Northern Gateway (JPA1.1)

Outline Planning Application

Flood Risk Assessment

NORTHERN GATEWAY

April 2025

Northern Gateway, JPA1.1

784-B048805

Flood Risk Assessment

P03

Northern Gateway Development Vehicle LLP

March 2025

Document prepared on behalf of Tetra Tech Limited. Registered in England number: 01959704

TETRA TECH

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Document:	Flood Risk Assessment
Project:	Northern Gateway, JPA1.1
Client:	Northern Gateway Development Vehicle LLP
Project number:	784-B048805
File origin:	\\lds-dc-vm-101\Data\Projects\784-B048805_Northern_Gateway_2023\60 Project Output\61 Work in Progress\Flood\05 Flood Risk Assessment\JPA1.1\4. P03 Mar 25\784-B048805_Northern_Gateway_JPA1.1_FRA_P03.docx

Revision:	P01	**Prepared by:**	TK
Date:	December 2024	**Checked by:**	LS / EL
Status:	First Issue	**Approved by:**	FH
Description of revision:	First Issue		

Revision:	P02	**Prepared by:**	TH
Date:	January 2025	**Checked by:**	EL
Status:	Second Issue	**Approved by:**	FH
Description of revision:	Update following Turleys comments.		

Revision:	P03	**Prepared by:**	TH
Date:	March 2025	**Checked by:**	FH
Status:	Third Issue	**Approved by:**	FH
Description of revision:	Update following hydraulic modelling updates and Turleys comments.		

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Acronyms/Abbreviations

Acronyms/Abbreviations	Definition
AEP	Annual Exceedance Probability
BBC	Bury Borough Council
BGS	British Geological Survey
DTM	Digital Terrain Model
EA	Environment Agency
FRA	Flood Risk Assessment
GMCA	Greater Manchester Combined Authority
LFRMS	Local Flood Risk Management Strategy
m AOD	Meters Above Ordnance Datum
MAGIC	Multi-Agency Geographic Information for the Countryside
MSA	Motorway Services Area
NPPF	National Planning Policy Framework
OS	Ordnance Survey
PPG	Planning Practice Guidance
RMBC	Rochdale Metropolitan Borough Council
SFRA	Strategic Flood Risk Assessment
SPZ	Source Protection Zone
SuDS	Sustainable Drainage Systems
UDP	Unitary Development Plan
UU	United Utilities

Note On Flood Frequencies

The frequency of a flood can be quoted in terms of a return period, which is defined as the average time between years with at least one larger flood, or as an annual exceedance probability (AEP), which is the inverse of the return period.

Return periods can be expressed more succinctly than AEP. However, AEP can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval.

The following table is provided to enable quick conversion between return periods and annual exceedance probabilities..

AEP (%)	50	20	10	5	3.33	2	1.33	1	0.5	0.1
AEP	0.5	0.2	0.1	0.05	0.033	0.02	0.013	0.01	0.005	0.001
Return Period (1 in X)	2	5	10	20	30	50	75	100	200	1000

1.0 INTRODUCTION

1.1 Purpose of this Report

1.1.1 Tetra Tech Ltd has been commissioned by Northern Gateway Development Vehicle LLP (the 'Applicant') to prepare a Flood Risk Assessment (FRA) to support the cross-boundary application for outline planning permission (all matters reserved) ('the Application') for a national-scale employment development, including logistics, warehousing, industrial and manufacturing uses, with a range of other supporting ancillary uses and associated demolition works, landscaping, drainage, ecological enhancements, highway works, cycleway and footpath linkages and other ancillary infrastructure ('the Proposed Scheme'). The Application is submitted to Bury Council and Rochdale Borough Council (collectively 'the Councils').

1.1.2 The report has been prepared for the stated purpose only and relates only to land extending to 209.83 hectares (ha), shown in Appendix A, situated north of Manchester, located north of the M62, Heywood, M25 2RS (the 'application site').

1.2 Requirement for this Report

1.2.1 According to the Environment Agency (EA) Flood Risk Mapping, the application site is shown to be located partially within Flood Zone 2 and 3, which corresponds with the Brightley Brook and Whittle Brook 'Main River'. In addition, the application site is greater than 1 hectare (ha) in size, therefore an FRA is required to support the application.

1.3 Scope of the Report

1.3.1 The FRA will consider all potential sources of flood risk including 'Main Rivers', 'Ordinary Watercourses', surface water and overland flow routes, sea, groundwater, sewers, and reservoirs. It will identify the level of risk and, where necessary, propose mitigation to manage flood risk.

1.3.2 The assessment will be undertaken in accordance with the National Planning Policy Framework (NPPF) (Chapter 14), Planning Practice Guidance (PPG) (Flood Risk and

Coastal Change), Environment Agency (EA) guidance and Rochdale Metropolitan Borough Council (RMBC) and Bury Borough Council (BBC) local flood risk policy and documents.

1.4 Limitations of this Report.

1.4.1 This report has been prepared by Tetra Tech Ltd on behalf of the Applicant in connection with the scope of the report as described in Section 1.3 above and taking into account the particular instructions and requirements set out in Tetra Tech's fee proposal and the Applicant's acceptance. It is not intended for and should not be relied on by any third party and no responsibility is undertaken to any third party.

1.4.2 Tetra Tech Ltd accepts no duty or responsibility (including in negligence) to any party other than the client and disclaims all liability of any nature whatsoever to any such party in respect of this report.

1.4.3 This report cannot be reproduced without Tetra Tech's written consent.

2.0 Existing Site

2.1 Site location

2.1.1 The application site is located to the north of the M62, Heywood. The nearest post code is M24 2SH and the application site's central grid reference is SD 83751 08271. The application site is 209.83 ha. A location plan is shown in Figure 2-1.

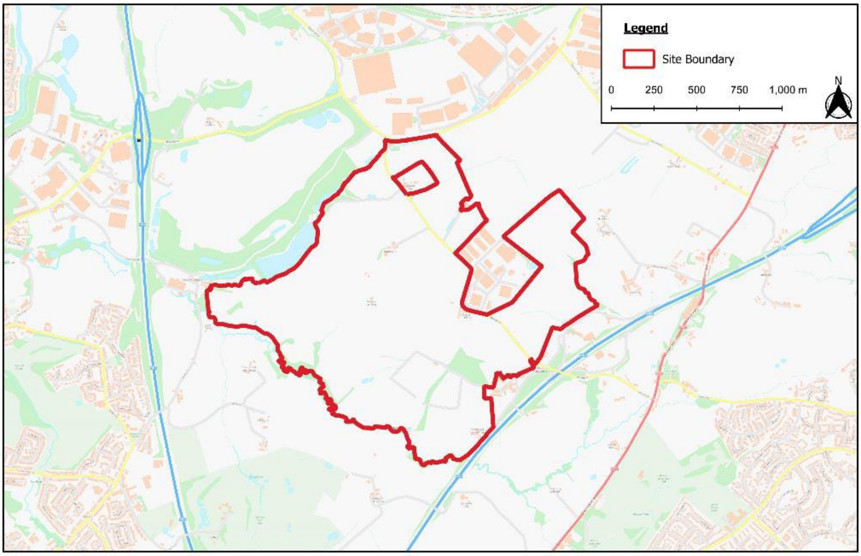

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Figure 2-1: Proposed Scheme Boundary

2.2 Site Description

2.2.1 The application site is split into 6 greenfield plots of land (Plot A – F). The plots are shown in the Outline Application Parameters Plan in Appendix A.

2.2.2 Plot D is bounded by Moss Hall Road to the east and is bounded by Brightley Brook to the north and Whittle Brook to the west.

2.2.3 Plots A, B and C are located to the north of the boundary and Plots E and F to the east.

2.2.4 Birch Industrial Park is located within the centre of the application site but is not part of the Application site.

2.2.5 The application site is situated adjacent to:

- The Heywood Industrial Estate to the north;
- The Whittle Brook Park housing development to the northeast, approved as per planning application 16/01399/HYBR and 22/00787/REM to the north east and under construction at time of writing;
- Agriculture land to the east;
- The M62 and Birch Service Station to the south and southeast;
- Greenfield agriculture land to the south west; and
- The Pilsworth South Landfill former quarry to the north west.

2.2.6 Vehicular and pedestrian access to the application site is provided:

- From the north via Pilsworth Road and Moss Hall road; and
- From south via the M62 Motorway and Whittle Lane

2.2.7 A site walkover was carried out in May 2024 by Tetra Tech.

2.3 Site Topography

2.3.1 A review of the 1 m resolution EA LiDAR Digital terrain Model (DTM) (refer to Figure 2-2 below) has been undertaken to establish ground levels within proximity to the application site. Ground levels in the vicinity of the application site are shown to generally slope down towards the southwest of the application site.

2.3.2 Site levels can be generally described as follows:

- The ground levels at the application site slope down from the Birch Industrial Estate from approximately 130 m Above Ordnance Datum (AOD) to 115 m AOD and 80 m AOD in the east and west respectively.
- The ground levels around the centre of the application site and Birch Industrial Estate ranges from approximately 110 - 130 m AOD;
- The ground levels in the southeast of the application site range from 110 m - 120 m AOD;
- The ground levels in the southwest of the application site range from 80 m - 100 m AOD;

- The ground levels in the northwest of the application site range from 95 m - 110 m AOD;
- The application site is bordered by the Heybrook Estate to the northeast with levels typically between 110 m – 120 m AOD;
- The application site is bordered by M62 in the south and southeast with levels typically around 100 m AOD;
- The application site is bordered by the Whittle Brook and agriculture land to the south west with levels typically between 95 m - 110 m AOD; and
- The ground levels along the Brightley Brook on the northern and north-western perimeter of the application site range between 90 m – 110 m AOD.

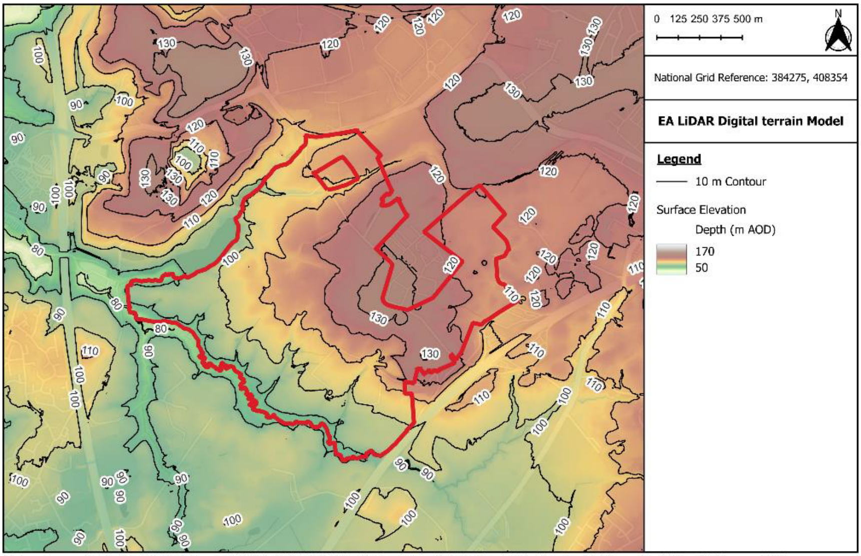

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Figure 2-2: EA Composite LIDAR 1M-DTM

2.4 Hydrological Setting

2.4.1 A review of Ordnance Survey (OS) mapping indicates the following watercourses located within or within close proximity of the application site:

- The Whittle Brook is classified as an EA Main River. The Whittle Brook flows in a south-westerly direction outside of the application site where it confluences with an unnamed tributary and Mere Brook before running in a north-westerly direction through Plot D of the application site;

- The Castle Brook forms a confluence with the Whittle Brook outside of the western border of Plot D. The Castle Brook is classified as an EA Main River and flows in a northerly direction;
- The Brightley Brook bounds the north of the application site along Plot A, B and D, flowing in a westerly direction. Pilsworth Clough which flows through the north-eastern part of the application site confluences with Brightley Brook within Plot B. The Brightley Brook and Pilsworth Clough are classified as EA Main Rivers;
- Whittle Brook and Brightley Brook confluence just outside of the application site, to the northwest of Plot D, to form Hollins Brook which is hydrologically linked to the River Roch to the west of the application site.

2.4.2 These watercourses can be seen in Figure 2-3 below.

2.4.3 There are a few ponds within the application site, including in the north close to the Pilsworth Clough watercourse, adjacent to Plot B.

2.4.4 There is a reservoir associated with the Pilsworth South landfill former quarry bounding Plot D to the north.

2.4.5 There are no canals located within the vicinity of the application site.

2.4.6 Within the application site there are small linear water features that form tributaries of the Whittle Brook. Their existing purpose is understood to be for drainage of the agricultural land.

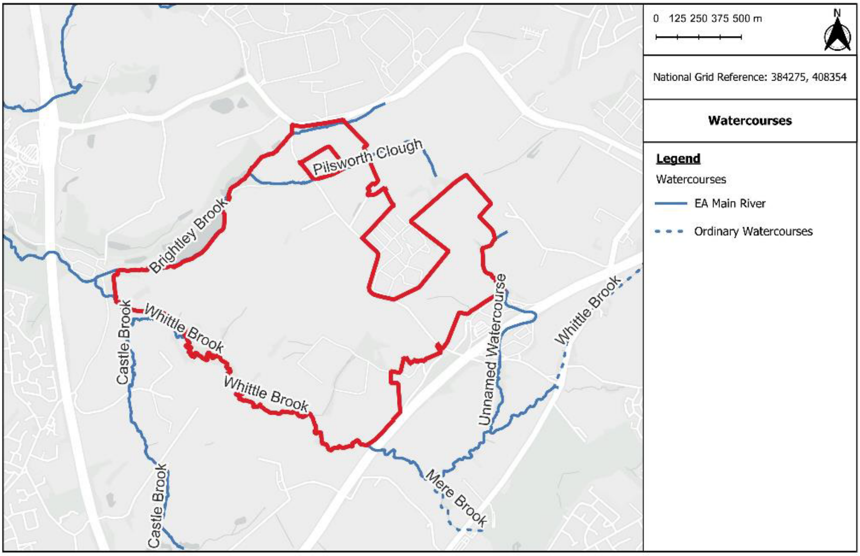
0 125 250 375 500 m
N
National Grid Reference: 384275, 408354
Watercourses
Legend
Watercourses
EA Main River
Ordinary Watercourses
Pilsworth Clough
Brightley Brook
Castle Brook
Whittle Brook
Whittle Brook
Castle Brook
Unnamed Watercourse
Whittle Brook
Mere Brook

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Figure 2-3: Watercourses

2.5 Existing Drainage

On-Site Drainage

2.5.1 There are no public sewers within the application site.

2.5.2 Based on the nature of the existing application site largely as agriculture fields, the site walkover and topographic data showing the presence of drainage ditches suggest that there is informal agricultural drainage infrastructure serving these areas of the application site. Therefore, it is understood that surface water runoff generated within much of the existing site currently discharges to the nearby watercourses predominantly via the drainage channels and overland flows. In general, ground conditions do not appear to be favourable to infiltration.

Off-Site Drainage

2.5.3 Birch Business Park is assumed to have on-site foul treatment which discharges to site ditches. Existing foul and potable water connections service the existing Birch Business Park and farm buildings within the application site.

2.5.4 Public sewer records obtained from United Utilities (UU) (included as Appendix B) indicates the following sewers within the vicinity of the application site:

- A 225 mm diameter public surface water sewer is shown to be located approximately 800 m north of the application site beneath Pilsworth Road. The sewer is shown to flow in a westerly direction; and
- A 225 mm diameter public combined sewer is shown to be located approximately 800 m northwest of the application site beneath Pilsworth Road. The sewer is shown to flow in a westerly direction.

2.5.5 It is also anticipated that there is highway drainage within the M62 and the Motorway Services Area (MSA) to the south of the application site.

2.6 Hydrogeological Setting

Soils

2.6.1 A review of Defra's online Multi Agency Geographic Information for the Countryside (MAGIC) website[1] mapping indicates that the underlying soils are classified as naturally wet very acid sandy and loamy soils in northern and eastern areas of the application site, and as slowly permeable seasonally wet acid loamy and clayey soils in central, southern and western areas of the site. Areas in the south of Plot D and E are shown to be underlain by freely draining slightly acid sandy soils.

Geology

2.6.2 A review of the British Geological Survey (BGS)[2] online geological mapping (1:50,000 scale) indicates the application site is underlain by varied superficial deposits including:

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[1] https://magic.defra.gov.uk/MagicMap.aspx

[2] British Geological Survey (2019), Geology of Britain Viewer, https://geologyviewer.bgs.ac.uk/?_ga=2.182714982.1561700490.1700054154-1558315947.1700054154

- Head which is described as comprising clay, silt and gravel aligned with Pilsworth Clough, Brightley Brook and Whittle Brook;
- Lacustrine deposits which are described as comprising sand and gravel within most of Plot F and a small area of Plot E;
- Glaciofluvial ice contact deposits, Devensian which is described as comprising sand and gravel within areas of Plot C, D and E;
- Till, Devensian described as comprising Diamitcon within the majority of the application site.

2.6.3 The application site is shown to be further underlain varied bedrock deposits including:

- Pennine Lowe Coal Measures which are described as comprising mudstone, siltstone and sandstone across almost the entire application site;
- Wood Head Hill Rock which is described as comprising sandstone in a small area of Plot A and B;
- Rough Rock which is described as comprising sandstone in a small area of Plot A and B.

2.6.4 Numerous BGS boreholes[3] are located within the application site. Boreholes in the western, northern and central areas of the application site largely record the presence of clays to depths of 5.5 m – 6.5 m below ground level (BGL). Boreholes in the south and east of the application site record the presence of sands to depths of 1.5 m – 9.5 m BGL, with clays beneath this in places.

Hydrogeology

2.6.5 A review of Defra's online 'MAGIC' website indicates that superficial geology beneath central areas of the application site is classified as a Secondary A aquifer. These comprise permeable layers that can support local water supplies and may form an important source of base flow to rivers.

2.6.6 Superficial geology beneath the rest of the application site is classified as a Secondary Undifferentiated aquifer. These are aquifers where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value.

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[3] https://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSBoreholes&_ga=2.88422937.327605059.1659948635-943071664.1659948635

2.6.7 The application site is further underlain by bedrock deposits which are classified as Secondary A. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

2.6.8 Ground investigations are scheduled to be undertaken by Tetra Tech to establish the groundwater conditions within the application site in Spring 2025. This will provide site-specific information for the plots on the groundwater levels.

Source Protection Zones (SPZ)

2.6.9 A review of DEFRA’s online ‘Magic’ mapping indicates that the application site is not located within a groundwater Source Protection Zone (SPZ).

3.0 FLOOD RISK

3.1 Fluvial & Tidal Flood Risk

3.1.1 A floodplain is the area that would naturally be affected by flooding if a river rises above its banks, or as a result of tidal inundation. In England, floodplains are divided into flood zones for planning purposes. These show the extent of the natural floodplain area at risk of inundation if there were no flood defences or certain other manmade structures and channel improvements. They are divided as follows:

- Flood Zone 1 is land having a less than 1 in 1,000 (0.1%) annual probability of fluvial or tidal flooding. The risk of flooding is low.
- Flood Zone 2 is land having between a 1 in 100 (1%) and 1 in 1,000 (0.1%) annual probability of fluvial flooding; or land having between a 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability of tidal flooding. The risk of flooding is medium.
- Flood Zone 3 is land having a 1 in 100 (1%) or greater annual probability of fluvial flooding; or land having a 1 in 200 (0.5%) or greater annual probability of tidal flooding. The risk of flooding is high.

3.1.2 The Environment Agency's Flood Map for Planning, included as Figure 3-1, indicates the application site is predominantly located within Flood Zone 1. The south-western and north-western borders are shown to be located in Flood Zone 2 and 3 as associated with the Whittle Brook and Brightley Brook respectively. Based on the extent of flooding and site location, the application site is not affected by tidal flood risk.

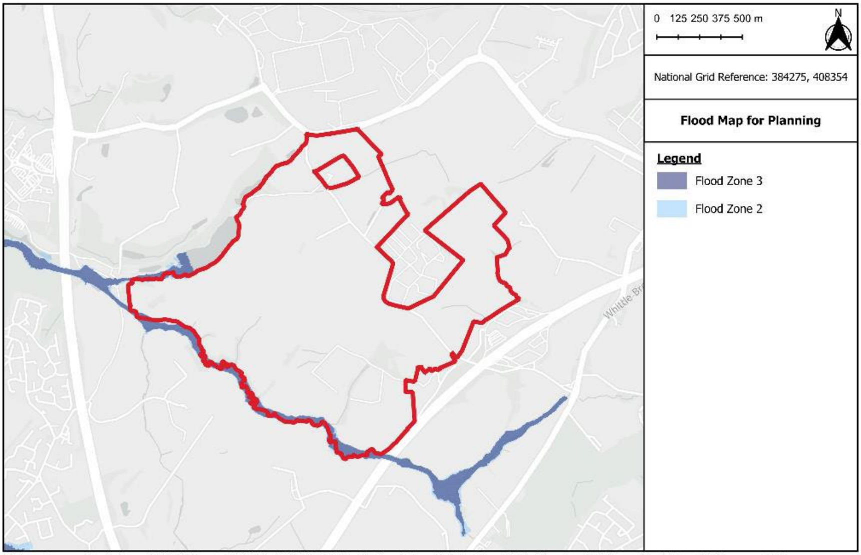

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Figure 3-1: Environment Agency’s Flood Map for Planning

Environment Agency Lower Roch Model 2011

3.1.3 Based on the extent of flooding within the application site, consultation has been undertaken with the EA to obtain modelled flood level data. Within their response, (dated March 2024) the EA provided flood data for a series of return periods derived from the Model output data for Lower Roch 2017.

3.1.4 In July 2021, the EA published updated climate change guidance which requires climate change allowances to be applied based on mapped Flood Zones, the nature and anticipated lifespan of development, and with consideration of the river management catchment in which the site is located.

3.1.5 According to the EA peak river flow map, the site is located within the Irwell Management Catchment. The EA climate change guidance requires ‘More Vulnerable’ development located in Flood Zone 3 to consider the central allowance for climate change. This equates to a 35% increase in peak river flows within the Irwell Management Catchment for the 2080s epoch which represents development with a design life up to the year 2115. No climate change guidance is currently available beyond this point.

3.1.6 The data provided by the EA is based on previous climate change guidance (published in 2017) and includes for the 25%, 35% and 70% climate change scenarios. For the purposes of this assessment, considering the latest guidance, the 1% AEP plus 35% climate change scenario has been considered.

3.1.7 A review of the modelled flood extents for the 1% AEP plus 35% climate change event (included as Figure 3-2) indicate that the application site is not impacted by flooding from the River Roch in this event.

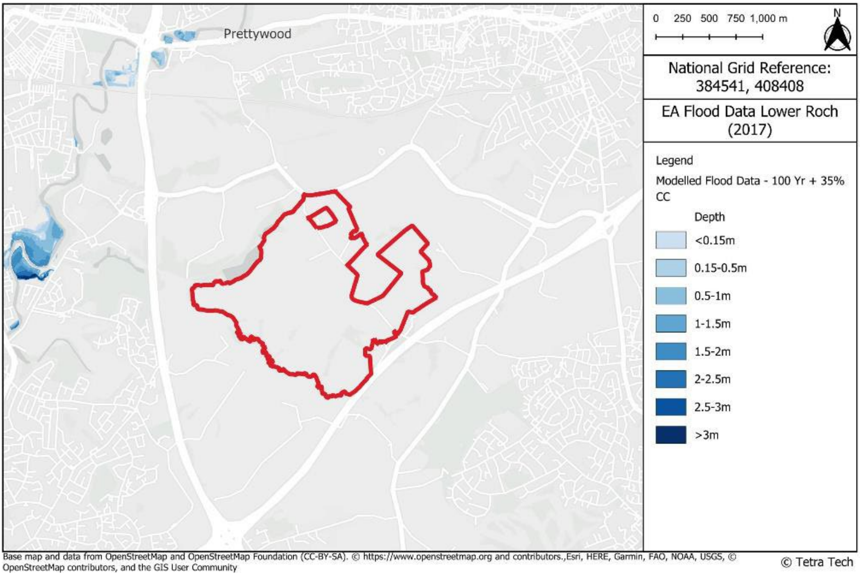
Prettywood
0 250 500 750 1,000 m
N
National Grid Reference:
384541, 408408
EA Flood Data Lower Roch
(2017)
Legend
Modelled Flood Data - 100 Yr + 35% CC
Depth
<0.15m
0.15-0.5m
0.5-1m
1-1.5m
1.5-2m
2-2.5m
2.5-3m
>3m
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Figure 3-2: 1% AEP plus 35% climate change flood extents

3.1.8 A review of EA Flood Modelled Data depicts that the modelling provided will not be sufficient for the assessment of fluvial flooding associated with the Castle brook, Whittle Brook and Brightley Brook. Therefore, additional site-specific flood modelling is required to assess the future climate change impacts.

Site Specific Hydraulic Modelling

3.1.9 Tetra Tech have undertaken site-specific modelling to support this application (784-B048805 Hydraulic Modelling Report JPA 1.1, Tetra Tech, October 2024) which can be seen in Appendix C. The study area covers an area that is larger than the application site, the extent of which can be seen within the report. Within this FRA the results of the model pertaining to the application site only will be discussed, discussion of modelling of the wider area can be found within the appended hydraulic report.

3.1.10 The model has been simulated for the 3.3%, 1%, and 0.1% AEP events, as well as the 1% and 0.1% AEP event with central 2080s climate change allowances of 35%. These depths and extents can be seen in Appendix D.

3.1.11 The baseline model results show reduced extents to those shown in the existing EA Flood Risk Map for Planning.

3.1.12 During a 1% AEP event in the present day, the flood extents within the application site follow the watercourse alignments of the Whittle Brook, Brightley Brook and the unnamed watercourse within Plot E. See Figure 3-3.

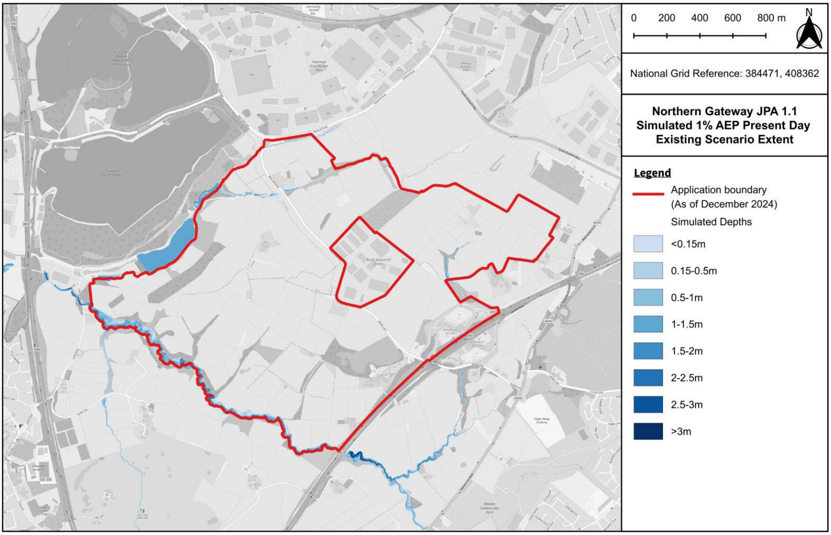
0
200
400
600
800 m
N
National Grid Reference: 384471, 408362
Northern Gateway JPA 1.1
Simulated 1% AEP Present Day
Existing Scenario Extent
Legend
Application boundary
(As of December 2024)
Simulated Depths
<0.15m
0.15-0.5m
0.5-1m
1-1.5m
1.5-2m
2-2.5m
2.5-3m
>3m

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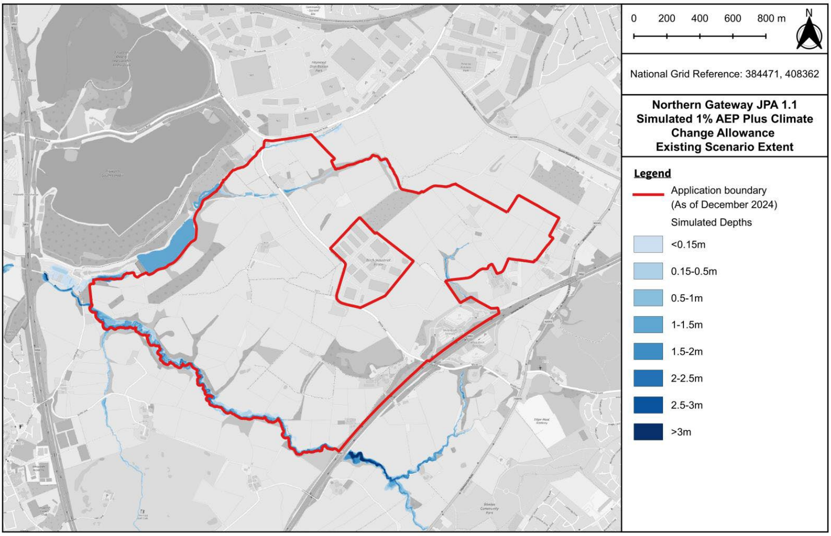
Figure 3-3: Flood depths and extent for 1% AEP present day event

3.1.13 Analysis of the 1% AEP plus 35% climate change allowance event shows more significant increases in depths and an increase in extents across the application site, as shown in Figure 3-4. However, the modelled flood extents are still predominantly located within the confines of the channel and floodplain.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Northern Gateway JPA 1.1
Simulated 1% AEP Plus Climate Change Allowance
Existing Scenario Extent
Legend
Application boundary (As of December 2024)
Simulated Depths
<0.15m
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0.5-1m
1-1.5m
1.5-2m
2-2.5m
2.5-3m
>3m

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Figure 3-4: Flood depths and extent for 1% AEP plus 35% climate change event

3.1.14 Based on the above, the overall risk of fluvial flooding to the application site is considered to be **high** within the floodplain as defined by the hydraulic model, but **low** for most of the application site. This risk of tidal flooding is considered to be **negligible** due to the inland nature of the application site.

3.2 Surface Water and Overland Flows

3.2.1 Surface water flooding can occur during high intensity rainfall events as sheet runoff from fields or hard paved areas. It is particularly prevalent in areas with significant hard standing or poorly permeable soils (i.e., clay). This is because the grounds capacity for infiltration is reduced. In addition, the inability to enter local drainage systems also contributes to risk from this source. The risk of surface water flooding is divided as follows, as defined by the EA:

- Very low risk means that the annual probability of flooding is less than 1 in 1,000 (<0.1%).
- Low risk means that the annual probability of flooding is between 1 in 1,000 (0.1%) and 1 in 100 (1%).

- Medium risk means that the annual probability of flooding is between 1 in 100 (1%) and 1 in 30 (3.3%).
- High risk means that the annual probability of flooding of greater than 1 in 30 (3.3%).

3.2.2 According to the Environment Agency's Surface Water Flood Map (Figure 3-5), the application site is shown to be at a predominantly very low risk of surface water flooding with localised areas of low to high risk identified across the application site, mostly aligned with the previously identified watercourses, topographical depressions and existing ponds and drainage ditches. These areas of pooling are common in but not confined to the east of the application site.

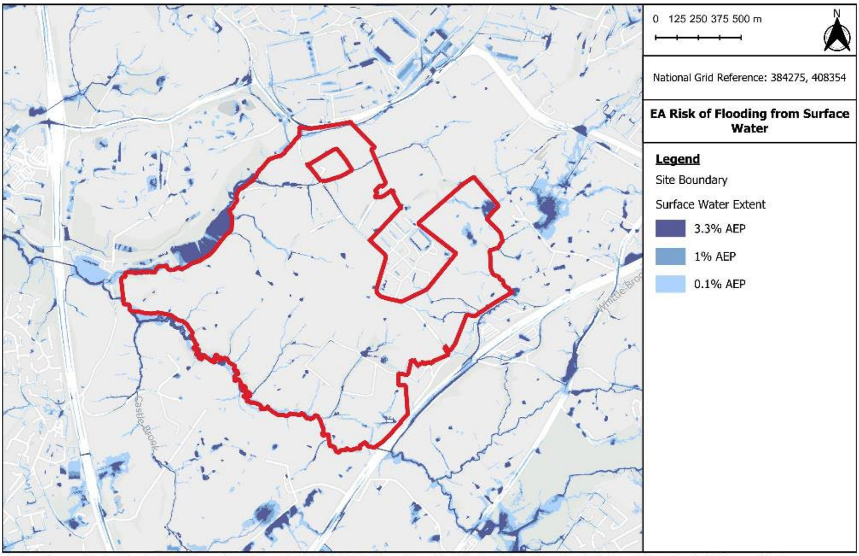
0 125 250 375 500 m
N
National Grid Reference: 384275, 408354
EA Risk of Flooding from Surface Water
Legend
Site Boundary
Surface Water Extent
3.3% AEP
1% AEP
0.1% AEP
Castle Brook
Whittle Brook

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Figure 3-5: Environment Agency's Flood Risk from Surface Water extent

3.2.3 According to the Environment Agency's Surface Water Flood Depth Mapping for the Medium Risk (1% AEP) event, numerous areas across the site away from the aforementioned watercourses are shown to experience flood depths of up to 900 mm in this event (Figure 3-6). It should be noted that flooding at these locations is mostly indicated to be as a result of pooling from topographic depressions and not from overland flow routes.

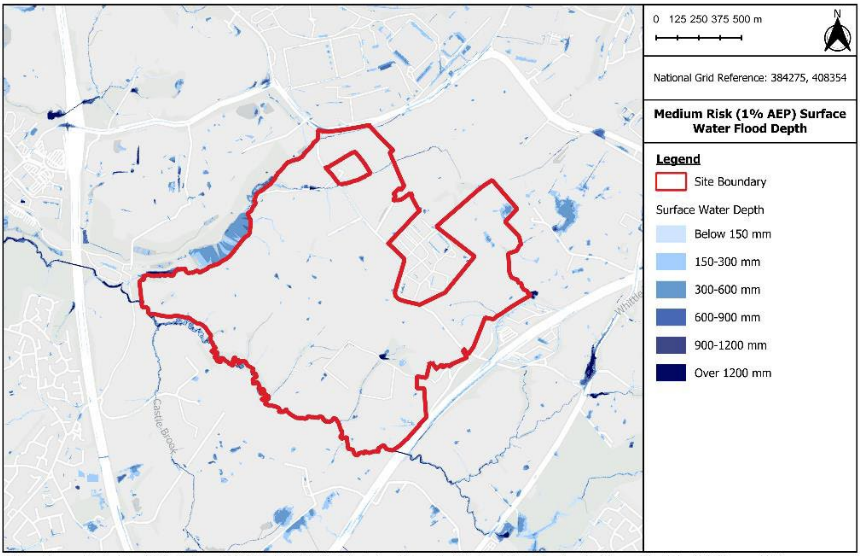
0 125 250 375 500 m
N
National Grid Reference: 384275, 408354
Medium Risk (1% AEP) Surface Water Flood Depth
Legend
Site Boundary
Surface Water Depth
Below 150 mm
150-300 mm
300-600 mm
600-900 mm
900-1200 mm
Over 1200 mm
Castle Brook
Whittle

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Figure 3-6: Environment Agency Medium Risk Surface Water Flood Event Depths (1% AEP)

3.2.4 According to the Environment Agency's Surface Water Hazard Mapping (Figure 3-7), the application site is predominantly at no risk with some localised areas of 'Caution' and 'Danger for some' primarily located by the watercourses, ponds, ditches and other topographic low points. There are localised areas of 'danger for most' and 'danger for all' located to the west of the application site, which are also associated with the Whittle Brook.

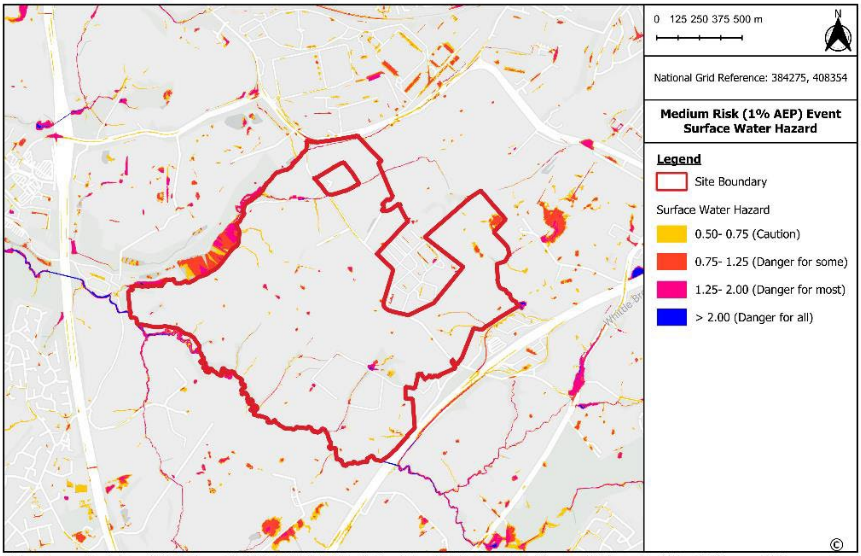
0 125 250 375 500 m
N
National Grid Reference: 384275, 408354
Medium Risk (1% AEP) Event Surface Water Hazard
Legend
Site Boundary
Surface Water Hazard
0.50- 0.75 (Caution)
0.75- 1.25 (Danger for some)
1.25- 2.00 (Danger for most)
> 2.00 (Danger for all)
Whittle Br
©

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Figure 3-7: Environment Agency's Flood Risk from Surface Water Hazard Mapping (1% AEP)

3.2.5 It should be noted that the EA Long Term Surface Water flood map does not take into account the presence of local drainage networks and may therefore be overestimating the risk of surface water flooding if there are drainage systems present within the road networks.

3.2.6 Based on the above, the overall risk of surface water flooding is considered to be **low.**

3.3 Groundwater Flooding

3.3.1 Groundwater flooding occurs when water levels in the ground rise above the land surface. This type of flooding is most likely to occur in areas above an aquifer. The occurrence of groundwater flooding is usually local and does not generally pose a significant risk to life due to the slow rate at which the water level rise.

3.3.2 Within the Rochdale Metropolitan Borough Council Strategy for Flood Risk Management (2013), there is an Areas Susceptible to groundwater flooding map

(Appendix D) and the Bury Borough Council (BBC) Local Flood Risk Management Strategy (LFRMS) (2018) Groundwater flooding map (Appendix E), the application site is located where susceptibility to groundwater flooding ranges from < 25% to 50 % - 75%. However, it should be noted that susceptibility to groundwater flooding does not directly translate into risk. In addition, the BBC LFRMS states that there are relatively few reported incidents of groundwater flooding within the borough.

3.3.3 Moreover, a review of the EA's Long-Term Flood Risk website[4] indicates that groundwater flooding is considered to be unlikely in this area.

3.3.4 Based on the proximity of a number of watercourses running through the application site, it is anticipated that groundwater levels in areas close to the watercourses are likely to be in hydraulic continuity with the rivers and would fluctuate as river levels rise and fall.

3.3.5 Based on the above, the overall risk of groundwater flooding is considered to be **low**, however, ground investigations are scheduled to be undertaken to establish the groundwater conditions within the application site in Spring 2025. This will provide site-specific information for the plots on the groundwater levels.

3.4 Sewer Flooding

3.4.1 Sewer flooding occurs when intense rainfall overloads the sewer system capacity and/or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system.

3.4.2 There are no sewers present within the application site, however there are existing sewers in proximity to the application site as described in Section 2.5. It is understood that the Birch Business Park has a proprietary system in place to manage flows on site, however, in the event of surcharging of this network, there may be potential for flooding to occur. The topography of the area flows away from the Birch Business Park towards the Whittle Brook, meaning there is a risk of flows onto the application site if it were overwhelmed, however, it is anticipated that flooding would be relatively shallow and of a short duration.

---

[4] Check the long term flood risk for an area in England - GOV.UK

3.4.3 In the event of surcharging of the sewers beneath the M62 and the MSA in the vicinity of or within the application site, it is anticipated that flooding would be limited within the road and follow the route of overland flow paths west along the M62 and is unlikely to impact the application site. Any surcharging within the roads to the north of the application site (Pilsworth Road) is likely to remain within the road, and any exceedance would follow local topography to the Brightley Brook and not impact the application site.

3.4.4 The United Utilities historic sewer flood incidents and Surface Water Management Plan Hotspots map provided within the Greater Manchester Combined Authority (GMCA) Level 1 Strategic Flood Risk Assessment (SFRA) (2020) indicates no surface water flooding incidents have been recorded within the application site (Appendix F).

3.4.5 Based on above, overall risk of sewer flooding is considered to be **low**.

3.5 Reservoir Flooding

3.5.1 Flooding from reservoirs occurs when a reservoir dam is overtopped or breaches due to structural failure.

3.5.2 According to Long Term Reservoir Flood Map (Figure 3-8), the northwestern borders of the application site are shown to be located within an area that is at risk of flooding in the event of reservoir failure. These areas align with the floodplain of the Whittle Brook and Brightley Brook. The consequence of such an event would be severe, however, the probability of a catastrophic dam failure is considered to be extremely low due to the management and maintenance required under the Reservoirs Act 1975.

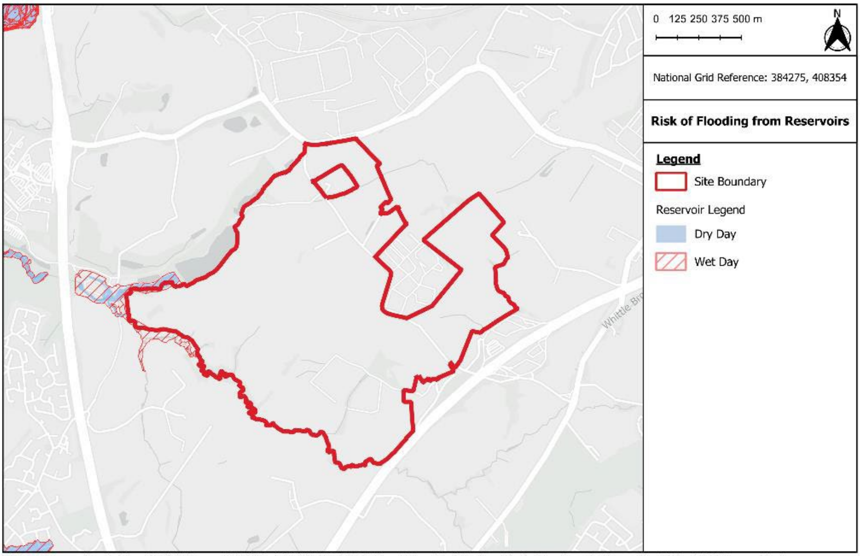
0 125 250 375 500 m
N
National Grid Reference: 384275, 408354
Risk of Flooding from Reservoirs
Legend
Site Boundary
Reservoir Legend
Dry Day
Wet Day
Whittle Br

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Figure 3-8: EA Long Term Reservoir Flood Map

3.5.3 Based on the above, the overall risk of reservoir flooding is considered to be **high** within the northwestern reaches of the Whittle Brook and the Brightley Brook floodplains and **low** throughout the rest of the application site.

3.6 Canal Flooding

3.6.1 Flooding from a canal occurs when the canal is overtopped or breaches due to failure. However, Based on the Online Canal and River Trust Mapping, no canals are located within or in close proximity of the application site.

3.6.2 Based on the above, the overall risk of canal flooding is considered to be **negligible.**

3.7 Summary

Source	Risk
Fluvial	**Low** (**high** within the floodplain as defined by the hydraulic model)
Tidal	**Negligible**
Surface Water	**Low** (areas of ponding classified as **high** throughout the application site)
Groundwater	**Low**
Sewer	**Low**
Reservoir	**Low** (**high** within the northwestern reaches of the Whittle Brook and the Brightley Brook floodplains)
Canal	**Negligible**

4.0 Planning Policy and Guidance

4.1 National Planning Policy Framework (December 2024)

4.1.1 The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these should be applied with a presumption in favour of sustainable development. Chapter 14 'Meeting the challenge of climate change, flooding and coastal change' sets out the Government's policies in relation to flood risk and drainage. The NPPF aims to guide development away from areas at the highest risk of flooding during the present day and future climate change scenarios. Where development is necessary in high-risk areas, the NPPF requires development to be made safe for its lifetime without increasing flood risk elsewhere. The NPPF is supported by relevant planning practice guidance (PPG) which provides technical advice on how to take account of and address the risk associated with flooding in the planning process.

4.2 Local Policy Documents

4.2.1 The west of the application site (comprising 120.15 ha of land) is located within the administrative boundary of the BBC. The Bury Unitary Development Plan (UDP) was adopted by the Council in August 1997. The Council is now working to replace the adopted UDP with the Bury Local Plan. In addition, the Joint Places for Everyone Development Plan Document for the nine districts of the GMCA, including BBC and RMBC, was adopted by Bury Council with effect from 21 March 2024 and supersedes some of the Bury UDP policies, including for flood risk and drainage. Therefore, the policies of the Joint Places for Everyone Development Plan Document are considered as relevant for the site.

4.2.2 The adopted Joint Places for Everyone Development Plan Document contains the following policy with relation to flood risk:

> "Policy JP-S4: Flood Risk and the Water Environment
>
> An integrated catchment-based approach will be taken to protect the quantity and quality of water bodies with reference to the North West River Basin Management Plan and managing flood risk, by:
>
> 1. Returning rivers to a more natural state, where practicable;

2. Working with natural processes and adopting a natural flood management approach to slow the speed of water drainage and intercept water pollutants;
3. Locating and designing development so as to minimise the impacts of current and future flood risk, including retrofitting or relocating existing developments, infrastructure and places to increase resilience to flooding;
4. Expecting developments to manage surface water runoff through sustainable drainage systems and as close to source as possible. Development should achieve greenfield run-off rates unless it is demonstrated to be impracticable. District local plans should consider setting more detailed surface water drainage policies to reflect local circumstances, including alternative surface water discharge rates, such as in areas with critical drainage issues;
5. Ensuring that sustainable drainage systems:
    i. Are designed to provide multifunctional benefits wherever possible, including for water quality, nature conservation and recreation;
    ii. Avoid adverse impacts on water quality and any possibility of discharging hazardous substances to ground;
    iii. Are delivered in a holistic and integrated manner, including on larger sites split into different phases; and
    iv. Are managed and maintained appropriately to ensure their proper functioning over the lifetime of the development.
6. Securing the remediation of contaminated land and the careful design of developments to minimise the potential for urban diffuse pollution to affect the water environment; and
7. As a minimum, residential development should meet the mandatory water efficiency standard of 125 litres/person/day as set out in Building Regulations. District local plans may and should consider setting a tighter water efficiency standard of 110 litres/person/day where there is a clear local need with reference to national guidance on housing optional technical standards.”

4.2.3 The east of the application site (comprising 89.65 ha of land) is located within the administrative boundary of RMBC. The RMBC Core Strategy was adopted in 2016 and aims to guide development in Rochdale Borough up to 2028. The adopted Core Strategy contains the following policy in relation to flood risk:

“G6 - Enhancing green infrastructure

We will sustain and enhance a green network to support growth and regeneration in the borough and provide a high quality environment that meets the needs of our community and visitors to the borough. We will protect and improve green spaces and water bodies and ensure that their value to sustainable development and regeneration is maximised. Our priorities are to improve opportunities for recreation in urban areas and the countryside, improve opportunities for healthy lifestyles, and to help manage and respond to environmental risks such as flooding and the impacts of climate change. We will also ensure that the network supports the sustainable growth of the Greater Manchester city region and links with a wider Greater Manchester strategic green infrastructure network. We will protect, improve and create green infrastructure to help deliver strategic sustainable development priorities and meet local needs in the following locations:

> […]
>
> 3. Other river valleys and green corridors where the focus will be on enhancing recreational links between urban areas and open countryside to allow passage of wildlife, provide local opportunities for recreation, improving visual amenity, and contribution to local and wider environmental management e.g. reducing air pollution and managing flood risk.
>
> 4. Other water bodies (lakes, streams, reservoirs, ponds etc) where the focus will be on celebrating water and promoting water features as a key characteristic of the local landscape, to improve their recreational and biodiversity value, maximise their potential for flood risk management and to incorporate water features (existing and new) as part of new developments, public realm initiatives, town centre design and neighbourhood regeneration initiatives where practicable.
>
> […]
>
> 8. Local urban open spaces where the focus will be on improvements to the quality of accessible greenspace close to where people live and work

> (prioritising those areas with the greatest deficiency or need e.g. poor health or lack of private gardens), securing tree planting and other urban greening in new areas of public open space in town centres and housing growth areas, protecting allotments and supporting local food growing, enhancing flood risk management and protecting and improving urban wildlife value and natural areas.)
>
> 9. Urban areas and new development where the focus will be on incorporating green infrastructure into new development, sustainable urban drainage, increasing the number of street trees, greening housing areas and main roads, developing new green spaces, and incorporating green roofs and walls in new development.
>
> […]"

"G8 - Managing water resources and flood risk

We will ensure that new development (including flood risk mitigation measures) does not lead to any form of increased flooding locally or further downstream, does not impede natural water and flood risk management, is not detrimental to existing or potential flood storage areas, contributes where possible to alleviating existing flood risk, is itself well protected from flood risk and ensures prudent use of water resources. We will require:

a. Compliance with a 'sequential' approach to new development and flood risk, directing development away from areas of high risk, in accordance with the National Planning Policy Framework;
b. Full regard to and compliance with the advice of the Environment Agency (or equivalent agency) and the objectives and priorities for flood risk management set out in the Local Flood Risk Management Strategy, including any mitigation measures recommended for particular sites;
c. Full regard to the published evidence of local flood risk and its significance as included in Strategic Flood Risk Assessments, Surface Water Management Plans and other recognised sources of flood risk data and the production of additional Flood Risk Assessments (FRAs) as appropriate;

d. Incorporation of appropriate measures for the management of surface and flood water, including flood storage areas, Sustainable Urban Drainage Systems (SUDS) and the protection of 'overland flow paths';
e. Compliance with any Surface Water Management Plan or drainage strategies produced, such as for the identified critical drainage areas of Littleborough and Heywood;
f. The avoidance of culverting, and support the opening up of existing culverts wherever possible;
g. The incorporation of measures for the conservation of water to minimise potable water consumption, including rainwater collection measures, which should be integral to the design of buildings and spaces;
h. Development that does not directly or indirectly lead to pollution of existing water resources such as watercourses and groundwater or the derogation of the quantity of groundwater;
i. The incorporation of measures to improve water quality; and
j. The taking of opportunities to improve the habitat value of watercourses and water bodies.

In addition, we will identify additional flood storage areas which will be protected from development.''

“DM1 - General development requirements

All development proposals, including changes of use of land and buildings, extensions and alterations, will be expected to demonstrate that they:

k. Are of high quality design and take the opportunity to enhance the quality of the area;
l. Are compatible with surrounding land uses, both in terms of its impact upon those uses and the impact of the surrounding land uses upon the amenities of future residents / users;
m. Do not adversely affect the amenity of residents or users through visual intrusion, overbearing impact, overshadowing or loss of privacy;

n. mitigate against any impacts due to noise, air, dust, light and odour pollution, traffic generation or inadequate access, where such mitigation is identified as being necessary;

o. Provide satisfactory vehicular access with adequate parking, manoeuvring, and servicing arrangements taking into account of the proposed use and location;

p. Do not have an adverse impact on health, through its impact or the effect of existing problems e.g. land contamination, or poor air quality;

q. Provide, or demonstrate the availability of, the service and community infrastructure necessary to meet local needs e.g. local shops, community, leisure and sport facilities and provision of open space;

r. Minimise opportunities for crime against people or property;

s. Take account of ground conditions including unstable or contaminated land - where a potential risk exists, a survey should be carried out and any necessary remedial measures identified and carried out;

t. Incorporate, where appropriate, high quality landscape schemes;

u. Have assessed whether the development may be affected by ground instability;

v. Have considered the availability of water and wastewater infrastructure, and any need for additional capacity; and

w. Do not lead to impacts detrimental to the conservation interests of European Protected Sites.”

5.0 Proposed Scheme

5.1.1 The Proposed Scheme is described as an application for outline planning permission (all matters reserved) for a national-scale employment development, comprising:

- Storage & Distribution (Use Class B8) and Industrial (Use Classes B2, E(g)(ii) and E(g)(iii)) uses (including, but not limited to, Logistics, Manufacturing Processes and Data Centres),
- Supporting ancillary uses including Hotel (Use Class C1),
- Commercial, Business & Service (Uses Class E(a-g)),
- Education (Use Class F1(a)),
- Local Community (Use Class F2(a-c) uses,
- Sui Generis uses (in accordance with the Development Specification),
- Associated demolition works, landscaping, drainage, ecological enhancements, highway works, cycleway and footpath linkages and other ancillary infrastructure.

5.1.2 Therefore the Proposed Scheme may contain areas from all vulnerability classifications in accordance with Annex 3 of the NPPF.

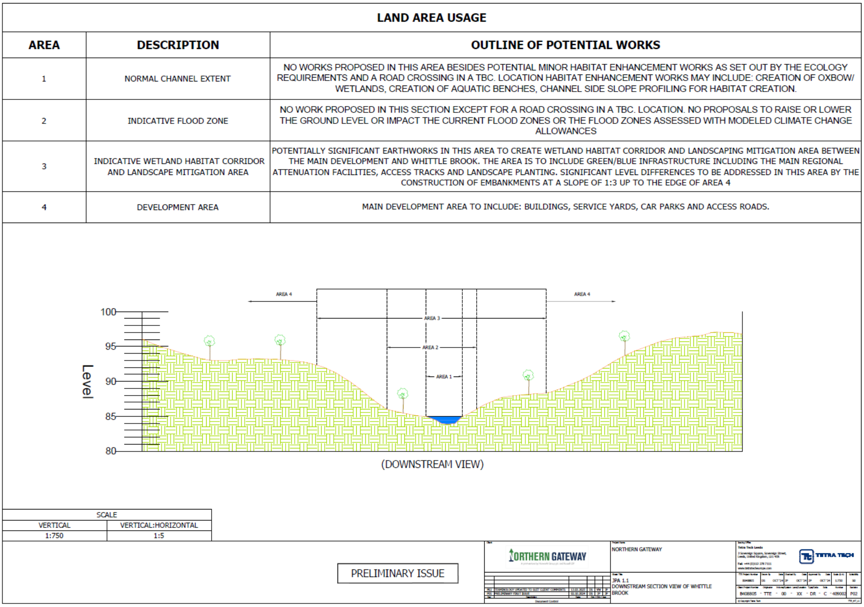
5.2 Flood Risk to the Proposed Scheme

5.2.1 Within the application site the sources of flood risk identified were Fluvial, reservoir (which aligned with the fluvial flood zones) and Surface Water flooding in topographic low spots throughout.

Risk from Fluvial and Reservoir flooding

5.2.2 The alignments of Hollins Brook, Whittle Brook, Brightley Brook / Pilsworth Clough and the un-named water course on the eastern border of Application Plot E will be retained in their existing alignments within the application site. Their retention is accommodated within the Wetland Habitat Corridors (Inner Zone) and Landscape Mitigation Area (Outer Zone) as shown within the Parameters Plan attached as Appendix A.

5.2.3 Whittle Brook has a profile with a clearly defined floodplain, as shown in Figure 5-1 below. The modelled flood extents in the 1% AEP event shown above are mostly contained within this floodplain.



LAND AREA USAGE		
AREA	**DESCRIPTION**	**OUTLINE OF POTENTIAL WORKS**
1	NORMAL CHANNEL EXTENT	NO WORKS PROPOSED IN THIS AREA BESIDES POTENTIAL MINOR HABITAT ENHANCEMENT WORKS AS SET OUT BY THE ECOLOGY REQUIREMENTS AND A ROAD CROSSING IN A TBC. LOCATION HABITAT ENHANCEMENT WORKS MAY INCLUDE: CREATION OF OXBOW/ WETLANDS, CREATION OF AQUATIC BENCHES, CHANNEL SIDE SLOPE PROFILING FOR HABITAT CREATION.
2	INDICATIVE FLOOD ZONE	NO WORK PROPOSED IN THIS SECTION EXCEPT FOR A ROAD CROSSING IN A TBC. LOCATION. NO PROPOSALS TO RAISE OR LOWER THE GROUND LEVEL OR IMPACT THE CURRENT FLOOD ZONES OR THE FLOOD ZONES ASSESSED WITH MODELED CLIMATE CHANGE ALLOWANCES
3	INDICATIVE WETLAND HABITAT CORRIDOR AND LANDSCAPE MITIGATION AREA	POTENTIALLY SIGNIFICANT EARTHWORKS IN THIS AREA TO CREATE WETLAND HABITAT CORRIDOR AND LANDSCAPING MITIGATION AREA BETWEEN THE MAIN DEVELOPMENT AND WHITTLE BROOK. THE AREA IS TO INCLUDE GREEN/BLUE INFRASTRUCTURE INCLUDING THE MAIN REGIONAL ATTENUATION FACILITIES, ACCESS TRACKS AND LANDSCAPE PLANTING. SIGNIFICANT LEVEL DIFFERENCES TO BE ADDRESSED IN THIS AREA BY THE CONSTRUCTION OF EMBANKMENTS AT A SLOPE OF 1:3 UP TO THE EDGE OF AREA 4
4	DEVELOPMENT AREA	MAIN DEVELOPMENT AREA TO INCLUDE: BUILDINGS, SERVICE YARDS, CAR PARKS AND ACCESS ROADS.

SCALE	
VERTICAL	VERTICAL:HORIZONTAL
1:750	1:5

AREA 4
AREA 4
AREA 3
AREA 2
AREA 1
100
95
90
85
80
Level
(DOWNSTREAM VIEW)
PRELIMINARY ISSUE
NORTHERN GATEWAY
NORTHERN GATEWAY
JPA 1.1
DOWNSTREAM SECTION VIEW OF WHITTLE BROOK
TETRA TECH
B408805 - TTE - 00 - XX - DR - C - 409002
P02
P02 TERMINOLOGY UPDATED TO SUIT CLIENT COMMENTS
P01 PRELIMINARY FIRST ISSUE
Document Control

Figure 5-1: Example cross section of Whittle Brook floodplain delineation.

5.2.4 The modelled extent of the 0.1% AEP plus 35% climate change event is contained within the Inner Zone of the Wetland Habitat Corridor.

5.2.5 No development of buildings will take place within either the Inner or Outer zones. There will be limited development within the Inner Zone related to structural interventions to allow primary and secondary access routes across the application site, where necessary. It is intended that bridge spans/crossings will be implemented on a section(s) of all Main Rivers. There is no intention to culvert the Main Rivers in the interests of flood management and biodiversity. There may be some very minor localized culverting of retained tributaries, but future designs will attempt to avoid this where feasible. Works required for primary and secondary access routes will not be undertaken within the channel of the Brook itself.

5.2.6 Most other linear water features will be removed to allow for reprofiling of the application site. Sections of minor tributaries of brooks outside of the outer zone only, may require removal as their purpose will be replaced by a new surface water drainage strategy and their existing purpose will be removed.

5.2.7 Considering the above, the risk from fluvial flooding to the Proposed Scheme is low. Therefore, there is no need for further flood alleviation measures.

Risk from Surface Water flooding

5.2.8 A surface water drainage strategy is required to ensure current onsite risk can be managed effectively from increased hardstanding areas. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques.

