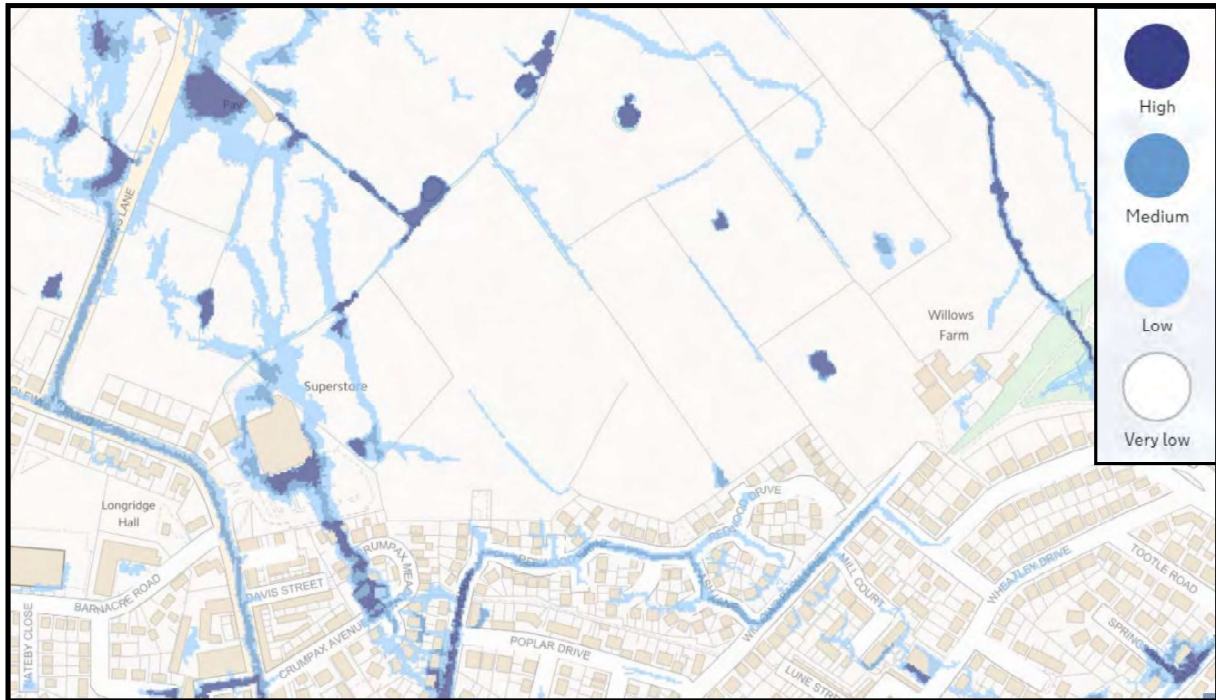
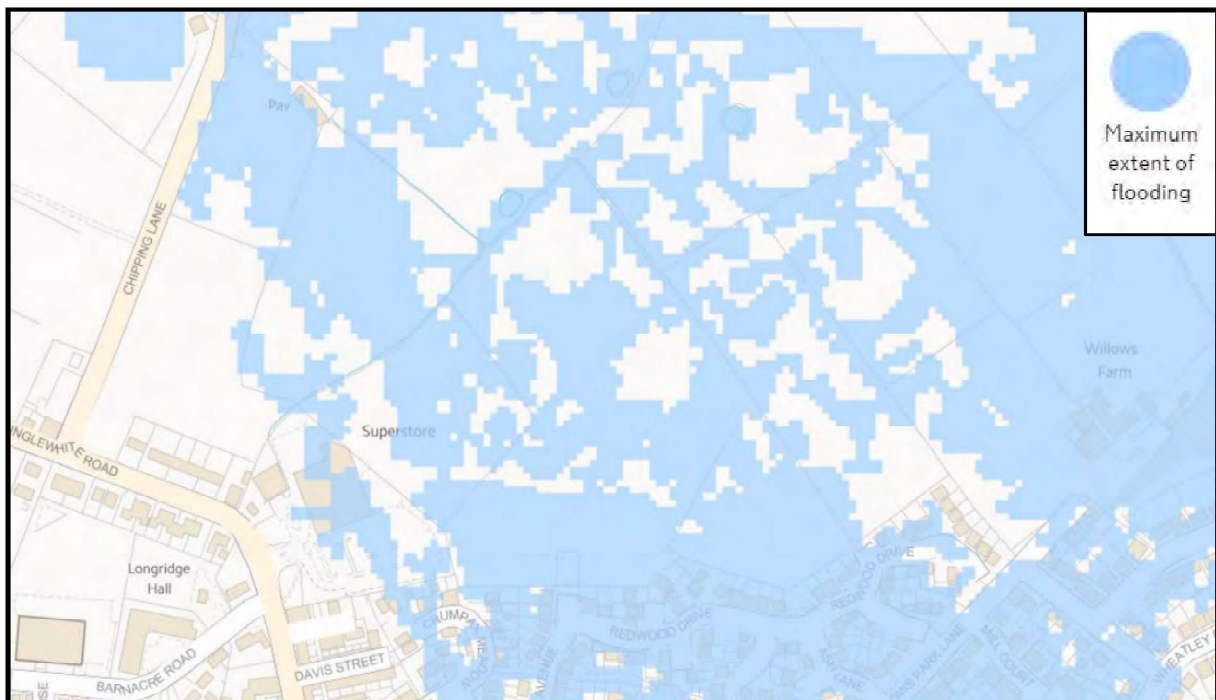


Long Term Flood Risk – Surface Water



Long Term Flood Risk - Reservoirs



Megan Berry

From: CMBLNC Info Requests <Inforequests.cmbLnc@environment-agency.gov.uk>
Sent: 31 October 2018 11:41
To: Megan Berry
Subject: CL104827HR

Dear Megan

Enquiry regarding product 4 data for Chippings Lane, Longridge.

