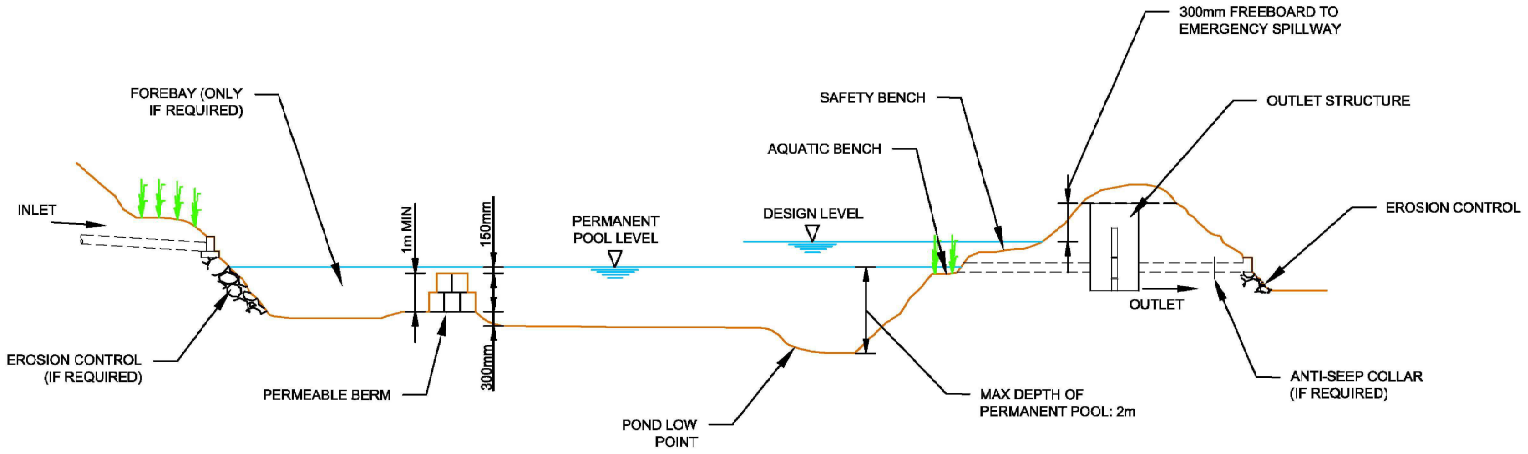


PLAN VIEW



1. WHERE THE GROUND IS VERY PERMEABLE OR GROUNDWATER IS VULNERABLE, THE LINER SHOULD EXTEND TO THE TOP OF THE PERMANENT POND LEVEL. WHERE SLOW INFILTRATION IS ACCEPTABLE, THE TOP LINER LEVEL CAN BE LOWERED A LITTLE.

TYPICAL POND EDGE GEOMETRY



PROFILE

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DRAWING STATUS: PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
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Tel: 01244 288173 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT: TYPICAL SUDS DETAIL

TITLE: WET PONDS

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
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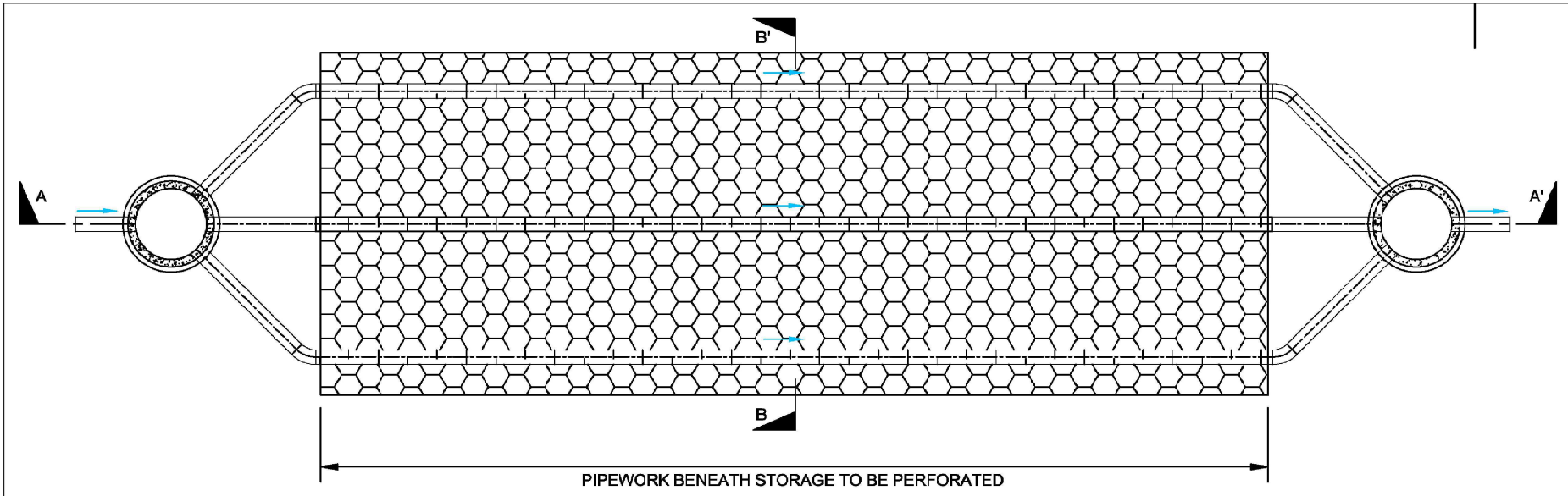

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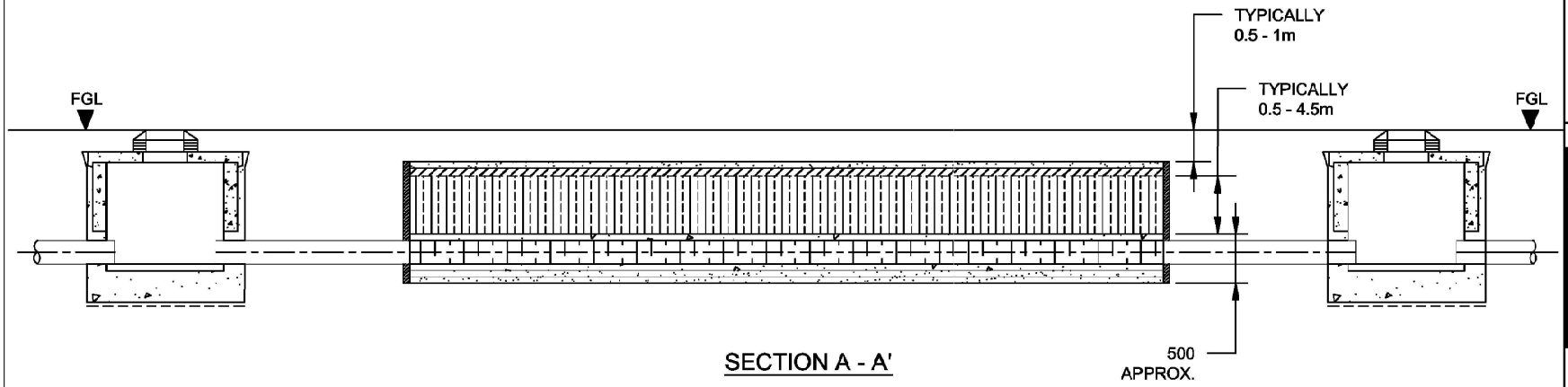
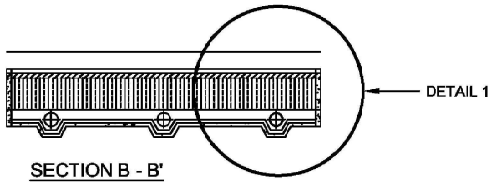
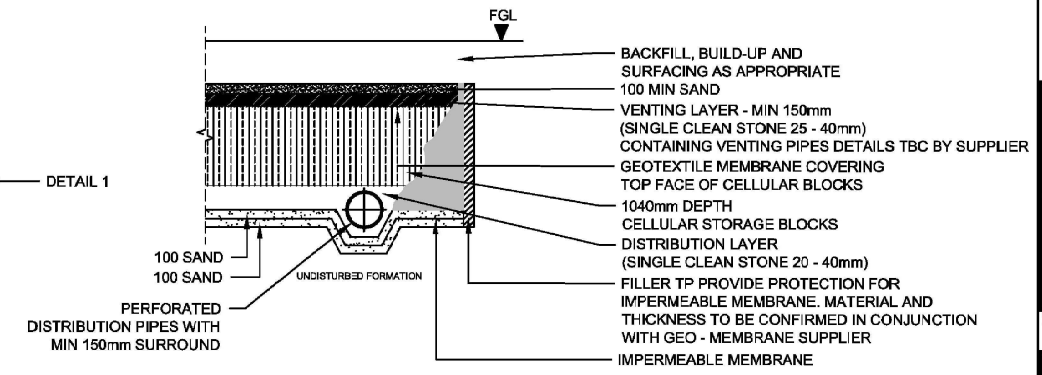