5.2.9 The design of the surface water drainage system will be undertaken to suit the site phasing strategy, as such, as the design develops there may be a requirement to utilise temporary drainage features / outfalls to facilitate the required phasing arrangements.

5.2.10 Attenuation requirements are considered based on the volume of water generated by the 1% AEP year storm with allocation of 45% climate change as advised for the Irwell Catchment. These basins required for attenuation will utilise space within the Outer Zones and further attenuation will be provided within the Developable Areas (as defined by the Parameters Plans submitted with the Application).

5.2.11 The site levels will be changed, thereby removing the localise topographic depressions that result in ponding. The surface water drainage strategy will manage these flows.

5.2.12 Therefore, the risk of surface water flooding to the Proposed Scheme is low as onsite surface water will be managed effectively.

5.3 Flood Risk Arising from the Proposed Scheme

5.3.1 As described above, there is no development proposed within the Wetland Habitat Corridor, which encompasses the 0.1% AEP plus 35% climate change fluvial flood extent. Where watercourse crossings could be required to facilitate access, the design principle is to ensure these are bridge crossing which will not impede flood flow along the brooks. Where abutments are needed to support bridges these will be designed to minimise the risk of displacement or impedance to flow across the floodplain. Therefore the risk of the Proposed Scheme altering fluvial flood risk elsewhere is low.

5.3.2 A drainage strategy[5] has been developed to ensure current onsite risk can be managed effectively with no increase in surface water flood risk elsewhere as a result of the proposed scheme. Surface water is proposed to discharge at a rate equivalent to the existing greenfield runoff, with an ultimate outfall into the designated main rivers or tributaries within the application site: Whittle Brook and Brightley Brook. The surface water strategy has, where possible, attempted to maintain the existing catchment regimes. Any changes to catchments will be minor and the risk of surface water flooding off-site arising from the Proposed Scheme is low.

---

[5] 784-B048805 Drainage Strategy Technical Note JPA1.1, Tetra Tech, 2024

6.0 CONCLUSIONS

6.1 Conclusions

6.1.1 The application site has areas of Flood Zone 2 and 3 located along the alignment of the watercourses within the application site (Whittle Brook, Brightley Brook, Pilsworth Clough and the unnamed watercourse).

6.1.2 Site specific fluvial modelling has been undertaken to identify areas of fluvial flood risk up to the 0.1% AEP plus 35% climate change allowance fluvial event.

6.1.3 Within the application site, the areas around the watercourses have been allocated as a Wetland Habitat Corridor. This encompasses the extents of the 0.1% AEP plus 35% climate change allowance event.

6.1.4 There are no developments proposed within the Wetland Habitat Corridor with the exception of structural interventions for bridge crossings at strategic locations, which are expected to be minor (as indicated within the submitted Parameters Plans). The minor works within the Wetland Habitat Corridor are not expected to pose any additional fluvial risk to the site or elsewhere, and the siting of the development outside of these Zones removes the risk from the Proposed Scheme and negates the need for flood alleviation measures.

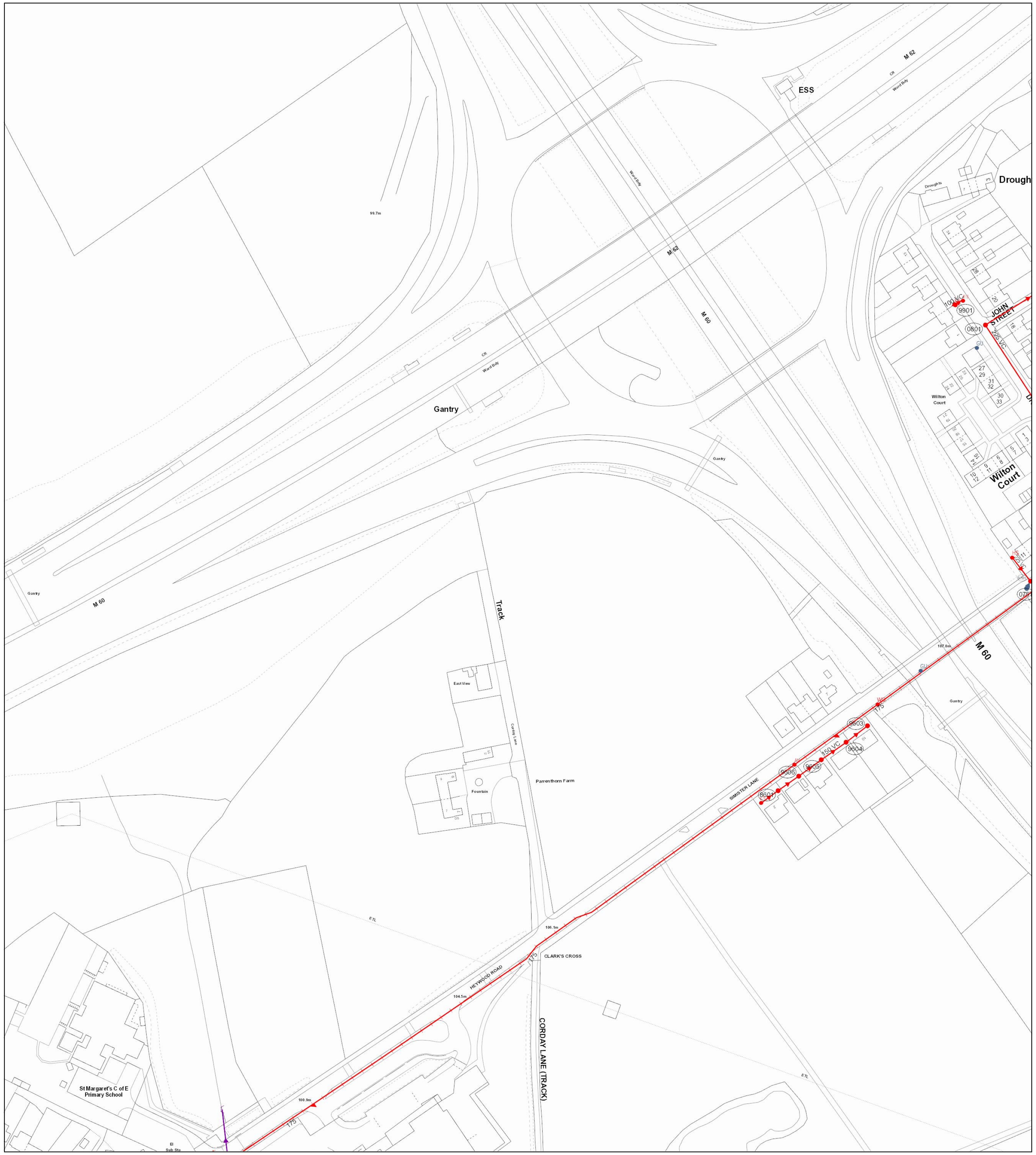
6.1.5 Surface water flooding on the application site is aligned with the watercourses, and the mitigation posed for fluvial risk (siting outside of the Wetland Habitat Corridor) will also provide appropriate mitigation to the surface water risk along the watercourses.

6.1.6 The application site has areas of topographic low points throughout the site; however the Proposed Scheme will require reprofiling which will remove these risks.

6.1.7 The additional hard standing areas that will be introduced from the Proposed Scheme have the potential to increase the risk of surface water flooding to the application site and elsewhere. The provision of a Surface Water Drainage Strategy will mitigate the risk of surface water flooding on site and reduce the risk of flows off site causing flooding.

APPENDIX A – Outline Application Parameters Plan

APPENDIX B – United Utilities Sewer Records


ESS
M 62
Drough
Gantry
M 60
JOHN STREET
Wilton Court
9901
0801
Track
East View
Parrenthorn Farm
Fountain
SIMISTER LANE
9603
9604
9605
9606
8601
HEYWOOD ROAD
CLARK'S CROSS
CORDAY LANE (TRACK)
St Margaret's C of E Primary School
150 VC
225 VC

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

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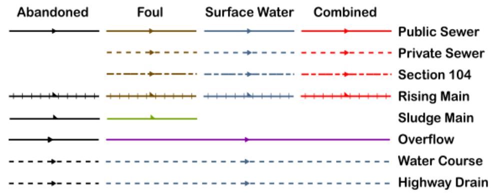
Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad
0751	107.34	SW	104.59	225			VC	4.472136	1 in 64
0751	107.34	SW	104.59	225			VC	4.472136	1 in 64
9604		CO		150			VC	15.07877	
0801		CO	0	225			VC	56.60389	
0801		CO	0	225			VC	56.60389	
0701	107.37	CO	104.53	225			VC	57.2014	1 in 99
0701	107.37	CO	104.53	225			VC	57.2014	1 in 99
9606		CO		150			VC	15.32549	
8601		CO		150			VC	14.12485	
9605		CO		150			VC	16.85521	
0802	106.69	CO	103.51	225			VC	96.79876	

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad

LEGEND


Abandoned
Foul
Surface Water
Combined
Public Sewer
Private Sewer
Section 104
Rising Main
Sludge Main
Overflow
Water Course
Highway Drain

All point assets follow the standard colour convention:
red - combined blue - surface water
brown - foul purple - overflow

- ● Manhole
- HS Head of System
- ES Extent of Survey
- RE Rodding Eye
- IN Inlet
- DP Discharge Point
- VX Vortex
- PE Penstock
- WO Washout Chamber
- VA Valve
- AV Air Valve
- NR Non Return Valve
- SO Soakaway
- GU Gully
- CA Cascade
- FM Flow Meter
- HB Hatch Box
- OI Oil Interceptor
- SM Summit
- DS Drop Shaft
- OP Orifice Plate

- Side Entry Manhole
- Outfall
- Screen Chamber
- IC Inspection Chamber
- Bifurcation Chamber
- LH Lamp Hole
- T Junction / Saddle
- Catchpit
- Valve Chamber
- Vent Column
- Vortex Chamber
- Penstock Chamber
- Network Storage Tank
- Sewer Overflow
- Ww Treatment Works
- ▲ Ww Pumping Station
- Septic Tank
- Control Kiosk
- ▽ Change of Characteristic

MANHOLE FUNCTION

FO	Foul
SW	Surface Water
CO	Combined
OV	Overflow

SEWER SHAPE

CI	Circular	TR	Trapezoidal
EG	Egg	AR	Arch
OV	Oval	BA	Barrel
FT	Flat Top	HO	HorseShoe
RE	Rectangular	UN	Unspecified
SQ	Square		

SEWER MATERIAL

AC	Asbestos Cement
BR	Brick
PE	Polyethylene
RP	Reinforced Plastic Matrix
CO	Concrete
CSB	Concrete Segment Bolted
CSU	Concrete Segment Unbolted
CC	Concrete Box Culverted
PSC	Plastic / Steel Composite
GRC	Glass Reinforced Plastic
DI	Ductile Iron
PVC	Polyvinyl Chloride
CI	Cast Iron
SI	Spun Iron
ST	Steel
VC	Vitrified Clay
PP	Polypropylene
PF	Pitch Fibre
MAC	Masonry, Coursed
MAR	Masonry, Random
U	Unspecified

Address or Site Reference:

G1.2,

OS sheet Number: SD8205NE
Scale: 1:1250 **Date:** 15/11/2019
Nodes: 11
Sheet: 4 of 7

Printed by: Property Searches

SEWER RECORDS

United Utilities
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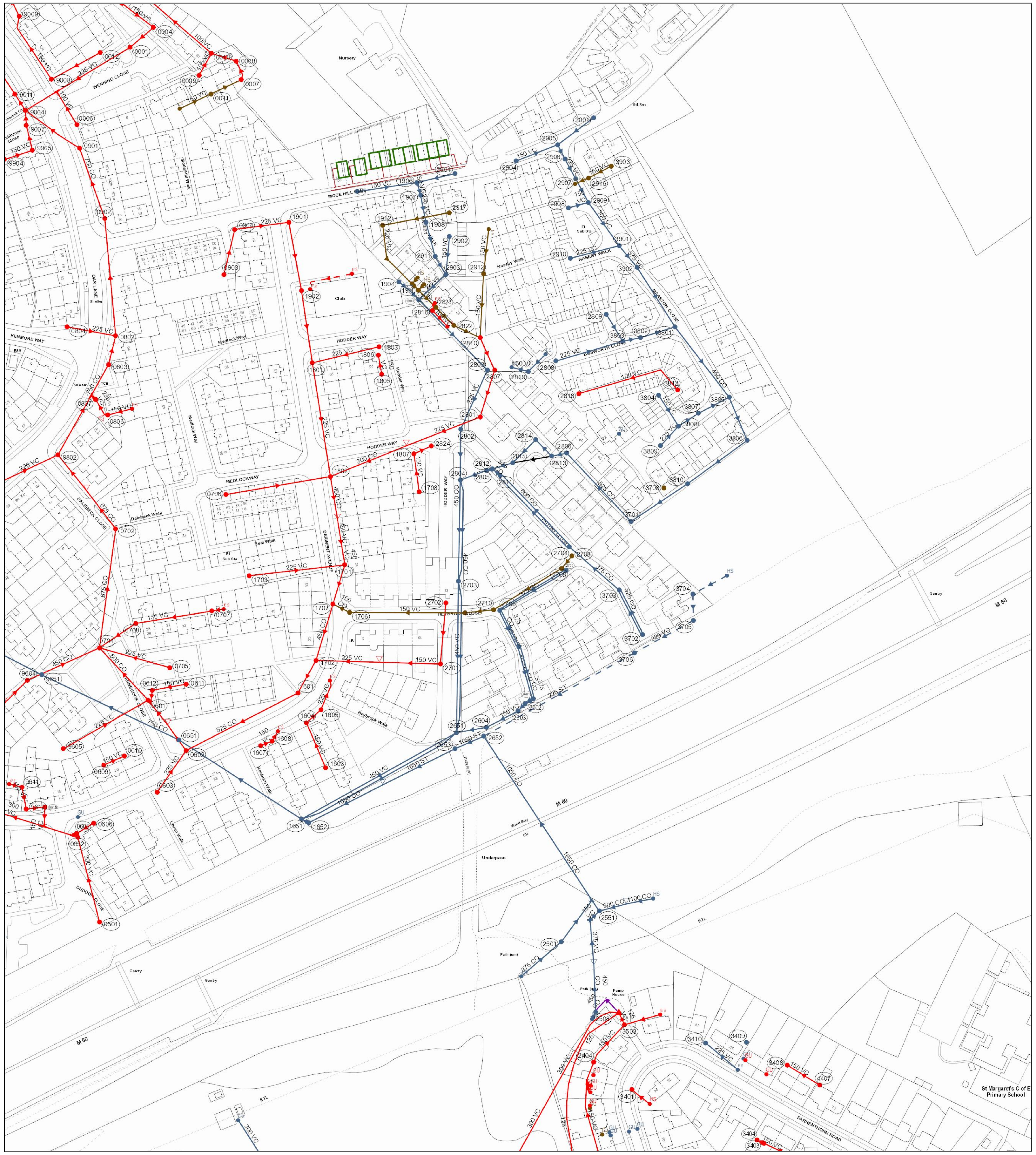
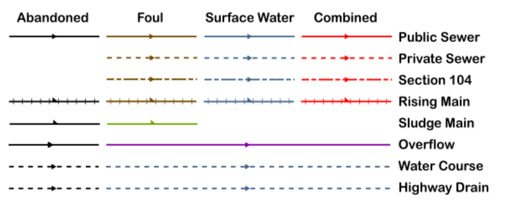


Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad
0702	93.1	CO	88.24	675			CO	26.40076	1 in 264
0611		CO		150			VC	19.0503	
1702	91.76	CO	89.28	450			CO	20.59126	1 in 82
9004	92.55	CO	87.88	750			CO	54.86152	
0705		CO	0	225			VC	40.5216	
1905	93.67	SW	92.73	150			VC	33.37664	1 in 73
2252	96.02	SW	94.02	300			VC	219.9682	
2704		SW		600			CO	56.20532	
1803		CO	0	225			VC	38.07887	
1651		SW	0	750			CO	80.99383	
9605	91.28	CO	89.59	225			VC	54.20332	1 in 115
0902	95.77	CO	87.87	750			CO	41.4367	
1605		CO		225			VC	17.37348	
2707		SW	0	375			CO	30.5955	
2703		SW	0	450			VC	84.32053	
2803	92.34	SW	91.12	225			VC	36.06559	1 in 78
3903		FO		150			VC	14.20356	
0603	92.56	CO	89.53	225			VC	28.01785	1 in 108
2910	92.62	SW	91.72	225			VC	27.89265	1 in 155
0011		FO		150			VC	18.44569	
9004	92.55	CO		750			CO	10.87287	
1703	92.17	CO	90.41	225			VC	53.33854	1 in 167
9611		CO		150			VC	12.35377	
0706	93.7	CO	91.96	225			VC	58.85575	1 in 92
0708		CO		150			VC	24.19754	
2816		CO		100			VC	12.25612	
2602		SW	0	150			VC	5.696429	
0704	91.62	CO	88.53	675			CO	66.61081	1 in 238
0001		CO	0	225			VC	67.74216	
2804	91.61	SW	90.53	450			CO	56.45259	
2652	92.68	SW	91.18	1050			ST	17.46425	1 in 134
9613		CO		150			VC	10.89182	
2203	96	CO	93.4	300			VC	293.8859	
0009		CO		100			VC	14.0689	
1903	93.37	SW	91.63	225			VC	54.45181	1 in 109
0006		CO		100			VC	21.58714	
2905	94.04	SW	91.99	225			VC	8.944272	1 in 128
9604	91.73	CO	88.83	450			CO	43.86343	1 in 439
0605		CO		150			VC	2.436164	
2402		CO		150			VC	60.21351	
1906	93.55	SW	92.25	150			VC	3.162278	1 in 53
1904	93.97	SW	92.28	150			VC	7.81025	1 in 24
9651	91.71	SW	89.8	750			CO	65.29931	
1707		CO	89.13	450			CO	32.62936	
3902	92.62	SW	91.43	375			VC	39.11522	1 in 244
3704		SW		225			VC	14.66231	1 in
2911	93.43	SW	91.92	225			VC	11.6619	1 in 78
2604		SW	0	150			VC	16.80216	
2909	92.86	SW	91.7	300			VC	29.41088	1 in 147
3807	92.87	SW	91.53	225			VC	19.23538	1 in 101
1913		FO		225			VC	13.60007	
0501	93.8	CO	91.11	300			VC	48.50773	1 in 135
0501	93.8	CO	91.11	300			VC	48.50773	1 in 135
0651	91.87	SW	90.14	750			CO	84.09518	1 in 255
1601	91.69	CO	88.97	525			CO	69.77106	1 in 872
1801		CO	0	225			VC	63.78872	
2701	91.38	CO	89.67	150			VC	34.0147	1 in 850
2705		SW	0	375			CO	43.42638	
3803	92.69	SW	91.65	225			VC	10.19804	1 in 146
2812		SW	0	525			CO	3.268058	
1701	91.61	CO	89.13	450			CO	22.73308	
9904		CO		150			VC	16.26534	
2702	91.67	CO	89.99	150			VC	34.1321	1 in 110
3805	92.69	SW	91.18	450			CO	26	1 in 2600
0707		CO		150			VC	42.70714	
9802	93.79	CO	88.05	750			CO	57.30619	1 in 1433
3809	93.02	SW	91.75	225			VC	14.86607	1 in 114
1907	93.41	SW	92.12	225			VC	15.29706	1 in 1530
2806	92.42	SW	90.88	525			CO	8.484115	
2908	93	SW	91.75	150			VC	11.40175	
3503	92.87	CO	91.2	125			VC	7.28345	
3503	92.87	CO	91.2	125			VC	7.28345	
2917		FO		225			VC	37.50442	
0804	94.41	CO	91.57	225			VC	27.45906	1 in 78
0012		CO		150			VC	30.93111	
0807		CO		225			VC	3.3598	
0652	92.83	CO	90.71	300			VC	73.37575	1 in 120
1908	93.31	SW	92.1	225			VC	19.64688	1 in 116
2707		SW	0	375			CO	30.44319	
2802	91.46	SW	90.65	225			VC	28.12058	1 in 256
0601	91.94	CO	88.72	600			CO	39.62323	1 in 396
4401		CO		150			VC	18.95707	
3801	92.66	SW	91.26	450			CO	49.20366	1 in 703
0007		CO		100			VC	11.25582	
1706		FO	0	150			CO	10.35349	
2904	93.49	SW	92.37	150			VC	24.69818	1 in 73
2705		SW	0	375			CO	43.40717	
2808	92.71	SW	91.78	225			VC	38.60052	1 in 322
2916		FO		150			VC	8.338629	
3705		SW		225			VC	37.2664	1 in
2706		SW	0	375			CO	22.90296	
1608		CO		150			VC	6.109011	
2703		SW	0	450			VC	84.00595	
1802	92.81	CO	89.41	450			CO	24.33105	1 in 221
2603		SW	0	150			VC	19.65259	
3901	92.6	SW	91.47	375			VC	15.6205	1 in 521
3810	92.99	SW	91.11	525			CO	37.74458	1 in 210
2704		SW		600			CO	55.84533	
2706		SW	0	375			CO	23.01205	
3802	92.63	SW	91.57	225			VC	19.92486	1 in 74
0903	96.78	CO	94.45	225			VC	25.70992	1 in 89
1901	95.61	CO	92.66	225			VC	38.63936	1 in 77
9009		CO		150			VC	17.55115	
0008		CO		100			VC	14.41337	
1652	92.42	SW	90.39	750			CO	4.472136	
4407		CO		150			VC	21.02151	
4407		CO		150			VC	21.02151	
0904	96.98	CO	94.15	225			VC	30.26549	1 in 20
0803	94.99	CO	87.99	750			CO	16.49242	1 in 825
2804	91.61	SW	89.81	450			CO	56.00893	
9007		CO		150			VC	8.37149	
3703		SW	0	375			CO	36.68269	
2651	92.93	SW	91.36	450			VC	98.83119	
2653	92.59	SW	91.05	1650			ST	44.72136	1 in 128
2404		CO		150			VC	27.06427	
2404		CO		150			VC	27.06427	
2651	92.93	SW	91.36	450			VC	98.48858	
2711		FO	0	150			VC	63.80659	
0606		CO		150			VC	11.03652	
0802	95.44	CO	87.96	750			CO	65.27634	1 in 725
2809	92.82	SW	91.82	150			VC	17.49286	1 in 175
9612		CO		150			VC	10.30952	
1912		FO		225			VC	38.41493	
2813		SW	0	525			CO	12.70097	
0609		CO		150			VC	12.57419	
2907	93.54	SW	91.81	225			VC	14.76482	1 in 148
3812		CO		100			VC	61.83148	
2708		FO	0	150			VC	8.907598	
2903	93.2	SW	91.75	225			VC	20.51828	1 in 228
3701	92.6	SW	90.92	525			CO	52.01282	1 in 5201
1603		CO		150			VC	27.16352	
0612		CO		150			VC	7.064793	
9008		CO		150			VC	40.83394	
3403		CO		150			VC	4.215875	
3403		CO		150			VC	4.215875	
1604		CO		225			VC	10.84837	
2906	94.12	SW	91.89	225			VC	12.52996	1 in 179
2805	92.08	SW	90.8	525			CO	15.63679	1 in 391
2501	92.6	SW	91.41	375			CO	28.6007	
2501	92.6	SW	91.41	375			CO	28.6007	
3804	92.67	SW	91.82	150			VC	20.24846	1 in 127
2901	93.46	SW	92.54	150			VC	21.58703	1 in 80
2815		SW	0	525			CO	11.69513	
0004		CO		150			VC	17.00051	
2912		FO		150			VC	35.38	
2902	92.95	SW	92.07	150			VC	21.09502	1 in 78
2508	93.36	SW	91.5	450			CO	26.01922	
2508	93.36	SW	91.5	450			CO	26.01922	
2814		SW	0	525			CO	18.13732	
2807	92.41	CO	90.3	225			VC	27.20294	
3706		SW		225			ST	95.46697	1 in
3702		SW	0	525			CO	28.17403	
0901	93.81	CO	87.9	750			CO	36.63925	
9905		CO		150			VC	14.16905	
1607		CO		150			VC	6.937133	
3806	93.3	SW	91.16	525			CO	40.80441	1 in 1360
2551	95.07	SW	91.16	1050			CO	116.2111	
2551	95.07	SW	91.16	1050			CO	116.2111	
3702		SW	0	525			CO	28.07204	
2601		SW	0	375			CO	5.548374	
1805		CO		150			VC	10.71623	
0010		CO		100			VC	54.26541	
2001	94.75	SW	92.31	150			VC	25	1 in 93
2819		SW		150			VC	9.484123	
0602	92.13	CO	88.85	525			CO	17.20465	1 in 344
1902	95.56	CO	92.16	225			VC	40.4475	
3808	92.95	SW	91.6	225			VC	13.0384	1 in 217
1911		FO		225			VC	4.97331	
2823		FO		225			VC	14.15681	
2810	92.7	CO	0	225			VC	19.69772	
0806		CO		150			VC	1.846026	
2811		SW	0	525			CO	5.563354	
2709		FO	0	150			VC	44.11528	
2822		FO		225			VC	16.05855	
2710		FO	0	150			VC	16.04791	
2601		SW	0	375			CO	5.506853	
1807		CO		150			VC	10.4952	
2801	91.79	CO	90.89	225			VC	44.01136	1 in 68

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad

LEGEND



All point assets follow the standard colour convention:
red - combined
blue - surface water
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purple - overflow

- ● Manhole
- Head of System
- Extent of Survey
- Rodding Eye
- Inlet
- Discharge Point
- Vortex
- Penstock
- Washout Chamber
- Valve
- Air Valve
- Non Return Valve
- Soakaway
- Gully
- Cascade
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- Summit
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- Bifurcation Chamber
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- Vent Column
- Vortex Chamber
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- Network Storage Tank
- Sewer Overflow
- Ww Treatment Works
- ▲ Ww Pumping Station
- Septic Tank
- Control Kiosk
- ▽ Change of Characteristic

MANHOLE FUNCTION

FO	Foul
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SEWER SHAPE

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Address or Site Reference:

G1.2,

OS sheet Number:	SD8205NW
Scale:	1:1250
Date:	15/11/2019
Nodes:	178
Sheet:	1 of 7
Printed by:	Property Searches

SEWER RECORDS

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

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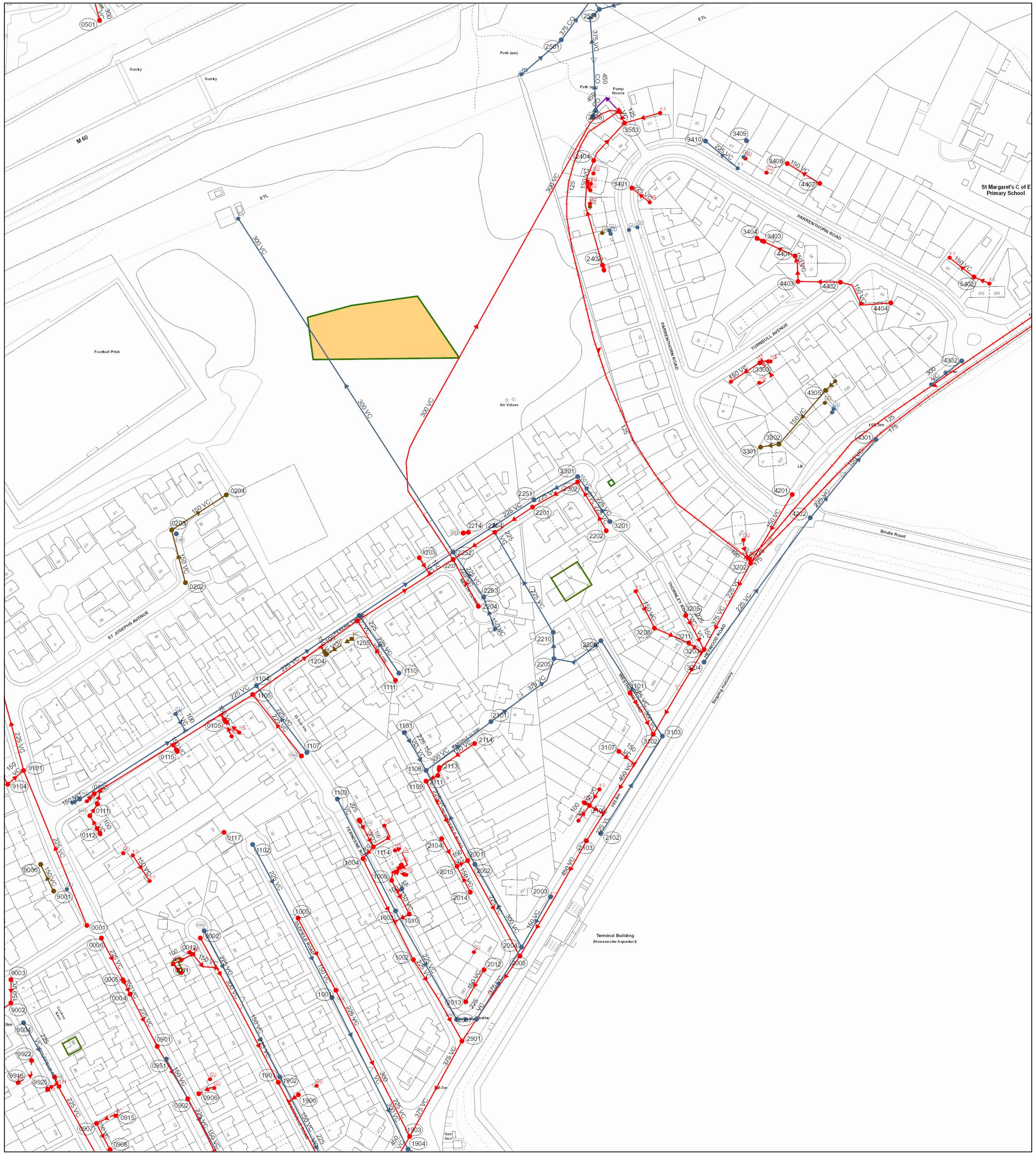

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Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad
4305		FO		150			VC	39.42585	
1201	99.3	SW	97.3	225			VC	62.68174	1 in 19
0113		CO		100			VC	7.659512	
1001	106.93	CO	104.13	225			VC	90.78546	1 in 84
4401		CO		150			VC	18.95707	
9003	109.82	CO	107.87	150			VC	13	1 in 41
2106		CO		150			VC	9.020096	
3102	105.87	CO	103.97	450			VC	69.64194	1 in 240
0908		CO		150			VC	0.00169746	
1010		CO		150			VC	9.37092	
2015		CO		150			VC	6.750944	
0115		CO		150			VC	4.590699	
2204	98.48	CO	95.78	225			VC	29.52965	1 in 16
9903	111.42	CO	107.32	225			VC	153.0655	1 in 42
9004	110.79	SW	109.29	225			VC	34.48188	1 in 18
2252	96.02	SW	94.02	300			VC	219.9682	
1003	105.82	SW	104.57	225			VC	68.96376	1 in 192
3204	105.9	SW	104.9	225			VC	99.40322	1 in 1243
1111	101.49	CO	99.79	225			VC	39.11522	1 in 19
2005	105.9	CO	103	375			VC	28.01785	1 in 133
0002	108.3	CO	106.55	300			VC	45.65085	1 in 55
2002	105.88	SW	103.43	300			VC	58.59181	1 in 167
0003	108.28	SW	106.98	225			VC	45.17743	1 in 43
2200	105.45	SW	102.65	225			VC	9.219544	
2210		SW		225			VC	64.26706	
1102	107.13	SW	106.18	225			VC	47.41308	1 in 53
1108	105.72	SW	103.06	300			VC	45	1 in 115
0004	109.03	CO	106.5	225			VC	32.64965	1 in 126
1103	106.24	SW	104.99	225			VC	69.77106	1 in 174
4202	105.94	SW	104.79	225			VC	28.42534	1 in 98
0907		CO		150			VC	16.50911	
2901	105.87	CO	102.64	375			VC	60.41523	1 in 137
1005	107.62	CO	104.53	225			VC	45.17743	1 in 122
2003	105.89	SW	104.8	150			VC	32.24903	1 in 43
2202	102.65	CO	100.45	225			VC	16.12452	1 in 24
2006	105.88	SW	104.22	225			VC	11	1 in 100
2251	100.12	SW	97.22	225			VC	53.53503	1 in 20
4407		CO		150			VC	21.02151	
4407		CO		150			VC	21.02151	
0111		CO		150			VC	7.90433	
2201	100.12	CO	96.92	225			VC	25.23886	1 in 74
1202	99.37	CO	97.07	225			VC	62.96825	1 in 17
1902	107.01	CO	103.83	225			VC	90.82401	1 in 90
3302		FO		150			VC	10.38453	
1106	104.82	CO	103.07	225			VC	43.41659	1 in 21
1051	106.85	SW	104.66	150			VC	46.95743	1 in 23
2007	105.8	SW	104.08	225			VC	47.16991	
1203		CO		150			VC	10.89933	
0011		CO		100			VC	12.16253	
1109	105.77	CO	104.32	225			VC	49.64877	1 in 87
2404		CO		150			VC	27.06427	
2404		CO		150			VC	27.06427	
3202	105.94	CO	104.87	225			VC	27.29469	1 in 101
1901	107	SW	104.97	150			VC	89.00562	1 in 43
2114		CO		150			VC	23.60024	
2302	100.58	CO	99.03	225			VC	28.6531	1 in 58
2301	100.57	SW	99.02	225			VC	27.29469	1 in 16
2203	96	CO	93.4	300			VC	293.8859	
3201	102.51	SW	0	225			VC	15.81139	
3208		CO		150			VC	20.68832	
1114		CO		100			VC	8.799988	
1906		CO		150			VC	6.790132	
2253	98.48	SW	96.33	225			VC	30.23243	1 in 13
1903	104.77	CO	102.19	450			VC	58.30952	1 in 150
2402		CO		150			VC	60.21351	
0102	105.34	CO	103.59	225			VC	103.7738	1 in 39
3205	106.11	CO	104.96	225			VC	10.29563	1 in 41
4404		CO		150			VC	35.22446	
1105	102.81	CO	100.91	225			VC	71.02816	1 in 19
2254	99.36	CO	96.53	225			VC	27.45906	1 in 9
3403		CO		150			VC	4.215875	
3403		CO		150			VC	4.215875	
0105		CO		150			VC	4.468547	
2014		CO		150			VC	16.3	
2104		CO		150			VC	17.38721	
2205	105.6	SW		225			VC	14.52284	
4403		CO		150			VC	10.05421	
2501	92.6	SW	91.41	375			CO	28.6007	
2501	92.6	SW	91.41	375			CO	28.6007	
2001	105.89	CO	103.72	225			VC	60.41523	1 in 96
0012		CO		150			VC	16.51452	
2111		CO		150			VC	7.361799	
9002	110.43	CO	107.38	225			VC	74.06078	1 in 224
1101	105.43	SW	104.08	225			VC	11.6619	1 in 69
2508	93.36	SW	91.5	450			CO	26.01922	
2508	93.36	SW	91.5	450			CO	26.01922	
0203		FO		150			VC	36.13997	
9001		FO		150			VC	16.44662	
3103	105.89	SW	103.54	225			VC	62.96825	1 in 78
1204		FO		150			VC	5.256345	
2102	105.92	SW	104.37	225			VC	63.81223	1 in 82
0501	93.8	CO	91.11	300			VC	48.50773	1 in 135
0501	93.8	CO	91.11	300			VC	48.50773	1 in 135
2213		CO		150			VC	3.052598	
0006	107.53	CO	0	225			VC	25.94224	
2551	95.07	SW	91.16	1050			CO	116.2111	
2551	95.07	SW	91.16	1050			CO	116.2111	
9101	106.18	CO	103.83	225			VC	53.85165	1 in 154
0001	107.39	CO	105.69	225			VC	92.84934	1 in 51
3303		CO		150			VC	19.15774	
0202		FO		150			VC	30.0877	
1104	102.72	SW	101.22	225			VC	69.06519	1 in 18
9925		CO		150			VC	6.024174	
0901	109.66	CO	106.22	225			VC	33.61547	1 in 78
1009		CO		150			VC	20.96134	
1004	106.41	CO	103.14	225			VC	62.60991	1 in 330
2113		CO		150			VC	4.504671	
5402		CO		150			VC	17.29277	
5402		CO		150			VC	17.29277	
0112		CO		100			VC	8.20413	
4201	106.17	CO	105.32	150			VC	44.41846	1 in 103
9104		CO		150			VC	11.62976	
3203	105.89	CO	104.33	375			VC	26.92582	1 in 117
2012		CO		150			VC	20.57911	
3503	92.87	CO	91.2	125			VC	7.28345	
3503	92.87	CO	91.2	125			VC	7.28345	
1110	101.35	SW	100.2	225			VC	38.83298	1 in 19
2103	105.93	CO	103.63	450			VC	36.71512	1 in 118
3107		CO		150			VC	11.12096	
2004	105.91	SW	103.77	300			VC	52.83938	1 in 182
3101	105.75	CO	104.22	225			VC	13.0384	1 in 163
2101	105.84	SW	103.62	300			VC	20	
1107	104.92	SW	103.37	225			VC	46.40043	1 in 23
1002	105.78	CO	102.93	225			VC	26.07681	1 in 174
4402		CO		150			VC	23.43096	
1904	104.63	SW	100.71	300			VC	14.31782	1 in 95
0005	109.04	CO	106.69	225			VC	4.472136	1 in 50
0951	109.55	SW	105.4	150			VC	77.41447	1 in 46
0902	108.69	CO	105.73	225			VC	66.19468	1 in 66
3211		CO		150			VC	9.097001	
0101	105.71	SW	104.21	225			VC	116.5032	1 in 40

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad

LEGEND

	Abandoned	Foul	Surface Water	Combined
Public Sewer	→	→	→	→
Private Sewer		- - → - -	- - → - -	- - → - -
Section 104		- — → — -	- — → — -	- — → — -
Rising Main	┼┼→┼┼	┼┼→┼┼	┼┼→┼┼	┼┼→┼┼
Sludge Main	→	→		
Overflow	→	→		
Water Course	- - → - -	- - → - -		
Highway Drain	- - → - -	- - → - -		

All point assets follow the standard colour convention:
red - combined blue - surface water
brown - foul purple - overflow

- ● Manhole
- HS Head of System
- ES Extent of Survey
- RE Rodding Eye
- IN Inlet
- DP Discharge Point
- HY Vortex
- PE Penstock
- WO Washout Chamber
- VA Valve
- AV Air Valve
- NRV Non Return Valve
- SO Soakaway
- GU Gully
- CA Cascade
- FM Flow Meter
- HA Hatch Box
- OI Oil Interceptor
- SM Summit
- DS Drop Shaft
- OP Orifice Plate
- Side Entry Manhole
- (Outfall
- ▦ Screen Chamber
- IC Inspection Chamber
- Bifurcation Chamber
- LH Lamp Hole
- T Junction / Saddle
- CA Catchpit
- VC Valve Chamber
- Vent Column
- Vortex Chamber
- Penstock Chamber
- Network Storage Tank
- Sewer Overflow
- WwTW Ww Treatment Works
- ▲ Ww Pumping Station
- ST Septic Tank
- CK Control Kiosk
- ▽ Change of Characteristic

MANHOLE FUNCTION

FO	Foul
SW	Surface Water
CO	Combined
OV	Overflow

SEWER SHAPE

CI	Circular	TR	Trapezoidal
EG	Egg	AR	Arch
OV	Oval	BA	Barrel
FT	Flat Top	HO	HorseShoe
RE	Rectangular	UN	Unspecified
SQ	Square		

SEWER MATERIAL

AC	Asbestos Cement
BR	Brick
PE	Polyethylene
RP	Reinforced Plastic Matrix
CO	Concrete
CSB	Concrete Segment Bolted
CSU	Concrete Segment Unbolted
CC	Concrete Box Culverted
PSC	Plastic / Steel Composite
GRC	Glass Reinforecd Plastic
DI	Ductile Iron
PVC	Polyvinyl Chloride
CI	Cast Iron
SI	Spun Iron
ST	Steel
VC	Vitrified Clay
PP	Polypropylene
PF	Pitch Fibre
MAC	Masonry, Coursed
MAR	Masonry, Random
U	Unspecified

Address or Site Reference:

G1.2,

OS sheet Number: SD8205SW
Scale: 1:1250 **Date:** 15/11/2019
Nodes: 131
Sheet: 2 of 7

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SEWER RECORDS

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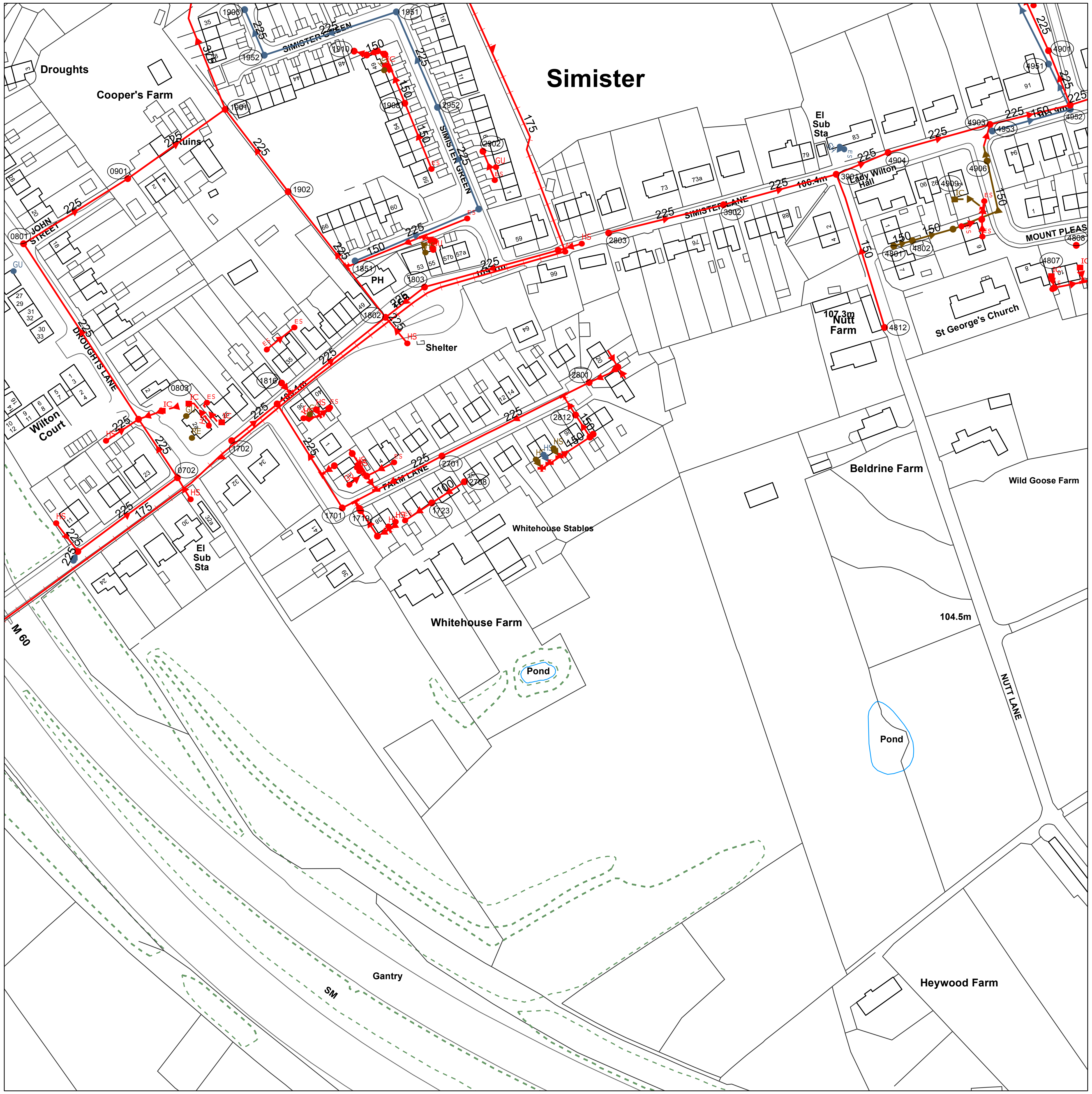
Simister
Droughts
Cooper's Farm
Ruins
JOHN STREET
DROUGHTS LANE
Wilton Court
SIMISTER GREEN
SIMISTER LANE
FARM LANE
MOUNT PLEAS
PH
Shelter
El Sub Sta
El Sub Sta
107.3m
Nutt Farm
106.4m
Lady Wilton Hall
St George's Church
Beldrine Farm
Wild Goose Farm
Whitehouse Stables
Whitehouse Farm
Pond
Pond
104.5m
NUTT LANE
Heywood Farm
Gantry
SM
M 60
225
150
175
100
0701
0702
0801
0802
0803
0901
1701
1702
1710
1723
1801
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1816
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1901
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1905
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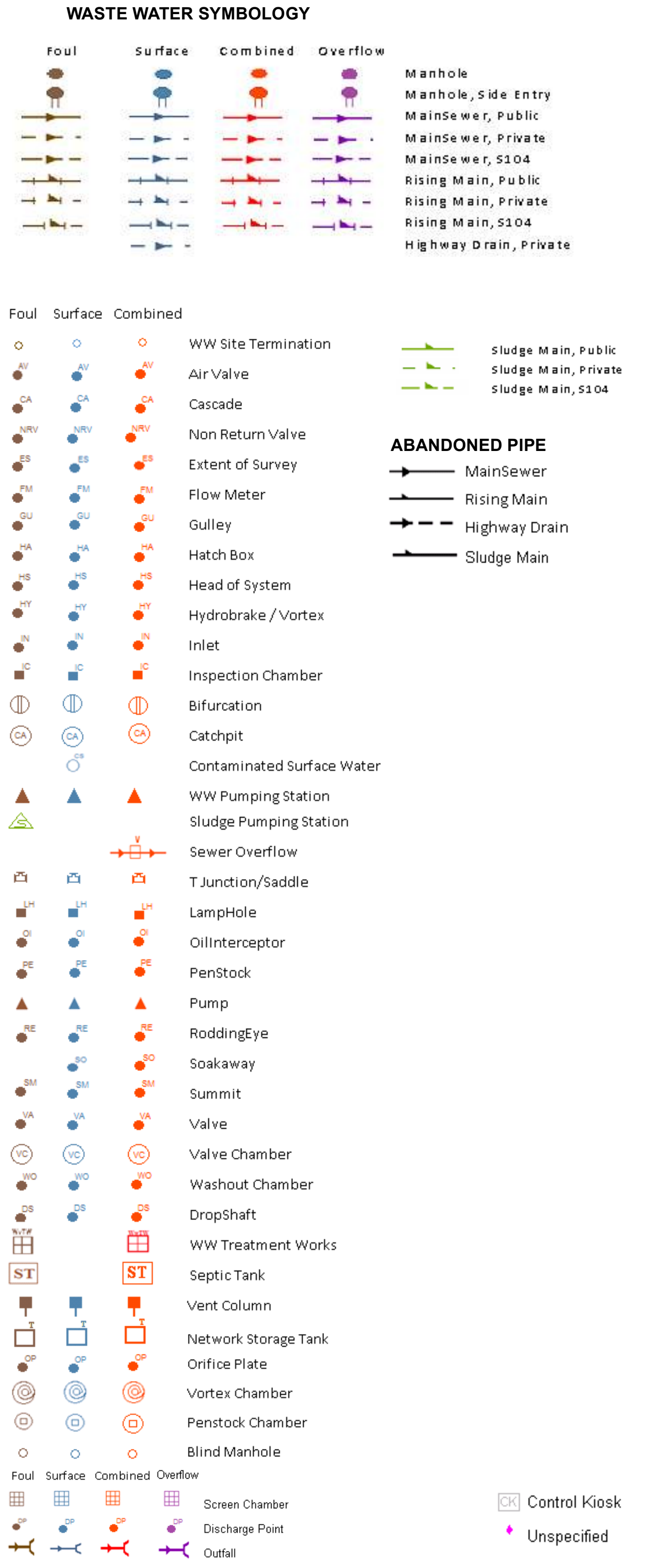
1951
1952
2701
2708
2801
2803
2812
3902
4801
4802
4807
4808
4812
4901
4903
4904
4906
4909
4951
4952
4953

Refno	Cover	Func	Invert	Size.x	Size.y	Shape	Matl	Length	Grad
0701	107.37	CO							
0702	107.99	CO							
0751	107.34	SW							
0801		CO							
0802	106.69	CO							
0803		CO							
0804		CO							
0901		CO							
1701	108.51	CO							
1702	108.6	CO	106.62	225		CI	VC	27.02	150
1704		CO		100		CI	VC	12.39	
1705		CO		100		CI	VC	7.96	
1715		CO		100		CI	VC	7.21	
1718		CO		100		CI	VC	13.97	
1719		CO		100		CI	VC	5.1	
1723		CO		100		CI	VC	14.72	
1801	109.09	CO							
1802	108.37	CO							
1803	108.58	CO	106.8	225		CI	VC	22.8	67
1807		CO		150		CI	VC	5.84	
1815		CO							
1816		CO		100		CI	VC	6.4	
1819		CO							
1824		CO							
1851		SW	0	225		CI	VC	61.85	
1901		CO							
1902		CO	0	225		CI	VC	47.8	
1903		SW							
1905		CO		150		CI	VC	5.33	
1906		CO							
1908		CO							
1909		CO							
1910		CO							
1911		CO		150		CI	VC	6.07	
1951	100.91	SW							
1952	100.65	SW							
2701	109.02	CO	107	225		CI	VC	51.88	741
2708		CO		100		CI	VC	17.98	
2801	108.5	CO							
2802	108.75	CO	107.31	225		CI	VC	64	136
2803	108.17	CO	106	225		CI	VC	54.57	57
2807		CO							
2810		CO		100		CI	VC	5.18	
2812		CO		150		CI	VC	10.72	
2813		CO		100		CI	VC	2	
2902		CO							
2951	107.01	SW							
2952	103.45	SW							
3901	106.48	CO							
3902	107.42	CO							
4801		FO		150		CI	VC	8.96	
4802		FO							
4803		FO							
4806		CO							
4807		CO							
4808		CO							
4809		CO							
4812		CO		150		CI	UN	74.11	
4901	102.82	CO	97.68	225		CI	VC	50.57	
4902	103.87	CO							
4903	104.37	CO	102.74	225		CI	VC	38.08	63
4904	105.92	CO	103.58	225		CI	VC	48.76	59
4906		FO							
4907		CO		100		CI	VC	8.52	
4909		FO							
4951	103.47	SW							
4952	104.03	SW							
4953	104.48	SW	103.4	150		CI	VC	37.36	57
0703		CO	0	225		CI	VC	16.4	
0704		CO	0	225		CI	VC	11.66	
0705		CO	0	225		CI	VC	18.03	
0805		CO							
0806		CO							
0809		SW							
0811		FO							
1703		CO							
1708		CO							
1709		CO							
1710		CO							
1716		CO							
1720		CO							
1804		CO	0	225		CI	VC	15.62	
1808		CO							
1810		FO							
1811		FO							
1812		CO							
1820		FO							
1821		CO							
1822		CO							
1825		CO							
1907		FO							
1913		CO							
1915		CO							
2703		FO							
2705		SW		100		CI	VC	4.89	
2707		FO							
2804		CO							
2805		CO	0	225		CI	VC	11.22	
2809		CO		100		CI	VC	9.09	
2811		CO		100		CI	VC	6.19	
2903		CO							
3904		SW							
4905		CO							
4005		CO	0	300		CI	VC	28.79	
1706		CO							
1711		CO							
1712		CO							
1713		CO							
1714		CO							
1717		CO							
1721		CO							
1809		CO							
1813		CO							
1814		CO							
1817		CO							
1818		CO		100		CI	VC	5.04	
1912		CO							
1914		CO							
2702		CO		150		CI	VC	26.53	
2704		CO							
2706		CO							
2806		CO	0	175		CI	PVC	375.89	
2808		CO							
4810		CO							
4910		CO							

Refno	Cover	Func	Invert	Size.x	Size.y	Shape	Matl	Length	Grad

WASTE WATER SYMBOLOGY


Foul
Surface
Combined
Overflow
Manhole
Manhole, Side Entry
MainSewer, Public
MainSewer, Private
MainSewer, S104
Rising Main, Public
Rising Main, Private
Rising Main, S104
Highway Drain, Private
Foul
Surface
Combined
WW Site Termination
Air Valve
Cascade
Non Return Valve
Extent of Survey
Flow Meter
Gulley
Hatch Box
Head of System
Hydrobrake / Vortex
Inlet
Inspection Chamber
Bifurcation
Catchpit
Contaminated Surface Water
WW Pumping Station
Sludge Pumping Station
Sewer Overflow
T Junction/Saddle
LampHole
OilInterceptor
Penstock
Pump
RoddingEye
Soakaway
Summit
Valve
Valve Chamber
Washout Chamber
DropShaft
WW Treatment Works
Septic Tank
Vent Column
Network Storage Tank
Orifice Plate
Vortex Chamber
Penstock Chamber
Blind Manhole
Sludge Main, Public
Sludge Main, Private
Sludge Main, S104
ABANDONED PIPE
MainSewer
Rising Main
Highway Drain
Sludge Main
Foul
Surface
Combined
Overflow
Screen Chamber
Discharge Point
Outfall
Control Kiosk
Unspecified

LEGEND

MANHOLE FUNCTION

FO	Foul
SW	Surface Water
CO	Combined
OV	Overflow

SEWER SHAPE

CI	Circular	TR	Trapezoidal
EG	Egg	AR	Arch
OV	Oval	BA	Barrel
FT	Flat Top	HO	HorseShoe
RE	Rectangular	UN	Unspecified
SQ	Square		

SEWER MATERIAL

AC	Asbestos Cement	DI	Ductile Iron
BR	Brick	PVC	Polyvinyl Chloride
PE	Polyethylene	CI	Cast Iron
RP	Reinforced Plastic Matrix	SI	Spun Iron
CO	Concrete	ST	Steel
CSB	Concrete Segment Bolted	VC	Vitrified Clay
CSU	Concrete Segment Unbolted	PP	Polypropylene
CC	Concrete Box Culverted	PF	Pitch Fibre
PSC	Plastic/Steel Composite	MAC	Masonry, Coursed
GRC	Glass Reinforced Concrete	MAR	Masonry, Random
GRP	Glass Reinforced Plastic	U	Unspecified

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OS Sheet No: SD8305NW
Scale: 1:1250 Date: 18/07/2017
125 Nodes
Sheet 1 of 1

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SEWER RECORDS

OS Sheet No: SD8305NW

Scale: 1:1250 Date: 18/07/2017

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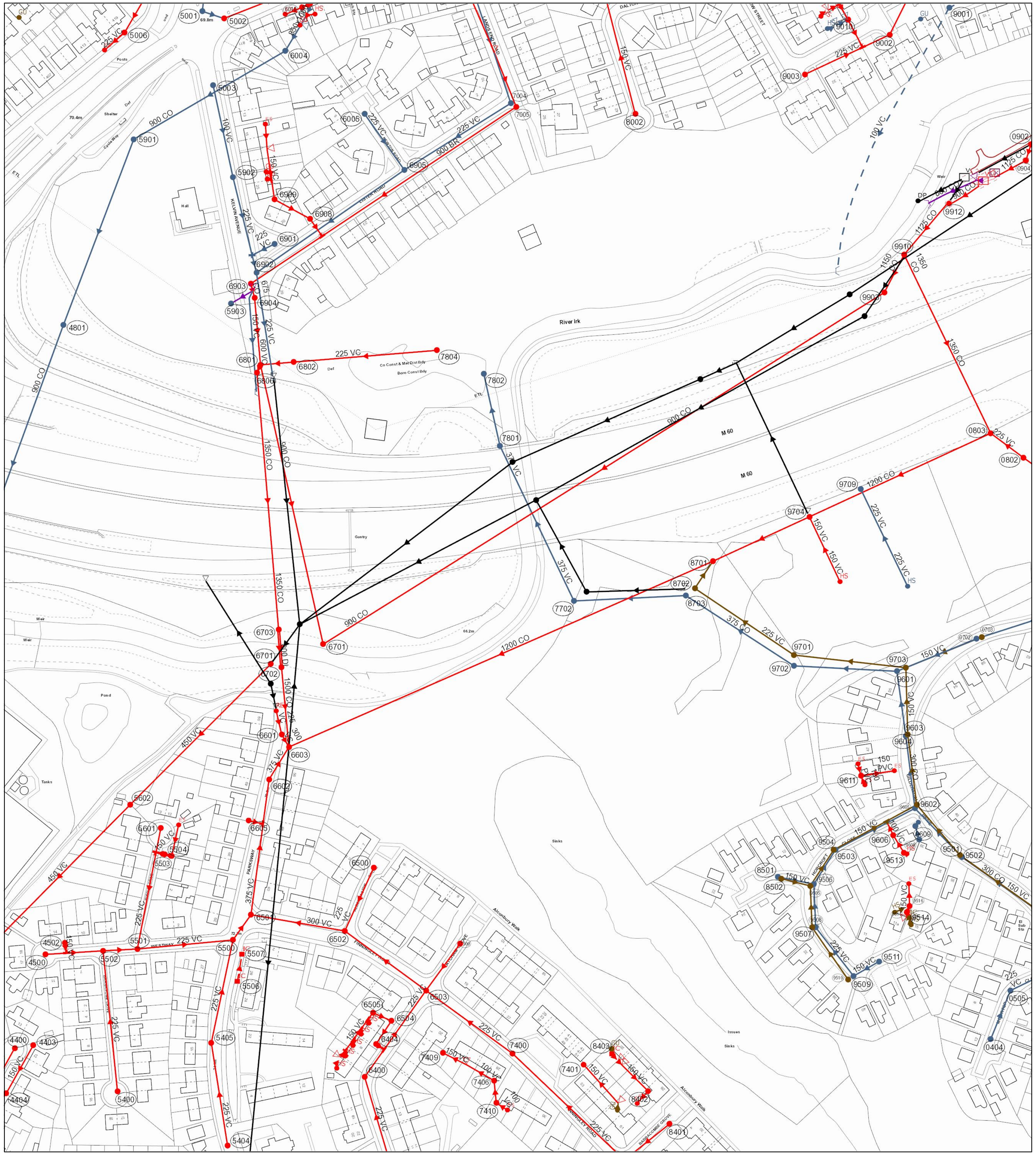