Thank you for your enquiry received today.

We respond under the Freedom of Information Act 2000 and Environment Regulations 2004.

The area you are looking at does not fall in a flood zone, as such we have no data to provide.

Please get in touch if you have any further queries or contact us within 2 months if you would like us to review the information we have sent.

Kind regards.

Helen Reynolds
Customers and Engagement Officer, Cumbria and Lancashire
Environment Agency | Ghyll Mount, Gillan Way, Penrith 40 Business Park, Penrith, Cumbria, CA11 9BP



I'm a friend of the Environment Agency LGBT+ network because I want to encourage a friendly open workplace where everyone can be themselves.



Got a question or want to talk to someone about mental health?

Drop us an [email](#) or join the conversation on our 'Mental Health Support' Yammer Group. Our Wellbeing Supporters can provide a listening ear from someone with a shared experience. To find out more e-mail the Mental Health Network.

HELP employee assistance – <https://hereto.helpeap.com>

From: Megan Berry [mailto:meganberry@betts-associates.co.uk]
Sent: 31 October 2018 11:22

To: CMBLNC Info Requests <Inforequests.cmblnc@environment-agency.gov.uk>
Subject: Historical Flood Information - Product 4

F.A.O Flood Risk, Drainage and/or Planning department

Please forward to the correct department/ office

To whom it may concern,

Chippings Lane, Longridge

Please could you confirm whether you have any information that you feel would be valuable to a Flood Risk Assessment and Drainage Management Strategy for the site above (see location plan attached), including details of historical flooding, predicted flood water levels and current drainage issues; this would be greatly appreciated. If there are any specific requirements that you require in a scope of works for this site please can you advise at this stage so that it can be fully incorporated into the proposals at an early stage.

Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Megan Berry BSc(Hons) GradCIWEM
Graduate Flood Risk Analyst

BETTS HYDRO
Specialists in Drainage and Flood Risk
Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY

CHESTER OFFICE - 01244 289041

meganberry@betts-associates.co.uk
www.betts-associates.co.uk

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APPENDIX C: UU CORRESPONDENCE

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Megan Berry

From: Dodd, Matthew <Matthew.Dodd@uuplc.co.uk>
Sent: 14 November 2018 15:34
To: Megan Berry
Cc: Wastewater Developer Services
Subject: RE: Historical Sewer Flooding Information - GE1835

Good Afternoon

I can confirm that we have no current records of sewer flooding on our DG5 register within the vicinity of the proposed development. The DG5 register is a register of properties that have flooded as a result of hydraulic inadequacy of the public sewer network.

Please note that United Utilities Water Limited (Uuw) can only record and check flooding events which are reported to us and we have to comply with our Regulators instructions on the qualification of flooding events to place on the register.

Our response does not include:

- any sewer flooding events caused by blockages or collapses which are the result of third party actions, natural events or other actions over which Uuw has no control and not a facet of sewer capacity; or
- any historical sewer flooding events that have been removed from the register as a result of investment in our infrastructure.

As with all development sites, we recommend you liaise with our water and wastewater engineers by contacting our Developer Services team so the details of your development proposal can be considered further. Details can be found at the following link.

<https://www.unitedutilities.com/services/builders-developers/>

Should you require any further information please do not hesitate to contact me.

Kind regards

Matthew Dodd
Assistant Developer Engineer
Developer Services and Planning
Network Delivery
United Utilities
T: 01925 679369 (internal 79369)
unitedutilities.com

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From: Megan Berry [mailto:meganberry@betts-associates.co.uk]
Sent: 31 October 2018 11:23
To: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Subject: Historical Sewer Flooding Information

F.A.O Flood Risk, Drainage and/or Planning department

Please forward to the correct department/ office

To whom it may concern,

Chippings Lane, Longridge

Please could you confirm whether you have any information that you feel would be valuable to a Flood Risk Assessment and Drainage Management Strategy for the site above (see location plan attached), including details of historical flooding, predicted flood water levels and current drainage issues; this would be greatly appreciated. If there are any specific requirements that you require in a scope of works for this site please can you advise at this stage so that it can be fully incorporated into the proposals at an early stage.

Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Megan Berry BSc(Hons) GradCIWEM
Graduate Flood Risk Analyst

BETTS HYDRO
Specialists in Drainage and Flood Risk
Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
CHESTER OFFICE - 01244 289041

meganberry@betts-associates.co.uk
www.betts-associates.co.uk

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United Utilities Group PLC, Haweswater House, Lingley Mere
Business Park, Lingley Green Avenue, Great Sankey,

Megan Berry

From: Tucker, Sophie <Sophie.Tucker@uuplc.co.uk>
Sent: 10 February 2017 09:36
To: Doyle, Corinne
Cc: SewerAdoptions
Subject: *Ext: HOUSING DEVELOPMENT, CHIPPING LANE, LONGRIDGE, RIBBLE VALLEY – UU Ref 4200014205
Attachments: Pre-start form with Invoice.docx; mg_info.txt
Importance: High
Follow Up Flag: Follow up
Flag Status: Flagged

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Dear Corinne,

HOUSING DEVELOPMENT, CHIPPING LANE, LONGRIDGE, RIBBLE VALLEY – UU Ref 4200014205

I refer to your correspondence dated **8th February 2017** and to the plans enclosed therewith, and would inform you that your submission is now satisfactory for incorporating into a Water Industry Act 1991, Section 104 Agreement, providing that the works can be constructed in full accordance with the acceptable drawings numbered as follows:-.

Drainage Layout – 459/ED/02 Rev L

1 in 20 Manholes Details – 459/ED/05 Rev B, 459/ED/09 Rev B, 459/ED/26 Rev C, 459/ED/16 (Flow control)

Long Sections – 459/ED/10 Rev E, 459/ED/11 Rev E, 459/ED/13 Rev B

A3 Land Transfer Plan – 459/ED/01/S104-2

A3 Site Plan - 459/ED/01/S104 Rev D

United Utilities Standard Construction Details (available for download via the following link

<http://www.unitedutilities.com/documents/developer-services-construction-details.pdf>)

(Please note that the following drawings appear to be acceptable, however any works completed to the Pumping Station or Rising Main until the full M&E design is confirmed in writing to be Technically Accepted would be completed at risk. Pumping Station Designers submission now received and request for service to complete a review with UU M&E has been raised).

Pumping Station Civils - 459/ED/15 Rev E

Rising Main Long Section - 459/ED/27 Rev C

To enable the Section 104 Agreement to be completed and inspections to start on site, I would be grateful if you could now provide me with the following:

- **Cheque/payment** for the remainder of the S104 fees **£25,384.00**
- Sign and return the enclosed “Request for approval to commence construction of sewers before signing of agreement form”

Full details of this arrangement are in our ‘Developers Guide’ document a copy of which should already have been provided.

The Developer or his contractor is responsible for verifying all existing service positions and levels on site, including those of the existing public sewerage system, before work commences.

Any costs associated with service diversions required to enable the scheme to be carried in accordance with the acceptable drawings must be borne by the developer.

Where connections are to be made to existing public sewer manholes, the costs for rebuilding the manhole to United Utilities requirements, if deemed necessary by United Utilities, must be borne by the developer. If the works cannot be constructed in accordance with the acceptable plans, the developer must submit revised proposals for appraisal before continuing with the works.

The developer must also obtain specific permission to construct any new manhole or make any connections to the public sewerage system. Please visit our web-site where you will find the S106 Sewer Connection Application form. The form is in two parts but only the second part is required for this scheme which is called '**Request for permission to work on a public sewer**' application form, which the appointed contractor must complete and return to the address on the form. Here is the link to the form: <http://www.unitedutilities.com/connecting-public-sewer.aspx>

I look forward to receiving the drawings and information requested above at your earliest convenience, but should you require any further information in the meantime, please do not hesitate to contact me.

Regards,
Sophie

Sophie Tucker

Developer Engineer for Adoptions

Developer Services and Planning

Operational Services

United Utilities

T: 01925 679357 (internal 79357)

E: seweradoptions@uuplc.co.uk

unitedutilities.com



Barratt Manchester
 4 Brindley Rd
 City Park
 Manchester
 M16 9HQ

Job No	459
Date	25.10.16
Designer	CD

Pumping Station Storage Calculations

Project **Chipping Lane, Longridge - Pump Station with Online Storage Pipe**

Designed to Sewer for Adoption 6th Edition

Input

No. of Dwellings = Units
 Max. starts/hour =
 Wet Well Diameter = m
 Lowest Drag Out IL m

Incoming Flow

Incoming flow = (4000L/dwelling/day) = **23.75 L/s**

Estimate depth of stop/start storage required

Maximum No. of Starts/hour = **15.0**
 Duration of Incoming Flow = **4.00 mins**
 Volume of Incoming Flow /Cycle = **5.700 m³**
 Cross-sectional area of wet well = **7.069 m³**
 Depth of storage between starts = **0.806 m**
 Minimum height between start and stop levels = **806 mm**
 Set height between start/stop levels (duty start) to **850 mm**

Check number of starts/hour

Volume of storage = **6.008 m³**
 Time between starts = **4.22 mins**
 Number of starts/hour = **14.2**

say 14 starts/hour

The number of starts is less than permissible, therefore OK





Barratt Manchester
4 Brindley Rd
City Park
Manchester
M16 9HQ

Job No	459
Date	25.10.16
Designer	CD

Pumping Station Storage Calculations

Project **Chipping Lane, Longridge - Pump Station with Online Storage Pipe**

Volume & Depth of Emergency Storage required

Storage volume required based on 160L/dwelling = 82.08 m³

Storage of Pipes Foul system upstream of wet well = 35.30 m³

Length of 150dia pipe=	275.39
Length of 225dia pipe=	98.15
Length of 750dia pipe=	60.06