SECTION A - A'

ALL DIMENSIONS AND DEPTHS DEPENDENT ON REQUIRED VOLUME AND LOCAL GROUND CONDITIONS



SECTION B - B'



DETAIL 1

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
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PROJECT: TYPICAL SUDS DETAIL

TITLE: CELLULAR STORAGE

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SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
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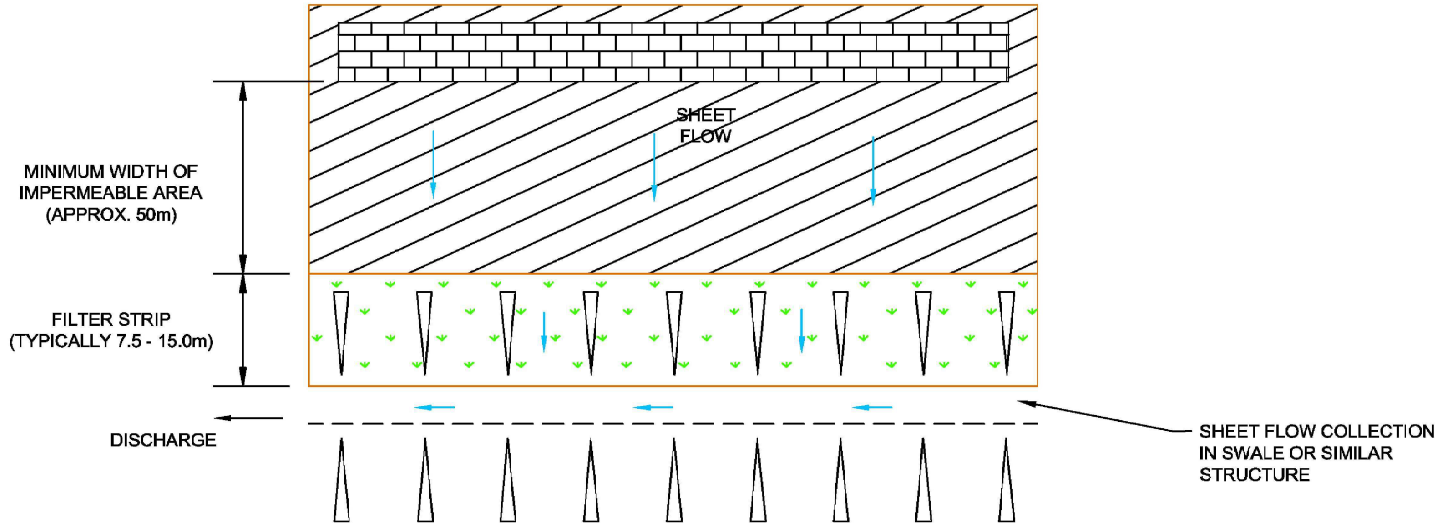

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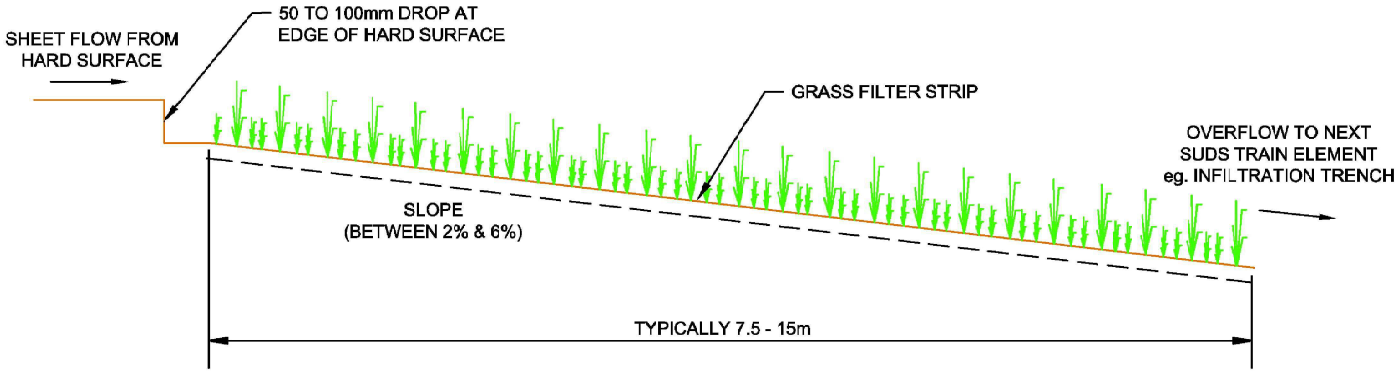

ELEVATION

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
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Tel: 01244 288173 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT: TYPICAL SUDS DETAIL

TITLE: FILTER STRIPS

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
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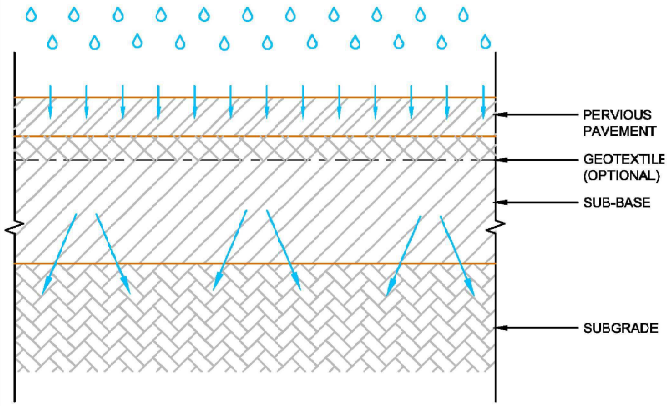

