

Appendix 9A

Flood Risk Assessment (FRA)

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Executive Summary

A new railway station is proposed on the Kirkby branch line at Headbolt Lane, Kirkby, with associated parking, substation, and interchange facilities.

This Flood Risk Assessment has been prepared by Arup on behalf of Buckingham Group Contracting Limited (BGCL) to assess the risk of flooding both to and as a result of the proposed development.

The existing site is open grassland, bounded by Headbolt Lane to the north and east, the A506 to the west and the Kirkby Branch railway to the south. Ground levels vary between 28-30m AOD along the northern boundary and between 22-31m AOD along the southern boundary.

Kirkby Brook bisects the site from east to west and is an Environment Agency designated main river. Bed levels vary between 20-25m AOD.

The proposed station building is to have a threshold level of approximately 30m AOD. Site car parks and access routes vary in level from 27-30m AOD. The proposed substation compound has a floor level at approximately 27m AOD.

A road bridge and one footbridges are proposed over Kirkby Brook (currently in development at the time of writing).

Modifications are also proposed to the existing railway and Kirkby Station west of the new station site. These works are within the existing railway corridor and do not include modifications to drainage systems and are therefore not assessed as part of this flood risk assessment.

Fluvial flood mapping indicates that the flood extents of Kirkby Brook are limited to the immediate vicinity of the watercourse, with flood levels for the 0.1% annual exceedance probability (AEP) event with 30% uplift for climate change ranging from 22.08m AOD at the downstream end and 25.91m AOD at the upstream end.

The risk of fluvial flooding to the station building and site infrastructure is therefore negligible.

Flood risk from other sources including surface water (pluvial) flooding, groundwater, reservoirs and sewers is also considered to be negligible.

To ensure the proposed development does not result in an increase in flood risk on or off the site, the following measures are proposed:

- Bridges constructed over Kirkby Brook shall have abutments positioned beyond the extents of the highest modelled flood scenario. Soffit levels shall be a minimum of 600mm above the maximum modelled flood level.
- A surface water drainage strategy has been developed based on Knowsley Metropolitan Borough Council (KMBC) guidance which aims to maintain discharge rates into Kirkby Brook as close as is reasonably practicable to greenfield runoff rates. The drainage strategy will be developed during detailed design in consultation with KMBC.

1 Introduction

Arup was commissioned by Buckingham Group Contracting Limited (BGCL) to undertake a Flood Risk Assessment in support of a planning application for the Headbolt Lane New Station development site.

This report has been compiled in response to the requirements of the National Planning Policy Framework (NPPF) and associated Planning Practice Guidance (PPG) relating to Flood Risk and Coastal Change¹

The principles of the NPPF encourage sustainability by avoiding development in areas at risk of flooding and ensuring that where development is necessary in such areas, it is made safe for its lifetime without increasing flood risk elsewhere.

As Lead Local Flood Authority, Knowsley Metropolitan Borough Council (KMBC) have also prepared Level 1 and Level 2 Strategic Flood Risk Assessments (SFRAs) which reinforce the requirements and principles of the NPPF and provide local context and historic information relating to flood risk.

This report has been prepared with due regard to the PPG requirement for assessments to be “proportionate to the scale, nature and location of the development” and to “make optimum use of information already available”. The scope of this assessment has therefore comprised:

- Gathering existing information pertaining to flood risk to the site;
- Identification of potential sources and mechanisms of flooding;
- Assessment of flood risk to the development, and potential off-site impacts of the proposals; and,
- Identification of measures for mitigation and management, where appropriate, to reduce flood risk to acceptable levels.

This report has been prepared by Arup for BGCL for the Headbolt Lane New Station site. It shall not be relied upon for use on any other project. Whilst Arup does not guarantee, nor accept liability for the accuracy of any information derived from secondary sources, endeavours have been made to verify the suitability of information used in this report.

¹ <https://www.gov.uk/guidance/flood-risk-and-coastal-change>

2 Development Site and Location

2.1 Location

The Headbolt Lane New Station site is located south of the settlement of Northwood. The site is bounded by Headbolt Lane to the north and east, the A506 to the west and the Kirkby Branch railway line to the south. Liverpool city centre is located approximately 12km south west of the proposed station.



Figure 1 - Site Location (boundary shown in red)

The approximate Ordnance Survey coordinates of the site are E341319, N399806.

2.2 Site Characteristics

2.2.1 Site Layout

The site is currently greenfield land approximately 5.0ha in area. A footpath crosses the site from west to east, connecting the A506 to residential areas north-east of the site via an underpass beneath Headbolt Lane.

2.2.2 Watercourses

The site is divided by Kirkby Brook which crosses under the Kirkby Branch Railway and emerges into the site to the east before turning west and heading downstream in a westerly direction and exiting the site under the A506.