Manhole	F31	F32
Invert Lvl	102.524	102.12
Dia	1200	1200
Volume	0.708	1.165

Manhole	F29	F34	F30	F15	F16	F17	F18
Invert Lvl	102.017	102.581	101.918	101.688	101.585	101.503	101.373
Dia	1200	1200	1200	1350	1350	1200	1500
Volume	1.281	0.644	1.393	2.093	2.240	1.863	3.140

Manhole	F36	F37	F38	F39	F43	F19	Wet Well (HL alarm)
Invert Lvl	103.029	102.770	102.390	101.800	101.723	101.302	100.765
Dia	1200	1200	1350	1200	2100	2400	3000
Volume	0.137	0.430	1.088	1.527	4.943	8.360	16.858
Total							47.2

Total Volume provided = 82.46 m³

The total storage provided is greater than storage required therefore OK

Sum of dists upto HL Alarm= 1.350

Sump level of wet well = 99.415

Cover level of wet well = 105.80

Depth of wet well = 6.385



Megan Berry

From: Megan Berry
Sent: 20 November 2018 11:08
To: 'Wastewater Developer Services'
Subject: UU Pre-Development Enquiry - Land off Chipping Lane, Longridge
Attachments: HYD371 Surface Water Run-off Calcs.pdf; Preliminary Drainage Situation for UU .pdf; UU-Wastewater_predevelopment_enquiry.pdf; LOCATION PLAN.pdf

UU PREDEVELOPMENT ENQUIRY. Pro-forma attached.

To Whom It May Concern,

We are currently preparing a Flood Risk Management Assessment and Drainage Management Strategy to support a residential planning application on land off Chipping Lane in Longridge. As part of the preparation, a drainage management strategy has been devised and at this stage we are seeking to begin discussions with UU with regards to the proposed foul water: attached is the pre-application advice form with supporting information as required.

Surface Water: The primary method of discharging surface water in accordance with the national drainage hierarchy should ideally be through infiltration; however Soakaway Testing has been recommended to confirm onsite characteristics. Assuming infiltration does not work on the site, the next approach would be to discharge to the nearest watercourse which has been located crossing site (see drainage strategy attached). Detailed design will be required and full consents to be obtained as the application progresses.

Foul Water: Foul water flows generated by the development are proposed to connect to nearest the public foul water sewer. Review of the UU sewer records identify there to be a foul water pumping station onsite adjacent to the southern boundary. This pumping station has been accounted for within the planning proposals and a public foul water sewer (375mm.dia) associated with the pumping station has been identified onsite adjacent to the southern boundary. Due to the existing land-use onsite, no existing foul water connections to the public sewer network are present. Based on the proposals for the construction of up to 184no. residential units for Phase 2 & 3, the approximate peak foul water flows generated by the development are 8.5l/s. This is based on 4000 litres per dwelling per 24 hours; the guidance contained within Sewers for Adoption (SfA).

Phase 1 has a separate drainage management strategy as detailed in the approved supporting FRA&DMS (REF: 3/2014/0764), which shows foul from this portion of development will outfall into the foul water system located within Inglewhite Road to the south-east of Phase 1. The proposals are therefore to connect into the nearest public foul water sewer onsite adjacent to the southern boundary or divert flows from Phase 2 & 3 towards the pumping station within Phase 1, subject to confirmation of capacity within this existing infrastructure, which ultimately connects into the public sewer network within Inglewhite Road. Detailed design will be required to confirm feasibility based on the topographic levels following further detailed investigation. At this stage however it is understood that a pumped solution may be required based on the existing topographic levels onsite.

We are ultimately seeking to identify United Utilities preferred points of connection(s) and to confirm any constraints. It is acknowledged that considerable offsite work will likely be required to achieve connection to the public sewer network. Hopefully the summary above and the attached are of assistance and allow agreement in principle to be given, do not hesitate to contact me on the details below should you require any further assistance.

Kind Regards

Megan Berry BSc(Hons) GradCIWEM
Graduate Flood Risk Analyst

BETTS HYDRO
Specialists in Drainage and Flood Risk
Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY

APPENDIX D: LPA/LLFA CORRESPONDENCE

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Megan Berry

From: Freedom of Information <CSSGFreedom@lancashire.gov.uk>
Sent: 02 November 2018 15:15
To: Megan Berry
Subject: Request for Information (945.1747)PH Acknowledgement

Dear Ms Berry

Request for Information Under the Freedom of Information Act (2000) We are writing to acknowledge receipt of your enquiry of 31st October 2018, in which you request the disclosure of information. We can confirm that your enquiry will now be assigned to an officer who will commence a search for the information you require and they will respond in due course. The deadline date for issuing you with a full response is 28th November 2018. We will endeavour to provide a response well in advance of this date, however, should we envisage any delays, or require more details from you, we will contact you immediately.

If you have any queries about the above, please do not hesitate to contact us, quoting ref. 945.1747.

Yours sincerely,

On Behalf of the Information Governance Team Lancashire County Council PO Box 78 County Hall Preston
PR1 8XJ

From: Suds
Sent: 02 November 2018 10:29
To: Freedom of Information <CSSGFreedom@lancashire.gov.uk>
Subject: Historical Flood Information - Freedom of Information

Good morning,

Please see below a request for flooding information under the Freedom of Information Act.

We will start investigating the query but will await your response before we reply. I have logged the query on HAMS under CRNo136238 but have had to log it as Chipping Road as Chipping Lane is not showing on HAMS.