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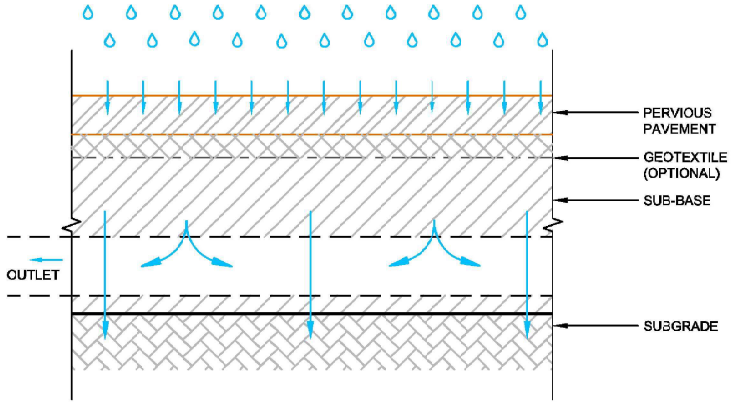
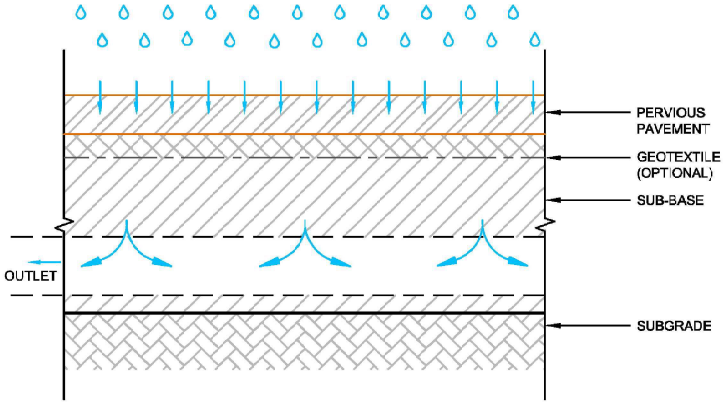
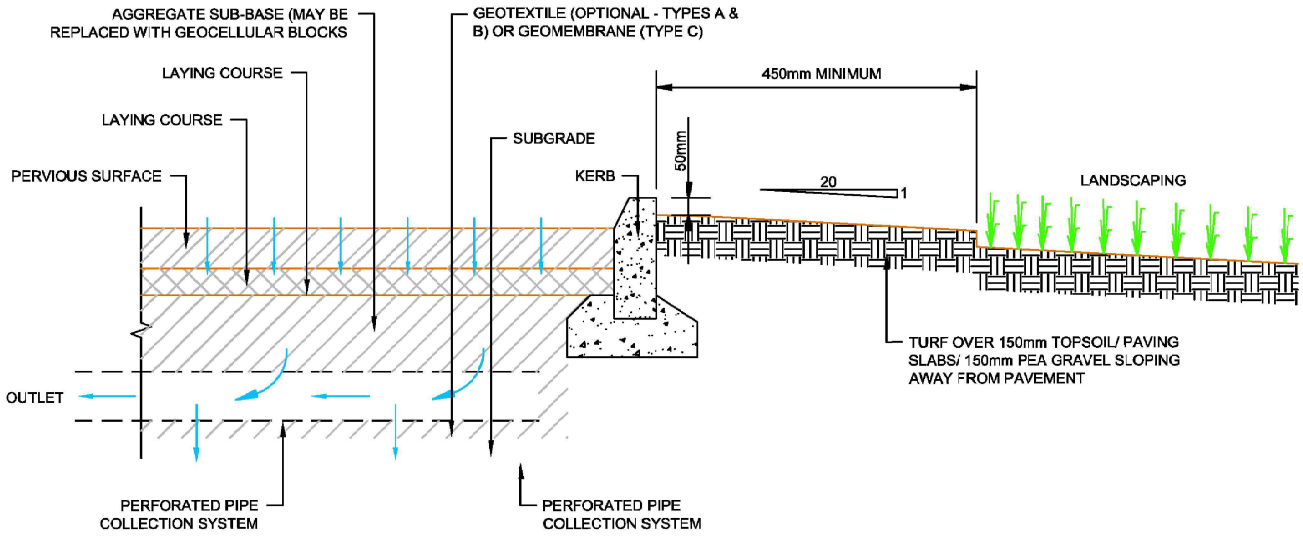


TYPE B: PARTIAL INFILTRATION



TYPE C: NO INFILTRATION



LANDSCAPING DETAIL

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
Unit 5, Olc Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288173 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT: TYPICAL SUDS DETAIL

TITLE: PERVIOUS PAVEMENTS

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	105	A

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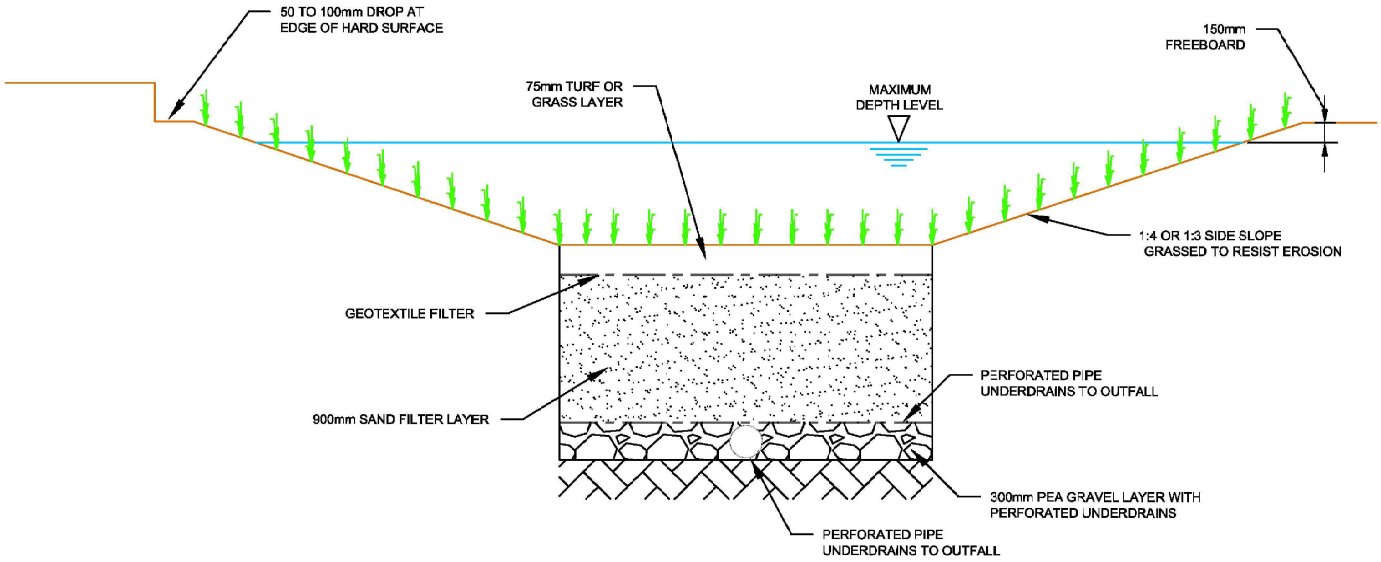