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

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Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad
6703	63.27	CO	60.65	800			DI	21.23	1 in 265
8703		SW	0	375			CO	62.07254	
6601	69.12	CO	65.42	300			VC	8.062258	
6602	69.9	CO	0	375			VC	21.09502	
9611		CO		150			PVC	18.61181	
8402		CO		150			VC	9.146832	
7804		CO	0	225			VC	79.51984	
5003		SW	0	100			VC	52.17279	
5003		SW	0	100			VC	52.17279	
7005	70.4	CO	66.54	900			BR	176.672	1 in 930
7005	70.4	CO	66.54	900			BR	176.672	1 in 930
5602		CO	0	450			VC	112.4322	
5602		CO	0	450			VC	112.4322	
8002		CO	0	150			VC	65	
8002		CO	0	150			VC	65	
0802		CO	0	225			VC	22.64229	
8401	83.25	CO	0	225			VC	32.01562	
6605		CO		150			VC	8.192343	
9702		SW	0	375			CO	71.56116	
9509	87.76	SW	85.53	225			VC	34.20526	1 in 13
5005		CO		225			VC	21.1353	
8501	83.72	SW	81.59	150			VC	20.39608	1 in 89
6802		CO	0	225			VC	18.51408	
9510	87.82	FO	85.97	150			VC	35.22783	1 in 13
9501	87.6	SW	84.91	300			CO	37.48333	1 in 14
6003	69.55	SW	65.74	850			BR	17	1 in 36
6505		CO		150			VC	11.20077	
9508	85.23	FO	83.07	150			VC	23.02173	1 in 16
6404		CO		150			VC	5.401882	
9506	83.76	SW	81.2	225			VC	22.4722	1 in 187
0803	73.67	CO	62.7	1200			CO	110.6828	1 in 209
6504		CO		150			VC	15.52236	
7500	77.99	CO	75.39	225			VC	32.20248	1 in 22
7001	70.53	SW	69.43	225			VC	72.73238	
5002	69.77	CO	0	375			VC	54.78138	
5002	69.77	CO	0	375			VC	54.78138	
5405	74.36	CO	72.25	225			VC	58.24946	1 in 38
9002		CO	0	225			VC	62.60991	
9002		CO	0	225			VC	62.60991	
7801		SW	0	375			VC	41	
6901	69.55	SW	0	225			VC	13.88078	
6901	69.55	SW	0	225			VC	13.88078	
7004		SW	0	225			VC	69.64194	
7004		SW	0	225			VC	69.64194	
5501	70.04	CO	66.53	225			VC	53.23532	1 in 205
0904	68.28	CO	65.83	1125			CO	19.71212	1 in 60
0904	68.28	CO	65.83	1125			CO	19.71212	1 in 60
6908		CO		150			VC	11.74628	
6908		CO		150			VC	11.74628	
6004	69.76	SW	0	900			CO	97.24711	
6004	69.76	SW	0	900			CO	97.24711	
6703	63.27	CO	60.65	800			CO	21.19462	1 in 265
5901	70.91	SW	0	900			CO	110.1363	
5901	70.91	SW	0	900			CO	110.1363	
4400	68.82	CO	67.05	225			VC	72.06941	1 in 58
4400	68.82	CO	67.05	225			VC	72.06941	1 in 58
0902	68.31	CO	65.92	1125			CO	9.389579	1 in 104
0902	68.31	CO	65.92	1125			CO	9.389579	1 in 104
5500	72.58	CO	66.26	225			VC	17.20465	
6801	65.31	CO	0	900			CO	158.7756	
9604	82.15	FO	79.67	150			VC	37.01351	
4403		CO		150			VC	30.66866	
4403		CO		150			VC	30.66866	
0702	82.85	SW	79.64	150			VC	47.53946	
9912	67.55	CO	65.55	1125			CO	37.77274	
9912	67.55	CO	65.55	1125			CO	37.77274	
6909		CO		150			VC	22.41766	
6909		CO		150			VC	22.41766	
9507	85.3	SW	82.82	225			VC	24.02082	1 in 15
9603	82.19	SW	79.37	300			CO	36.34556	
0505	93.74	SW	91.45	225			VC	34.43835	1 in 215
9511	88.07	SW	0	150			VC	16.12452	
9605	84.55	SW	80.71	300			CO	40.31129	1 in 31
5902		SW	0	225			VC	44.55107	
5902		SW	0	225			VC	44.55107	
9516		CO		150			VC	12.34136	
9001		SW		100			VC	159.9999	
9001		SW		100			VC	159.9999	
9515		CO		150			VC	3.759029	
5001		SW	0	150			VC	12.64911	
5001		SW	0	150			VC	12.64911	
6903	69.14	CO	66.11	675			CO	8.246211	
6904	68.98	CO	65.37	600			VC	37.21489	1 in 10
9910	66.46	CO	63.14	1350			CO	110.032	1 in 250
6502	73.39	CO	70.79	300			VC	52.7731	1 in 66
5115		SW	0	150			VC	82.58644	
6400	77.53	CO	75.18	225			VC	58.82177	1 in 37
5504		CO		150			VC	4.986892	
9910	66.46	CO	63.14	1150			CO	23.74042	
8702		FO	0	225			VC	18.02776	
6902	69.18	SW	67.43	225			VC	57.70615	
9703		FO	0	225			VC	62.39391	
9608		SW		0			VC	7.761896	
6010		CO		150			VC	10.07087	
6010		CO		150			VC	10.07087	
4500	68.73	CO	67.06	225			VC	32.06244	1 in 134
4500	68.73	CO	67.06	225			VC	32.06244	1 in 134
6701		CO	0	450			VC	110.3087	
0904	68.28	CO		0			UN	6.38147	
0904	68.28	CO		0			UN	6.38147	
9003		CO	0	225			VC	51.89412	
9003		CO	0	225			VC	51.89412	
0703	82.72	FO	79.9	150			VC	45.31004	
5503		CO		150			VC	4.109229	
7702		SW	0	375			VC	95.27329	
5006		CO		225			VC	14.83492	
5006		CO		225			VC	14.83492	
5006		CO		225			VC	14.83492	
5006		CO		225			VC	14.83492	
5502	69.61	CO	66.81	225			VC	19.0263	1 in 73
5502	69.61	CO	66.81	225			VC	19.0263	1 in 73
4801	73.45	SW	70.91	900			CO	163.8658	
4801	73.45	SW	70.91	900			CO	163.8658	
6702	63.27	CO	60.57	1500			CO	44.41994	1 in 202
8502	83.76	FO	81.84	150			VC	16.49242	1 in 92
9704		CO	62.17	1200			CO	58.89605	1 in 88
6905		SW	0	225			VC	99.86491	
6905		SW	0	225			VC	99.86491	
6503	75.89	CO	72.66	300			VC	55.80323	1 in 67
9701		FO	0	225			VC	66.28725	
5404	76.02	CO	73.76	225			VC	57.70615	1 in 39
8701	76.32	CO	61.5	1200			CO	256.5814	1 in 223
7410		CO		100			VC	12.4263	
6500	76.03	CO	73.34	225			VC	38.48376	1 in 15
9504	83.63	SW	81.04	225			VC	49.64877	1 in 165
6005		SW	0	225			VC	38.01316	
6005		SW	0	225			VC	38.01316	
5601	69.05	CO	67.2	225			VC	68.24954	1 in 108
5400	71.76	CO	69.91	225			VC	78.40918	1 in 38
5400	71.76	CO	69.91	225			VC	78.40918	1 in 38
9903		CO	0	900			CO	367.0776	
4404		CO		150			VC	15.44606	
4404		CO		150			VC	15.44606	
6806		CO	0	1350			CO	142.925	
9601		SW	0	375			CO	57.07889	
0404	93.5	SW	91.63	225			VC	29.15476	1 in 182
6501	72.11	CO	69.98	375			VC	75.66444	1 in 17
7406		CO		100			VC	17.60476	
9609		SW		0			VC	2.501009	
6801	65.31	CO	61.36	1350			CO	4.745431	
9502	86.94	FO	84.58	150			VC	36.87818	1 in 18
4502		CO		150			VC	5.74484	
4502		CO		150			VC	5.74484	
9503	83.64	FO	81.42	150			VC	52.35456	1 in 154
7400	79.67	CO	77.04	225			VC	59.40539	1 in 20
9513		CO		100			VC	11.397	
9602	84.53	FO	81.01	150			VC	39.31921	1 in 31
9505	83.83	FO	81.61	150			VC	23.85372	1 in 149
9606		CO		100			VC	8.653045	

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad

LEGEND

Abandoned	Foul	Surface Water	Combined	
—▸—	—▸—	—▸—	—▸—	Public Sewer
	- -▸- -	- -▸- -	- -▸- -	Private Sewer
	-–▸-–	-–▸-–	-–▸-–	Section 104
++▸++	++▸++	++▸++	++▸++	Rising Main
—▸—	—▸—			Sludge Main
—▸—	—▸—			Overflow
- -▸- -	- -▸- -			Water Course
- -▸- -	- -▸- -			Highway Drain

All point assets follow the standard colour convention:
red - combined blue - surface water
brown - foul purple - overflow

● Manhole
HS Head of System
ES Extent of Survey
RE Rodding Eye
IN Inlet
DP Discharge Point
HY Vortex
PE Penstock
WO Washout Chamber
VA Valve
AV Air Valve
NRV Non Return Valve
SO Soakaway
GU Gully
CA Cascade
FM Flow Meter
HA Hatch Box
OI Oil Interceptor
SM Summit
DS Drop Shaft
OP Orifice Plate

Side Entry Manhole
Outfall
Screen Chamber
IC Inspection Chamber
Bifurcation Chamber
LH Lamp Hole
T Junction / Saddle
CA Catchpit
VC Valve Chamber
Vent Column
Vortex Chamber
Penstock Chamber
Network Storage Tank
Sewer Overflow
WwTW Ww Treatment Works
▲ Ww Pumping Station
ST Septic Tank
CK Control Kiosk

▽ Change of Characteristic

MANHOLE FUNCTION

FO	Foul
SW	Surface Water
CO	Combined
OV	Overflow

SEWER SHAPE

CI	Circular	TR	Trapezoidal
EG	Egg	AR	Arch
OV	Oval	BA	Barrel
FT	Flat Top	HO	HorseShoe
RE	Rectangular	UN	Unspecified
SQ	Square		

SEWER MATERIAL

AC	Asbestos Cement
BR	Brick
PE	Polyethylene
RP	Reinforced Plastic Matrix
CO	Concrete
CSB	Concrete Segment Bolted
CSU	Concrete Segment Unbolted
CC	Concrete Box Culverted
PSC	Plastic / Steel Composite
GRC	Glass Reinforecd Plastic
DI	Ductile Iron
PVC	Polyvinyl Chloride
CI	Cast Iron
SI	Spun Iron
ST	Steel
VC	Vitrified Clay
PP	Polypropylene
PF	Pitch Fibre
MAC	Masonry, Coursed
MAR	Masonry, Random
U	Unspecified

Address or Site Reference:

Simister wide plan,

OS sheet Number: SD8404NE
Scale: 1:1250 **Date:** 07/05/2019
Nodes: 149
Sheet: 17 of 20

Printed by: Property Searches

SEWER RECORDS

United Utilities
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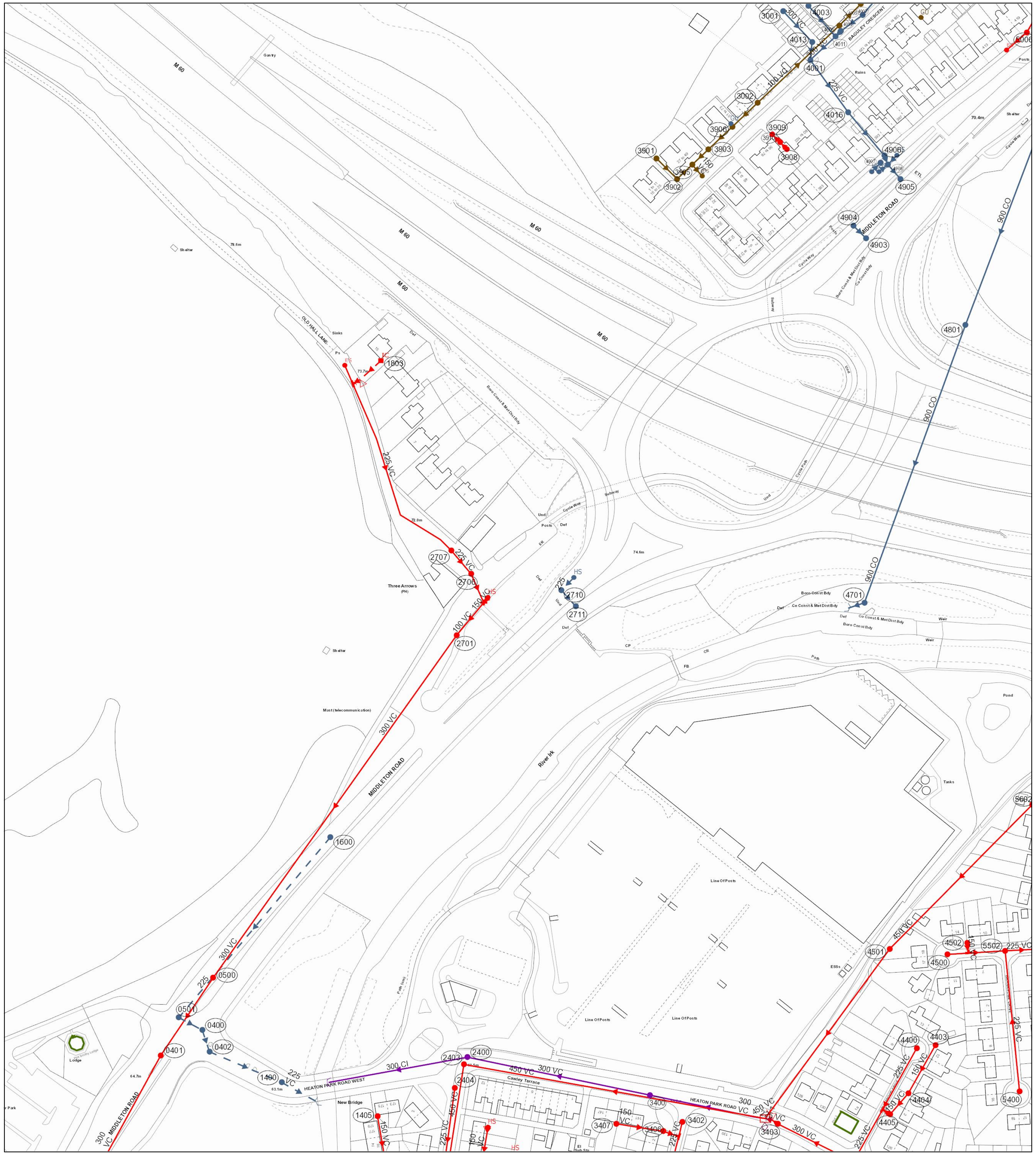
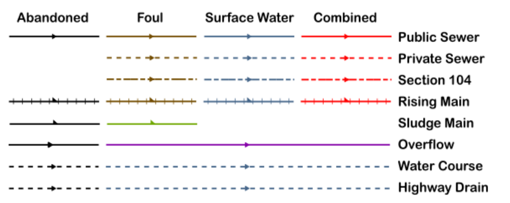

M 60
Gantry
3001
4003
4013
4011
4001
3002
100 VC
225 VC
4016
3909
3906
3903
3908
3901
3905
3902
4906
4905
4904
4903
MIDDLETON ROAD
BAGULEY CRESCENT
900 CO
4801
70.4m
Shelter
Cycle Way
78.8m
OLD HALL LANE
Sinks
1803
225 VC
2707
2706
2701
150 VC
100 VC
2710
2711
HS
Three Arrows (PH)
Posts
4701
Boro Const Bdy
Co Const & Met Dist Bdy
Weir
Path
74.9m
Mast (telecommunication)
300 VC
MIDDLETON ROAD
River Irk
Pond
Tanks
5602
1600
Line Of Posts
ESSs
300 VC
0500
225
0501
0400
0402
0401
Lodge
1400
1405
HEATON PARK ROAD WEST
New Bridge
2403
2400
2404
300 CI
450 VC
300 VC
Cawley Terrace
3400
3407
3406
3402
3403
HEATON PARK ROAD
4501
4502
4500
5502
225 VC
4400
4403
4404
4405
5400
150 VC

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad
3903		FO		100			VC	18.17553	
3903		FO		100			VC	18.17553	
1600	72.11	SW	70.23	225				130.5986	1 in 25
0402	64.68	SW	62.79	225				43.46263	1 in 36
3001	75.78	SW	74.28	300			VC	23.34524	1 in 40
3001	75.78	SW	74.28	300			VC	23.34524	1 in 40
2404	63.72	CO	62.33	225			VC	58.54913	1 in 122
3901		FO		100			VC	16.13335	
3901		FO		100			VC	16.13335	
0401	65.19	CO	60.41	300			VC	168.7157	1 in 174
4006	76.3	FO	75.61	150			VC	16.97056	1 in 242
4006	76.3	FO	75.61	150			VC	16.97056	1 in 242
4016	74.47	SW	0	225			VC	31.241	
4016	74.47	SW	0	225			VC	31.241	
4001	75.06	SW	72.89	225			VC	35.80503	
4001	75.06	SW	72.89	225			VC	35.80503	
4007	76.25	FO	75.53	150			VC	18.43909	
4007	76.25	FO	75.53	150			VC	18.43909	
2400	63.5	OV	61.37	300			CI	78.26238	1 in 36
5602		CO	0	450			VC	112.4322	
5602		CO	0	450			VC	112.4322	
2701	71.88	CO	0	300			VC	233.0772	
4005		SW	0	225			VC	15	
4005		SW	0	225			VC	15	
3905		FO		150			VC	8.402295	
3905		FO		150			VC	8.402295	
4015	75.34	SW	73.51	225			VC	4.24264	1 in 47
4015	75.34	SW	73.51	225			VC	4.24264	1 in 47
4701		SW	0	900			CO	9.486833	
3403	67.37	CO	64.64	300			VC	3.605551	1 in 90
2707	71.38	CO	0	225			VC	17.02939	
3908		CO		100			VC	5.348752	
3908		CO		100			VC	5.348752	
4908	71.49	SW	69.55	225			VC	10.63015	1 in 22
4908	71.49	SW	69.55	225			VC	10.63015	1 in 22
3400	65.73	OV	63.11	300			VC	103.1601	1 in 60
5005		CO		225			VC	21.1353	
3910		CO		100			VC	6.1593	
3910		CO		100			VC	6.1593	
4013	75.2	SW	73.67	225			VC	10.04988	1 in 14
4013	75.2	SW	73.67	225			VC	10.04988	1 in 14
0400	65.74	SW	64.24	225				12.64911	1 in 10
4500	68.73	CO	67.06	225			VC	32.06244	1 in 134
4500	68.73	CO	67.06	225			VC	32.06244	1 in 134
6701		CO	0	450			VC	110.3087	
4011	74.98	SW	73.44	300			VC	19.10497	1 in 60
4011	74.98	SW	73.44	300			VC	19.10497	1 in 60
5006		CO		225			VC	14.83492	
5006		CO		225			VC	14.83492	
5006		CO		225			VC	14.83492	
5006		CO		225			VC	14.83492	
4012	76	SW	74.12	225			VC	18.43909	
4906	71.46	SW	69.72	225			VC	5.385165	1 in 36
4906	71.46	SW	69.72	225			VC	5.385165	1 in 36
5502	69.61	CO	66.81	225			VC	19.0263	1 in 73
5502	69.61	CO	66.81	225			VC	19.0263	1 in 73
4801	73.45	SW	70.91	900			CO	163.8658	
4801	73.45	SW	70.91	900			CO	163.8658	
3902		FO		100			VC	12.4241	
3902		FO		100			VC	12.4241	
4405		CO		150			VC	4.92371	
2710	74.32	SW	72.77	225				12.04159	1 in 33
1400	63.3	SW	60.47	225			VC	22.82542	1 in 16
2403	63.62	CO	55.68	450			VC	149.7765	1 in 174
3903		FO		100			VC	19.19835	
3903		FO		100			VC	19.19835	
3903		FO		100			VC	62.32206	
3903		FO		100			VC	62.32206	
2706	71.31	CO	69.16	225			VC	17.46425	
5400	71.76	CO	69.91	225			VC	78.40918	1 in 38
5400	71.76	CO	69.91	225			VC	78.40918	1 in 38
4003		SW	0	225			VC	22.67157	
4003		SW	0	225			VC	22.67157	
1405		CO		150			VC	31.39963	
4904	73.05	SW	71.2	225			VC	9.899495	1 in 14
4904	73.05	SW	71.2	225			VC	9.899495	1 in 14
5901	70.91	SW	0	900			CO	110.1363	
5901	70.91	SW	0	900			CO	110.1363	
3902		FO		100			VC	11.56015	
3902		FO		100			VC	11.56015	
4400	68.82	CO	67.05	225			VC	72.06941	1 in 58
4400	68.82	CO	67.05	225			VC	72.06941	1 in 58
4404		CO		150			VC	15.44606	
4404		CO		150			VC	15.44606	
4004		SW	0	225			VC	14.76482	
0500	67.45	CO	61.72	300			VC	51.86521	1 in 98
4403		CO		150			VC	30.66866	
4403		CO		150			VC	30.66866	
0501	66.13	SW	64.92	225				14.76482	1 in 25
4502		CO		150			VC	5.74484	
4502		CO		150			VC	5.74484	
3402	66.39	CO	64.49	225			VC	54.57404	1 in 114
4501		CO	0	450			VC	116.6062	
3406		CO		150			VC	9.175671	

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad

LEGEND


Abandoned
Foul
Surface Water
Combined
Public Sewer
Private Sewer
Section 104
Rising Main
Sludge Main
Overflow
Water Course
Highway Drain

All point assets follow the standard colour convention:
red - combined blue - surface water
brown - foul purple - overflow

- ● Manhole
- ● HS Head of System
- ● ES Extent of Survey
- ● RE Rodding Eye
- ● IN Inlet
- ● DP Discharge Point
- ● HY Vortex
- ● PE Penstock
- ● WO Washout Chamber
- ● VA Valve
- ● AV Air Valve
- ● NRV Non Return Valve
- ● SO Soakaway
- ● GU Gully
- ● CA Cascade
- ● FM Flow Meter
- ● HA Hatch Box
- ● OI Oil Interceptor
- ● SM Summit
- ● DS Drop Shaft
- ● OP Orifice Plate
- Side Entry Manhole
- (Outfall
- ▦ Screen Chamber
- ■ IC Inspection Chamber
- ⦶ Bifurcation Chamber
- ■ LH Lamp Hole
- T Junction / Saddle
- Ⓒ CA Catchpit
- VC Valve Chamber
- Vent Column
- ◎ Vortex Chamber
- Penstock Chamber
- ☐ T Network Storage Tank
- ☐ V Sewer Overflow
- WwTW Ww Treatment Works
- ▲ Ww Pumping Station
- ST Septic Tank
- CK Control Kiosk
- ▽ Change of Characteristic

MANHOLE FUNCTION

FO	Foul
SW	Surface Water
CO	Combined
OV	Overflow

SEWER SHAPE

CI	Circular	TR	Trapezoidal
EG	Egg	AR	Arch
OV	Oval	BA	Barrel
FT	Flat Top	HO	HorseShoe
RE	Rectangular	UN	Unspecified
SQ	Square		

SEWER MATERIAL

AC	Asbestos Cement
BR	Brick
PE	Polyethylene
RP	Reinforced Plastic Matrix
CO	Concrete
CSB	Concrete Segment Bolted
CSU	Concrete Segment Unbolted
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PSC	Plastic / Steel Composite
GRC	Glass Reinforced Plastic
DI	Ductile Iron
PVC	Polyvinyl Chloride
CI	Cast Iron
SI	Spun Iron
ST	Steel
VC	Vitrified Clay
PP	Polypropylene
PF	Pitch Fibre
MAC	Masonry, Coursed
MAR	Masonry, Random
U	Unspecified

Address or Site Reference:

Simister wide plan,

OS sheet Number: SD8404NW
Scale: 1:1250 **Date:** 07/05/2019
Nodes: 94
Sheet: 3 of 20

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SEWER RECORDS

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The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

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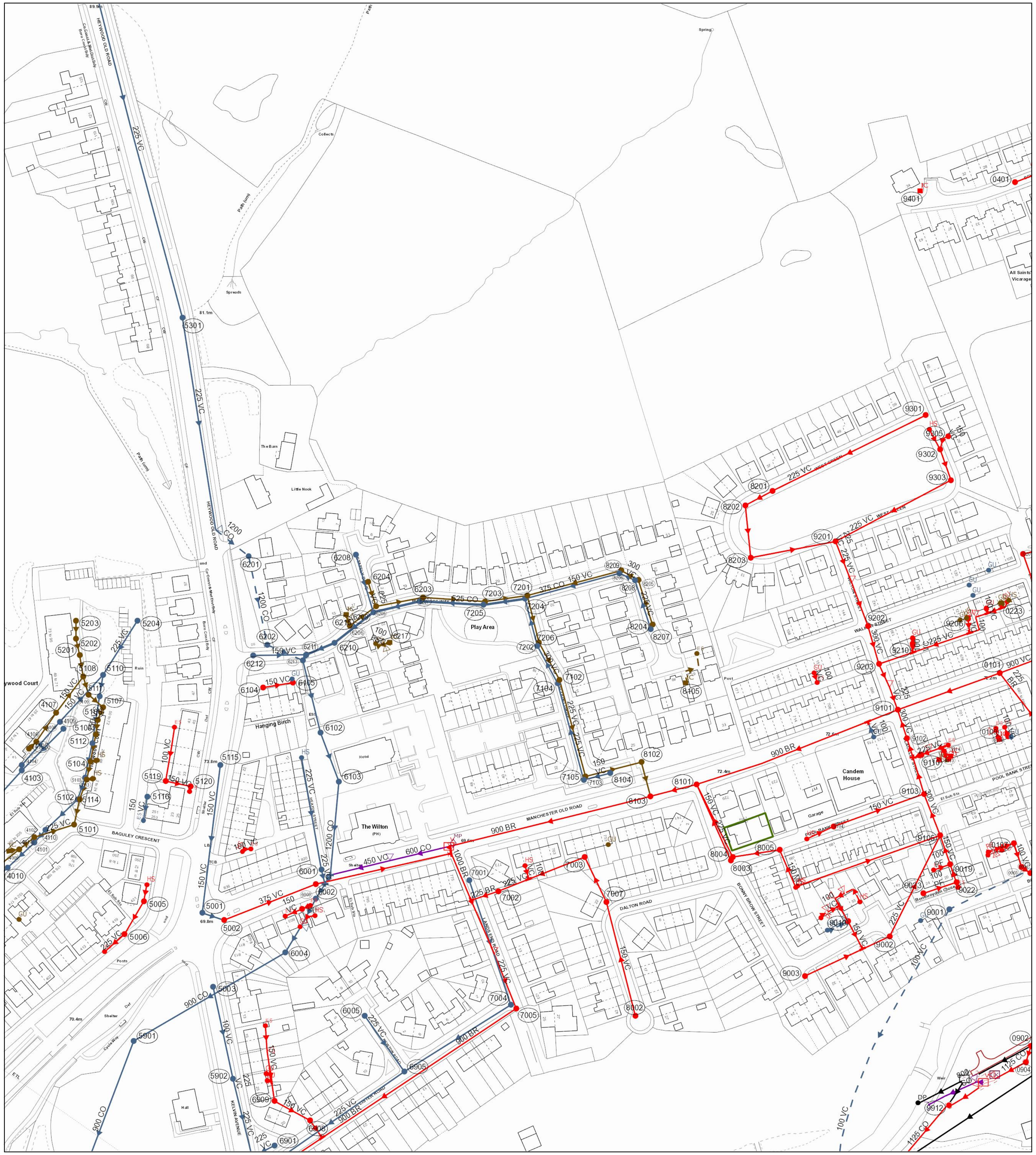

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad
6201	73.66	SW		1200			CO	21.55676	
9301	74.44	CO	72.74	225			VC	94.81033	
5102		FO	0	150			VC	14.31782	
5102		FO	0	150			VC	14.31782	
0107		CO		100			VC	13.93157	
7201		FO	68.69	225			VC	26.80562	1 in 148.920099
7202		FO	68.51	225			VC	23.6735	1 in 147.959399
9023		CO		100			PF	19.26357	
6211		SW	69.28	0			UN	3.722638	1 in 5.39512814
4105	87.51	FO	86.8	150			VC	5.656854	1 in 40
4105	87.51	FO	86.8	150			VC	5.656854	1 in 40
9305		CO		150			VC	9.40594	
5108		FO	0	150			VC	10.44031	
5108		FO	0	150			VC	10.44031	
5204		SW	0	225			VC	35.51056	
5003		SW	0	100			VC	52.17279	
5003		SW	0	100			VC	52.17279	
7005	70.4	CO	66.54	900			BR	176.672	1 in 930
7005	70.4	CO	66.54	900			BR	176.672	1 in 930
6201	73.66	SW		1200			CO	52.06475	
8002		CO	0	150			VC	65	
8002		CO	0	150			VC	65	
9101	72.35	CO	67.27	900			BR	118.8311	1 in 424
5107		FO	0	150			VC	7.615773	
5107		FO	0	150			VC	7.615773	
5203		FO	0	150			VC	10	
5203		FO	0	150			VC	10	
8209		SW	69.97	375			CO	54.27714	1 in 246.714269
5005		CO		225			VC	21.1353	
9201	72.7	CO	0	225			VC	24.69818	
6212		SW	73	150			VC	29.38516	1 in 7.89923712
8206		FO	69.53	150			VC	53.89359	1 in 69.9916799
4106	87.23	FO	86.64	150			VC	19.41649	1 in 29
4106	87.23	FO	86.64	150			VC	19.41649	1 in 29
0104		CO		100			VC	5.510288	
6003	69.55	SW	65.74	850			BR	17	1 in 36
4008		FO	0	150			VC	27.55404	
7104		SW	70.05	300			VC	23.76045	1 in 125.054990
8004	72.54	CO	70.95	150			VC	44.97197	1 in 41
0401		CO		150			VC	43.66489	
0401		CO		150			VC	43.66489	
7001	70.53	SW	69.43	225			VC	72.73238	
5002	69.77	CO	0	375			VC	54.78138	
5002	69.77	CO	0	375			VC	54.78138	
5112	80.01	SW	77.47	225			VC	19.41649	1 in 15
5112	80.01	SW	77.47	225			VC	19.41649	1 in 15
9002		CO	0	225			VC	62.60991	
9002		CO	0	225			VC	62.60991	
8202		CO	0	225			VC	29.15476	
4110	77.14	SW	75.51	225			VC	9.219544	1 in 154
4110	77.14	SW	75.51	225			VC	9.219544	1 in 154
6901	69.55	SW	0	225			VC	13.88078	
6901	69.55	SW	0	225			VC	13.88078	
6204		FO	69.68	150			VC	14.36677	1 in 34.2066047
7004		SW	0	225			VC	69.64194	
7004		SW	0	225			VC	69.64194	
6203		FO	69.08	225			VC	34.50125	1 in 143.755192
9105	71.76	CO	68.32	300			VC	24.69818	1 in 112
0904	68.28	CO	65.83	1125			CO	19.71212	1 in 60
0904	68.28	CO	65.83	1125			CO	19.71212	1 in 60
6908		CO		150			VC	11.74628	
6908		CO		150			VC	11.74628	
6209		SW	69.39	525			CO	27.53191	1 in 393.313059
6004	69.76	SW	0	900			CO	97.24711	
6004	69.76	SW	0	900			CO	97.24711	
5202		FO	0	150			VC	9.219544	
5202		FO	0	150			VC	9.219544	
4108		SW	0	150			VC	35.38361	
4108		SW	0	150			VC	35.38361	
5901	70.91	SW	0	900			CO	110.1363	
5901	70.91	SW	0	900			CO	110.1363	
0902	68.31	CO	65.92	1125			CO	9.389579	1 in 104
0902	68.31	CO	65.92	1125			CO	9.389579	1 in 104
7003		CO	0	225			VC	51.62364	
5116		SW		150			VC	13.29401	
9303	73.21	CO	71.39	225			VC	72.47068	1 in 91
8208		SW	70.09	300			VC	9.425949	1 in 188.518990
8205		FO	69.64	150			VC	10.73486	1 in 97.5896139
4104	84.44	SW	83.07	150			VC	31.89044	
4104	84.44	SW	83.07	150			VC	31.89044	
8101	72.34	CO	0	900			BR	26.42491	
9104	72.25	CO	70.55	150			VC	53.14132	1 in 130
8203		CO	0	225			VC	47.85394	
9912	67.55	CO	65.55	1125			CO	37.77274	
9912	67.55	CO	65.55	1125			CO	37.77274	
4109	86.9	SW	83.23	225			VC	32.52691	
4109	86.9	SW	83.23	225			VC	32.52691	
6909		CO		150			VC	22.41766	
6909		CO		150			VC	22.41766	
0002		CO	0	225			VC	39.20459	
5111		SW	0	225			VC	26.30589	
5111		SW	0	225			VC	26.30589	
9110		CO	0	225			VC	4.817728	
6201	73.66	SW		1200			CO	50.21382	
9202	72.63	CO	69.86	300			VC	21.84033	1 in 70
5902		SW	0	225			VC	44.55107	
5902		SW	0	225			VC	44.55107	
5106		FO	0	150			VC	8.062258	
5106		FO	0	150			VC	8.062258	
4101	77.23	SW	75.42	225			VC	20.51828	1 in 22
4101	77.23	SW	75.42	225			VC	20.51828	1 in 22
7007		CO	0	225			VC	27.73085	
9001		SW		100			VC	159.9999	
9001		SW		100			VC	159.9999	
0101	72.36	CO	67.07	900			BR	60.18025	
5104		FO	0	150			VC	10.19804	
5104		FO	0	150			VC	10.19804	
6206		FO	70.02	150			VC	18.1475	1 in 23.8782949
5001		SW	0	150			VC	12.64911	
5001		SW	0	150			VC	12.64911	
6208		SW	70.5	225			VC	33.29655	1 in 29.9968889
6104		CO		150			VC	16.66387	
5201		FO	0	150			VC	12.16553	
5201		FO	0	150			VC	12.16553	
5105		FO	0	150			VC	15.29706	
5105		FO	0	150			VC	15.29706	
7203		FO	68.84	225			VC	23.64988	1 in 157.665854
7102		FO	68.35	225			VC	55.49141	1 in 149.976795
5301		SW	0	225			VC	119.0282	
5110		SW	0	225			VC	12.16553	
5110		SW	0	225			VC	12.16553	
0003		CO		100			VC	5.951587	
5115		SW	0	150			VC	82.58644	
9102	71.91	CO	0	300			VC	16.68775	
7103		FO	67.98	225			VC	31.94821	1 in 152.134353
8102		FO	67.77	225			VC	19.5756	1 in 150.581525
5601		SW	0	225			VC	252.2604	
5601		SW	0	225			VC	252.2604	
6010		CO		150			VC	10.07087	
6010		CO		150			VC	10.07087	
9203	72.64	CO	69.47	300			VC	14.31782	
0904	68.28	CO		0			UN	6.38147	
0904	68.28	CO		0			UN	6.38147	
9003		CO	0	225			VC	51.89412	
9003		CO	0	225			VC	51.89412	
6001		SW	0	225			VC	8.246211	
7204		SW	69.6	525			CO	23.30825	1 in 466.164960
6210		SW	69.32	525			CO	16.83529	1 in 420.882385
5006		CO		225			VC	14.83492	
5006		CO		225			VC	14.83492	
5006		CO		225			VC	14.83492	
5006		CO		225			VC	14.83492	
8003	72.61	CO	70.91	225			VC	46.35397	
4107	87.28	FO	85.9	150			VC	25	
4107	87.28	FO	85.9	150			VC	25	
9302	73.51	CO	71.56	225			VC	18.02776	1 in 120
6205		FO	69.26	225			VC	26.52715	1 in 147.373043
8204		FO	69.9	150			VC	26.05876	1 in 100.225992
9103	71.7	CO	68.08	300			VC	20.88061	
6905		SW	0	225			VC	99.86491	
6905		SW	0	225			VC	99.86491	
9022		CO		150			VC	10.54387	
4014		FO		150			VC	10.86471	
4014		FO		150			VC	10.86471	
5103		FO	0	150			VC	11.7047	
5103		FO	0	150			VC	11.7047	
8104		SW	70.9	150			VC	15.10808	1 in 100.720530
6201	73.66	SW		1200			CO	29.01177	
6005		SW	0	225			VC	38.01316	
6005		SW	0	225			VC	38.01316	
7105		SW	70.68	225			VC	55.34121	1 in 100.620374
8207		SW	70.35	225			VC	28.39871	1 in 149.466881
5113	78.94	SW	76.2	225			VC	12.64911	1 in 90
5113	78.94	SW	76.2	225			VC	12.64911	1 in 90
4103		SW	0	225			VC	84.95882	
4103		SW	0	225			VC	84.95882	
4102	77.67	FO	75.03	225			VC	23.08679	
4102	77.67	FO	75.03	225			VC	23.08679	
7205		SW	69.55	525			CO	35.18365	1 in 351.836522
6201	73.66	SW		1200			CO	41.17992	
8005	72.47	CO	71.48	150			VC	26.30589	1 in 51
8201		CO	0	225			VC	17	
6207		SW	69.45	525			CO	26.56135	1 in 442.689098
5114	77.22	SW	76.03	225			VC	24.75884	1 in 50
5114	77.22	SW	76.03	225			VC	24.75884	1 in 50
5109		FO	0	150			VC	10.63015	
5109		FO	0	150			VC	10.63015	
4010	76.46	SW	74.49	225			VC	19.10497	1 in 53
4010	76.46	SW	74.49	225			VC	19.10497	1 in 53
7206		SW	69.86	375			CO	26.96401	1 in 103.707736
0201	73.18	CO	69.92	300			VC	57.24509	
8101	72.34	CO	0	900			BR	115.131	
9210		CO		100			VC	4.808618	
5119		CO		150			VC	14.05871	
6002	69.24	CO	67.5	375			VC	76.90253	
7002		CO	0	225			BR	15.81139	
5120		CO		150			VC	2.970975	

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad

LEGEND

Abandoned Foul Surface Water Combined

Public Sewer
Private Sewer
Section 104
Rising Main
Sludge Main
Overflow
Water Course
Highway Drain

All point assets follow the standard colour convention:
red - combined blue - surface water
brown - foul purple - overflow

- Manhole
- Head of System
- Extent of Survey
- Rodding Eye
- Inlet
- Discharge Point
- Vortex
- Penstock
- Washout Chamber
- Valve
- Air Valve
- Non Return Valve
- Soakaway
- Gully
- Cascade
- Flow Meter
- Hatch Box
- Oil Interceptor
- Summit
- Drop Shaft
- Orifice Plate
- Side Entry Manhole
- Outfall
- Screen Chamber
- Inspection Chamber
- Bifurcation Chamber
- Lamp Hole
- T Junction / Saddle
- Catchpit
- Valve Chamber
- Vent Column
- Vortex Chamber
- Penstock Chamber
- Network Storage Tank
- Sewer Overflow
- Ww Treatment Works
- Ww Pumping Station
- Septic Tank
- Control Kiosk
- Change of Characteristic

MANHOLE FUNCTION

FO	Foul
SW	Surface Water
CO	Combined
OV	Overflow

SEWER SHAPE

CI	Circular	TR	Trapezoidal
EG	Egg	AR	Arch
OV	Oval	BA	Barrel
FT	Flat Top	HO	HorseShoe
RE	Rectangular	UN	Unspecified
SQ	Square		

SEWER MATERIAL

AC	Asbestos Cement
BR	Brick
PE	Polyethylene
RP	Reinforced Plastic Matrix
CO	Concrete
CSB	Concrete Segment Bolted
CSU	Concrete Segment Unbolted
CC	Concrete Box Culverted
PSC	Plastic / Steel Composite
GRC	Glass Reinforced Plastic
DI	Ductile Iron
PVC	Polyvinyl Chloride
CI	Cast Iron
SI	Spun Iron
ST	Steel
VC	Vitrified Clay
PP	Polypropylene
PF	Pitch Fibre
MAC	Masonry, Coursed
MAR	Masonry, Random
U	Unspecified

Address or Site Reference:

Simister wide plan,

OS sheet Number: SD8405SE
Scale: 1:1250
Date: 07/05/2019
Nodes: 187
Sheet: 18 of 20

Printed by: Property Searches

SEWER RECORDS

United Utilities
helping life flow smoothly

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

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APPENDIX C – Tetra Tech Hydraulic Modelling Report JPA 1.1

Northern Gateway

784-B048805

Hydraulic Modelling Report JPA 1.1

For Information

Northern Gateway Joint Venture Ltd

March 2025

Document prepared on behalf of Tetra Tech Limited. Registered in England number: 01959704

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Document:	Hydraulic Modelling Report JPA 1.1
Document name:	B048805-TTE-00-00-RP-MO-001
Project:	Northern Gateway
Client:	Northern Gateway Joint Venture Ltd
Project number:	784-B048805
File origin:	\\lds-dc-vm-101\Data\Projects\784-B048805_Northern_Gateway_2023\60 Project Output\61 Work in Progress\Flood\04 Hydraulic Modelling\JPA 1.1\Reporting\B048805-TTE-00-00-RP-MO-001 Hydraulic Modelling Report JPA1.1 P02.docx

Revision:	P01	**Prepared by:**	GC
Date:	18/10/2024	**Checked by:**	FH
Status:	For Information	**Approved by:**	FH
Description of revision:	First issue		

Revision:	P02	**Prepared by:**	AW
Date:	12/03/2025	**Checked by:**	FH
Status:	For Information	**Approved by:**	FH
Description of revision:	Updates to address EA review feedback		

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Appendices

Appendix A: Flood Estimation Report

Appendix B: Structures

Appendix C: Photos

Appendix D: Baseline Hydraulic Model Results

Appendix E: Sensitivity Test Results

Flood Frequencies

The frequency of a flood can be quoted in terms of a return period, which is defined as the average time between years with at least one larger flood, or as an annual exceedance probability (AEP), which is the inverse of the return period.

Return periods can be expressed more succinctly than AEP. However, AEP can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval.

The following table is provided to enable quick conversion between return periods and annual exceedance probabilities.

AEP (%)	50	20	10	5	3.33	2	1.33	1	0.5	0.1
AEP	0.5	0.2	0.1	0.05	0.033	0.02	0.013	0.01	0.005	0.001
Return Period (years)	2	5	10	20	30	50	75	100	200	1000

Disclaimer

This report has been prepared by Tetra Tech on behalf of Northern Gateway Joint Venture Ltd in connection with the scope of the report as described in Section 1.2 and considering the particular instructions and requirements set out in Tetra Tech's fee proposal and the Client's acceptance. It is not intended for and should not be relied on by any third party and no responsibility is undertaken to any third party.

Tetra Tech accepts no duty or responsibility (including in negligence) to any party other than Northern Gateway Joint Venture Ltd and disclaims all liability of any nature whatsoever to any such party in respect of this report. This report cannot be reproduced without Tetra Tech's written consent.

This assessment has been completed based on the best available data at the time of writing. Flood risk and climate change is an evolving science and therefore documents such as this should be revisited at regular intervals in the future when new flood risk and climate change information, guidance or data is published.

1.0 Introduction

1.1 Background

1.1.1 Tetra Tech have been appointed by Northern Gateway Joint Venture Ltd to undertake hydraulic modelling of watercourses within the Northern Gateway development site. The scope of this exercise is to gain a full understanding of the risk of flooding to the site and to demonstrate that the developed site would not be at risk of flooding up to and including the 1% AEP plus climate change event and will not cause an increase in flood risk elsewhere.

1.2 Scope

1.2.1 To establish a fluvial hydraulic model of the development site using data collected from topographical survey and available third-party data such as LiDAR Digital Terrain Model (DTM).

1.2.2 This hydraulic modelling is required to support the outline planning application for the development. The hydraulic model will be used to understand how the risk of fluvial flooding changes post development.

1.3 Purpose of this report

1.3.1 This report outlines the development of a hydraulic model that has been used to understand flood risk to the site and beyond. This technical report details the hydraulic modelling methods applied, assumptions made and the limitations within the approach. It details the data used together with the results of any quality assurance and validation checks.

1.4 Study area description

1.4.1 The study area is located north of Manchester on the east side of the M66 between Junctions 3 and 4, and the M60 between Junctions 18 and 19 on predominately greenfield land. The site is split into two parts, JPA 1.1 and JPA 1.2, which are situated on the north and south sides respectively of the M62 between Junctions 18 and 19. This is shown in Figure 1-1.

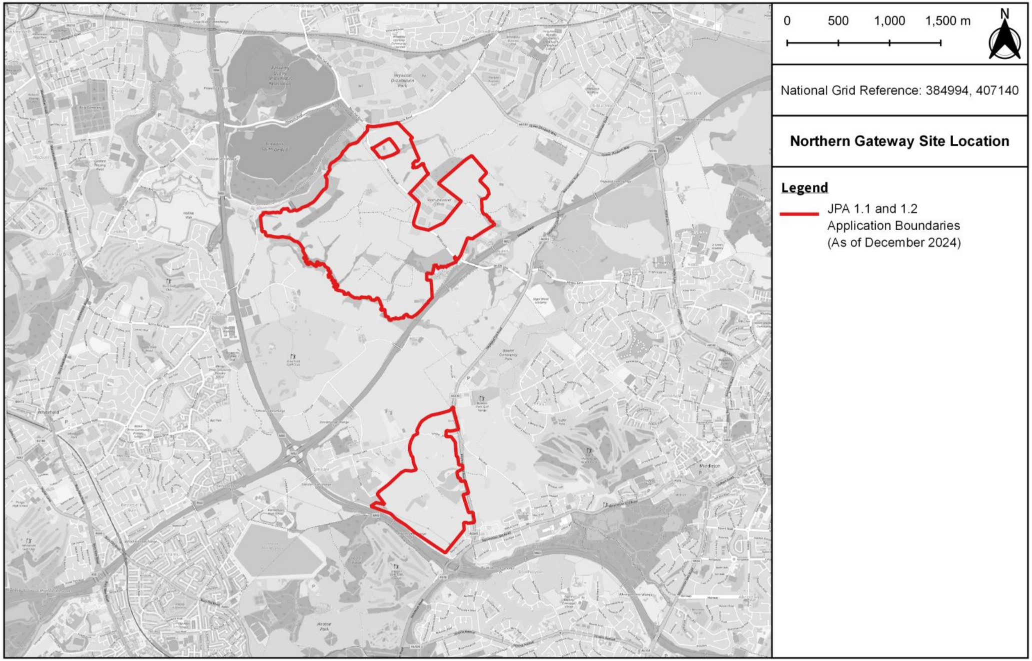
1.4.2 This report details the hydraulic modelling undertaken for the northern JPA 1.1 development site.

1.4.3 JPA 1.1 has a total area of approximately 4.5km^2 (450 hectares). There are several watercourses which flow through the site. On the JPA 1.1 site, there are the Hollins, Brightley, Castle and Whittle Brooks. There is also Mere Brook off site south of the M62 which confluences with Whittle Brook.

1.4.4 There is a reservoir approximately 41000m^2 in size situated immediately to the northwest of the site adjacent to Brightley Brook.

1.4.5 The site slopes from 138mAOD from its highest point in the central east of the site to 79mAOD in northwest of the site, as indicated in Figure 1-2. The east of the site is situated at higher elevations than the west of the site.

1.4.6 The existing Environment Agency (EA) Flood Risk Map for Planning, Figure 1-3, shows the existing flood zones on the site.


0
500
1,000
1,500 m
N
National Grid Reference: 384994, 407140
Northern Gateway Site Location
Legend
JPA 1.1 and 1.2
Application Boundaries
(As of December 2024)

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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Figure 1-1. Site location

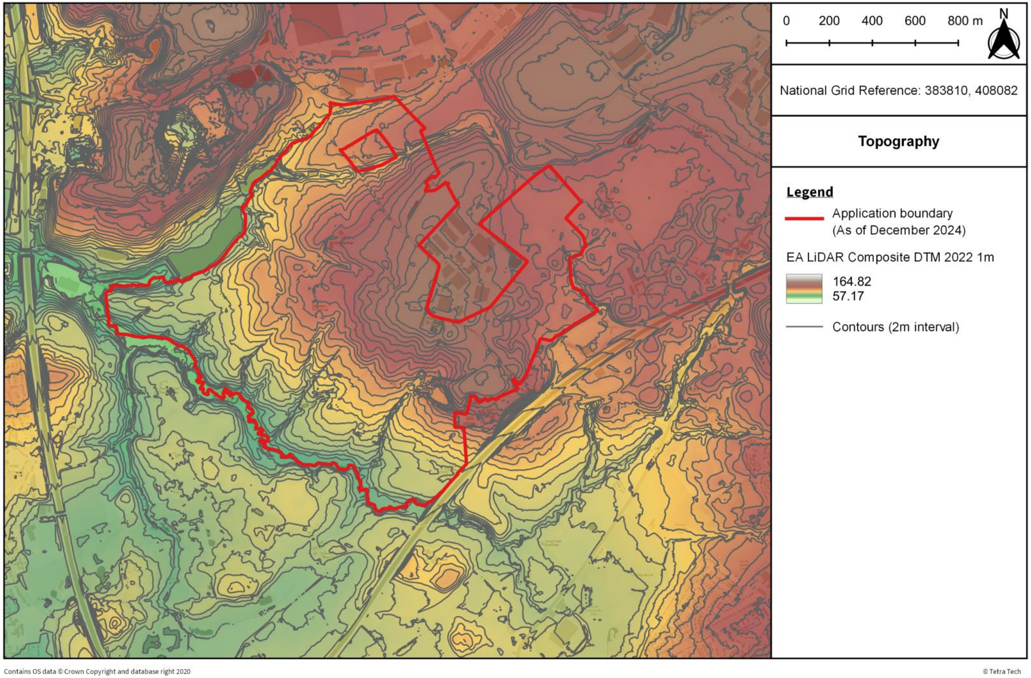
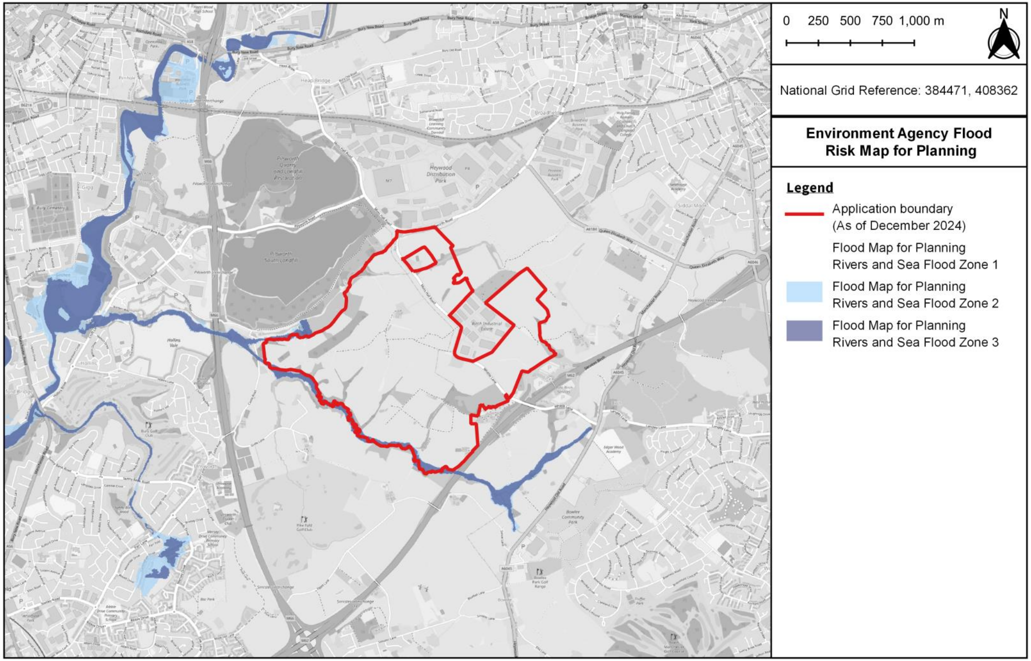

0
200
400
600
800 m
N
National Grid Reference: 383810, 408082
Topography
Legend
Application boundary (As of December 2024)
EA LiDAR Composite DTM 2022 1m
164.82
57.17
Contours (2m interval)
Contains OS data © Crown Copyright and database right 2020
© Tetra Tech

Figure 1-2. Study area topography


0 250 500 750 1,000 m
N
National Grid Reference: 384471, 408362
Environment Agency Flood Risk Map for Planning
Legend
Application boundary (As of December 2024)
Flood Map for Planning Rivers and Sea Flood Zone 1
Flood Map for Planning Rivers and Sea Flood Zone 2
Flood Map for Planning Rivers and Sea Flood Zone 3

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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Figure 1-3. EA Flood Risk Map for Planning

2.0 Available data

2.1 Data availability

Table 2-1. Project data

Data	Description	Source	Date
LiDAR	Environment Agency LiDAR Composite DTM 1m	EA	2022
Flood Mapping	Environment Agency maps showing flood risk to the site from surface water sources using high level modelling techniques	EA	2024
Hydraulic model of the River Roch	Environment Agency Flood Modeller TUFLOW linked model of the River Roch from Rochdale to its confluence with the River Irwell Including the catchment hydrology study.	EA	2017
Level 2 SFRA	Outputs from JBA Consulting JFlow study for GMCA Level 2 SFRA. Includes Whittle, Brightley and Castle Brook on the JPA 1.1 site	GMCA	2019
South Heywood hydraulic model	Partial model data received for model covering upper extent of Brightley Brook upstream of this study area in the South Heywood. The model from 2023 has not been provided, the model received dates to 2017. There is a small overlap between the study areas, approximately 235m, with 7 surveyed cross sections. This data has not been used to inform this model build. A conservative approach using LiDAR data to model the channel conveyance was used. Additionally, the model predates the construction of the junction at Pilsworth Road and Hareshill Road and does not represent any changes that have been made to the watercourse in this location.	WSP	2023
FEH data	Catchment descriptors at 10 locations for the key watercourses in the catchment	FEH Web Service	2024
Ordnance Survey Data	MasterMap, OpenMap Local and VectorMap District data for the study area	Ordnance Survey	2024
Survey	Watercourse survey was undertaken in July and August 2024. Channel cross sections and bank crest elevations were collected on Brighley Brook. Elsewhere survey was collected for key structures on Whittle, Castle Hollins Brook. However data for some structures was not collected due to access or health and safety issues.	Tetra Tech	2024

3.0 Hydrology

3.1 Approach

3.1.1 Appendix A contains the Flood Estimation Report which provides a detailed breakdown of the data, methods, calculations and results from the hydrological assessment. The flood estimation study was undertaken to understand the hydrology and to derive peak flow estimates to inform hydraulic modelling.

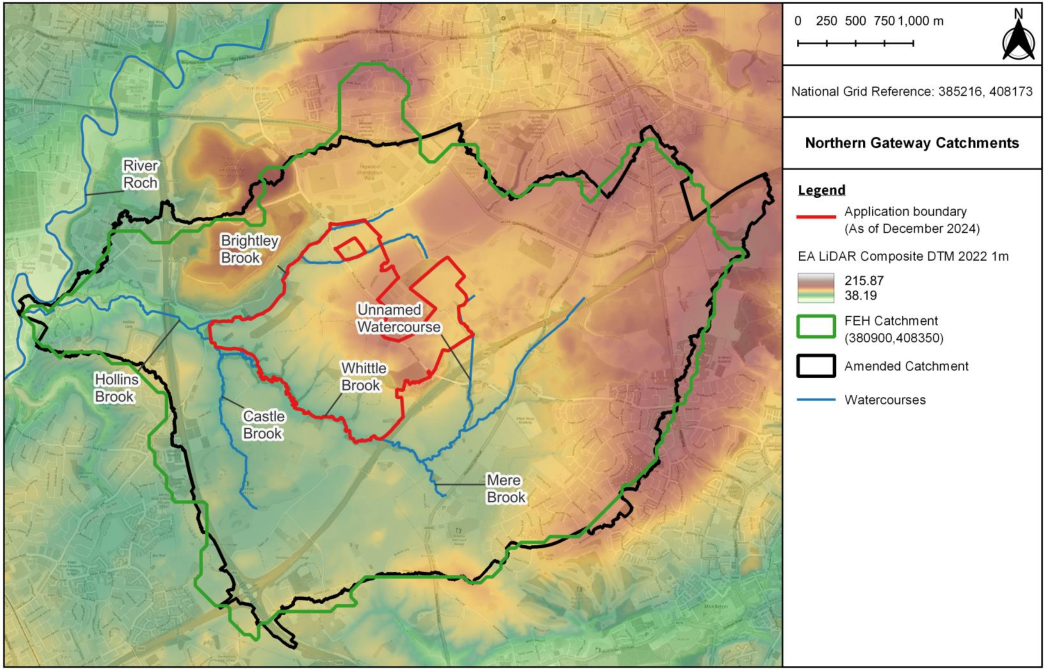
3.1.2 Peak flows have been estimated for the Hollins Brook, Whittle Brook, Brightley Brook and Castle Brook for the 50%, 20%, 10%, 5%, 3.33%, 2%, 1.33%, 1%, and 0.5% and 0.1% AEP events.

3.1.3 FEH catchment data has been extracted for the site and the catchment boundaries have been checked using GIS watershed analysis from the 1m EA LiDAR Composite DTM 2022. The checks indicated the FEH catchment did provide a good estimation of the Hollins Brook (HB01) catchment, however some modifications were made to the extent of the sub catchments of Brightley Brook and Whittle Brook, which impacted on the overall catchment area. This is shown in Figure 3-1. As a result of these changes, the catchment area has been decreased from 16.76km² to 16.38km².

3.1.4 The FEH catchment descriptors have been checked and updated as detailed in section 3.2 of the Flood Estimation Report (Appendix A).

3.1.5 The URBEXT value has been updated following a review of aerial imagery and increased to 0.164. This URBEXT value has then been updated to 0.171 using the CPRE urban expansion factor equations for the year 2024.

3.1.6 The catchment descriptor estimate of QMED for the watercourses has been improved using donor transfer methods from nearby gauged sites. FEH Statistical and ReFH2 methods were applied to derive peak flow estimates at the flood estimation locations. The results and methods were compared with statistical flow estimates preferred due to the use of pooled observed data from similar catchments to derive flood frequency curves.


0 250 500 750 1,000 m
N
National Grid Reference: 385216, 408173
Northern Gateway Catchments
Legend
Application boundary (As of December 2024)
EA LiDAR Composite DTM 2022 1m
215.87
38.19
FEH Catchment (380900,408350)
Amended Catchment
Watercourses
River Roch
Brightley Brook
Unnamed Watercourse
Hollins Brook
Whittle Brook
Castle Brook
Mere Brook

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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Figure 3-1. Hollins Brook catchment

3.2 Flow estimates

3.2.1 Flow estimates derived from the hydrological assessment are provided in Table 3-1. Final flows selected are estimated using the FEH Statistical Method as they are based on gauged data from similar sites, with the estimate of QMED improved from local donor gauges.

Table 3-1. Peak flow estimates

Site Code	Flood peak (m3/s) for the following AEP (%) events		
	3.3%	1%	0.1%
BB01	5.40	7.28	12.45
BB02	4.17	5.63	9.63
BB03	1.11	1.50	2.56
CB01	1.82	2.45	4.19
CB02	0.78	1.05	1.80
HB01	21.17	28.54	48.83
MB01	5.24	7.06	12.08
WB01	13.11	17.67	30.24
WB02	5.64	7.60	13.00
WB03	2.51	3.38	5.79
BB01i	0.38	0.51	0.87
CB01i	1.48	1.99	3.41
HB01i	3.71	5.00	8.56
WB01i	2.54	3.43	5.87

3.3 Events

3.3.1 A design storm duration of 5.5 hours (05:30) with a 0.1-hour (00:10) timestep has been applied as recommended using ReFH2 for HB01. The recommended design storm duration is a function of the average annual rainfall (SAAR) and the time to peak.