Kirkby Brook is a designated main river maintained by the Environment Agency.

There are two existing footbridges over Kirkby Brook within the site.

2.2.3 Flood Zone

EA Flood Map for Planning data indicates that the site is predominantly in Flood Zone 1 (see Appendix A). The flood zone 2 and 3 extents relating to Kirkby Brook are largely constrained to the immediate vicinity of the watercourse.

2.2.4 Topography

Site level information is based on a 2020 InoRail Topographical Survey. Ground levels vary between 28-30m AOD along the northern boundary and between 22-31m AOD along the southern boundary. Kirkby Brook forms a valley within the site with a bed level varying between 20-25m AOD.

2.2.5 Artificial Drainage

United Utilities (UU) sewer records indicate surface water and foul water public sewer networks within the site boundary (see Appendix B).

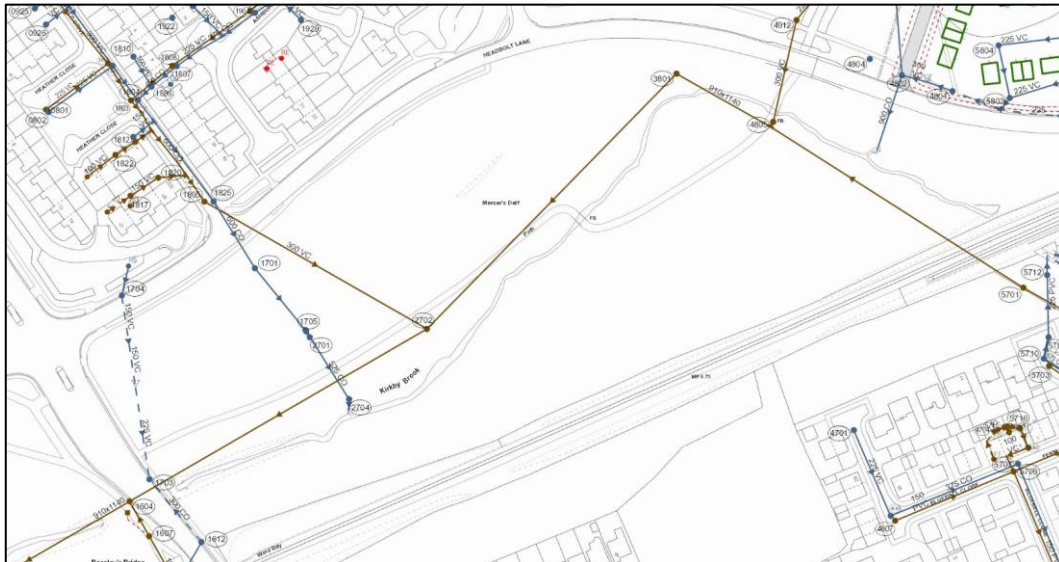


Figure 2 – Extract from United Utilities records showing sewers within the site.

A 900mm surface water sewer discharges into Kirkby Brook at the east of the site. A 525mm surface water sewer also discharges to the brook at the west of the site.

A 910mm x 1140mm foul water culvert crosses the railway to the east of the site and passes beneath Kirkby Brook. The culvert then flows south-west parallel to Kirkby Brook and leaves the site under the A506.

Public sewers are typically subject to an easement set 6m either side from the centreline of the sewers (to be confirmed by UU). Any works within such easements will be subject to agreement with UU.

Highway drainage records indicate a 225mm surface water sewer crossing the site at the western boundary. Records also indicate gullies along Headbolt Lane connecting to small sections of carrier pipework with unconfirmed outfalls along the northern boundary of the site (see Appendix C).

2.2.6 Geotechnical Information

A ground investigation factual report for the site was issued by CC Geotechnical Ltd in November 2020.

Trial pits indicate sand and gravel subsoils with some areas of made ground.

Two soakaway tests were undertaken near to Kirkby Brook in accordance with BRE Digest 365. Tests were undertaken at a level of 22.5m AOD and 24.2m AOD within sand strata and the infiltration rates were in the order of 10^{-5} m/s, indicating good potential for infiltration of surface water runoff.

Groundwater was not encountered in any of the trial pits undertaken on site or in either of the four boreholes undertaken down to a maximum depth of 24.51m AOD (boreholes were terminated at 1.3m to 2.7m depth as sandstone was encountered). Boreholes generally remained dry during groundwater monitoring at three intervals in the preceding 7-week period, with limited amounts of water encountered close to the bottom of two boreholes.