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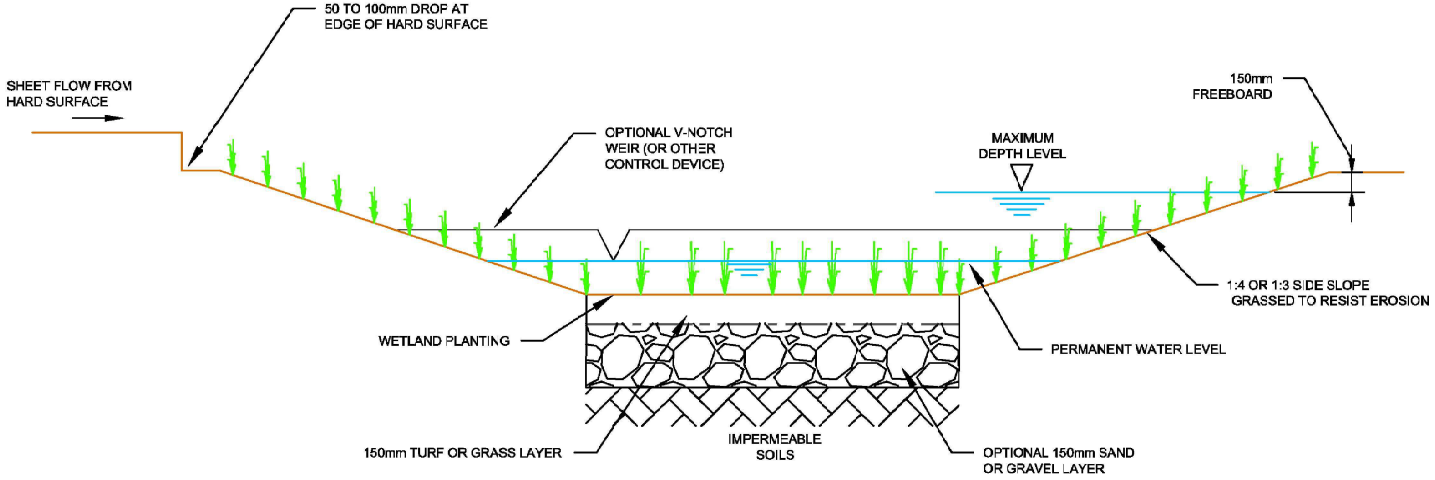

WET SWALE

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
Unit 5, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288173 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT: TYPICAL SUDS DETAIL

TITLE: SWALES (1 of 2)

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	103	A

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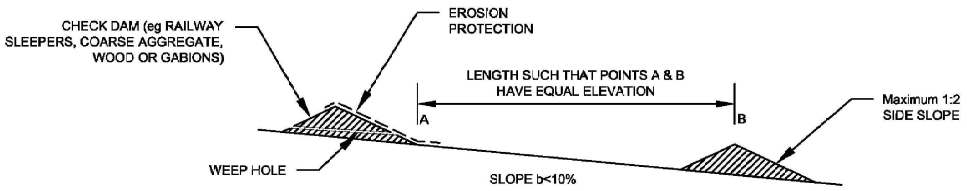

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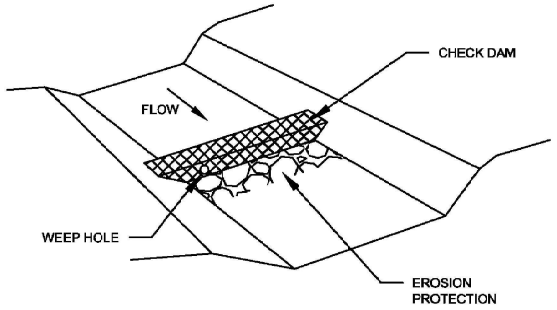

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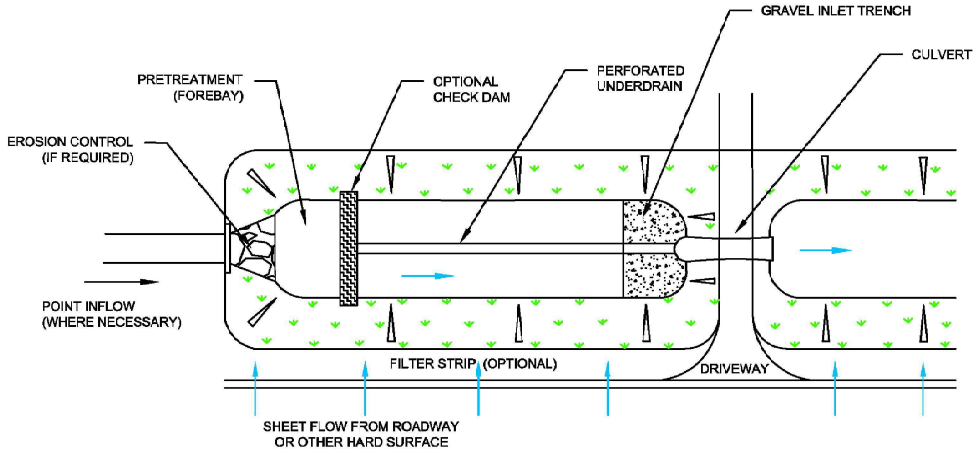

ENHANCED DRY SWALE

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
Unit 5, Olc Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288173 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT: TYPICAL SUDS DETAIL

TITLE: SWALES (2 of 2)

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	104	A

APPENDIX N: NOTES OF LIMITATIONS

The data essentially comprised a study of available documented information from various sources together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our conclusions, we request the opportunity to review the information, reassess the potential concerns, and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information.

This report was prepared by Betts Hydro Ltd for the sole and exclusive use of the titled client in response to instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

This document has been prepared for the titled project only and should any third party wish to use or rely upon the contents of the report, written approval from Betts Hydro Ltd must be sought.

Betts Hydro Ltd accepts no responsibility or liability for the consequences of this document being used for the purpose other than that for which it was commissioned and for this document to any other party other than the person by whom it was commissioned.

Appendix B
Hydraulic Assessment

BETTS HYDRO
CONSULTING ENGINEERS

LAND AT CHIPPING LANE, LONGRIDGE

HYDRAULIC ASSESSMENT

For
Barratt Homes Manchester
4 Brindley Road,
City Park,
Manchester,
M16 9HQ.

July 2016

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LAND AT CHIPPING LANE, LONGRIDGE

HYDRAULIC ASSESSMENT

Document Tracking Sheet

Document Reference: HYD068_CHIPPINGLANE_HYDRAULIC_ASSESSMENT
Revision: 1.0
Date of Issue: 8th July 2016
Report Status: FINAL

Prepared by [redacted]
Dominic Kearney BEng (Hons), MSc, PhD
Principal Hydraulic Analyst

Checked by: [redacted]
Richard Nicholas BEng (Hons) MBA
Director

Authorised [redacted]
Rob Ankers
Director

Revision History:

Rev.:	Date:	Status:	Prepared by:	Checked by:	Issued by:
1.0	04/07/16	Final	DK	RN	DK

Old Marsh Farm Barns
Welsh Road, Sealand
Flintshire CH5 2LY
Telephone: 01244 289 041

www.betts-associates.co.uk

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CONTENTS

Figures & Tables

Specialist Software

- Flood Estimation Handbook FEH CD-ROM (v.3.0) – Determination of Catchment Descriptors and depths of rainfall.
- ISIS (3.7) – 2013 - 1D Hydraulic Model

Abbreviations & Acronyms

AEP	Annual Exceedance Probability	mAOD	Metres Above Ordnance Datum
BGL	Below Ground Level	NGR	National Grid Reference
CC	Climate Change	NPPF	National Planning Policy Framework
EA	Environment Agency	OS	Ordnance Survey
FEH	Flood Estimation Handbook	PFRA	Preliminary Flood Risk Assessment
FRA	Flood Risk Assessment	PPS	Planning Policy Statement
FZ	Flood Zone	SFRA	Strategic Flood Risk Assessment
Ha	Hectare	LCC	Lancashire County Council
LLFA	Lead Local Flood Authority	TWL	Top Water Level
LPA	Local Planning Authority	UU	United Utilities

1.0 EXISTING SITE SITUATION

1.1 The proposed development site is located on land at Chipping Lane, Longridge and is directly accessed off Chipping Lane. The Ordnance Survey National Grid Reference (OS NGR) for the site is Eastings 360073, Northings 437980 and the nearest postcode is PR3 2NA.