3.3.2 Storm duration testing was completed using peak flows from the ReFH2 method. Storm durations tested in addition to the 5.5 hour storm were the 3, 9, 15, and 24 hour durations. It was found that over the majority of the study area the 5.5 hour storm produced the greatest depths and extents, with the exception of ponding behind the culvert BB01_0020 where the longer storm durations produced greater flood extents. This is likely due to the greater volume produced by these events and the potential conservative sizing of the culvert due to lack of survey data. The 5.5 hour storm was selected as the critical storm in accordance with the Flood Estimation Guidelines as it is physically realistic to have identical storm durations applied across the model.

3.3.3 Flow hydrographs have been derived for each model inflow by using ReFH2 to generate hydrographs which were scaled to the Statistical method peak flow estimates in Table 3-1. The 3.33%, 1%, and 0.1% AEP event shave been simulated in the model. In addition, the 1% and 0.1% AEP events have also been simulated with a central uplift of 35% for climate change for the 2080s epoch.

3.4 Climate change

3.4.1 Climate change allowances are based on projections of change in peak flows. There are different allowances based on the possible scenarios. The central allowance is based on the 50th percentile and is exceeded by 50% of the projections in the range. The upper end allowance is based on the 95th percentile and is exceeded by 5%.

3.4.2 There are climate change allowances for different epochs which are periods of time over the coming century. The 2020s epoch covers the period 2015 to 2039. The 2050s epoch covers the period 2040 to 2069. The 2080s epoch covers the period 2070 to 2125.

3.4.3 The study area is within the Irwell Management Catchment. EA climate change guidance[1] (updated in May 2022) has been applied to this study. For this catchment the allowances show a trend of peak flows increasing over time into the future.

3.4.4 Peak flow climate change allowances[2] as of August 2024 are summarised in Table 3-2.

Table 3-2. Irwell Management Catchment peak river flow allowances

	Central	Higher	Upper
2020s	12%	15%	24%
2050s	19%	26%	43%
2080s	35%	46%	75%

3.4.5 This study will apply the Central allowance for the 2080s epoch (35%). A full summary of model simulations to be completed is provided in the method statement.

---

[1] Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)

[2] Irwell Management Catchment peak river flow allowances

4.0 Baseline scenario hydraulic model build

4.1 Overview

4.1.1 A hydraulic model providing a 2D representation of the watercourses, with 1D presentation of Brightley Brook has been built using TUFLOW modelling software. This approach is deemed appropriate due to the site topography and scale of the catchment, and resolution of the available LiDAR data.

4.1.2 The ground model is derived from Environment Agency LiDAR Composite DTM 2022 1m resolution data.

4.2 Model extent

4.2.1 The area of the 2D model domain is approximately 3.12km^2 encompassing Hollins Brook, Whittle Brook, Brightley Brook and Castle Brook.

4.2.2 A 1D domain has been used on Brightley Brook where LiDAR data was found to have a poor representation of the channel. This 1D modelled reach extends approximately 1.5km from the Brightley Brook confluence with Hollins Brook to upstream of the reservoirs where a tributary meets Brightley Brook from the south (named BB03 in this study).

4.2.3 Structures have been represented using 1D model network elements.

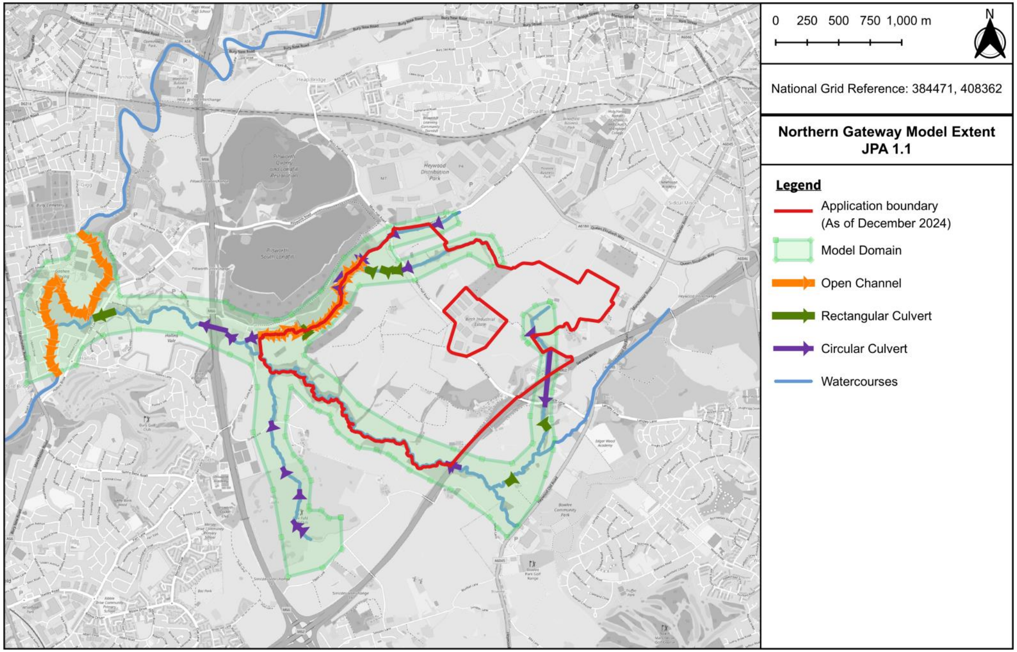
0 250 500 750 1,000 m
N
National Grid Reference: 384471, 408362
Northern Gateway Model Extent JPA 1.1
Legend
Application boundary (As of December 2024)
Model Domain
Open Channel
Rectangular Culvert
Circular Culvert
Watercourses

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Figure 4-1. Model domain

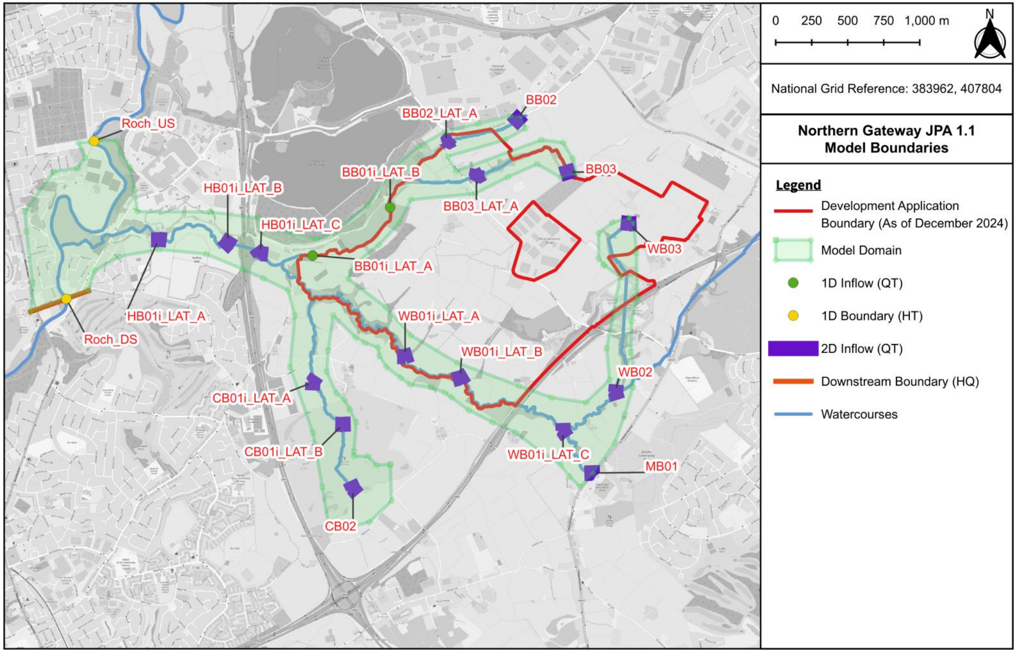
0 250 500 750 1,000 m
N
National Grid Reference: 383962, 407804
Northern Gateway JPA 1.1
Model Boundaries
Legend
Development Application Boundary (As of December 2024)
Model Domain
1D Inflow (QT)
1D Boundary (HT)
2D Inflow (QT)
Downstream Boundary (HQ)
Watercourses
Roch_US
Roch_DS
HB01i_LAT_A
HB01i_LAT_B
HB01i_LAT_C
BB01i_LAT_A
BB01i_LAT_B
BB02_LAT_A
BB02
BB03
BB03_LAT_A
WB03
WB02
WB01i_LAT_A
WB01i_LAT_B
WB01i_LAT_C
MB01
CB01i_LAT_A
CB01i_LAT_B
CB02

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Figure 4-2. Model boundaries

4.3 Method summary

Table 4-1. Model summary

Item	Summary
Software & Version	TUFLOW HPC Build 2023-03-AE. Single Precision.
Model Area	The model extent covers Hollins Brook, Whittle Brook, Mere Brook, Brightley Brook and Castle Brook, and extends to cover an approximately 2km reach of the River Roch.
Upstream Boundary	Brightley Brook: Approximately 500m southwest of Harehills Road at the upstream extent of the watercourse. Whittle Brook: Approximately 350m upstream from the confluence between the Whittle Brook and the unnamed watercourse from the north, not the upstream extent of Whittle Brook. Castle Brook: Approximately 200m northwest of the M62 at the upstream extent of the watercourse.
Downstream Boundary	The River Roch, approximately 380m west of the confluence between Hollins Brook and the River Roch, 250m upstream of Blackford Bridge. A 1D HT boundary has been applied and uses modelled water levels for the equivalent return periods at node ROCH01_1076. A 2D HQ boundary is used on the adjacent floodplain to allow any overland flows to exit the domain. A slope of 0.01.
Inflows	Inflows have been inserted at the upstream extents of the modelled watercourses with additional lateral inflows inserted at key sub catchment locations. Figure 4-2 shows the location of model inflows. Inflows have been applied as 2D QT boundary lines at the upstream extents of Brightley Brook, Castle Brook, Whittle Brook and Mere Brook. Intervening flows are applied as 2d_bc lines applied at key tributaries. River Roch water levels applied via HT boundary based on modelled water levels for the equivalent return periods.
2D cell size	A 3m cell size has been applied with sub-grid sampling frequency set to 5, sampling 5 points across each cell face.

Item	Summary
Orientation of Grid	Southeast to Northwest (~315 degrees). This aligns the model with the main direction of flow within the catchment
Ground Model	EA LiDAR Composite DTM with 1m resolution, flown in 2020.
Topography Modifications	Topography has been modified around Brightley Brook using the channel survey data to modify the banks of the channel and 1D-2D connection. Other topographic modifications to the ground model include representation of the M62 central reservation and amendments to pond and bridge elevations.
Channel Representation	Watercourses are modelled primarily in 2D with approximately 1.5km of Brightley Brook modelled in 1D.
Structure Representation	There are 25 structures explicitly included within the 1D model domain: 3 on Hollins Brook, 12 on Brightley Brook, 5 on Whittle Brook, and 5 on Castle Brook. Additional structures have been modelled in 2D. Appendix B provides a full summary of the structures within the model domain and the assumptions that have been made for the hydraulic model build.
Roughness	Chow 1959[3] has been used to define roughness values applied at structures and on watercourses and floodplain in the 1D and 2D domains.
Initial Conditions	1D IWL points for river sections on River Roch and Brightley Brook. IWL grid for watercourses in the 2D domain. IWL polygons on 2 lakes and ponds on Brightley Brook within the 2D domain.
Parameters	No parameters changed from default Model simulation time: 12 hours 2D timestep: 2 seconds 1D timestep: 1 second Solution scheme: HPC (adaptive time-stepping) Map / time series output interval: 15 minutes
File naming	The naming of the files has adhered to the standard TUFLOW file naming convention.

---

[3] Chow, V.T., 1959, Open-channel hydraulics: New York, McGraw-Hill, 680 p.

4.4 Model grid

4.4.1 The EA LiDAR Composite DTM at 1m resolution was used for the ground model. This data was flown in February and March of 2019, and is the most up to date data available. The LiDAR was checked using satellite imagery to confirm topographical features had been correctly observed and structures accounted for within the DTM. The LiDAR was also checked along watercourses through areas of woodland. It was found to represent the channel bed adequately for the purposes of this study given the channel morphology adhering itself to 2D representation.

4.4.2 Following these checks a section of Brightley Brook adjacent to Pilsworth Fishery was identified as being of poor quality and did not provide adequate representation of the watercourse. Topographic channel survey was commissioned in order to represent this section in greater detail.

4.4.3 In addition, a number of topographic edits were made in the model using zsh features. The following edits to the model grid were applied to the model grid defined by LiDAR:

- Brightley Brook bank elevations have been defined using zsh points and lines and are based on bank crest elevation survey. Adjacent to the main Pilsworth Fishery lake this level was set to the top of the brick/concrete wall running adjacent to the channel (See Appendix C Photo 20). These were snapped to HX lines along the right bank and part of the left bank.
- The two lakes at Pilsworth Fishery are defined using zsh regions to set bed elevations of the lakes derived from the channel survey. IWL polygons set the water level in the lakes.
- Bridges on Castle Brook (CB01_1453 and CB01_1153) poorly defined in the ground model have been edited using zsh lines set at the deck level of the bridge. Elevations were obtained from survey data. This method was applied as the LiDAR data did not pick up these elevations and without the changes there may have been double counting of flows through the structure in 1D and 2D domains.
- M62 central reservation has been defined using a zsh line raising existing cell elevations by 0.8m, consistent with the typical height of a concrete central reservation of its type.

4.4.4 The 2D domain was modelled with a grid cell size of 4m however, Sub Grid Sampling (SGS) was used. SGS of ground elevations at sub-cell resolutions for defining cell storage and cell face conveyance produce more accurate cell volume estimated and flow exchange between neighbouring vells at resolutions finer than the 2D grid resolution. A range of sensitivity tests were undertaken on cell sizes with the key sense test summarised in Table 4-4. This configuration was selected as it provided a suitable balance between model run times and the accuracy of the mapped results.

4.5 Representation of watercourses and structures

4.5.1 The following watercourses have been represented in the 1D and 2D domains of the model:

- River Roch approximately 2000m
- Hollins Brook approximately 2300m
- Whittle Brook approximately 4900m
- Castle Brook approximately 1500m
- Brightley Brook approximately 3400m
- Mere Brook approximately 400m

4.5.2 The model represents approximately 14500m of watercourse. Most of the watercourses in the model have been represented in 2D. A 2D representation was deemed appropriate in most cases as the watercourse are generally flowing through large open areas with well-defined channels and floodplains. Collecting survey to provide full 1D representation at this scale would be a large undertaking and, in most cases, would not significantly improve the outputs of the model. For example Whittle Brook has a complex geomorphology with a highly sinuous channel that lends itself to 2D representation and would be challenging to appropriately represent in a 1D domain.

4.5.3 However, modelling smaller watercourses in 2D requires a consideration of model cell size. A 3m cell size has been applied with Sub Grid Sampling frequency set to 5. Elevations are sampled at 5 points across each cell face, a sample distance of

0.75m. This cell size has been used as it allows for sampling of five additional points along the cell edge with a sample taken from each 1m LiDAR square within the 3m grid cell to achieve the maximum possible detail within each cell. Model sensitivity testing was undertaken during the initial model build to understand the impact of changing the model cell size and the sub-grid sampling frequency. The results indicated that the model was somewhat sensitive to grid size around the fishing lakes on Brightley Brook with the 3m cell size producing a slightly delayed hydrograph downstream of the lake spillway which produces small variances in flood depth of +/-0.01m. Additional extent is observed on the Garic site as a result. Hydrographs and maximum depth grids are otherwise closely aligned between the two resolutions throughout the model domain. A summary of the key sense test summarised in Table 4-4.

4.5.4 Following review of the ground model, a section of Brightley Brook was identified as being unsuitable to model in the 2D domain. Therefore approximately 1.5km of Brightley Brook has been modelled in 1D extending from the confluence of the two branches of Brightley Brook to the confluence with Hollins Brook. Based on survey and LiDAR elevations levels as well as site observations the channel adjacent to Pilsworth Fishery is unlikely to spill on its left bank due to the steeply rising elevations. Therefore is has been assumed that flood water will only spill out of channel on the right bank, as such, the right bank only is connected to the 2D domain using a 2d_bc HX line for the majority of the reach. The spill level has been set by a 2d_zsh line which sets the elevation, based on crest survey, of a wall on the right bank of the channel. Where the wall ends, it is set to the path elevation. One section of the left bank has been given a HX connection at the upper end of the 1D Brightley Brook domain to allow for flow from BB03 to enter the channel. A similar use of crest survey defined points and lines sets the elevation for this.

4.5.5 At the Pilsworth Fishery spillway the channel has been modelled in 2D due to stability issues modelling a short, steep slope in 1D. It also allows for the direct connection of the incoming culvert from the Brightley Brook channel at a mid-point along the spillway as observed. A HX line is used at the downstream extent of the spillway to capture any flows from the spillway.

4.5.6 Several smaller watercourses and drainage ditches on the site have not been explicitly modelled. These have been represented hydrologically with lateral inflows weighted to the sub catchment area inserted at key confluences with the main channels represented in the model.

4.5.7 Key structures have been represented in the model using a 1D network connected to the 2D domain via SX points or lines depending on the size of the structure. Appendix B contains a detailed summary of the structures within the model domain including the decisions that have been made to represent them in the model. Photographs at key structures are included in Appendix C.

4.6 Roughness

4.6.1 In the 1D domain roughness is applied using manning's n coefficient with values defined using site observations and photographs.

4.6.2 On Brightley Brook, channel bed roughness is typically set to 0.035 as the channel is generally straight with some weeds and stones (Appendix C Photo 17). Bank roughness is typically set between 0.06 and 0.08 depending on vegetation levels, with the left bank generally less well maintained and therefore rougher. In some parts of the channel, a brick wall follows parallel to the watercourse (Appendix C Photo 20). Where this is the case, a roughness value of 0.025 has been set to representative points on the cross section to simulate this smoother material. Other values such as 0.03 on the banks represent shorter, maintained grass.

4.6.3 On the River Roch the manning's n coefficient values have been maintained from the EA model.

4.6.4 For 1D structures the roughness is applied using manning's n coefficient with values defined using site observations and photographs, the majority of structures are of concrete construction therefore a manning's n value of 0.011 has been used. Where structures were not accessed construction material is assumed to be concrete.

4.6.5 In the 2D domain OS OpenMap Local and VectorMap District mapping data has been used to define material zones. The OS OpenMap Local and VectorMap District data does not provide roads as polygon features therefore OS MasterMap data has been extracted to provide a representation of the roads in the study area.

Some materials zones have been digitised manually following review of mapping, satellite imagery and site observations. The M62, M66 and Birch Services have been manually digitised using available mapping as well as sections of the Whittle Brook floodplain downstream of the M62 culvert and around its confluence with Castle Brook.

4.6.6 Table 4-2 lists the 2D materials layers and the Manning's n coefficient values applied.

Table 4-2. 2D roughness materials

Roughness category	Manning's n
Grass/General Surface	0.04
Buildings	0.3
Roads	0.02
Woodland	0.1
Surface Water	0.030
Gravel Track	0.035
Brush	0.065

4.7 Initial conditions

4.7.1 Model initial conditions have been applied to the model 1D and 2D domains. To set initial conditions in the watercourses a baseflow simulation has been undertaken. Baseflow was derived from the received River Roch model. For the Hollins Brook catchment the initial flow rate from the lateral flow node 'Whittle_Brook', which is used to insert flows from the Hollins Brook catchment to the River Roch, was extracted. The flow was split and area weighted to the model inflow locations and the model was simulated with this constant flow rate for a period of 30 hours. Results were extracted in 1D and 2D to be used as the initial conditions for the model.

4.7.2 In the 1D domain, River Roch and Brightley Brook, water levels were extracted and are applied to the model via 1d_iwl points at each section. In the 2D domain the baseflow simulation h_max grid has been used as a 2d_iwl grid.

4.7.3 Additional initial conditions have been applied at the 2 water bodies at Pilsworth Fishery. These were selected as they were identified as interacting with the modelled flood mechanisms during the initial model build. Initial water levels were applied using 2d_iwl polygons. The extent of these polygons was derived using OS mapping and satellite imagery. Initial water levels were extracted from LiDAR or survey data where this was available. For example, at Pilsworth Fishery water levels were inferred from the topographic channel survey that extended beyond the footpath, separating Brighley Brook from the fishing lake, down the bank to the lake.

4.8 Baseline model performance

4.8.1 Table 4-3 reports the peak mass balance error and the time of this occurrence, as well as the final cumulative mass error for each modelled event. Figure 4-3 shows the reported mass balance error during the modelled events.

Table 4-3. Baseline mass balance summary

Modelled Event (% AEP)	Peak Mass Balance Error (%)	Time of Peak Mass Balance Error (hr)	Final Cumulative Mass Balance Error (%)
3.33%	-0.013	0.75	-0.006
1	-0.009	0.5	-0.007
1% with climate change allowance	0.011	0.5	-0.003
0.1%	-0.118	6.75	-0.073
0.1% with climate change allowance	-0.412	7.25	--0.289

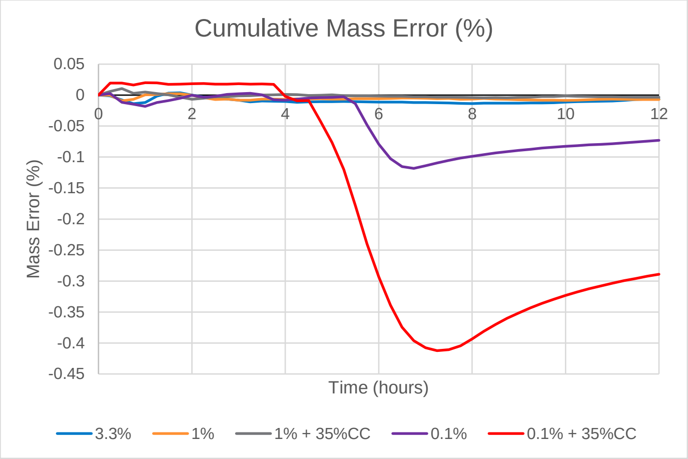


Figure 4-3. Baseline mass balance graph

4.8.2 The acceptable range of mass balance is +/- 1%. The baseline model lies well within this range at <+/-0.1% cumulative mass error for the majority of baseline simulations with the exception of the 0.1% AEP plus climate change simulation which peaks at -0.4% mass error. The model has been run in TUFLOW HPC which uses a finite volume solution scheme to conserve volume throughout the 2D domain. Small fluctuations in mass balance are typically observed at connections between the 1D and 2D domains.

4.9 Model messages

4.9.1 Messages recorded for the 1% AEP plus climate change allowance event:

- WARNINGs prior to simulation: 164
- WARNINGs during simulation: 2
- CHECKs prior to simulation: 13
- CHECKs during simulation: 2

4.9.2 Warnings are produced on some of the high manning’s n values in the model whereby the model limits bed friction used in viscosity calculations in areas of high roughness where flow velocity is much slower and the elevated viscosity has little effect, to preserve model runtime due to the impact on timestep parameters. Momentum calculations not affected. Given the limited number of buildings impacted by flooding in the simulations this warning is likely to have little to no impact on results. Warnings are also observed due to null shape objects. There are no missing objects within the model, and therefore there is no impact on the results. The final warning is a change to model settings due to an unused zsh type.

4.9.3 The majority of checks are either 2D bed lowering as a result of SXZ nodes or repeat application of boundaries. These do not have an impact on the model results nor do the rest of remaining check files reported.

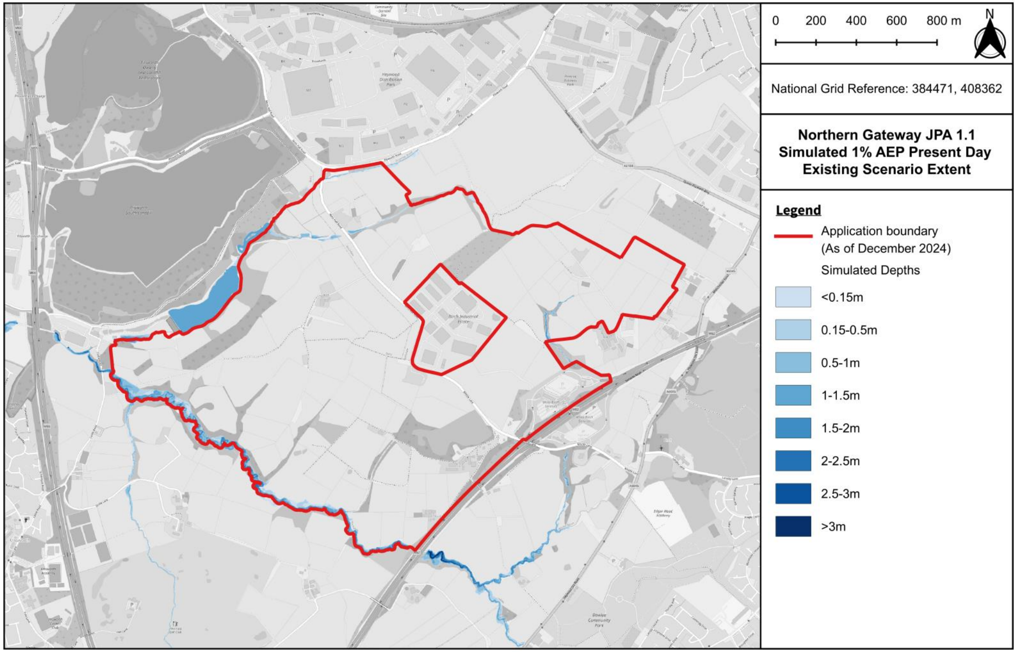
4.9.4 Warnings during simulation relate to two situations of repeated timesteps. The first occurs at 00:03:00 and 04:22:00 into the simulation time approximately. The warnings have no impact on the simulation as this is an indicator of the timestep adapting to successfully prevent mass error in the model.

4.10 Baseline results

4.10.1 Appendix D shows the baseline hydraulic model results for all events simulated.

4.10.2 The 1% AEP present day simulation results, Figure 4-4, shows the following:

- Flooding can be seen on the immediate floodplain downstream of the confluence of Hollins Brook and Castle Brook. It is generally flat with the main channel incised within and hence stores larger volumes of floodwater in more frequent events. The simulation shows this to be up to 2m in places at this location.
- Ponding occurs behind the M62 culvert on Whittle Brook further upstream.
- On Brightley Brook, there is significant storage of water (over 2m in places) on the floodplain downstream of the reservoir and upstream of the culvert labelled BB01_0020.
- At the fisheries car park, water overtops the culvert and spills across the car park and into the reservoir with a depth of up to 0.25m.
- On BB03, due to poor connectivity of the channels and culvert system there is overland flow originating from the pond west of Moss Hall Road which spills into the Brightley Brook channel.


0
200
400
600
800 m
N
National Grid Reference: 384471, 408362
Northern Gateway JPA 1.1
Simulated 1% AEP Present Day
Existing Scenario Extent
Legend
Application boundary
(As of December 2024)
Simulated Depths
<0.15m
0.15-0.5m
0.5-1m
1-1.5m
1.5-2m
2-2.5m
2.5-3m
>3m

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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Figure 4-4. Baseline maximum modelled flood depths 1% AEP present day event

4.10.3 The 1% AEP present day plus 35% climate change allowance simulation results, Figure 4-5, show the following:

- With the addition of the 2080s epoch climate change allowance to the 1% event, the results show more significant increases in depths around the Garic site adjacent to Hollins Brook with the site becoming flooded with depths of up to 0.3m. There is approximately 0.2m of additional depth on the floodplain downstream of the Castle Brook and Whittle Brook confluence.
- On Whittle Brook, additional depth can be seen behind the M62 culvert of approximately 1m, as well as a slight growth in the extent of flooding around the Mere Brook and Whittle Brook confluence.
- On Castle Brook, the results are similar to those in the present day 1% AEP event, however there are increased levels upstream of the Griffe Lane culvert by approximately 0.2m as well as a small extent increase.
- On Brightley Brook, the lower floodplain downstream of the spillway sees increases in depth of approximately 0.7m. The flow path from the small pond is also deeper by around 0.04m.
- Flood water is also seen to back up behind the Moss Hall Road culvert and floods the adjacent building in this event. Additionally, there are some shallow flows across fields towards the upstream extent of Brightley Brook by Pilsworth Road.

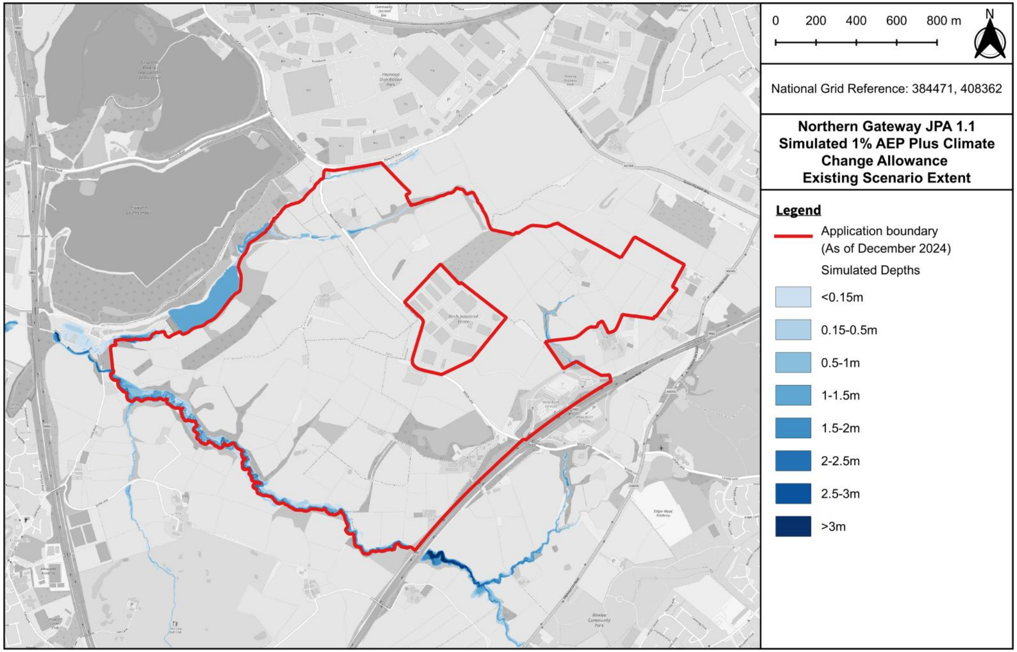
0
200
400
600
800 m
N
National Grid Reference: 384471, 408362
Northern Gateway JPA 1.1
Simulated 1% AEP Plus Climate Change Allowance
Existing Scenario Extent
Legend
Application boundary (As of December 2024)
Simulated Depths
<0.15m
0.15-0.5m
0.5-1m
1-1.5m
1.5-2m
2-2.5m
2.5-3m
>3m

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Figure 4-5. Baseline maximum modelled flood depths 1% AEP 2080s central climate change event

4.11 Baseline model validation

4.11.1 When compared to the existing EA mapping, the baseline model results show similar extents across much of the model, particularly along the Whittle Brook reach, at the downstream extent of Brightley Brook, and Hollins Brook downstream of the M66. However, these are generally more confined to the channel because of the higher resolution data used in this study.

4.11.2 The main difference in flood extents are around key flow constrictions. In this model, the simulations show a reduced extent across the whole of the Garic site at the upstream inlet of the M66 culvert. This is likely due to the inclusion of surveyed culvert data which enables more detailed modelling of the culvert.

4.11.3 This model includes more detail on the size and current condition of the culvert which has resulted in this increased extent.

4.11.4 At the confluence of Mere and Whittle Brook, extent is greatly reduced because of the higher resolution of data used in the model with flooding more aligned to the channel.

4.11.5 The model is also able to capture flood extents on Castle Brook and Whittle Brook that are not shown on the EA mapping.

4.12 Sensitivity testing

4.12.1 Sensitivity to a range of parameters has been tested in the hydraulic model. Tests undertaken are summarised in Table 4-4 and mapped results are included in Appendix E.

4.12.2 All sensitivity tests have been undertaken for the 1% AEP event with a 35% climate change uplift for the 2080s epoch (central) unless otherwise specified.

Table 4-4. Sensitivity simulations results summary

Sensitivity Test	Summary	Summary of results compared to baseline
Increased roughness(1% AEP event simulated)	Increased roughness in pipes and channel cross sections (1.2x multiplier in 1d_nwk layer) All 2D roughness values in .tmf file increased by 20%	Minor increases to flood extents and depths throughout model, typically 0.05-0.07m in open channel on Whittle Brook. At flow constrictions around the M62 culvert by Sandfield Farm this is greater at 0.10-0.3m. In the upper catchment depth increases are low at 0.01-0.03m typically. Garic remains dry. Increased extent on Whittle, Castle and Brightley Brook floodplains.
Decreased roughness(1% AEP event simulated)	Decreased roughness in pipes and channel cross sections (0.8x multiplier in 1d_nwk layer) All 2D roughness values in .tmf file decreased by 20%	The inverse of the above is generally observed in terms of simulated depths. Additional key differences include: • Increase in flood depths on downstream end of BB01_0020 (0.06-0.1m) and at the M66 culvert (0.02-0.06m)
Downstream Boundary (1% AEP event simulated)	Roch set to constant flood level throughout event	No change to simulated depths and extents upstream of M66. Small depth and extent changes downstream of HB01_0455 adjacent to the River Roch.
Structure blockage (1% AEP event)	50% blockage at the following structures: • HB01_1542 • BB01_1070 • BB02_0338 • WB01_2523a+b • WB02_0448 • CB01_0533	Largest increases upstream of M66 culvert and at Mere Brook confluence with Whittle Brook. Increases of up to 3m at M66 culvert and 2m at Sandfield Farm Garic site flooded. Decreases in flood depths and extents downstream of M66 and on Whittle Brook downstream of the M62 culvert at Sandfield Farm. Change in depth typically 0.2-0.3m.

Sensitivity Test	Summary	Summary of results compared to baseline
Structure blockage	50% blockage at the following structures: - HB01_1542 - BB01_1070 - BB02_0338 - WB01_2523a+b - WB02_0448 - CB01_0533	Large increases in flooding upstream of M62 at Garic. The Garic site is simulated to have an addition 1m of flooding with blockages in this event. 0.9m additional depth at Moss Hall Road culvert 1.5m additional depth at M62 culvert near Mere Brook and increases in flooding at Mere Brook. Reduction in depths downstream of the M66 and M62. Depths reduced by 0.1-0.25m. Flooding behind Griffe Lane culvert on Castle Brook approximately 0.4m increase.
Flow increase	bc_dbase multipliers increased by 20% for inflows	Flood extents increased around Garic and depths increased by approximately 0.5m in adjacent channel. Increase in flooding on Garic site by approximately 0.04m. Upstream of the M62 culvert, depths are increased by 0.6-0.7m as well as extents at Mere Brook. Generally greater extents and depths across model and particularly sensitive at culvert inlets
Flow decrease	bc_dbase multipliers decreased by 20% for inflows	Reduction in flood extents at Garic, majority of flood extent in this area no occurring in this simulation. Reduction in depths on Hollins Brook in adjacent channel by 0.2-0.5m. Reduction in flood extents and depths at Mere Brook by 0.5-0.8m.
Model cell size	Model cell size at 2m resolution with SGS. tgc set to apply 2m grid resolution.	Changes +/-0.1m along Whittle Brook, reduction in levels in fishing pond and on Brightley Brook. Peak flows from Brightley Brook lake spillway approximately 30 minutes earlier. More coincident than baseline with peak flows from Whittle Brook. This may be producing higher levels at Garic.

Sensitivity Test	Summary	Summary of results compared to baseline
Hollins Brook weir crest elevation	Two zsh lines have been applied to the 2D domain at the Hollins Brook weirs. They are set to raise the effective crest elevation depiction in the 2D cells. The upstream weir's crest elevation has been set to 78.8mAOD, and the downstream weir's crest elevation to 77.8mAOD.	Minimal impact on levels across model with no impact beyond structures under Castle Road small increases in depths at weir locations typically in the range of +/- 0.05m
Structures dimensions	Testing of structure dimensions where key assumptions on size have been made. BB01_0020 and HB01_1792 pipe diameter set to 1.4m	Garic site is dry. Increase in depth in Hollins Brook channel adjacent to Garic, Increase of 0.4-0.5m upstream of HB01_1792 and 0.3-0.4m downstream. Reduction in depth by 2m at downstream end of Brightley Brook upstream of BB01_0020. Increase in depths downstream of M66 culvert by 0.05-0.06m.

5.0 Conclusion

5.1 Overview

5.1.1 A 2D hydraulic model of the watercourses within the site has been established in TUFLOW HPC and ESTRY.

5.1.2 The model is built using Environment Agency LiDAR Composite DTM 2022 1m data that was flown in 2020.

5.1.3 A model grid size of 3m with Sub Grid Sampling enabled is assumed appropriate to capture the level of detailed required balanced against the model run time.

5.1.4 The model has been simulated for the 3.3%, 1%, and 0.1% AEP events, as well as the 1% and 0.1% AEP event with central 2080s climate change allowances.

5.1.5 The baseline model results show reduced extents to those shown in the existing EA Flood Risk Map for Planning.

5.2 Assumptions

5.2.1 Hydraulic models are powerful tools if they are planned, implemented, calibrated, and managed properly and can be an asset. However hydraulic models are also built using data that may have gaps or apply uniform assumptions to represent complex interactions between water and the built environment. Several assumptions have been made during the development of this model.

5.2.2 The Environment Agency hydraulic model has been used to include the River Roch. It is assumed that it is suitable to use for this assessment.

5.2.3 The ground model is based on a 1m resolution LiDAR DTM. It is assumed this is an accurate depiction of the catchment topography.

5.2.4 Two HX connection lines have been applied to the Brightley Brook channel. One adjacent to the lakes to model spilling from the channel from 1D-2D, and the other to accept flow from BB03 into the Brightley Brook channel on the left bank. It is assumed this is an accurate representation of the likely direction of flow out of the channel in a flood event given the steep floodplain topography on the left bank.

5.2.5 Many culverts have assumed dimensions where gaps in data were found and where survey was not possible due to issue with access or health and safety. Where this occurs, an assessment has been made on the nearby culvert dimensions, satellite imagery, site observations, and LiDAR data and a size inferred based on this.

5.2.6 On the open channel section between the Brightley Brook confluence with Hollins Brook and upstream of the M62 culvert inlet, satellite imagery shows what appears to be two weirs which could have an impact hydraulically on flows leaving the study site. At the time of this model build, access was not granted by Garic for survey to be completed on this section of watercourse. Sensitivity testing shows that the impact of the weirs on the extent and depth of flooding would be minimum to none.

5.2.7 At the downstream end of the BB03 reach, there is a large data gap where culverts observed on site were not able to be surveyed. Additionally, an outfall has not been found for an additional small culvert near BB03_0081. It was decided not to model the culvert to prevent water being displaced in the model where large assumptions would have to be made.

5.3 Recommendations

5.3.1 For future work and to improve confidence in the hydraulic model results it is recommended that further survey work is completed on structures which were unable to be surveyed as part of this model construction.

5.3.2 It is recommended that further survey is completed of Hollins Brook adjacent to the Garic site to gain further understanding of the hydraulic impact of structures found within the channel.

5.3.3 Gauging of the catchment would improve the understanding of the response of the catchment to rainfall events and improve confidence in the model.

5.3.4 It is recommended that the hydrology is periodically reviewed to ensure that the latest available data and methods are applied to the assessment.

Appendix A: Flood Estimation Report

Northern Gateway

784-B048805

Flood Estimation Report JPA 1.1

For Information

Northern Gateway Joint Venture

February 2025

Document prepared on behalf of Tetra Tech Limited. Registered in England number: 01959704

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Appendix A: HB01 pooling group composition

1.0 Summary of assessment

1.1 Catchment location

1.1.1 The Northern Gateway JPA 1.1 development site catchment is located to the north of Manchester on the east side of the M66 between Junctions 3 and 4, and the north side of the M62 between Junctions 18 and 19 on predominately greenfield land.

1.1.2 The JPA 1.1 development site is within the Hollins Brook catchment which generally flows from southeast to northwest. The main sub catchments are Brightley, Castle and Whittle Brooks.

1.2 Purpose of study and complexity

1.2.1 Tetra Tech have been appointed by Northern Gateway Joint Venture Ltd to undertake hydraulic modelling of watercourses within the Northern Gateway development site. The scope of this exercise is to gain a full understanding of the catchment hydrology and risk of flooding to the JPA 1.1 development site and to inform design and ensure that the developed site would not be at risk of flooding up to and including the 1% AEP plus climate change event and will not increase flood risk elsewhere.

1.3 Key catchment features

1.3.1 The present catchment is generally greenfield. The study area has overall URBEXT value of approximately 0.17 which would categorise it as ‘heavily urbanised’ according to the Flood Estimation Handbook.

1.3.2 There are urban areas encroaching on the northern and southeastern extents of the catchment. The sub catchments of Brightley Brook and Mere Brook are the most urbanised.

1.3.3 The catchment is generally permeable, with areas of slowly permeable soils and naturally wet soils.

1.3.4 Some attenuation is present within the catchment on Brightley Brook where ponds are present which are used for recreation.

1.4 Flooding mechanisms

1.4.1 Flooding within the catchment is generally limited as evidenced by the Environment Agency's Flood Risk Map for Planning with Flood Zones confined to the channel and immediate floodplain. The main source of fluvial flooding is due to the interaction of Hollins Brook with the River Roch. This caused small scale flooding to the Croft Lane and Pilsworth Road area in 2015[1]. Other reports include flooding of the M62 between junctions 18 and 19.

1.4.2 During extreme rainfall events both the M66 and M62 have been flooded, with the M66 closing between Junction 3 and Simister Island during Storm Fergus (December 2023) and the M62 had closures in February 2024. These events are a result of insufficient highway drainage capacity for the rainfall during these events.

1.5 Gauged / ungauged

1.5.1 There are no gauges within the study catchment to inform the assessment.

1.5.2 The closest gauge is at Blackford Bridge on the River Roch approximately 800m downstream of the confluence with Hollins Brook.

1.6 Final choice of method

1.6.1 The FEH Statistical method is preferred. The estimation of QMED has been improved using a donor stations. The peak flow estimates are based on pooled gauged data from similar sites.

1.7 Key limitations / uncertainties in results

1.7.1 It is assumed that adjustments made to the FEH catchment descriptors are correct.

1.7.2 It is assumed that the donor stations used are appropriate and the pooled sites are similar to the subject sites. There is no recorded flow data in the study area to improve the estimates.

1.7.3 The assumptions around the attenuation provided by the ponds on Brightley Brook are assumed appropriate.

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[1] Bury Local Flood Risk Management Strategy

2.0 Method statement

2.1 Requirements for flood estimates

Overview and project scope

2.1.1 Tetra Tech Ltd have been appointed by Northern Gateway Joint Venture Ltd to prepare a Flood Risk Assessment and Drainage Strategy to support the environmental impact assessment (EIA) and outline planning application submission for proposed commercial development.

2.1.2 Hydraulic modelling is required of watercourses within the Northern Gateway JPA 1.1 development site. The scope of this exercise is to gain a full understanding of the risk of flooding to the site to inform design and ensure that the developed site would not be at risk of flooding up to and including the 1% AEP plus climate change event and will not increase flood risk elsewhere.

2.1.3 This flood estimation study will provide hydrological flow estimates for the watercourses within the site and the wider hydraulic model extent.

2.1.4 Peak flow estimation is required for the 1% AEP event. Climate change sensitivity simulations will be undertaken using the climate change allowances guidance updated 27th May 2022[2]. Peak river flow allowances for the Irwell Management Catchment will be applied.

2.1.5 This report summarises the hydrological assessment undertaken. This is a routine study where the FEH Statistical and ReFH2 methods will be used to derive peak flow estimates. The FEH Statistical assessment will use the latest available NRFA peak flows dataset and WINFAP5 software. Donors will be used to improve the estimation of QMED, and a pooling group will be derived for the study catchment and used to derive peak flow estimations at each flood estimation location. The ReFH2 method will be applied. The results from the Statistical and ReFH2 methods will be compared, and the most appropriate flows will be used to insert as the hydrological boundaries in the hydraulic model.

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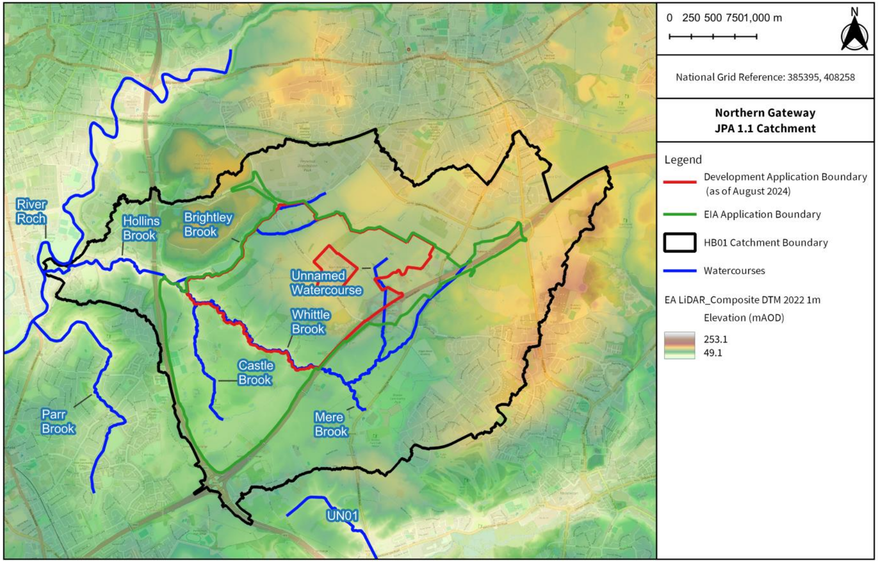
[2] Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)

2.1.6 Partial outputs from a previous study by JBA Consulting for the Greater Manchester Combined Authority Level 2 Strategic Flood Risk Assessment have been made available. The outputs provided are limited to JFlow hydraulic model mapped simulation results which will be used as part of a validation process for the hydraulic modelling to check the flows derived and inserted into the hydraulic model built for this study.

2.1.7 The Flood Estimation Report received as part of the JBA Lower Roch Flood Mapping Study for the Environment Agency will be used as a comparison against which the flows derived from this study can be checked against. This study included an estimate at the same location as HB_01 in this study, which in the JBA study was called Whittle Brook (WB_01). The total catchment area was found to be 15.8km^2. The flow estimates at this location were derived from a data transfer for QMED and pooling for derivation of growth curves using the Statistical Method.

2.2 The catchment

Maps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Northern Gateway
JPA 1.1 Catchment
Legend
Development Application Boundary (as of August 2024)
EIA Application Boundary
HB01 Catchment Boundary
Watercourses
EA LiDAR_Composite DTM 2022 1m
Elevation (mAOD)
253.1
49.1
River Roch
Hollins Brook
Brightley Brook
Unnamed Watercourse
Whittle Brook
Castle Brook
Parr Brook
Mere Brook
UN01

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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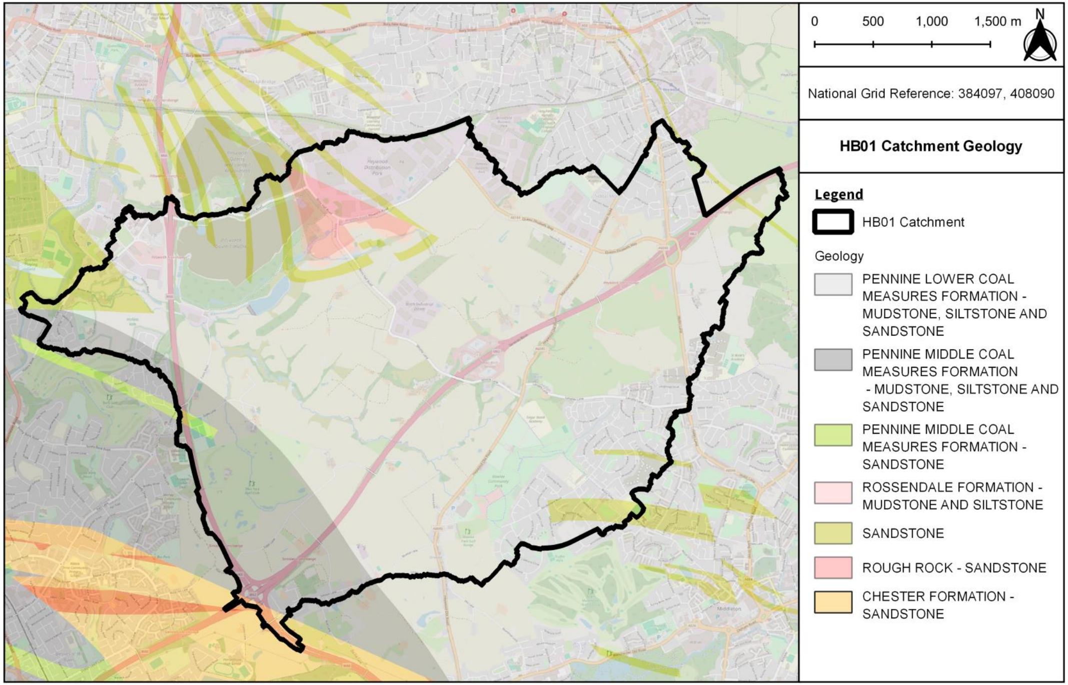
Figure 2-1. Catchment overview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HB01 Catchment Geology
Legend
HB01 Catchment
Geology
PENNINE LOWER COAL MEASURES FORMATION - MUDSTONE, SILTSTONE AND SANDSTONE
PENNINE MIDDLE COAL MEASURES FORMATION - MUDSTONE, SILTSTONE AND SANDSTONE
PENNINE MIDDLE COAL MEASURES FORMATION - SANDSTONE
ROSSENDALE FORMATION - MUDSTONE AND SILTSTONE
SANDSTONE
ROUGH ROCK - SANDSTONE
CHESTER FORMATION - SANDSTONE

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Figure 2-2. Catchment geology

Catchment description

2.2.1 The Northern Gateway development site covers an area approximately 2.7km^2 to the north of Manchester in the northwest of England. The site is generally bounded by the M62 to the south, the M66 to the west, the Pilsworth landfill to the north and commercial / industrial land to the east.

2.2.2 The site falls within the Hollins Brook catchment which has an area approximately 16.4km^2 and is a tributary of the River Roch. The catchment generally slopes from east to west draining to the River Roch approximately 1.5km west of the M66 downstream of the site.

2.2.3 There are three main watercourses which drain the landscape surrounding the development to Hollins Brook. These are Whittle, Castle and Brightley Brooks. These watercourses generally flow from east to west, Whittle Brook is the largest of these sub catchments and draining the highest parts on the east of the catchment. Downstream of the confluence of Castle and Whittle Brooks (SD 82614 08006) the watercourse becomes Hollins Brook. Approximately 350m downstream (SD 82399 08253) Brightley Brook joins from the east, Hollins Brook flows to the west from here and is culverted through the M66 approximately 300m downstream.

2.2.4 Whittle Brook is largely unmanaged in its lower reach, downstream of the M62. In this area the watercourse is highly connected with its floodplain and there is evidence of channel movement with active erosion and deposition changing the channel flow path over time. It is culverted through the M62 with additional structures upstream of this.

2.2.5 Castle Brook flows through arable land and through Pike Fold Golf course. This watercourse has been modified and straightened in its middle and upper reaches in particular through the golf course.

2.2.6 Brightley Brook flows through arable land in it upper reaches, in the lower reaches it flows adjacent to a series of fishing lakes the largest of which has a surface area approximately 0.04km^2 is a heavily modified watercourse with the addition of a number of structures along its length and reinforced banks in the area around Pilsworth fishery. There are reaches where the channel is heavily incised with limited floodplain connectivity.

2.2.7 The Hollins Brook catchment slopes east to west from approximately 158mAOD within the Whittle Brook sub catchment (SD 87166 08880) to approximately 64mAOD in the western side of the catchment where the Hollins Brook confluences with the River Roch (SD 80855 08355). The mean altitude of the catchment (ALTBAR) is approximately 110mAOD.

2.2.8 Rainfall in the North West of England tends to be associated with Atlantic depressions or with convection. The Atlantic depressions or 'lows' bring most of the rainfall in the autumn and winter seasons. In the summer, convection is caused by solar surface heating, and is characterised by showers and thunderstorms.

2.2.9 The North West of England is exposed to the westerly maritime air masses and contains extensive areas of high ground resulting in the region including some of the wettest areas in the country. The city of Manchester receives on average an annual rainfall of 830 mm[3]. The SAAR at the site is 1041mm and is therefore greater than the average for Manchester.

2.2.10 British Geological Survey (BGS)[4] geological mapping (1:50,000 scale) indicates the catchment is underlain by two main types of bedrock deposits, in the west is the Pennine Middle Coal Measures Formation and in the east is the Pennine Lower Coal Measures Formation. Both are described as sedimentary bedrocks comprising of mudstone, siltstone, and sandstone. There are isolated patches of other bedrock geologies present in the catchment consisting of sandstone as indicated in Figure 2-2.

2.2.11 The site is underlain by varied superficial deposits which are sedimentary in nature. The majority of the site is underlain by Devensian till, which is described as comprising diamicton. There are patches of other superficial geologies with glacial origins which comprise sands and gravels. Head and alluvium deposits follow the main watercourses comprising clay, silt, sand and gravels.

2.2.12 There are a mixture of soil types across the site that are classified as Soilscapes 10, 15 and 17 using the LandIS Soilscapes mapping[5]. The majority of the catchment, approximately 53%, is classified as Soilscape 17 which are slowly permeable seasonally wet acid loamy and clayey soils that have impeded drainage. Soilscape 15 is the second largest, approximately 26%, soil type and is classed as naturally wet very acid sandy and loamy soils that are naturally wet. Soilscape 10 makes up the remaining area, approximately 21%, and are freely draining slightly acid sandy soils.

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[3] https://www.metoffice.gov.uk/research/climate/maps-and-data/regional-climates/index

[4] BGS Geology Viewer - British Geological Survey

[5] LandIS - Land Information System - Soilscapes soil types viewer

2.2.13 The site is found within a Secondary A aquifer which comprise permeable layers that can support local water supplies, and may form an important source of base flow to rivers.

2.2.14 The catchment has a mixed land use with large areas in the centre of the catchment that could be described as rural and generally used for arable purposes, however on the catchment boundaries there are large urban areas with mixed residential and industrial use. As a result, the Hollins Brook catchment is categorised as a ‘slightly to heavily urbanised’ catchment according to Environment Agency Flood Estimation Guidelines[6].

2.2.15 Land use comprises of mostly rural arable land within the site, with the wider Hollins Brook catchment entering the urban dwellings in Heywood and Middleton.

2.3 Hydrometric data

Source of flood peak data

2.3.1 NRFA peak flows dataset, version 13 released 29th of August 2024. This contains data up to the end of September 2023, water year 2022-2023.

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[6] Environment Agency (2022). LIT 11832 Flood Estimation Guidelines

Other data available and how it has been obtained

Type of data	Data relevant to this study	Data available?	Source of data	Details
Check flow gaugings	No	N/A	N/A	Not relevant to this study as there are no gauges and rating review is not required.
Historical flood data	Yes	Yes	Various web sources	Historical flooding information in the study area has been sought online, there is limited information on historical flooding at the study site. History of flooding in Radcliffe. One event in Boxing Day 2015 caused overtopping at Riverside Drive and damage to property. The M62 and M66 have both experienced surface water flooding in recent years.
Flow or river level data for events	Yes	No	NRFA EA Hydrology Data Explorer	There are no maintained gauges in the study site or in the wider Hollins Brook catchment.
Rainfall data for events	No	Yes		Rainfall data is available via a rain gauge located approximately 1.5km to the south of the catchment in Heaton Park. A second rain gauge at Bury is located approximately 700m southwest of the Hollins Brook and River Roch confluence.
Potential evaporation data	No	N/A	N/A	Not required for this study as calibration of the ReFH2 model will not be undertaken.
Results from previous studies	Yes	Yes	GMCA Environment Agency	GMCA level 2 SFRA study JFlow hydraulic model results for all watercourses included in this study. River Roch hydraulic model (2017) products 5,6,7. Lateral inflow node to the Roch provided representing inflow from Hollins Brook (Statistical Method flow estimation). Total area for the catchment and catchment descriptors are also provided.
Other data or information	No	N/A	N/A	The watercourses are not tidally influenced. The impact of groundwater is not considered in this study. Low flows are not being assessed.

Conceptual model

2.3.2 The Northern Gateway development site is the main area of interest for this study. The main watercourses flowing through the development site are Castle, Whittle and Brighley Brook.

2.3.3 Flood mechanisms on the site are likely to be due to a lack of capacity of culverts to convey the flow within watercourses resulting in flows backing up in the watercourse behind these structures. For Whittle Brook the watercourse shows strong evidence being highly active and connected to the floodplain suggesting that the floodplain may regularly flood.

2.3.4 As there is no record of fluvial flooding in the site, it is assumed that the studied watercourses are likely to flood only during infrequent events, and flood extents are likely contained to the greenfield areas where development will not take place.

Unusual catchment features

2.3.5 There are numerous culvert structures within the catchment as indicated in Figure 2-3. They are generally located under existing roads and footbridges or under land as land drainage.

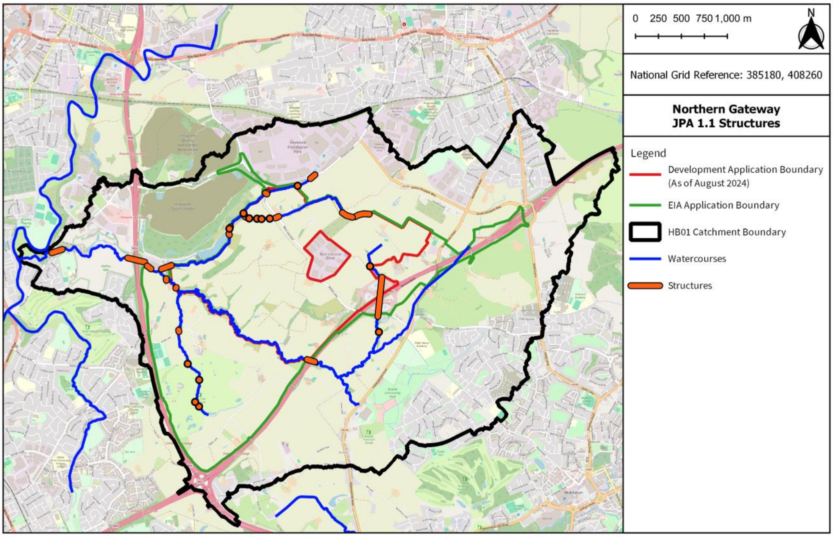
2.3.6 The Hollins Brook catchment is classed as a slightly to heavily urbanised catchment according to the Flood Estimation Guidelines with an $URBEXT_{2000}$ of 0.17.

2.3.7 The presence of two reservoirs in the Brightley Brook catchment results in FARL values <0.9. The Flood Estimation Guidelines suggested QMED cannot be relied upon from the Statistical Method unless the reservoirs are kept permanently full. This is the case in this study where the reservoirs are kept full for recreational purposes and thus act as natural lakes.

2.3.8 A landfill site is found on the northwestern side of the catchment which impacts on the topography of the catchment as well as modifying the permeability of the ground at the landfill site.