Regards

Helen Lord
Flood Risk Technical Support Officer
Community Services
Lancashire County Council
T: 01772 536275
W: www.lancashire.gov.uk

From: Megan Berry [<mailto:meganberry@betts-associates.co.uk>]
Sent: 31 October 2018 11:22
To: Suds <suds@lancashire.gov.uk>
Subject: Historical Flood Information - Freedom of Information

F.A.O Flood Risk, Drainage and/or Planning department

Please forward to the correct department/ office

To whom it may concern,

Chippings Lane, Longridge

Please could you confirm whether you have any information that you feel would be valuable to a Flood Risk Assessment and Drainage Management Strategy for the site above (see location plan attached), including details of historical flooding, predicted flood water levels and current drainage issues; this would be greatly appreciated. If there are any specific requirements that you require in a scope of works for this site please can you advise at this stage so that it can be fully incorporated into the proposals at an early stage.

Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Megan Berry BSc(Hons) GradCIWEM
Graduate Flood Risk Analyst

BETTS HYDRO
Specialists in Drainage and Flood Risk
Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
CHESTER OFFICE - 01244 289041
meganberry@betts-associates.co.uk
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Megan Berry

From: Megan Berry
Sent: 31 October 2018 11:22
To: 'contact@ribblevalley.gov.uk'
Subject: Historical Flooding Information - Freedom of Information
Attachments: LOCATION PLAN.pdf

F.A.O Flood Risk, Drainage and/or Planning department

Please forward to the correct department/ office

To whom it may concern,

Chippings Lane, Longridge

Please could you confirm whether you have any information that you feel would be valuable to a Flood Risk Assessment and Drainage Management Strategy for the site above (see location plan attached), including details of historical flooding, predicted flood water levels and current drainage issues; this would be greatly appreciated. If there are any specific requirements that you require in a scope of works for this site please can you advise at this stage so that it can be fully incorporated into the proposals at an early stage.

Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Megan Berry BSc(Hons) GradCIWEM
Graduate Flood Risk Analyst

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meganberry@betts-associates.co.uk
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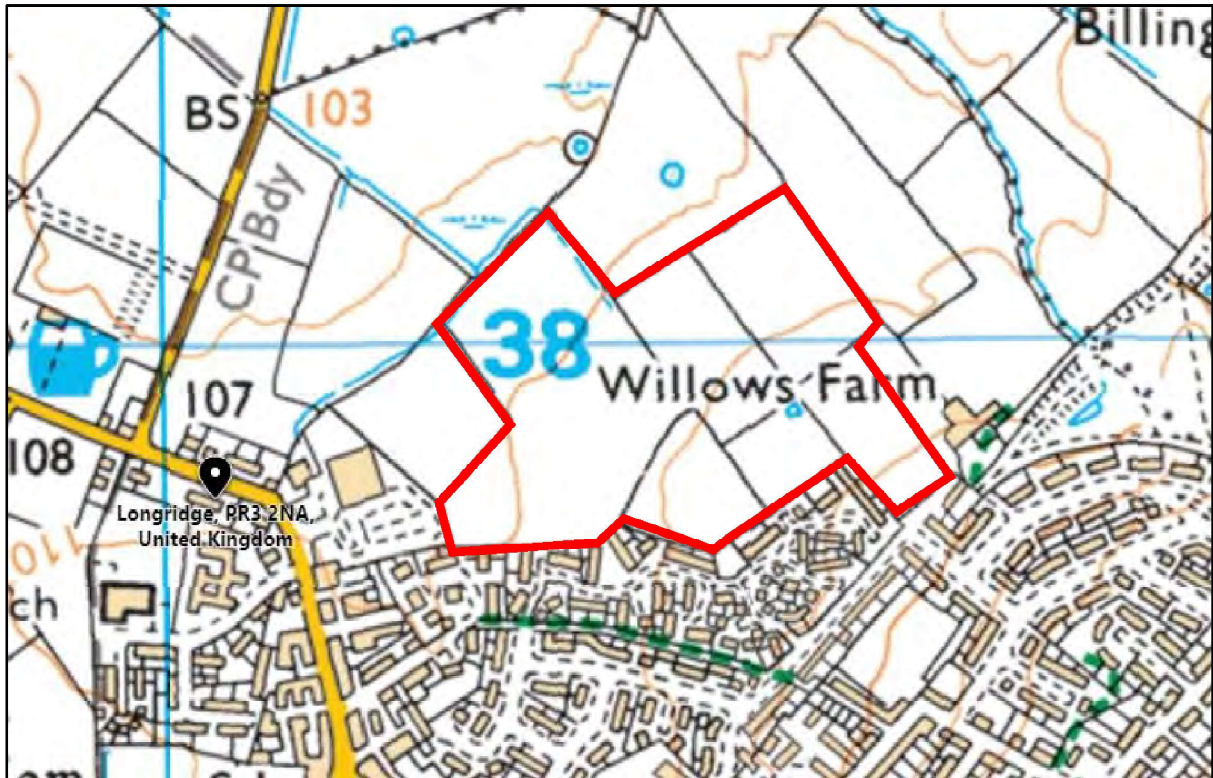
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APPENDIX E: LOCATION PLAN