1.2 The proposed development area is edged in red Figure 1 (below). A location plan is included Appendix A.

Figure 1: Aerial Photograph of site (proposed development area edged in red)

1.3 Two small watercourses enter the site from the south east and south west and flow in a north westerly direction, leaving the site via 600mm diameter culvert outfall by Chipping Lane north of the site.

1.4 The Environment Agency flood zone maps indicated that the site is entirely within Flood Zone 1, implying that the site is at low risk of fluvial flooding.

1.6 From a flood risk perspective it was considered prudent to undertake a hydraulic assessment of the watercourse to assess the peak water levels in the watercourse in both the existing and the post development scenarios.

2.0 DEVELOPMENT PROPOSALS

2.1 The initial proposals are a residential development within the red edge boundary indicated in Figure 2 and in Appendix B.

Figure 2: Indicative Planning Proposals

3.0 CATCHMENT DESCRIPTORS

3.1 The Flood Estimation Handbook (FEH) CD-ROM provided catchment descriptors for Higgin Brook upstream of a point north of the development site. Three smaller sub-catchments (Sub A, Sub B and Sub C) upstream of the 600mm culvert were identified using LiDAR data.

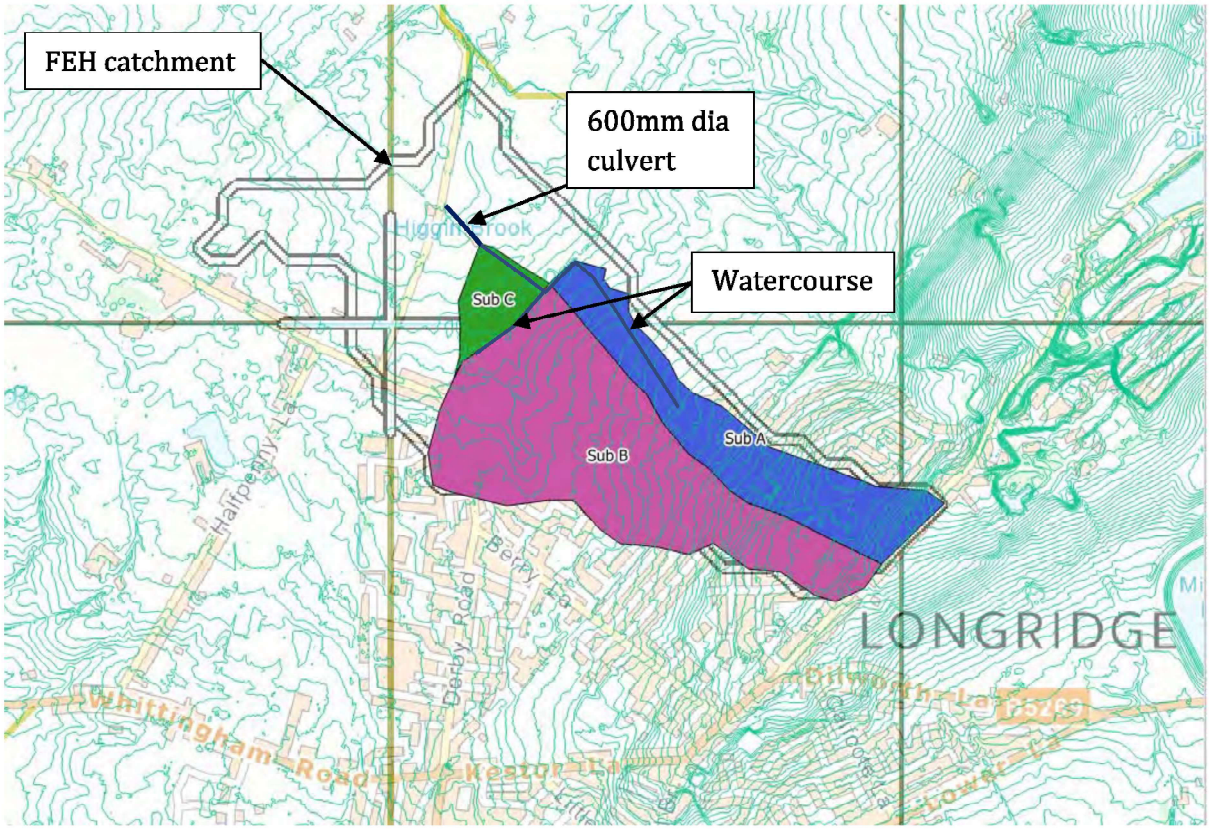

Figure 3: Upstream Sub-catchments

3.2 The FEH Catchment descriptors are summarised below and included in full in Appendix C.

Important Catchment Descriptors: All sub-catchments

DPSBAR (m/km)	22.3	Mean slope between nodes (m/km)
SAAR (mm)	1200	Standard annual average rainfall – 1961-1990
FARL	1.00	Flood attenuation due to reservoirs/lakes (no attenuation)
BFIHOST	0.417	Baseflow index from Hydrology of Soil Types
SPRHOST	35.03	Standard percentage runoff from soil types
PROPWET	0.51	Proportion of time catchment is wet
URBEXT1990	0.1643	Urban extent in 1990 (essentially rural)

3.3 The areas for the sub-catchments were calculated using GIS and mean drainage path length (DPLBAR) was calculated using formula 7.1 from the FEH Volume 5: Catchment Descriptors as follows: $DPLBAR = AREA^{0.548}$. The sub-catchment areas and DPLBAR values are shown in Table 1.

Sub-catchment	Area (km²)	DPLBAR (km)
Sub A	0.093	0.272
Sub B	0.200	0.414
Sub C	0.022	0.123

Table 1: Sub-catchment specific characteristics

4.0 HYDROLOGY

4.1 The Revitalised Flood Hydrograph (ReFH) method was applied for each sub-catchment based on catchment descriptors. The $URBEXT_{1990}$ <0.5 and BFIHOST<0.65 for all sub-catchments, therefore the use of the ReFH method is appropriate.

4.2 This study has considered the 1 in 5 year (20% AEP), 1 in 30 year (3.3% AEP), 1 in 100 year (1% AEP) and the 1 in 100 year (1% AEP) plus climate change (CC) return period flows in the watercourses.

4.3 These are considered to represent conservative flow estimates (i.e. adopts the precautionary approach). The site is considered to be predominantly greenfield and the catchment characteristics from the FEH CD-ROM were utilised. The peak flow estimates are shown in Table 2 below. Full details are shown in Appendix D.