2.3.9 There is evidence of historical mining in the area which may have had an impact on the soil profile in the area.

2.3.10 The Castle Brook catchment has high permeability with BFIHOST19 values of >0.65.


0 250 500 750 1,000 m
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National Grid Reference: 385180, 408260
Northern Gateway
JPA 1.1 Structures
Legend
Development Application Boundary (As of August 2024)
EIA Application Boundary
HB01 Catchment Boundary
Watercourses
Structures

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Figure 2-3. Culvert structures within catchment

2.4 Initial choice of approach

Are FEH methods appropriate?

2.4.1 The FEH Statistical and ReFH2 methods are appropriate. The catchment is slightly to heavily urbanised with URBEXT <0.6 as such these methods are appropriate. There are no other highly unusual or complex features that would affect flood estimation using these methods.

Initial Choice of method(s) and reasons

2.4.2 The FEH Statistical and ReFH2 methods will be applied to derive peak flow estimates at each subject site. The results will be compared to derive final flows.

2.4.3 For the FEH Statistical method donor transfer will be used to improve the estimation of QMED.

2.4.4 As the catchment is ungauged pooling group(s) will be used to pool data from similar catchments and will be compiled using WINFAP 5 and the NFRA peak flows dataset v12.1.

2.4.5 ReFH2.3 will be used to derive catchment descriptor estimates of flow.

How will hydrograph shapes be derived if required?

2.4.6 Hydrographs are required however the catchment is ungauged and average hydrograph shapes and duration cannot be defined. Therefore, the ReFH hydrograph will be used and scaled to fit the peak flow estimates from the Statistical method using Flood Modeller.

Will the catchment be split into sub-catchments? If so, how?

2.4.7 Lumped flows will be derived at multiple flow estimation locations at the upstream extent of the modelled watercourses.

2.4.8 For intervening catchment areas catchment descriptors will be recalculated using FEH methods which will be used to estimate peak flows.

Software to be used

2.4.9 FEH Web Service

2.4.10 WINFAP 5 version 5.1

2.4.11 ReFH2.3 version 4.1

2.4.12 Flood Modeller version 7.1

3.0 Location where flood estimates are required

3.1 Summary of subject sites

Site code	Type of estimate lumped (L) or sub-catchment (S)	Watercourse	Site name / description	Easting	Northing	AREA of FEH web Service (km2)	Revised AREA (if altered) (km2)
BB01	L	Brightley Brook	Downstream extent of Brightley Brook	382450	408300	3.27	2.677
BB02	L	Brightley Brook	Brightley Brook upstream of reservoirs to east	383300	408900	1.69	1.424
BB03	L	Brightley Brook	Brightley Brook upstream of reservoirs - tributary	383350	408800	0.84	0.679
CB01	L	Castle Brook	Downstream extent of Castle Brook at confluence with Whittle Brook	382600	407950	2.46	2.712
CB02	L	Castle Brook	Upstream extent of Castle Brook	382850	406700	1.43	1.648
HB01	L	Hollins Brook	Downstream extent of Hollins Brook	380900	408350	16.75	16.381
MB01	L	Mere Brook	South of study area at downstream extent of Mere/Langley Brook	384400	407000	1.70	2.092
WB01	L	Whittle Brook	Downstream extent of Whittle Brook at confluence with Castle Brook	382650	408000	9.39	9.028
WB02	L	Whittle Brook	Tributary of Whittle Brook from north in direction of M62 services	384750	407350	3.28	3.153
WB03	L	Whittle Brook	Whittle Brook confluence with WB02 tributary south of M62 services	384700	407400	1.60	1.811
BB01i	S	Brightley Brook	Intervening catchment area including the Pilsworth fishery reservoirs	382450	408300		0.574
CB01i	S	Castle Brook	Intervening area on Castle Brook extending from Pike Fold Golf Glub to the confluence with Whittle Brook	382600	407950		1.064

HB01i	S	Hollins Brook	Lower catchment extending west of the M66 to confluence with the River Roch	380900	408350		1.964
WB01i	S	Whittle Brook	Lower Whittle Brook catchment	382650	408000		1.972

3.2 Catchment descriptors

Final catchment descriptors at each subject site (updated / intervening sites indicated in red)

Site Code	AREA	SPRHOST	FARL	PROPWET	BFIHOST19	DPLBAR	DPSBAR	SAAR	URBEXT1990	URBEXT2000	FPEXT
BB01	2.677	34.880	1	0.57	0.475	1.715	37.7	1049	0.169	0.209	0.089
BB01i	0.574	33.355	0.717	0.57	0.512	0.738	62.3	1038	0.008	0.010	0.034
BB02	1.424	36.210	1	0.57	0.428	1.214	28.1	1054	0.308	0.381	0.098
BB03	0.679	33.380	1	0.57	0.542	0.809	37.0	1048	0.014	0.018	0.119
CB01	2.712	26.160	1	0.57	0.722	1.728	31.1	1018	0.037	0.046	0.107
CB01i	1.064	35.267	1	0.57	0.558	1.035	47.7	1023	0.012	0.015	0.062
CB02	1.648	20.280	1	0.57	0.828	1.315	20.4	1015	0.053	0.065	0.135
HB01	16.381	32.360	1	0.57	0.543	4.629	36.9	1041	0.139	0.171	0.097
HB01i	1.964	10.733	1	0.57	0.517	1.448	55.3	1048	0.179	0.221	0.092
MB01	2.092	35.670	1	0.57	0.438	1.499	34.9	1034	0.278	0.344	0.096
WB01	9.028	33.140	1	0.57	0.515	3.339	34.4	1044	0.151	0.187	0.097
WB01i	1.972	56.052	1	0.57	0.527	1.451	49.9	989	0.025	0.000	0.082
WB02	3.153	33.590	1	0.57	0.499	1.876	29.4	1059	0.141	0.174	0.082
WB03	1.811	29.610	1	0.57	0.619	1.385	25.7	1051	0.160	0.197	0.142

Catchment boundary checks and revisions

3.2.1 The FEH catchment boundaries were checked using OS mapping, satellite imagery and using 1m resolution LiDAR DTM including undertaking GIS watershed analysis.

3.2.2 New catchment boundaries have been defined via GIS analysis of the LiDAR data. Visual checks were undertaken on the LiDAR data using mapping and satellite imagery to ensure artificial obstructions present in the LiDAR which are not present in reality had been accounted for in the assessment i.e. bridges and culvert through embankments.

3.2.3 The study catchment and its main sub catchments are shown in Figure 3-1. Figure 3-2, Figure 3-3, and Figure 3-4 show further breakdown of the sub catchments with comparison against the FEH web service catchments boundaries.

3.2.4 Catchment centroids were recalculated following the area updates.

3.2.5 The assessment identified a number of changes to the catchment areas when compared against the FEH web service catchments. MB01 has the most significant area change of +23% on the FEH web service extent, due to a combination of Heywood Old Road and an elevated field boundary routing flow towards Mere Brook instead of Whittle Brook in the GIS analysis.

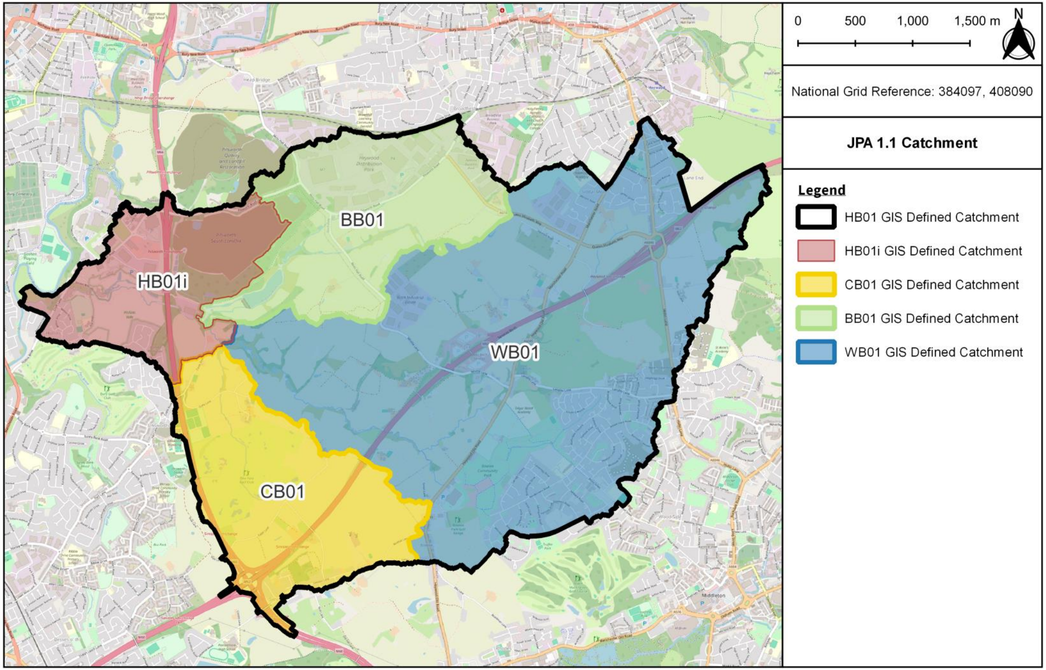
3.2.6 The BB01 catchment has been cut in its northern extent at the East Lancashire railway line. The railway cutting bisects the upper part of the catchment and has a large impact on the surrounding ground levels. To the west of the catchment the cutting is approximately 12m deep to the east it is approximately 3m in cutting. This was reviewed and as there were no watercourses or other drainage features that would enable drainage from north to south it was assumed that any runoff or flow generated in this part of the catchment would use local drainage arrangements or follow the railway cutting which slopes to the west.

3.2.7 An additional drainage ditch was also observed during site investigation on the ground and in the desk based assessment. This ditch is located to the northwest of the fishing lake adjacent to the footpath to the north. This takes flow to the west of the BB01 catchment draining to HB01i.

3.2.8 BB03 sees the greatest reduction in area with the GIS analysis showing that much of the catchment drains towards Whittle Brook, reducing BB03 by 19% and increasing WB03 by 13%.

3.2.9 The Castle Brook catchment has increased at CB01 by 10%, reducing the extent of the Whittle Brook catchment from the FEH extent. The GIS analysis shows a clear catchment delineation at an area of raised land which has been raised near a small bridge crossing over the M62.

3.2.10 Overall, the HB01 catchment GIS analysis shows a 2% reduction in area when compared against the FEH catchment with the overall catchment being well defined in the LIDAR.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HB01 GIS Defined Catchment
HB01i GIS Defined Catchment
CB01 GIS Defined Catchment
BB01 GIS Defined Catchment
WB01 GIS Defined Catchment
BB01
HB01i
WB01
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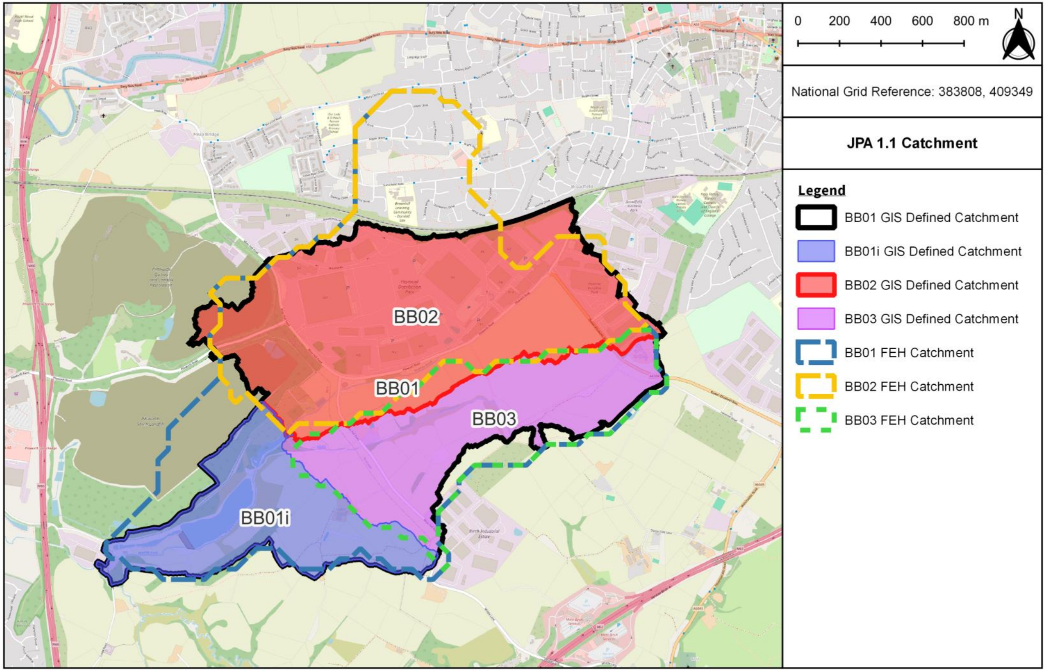
Figure 3-1. Hollins Brook (HB01) catchment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JPA 1.1 Catchment
Legend
BB01 GIS Defined Catchment
BB01i GIS Defined Catchment
BB02 GIS Defined Catchment
BB03 GIS Defined Catchment
BB01 FEH Catchment
BB02 FEH Catchment
BB03 FEH Catchment
BB02
BB01
BB03
BB01i

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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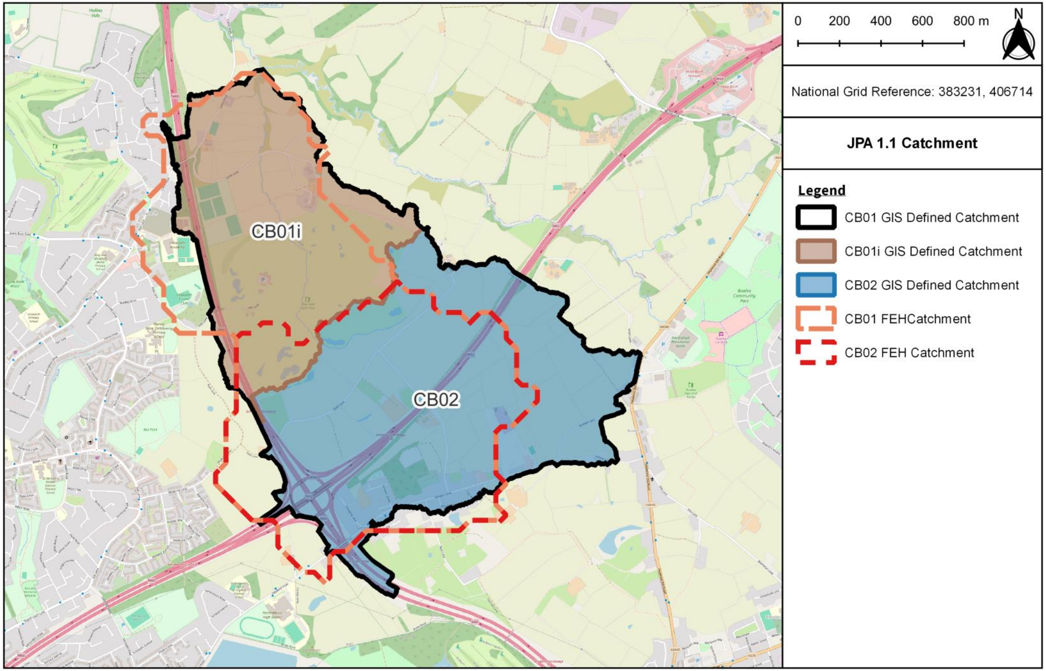
Figure 3-2. Brightley Brook (BB01) catchment


0
200
400
600
800 m
N
National Grid Reference: 383231, 406714
JPA 1.1 Catchment
Legend
CB01 GIS Defined Catchment
CB01i GIS Defined Catchment
CB02 GIS Defined Catchment
CB01 FEHCatchment
CB02 FEH Catchment
CB01i
CB02

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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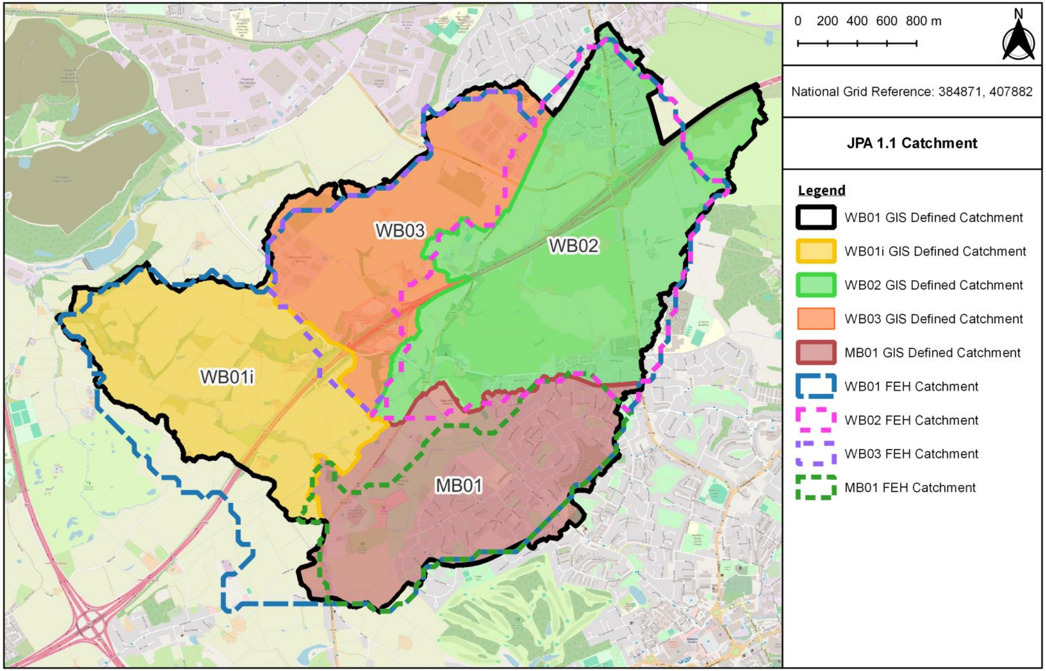
Figure 3-3. Castle Brook (CB01) catchment


0 200 400 600 800 m
N
National Grid Reference: 384871, 407882
JPA 1.1 Catchment
Legend
WB01 GIS Defined Catchment
WB01i GIS Defined Catchment
WB02 GIS Defined Catchment
WB03 GIS Defined Catchment
MB01 GIS Defined Catchment
WB01 FEH Catchment
WB02 FEH Catchment
WB03 FEH Catchment
MB01 FEH Catchment
WB03
WB02
WB01i
MB01

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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Figure 3-4. Whittle Brook (WB01) catchment

URBEXT source and method for updating

3.2.11 $URBEXT_{2000}$ has been used in this study.

3.2.12 $URBEXT_{2000}$ has been updated using the $URBAN_{50k}$ method for all updated catchments. Total $URBAN_{50k}$ area was calculated for each catchment from the urban area shown in 1:50,000 OS mapping. Manual checks were completed using satellite imagery and additional urban areas within the catchment were added to the extent shown in the 1:50,000 OS mapping. The URBEXT values were then derived from the equation in the 2006 CEH report on URBEXT2000[7].

$$URBEXT_{2000} = 0.629\ URBAN_{50k}$$

3.2.13 The CPRE formula was applied to the resulting $URBEXT_{2000}$ values to account for urban expansion to the year 2024.

BFIHOST source, checks and updates

3.2.14 BFIHOST19 was used for this study.

3.2.15 Soils were checked by assessing the revised catchment boundaries using Soilscapes mapping. The SPRHOST and BFIHOST19 values were considered representative of the soils within each catchment.

Checks and revisions to other catchment descriptors

3.2.16 Area weighting techniques have been applied to recalculate catchment descriptors for the intervening areas.

3.2.17 FARL has been updated for BB01 using the methodology outlined in FEH Volume 5 Section 4.3. Site visits have confirmed that Brightley Brook does not drain into the adjacent reservoirs and that therefore the reservoirs are offline. Offline reservoirs are not used in the FARL index. The resulting FARL values for both HB01 and BB01 have been set to 1 to reflect this.

3.2.18 SAAR is consistent with the catchment topography and geographical location for each catchment. The catchment SAAR is higher here than the Greater Manchester average as the study area is generally on higher ground as it slopes upwards towards the north and east and therefore greater rainfall is produced by orographic uplift.

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[7] URBEXT2000 – A new FEH catchment descriptor. Calculation, dissemination, and application

3.2.19 DPLBAR was updated by applying regression to the updated catchment area of as outlined in the FEH (AREA^0.548).

4.0 Stationary statistical methods

4.1 Method overview

What is the purpose of applying these methods

4.1.1 The Statistical method is applied here to estimate peak flows at each subject site.

4.1.2 The Statistical method relies on observed data from donor sites with similar characteristics to improve the estimates of flow.

4.1.3 Lumped flows at the upstream extent of each modelled watercourse will be inserted into the hydraulic model (BB02, BB03, CB02, MB01, WB02, WB03). Flows for the intervening catchment areas will be derived and inserted top the hydraulic model as lateral inflows (BB01i, CB01i, HB01i, WB01i).

4.1.4 All sites are treated as ungauged.

What methods will be used to estimate QMED and growth curves

Site code	Methods used for QMED	Methods used for growth curves
BB01	Donor Transfer	Pooled
BB01i	Donor Transfer	Pooled
BB02	Donor Transfer	Pooled
BB03	Donor Transfer	Pooled
CB01	Donor Transfer	Pooled
CB01i	Donor Transfer	Pooled
CB02	Donor Transfer	Pooled
HB01	Donor Transfer	Pooled
HB01i	Donor Transfer	Pooled
MB01	Donor Transfer	Pooled
WB01	Donor Transfer	Pooled
WB01i	Donor Transfer	Pooled
WB02	Donor Transfer	Pooled
WB03	Donor Transfer	Pooled

4.2 Estimating QMED

QMED at ungauged subject sites

Site code	Method (CD/DT/BCW)	Initial QMED (rural) from CDs (m3/s)	Donors used (NRFA number)	Distance between centroids	Urban adjustment factor	Final QMED (m3/s)
BB01	DT	1.607	69046 69048 27088 69017 27084 68007	13.80 15.85 21.87 32.43 37.21 33.79	1.16	2.28
BB02	DT	1.079	69046 69048 27088 69017 27084 68007	13.67 15.78 21.53 32.75 36.86 34.15	1.30	1.76
BB03	DT	0.405	69046 69048 27088 69017 27084 68007	14.18 15.54 21.90 32.17 28.85 33.65	1.00	0.47
CB01	DT	0.619	69046 69048 27088 69017 27084 68007	14.87 16.66 24.27 30.08 39.68 31.32	1.19	0.77
CB02	DT	0.243	69046 69048 27088 69017 27084 68007	15.30 16.40 24.40 29.98 39.87 31.09	1.39	0.33

HB01	DT	5.984	69046	14.81	1.18	8.95
			69048	15.45		
			27088	22.62		
			69017	31.39		
			27084	38.09		
			68007	32.83		
MB01	DT	1.409	69046	14.48	1.39	2.21
			69048	16.36		
			27088	23.14		
			69017	29.85		
			27084	38.82		
			68007	32.04		
WB01	DT	3.968	69046	14.53	1.20	5.54
			69048	15.57		
			27088	22.25		
			69017	30.81		
			27084	37.85		
			68007	33.02		
WB02	DT	1.748	69046	13.59	1.19	2.38
			69048	16.00		
			27088	21.35		
			69017	30.76		
			27084	37.04		
			68007	33.82		
WB03	DT	0.712	69046	14.76	1.19	1.06
			69048	14.98		
			27088	21.78		
			69017	31.48		
			27084	37.31		
			68007	33.58		
BB01i	DT	0.380	69046	13.70	1.00	0.16
			69048	16.49		
			27088	22.73		
			69017	32.39		
			27084	38.03		
			68007	33.04		
CB01i	DT	0.538	69046	14.19	1.05	0.63

			69048	17.08		
			27088	24.08		
			69017	30.24		
			27084	39.39		
			68007	31.72		
HB01i	DT	1.084	69046	12.83	1.11	1.57
			69048	17.60		
			27088	23.26		
			69017	33.14		
			27084	38.37		
			68007	32.89		
WB01i	DT	0.948	69046	14.70	1.00	1.08
			69048	15.96		
			27088	23.20		
			69017	31.15		
			27084	38.64		
			68007	32.32		

Methods: CD – Catchment descriptors alone, DT – catchment descriptors with donor transfer, BCW –catchment descriptors with bankfull channel width.

Urban adjustment of QMED

4.2.1 Urban adjustment of QMED has been completed using WINFAP v5 software based on the method published by Kjeldsen (2010).

4.2.2 The $URBEXT_{2000}$ values at each subject site have been updated using the $URBAN_{50k}$ method in Section 2.3 of the Flood Estimation Guidelines.

4.2.3 Default urban adjustment parameters have been used (IF = 0.3 and PRimp = 70%).

Search for donor sites

4.2.4 The latest flood estimation guidance[8] recommends the use of multiple stations when using donor adjustment. Furthermore, it is recommended that donors are selected purely on the basis of proximity. WINFAP 5 was used to select the closest six donor stations at each site.

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[8] Environment Agency (2022). LIT 11832 Flood Estimation Guidelines

4.2.5 Donor sites selected were those with a URBEXT_{2000} value of less than 0.03.

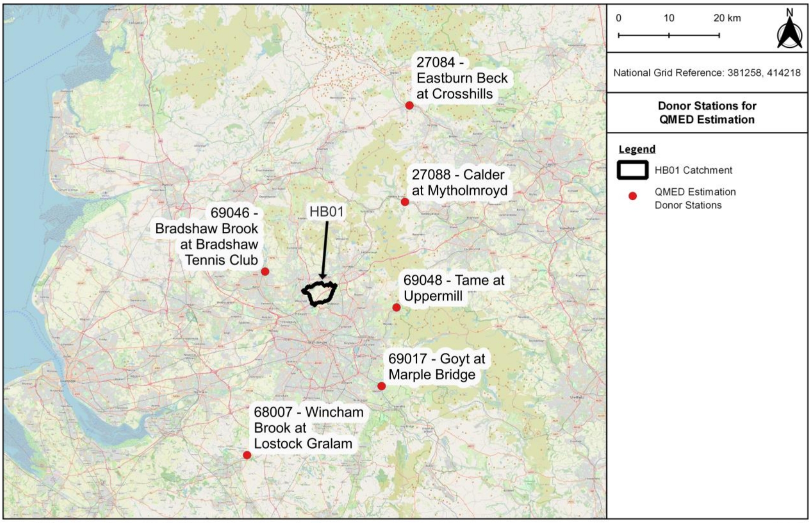
4.2.6 Urban adjustment was applied to all QMED estimations using the urban adjustment factor equation within WINFAP 5. This is recommended by the Flood Estimation Guidelines to prevent discontinuity produced when URBEXT_{2000} values exceed 0.03.

Donor sites chosen and QMED adjustment factors

NRFA no.	Method (AM/POT/LF)	Adjustment for climatic variation?	Initial QMED from flow data (m^3/s)	De-urbanised QMED from flow data (m^3/s) (A)	QMED from catchment descriptors (m^3/s) (B)	Adjustment ratio (A/B)
69046 (Bradshaw Brook @ Bradshaw Tennis Club)	AM	No	22.17	21.68	12.26	1.81
69048 (Tame @ Uppermill)	AM	No	22.33	21.86	22.43	1.00
27088 (Calder @ Mytholmroyd)	AM	No	82.33	80.63	81.85	1.01
69017 (Goyt @ Marple Bridge)	AM	No	61.96	60.33	53.10	1.17
27084 (Eastburn Beck @ Crosshills)	AM	No	28.85	28.414	27.633	1.03
68007 (Wincham Brook @ Lostock Gralam)	AM	No	20.78	20.257	19.576	1.06

Methods: AM – Annual Maxima, POT – Peaks over threshold, LF – Low flow (flow duration curve) statistics.

4.2.7 The location of these donor stations in relation to the subject catchment is indicated in Figure 4-1.


27084 - Eastburn Beck at Crosshills
27088 - Calder at Mytholmroyd
69046 - Bradshaw Brook at Bradshaw Tennis Club
HB01
69048 - Tame at Uppermill
69017 - Goyt at Marple Bridge
68007 - Wincham Brook at Lostock Gralam
0
10
20 km
N
National Grid Reference: 381258, 414218
Donor Stations for QMED Estimation
Legend
HB01 Catchment
QMED Estimation Donor Stations

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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Figure 4-1. Donor stations used in QMED estimation

4.3 Estimating growth curves

Derivation of growth curves at subject sites

Site code	Method (SS, P, ESS, H)	If P or ESS name of pooling group	Distribution used and reason for choice	Any urban or non-flood years adjustments	Parameters of distribution (location, scale and shape after adjustments)	Growth factor for 1% AEP event
All Sites	P	HB01	Kappa 3 provides the fit with the lowest absolute Z value aside from GEV which is not recommended	Urban adjustment applied using WINFAP 5.	Location: 0.933 Scale: 0.293 Shape: -0.179 Bound: -0.707	3.021

Methods: SS – Single Site, P – Pooled, ESS – Enhanced Single Site, H – Historical. Pooled and ESS growth curves were derived using the procedures from Science Report

SC050050 (2008). Urban adjustments are carried out using the method of Kjeldsen (2010).

Flood frequency curve plots

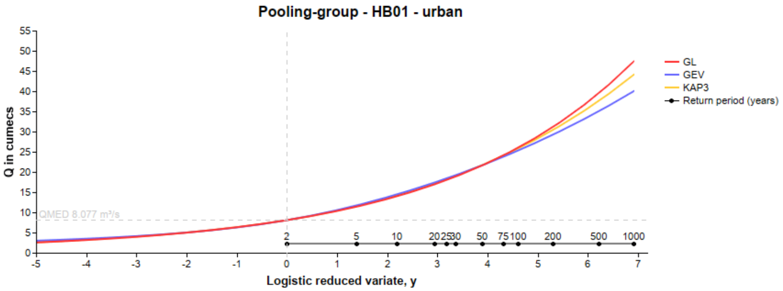

Figure 4-2. Flood Frequency Curve for HB01

Derivation of pooling groups

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (ESS)	URBEXT2000 threshold applied to pooling group selection?	L-moments deurbanised (including subject site for ESS)?	Small catchment pooling procedure applied?
HB01	HB01	No	0.03	L-CV: 0.275 L-Skew:0.234	No

Methods: Unless otherwise stated, pooling groups were derived using the procedures from Science Report SC050050 (2008). The small catchment pooling procedure is given in the Phase 2 report of project SC090031 (2021) and implemented in WINFAP 5.

Pooling group composition

Name of Group	Changes made to default pooling group, with reasons	Weighted average L-moments
HB01	No changes see 4.3.1	L-CV: 0.249 L-Skew:0.265

4.3.1 Following review the default group was used. The sites are all considered suitable for pooling. There are no sites with a record of less than 8 years. The sites 49005 (Bolingey Stream @ Bolingey Cocks Bridge) and 7012 (Lossie @ Ballachraggen) have been retained despite high discordancy. The AMAX series at each site was reviewed and both sites have a relatively short record, 9 and 13 years respectively, 7012 (Lossie @ Ballachraggen) has a particularly large AMAX (2017) relative to the rest of its record. BFIHOST19 values within the pooling group are generally reflective of the BFIHOST19 values of the sites in this study. Removing sites on the basis of differences in AREA, SAAR, FARL, and FPEXT was dismissed as any replacement sites would be less similar in these descriptors.

Final choice of QMED and growth curves

Name of Group	Final choice of QMED and reasons	Final choice of flood growth curve method and reasons
All Sites	QMED is derived from catchment descriptors and has been improved using donor transfer procedures. All sites have used six donor sites based on proximity with the exception of Arley Brook at Gore Farm (68011) which was discarded due to the short record length with missing periods of data.	A single flood growth curve has been derived for the full catchment to prevent unrealistic step changes in flow estimates. Urban adjustment used across all catchments to prevent discontinuity when catchments are below the URBEXT$_{2000}$ threshold of 0.03.

Final flood estimates from stationary statistical methods

Site code	Return period									
	2 50%	5 20%	10 10%	20 5%	30 3.3%	50 2%	75 1.3%	100 1%	200 0.5%	1000 0.1%
BB01	2.28	3.26	4.02	4.86	5.40	6.14	6.79	7.28	8.58	12.45
BB02	1.76	2.52	3.11	3.76	4.17	4.75	5.25	5.63	6.64	9.63
BB03	0.47	0.67	0.83	1.00	1.11	1.26	1.40	1.50	1.77	2.56
CB01	0.77	1.10	1.35	1.64	1.82	2.07	2.28	2.45	2.89	4.19
CB02	0.33	0.47	0.58	0.70	0.78	0.89	0.98	1.05	1.24	1.80
HB01	8.95	12.79	15.77	19.05	21.17	24.08	26.61	28.54	33.66	48.83
MB01	2.21	3.16	3.90	4.71	5.24	5.96	6.58	7.06	8.33	12.08
WB01	5.54	7.92	9.76	11.80	13.11	14.91	16.48	17.67	20.85	30.24
WB02	2.38	3.41	4.20	5.07	5.64	6.41	7.09	7.60	8.96	13.00
WB03	1.06	1.52	1.87	2.26	2.51	2.86	3.16	3.38	3.99	5.79
BB01i	0.16	0.23	0.28	0.34	0.38	0.43	0.47	0.51	0.60	0.87
CB01i	0.63	0.89	1.10	1.33	1.48	1.68	1.86	1.99	2.35	3.41
HB01i	1.57	2.24	2.76	3.34	3.71	4.22	4.67	5.00	5.90	8.56
WB01i	1.08	1.54	1.89	2.29	2.54	2.89	3.20	3.43	4.04	5.87

Flood peak in m3/s for the return periods in years or AEP (%) events

5.0 Revitalised Flood Hydrograph 2 (ReFH2) method

5.1 Method overview

What is the purpose of applying this method

5.1.1 The ReFH2 method is used to estimate peak flows at the subject sites. The ReFH2 flows will be checked against the Statistical method flows and the most appropriate will be selected.

5.1.2 As the site is ungauged and no analysis of hydrograph shape and response can be undertaken ReFH methods will be used to define flood hydrographs that will be used to insert flows into the hydraulic model.

Rural and urban catchment sub-divisions

5.1.3 All catchments have been treated as rural with the exception of MB01 and BB02 which have been treated as urban due to its URBEXT > 0.3. $URBEXT_{2000}$ was checked on all sub catchments using the methodology outlined in Section 3.2.12.

Version of ReFH2 applied

5.1.4 ReFH 2.3: software version: 4.1.

5.1.5 FEH22 model.

5.2 Model parameters

Summary of model parameters

Site code	Method	Tp_{rural} (hours)	Tp_{urban} (hours)	C_{max} (mm)	PR_{imp}	BL (hours)	BR
BB01	CD	1.57	1.57	343.28	70	28.76	2.46
BB02	CD	1.41	1.06	303.83	70	25.04	1.86
BB03	CD	1.03	1	408.54	70	26.45	2.92
CB01	CD	1.68	1.26	652.08	70	37.13	3.48
CB02	CD	1.64	1.23	858.78	70	38.02	4.08
HB01	CD	2.83	2.83	409.60	70	38.73	2.86

MB01	CD	1.49	1.12	311.83	70	26.58	1.97
WB01	CD	2.37	2.37	380.87	70	34.93	2.86
WB02	CD	1.80	1.80	365.37	70	30.22	2.80
WB03	CD	1.60	1.60	499.00	70	32.23	2.93
BB01i	CD	1.00	1	374.98	70	24.95	2.92
CB01i	CD	1.09	1	425.66	70	28.39	2.90
HB01i	CD	1.42	1.42	389.88	70	29.42	2.92
WB01i	CD	1.27	1	392.73	70	29.53	2.92

Analysis undertaken to derive model parameters

5.2.1 Catchment descriptor method used and therefore no further analysis required.

5.3 Design events

Site code	Rainfall DDF model	Urban or rural	Highly Permeable?	Season of design event (summer or winter)	Storm duration (hours)	Initial soil moisture Cini	Initial baseflow BFO
BB01	FEH22	Rural	No	Winter	3.25	Default	Default
BB02	FEH22	Urban	No	Winter*	2.75	Default	Default
BB03	FEH22	Rural	No	Winter	2.25	Default	Default
CB01	FEH22	Rural	Yes	Winter	3.25	Default	Default
CB02	FEH22	Rural	Yes	Winter	3.25	Default	Default
HB01	FEH22	Rural	No	Winter	5.50	Default	Default
MB01	FEH22	Urban	No	Winter*	3.25	Default	Default
WB01	FEH22	Rural	No	Winter	4.50	Default	Default
WB02	FEH22	Rural	No	Winter	3.75	Default	Default
WB03	FEH22	Rural	No	Winter	3.25	Default	Default
BB01i	FEH22	Rural	No	Winter	2.10	Default	Default
CB01i	FEH22	Rural	No	Winter	2.25	Default	Default
HB01i	FEH22	Rural	No	Winter	2.75	Default	Default
WB01i	FEH22	Rural	No	Winter	2.75	Default	Default

*Set to winter to maintain same seasonality across catchment despite sub catchment URBEXT > 0.3.

Storm duration testing

5.3.1 Different critical storm durations have been identified for each sub catchment. As per guidance for this approach, an identical storm duration has been applied to each sub catchment as to not introduce a scenario which is not physically realistic.

5.3.2 Storm duration has been set to that of the whole catchment of HB01 found from its catchment descriptors (5.5 hours). Further commentary on storm duration testing is provided in section 6.4.

5.4 Final choice of ReFH2 flow estimates

Method choice and reasons

Site Code	Final choice of design inputs and model parameters
BB01	Default model parameters derived from catchment descriptors. TP scaling factor set to 1 as per guidance for heavily urbanised catchment. Storm duration set to 5.5 hours from catchment descriptors for HB01.
BB02	Default model parameters derived from catchment descriptors. Catchment treated as urban as URBEXT > 0.3 as per guidance, however storm kept as winter to maintain seasonality across study area. Storm duration set to 5.5 hours from catchment descriptors for HB01
BB03	Default model parameters derived from catchment descriptors. Storm duration set to 5.5 hours from catchment descriptors for HB01
CB01	Default model parameters derived from catchment descriptors. Storm duration set to 5.5 hours from catchment descriptors for HB01
CB02	Default model parameters derived from catchment descriptors. Storm duration set to 5.5 hours from catchment descriptors for HB01
HB01	Default model parameters derived from catchment descriptors. TP scaling factor set to 1 as per guidance for heavily urbanised catchment. Storm duration set to 5.5 hours from catchment descriptors for HB01
MB01	Default model parameters derived from catchment descriptors. Catchment treated as urban as URBEXT > 0.3 as per guidance, however storm kept as winter to maintain seasonality across study area. Storm duration set to 5.5 hours from catchment descriptors for HB01
WB01	Default model parameters derived from catchment descriptors. TP scaling factor set to 1 as per guidance for heavily urbanised catchment. Storm duration set to 5.5 hours from catchment descriptors for HB01
WB02	Default model parameters derived from catchment descriptors. TP scaling factor set to 1 as per guidance for heavily urbanised catchment. Storm duration set to 5.5 hours from catchment descriptors for HB01
WB03	Default model parameters derived from catchment descriptors. TP scaling factor set to 1 as per guidance for heavily urbanised catchment. Storm duration set to 5.5 hours from catchment descriptors for HB01
BB01i	Default model parameters derived from catchment descriptors. Storm duration set to 5.5 hours from catchment descriptors for HB01

Flood estimates from the ReFH2 method

Site code	Flood peak (m3/s) for the following AEP (%) events									
	2 50%	5 20%	10 10%	20 5%	30 3.3%	50 2%	75 1.3%	100 1%	200 0.5%	1000 0.1%
BB01	1.19	1.65	1.99	2.34	2.56	2.84	3.08	3.26	3.73	5.13
BB02	1.07	1.51	1.82	2.14	2.34	2.59	2.81	2.96	3.37	4.55
BB03	0.28	0.40	0.49	0.58	0.64	0.71	0.77	0.82	0.94	1.30
CB01	0.42	0.59	0.71	0.85	0.93	1.04	1.13	1.20	1.39	1.98
CB02	0.17	0.24	0.29	0.35	0.38	0.43	0.47	0.50	0.59	0.84
HB01	4.32	5.81	6.92	8.06	8.79	9.77	10.61	11.24	12.96	18.27
MB01	1.45	2.03	2.44	2.86	3.12	3.46	3.74	3.96	4.52	6.14
WB01	2.83	3.85	4.60	5.38	5.87	6.52	7.07	7.48	8.60	11.95
WB02	1.24	1.71	2.05	2.41	2.63	2.92	3.17	3.36	3.85	5.32
WB03	0.46	0.64	0.77	0.92	1.00	1.12	1.22	1.29	1.49	2.09
BB01i	0.26	0.37	0.46	0.54	0.60	0.67	0.73	0.77	0.88	1.21
CB01i	0.38	0.55	0.67	0.80	0.88	0.98	1.07	1.14	1.31	1.81
HB01i	0.79	1.12	1.35	1.60	1.76	1.96	2.13	2.25	2.59	3.58
WB01i	0.75	1.06	1.29	1.53	1.68	1.87	2.03	2.15	2.47	3.42

6.0 Discussion and summary of results

6.1 Comparison of results from different methods

Site code	Ratio of ReFH2 to stationary statistical peak 50% AEP	Ratio of ReFH2 to stationary statistical peak 1% AEP
BB01	0.52	0.45
BB02	0.60	0.53
BB03	0.59	0.55
CB01	0.55	0.49
CB02	0.52	0.48
HB01	0.48	0.39
MB01	0.66	0.56
WB01	0.51	0.42
WB02	0.52	0.44
WB03	0.43	0.38
BB01i	1.63	1.52
CB01i	0.62	0.57
HB01i	0.50	0.45
WB01i	0.70	0.63

6.2 Final choice of method

Choice of method and reasons

6.2.1 The Statistical estimates have been used for this study.

6.2.2 The Statistical method uses observed data from similar catchments to increase the observed record length through pooled analysis.

6.2.3 The estimates of QMED have been improved using data from the six closest donors.

6.2.4 As a result of the use of gauged data through pooled analysis the Statistical method is preferred.

6.2.5 ReFH2 flows were estimated using catchment descriptors only.

6.2.6 A winter profiler has been used for all catchments within ReFH2 to maintain a consistent seasonality throughout the catchment.

6.2.7 Storm duration testing will be undertaken to determine the catchment wide critical storm duration.

How will the 0.1% AEP flows be estimated

6.2.8 The 0.1% AEP flows will be estimated using the Statistical Method. The Statistical Method 0.1/1% AEP ratio is higher than the equivalent ReFH2 ratio. It thus produces a greater peak flow for the 1000-year event and therefore a more conservative estimate from a flood risk perspective and hence has been selected for use in this study.

How will the flows be applied to the hydraulic model

6.2.9 The flow hydrographs will be derived from ReFH which will be scaled to the peak flow estimates generated by the statistical. Point and lateral inflows will be used to insert the flows into the hydraulic model.

6.2.10 Flow reconciliation will be used to match simulated flows with lumped estimates.

6.3 Final results

Site code	Flood peak (m3/s) for the following AEP (%) events									
	2 50%	5 20%	10 10%	20 5%	30 3.3%	50 2%	75 1.3%	100 1%	200 0.5%	1000 0.1%
BB01	2.28	3.26	4.02	4.86	5.40	6.14	6.79	7.28	8.58	12.45
BB02	1.76	2.52	3.11	3.76	4.17	4.75	5.25	5.63	6.64	9.63
BB03	0.47	0.67	0.83	1.00	1.11	1.26	1.40	1.50	1.77	2.56
CB01	0.77	1.10	1.35	1.64	1.82	2.07	2.28	2.45	2.89	4.19
CB02	0.33	0.47	0.58	0.70	0.78	0.89	0.98	1.05	1.24	1.80
HB01	8.95	12.79	15.77	19.05	21.17	24.08	26.61	28.54	33.66	48.83
MB01	2.21	3.16	3.90	4.71	5.24	5.96	6.58	7.06	8.33	12.08
WB01	5.54	7.92	9.76	11.80	13.11	14.91	16.48	17.67	20.85	30.24
WB02	2.38	3.41	4.20	5.07	5.64	6.41	7.09	7.60	8.96	13.00

WB03	1.06	1.52	1.87	2.26	2.51	2.86	3.16	3.38	3.99	5.79
BB01i	0.16	0.23	0.28	0.34	0.38	0.43	0.47	0.51	0.60	0.87
CB01i	0.63	0.89	1.10	1.33	1.48	1.68	1.86	1.99	2.35	3.41
HB01i	1.57	2.24	2.76	3.34	3.71	4.22	4.67	5.00	5.90	8.56
WB01i	1.08	1.54	1.89	2.29	2.54	2.89	3.20	3.43	4.04	5.87

Climate change

6.3.1 Climate change sensitivity simulations will be undertaken using the climate change allowances guidance last updated 27th May 2022.

6.3.2 The updated guidance recommends:

- Applying the central allowance for the design allowance.
- Using the extreme allowance to simulate more extreme change and exceedance events.

6.3.3 Peak river flow climate change allowances for the Irwell Management Catchment for the 2080s epoch are as follows[9]:

- Central 35%.
- Higher 46%.
- Upper 75%.

6.3.4 The Central and Upper allowances will be applied as two separate sensitivity scenarios. The percentage allowance for each will be applied as scaling factors for inflows inserted into the hydraulic model.

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[9] Irwell Management Catchment peak river flow allowances

6.4 Checks

Growth factor checks

6.4.1 The 1% AEP growth factor from the statistical method is 3.189 as the same pooling group has been applied to all catchments. The ReFH2 growth factors range from 2.61 to 2.97. This is in line with the recommended 2.1 to 4.0 range within the Flood Estimation Guidelines.

6.4.2 The ratio for the Statistical Method 0.1/1% AEP flows is 1.71. For the ReFH2 method they are between 1.54 and 1.67. The variation in ratios for the ReFH2 method appear to be linked to BFIHOST19 values for each sub catchment. Those sub catchments with higher ratios have higher BFIHOST19 values such as CB01 and CB02.

Specific discharge

Site Code	Statistical Method Specific Discharges (l/s/ha)									
	2 50%	5 20%	10 10%	20 5%	30 3.3%	50 2%	75 1.3%	100 1%	200 0.5%	1000 0.1%
BB01	8.52	12.18	15.02	18.15	20.17	22.94	25.35	27.18	32.07	46.52
BB02	12.39	17.70	21.83	26.37	29.31	33.34	36.84	39.50	46.60	67.60
BB03	6.92	9.89	12.20	14.74	16.38	18.63	20.59	22.07	26.04	37.77
CB01	2.83	4.05	4.99	6.03	6.70	7.62	8.42	9.03	10.65	15.45
CB02	2.00	2.85	3.52	4.25	4.72	5.37	5.94	6.37	7.51	10.89
HB01	5.46	7.81	9.62	11.63	12.92	14.70	16.25	17.42	20.55	29.81
MB01	10.58	15.12	18.64	22.52	25.03	28.47	31.46	33.73	39.80	57.73
WB01	6.14	8.77	10.81	13.07	14.52	16.52	18.25	19.57	23.09	33.49
WB02	7.56	10.80	13.32	16.09	17.88	20.34	22.48	24.10	28.43	41.24
WB03	5.86	8.37	10.32	12.47	13.86	15.77	17.42	18.68	22.04	31.97
BB01i	2.77	3.96	4.88	5.90	6.55	7.45	8.24	8.83	10.42	15.12
CB01i	5.87	8.39	10.35	12.51	13.90	15.81	17.47	18.73	22.10	32.05
HB01i	7.99	11.42	14.08	17.01	18.90	21.50	23.76	25.48	30.05	43.59
WB01i	5.45	7.79	9.61	11.61	12.90	14.67	16.21	17.38	20.51	29.75

6.4.3 The specific discharge is seen to be impacted by the URBEXT value such that those catchments with a higher URBEXT value are seen to have a higher specific discharge value. This is to be expected as more urban areas have more impermeable areas with greater runoff and therefore high discharges per hectare.

Spatial consistency of results

6.4.4 The spatial consistency is seen in the results. Estimates at confluences are no larger than the sum of the upstream estimates or lower than the largest upstream estimate.

6.4.5 However, BB01 has produced lower flow estimates in the Statistical method than that of BB02 which is likely due to the attenuation present within BB01. It is likely that in a flood scenario there would be some level of attenuation from these reservoirs and therefore the result can be considered spatially consistent.

Storm duration testing

6.4.6 In the absence of gauged data to assess storm duration and hydrograph shape, storm duration testing was undertaken in the hydraulic model. The storm duration of the ReFH derived hydrographs was updated and the model was simulated for the following catchment wide storm durations:

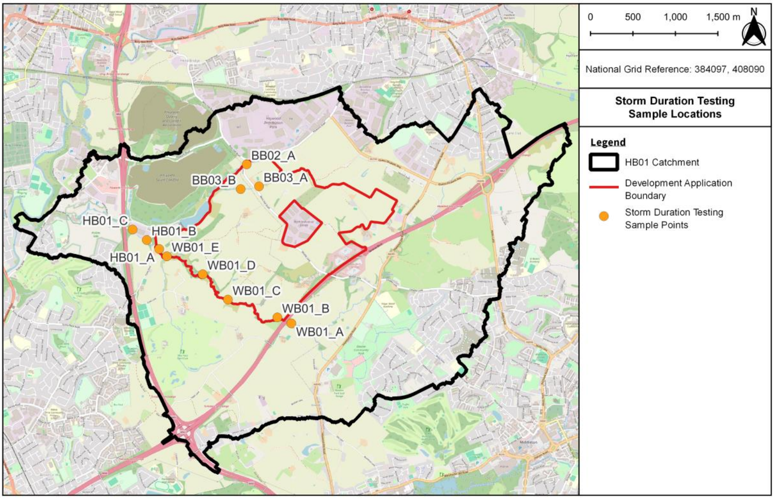
- 3 hours (average storm duration of all sub catchments),
- 5.5 hours (Hollins Brook catchment design storm duration),
- 9 hours,
- 15 hours,
- 24 hours.

6.4.7 It should be noted that the hydrographs were generated using ReFH2, and no scaling to Statistical peak flows was applied to avoid an overestimation of total flood volume.

6.4.8 A number of sampling locations were set up to monitor the difference in simulated depth for the different storm durations in the 1% AEP plus 35% climate change event. The results are tabulated for the locations indicated in Figure 6-1.

6.4.9 The 5.5 hour storm duration consistently produces the greatest depth of flooding throughout the model domain at the sampled locations. The 9 hour storm duration produces similar depths at most locations with the other events generally lower.

Sample Location	Modelled Depth (m)				
	3 hours	5.5 hours	9 hours	15 hours	24 hours
BB02_A	0.800	0.790	0.591	0.612	0.511
BB03_A	1.079	1.094	1.041	0.972	0.918
BB03_B	0.867	0.891	0.839	0.768	0.699
HB01_A	2.088	2.177	2.175	2.129	2.061
HB01_B	1.915	1.990	1.988	1.953	1.892
HB01_C	2.354	2.532	2.532	2.465	2.348
WB01_A	0.857	1.068	0.997	0.800	0.573
WB01_B	1.943	2.002	1.983	1.926	1.855
WB01_C	1.777	1.839	1.826	1.774	1.709
WB01_D	1.686	1.736	1.728	1.692	1.642
WB01_E	1.740	1.803	1.802	1.768	1.721


0
500
1,000
1,500 m
N
National Grid Reference: 384097, 408090
Storm Duration Testing Sample Locations
Legend
HB01 Catchment
Development Application Boundary
Storm Duration Testing Sample Points
BB02_A
BB03_B
BB03_A
HB01_C
HB01_B
WB01_E
HB01_A
WB01_D
WB01_C
WB01_B
WB01_A

Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

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Figure 6-1. Locations of sample points for storm duration analysis

6.4.10 The average storm duration for the individual sub catchments is 3 hours. Therefore, the 5.5 hour storm provides a conservative estimate for the volume of water present across the catchment.

6.4.11 The most sensitive areas of the model to the storm duration are flow constrictions at structures e.g. the culverts through the M62 and M66. HB01_C and WB01_A show a greater range of modelled flood depths across the different storm durations compared to BB03_A for example.

Comparison with previous studies

6.4.12 The results of this study have been compared against the study conducted by JBA when producing the River Roch model for the Environment Agency in 2017. The results from this previous study showed a QMED estimation using the Statistical method at HB01 of 8m^3/s, whereas in this study it is higher at 8.95m^3/s. This is due to differences in catchment descriptors; particularly the changes in FARL values on Brightley Brook where a more in-depth GIS analysis of the catchment and site visits have been conducted.

6.4.13 The JBA study estimated the 1 in 100 year flood event to have a peak flow of 22m^3/s which is less than in this study which estimated a flow of 28.5m^3/s. This is due to the increased QMED value obtained in this study multiplied by similar growth factors.

6.4.14 From this comparison, it is likely that the results of this study are a more accurate estimate of the HB01 catchment. Updated methods and data have been used and further information has been obtained to better depict the hydrological characteristics of the catchment through the updated catchment descriptors.

6.4.15 The hydraulic model has been used to check consistency between model flows and the peak flow estimates. However, due to the impact of various structures (e.g. the M62 and M62 culverts) within the hydraulic model and the storage of flows behind these the peaks are not matched. For example at the downstream extent of Hollins Brook the 1% AEP modelled peak flow is 21.3m^3/s approximately 7.2m^3/s lower than the peak flow estimate and the 3.33% AEP is 17.6m^3/s approximately 3.6m^3/s lower than the peak flow estimate. In addition this result is influenced by the interaction between Brightley Brook and the Pilsworth fishing lake and the storage of flow upstream of the culvert at Castle Road at the downstream extent of Brightley Book.

6.4.16 Additionally, the final modelled outputs for this study have been compared to previous studies including the JBA 2019 JFLOW model and the EA Flood Risk Map for Planning.

6.4.17 The JBA results show similar flood extents. The JBA model includes conservative sizing of culverts, particularly under the M62 and M66 where they did not have survey information. For example there is a 13x5m rectangular culvert in the JBA model for the Whittle Brook culvert under the M62 at Sandfield Farm, site observations from this study measured this structure as 2x1.6m diameter circular pipes. In these locations in this study greater flood extents have been modelled around these culvert inlets where surcharging of the culverts takes place.

6.4.18 The model also shows a similar extent to the EA Flood Risk Map for Planning especially upstream of the M66 culvert at Aviation Road and at the Mere Brook and Whittle Brook confluence.

6.5 Assumptions, limitations and uncertainty

Assumptions (specific to this study)

6.5.1 It is assumed that the checks and the changes applied to the catchment boundaries and descriptors are appropriate.

6.5.2 It is assumed that cutting the BB02 catchment at the railway line is appropriate. There are no visible watercourses or other drainage features which would allow north to south flow. As a result, any runoff or flow generated here is assumed to follow the railway cutting which slopes westwards.

6.5.3 It is assumed that the desk-based checks on the catchment descriptors is appropriate. This includes URBEXT changes and the changes to FARL values from the Brightley Brook sub catchment.

6.5.4 The FEH statistical method used flow data from similar sites, it is assumed that the selected donor sites are suitable to use.

6.5.5 It is assumed that the default ReFH2 parameters are suitable for the catchment descriptor only flow estimates.

6.5.6 It is assumed that the ReFH2 recommended storm duration from HB01 represents the study site and that a uniform storm duration with a winter profile is appropriate.

6.5.7 Non stationarity has not been considered.

Limitations

6.5.8 There is no gauged data in the catchment. The FEH Statistical method is thought to only be suitable for events up to 0.5% AEP. It has, however, been applied here to derive the 0.1% AEP estimates as the growth factor was greater than that from the ReFH2 estimate.

Uncertainty

6.5.9 There is always uncertainty in hydrological and hydraulic modelling. This study uses observed data from donor sites and is based on the most up to date flood estimation methods and guidance. Based on the flood estimation guidelines (EA

2022) six donor sites have been used to reduce uncertainty. The uncertainty bounds for the Statistical method are indicated in Section 6.6.

Suitability for future studies

6.5.10 The flood estimates are based on the data available at the time of the study. The results can be replicated and/or updated for future studies at the site.

6.5.11 The results should be considered in the context of this study and future users should satisfy themselves that the estimated design flows are suitable for their study.

6.5.12 As new hydrometrical data or flood estimation methods are updated the estimates should be reconsidered.

Recommendations for future work

6.5.13 More local gauged data is recommended. This would improve the confidence in the peak flow estimates and typical hydrograph volume / shape.

6.5.14 Additional understanding could be sought in regards to the connectivity of the reservoirs on Brightley Brook and thus their overall impact on flows from this part of the catchment.

6.6 Uncertainty bounds

6.6.1 Uncertainty bounds have been calculated, sites with missing values have an URBEXT >0.15 and do not have associated confidence intervals therefore uncertainty bounds have not been calculated.