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LOCATION PLAN

Chipping Lane, Longridge



OS X (Eastings)	360405
OS Y (Northings)	437794
Nearest Post Code	PR3 3HB
Lat (WGS84)	N53:50:06 (53.834883)
Long (WGS84)	W2:36:11 (-2.603137)
Lat, Long	53.834883, -2.603137
Nat Grid	SD604377 / SD6040537794
mX	-289779
mY	7104425

APPENDIX F: TOPOGRAPHIC SURVEY

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APPENDIX G: PROPOSED PLANNING LAYOUT

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SCHEDULE OF ACCOMMODATIONS

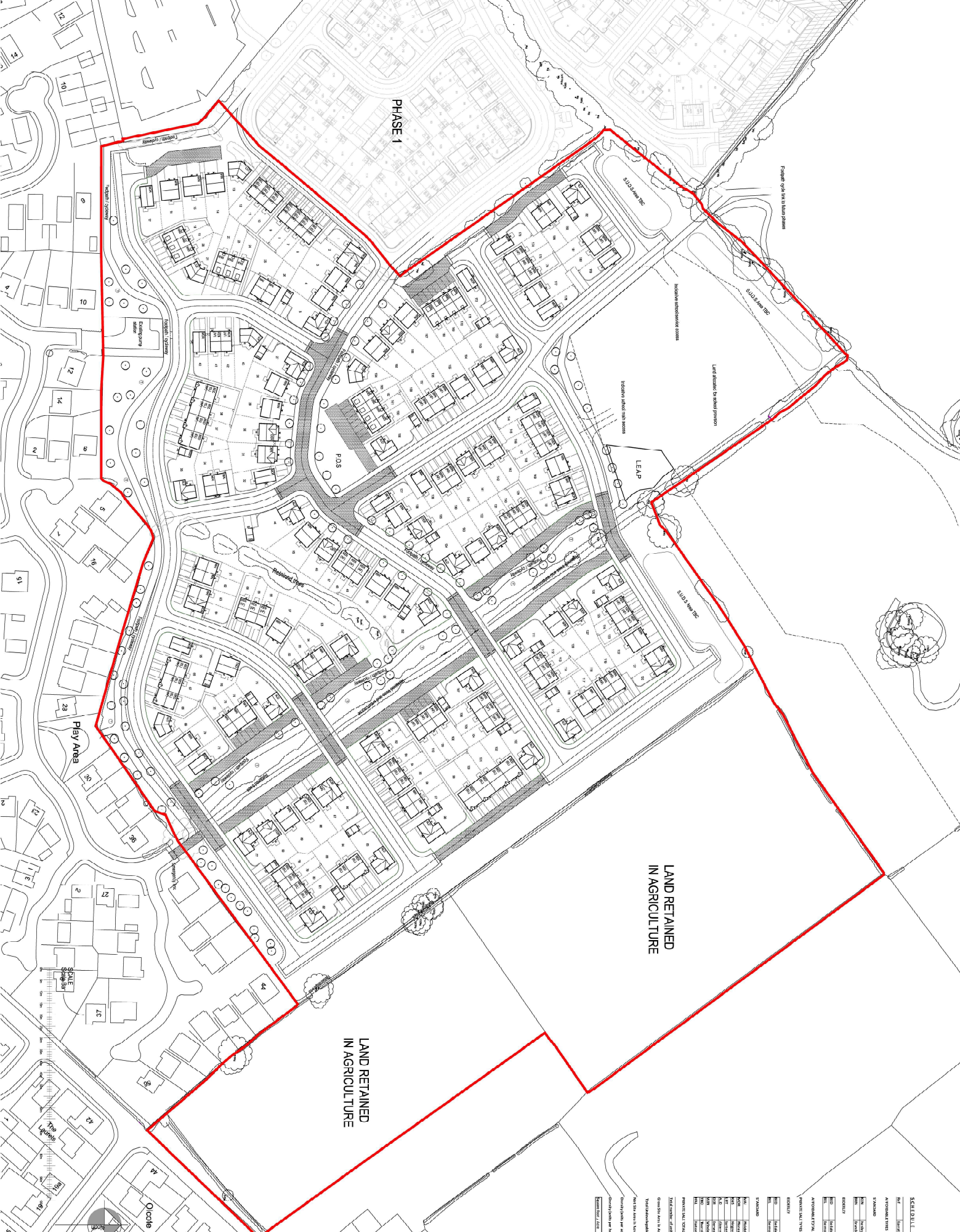
UNIT	APPROX. TYPE	NO. OF UNITS	NO. OF BEDS	NO. OF BATHS
STANDARD	Standard	100	200	100
DELUXE	Deluxe	50	100	50
APPROXIMATE TOTAL		150	300	150

NO.	DESCRIPTION	UNIT	NO.	NO.
1	Standard	100	200	100
2	Deluxe	50	100	50
3	APPROXIMATE TOTAL	150	300	150

PHASE 1

LAND RETAINED IN AGRICULTURE

LAND RETAINED IN AGRICULTURE



LEGEND

- JOINTLINE
- (M) APPROXIMATE DIMENSIONS
- (M) OPENING FOR THE EGRESS
- PROPOSED SIGN TOWER
- TREE/EDGE TO BE REMOVED
- TREE/EDGE TO BE RETAINED
- BLOCK PAVING (RED)
- REPAVED PAVEMENT
- TREE PLANTING
- EXISTING TREE/EDGE

BARRATT LONES MANCHESTER

1000 S. 1000 E. SUITE 1000
 DENVER, CO 80202
 (303) 733-1000

CORNWALL

1000 S. 1000 E. SUITE 1000
 DENVER, CO 80202
 (303) 733-1000

SCALE

1" = 100'

DATE

10/15/2023

PROJECT NO.