Sub-Catchment	20% AEP	3.3% AEP	1% AEP	1% AEP + CC
Sub A	0.11	0.18	0.24	0.29
Sub B	0.20	0.32	0.45	0.54
Sub C	0.03	0.06	0.08	0.10

Table 2: ReFH Peak Flow Estimates

4.4 The critical storm duration for the largest sub-catchment (Sub B) was 1.065 hours. It was assumed that the same storm would occur in all sub-catchments, as they are adjacent to one another.

4.5 The full hydrographs for all sub-catchments in all return periods are shown in Figures D.1 to D.10 in Appendix D.

5.0 HYDRAULIC MODELLING

Model Details

5.1 An unsteady state 1D model of the watercourse was developed using ISIS for the existing and the proposed development scenarios.

5.2 A topographical survey of the site and watercourse was undertaken and a 3D ground model was generated. Cross sections through the watercourse were generated from the ground model at locations shown in the model schematics shown in Figure 4. The cross sections (Figures E.1 to E.30) and watercourse profile (Figure E.15) are included in Appendix E.

5.3 The watercourse was modelled in the existing scenario for the 20%, 3.3%, 1% and 1% plus climate change AEP events.

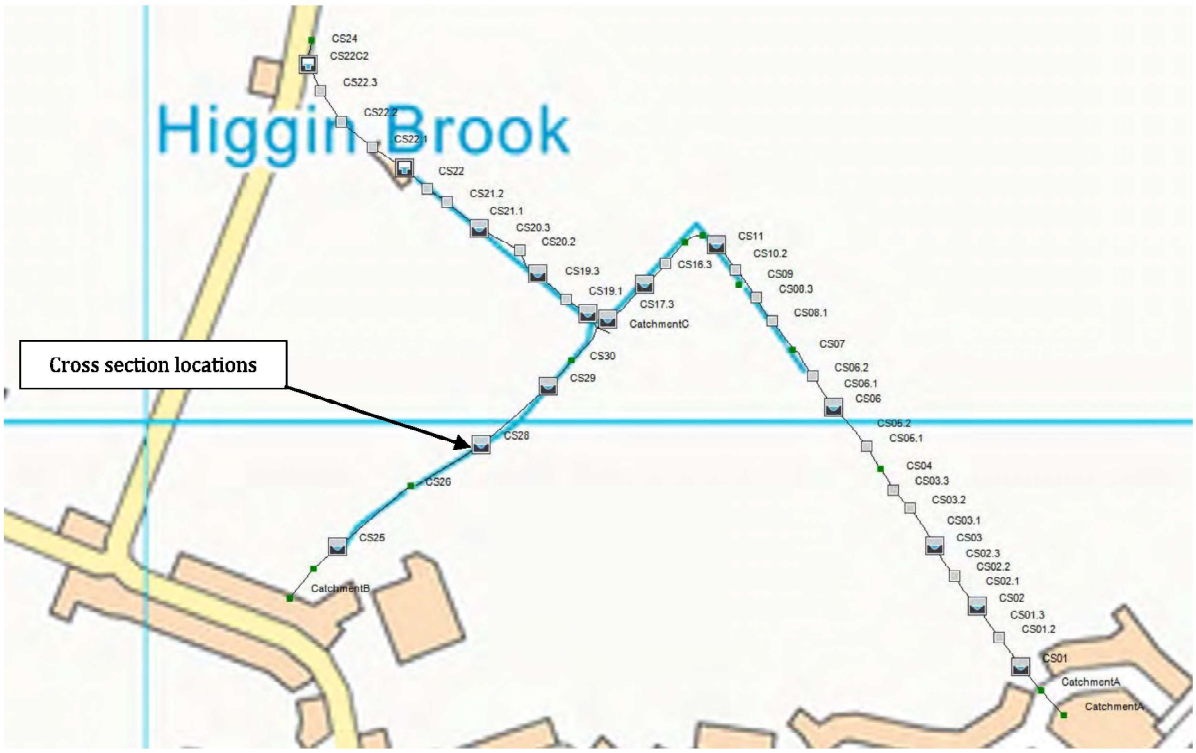

Figure 4: ISIS Model Schematic

5.4 Roughness coefficient allocation was based on aerial imagery. The watercourse channel is straight with some vegetation and as such the channel was assigned a roughness Manning's n value of 0.04 (refer to photographs in Appendix H).

5.5 There are seven structures within the modelled reach of the watercourse:

- 4 no. 300mm diameter pipes;
- 1 no. 525mm diameter pipe;
- 1 no. 575mm diameter pipe;

- 1 no. 600mm diameter pipe.

5.6 Overtopping of the bridges has been modelled in 1-D using a spill unit.

Model Assumptions

5.7 The cross sections were generated from a 3D ground model and so the profile of the channel may not be as true as if cross sections had been specifically surveyed. In some cases, the top water level on the date of the survey may have been used as the bed level. This approach is, however, conservative.

5.8 The diameters of pipes at cross sections 4, 9 and 15 have been assumed to be 300mm due to surveyed information not being available.

Model Results

Existing Scenario

5.7 The hydraulic modelling results including longitudinal profile and cross sections (including peak water levels) are included in Appendix E. Peak water levels for the 20%, 3.3%, 1% AEP and 1% AEP plus climate change events for the existing scenario are shown in Table 3.

5.8 The results show that water levels remain in bank for most of the reach in all AEPs. The peak water level is out of bank at the inlet to the 600mm diameter culvert.

Proposed Scenario

5.9 A 600mm diameter pipe, approximately 26m long, was inserted upstream of cross section number 26 to simulate a proposed crossing. The location of the new crossing is shown in Figure 5.

5.10 The hydraulic modelling results including longitudinal profiles and cross sections (including peak water levels) are included in Appendix F. Peak water levels for the 20%, 3.3%, 1% AEP and 1% AEP plus climate change events for the existing scenario are shown in Table 4.

5.11 Comparison of the existing and post development levels in the 1% AEP plus climate change event shows that peak levels remain largely unchanged, although with some small increases in places. The largest increase is of 27mm at cross section 26/26A, upstream of the proposed new culvert. There is also an increase of 25mm at cross section 25. These increases are relatively small and do not increase flood risk or the likelihood of surcharging of surface water outfalls.

Sensitivity Testing

5.12 Sensitivity testing was carried out on certain key model parameters to determine the effects on the simulated flows and water levels due to controlled changes in accordance with best practice.

5.15 The flow rate was increased by 20% and Manning's n values (channel roughness) were increased and decreased by 20%. These were all undertaken on the 1% AEP flow event (refer to Appendix G for the full sensitivity analysis results).

5.16 The increase in Manning's roughness coefficient, n, resulted in a mean increase in level of 0.022m and a maximum increase of 0.043m, occurring at cross section CS32 at the confluence of sub-catchments A and B. Reducing roughness coefficient by 20% had the effect of maximum decrease in water level of 0.057m. The mean effect was to reduce peak water levels by 0.021m.

5.17 Increasing flow by 20% resulted in a mean increase in peak water level of 0.073m and a maximum of 0.323m occurring at cross section CS07.

5.19 The sensitivity analysis has shown that water levels are not particularly sensitive to changes in channel roughness, with all mean and maximum changes within +/- 0.057m. When the 1% flow was increased by 20%, there were some isolated relatively large increases in water level, the maximum being 0.323m. The mean change was 0.073m and the change throughout most of the modelled reach was less than 0.100m.