Site code	Flood peak (m3/s) for the following return periods											
	50%				5%				1%			
	68%		95%		68%		95%		68%		95%	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
BB01												
BB02												
BB03	0.33	0.66	0.24	0.93	0.71	1.42	0.50	2.01	3.19	1.17	0.40	1.68
CB01	0.48	1.22	0.31	1.94	0.98	2.71	0.59	4.50	3.32	2.06	0.41	3.51
CB02	0.21	0.52	0.13	0.83	0.42	1.16	0.25	1.93	0.88	0.86	0.17	1.46
HB01												
MB01												
WB01												
WB02												
WB03												
BB01i	0.11	0.22	0.08	0.31	0.24	0.48	0.17	0.68	5.32	1.25	0.43	1.79
CB01i	0.39	0.99	0.25	1.58	0.80	2.21	0.48	3.66	2.00	1.94	0.39	3.31
HB01i												
WB01i	0.76	1.51	0.55	2.12	1.62	3.25	1.14	4.60	1.40	3.08	1.05	4.41

Appendix A: HB01 pooling group composition

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Discordancy
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	0.017	13	4.072	0.274	0.275	0.295	0.294	3.312
44008 (South Winterbourne @ Winterbourne Steepleton)	0.184	32	0.572	0.405	0.406	0.254	0.254	0.895
27010 (Hodge Beck @ Bransdale Weir)	0.188	41	9.42	0.224	0.224	0.293	0.293	0.353
73015 (Keer @ High Keer Weir)	0.569	33	12.421	0.204	0.205	0.189	0.189	0.213
72014 (Conder @ Galgate)	0.582	55	16.912	0.23	0.231	0.143	0.142	0.193
44013 (Piddle @ Little Puddle)	0.59	31	0.933	0.483	0.484	0.256	0.256	2.335
7012 (Lossie @ Ballachraggan)	0.595	9	7.262	0.488	0.488	0.67	0.67	3.062
25019 (Leven @ Easby)	0.652	45	5.09	0.341	0.342	0.373	0.372	0.293
28041 (Hamps @ Waterhouses)	0.656	38	26.313	0.213	0.214	0.284	0.283	0.814
24006 (Rookhope Burn @ Eastgate)	0.675	20	24.62	0.152	0.152	0.117	0.117	0.504
51003 (Washford @ Beggearn Huish)	0.7	55	6.12	0.202	0.203	0.086	0.086	0.714
49004 (Gannel @ Gwills)	0.723	54	13.795	0.259	0.26	0.133	0.132	0.452
48007 (Kennal @ Ponsanooth)	0.736	55	4.18	0.192	0.193	0.217	0.215	0.353
41020 (Bevern Stream @ Clappers Bridge)	0.766	54	13.78	0.199	0.2	0.164	0.162	0.509
Total		535						
Weighted Means				0.249	0.275	0.264	0.234	
H2 value	3.3116							
Goodness of fit			**General Logistic**		**Generalised Extreme Value**		**Kappa 3**	
			2.08		0.13		1.4	

Appendix B: Structures

Model ID	Location	XY	Surveyed	Type	Structure data	Parameters (Roughness / Coefficient)	Comments
HB01_0455	Hollins Brook at Croft Lane	381207 , 408427	No	Culvert	US Invert: 68.40m DS Invert: 67.00m Shape: Rectangular Size: 5x1.35m Barrels: 1	Mannings 'n': 0.013 HCon: 1 WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model. Invert levels from LiDAR. Dimensions estimated from photography (counts of bricks and standard pre-1970s brick sizes), OS MasterMap data and LiDAR Brick structure
N/A	Hollins Brook footpath off Aviation Road	381468 , 408489	No	Footbridge			Not included, unlikely to have significant hydraulic impact
N/A	Hollins Brook footpath off Boarden Way	381837 , 408502	No	Footbridge			Not included, unlikely to have significant hydraulic impact
HB01_1542	Hollins Brook at M66	382130 , 408351	Yes, downstream only	Culvert	US Invert: 74.50m DS Invert: 73.00m Shape: Circular Diameter: 2.00m Barrels: 2	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model. US invert levels from LiDAR due to access issues. DS Invert from LIDAR (surveyed level 0.5m below LIDAR levels). Dimensions from survey. Concrete structure.
HB01_1792	Hollins Brook south of Garic	382264 , 408277	No	Culvert	US Invert: 75.00m DS Invert: 74.80m Shape: Circular Diameter: 2.00m Barrels: 2	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model. Invert levels from LiDAR due to access issues. Dimensions taken from M66 culvert survey Assumed concrete structure.
N/A	Hollins Brook weir south of Garic	382292 , 408256	No	Weir			Represented in 2D via LiDAR elevations
N/A	Hollins Brook weir downstream of Brightley Brook confluence	382387 , 408239	No	Weir			Represented in 2D via LiDAR elevations
BB01_0020	Brightley Brook at Castle Road	382407 , 408254	No	Culvert	US Invert: 79.61m DS Invert: 78.5m Shape: Circular Diameter: 0.9m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR due to access issues Dimensions assumed from upstream culvert dimensions Assumed concrete structure
N/A	Spillway from fishing reservoir	382848 , 408331	No	Spillway			Modelled in 2D domain due to lack of survey data and stability issues with steep slope in 1D
Pond_Outfall	Brightley Brook culvert to spillway	382848 , 408331	Yes, upstream	Culvert	US Invert: 90.96m DS Invert: 90.43m Shape: Rectangular Size: 1x1m Barrels: 1	Mannings 'n': 0.013 HCon: 0.8 WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from survey upstream, LiDAR downstream Dimensions from survey Concrete structure
BB01_0993	Brightley Brook by Pilsworth Fishery downstream of weir	383139 , 408631	Surveyed but no levels given	Culvert	US Invert: 92.1m DS Invert: 92.1m Shape: Circular Size: 0.9m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR due to access issues Dimensions from surveyed pipe upstream Assumed concrete structure
BB01_1064	Brightley Brook by Pilsworth Fishery parking	383145 , 408697	No	Weir			Not included in model
Pond_Pipe	From northern pond into BB01_1070	383149 , 408705	Yes	Culvert	US Invert: 94.014m DS Invert: 93.92m Shape: Circular Diameter: 0.3m Barrels: 1	Mannings 'n': 0.013 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from survey Dimensions from survey Corrugated plastic pipe, smooth lined inner

Model ID	Location	XY	Surveyed	Type	Structure data	Parameters (Roughness / Coefficient)	Comments
BB01_1070	Brightley Brook by Pilsworth Fishery parking	383149 , 408705	Yes, upstream and downstream	Culvert	US Invert: 92.56m DS Invert: 92.56m Shape: Circular Diameter: 0.9m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert level upstream from survey, downstream assumed the same Dimensions from survey Concrete structure
BB01_1298	Top end of smaller fishing lake	383296 , 408861	Yes, downstream only	Culvert	West barrel: US Invert: 95.35m DS Invert: 92.96m East barrel: US Invert: 95.13m DS Invert: 94.83m Shape: Circular Diameter: 0.9m Barrels: 2	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert level upstream from LiDAR and photos, downstream from survey Dimensions from survey Assumed concrete structure
BB03_0001	On Brightley Brook ordinary watercourse towards pond	383330 , 408815	No	Culvert	300m circular		Not included, poor information about route and outfall
BB03_0081	On Brightley Brook ordinary watercourse towards pond	383358 , 408805	No	Culvert	US Invert: 97.1m DS Invert: 96.9m Shape: Rectangular Size: 0.7x0.7m Barrels: 1	Mannings 'n': 0.011 HCon: 0.8 WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from site observations Brick structure
BB03_0172	Downstream end of pond on BBO	383442 , 408802	Yes	Penstock			Not included, evidence of overflow channel suggests no flow through this culvert Non-functional penstock, likely causing nearby overflow channel from pond
BB03_0213	Upstream of pond on BB03	383494 , 408799	No	Culvert	US Invert: 101.5m DS Invert: 101.3m Shape: Rectangular Size: 0.7x0.7m Barrels: 1	Mannings 'n': 0.011 HCon: 0.8 WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from downstream culvert Assumed concrete structure
BB03_0304	Upstream of pond on BB03	383582 , 408803	No	Culvert	US Invert: 102.72m DS Invert: 102.69m Shape: Rectangular Size: 0.7x0.7m Barrels: 1	Mannings 'n': 0.011 HCon: 0.8 WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from downstream culvert Assumed concrete structure
BB03_0373	Under Moss Hall Road	383659 , 408815	No	Culvert	US Invert: 104.25m DS Invert: 103.6m Shape: Circular Diameter: 0.8m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from site observations Concrete structure
BB03_1253	NE of Birch Industrial Estate	384421 , 408831	No	Culvert	US Invert: 104.25m DS Invert: 103.6m Shape: Circular Diameter: 0.8m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from site observations Assumed concrete structure
BB03_1625	NE of Birch Industrial Estate	384585 , 408852	No	Culvert	0.65m circular concrete culvert		Not included in model, outside of final model domain
BB02_0336	Under Moss Hall Road by Pilsworth Road	383538 , 409076	Yes, downstream only	Culvert	Two lateral inflows into Brightley Brook, 0.9m and 0.375m circular pipes		Not included in model, no information on culvert inlets
BB02_0338	Under Moss Hall Road by Pilsworth Road	383539 , 409081	Yes, downstream only	Culvert	US Invert: 104.10m DS Invert: 104.00m Shape: Circular Diameter: 1.4m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert level downstream from LiDAR (0.5m above survey level to tie into LiDAR and allow free flow), upstream from LiDAR Dimensions from survey Concrete structure

Model ID	Location	XY	Surveyed	Type	Structure data	Parameters (Roughness / Coefficient)	Comments
BB02_0680	By Pilsworth road on Brightley Brook	383887 , 409162	No	Culvert	US Invert: 110.135m DS Invert: 109.75m Shape: Circular Diameter: 1.2m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from upstream surveyed culvert Assumed concrete structure
BB02_0842	Under Pilsworth Road	384045 , 409257	Yes, downstream only	Culvert	1.2m circular pipe		Not included, outside model extent
WB01_2523a	On Whittle Brook under M62	384037 , 407254	No	Culvert	US Invert: 88.1m DS Invert: 88.0m Shape: Circular Diameter: 1.6m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from site visit measurements Concrete structure
WB01_2523b	On Whittle Brook under M62	384037 , 407254	No	Culvert	US Invert: 88.1m DS Invert: 88.0m Shape: Circular Diameter: 1.6m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from site visit measurements Concrete structure
WB01_3123	On Whittle Brook near Mere Brook confluence	384482 , 407129	No	Culvert	US Invert:92.6m DS Invert: 92.6m Shape: Rectangular Size: 1.2m x 0.9m Barrels: 1	Mannings 'n': 0.011 HCon: 0.8 WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from upstream surveyed culvert Assumed concrete structure
CB01_0533	Culvert under Griffe Lane - Castle Brook	382589 , 407581	Yes, upstream and downstream	Culvert	US Invert: 88.25m DS Invert: 88.05m Shape: Circular Diameter: 1.8m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR. Dimensions from survey Assumed concrete structure
CB01_0931	Castle Brook at golf course	382688 , 407222	Yes, upstream and downstream	Bridge	US Invert: 86.882m DS Invert: 86.905m Shape: Circular Diameter: 1.8m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR - surveyed levels 0.4-0.5m below LiDAR levels. Survey shows culvert is free flowing Dimensions from survey Concrete structure
CB01_1153	Castle Brook at golf course	382818 , 407046	Yes, upstream and downstream	Bridge	US Invert: 87.713m DS Invert: 86.792m Shape: Circular Diameter: 1.8m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR - surveyed levels 0.4m below LiDAR levels. Survey shows culvert is free flowing Dimensions from survey Concrete structure Bridge deck forced into grid using 2d_zsh line
CB01_1453	Castle Brook at golf course	382770 , 406804	Yes, upstream and downstream	Bridge	US Invert: 88.692m DS Invert: 88.703m Shape: Circular Diameter: 1.8m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR - surveyed levels 0.7m below LiDAR levels. Survey shows culvert would not be this impeded Dimensions from survey Concrete structure Bridge deck forced into grid using 2d_zsh line
CB01_1518	Castle Brook at golf course	382814 , 406756	Yes, upstream and downstream	Bridge	US Invert: 88.939m DS Invert: 89.00m Shape: Circular Diameter: 0.9m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR - surveyed levels 0.6m below LiDAR levels. Survey shows culvert is free flowing Dimensions from survey Concrete structure
WB02_0253	On unnamed watercourse south of M62 service station	384763 , 407565	Yes , upstream and downstream	Culvert	US Invert: 97.05m DS Invert: 96.9886m Shape: Rectangular Size: 1.2m x 0.9m Barrels: 1	Mannings 'n': 0.015 HCon: 0.8 WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions from survey Brick structure

Model ID	Location	XY	Surveyed	Type	Structure data	Parameters (Roughness / Coefficient)	Comments
WB02_0448	Unnamed watercourse culvert under M62 service station	384768 , 407702	No	Culvert	US Invert: 107.75m DS Invert: 99.5m Shape: Circular Diameter: 1.5m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert levels from LiDAR Dimensions - measured on site visit Concrete structure Route assumed
WB02_1064a	Under farm track north of M62 service station	384673 , 408284	Yes, downstream only	Culvert	US Invert: 110.68m DS Invert: 110.44m Shape: Circular Diameter: 0.6m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert level upstream from LiDAR, downstream from survey Dimensions from survey Assumed concrete structure
WB02_1064b	Under farm track north of M62 service station	384673 , 408284	Yes, downstream only	Culvert	US Invert: 110.79m DS Invert: 110.43m Shape: Circular Diameter: 0.8m Barrels: 1	Mannings 'n': 0.011 HCon: N/A WCon: 1.0 EntryC: 0.5 ExitC: 1.0	Included in model Invert level upstream from LiDAR, downstream from survey Dimensions from survey Assumed concrete structure
HB01_2567	Over Hollins Brook	382562 , 408050	Yes, upstream only	Footbridge	3.5m span		Not included, flows bypassing unlikely to have significant hydraulic impact
HB01_2434	Hollins Brook at Castle Road	382457 , 408142	No	Bridge			No above level of channel, unlikely to impact flow

Appendix C: Photos

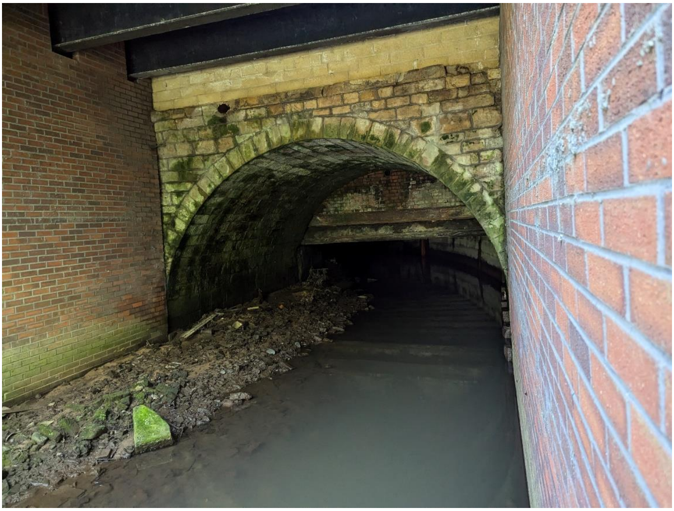


Photo 5-1. Upstream face of culvert under Croft Lane (HB01_0455)

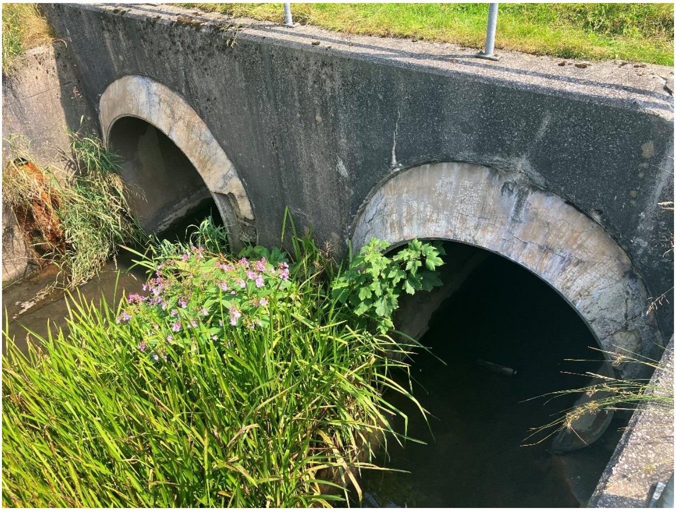


Photo 5-2. Downstream face of culvert under M66 (HB01_1452)

Photo 5-3. Bridge not modelled at Castle Road (HB01_2434)

Photo 5-4. Footbridge not modelled on Hollins Brook (HB01_2567)

Photo 5-5. Whittle Brook approximately 200m upstream of footbridge

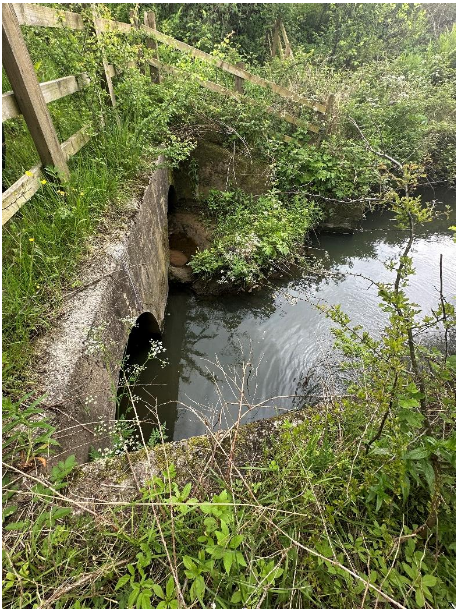


Photo 5-6. Downstream face of culvert under M66 (WB01_2523)

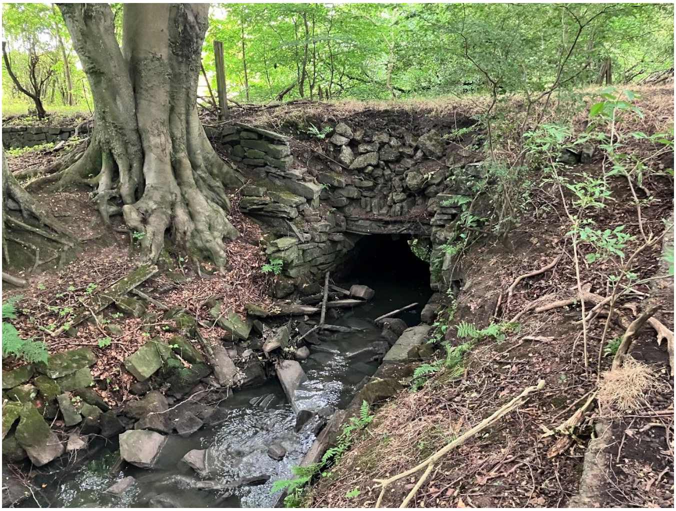


Photo 5-7. Downstream face of culvert (WB02_0253)

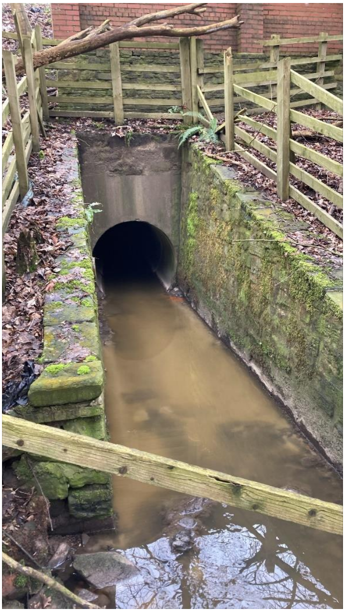


Photo 5-8. Downstream face of culvert at Birch Services (WB02_0448)

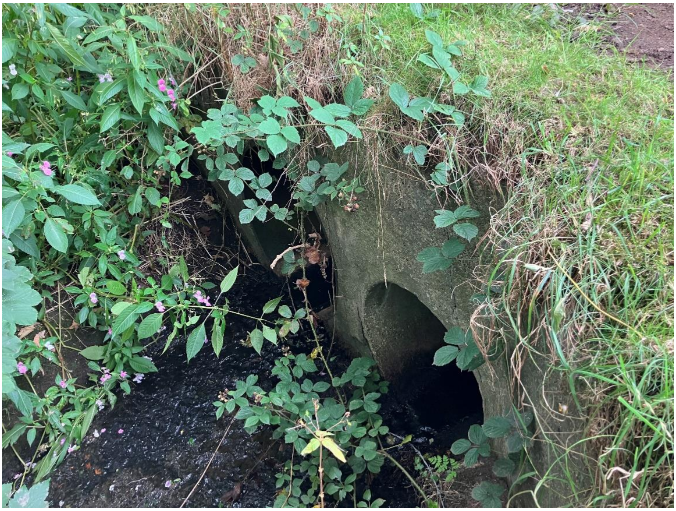


Photo 5-9. Culverts upstream of Brich Services (WB02_1064)

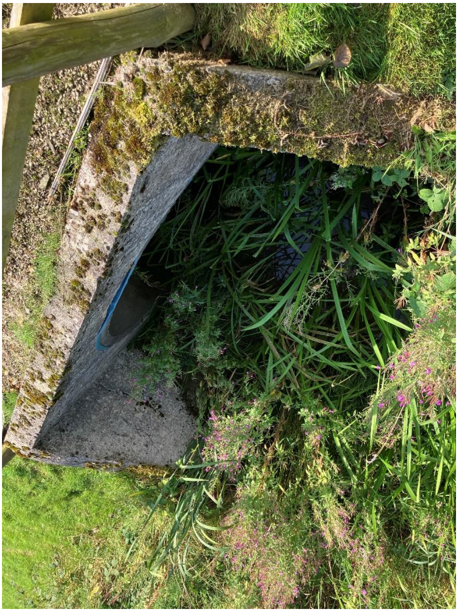


Photo 5-10. Castle Brook culvert (CB01_1518)

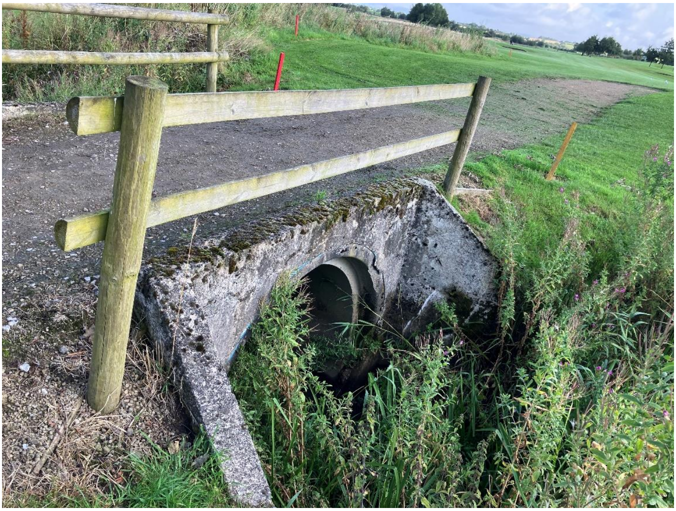


Photo 5-11. Castle Brook culvert (CB01_1453)

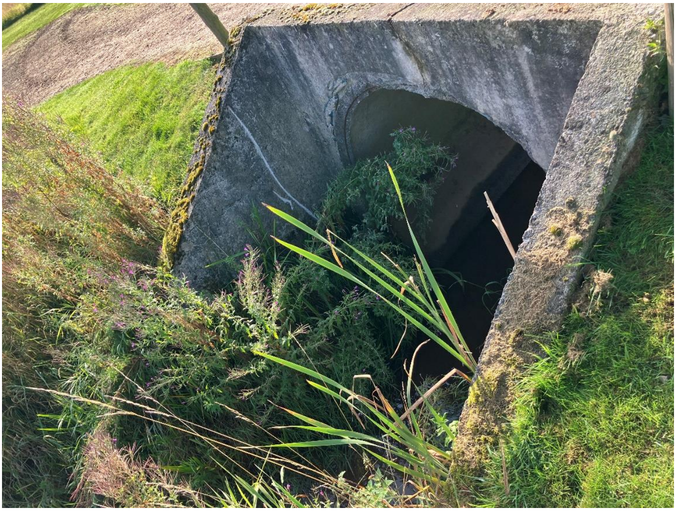


Photo 5-12. Castle Brook culvert (CB01_1153)

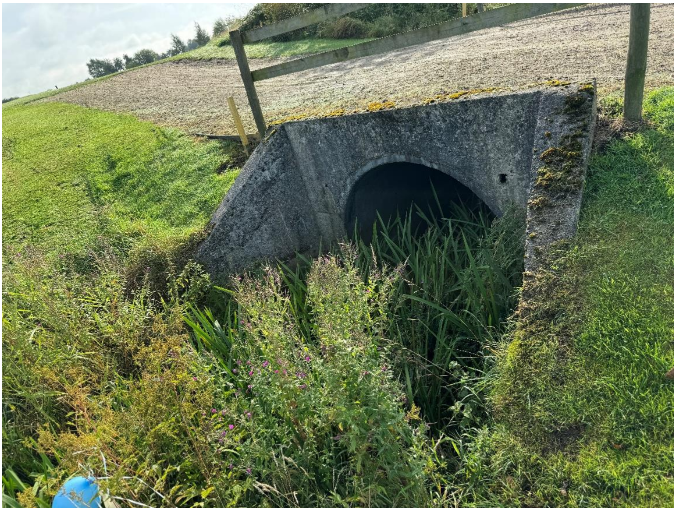


Photo 5-13. Castle Brook culvert (CB01_0931)

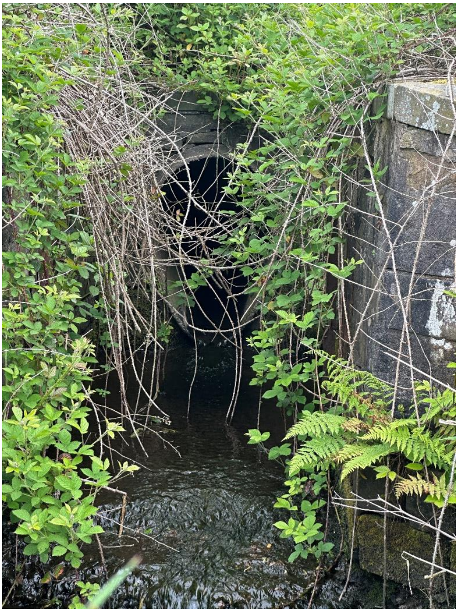


Photo 5-14. Downstream face of culvert at Moss Hall Road (BB03_0373)

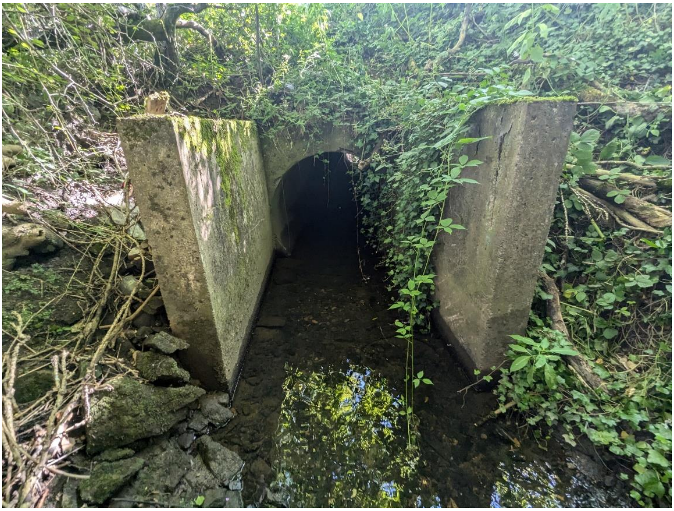


Photo 5-15. Downstream face of culvert at Moss Hall Road (BB02_0338)

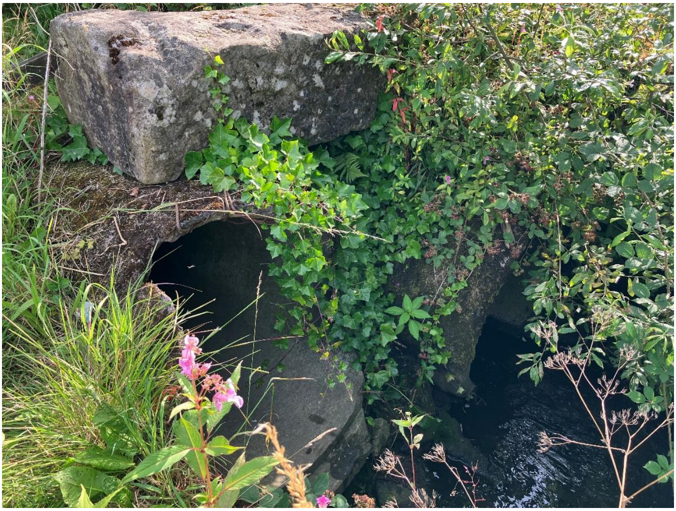


Photo 5-16. Culverts on Brightley Brook (BB01_1298)

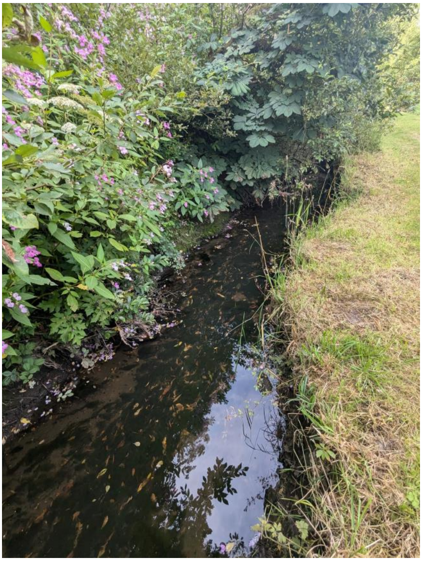


Photo 5-17. Brightley Brook at BB01_1251

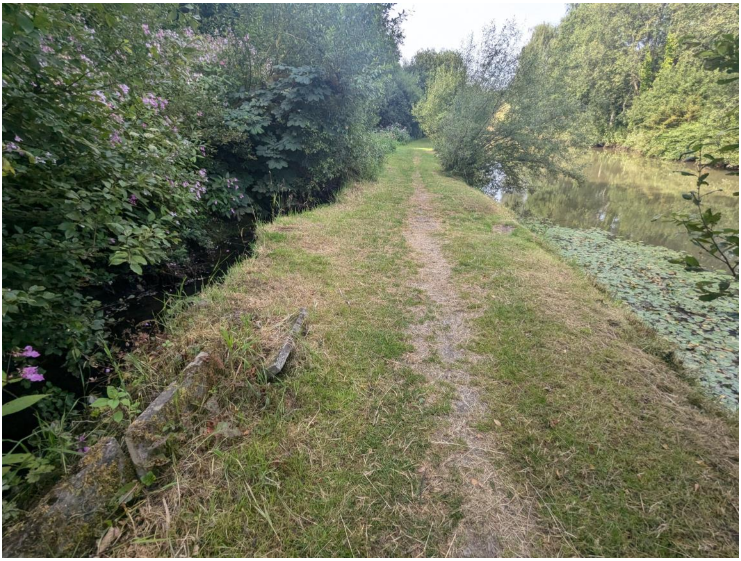


Photo 5-18. Brightley Brook at BB01_1221

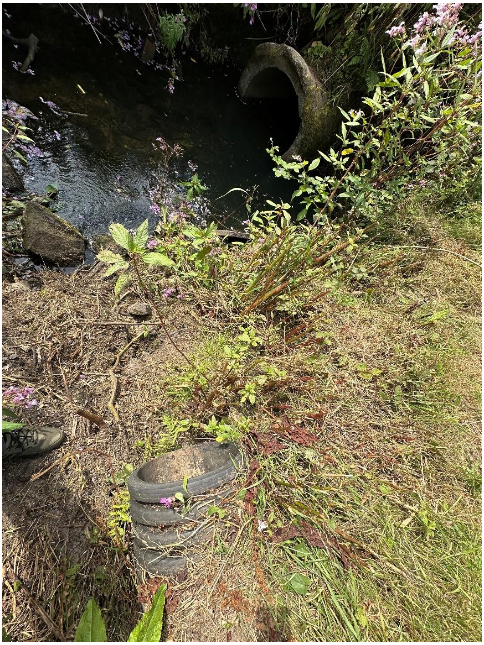


Photo 5-19. Culvert on Brightley Brook (BB01_1070) and connection from pond

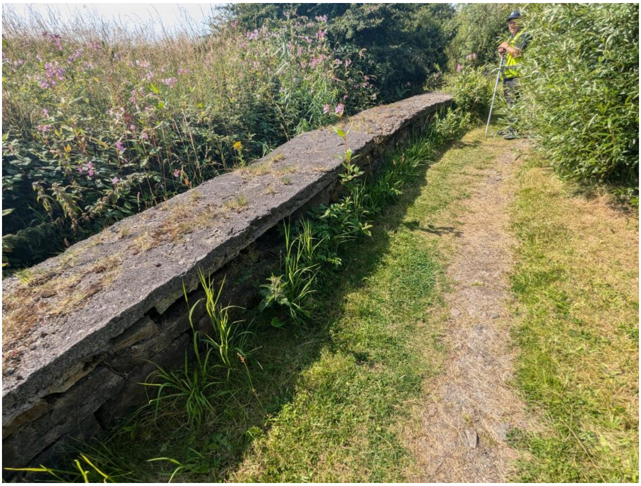


Photo 5-20. Brightley Brook at BB01_0643

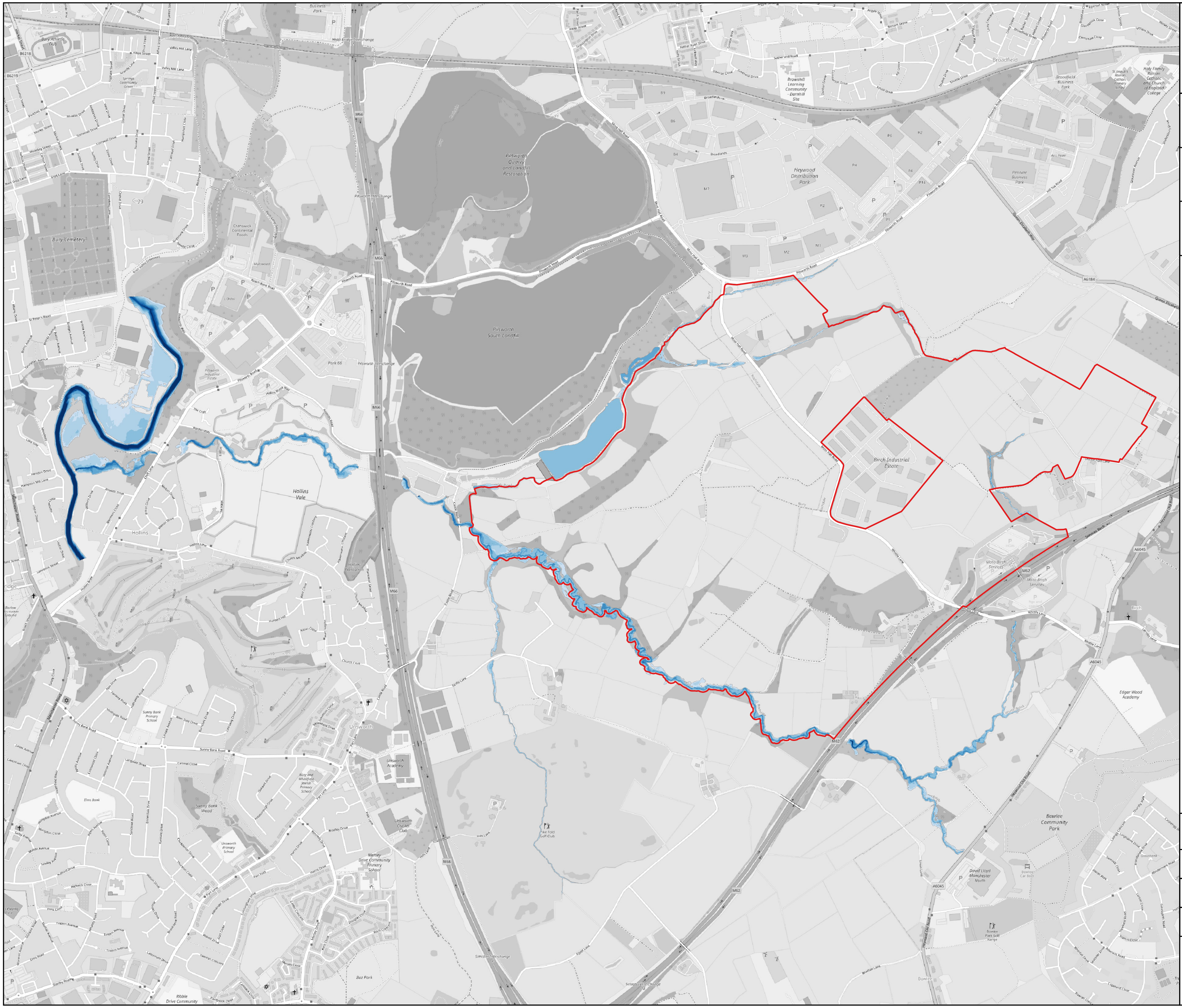
Appendix D: Baseline Hydraulic Model Results

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 1: Baseline 3.33% AEP present day



Bury Cemetery
Gigg
Pilsworth Quarry and Landfill Restoration
Pilsworth South Landfill
Park 66
M66
M62
Heywood Distribution Park
Broadfield
Broadfield Business Park
Pennine Business Park
Birch Industrial Estate
Hollins Vale
Hollins
Moto Birch Services
A6104
A6045
Edgar Wood Academy
Unsworth
Sunny Bank Wood
Bowlee Community Park
David Lloyd Manchester North

Legend

Development Application Boundary

Maximum Modelled Depth

- ▨ <0.15m
- ▨ 0.15-0.5m
- ▨ 0.5-1m
- ▨ 1-1.5m
- ▨ 1.5-2m
- ▨ 2-2.5m
- ▨ 2.5-3m
- ▨ >3m

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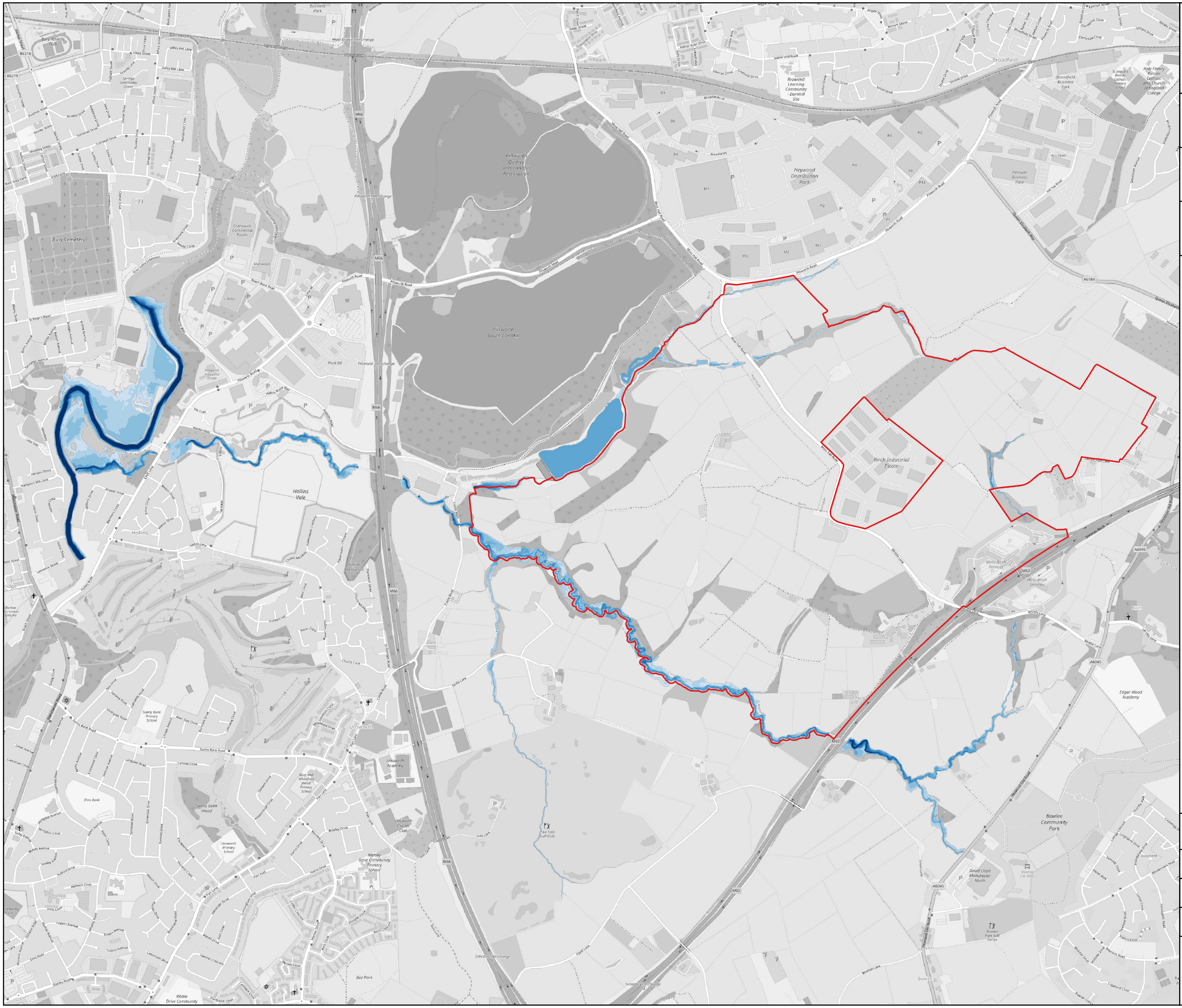
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Pilsworth South Landfill
Hollins Vale
Birch Industrial Estate
Heywood Distribution Park
Bury Cemetery
Broadfield
Pennine Business Park
Bowlee Community Park
Edgar Wood Academy
M66
M62
A6045
A6184

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 2: Baseline 1% AEP present day

Legend

— Development Application Boundary

Maximum Modelled Depth

- ▨ <0.15m
- ▨ 0.15-0.5m
- ▨ 0.5-1m
- ▨ 1-1.5m
- ▨ 1.5-2m
- ▨ 2-2.5m
- ▨ 2.5-3m
- ▨ >3m

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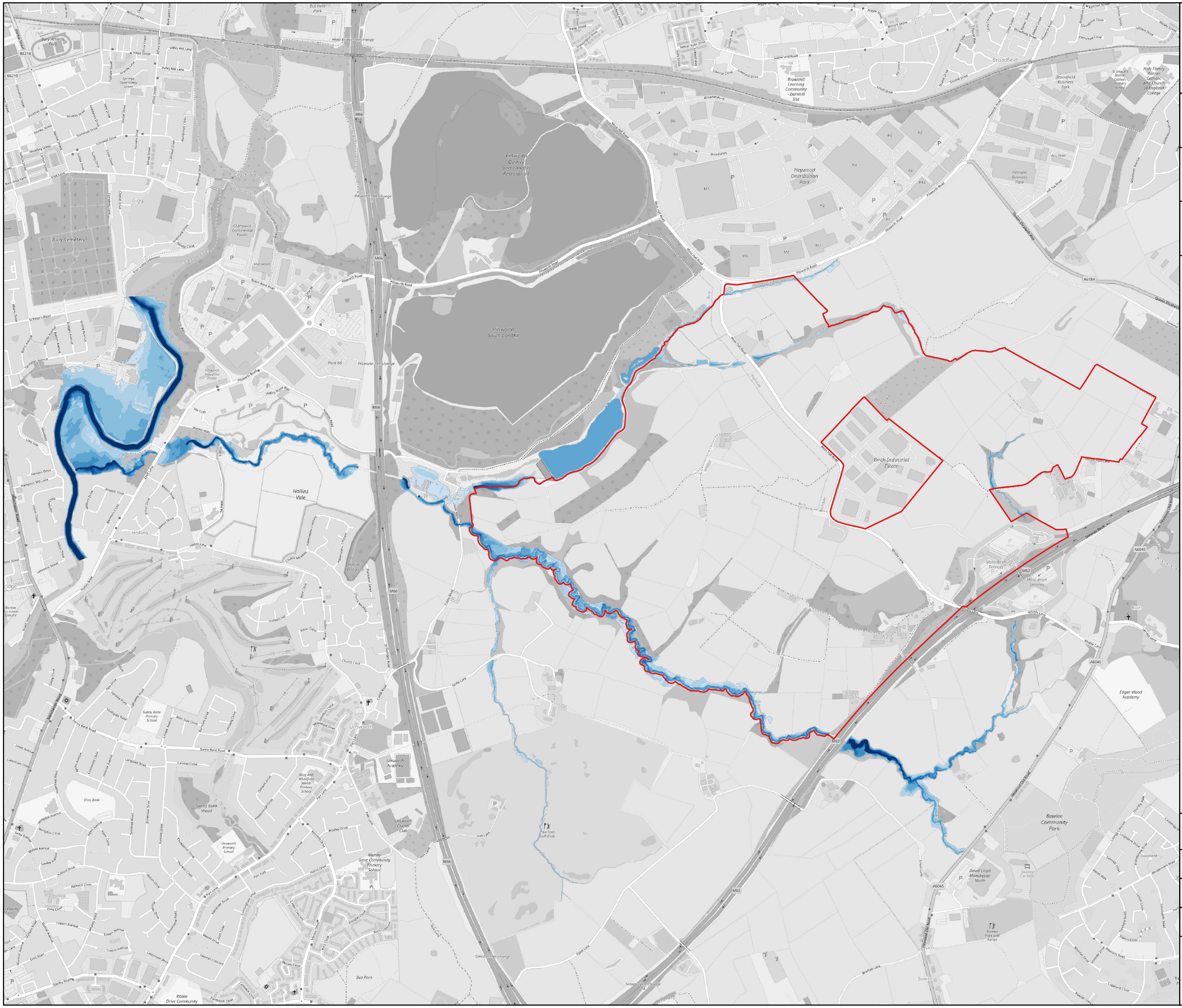
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Pilsworth South Landfill
Heywood Distribution Park
Broadfield
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Birch Industrial Estate
Hollins Vale
Hollins
M66
M62
A6045
Unsworth
Bowlee Community Park
Edgar Wood Academy

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 3: Baseline 1% AEP 2080s central (+35% peak flow allowance)

Legend

- Development Application Boundary

Maximum Modelled Depth

- <0.15m
- 0.15-0.5m
- 0.5-1m
- 1-1.5m
- 1.5-2m
- 2-2.5m
- 2.5-3m
- >3m

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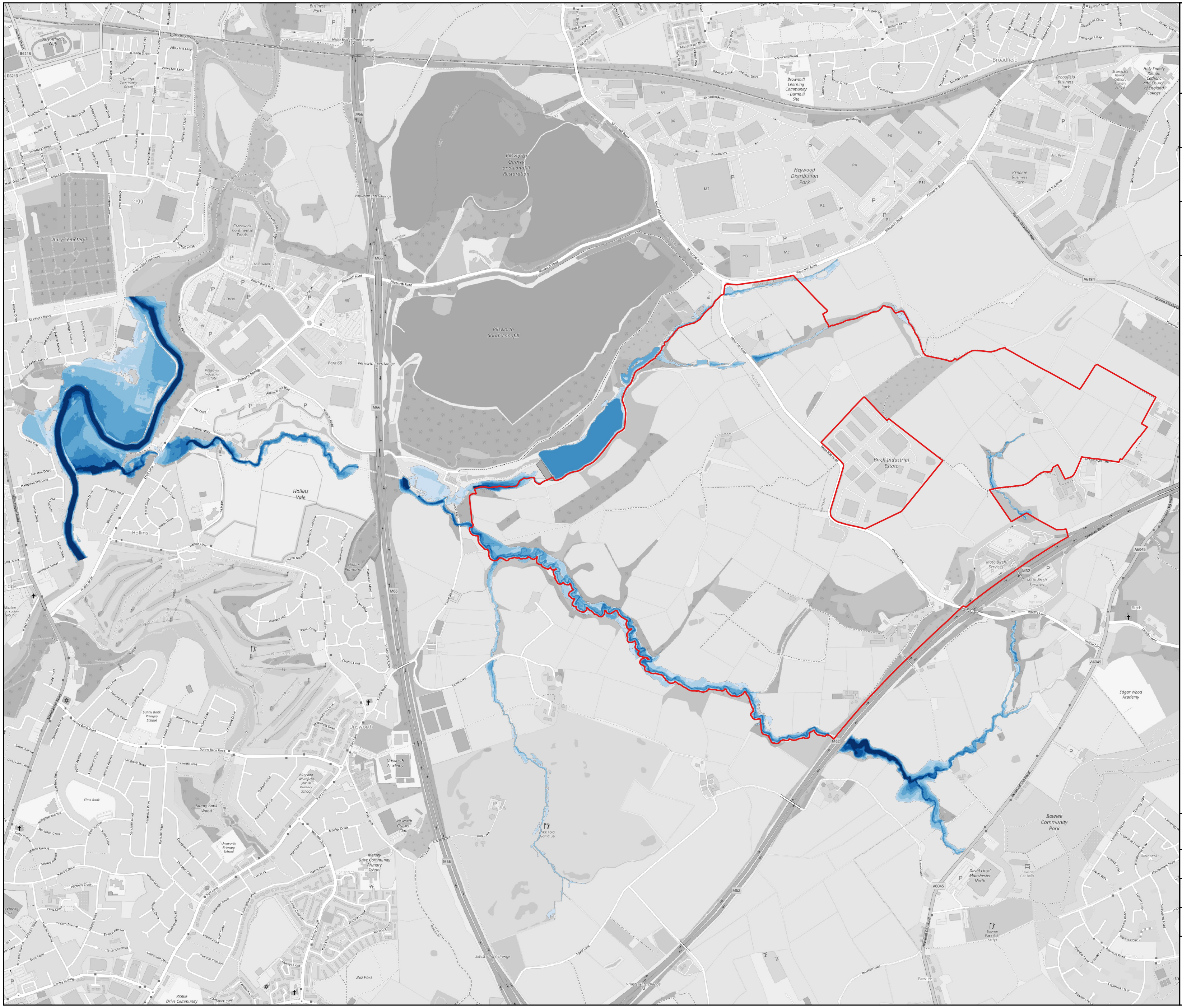
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Birch Industrial Estate
Hollins Vale
Bury Cemetery
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Heywood Distribution Park
Bowlee Community Park
Edgar Wood Academy
Unsworth
Hollins
M66
M62
A6045
A6184
Pilsworth Road
Moss Hall Road
Bury Old Road
Heywood Old Road
Simister Interchange

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 4: Baseline 0.1% AEP present day

Legend

— Development Application Boundary

Maximum Modelled Depth

- ■ <0.15m
- ■ 0.15-0.5m
- ■ 0.5-1m
- ■ 1-1.5m
- ■ 1.5-2m
- ■ 2-2.5m
- ■ 2.5-3m
- ■ >3m

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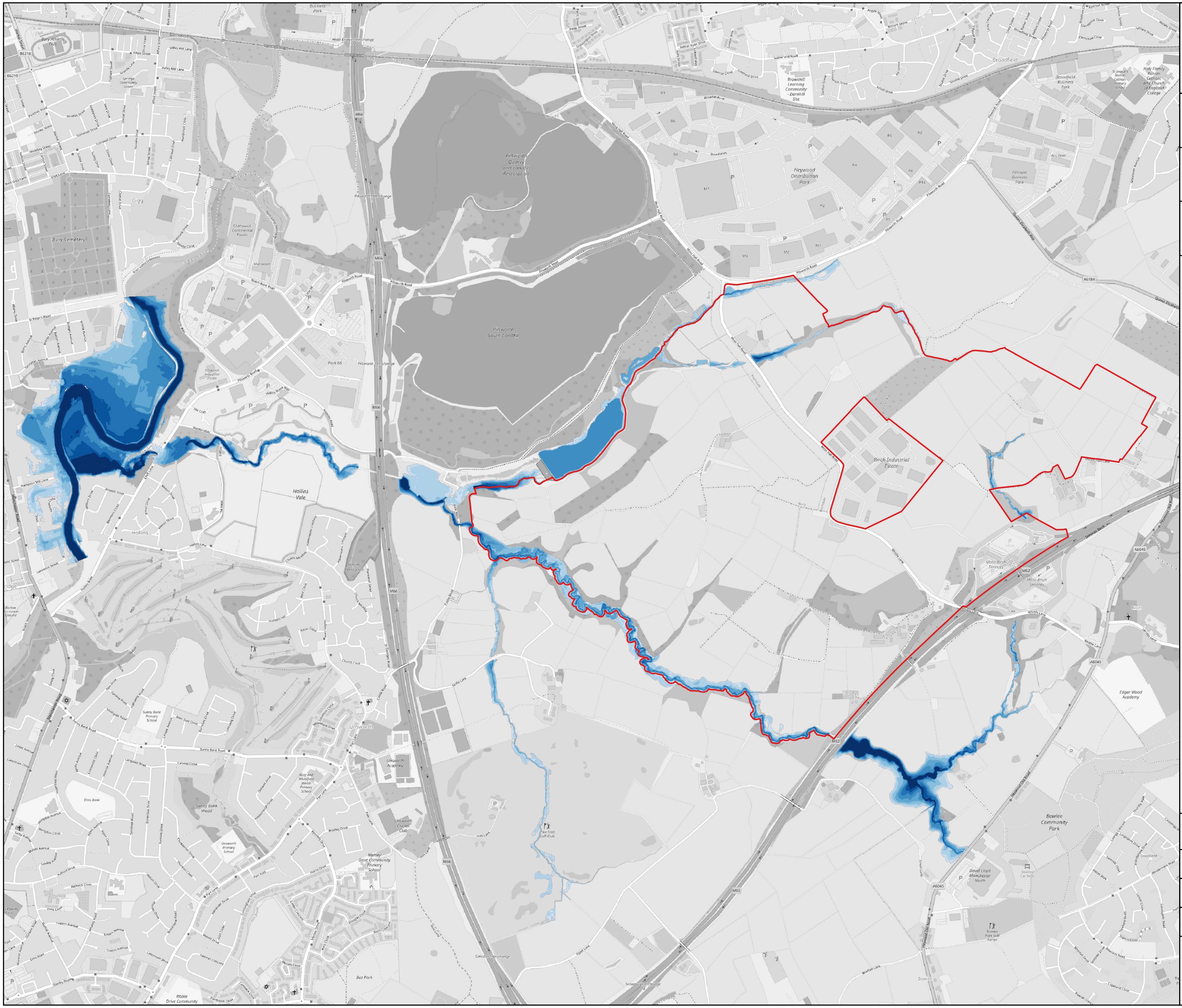
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Birch Industrial Estate
Hollins Vale
Bury Cemetery
Broadfield
Pennine Business Park
Unsworth
Bowlee Community Park
M66
M62
A6045
A6184

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 5: Baseline 0.1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth

- <0.15m
- 0.15-0.5m
- 0.5-1m
- 1-1.5m
- 1.5-2m
- 2-2.5m
- 2.5-3m
- >3m

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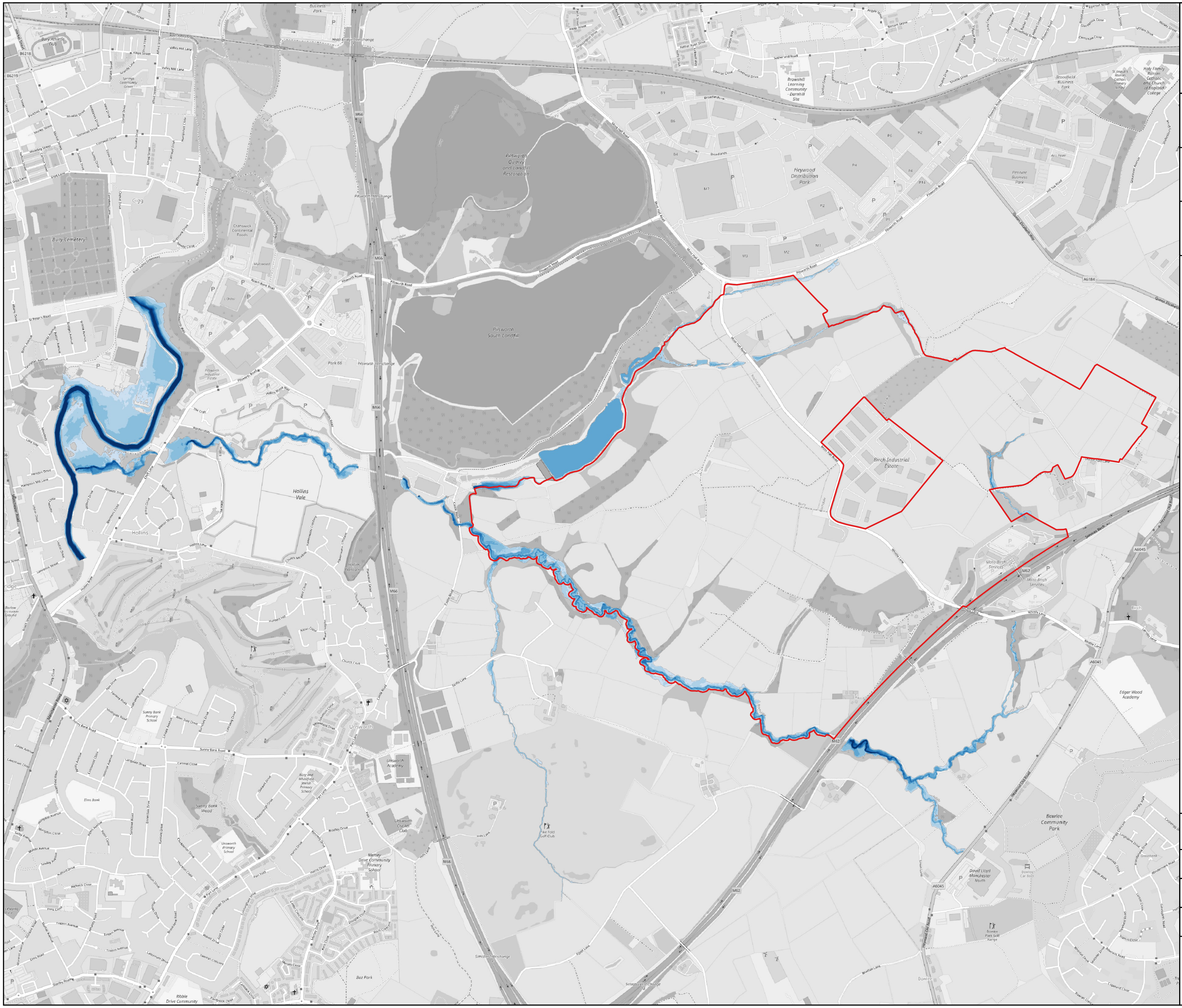
Appendix E: Sensitivity Test Results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Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
Hollins Vale
Bury Cemetery
Broadfield
Hollins
Unsworth
Bowlee Community Park
M66
M62
A6045
A6184

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 6: Roughness increase (20%) sensitivity test 1% AEP present day

Legend

— Development Application Boundary

Maximum Modelled Depth

- ▨ <0.15m
- ▨ 0.15-0.5m
- ▨ 0.5-1m
- ▨ 1-1.5m
- ▨ 1.5-2m
- ▨ 2-2.5m
- ▨ 2.5-3m
- ▨ >3m

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1:15,000

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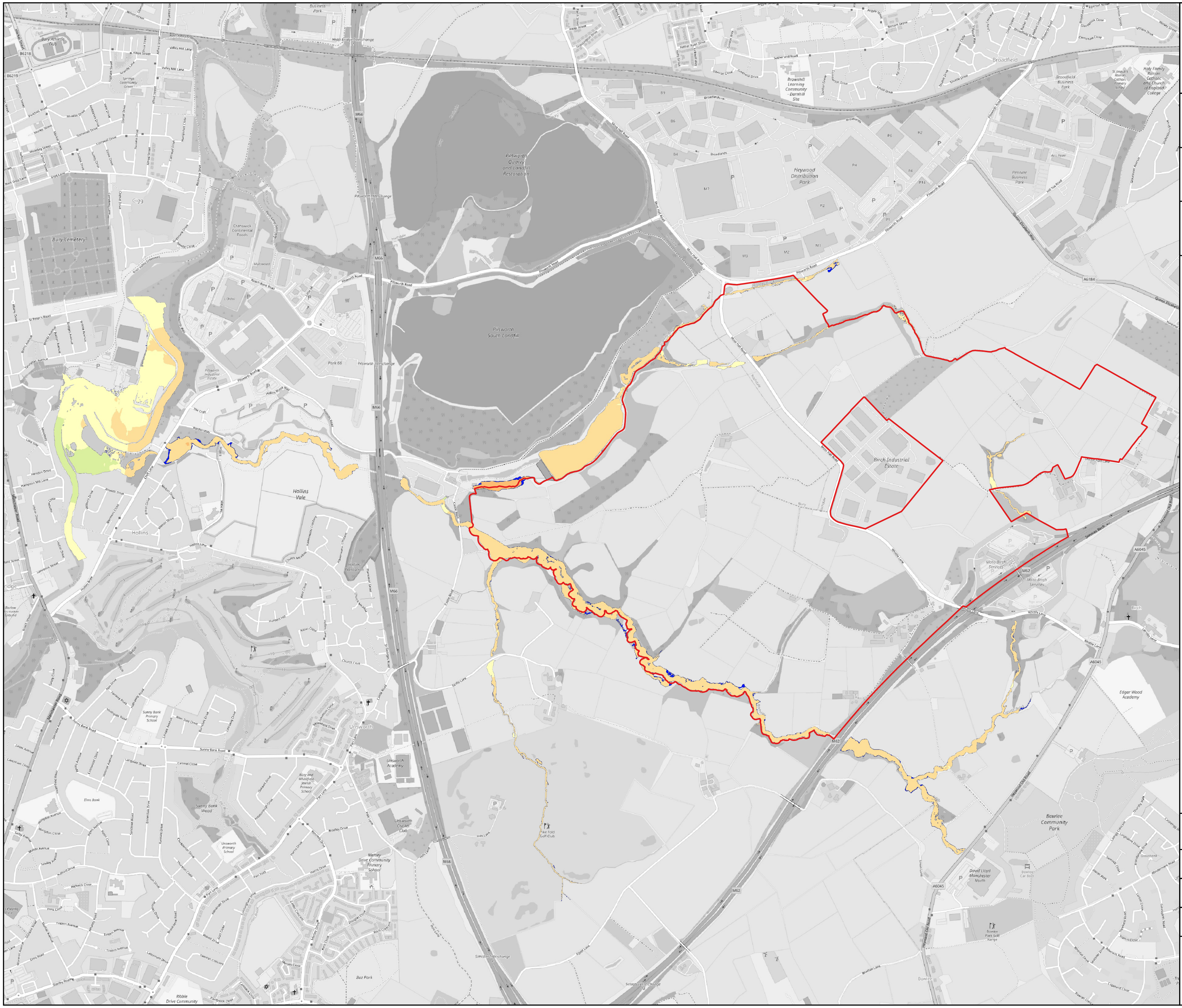
Bury Cemetery
Pilsworth Quarry and Landfill Restoration
Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
Hollins Vale
Hollins
Pennine Business Park
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Moto Birch Services
Unsworth
Pike Fold Golf Club
Bowlee Community Park
Edgar Wood Academy
David Lloyd Manchester North
M66
M62
A6045
A6184