2023-001

APPENDIX H: HYDRAULIC ASSESSMENT

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**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 by

[Redacted]
Director

Revision History:

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



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Head Office Betts Associates Ltd

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

www.betts-associates.co.uk

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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.

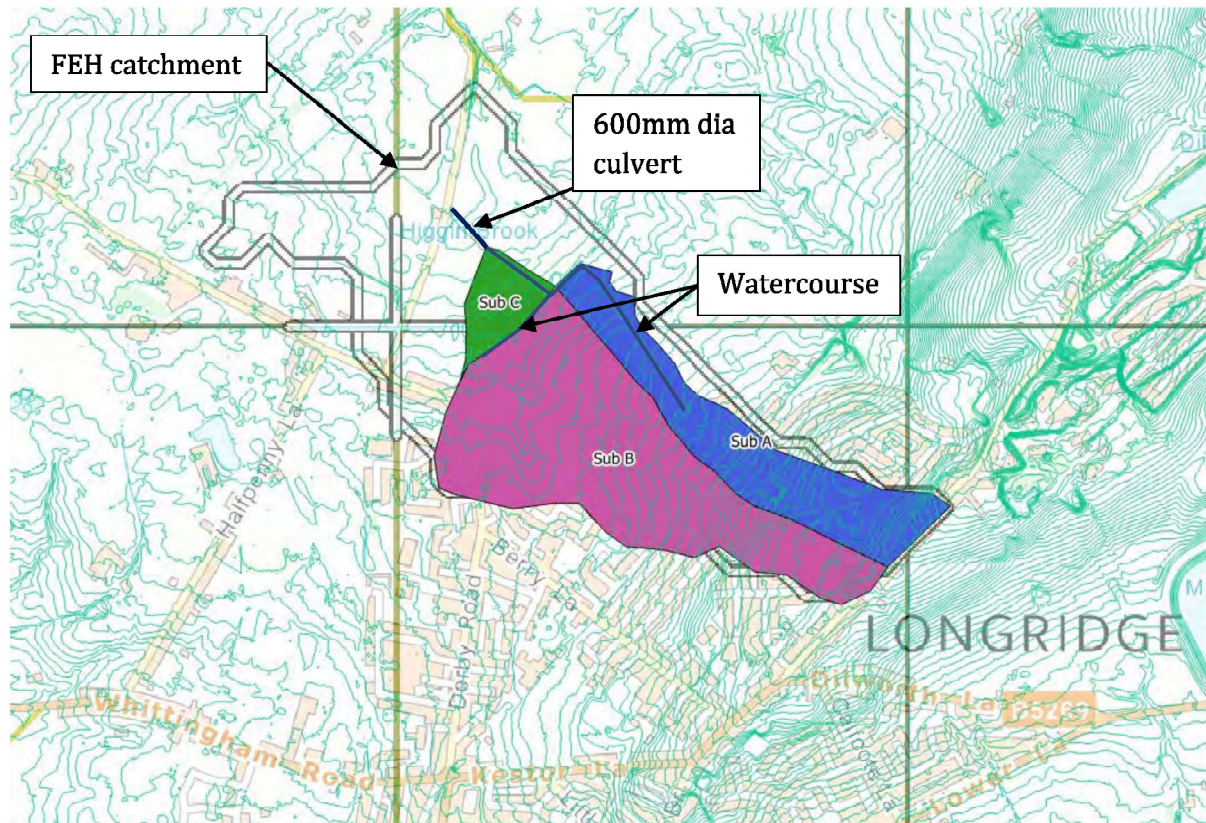


Figure 3: Upstream Sub-catchments

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.