5.20 The sensitivity due to these parameters should be taken into account when setting design levels.

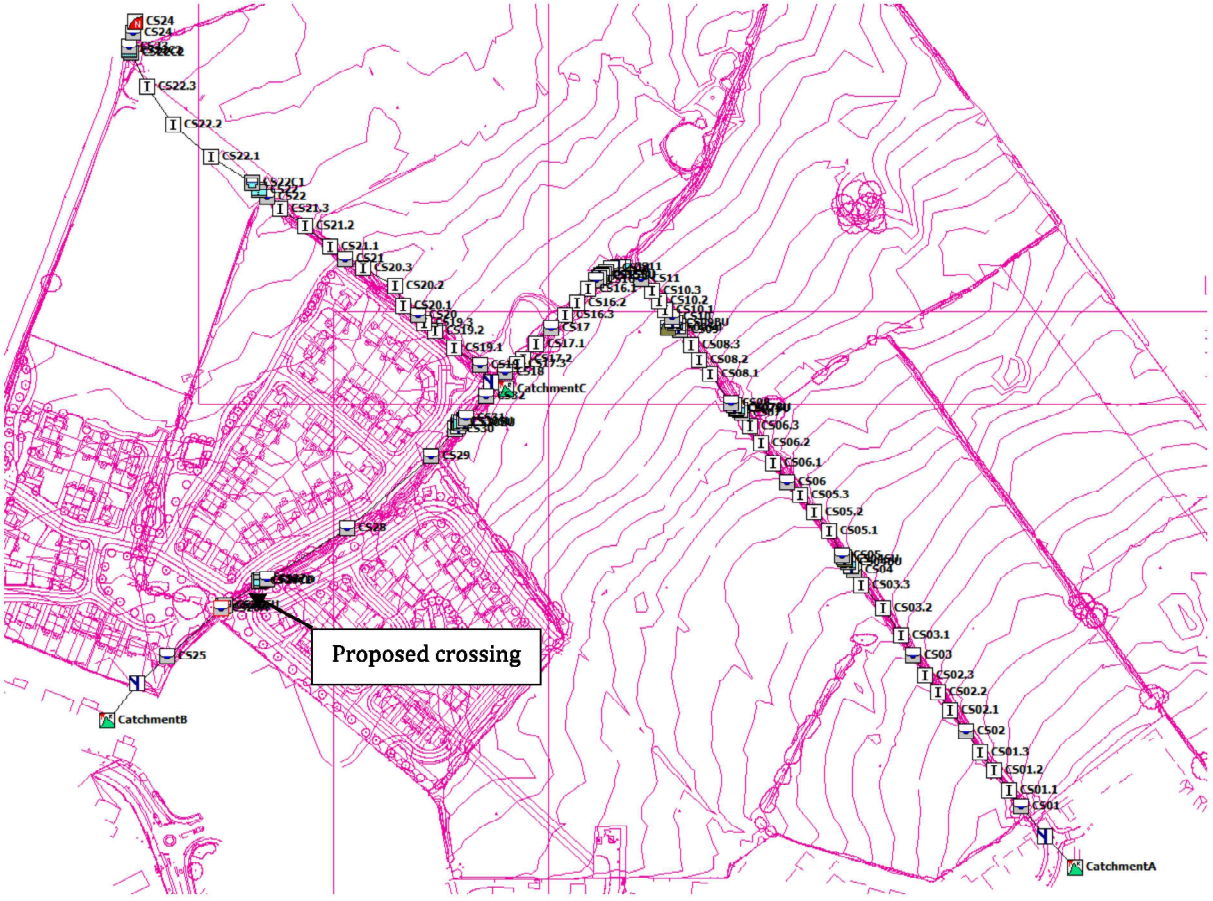

Figure 5: Proposed ISIS model schematic with new crossing

Cross Section	20% AEP (mAOD)	3.3% AEP (mAOD)	1% AEP level (mAOD)	0.1% AEP level (mAOD)
CS01	115.96	116.02	116.06	116.10
CS02	114.79	114.85	114.89	114.92
CS03	113.39	113.45	113.51	113.53
CS04	112.38	112.66	112.88	112.92
CS05	111.36	111.40	111.44	111.47
CS06	109.89	109.92	109.97	110.00
CS07	108.37	108.65	109.08	109.40
CS08	107.86	107.91	107.95	107.97
CS09	107.26	107.51	107.59	107.62
CS10	106.88	106.92	106.97	106.99
CS11	106.39	106.44	106.49	106.51
CS14	105.60	105.85	106.15	106.23
CS15	105.58	105.84	106.15	106.23
CS16	105.14	105.19	105.22	105.25
CS17	103.91	103.92	103.94	103.95
CS18	103.40	103.45	103.50	103.52
CS19	103.40	103.45	103.50	103.52
CS20	102.81	102.88	102.93	103.14
CS21	102.52	102.63	102.84	103.14
CS22	102.40	102.58	102.83	103.14
CS23	101.30	101.39	101.44	101.45
CS24	101.22	101.31	101.35	101.36
CS25	105.85	105.93	106.03	106.13
CS26	105.61	105.76	105.91	106.06
CS27	105.09	105.19	105.27	105.31
CS28	104.81	104.85	104.89	104.92
CS29	104.14	104.23	104.34	104.40
CS30	103.99	104.14	104.27	104.35
CS31	103.63	103.72	103.81	103.85
CS32	103.40	103.45	103.50	103.52

Table 3: Peak 20%, 3.3%, 1% and 0.1% AEP existing water levels

Cross Section	20% AEP (mAOD)	3.3% AEP (mAOD)	1% AEP level (mAOD)	0.1% AEP level (mAOD)
CS01	115.96	116.02	116.06	116.10
CS02	114.79	114.85	114.89	114.92
CS03	113.39	113.45	113.51	113.53
CS04	112.38	112.66	112.88	112.92
CS05	111.35	111.40	111.45	111.47
CS06	109.89	109.92	109.97	110.00
CS07	108.37	108.65	109.08	109.40
CS08	107.86	107.91	107.95	107.97
CS09	107.26	107.50	107.59	107.62
CS10	106.88	106.92	106.97	106.99
CS11	106.39	106.44	106.49	106.51
CS14	105.60	105.85	106.15	106.23
CS15	105.58	105.84	106.15	106.23
CS16	105.14	105.19	105.22	105.25
CS17	103.91	103.92	103.94	103.95
CS18	103.40	103.45	103.50	103.53
CS19	103.40	103.45	103.50	103.53
CS20	102.81	102.88	102.93	103.15
CS21	102.52	102.63	102.84	103.14
CS22	102.41	102.58	102.83	103.14
CS23	101.30	101.39	101.44	101.45
CS24	101.22	101.31	101.35	101.36
CS25	105.86	105.95	106.06	106.15
CS26A	105.67	105.81	105.97	106.09
CS27	105.09	105.19	105.28	105.31
CS28	104.81	104.85	104.89	104.92
CS29	104.14	104.24	104.34	104.41
CS30	103.99	104.14	104.28	104.36
CS31	103.63	103.72	103.81	103.86
CS32	103.40	103.45	103.50	103.53

Table 4: Peak 20%, 3.3%, 1% and 0.1% AEP proposed water levels

6.0 LOW FLOW ANALYSIS

6.1 In order to determine a typical water level above which to set the levels of the surface water outfalls, a low flow analysis was undertaken in accordance with the Institute of Hydrology Report number 108 (IH 108). The analysis included the soil HOST classification, the UK Hydrometric Register and the Flood Estimation Handbook (FEH) CD-ROM.