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 7: Roughness increase (20%) sensitivity test difference to baseline 1% AEP present day

Legend

🟥 Development Application Boundary

Maximum Modelled Depth Difference

- 🟥 Increase >1m
- 🟥 Increase 0.75-1m
- 🟧 Increase 0.5-0.75m
- 🟧 Increase 0.25-0.5m
- 🟨 Increase 0.01-0.25m
- 🟨 Negligible +/-0.01m
- 🟩 Decrease 0.01-0.25m
- 🟩 Decrease 0.25-0.5m
- 🟩 Decrease 0.5-0.75m
- 🟩 Decrease 0.75-1m
- 🟩 Decrease >1m

Maximum Modelled Extent Difference

- 🟦 Was Dry Now Wet
- 🟦 Was Wet Now Dry

0 100 200 300 400 500 m

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1:15,000

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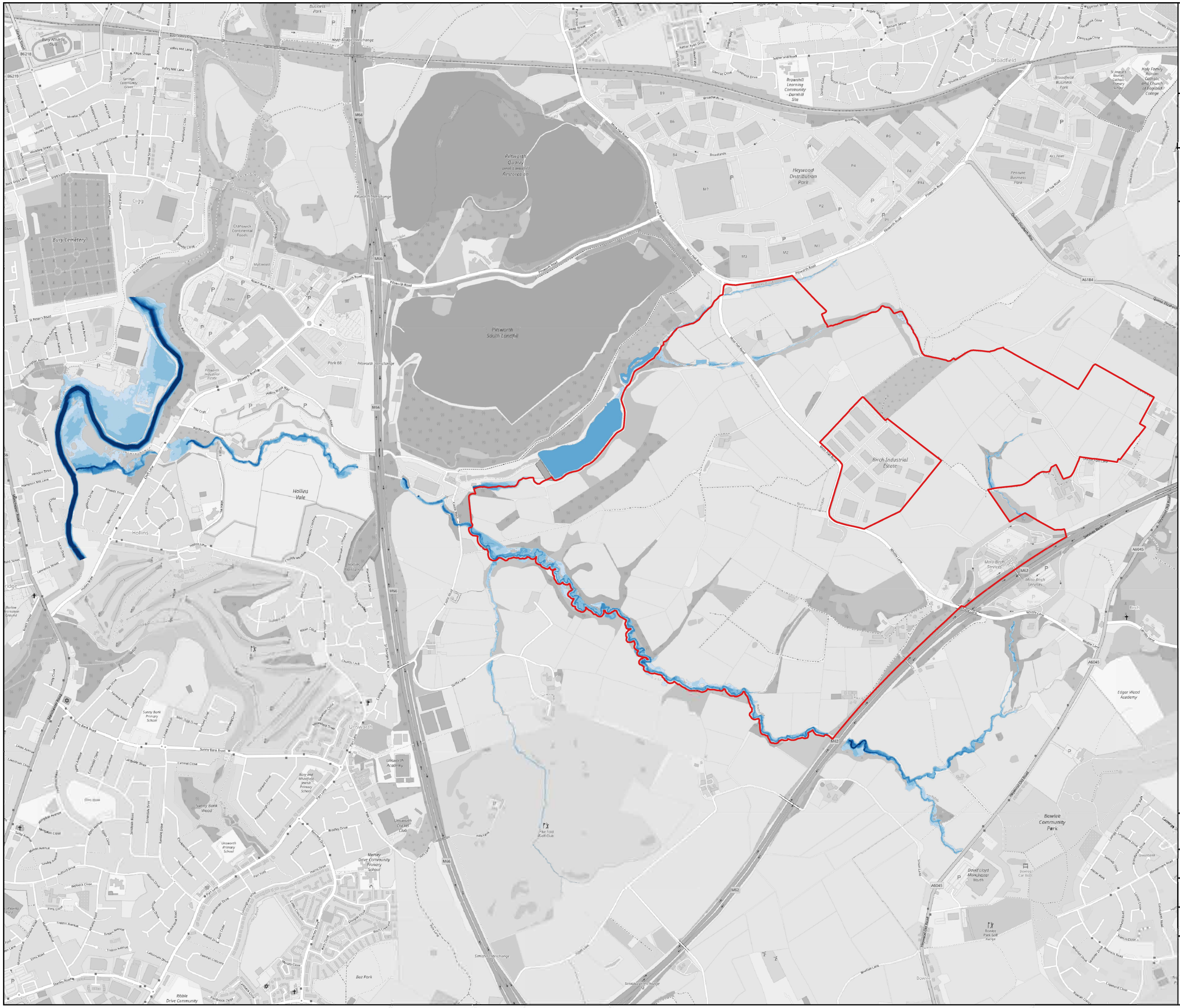
Pilsworth Quarry
Pilsworth South Landfill
Bury Cemetery
Hollins Vale
Hollins
Heywood Distribution Park
Birch Industrial Estate
Broadfield
Unsworth
M66
M62
A6045
Bowlee Community Park

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 8: Roughness decrease (20%) sensitivity test 1% AEP present day

Legend

—	Development Application Boundary

Maximum Modelled Depth

🟦	<0.15m
🟦	0.15-0.5m
🟦	0.5-1m
🟦	1-1.5m
🟦	1.5-2m
🟦	2-2.5m
🟦	2.5-3m
🟦	>3m

0 100 200 300 400 500 m

@ A3
1:15,000

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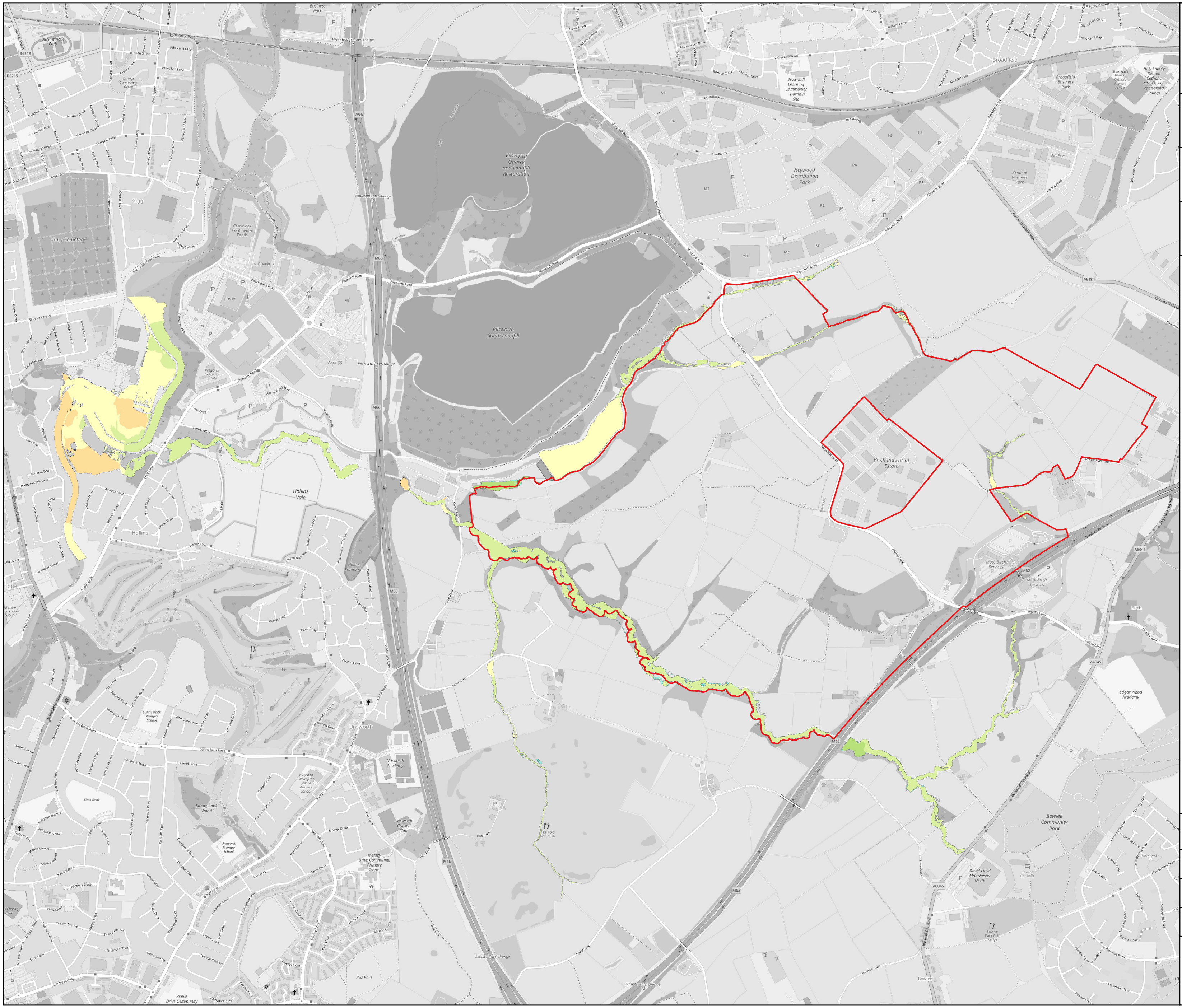
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Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
Hollins Vale
Bury Cemetery
Broadfield
Pennine Business Park
Bowlee Community Park
Unsworth
M66
M62
A6045
A6184

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

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Map 9: Roughness decrease (20%) sensitivity test difference to baseline 1% AEP present day

Legend

- 🟥 Development Application Boundary

Maximum Modelled Depth Difference

- 🟥 Increase >1m
- 🟥 Increase 0.75-1m
- 🟧 Increase 0.5-0.75m
- 🟧 Increase 0.25-0.5m
- 🟨 Increase 0.01-0.25m
- 🟨 Negligible +/-0.01m
- 🟩 Decrease 0.01-0.25m
- 🟩 Decrease 0.25-0.5m
- 🟩 Decrease 0.5-0.75m
- 🟩 Decrease 0.75-1m
- 🟩 Decrease >1m

Maximum Modelled Extent Difference

- 🟦 Was Dry Now Wet
- 🟦 Was Wet Now Dry

0 100 200 300 400 500 m

@ A3
1:15,000

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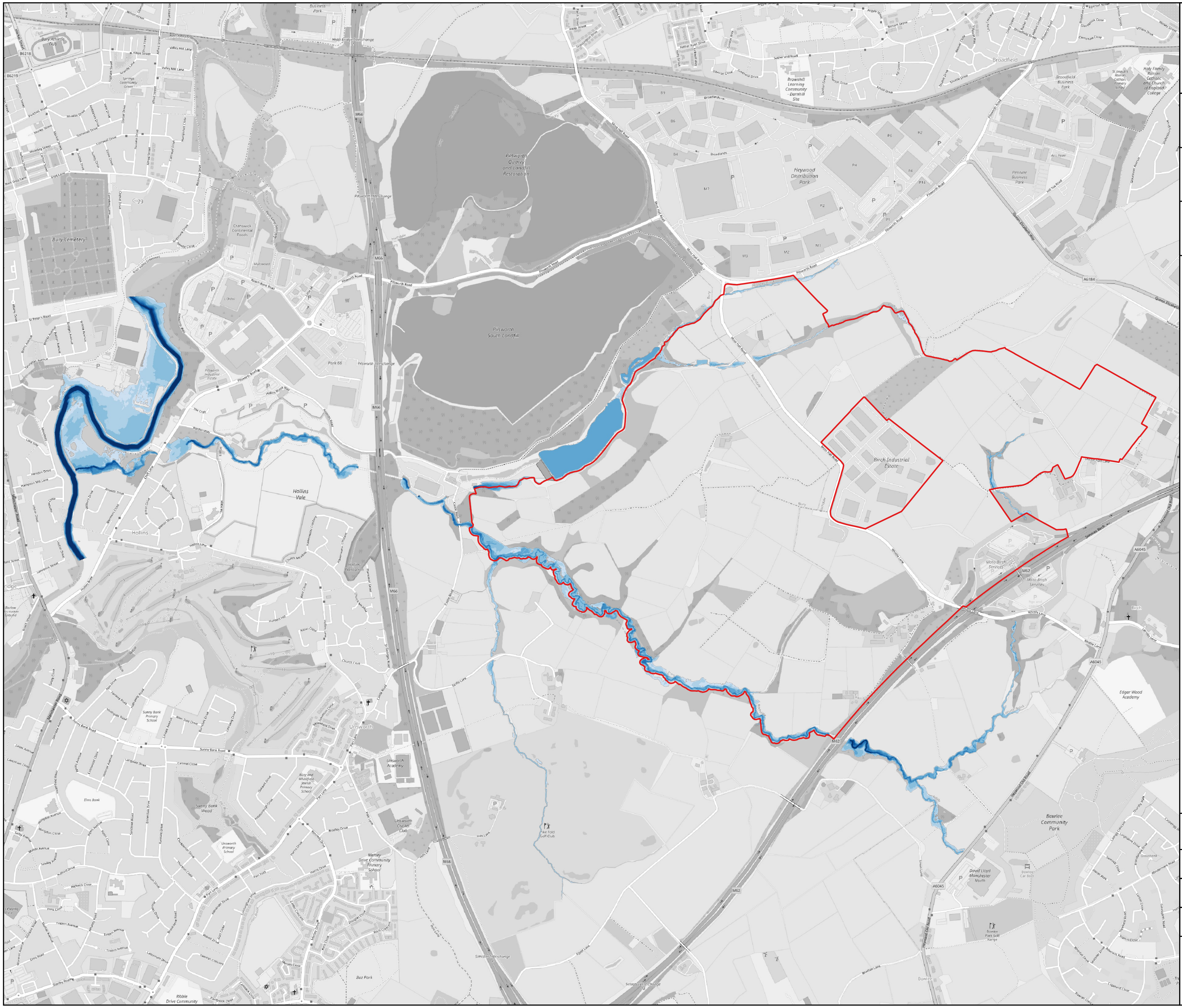
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Pilsworth South Landfill
Heywood Distribution Park
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Park 66
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Unsworth
Bowlee Community Park
Edgar Wood Academy
Birch Services
M66
M62
A6045
A6184
Hollins Lane
Pilsworth Road
Moss Hall Road
Unsworth Academy
Sunny Bank Primary School
Sunny Bank Wood
Elms Bank
David Lloyd Manchester North

Northern Gateway JPA 1.1

North Manchester
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NORTHERN GATEWAY
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Map 10: Downstream boundary sensitivity test 1% AEP present day

Legend

— Development Application Boundary

Maximum Modelled Depth

- 🟦 <0.15m
- 🟦 0.15-0.5m
- 🟦 0.5-1m
- 🟦 1-1.5m
- 🟦 1.5-2m
- 🟦 2-2.5m
- 🟦 2.5-3m
- 🟦 >3m

0 100 200 300 400 500 m

@ A3
1:15,000

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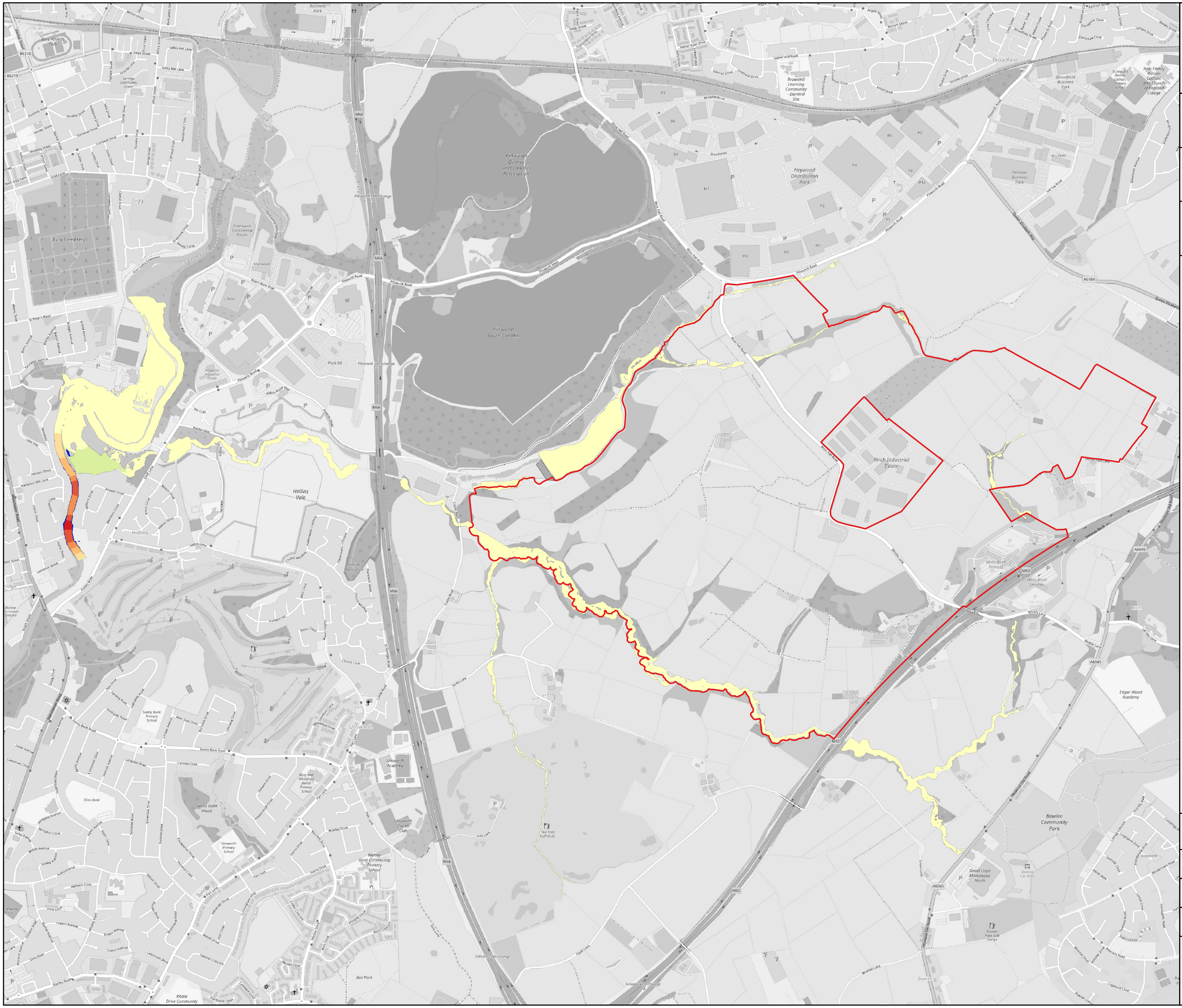
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Heywood Distribution Park
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Hollins
Bury Cemetery
Unsworth
Bowlee Community Park
Edgar Wood Academy
David Lloyd Manchester North
M66
M62
A6045
A6184

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Map 11: Downstream boundary sensitivity test difference to baseline 1% AEP present day

Legend

— Development Application Boundary

Maximum Modelled Depth Difference

- 🟥 Increase >1m
- 🟥 Increase 0.75-1m
- 🟧 Increase 0.5-0.75m
- 🟧 Increase 0.25-0.5m
- 🟨 Increase 0.01-0.25m
- 🟨 Negligible +/-0.01m
- 🟩 Decrease 0.01-0.25m
- 🟩 Decrease 0.25-0.5m
- 🟩 Decrease 0.5-0.75m
- 🟩 Decrease 0.75-1m
- 🟩 Decrease >1m

Maximum Modelled Extent Difference

- 🟦 Was Dry Now Wet
- 🟦 Was Wet Now Dry

0 100 200 300 400 500 m

@ A3
1:15,000

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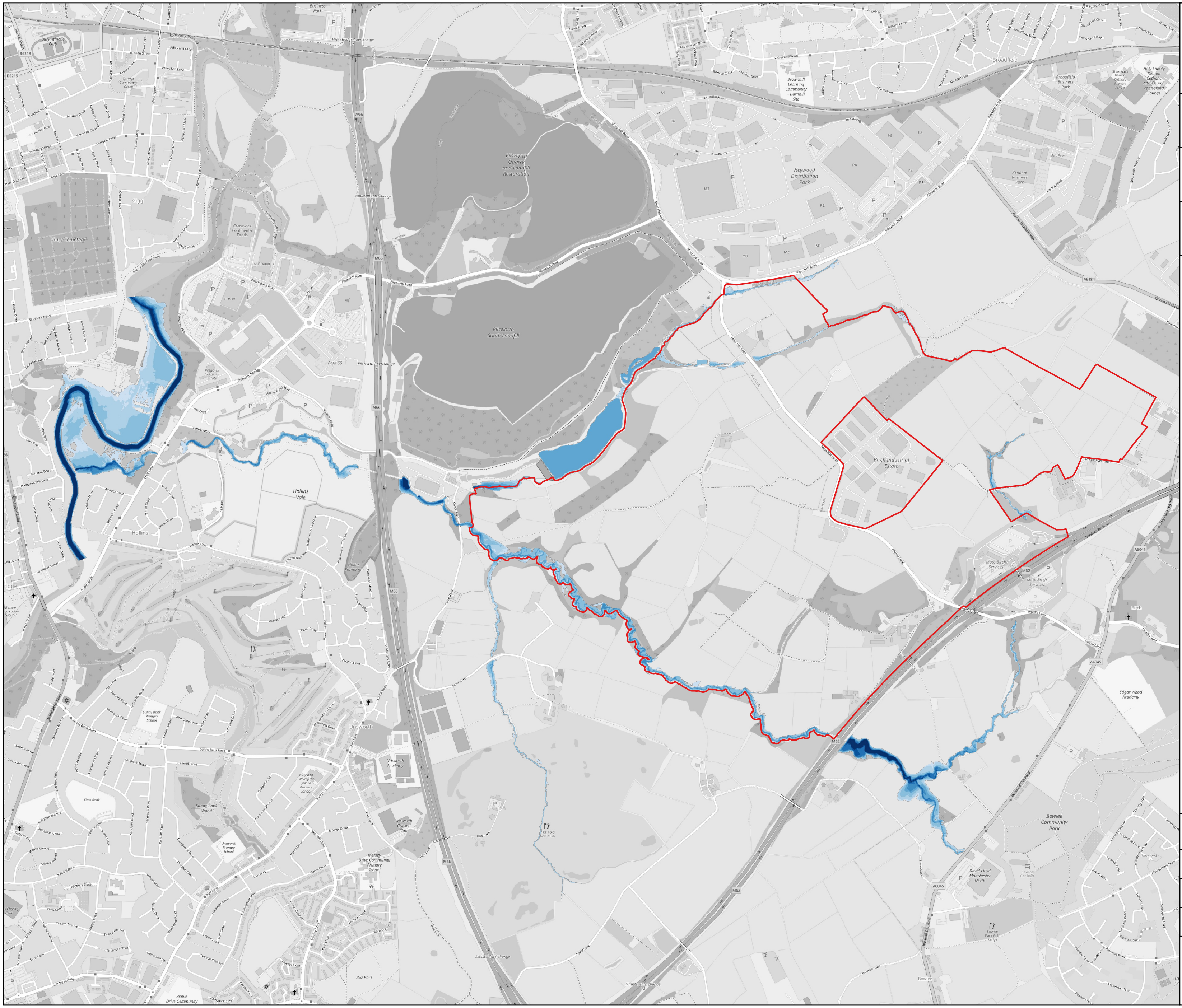
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Hollins Vale
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Pennine Business Park
Broadfield
Bowlee Community Park
Edgar Wood Academy
David Lloyd Manchester North
Unsworth
M66
M62
A6045
Birch Services

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
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Map 12: Structure blockage sensitivity test 1% AEP present day

Legend

— Development Application Boundary

Maximum Modelled Depth

- ▨ <0.15m
- ▨ 0.15-0.5m
- ▨ 0.5-1m
- ▨ 1-1.5m
- ▨ 1.5-2m
- ▨ 2-2.5m
- ▨ 2.5-3m
- ▨ >3m

0 100 200 300 400 500 m

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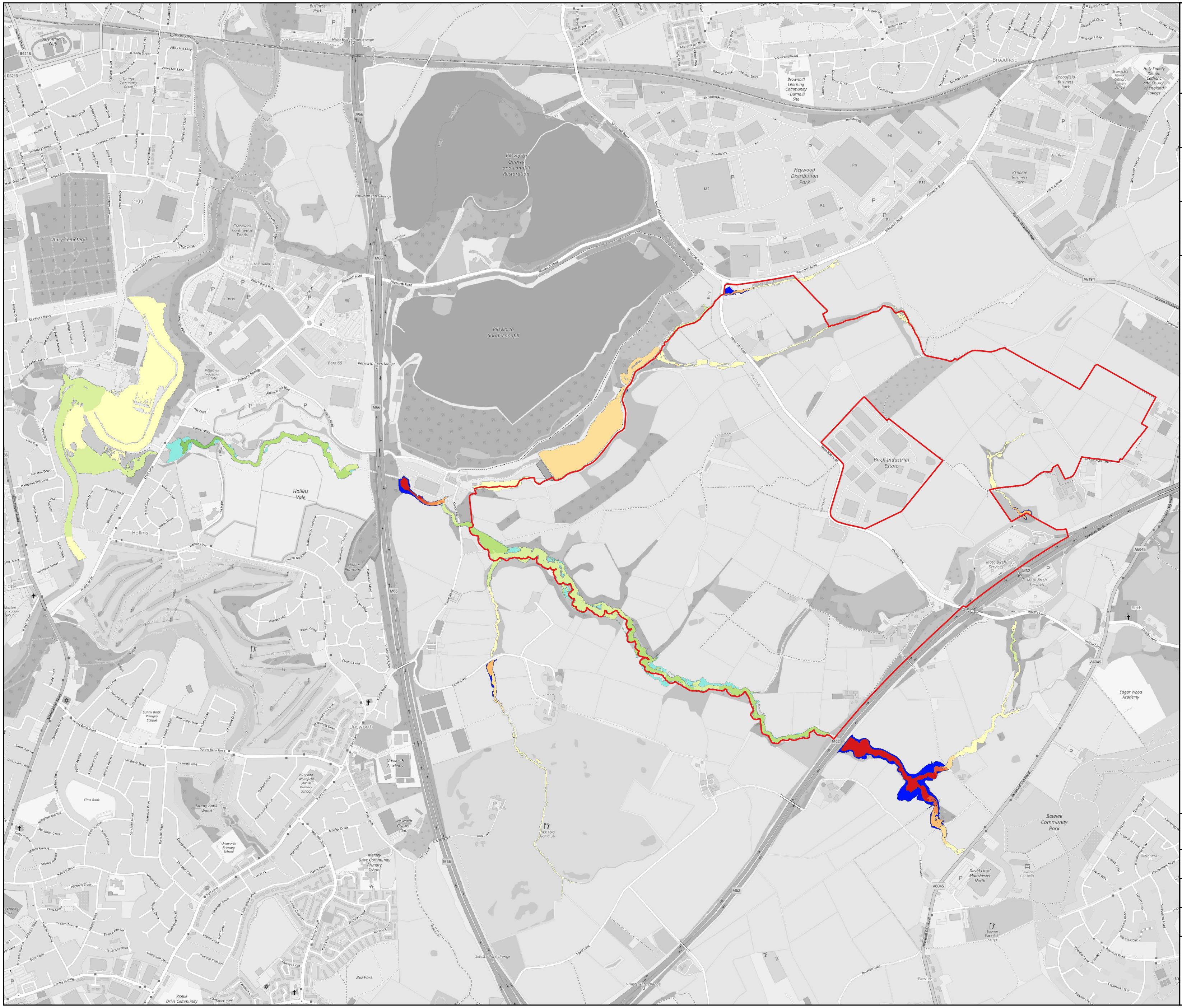
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Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
Hollins Vale
Hollins
Bury Cemetery
Broadfield
Pennine Business Park
Bowlee Community Park
Edgar Wood Academy
David Lloyd Manchester North
Heaton Park Golf Club
Unsworth
Pilsworth Road
Pilsworth Interchange
Heap Bridge Interchange
M66
M62
A6045
A6104
Birch Services
Bury Athletic Club

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North Manchester
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NORTHERN GATEWAY
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Map 13: Structure blockage sensitivity test difference to baseline 1% AEP present day

Legend

— Development Application Boundary

Maximum Modelled Depth Difference

- 🟥 Increase >1m
- 🟥 Increase 0.75-1m
- 🟧 Increase 0.5-0.75m
- 🟧 Increase 0.25-0.5m
- 🟨 Increase 0.01-0.25m
- 🟨 Negligible +/-0.01m
- 🟩 Decrease 0.01-0.25m
- 🟩 Decrease 0.25-0.5m
- 🟩 Decrease 0.5-0.75m
- 🟩 Decrease 0.75-1m
- 🟩 Decrease >1m

Maximum Modelled Extent Difference

- 🟦 Was Dry Now Wet
- 🟦 Was Wet Now Dry

0 100 200 300 400 500 m

@ A3
1:15,000

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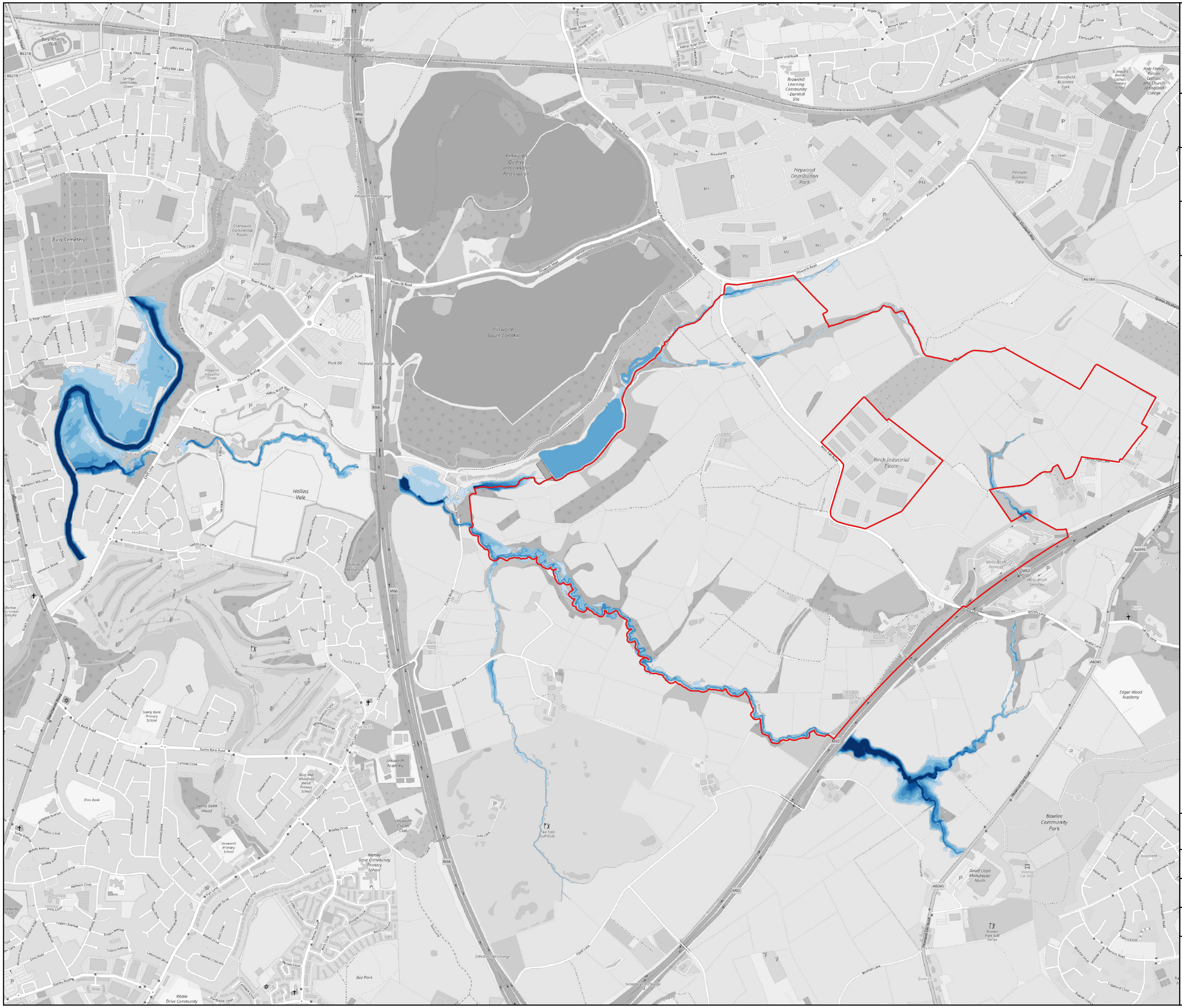
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Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
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Broadfield
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Unsworth
Hollins
Bowlee Community Park
Edgar Wood Academy
Unsworth Academy
M66
M62
A6045
A6104

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North Manchester
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NORTHERN GATEWAY
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Map 14: Structure blockage sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth

- ▨ <0.15m
- ▨ 0.15-0.5m
- ▨ 0.5-1m
- ▨ 1-1.5m
- ▨ 1.5-2m
- ▨ 2-2.5m
- ▨ 2.5-3m
- ▨ >3m

0 100 200 300 400 500 m

@ A3
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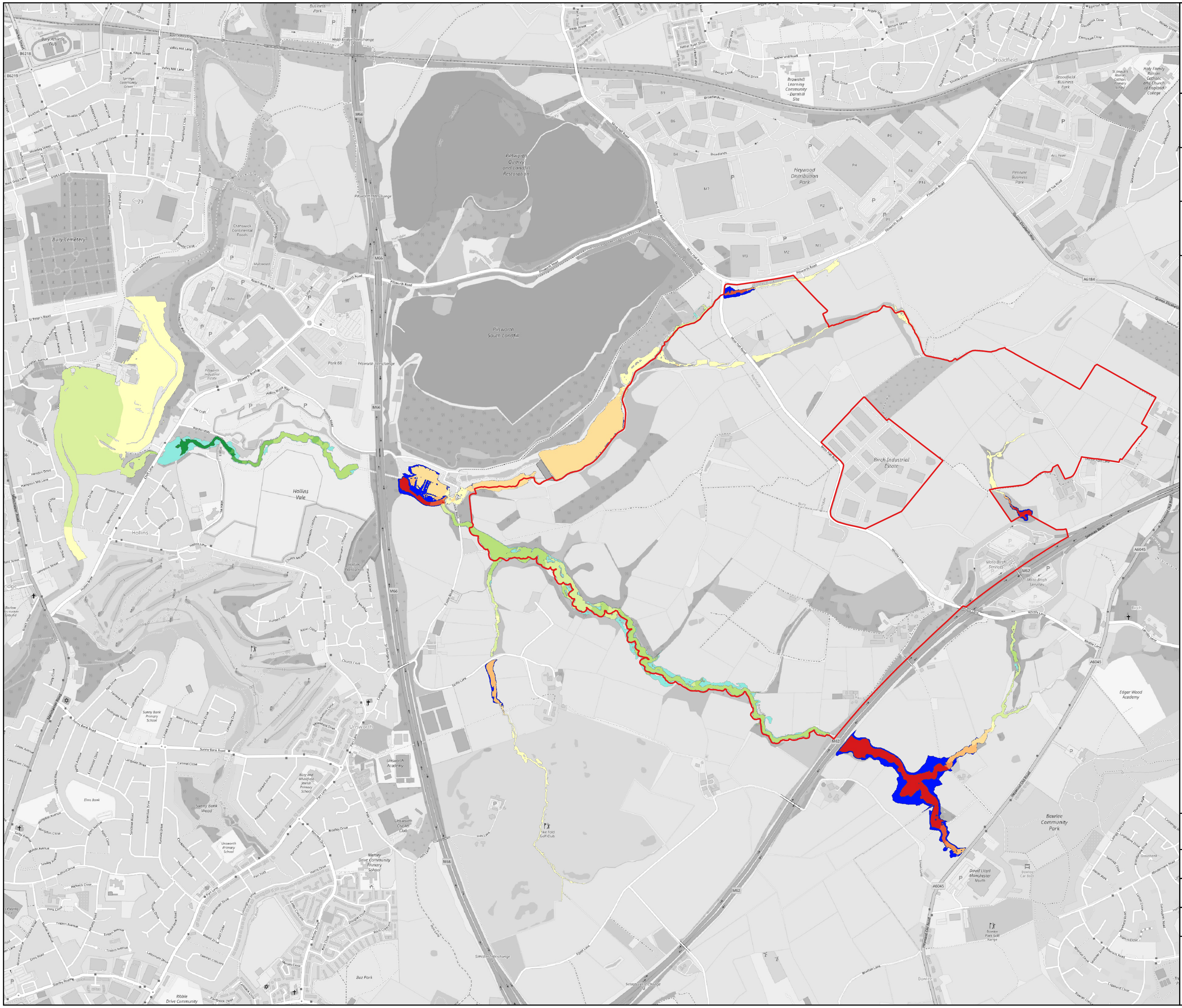
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Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
Pennine Business Park
Hollins Vale
Hollins
Bury Cemetery
Broadfield
Unsworth
Bowlee Community Park
M66
M62
A6045
A6046
A6184

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NORTHERN GATEWAY
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Map 15: Structure blockage sensitivity test difference to baseline 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth Difference

🟥 Increase >1m
🟥 Increase 0.75-1m
🟧 Increase 0.5-0.75m
🟧 Increase 0.25-0.5m
🟨 Increase 0.01-0.25m
🟨 Negligible +/-0.01m
🟩 Decrease 0.01-0.25m
🟩 Decrease 0.25-0.5m
🟩 Decrease 0.5-0.75m
🟩 Decrease 0.75-1m
🟩 Decrease >1m

Maximum Modelled Extent Difference

🟦 Was Dry Now Wet
🟦 Was Wet Now Dry

0 100 200 300 400 500 m
@ A3
1:15,000
N

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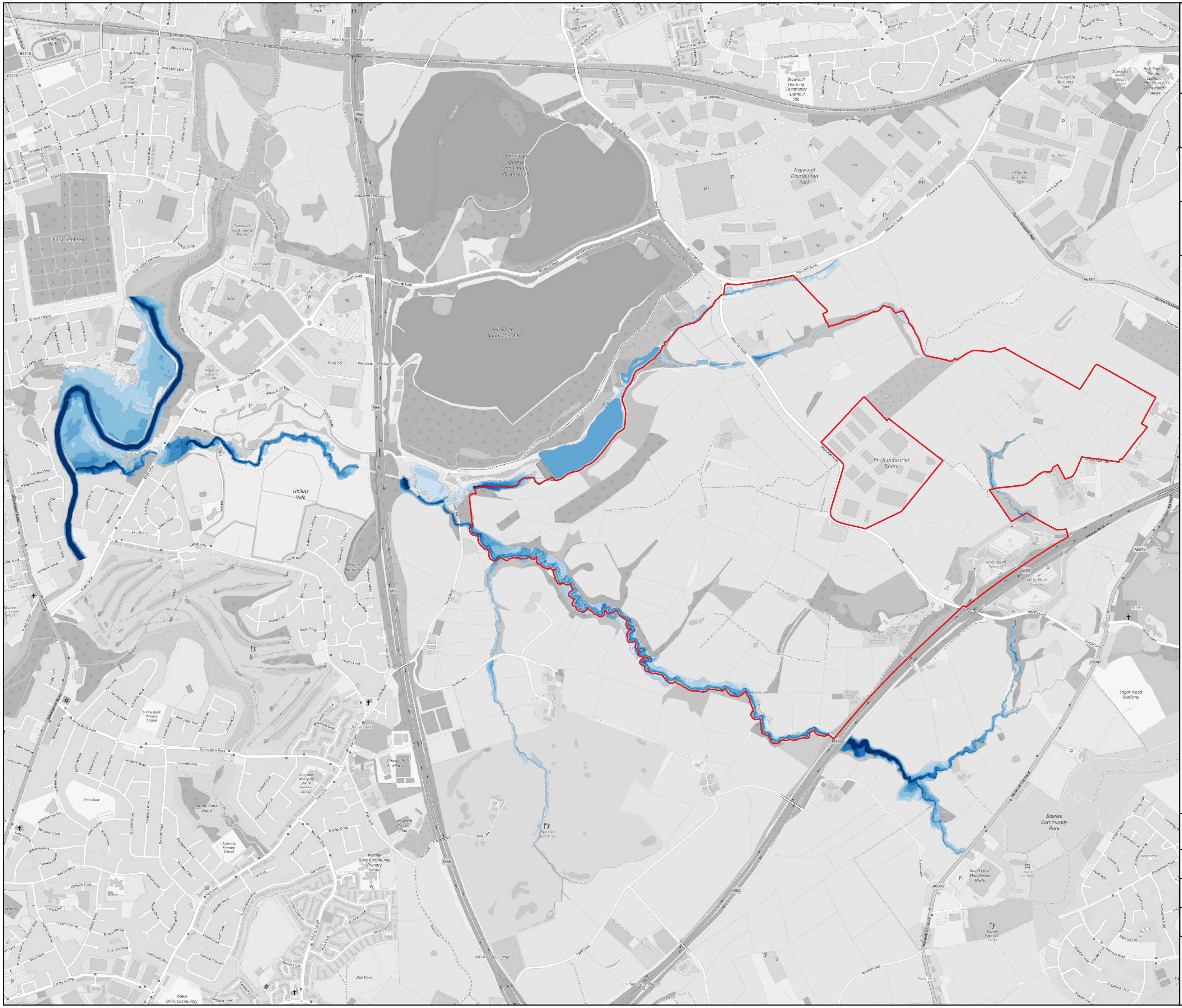
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Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
Hollins Vale
Bury Cemetery
Broadfield
Pennine Business Park
Broadfield Business Park
M66
M62
A6045
A6184
Unsworth
Unsworth Academy
Bowlee Community Park
Edgar Wood Academy
Moto Birch Services
Hollins
Park 66

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

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Map 16: Flow increase (20%) sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

― Development Application Boundary

Maximum Modelled Depth

▭	<0.15m
▭	0.15-0.5m
▭	0.5-1m
▭	1-1.5m
▭	1.5-2m
▭	2-2.5m
▭	2.5-3m
■	>3m

0 100 200 300 400 500 m

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1:15,000

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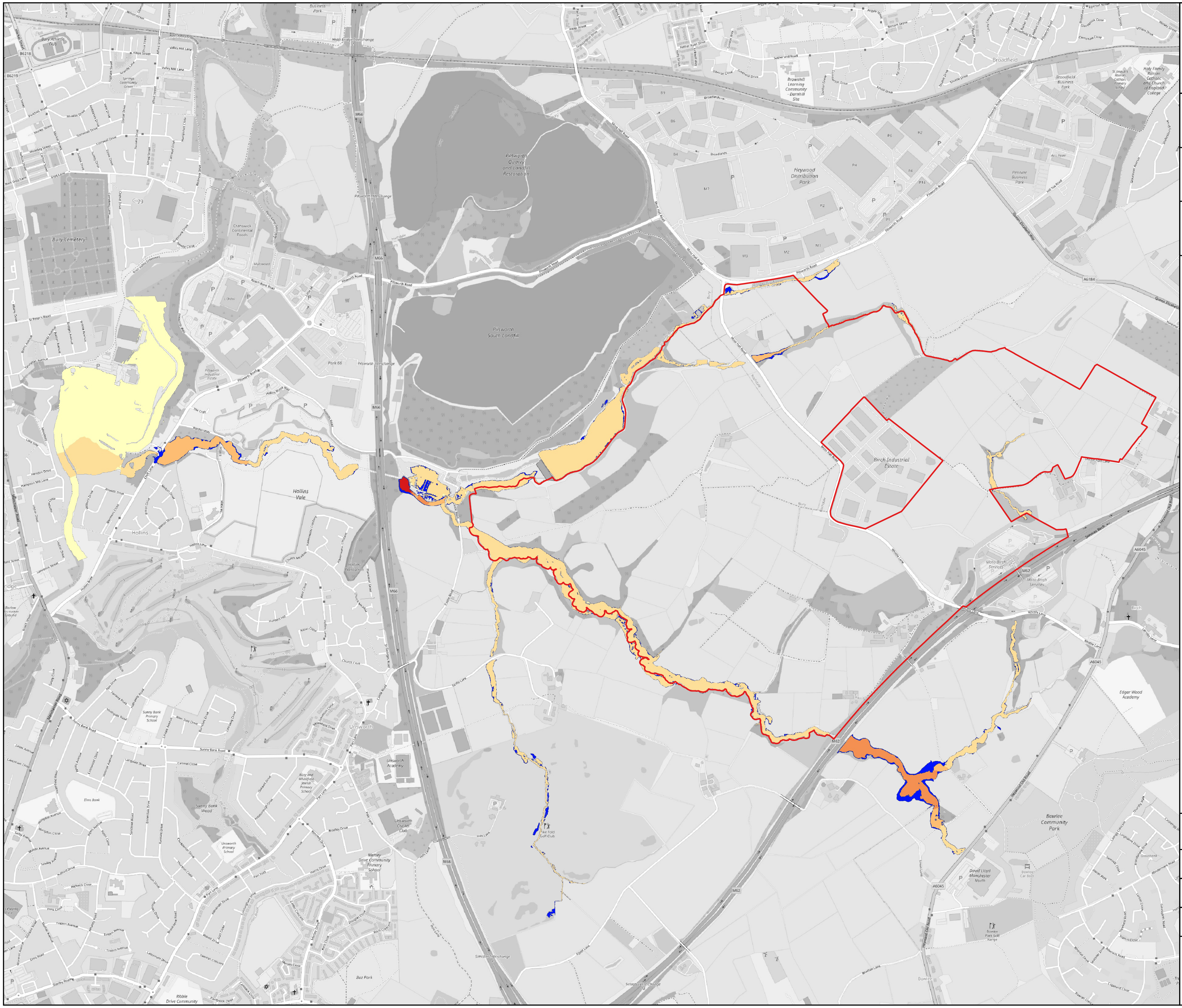
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Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
Hollins Vale
Bury Cemetery
Broadfield
M66
M62
A6045
A6184
Bowlee Community Park
Unsworth
Hollins
Simister Interchange
Pilsworth Interchange
Heap Bridge Interchange

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Map 17: Flow increase (20%) sensitivity test difference to baseline 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth Difference

🟥	Increase >1m
🟥	Increase 0.75-1m
🟧	Increase 0.5-0.75m
🟧	Increase 0.25-0.5m
🟨	Increase 0.01-0.25m
🟨	Negligible +/-0.01m
🟩	Decrease 0.01-0.25m
🟩	Decrease 0.25-0.5m
🟩	Decrease 0.5-0.75m
🟩	Decrease 0.75-1m
🟩	Decrease >1m

Maximum Modelled Extent Difference

🟦	Was Dry Now Wet
🟦	Was Wet Now Dry

0 100 200 300 400 500 m

@ A3
1:15,000

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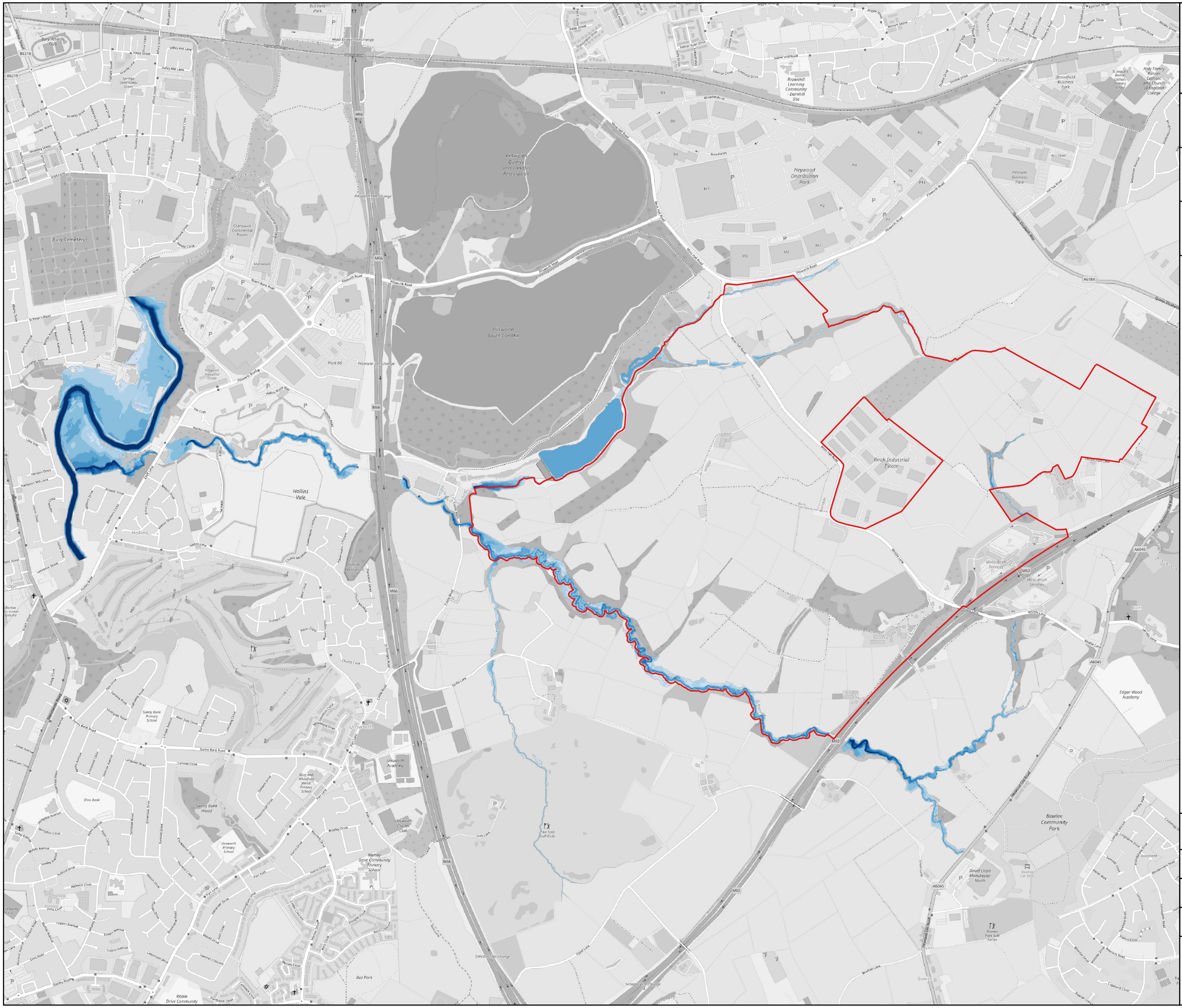
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Pilsworth South Landfill
Heywood Distribution Park
Broadfield
Pennine Business Park
Birch Industrial Estate
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Hollins
Unsworth
Bowlee Community Park
Egdar Wood Academy
M66
M62
A6045
A6184
Pilsworth Road
Pilsworth Interchange
Simister Interchange

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Map 18: Flow decrease (20%) sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

🟥 Development Application Boundary

Maximum Modelled Depth

■	<0.15m
■	0.15-0.5m
■	0.5-1m
■	1-1.5m
■	1.5-2m
■	2-2.5m
■	2.5-3m
■	>3m

0 100 200 300 400 500 m

@ A3
1:15,000

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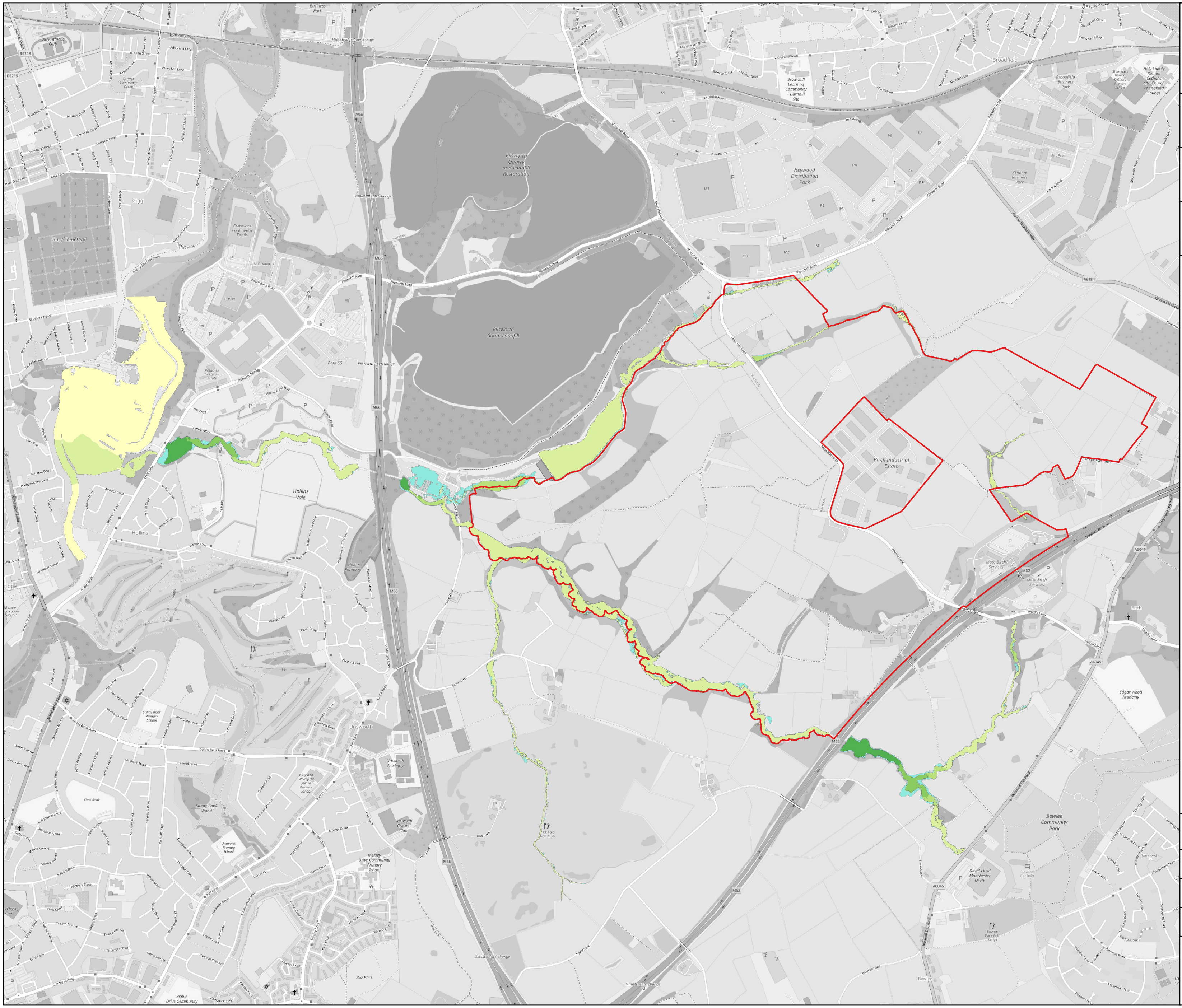
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Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
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Bowlee Community Park
Edgar Wood Academy
M66
M62
A6045
A6104

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Map 19: Flow decrease (20%) sensitivity test difference to baseline 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth Difference

🟥 Increase >1m
🟥 Increase 0.75-1m
🟧 Increase 0.5-0.75m
🟧 Increase 0.25-0.5m
🟨 Increase 0.01-0.25m
🟨 Negligible +/-0.01m
🟩 Decrease 0.01-0.25m
🟩 Decrease 0.25-0.5m
🟩 Decrease 0.5-0.75m
🟩 Decrease 0.75-1m
🟩 Decrease >1m

Maximum Modelled Extent Difference

🟦 Was Dry Now Wet
🟦 Was Wet Now Dry

0 100 200 300 400 500 m
@ A3
1:15,000
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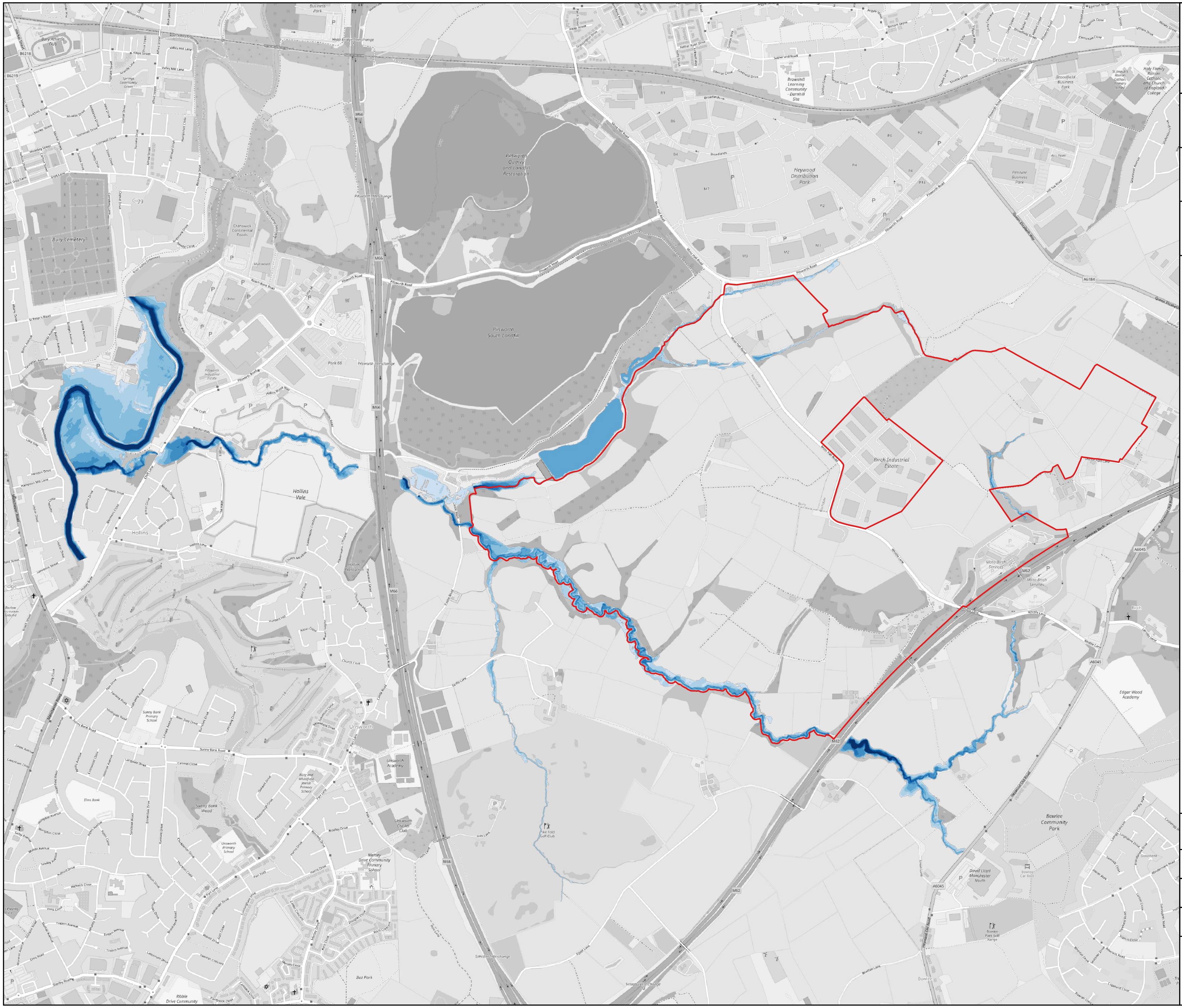
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Pilsworth South Landfill
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Birch Industrial Estate
Pennine Business Park
Broadfield
Hollins Vale
Bury Cemetery
Edgar Wood Academy
Bowlee Community Park
M66
M62
A6045