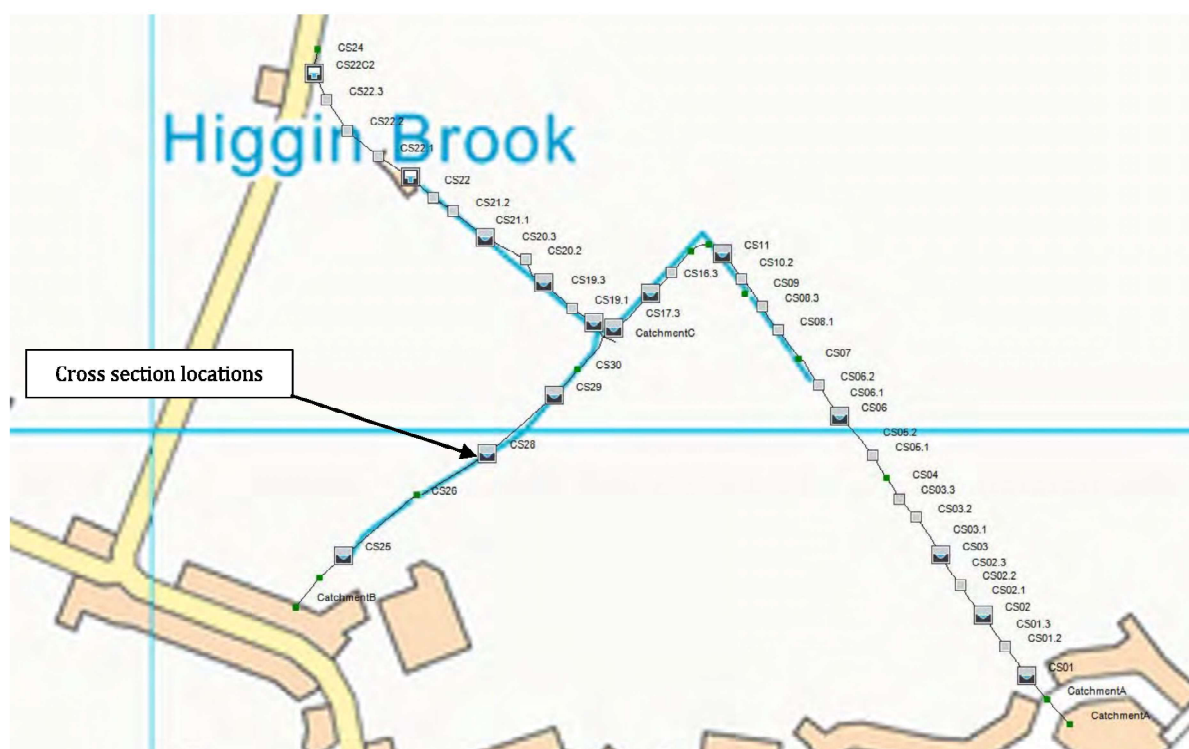


Figure 4: ISIS Model Schematic

- 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.

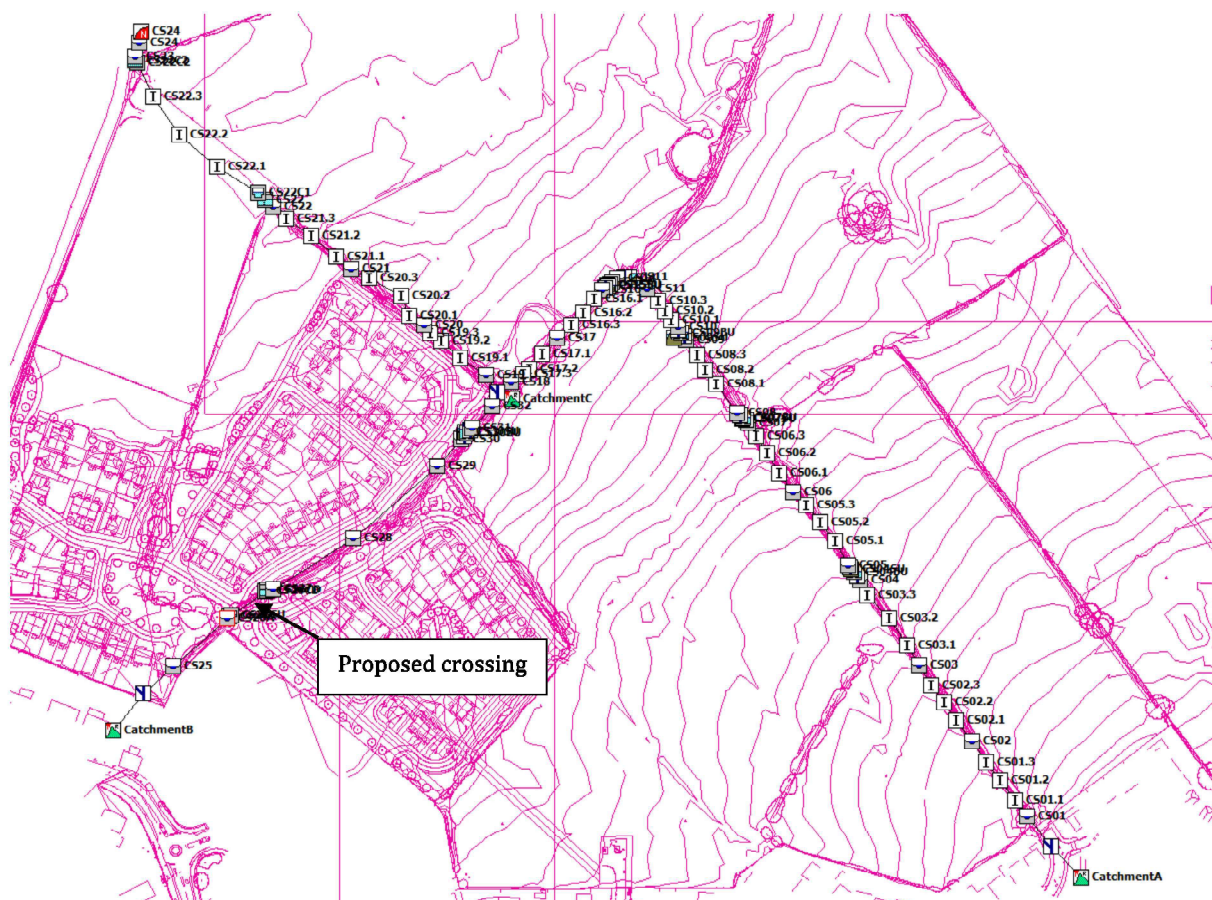


Figure 5: Proposed ISIS model schematic with new crossing

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