6.2 An extract from the soil HOST maps is shown in Figure 6, indicating that the soil classification for the catchment is 711m.

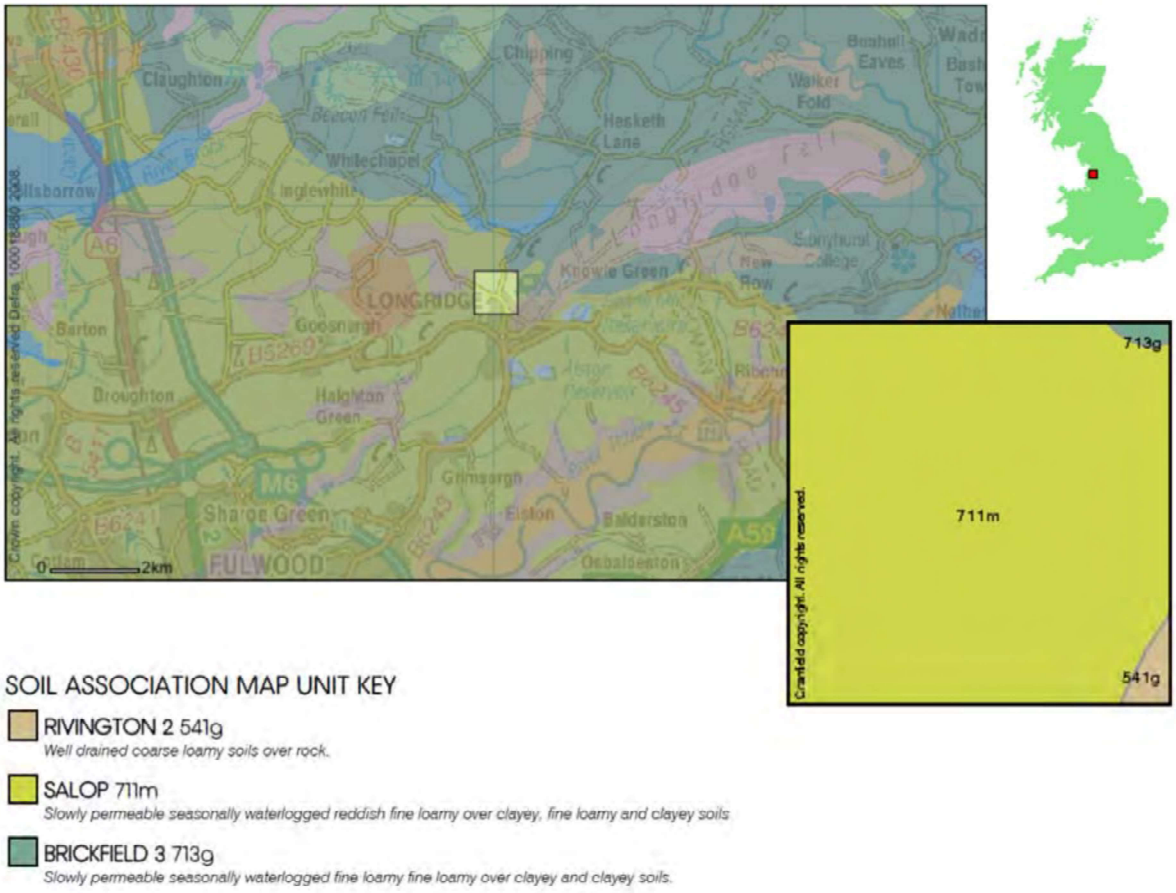

Figure 6: Soil HOST map classification

6.3 The FEH CD-ROM gives the Catchment Area = 0.52km² and standard average annual rainfall, SAAR = 1200mm. The FEH catchment is shown in Figure 7.

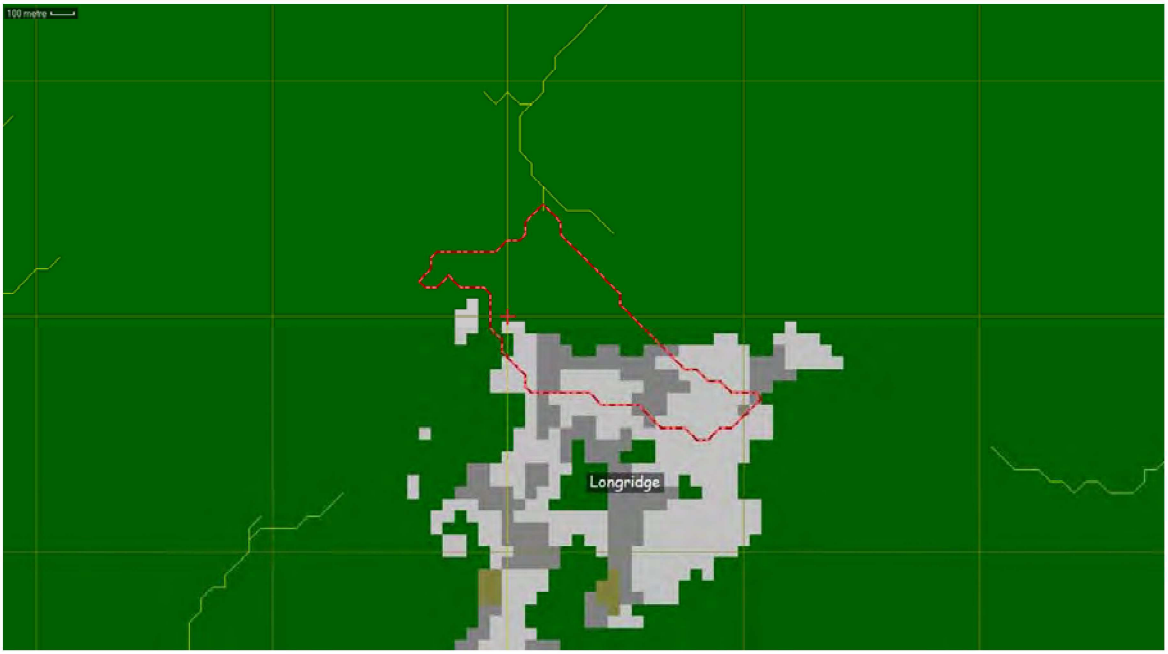

Figure 7: FEH CD-ROM catchment

6.4 From UK Hydrometric Register River Hodder @ Hodder Place (Station Number 71008):

Potential evaporation, PE = 600mm

6.5 From Institute of Hydrology (IH) report 108, section 7.3.2:

Annual Average Runoff Depth (AARD) = SAAR – Losses
Losses = r x PE where r=1 for SAAR>= 850mm

AARD = 1200 – 600
AARD = 600mm

Convert AARD to Mean Flow (MF)

MF = AARD x AREA x (3.17×10^{-5})
MF = $600 \times 0.52 \times 3.17 \times 10^{-5}$
MF = 0.0099 m^3/s

6.6 From IH 108 Appendix 4

Soil type 711m gives the 95 percentile 1-day flow, Q95(1), of 10.7% of mean flow, therefore

Q95(1) = MF x 10.7/100
Q95(1) = 0.0011 m^3/s