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North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
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Map 20: Cell size sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

Development Application Boundary

Maximum Modelled Depth

- <0.15m
- 0.15-0.5m
- 0.5-1m
- 1-1.5m
- 1.5-2m
- 2-2.5m
- 2.5-3m
- >3m

0 100 200 300 400 500 m

@ A3
1:15,000

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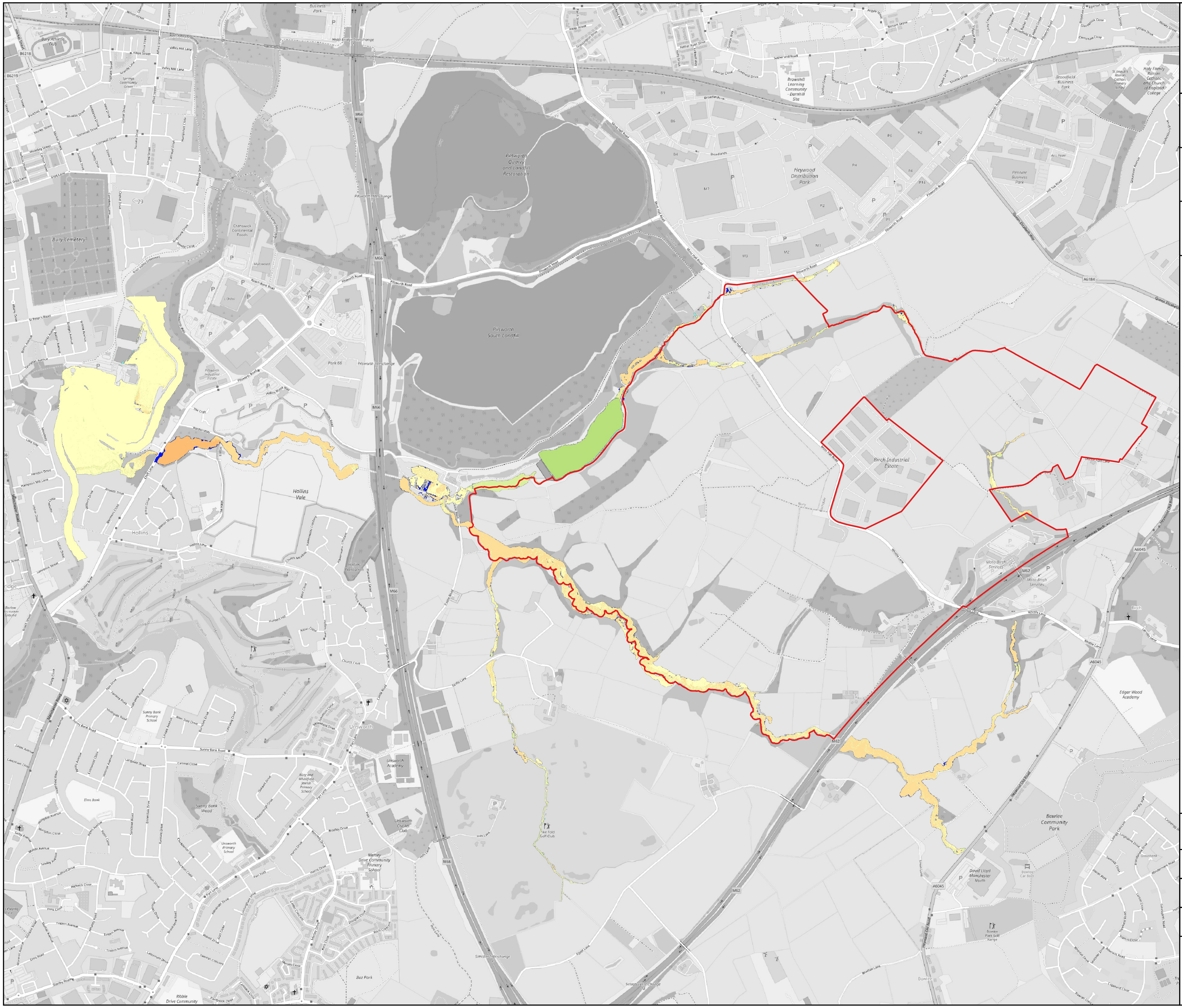
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Pilsworth South Landfill
Heywood Distribution Park
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Edgar Wood Academy
Unsworth Academy
Hollins
Unsworth
M66
M62
A6045
A6104

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North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
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Map 21: Cell size sensitivity test difference to baseline 1% AEP 2080s central (+35% peak flow allowance)

Legend

― Development Application Boundary

Maximum Modelled Depth Difference

- 🟥 Increase >1m
- 🟥 Increase 0.75-1m
- 🟧 Increase 0.5-0.75m
- 🟧 Increase 0.25-0.5m
- 🟨 Increase 0.01-0.25m
- 🟨 Negligible +/-0.01m
- 🟩 Decrease 0.01-0.25m
- 🟩 Decrease 0.25-0.5m
- 🟩 Decrease 0.5-0.75m
- 🟩 Decrease 0.75-1m
- 🟩 Decrease >1m

Maximum Modelled Extent Difference

- 🟦 Was Dry Now Wet
- 🟦 Was Wet Now Dry

0 100 200 300 400 500 m

@ A3
1:15,000

N

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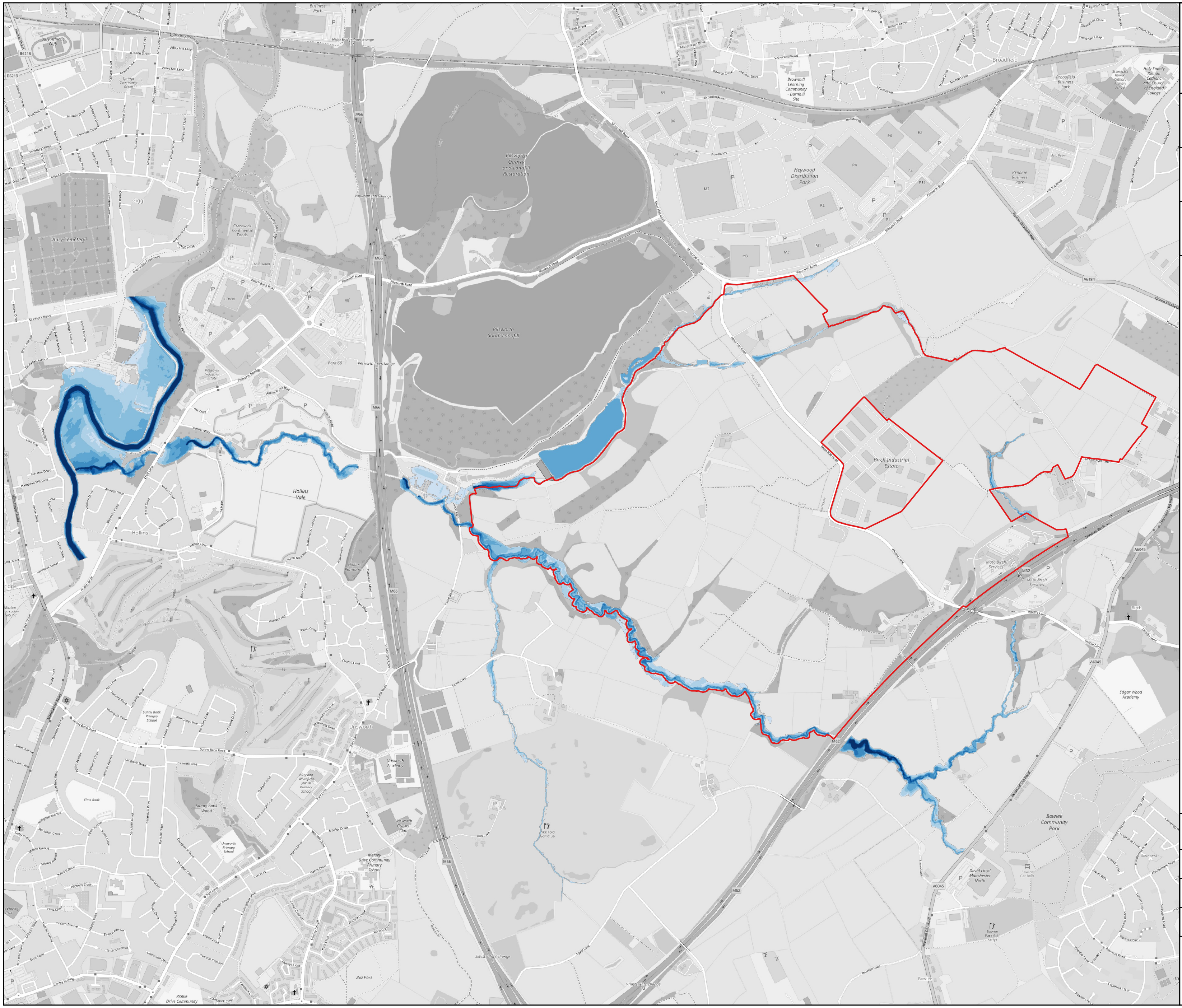
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Unsworth
Bowlee Community Park
Edgar Wood Academy
M66
M62
A6045
A6104

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 22: Weir sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth

▨	<0.15m
▨	0.15-0.5m
▨	0.5-1m
▨	1-1.5m
▨	1.5-2m
▨	2-2.5m
▨	2.5-3m
■	>3m

0 100 200 300 400 500 m

@ A3
1:15,000

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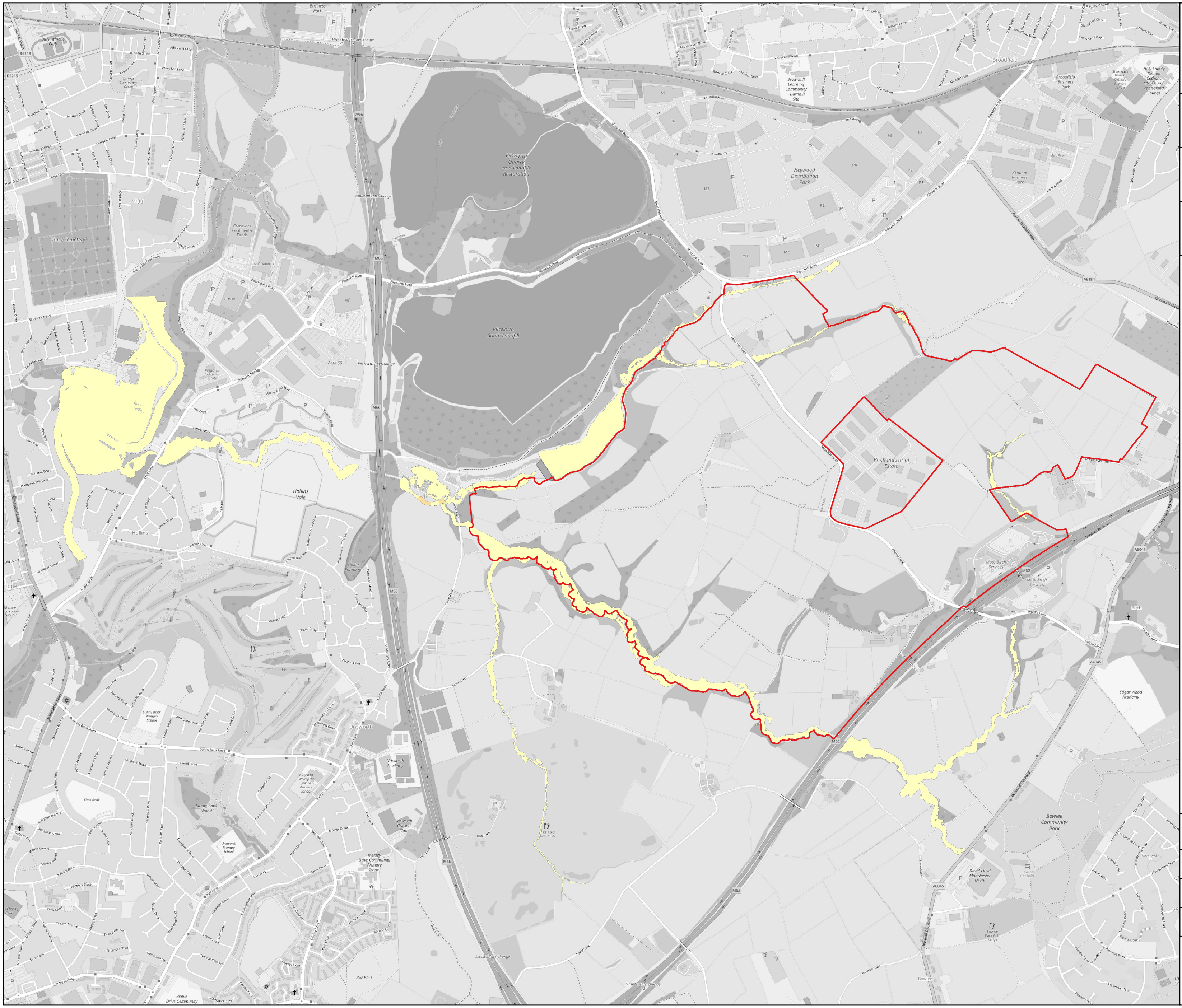
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Edgar Wood Academy
M66
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A6045
A6184

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NORTHERN GATEWAY
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Map 23: Weir sensitivity test difference to baseline 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth Difference

- 🟥 Increase >1m
- 🟥 Increase 0.75-1m
- 🟧 Increase 0.5-0.75m
- 🟧 Increase 0.25-0.5m
- 🟨 Increase 0.01-0.25m
- 🟨 Negligible +/-0.01m
- 🟩 Decrease 0.01-0.25m
- 🟩 Decrease 0.25-0.5m
- 🟩 Decrease 0.5-0.75m
- 🟩 Decrease 0.75-1m
- 🟩 Decrease >1m

Maximum Modelled Extent Difference

- 🟦 Was Dry Now Wet
- 🟦 Was Wet Now Dry

0 100 200 300 400 500 m

@ A3
1:15,000

N

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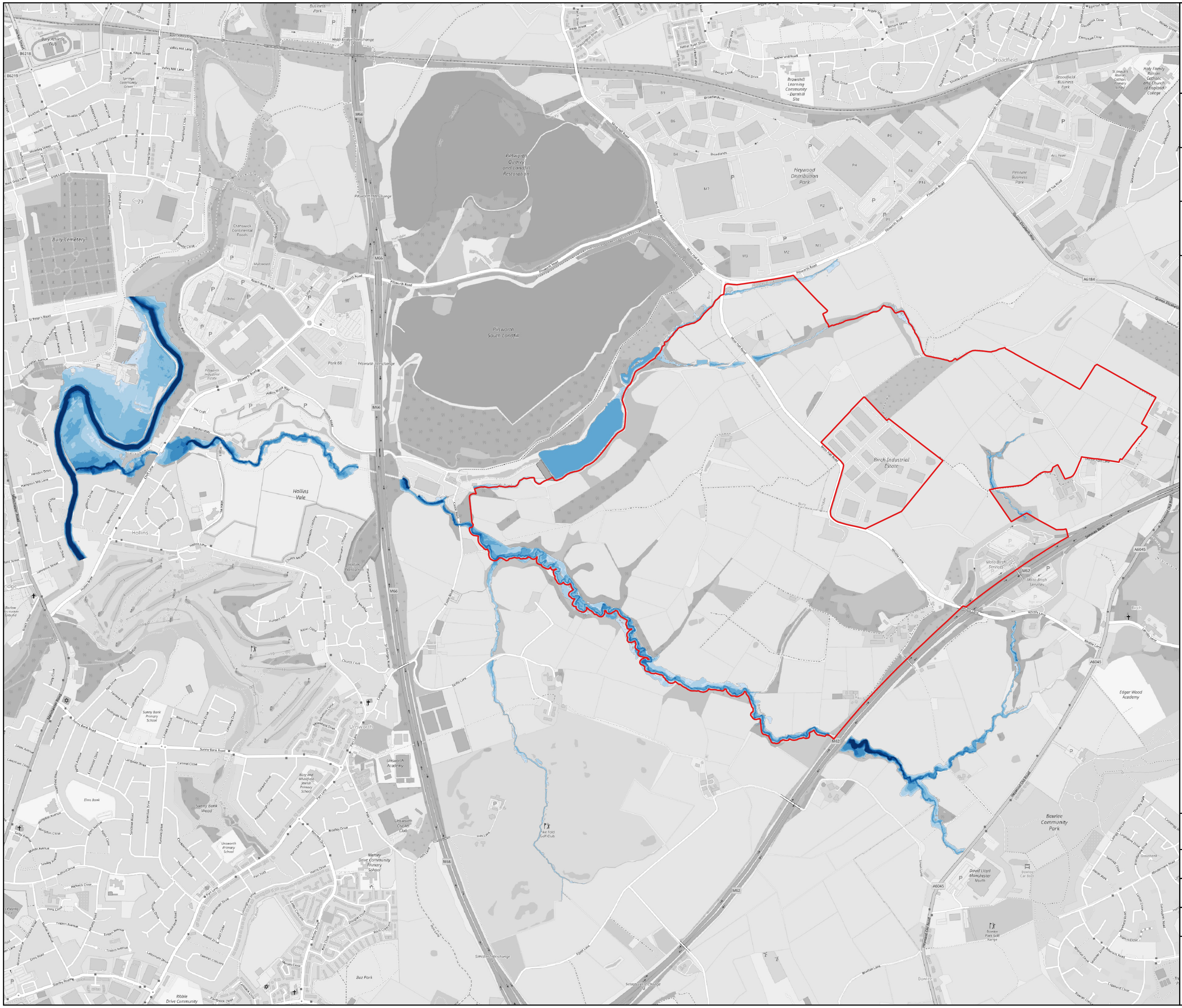
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Broadfield
Pennine Business Park
Bowlee Community Park
Edgar Wood Academy
Unsworth
Hollins
M66
M62
A6045

Northern Gateway JPA 1.1

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NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 24: Structure sizing sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

- Development Application Boundary

Maximum Modelled Depth

- ▢ <0.15m
- ▢ 0.15-0.5m
- ▢ 0.5-1m
- ▢ 1-1.5m
- ▢ 1.5-2m
- ▢ 2-2.5m
- ▢ 2.5-3m
- ■ >3m

0 100 200 300 400 500 m

@ A3
1:15,000

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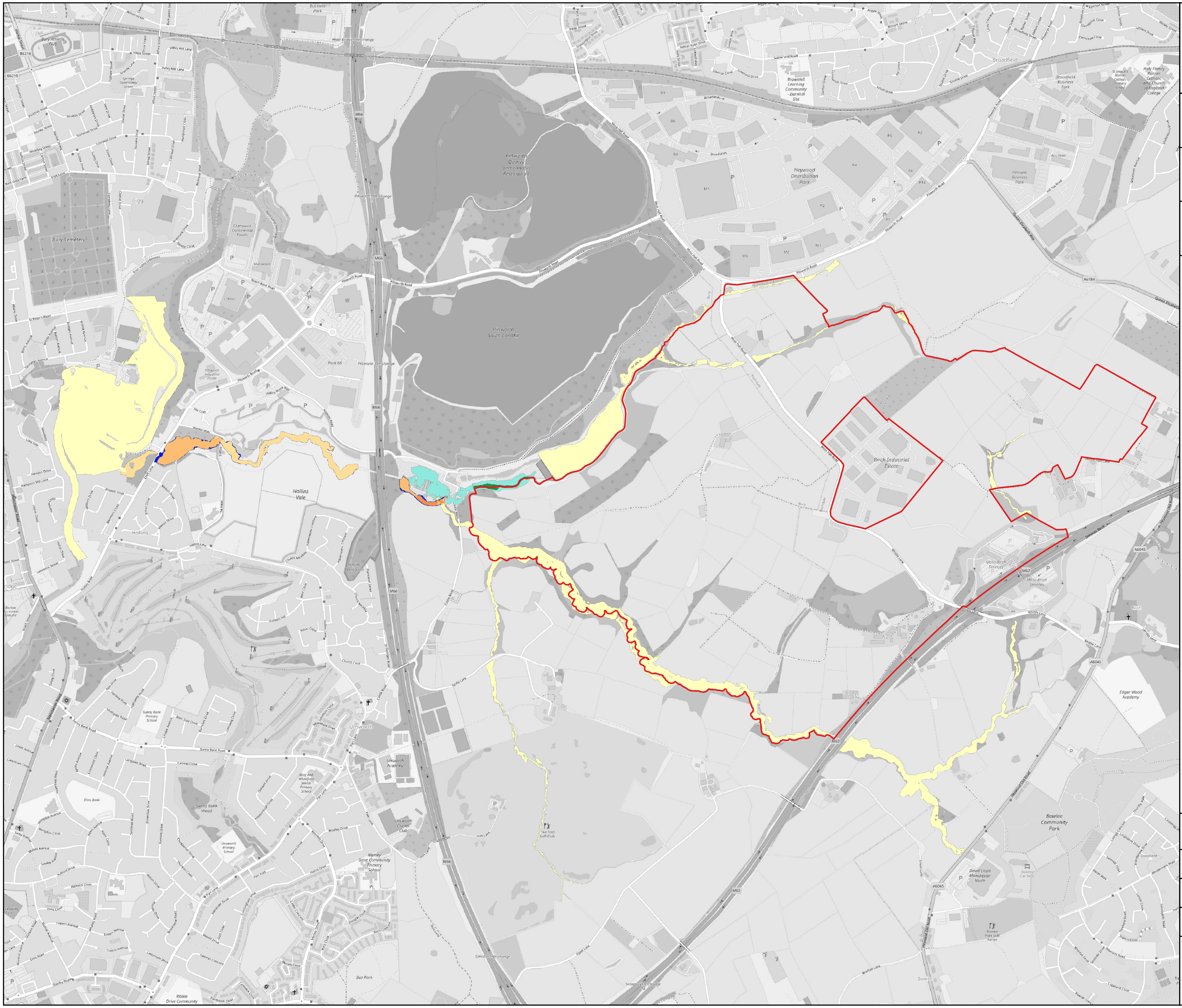
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Hollins
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Broadfield
Pennine Business Park
Unsworth
Bowlee Community Park
Edgar Wood Academy
Pilsworth Interchange
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Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 25: Structure sizing sensitivity test difference to baseline 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth Difference

- 🟥 Increase >1m
- 🟥 Increase 0.75-1m
- 🟧 Increase 0.5-0.75m
- 🟧 Increase 0.25-0.5m
- 🟨 Increase 0.01-0.25m
- 🟨 Negligible +/-0.01m
- 🟩 Decrease 0.01-0.25m
- 🟩 Decrease 0.25-0.5m
- 🟩 Decrease 0.5-0.75m
- 🟩 Decrease 0.75-1m
- 🟩 Decrease >1m

Maximum Modelled Extent Difference

- 🟦 Was Dry Now Wet
- 🟦 Was Wet Now Dry

0 100 200 300 400 500 m

@ A3
1:15,000

N

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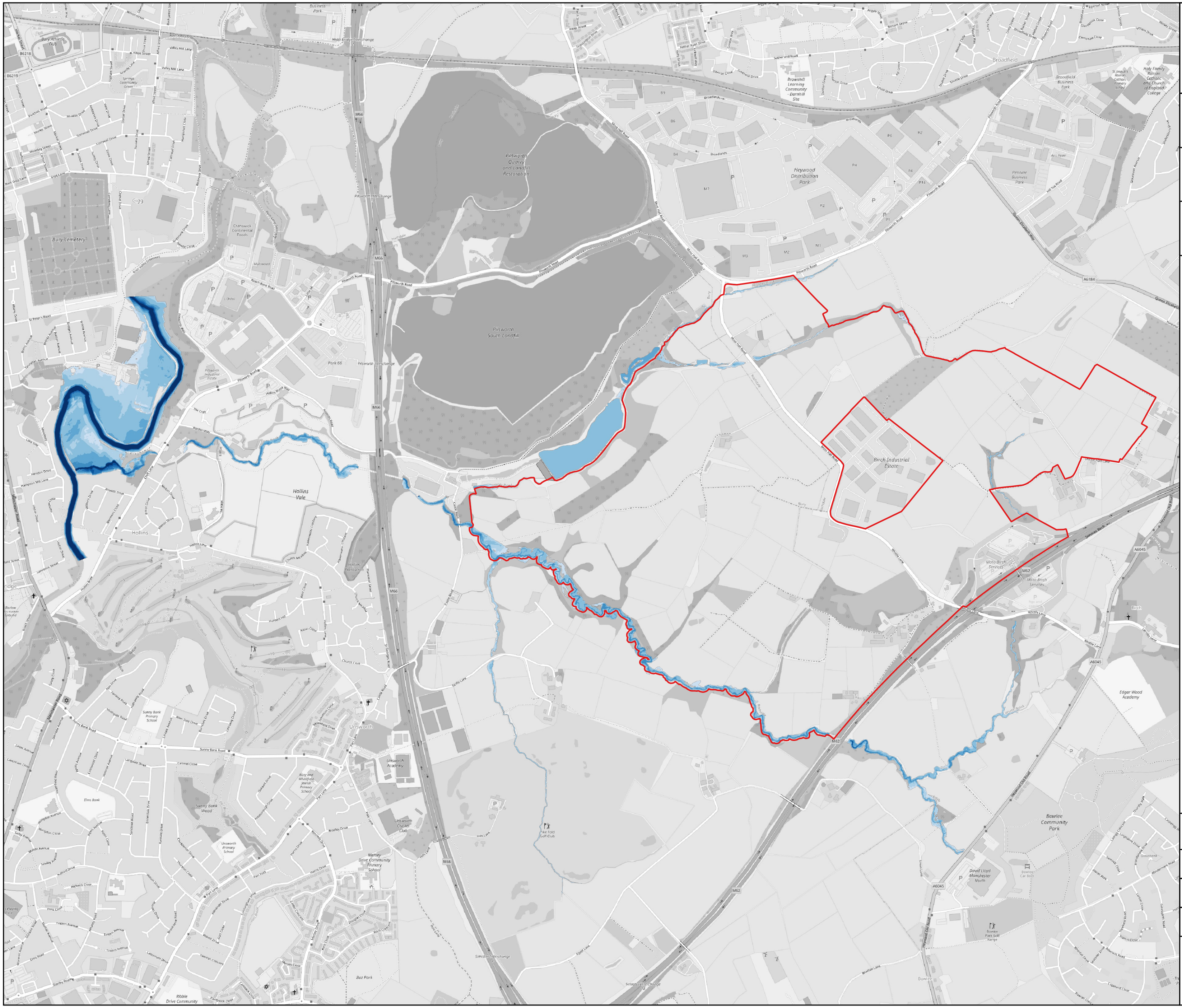
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Pilsworth South Landfill
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Birch Industrial Estate
Hollins Vale
Bury Cemetery
Broadfield
Pennine Business Park
Bowlee Community Park
Edgar Wood Academy
David Lloyd Manchester North
Heaton Park Golf Course
Pike Fold Golf Club
Unsworth
Hollins
M66
M62
A6045
A6184
Pilsworth Road
Moss Hall Road
Birch Road
Bury Old Road
Heywood Old Road

Northern Gateway JPA 1.1

North Manchester
National Grid Reference: 383005, 408224

NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 26: Storm duration (3 hour) sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth

- 🟦 <0.15m
- 🟦 0.15-0.5m
- 🟦 0.5-1m
- 🟦 1-1.5m
- 🟦 1.5-2m
- 🟦 2-2.5m
- 🟦 2.5-3m
- 🟦 >3m

0 100 200 300 400 500 m

@ A3
1:15,000

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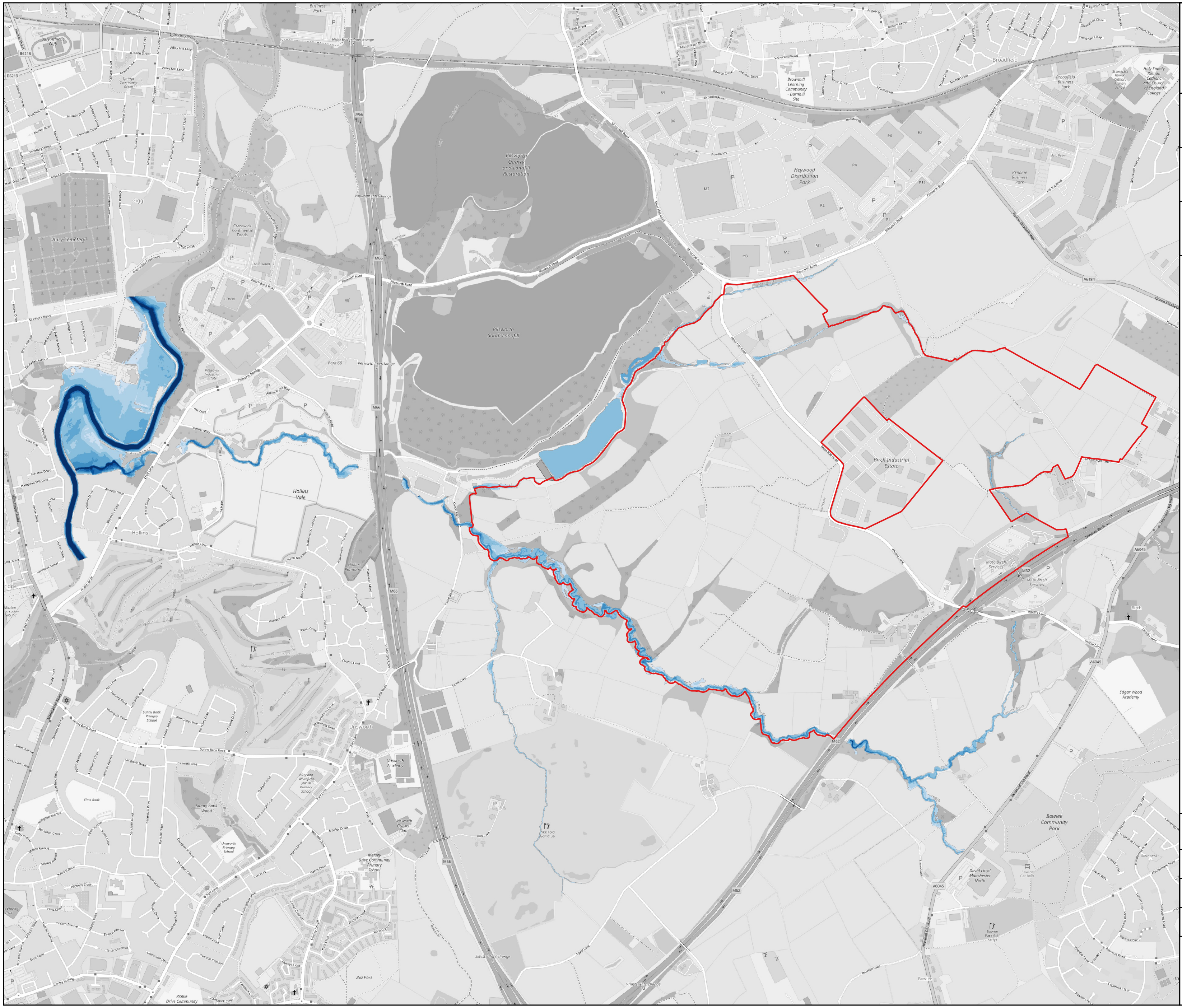
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Pilsworth South Landfill
Heywood Distribution Park
Birch Industrial Estate
Hollins Vale
Bury Cemetery
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Hollins
Bowlee Community Park
Edgar Wood Academy
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Northern Gateway JPA 1.1

North Manchester
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NORTHERN GATEWAY
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Map 27: Storm duration (5.5 hour) sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

🟥 Development Application Boundary

Maximum Modelled Depth

🟦	<0.15m
🟦	0.15-0.5m
🟦	0.5-1m
🟦	1-1.5m
🟦	1.5-2m
🟦	2-2.5m
🟦	2.5-3m
🟦	>3m

0 100 200 300 400 500 m

@ A3
1:15,000

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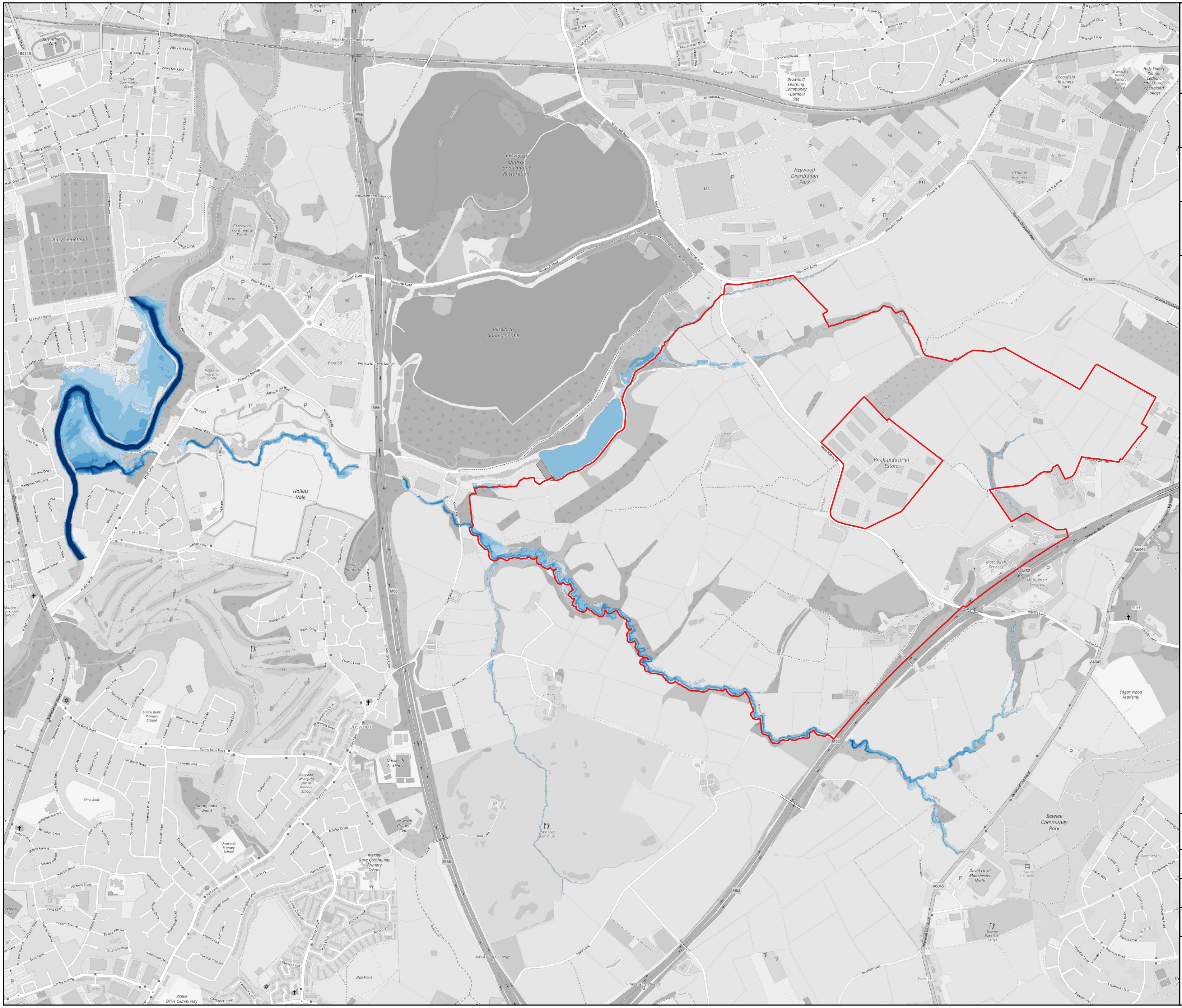
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Heywood Distribution Park
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Broadfield
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Hollins
Unsworth
Bowlee Community Park
Edgar Wood Academy
David Lloyd Manchester North
M66
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A6184

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NORTHERN GATEWAY
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Map 28: Storm duration (9 hour) sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth

- ■ <0.15m
- ■ 0.15-0.5m
- ■ 0.5-1m
- ■ 1-1.5m
- ■ 1.5-2m
- ■ 2-2.5m
- ■ 2.5-3m
- ■ >3m

0 100 200 300 400 500 m
@ A3
1:15,000
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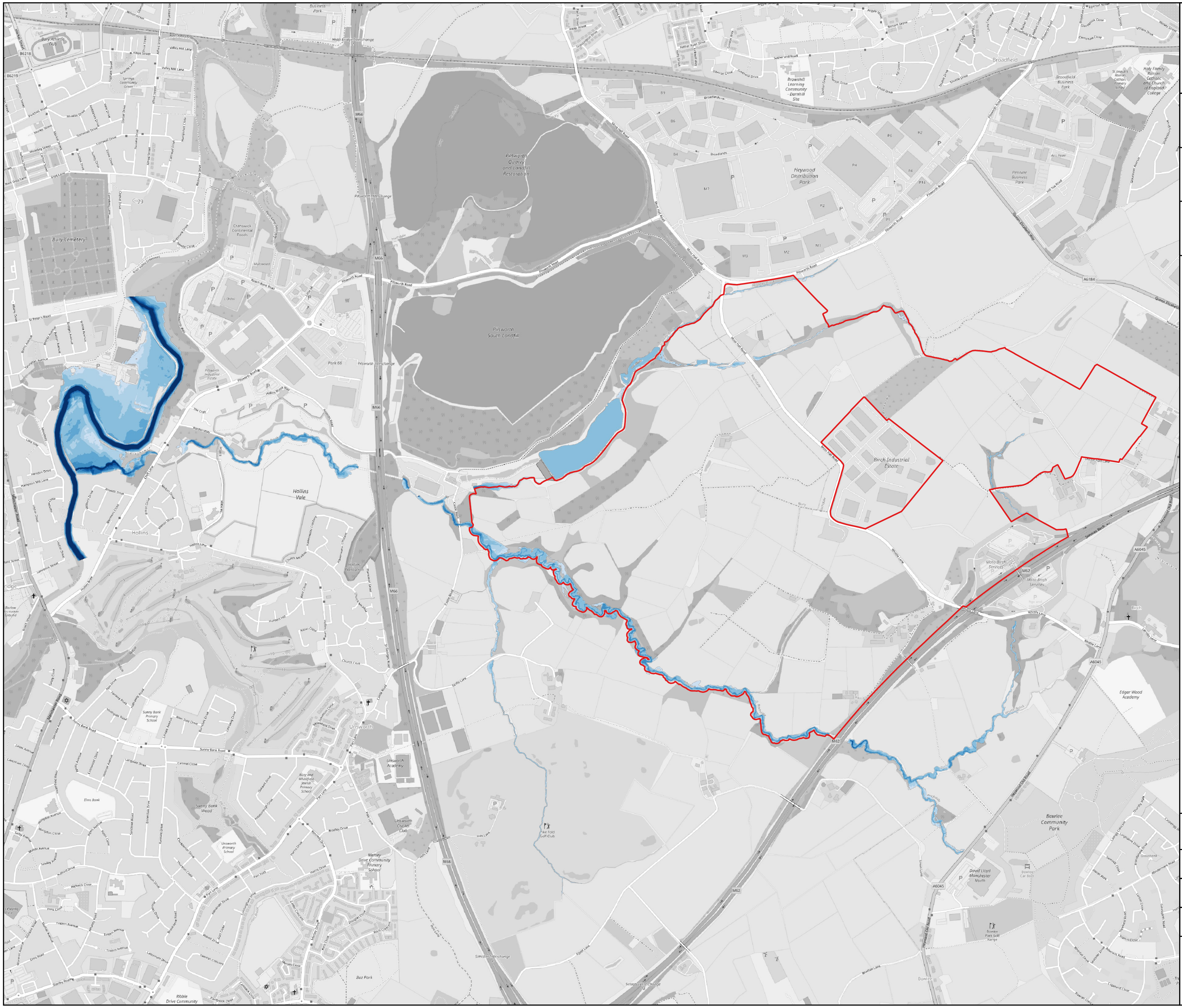
Bury Cemetery
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Hollins Vale
Hollins
Pilsworth Quarry and Landfill Restoration
Pilsworth South Landfill
M66
M62
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Pennine Business Park
Broadfield
Birch Industrial Estate
Birch Services
A6045
A6184
Edgar Wood Academy
Bowlee Community Park
Unsworth
Unsworth Academy

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A joint venture by Harworth Group plc and Russell LDP

Map 29: Storm duration (15 hour) sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

Development Application Boundary

Maximum Modelled Depth

- ▨ <0.15m
- ▨ 0.15-0.5m
- ▨ 0.5-1m
- ▨ 1-1.5m
- ▨ 1.5-2m
- ▨ 2-2.5m
- ▨ 2.5-3m
- ▨ >3m

0 100 200 300 400 500 m

@ A3
1:15,000

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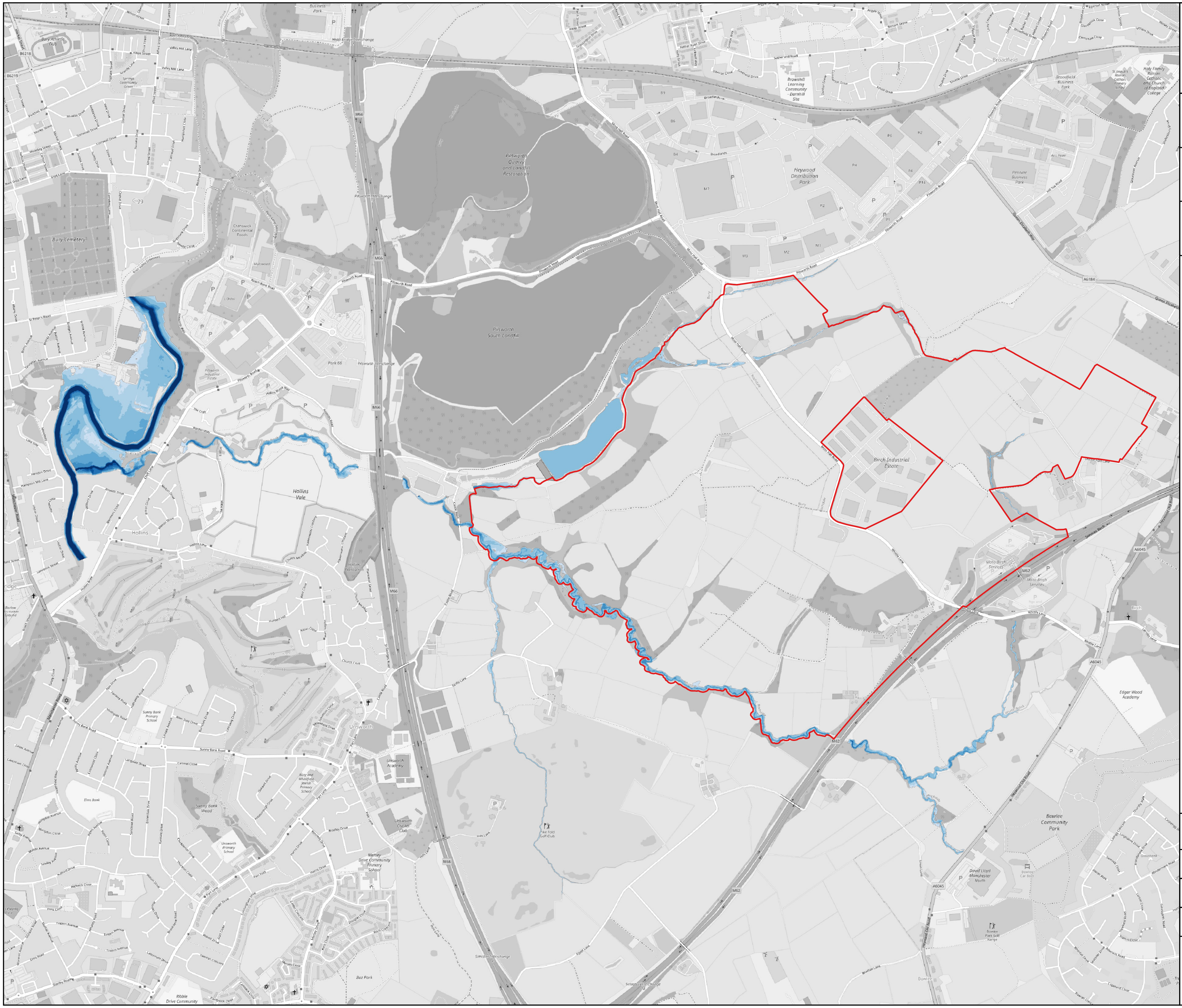
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Unsworth
Bowlee Community Park
M66
M62
M60
A6045
A6184
Edgar Wood Academy

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NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 30: Storm duration (24 hour) sensitivity test 1% AEP 2080s central (+35% peak flow allowance)

Legend

— Development Application Boundary

Maximum Modelled Depth

- 🟦 <0.15m
- 🟦 0.15-0.5m
- 🟦 0.5-1m
- 🟦 1-1.5m
- 🟦 1.5-2m
- 🟦 2-2.5m
- 🟦 2.5-3m
- 🟦 >3m

0 100 200 300 400 500 m

@ A3
1:15,000

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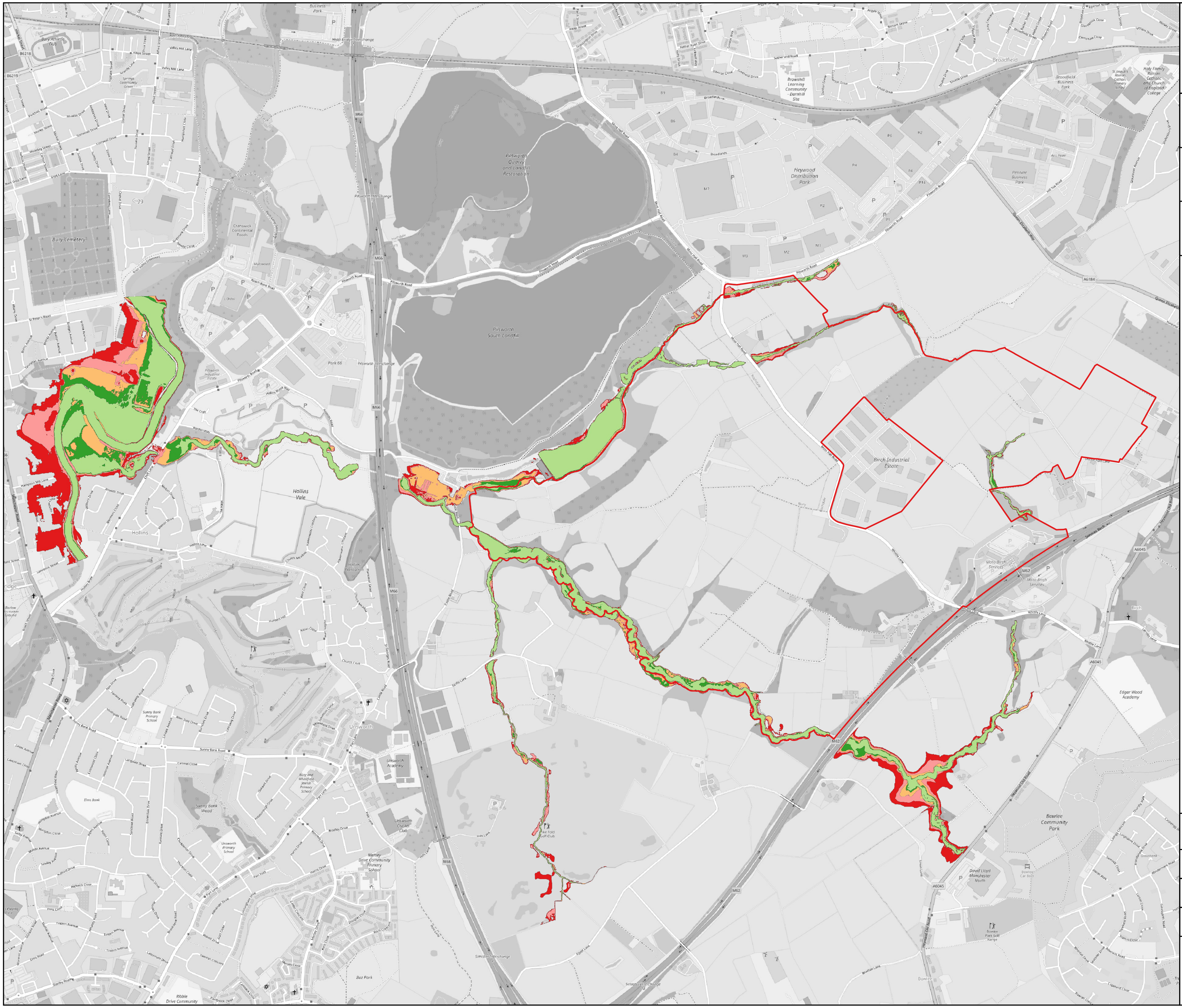
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Unsworth
Bowlee Community Park
Edgar Wood Academy
Park 66
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M62
A6045
A6184
Pilsworth Road

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North Manchester
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NORTHERN GATEWAY
A joint venture by Harworth Group plc and Russell LDP

Map 31: Baseline modelled flood extents

Legend

— Development Application Boundary
🟩 3.33% AEP Present Day
🟩 1% AEP Present Day
🟧 1% AEP 2080s Central
🟥 0.1% AEP Present Day
🟥 0.1% AEP 2080s Central

0 100 200 300 400 500 m
@ A3
1:15,000
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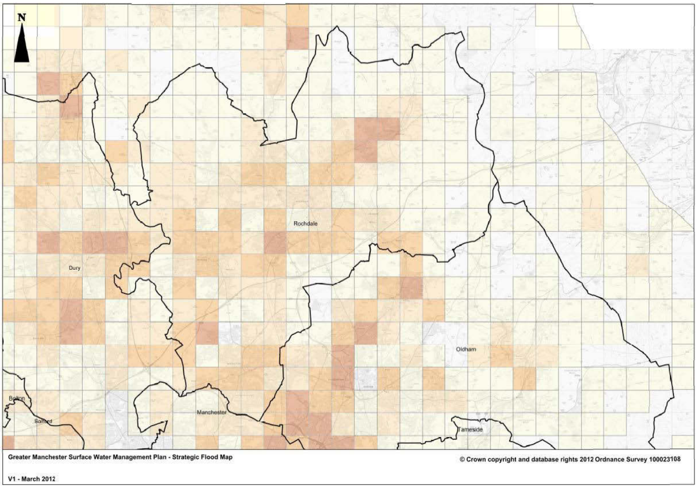
APPENDIX E – RMBC Areas Susceptible to groundwater flooding map

Groundwater flooding

5.14 Groundwater flooding occurs where water levels in rock and soil are high enough for the water to appear near to or above ground. It can be caused by rainfall either locally or some distance away. Whilst this is uncommon as a type of flooding, limited smaller scale flooding, often of cellars and under floors has occurred. Further work to identify areas where this is a significant source of flood risk will be undertaken by the LLFA working with other risk management agencies. An illustration of areas susceptible to groundwater flooding can be seen in Figure 6 below.

Figure 6 Areas susceptible to groundwater flooding in Rochdale borough



Greater Manchester Surface Water Management Plan - Strategic Flood Map

V1 - March 2012

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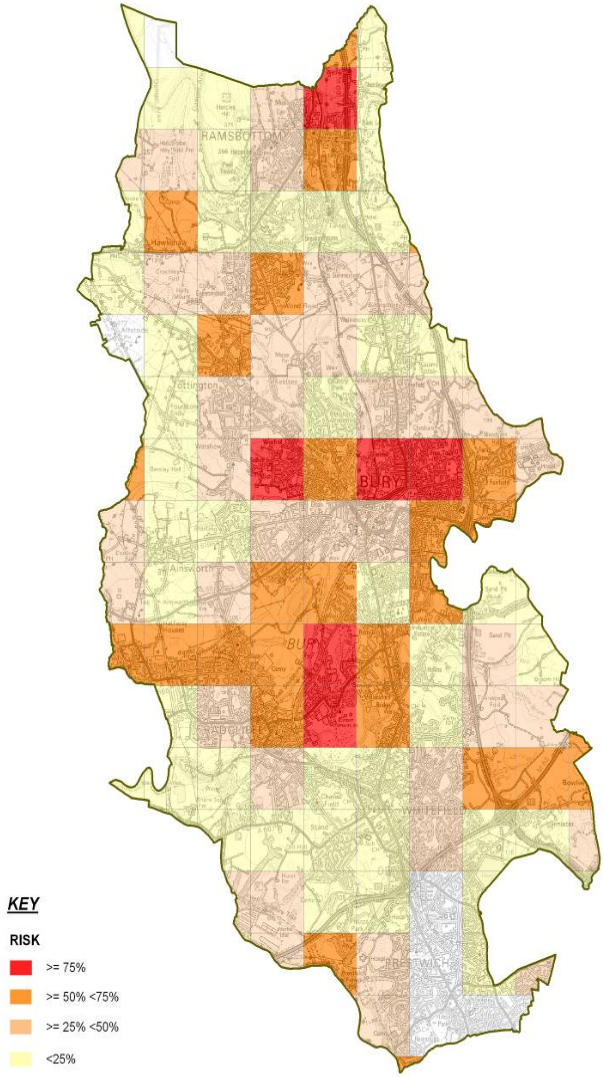
Canal flooding

5.15 The Rochdale Canal runs through a significant part of Rochdale borough on its route between West Yorkshire and Manchester City Centre. As canals have various features which allow for regulation of water flow their flood risk is generally low. Flood risk from the Rochdale Canal is largely from breaches in the canal walls or blockages which occur before measures to manage flow can be taken.

APPENDIX F – BBC LFRMS Groundwater flooding map

Figure 7 – Groundwater Flooding


RAMSBOTTOM
Hawkshaw
Tottington
Walshaw
BURY
Ainsworth
RADCLIFFE
WHITEFIELD
PRESTWICH
KEY
RISK
🟥 >= 75%
🟧 >= 50% <75%
>= 25% <50%
<25%

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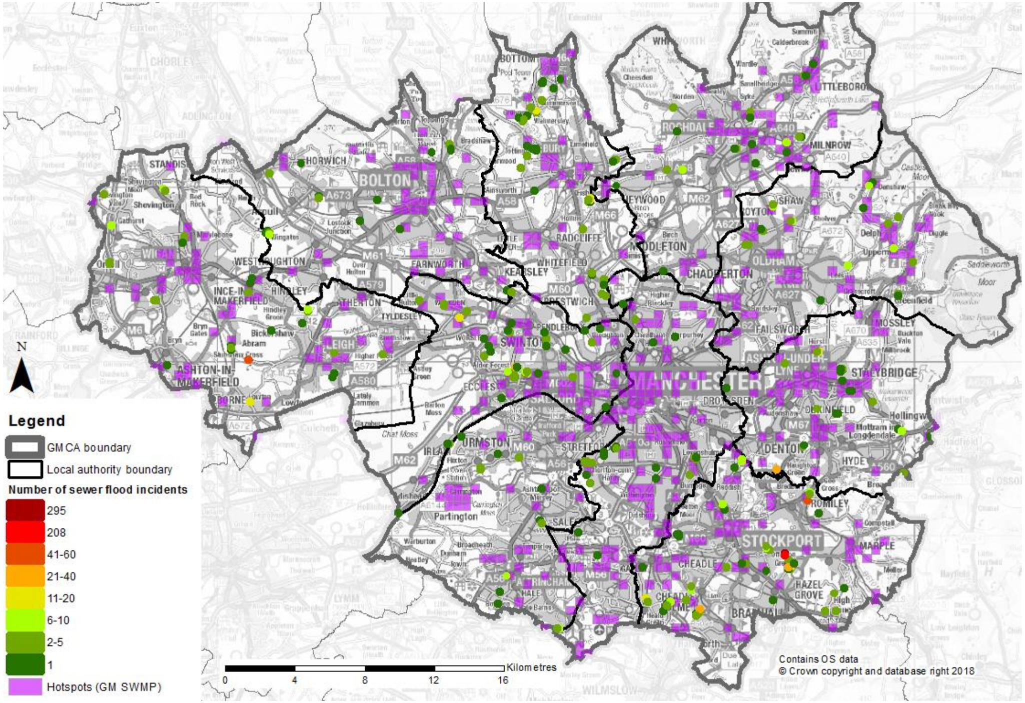
Source: Bury Council, 2016

APPENDIX G – GMCA SFRA Surface Water Management Plan Hotspots map

Figure 6-8: UU historic sewer flooding incidents and GM SWMP Hotspots


N
Legend
GMCA boundary
Local authority boundary
Number of sewer flood incidents
295
208
41-60
21-40
11-20
6-10
2-5
1
Hotspots (GM SWMP)
0
4
8
12
16
Kilometres
BOLTON
BURY
ROCHDALE
LITTLEBOROUGH
MILNROW
HEYWOOD
MIDDLETON
OLDHAM
SHAW
ROYTON
CHADDERTON
FAILSWORTH
WIGAN
STANDISH
HORWICH
WESTHOUGHTON
INCE-IN-MAKERFIELD
HINDLEY
ATHERTON
TYLDESLEY
LEIGH
ASHTON-IN-MAKERFIELD
FARNWORTH
KEARSLEY
RADCLIFFE
WHITEFIELD
PRESTWICH
SWINTON
PENDLEBURY
ECCLES
MANCHESTER
DROYLSDEN
ASHTON-UNDER-LYNE
STALYBRIDGE
MOSSLEY
DUKINFIELD
DENTON
HYDE
ROMILEY
MARPLE
STOCKPORT
CHEADLE
HAZEL GROVE
BRAMHALL
SALE
ALTRINCHAM
HALE
URMSTON
STRETFORD
IRLAM
Partington
CHORLEY
WILMSLOW
M60
M61
M62
M66
M6
M56
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