3 Development Proposals

Merseytravel is seeking to extend the Merseyrail network beyond the existing terminus at Kirkby Station to a new transport interchange at Headbolt Lane. The station will become the new interchange location between Merseyrail services to Liverpool and Northern Rail services to Wigan

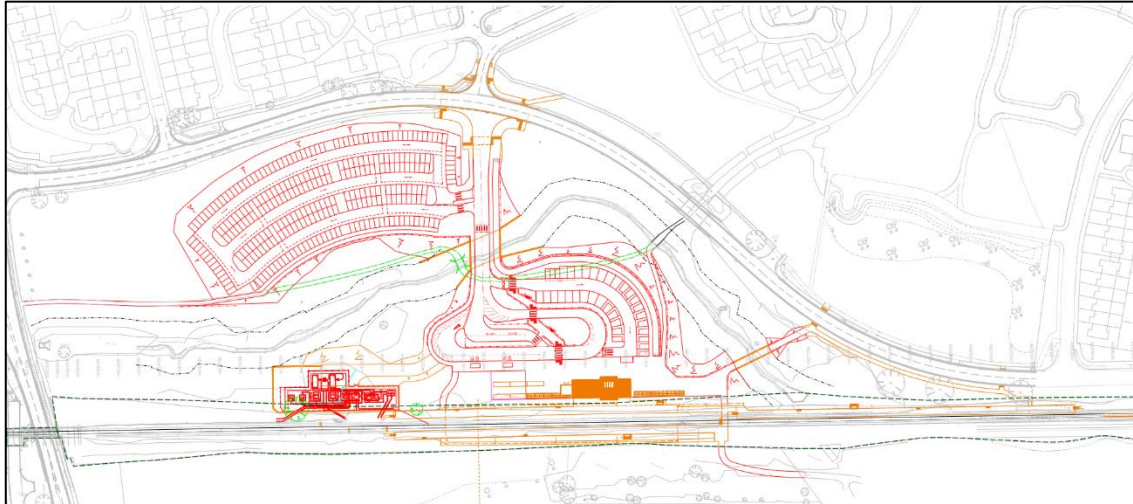


Figure 3 - Headbolt Lane New Station development proposals.

Headbolt Lane will be a three-platform station with a ticketing office, car park, cycle storage, drop-off area and bus interchange facilities. A substation serving the railway will also be located on the site.

Building threshold levels are set at approximately 30.0m AOD.

Vehicular access to the site will be provided from Headbolt Lane to the north with a new bridge over Kirkby Brook. Pedestrian and cycle access will also be provided to the east and to the west via new bridges over Kirkby Brook.

Earthworks are required to regrade the site into a profile suitable for the car park and access routes. Levels are to be increased south of Kirkby Brook to achieve the required levels for the station building and platforms and provide accessible gradients in the forecourt and parking areas.

North of Kirkby Brook site levels shall be reduced and raised to the north and south of the main car park respectively in order to achieve a favourable cut and fill balance across the site.

One of the two existing footbridges over Kirkby Brook is to be removed.

Modifications are also proposed to the existing railway and Kirkby Station west of the new station site. These works are within the existing railway corridor and do not include modifications to drainage systems and are therefore not assessed as part of this flood risk assessment.

3.1 Flood Vulnerability Classification

Flood vulnerability classifications are described in Table 2 of the Planning Practice Guidance for Flood Risk and Coastal Erosion.

Station buildings are considered as ‘less vulnerable’ development. The substation and associated electrical equipment are considered ‘essential infrastructure’. However, all development will be located within Flood Zone 1.

Bridges over Kirkby Brook shall be considered as ‘essential infrastructure’ for the purpose of determining climate change allowances.

4 Sequential Test

Paragraphs 157 and 158 of the NPPF describe the sequential, risk-approach to the location of development to avoid flood risk where possible. The sequential test seeks to steer new development away from areas of high flood risk to areas of lower flood risk.

As the development is entirely within Flood Zone 1, the Sequential Test does not apply to this site.

Proposed bridges crossing Kirkby Brook shall be designed in consultation with the Environment Agency to avoid increases in flood risk (see section 6).

5 Climate Change

To minimise vulnerability and provide resilience against the potential impacts of climate change, the proposed development will consider the potential for increases in peak river flow and peak rainfall intensity.

Climate change allowances are specified by the Environment Agency for different scenarios over different epochs².

Peak river flow climate change allowances for the North West river basin area are provided in Table 1.

Table 1: EA peak river flow allowances (North West basin)

Allowance Category	Total Potential Change Anticipated for the '2020s' (2015-2039)	Total Potential Change Anticipated for the '2050s' (2040-2069)	Total Potential Change Anticipated for the '2080s' (2070-2115)
H++	25%	45%	95%
Upper End (90 th percentile)	20%	35%	70%
Higher Central (70 th percentile)	20%	30%	35%
Central (50 th percentile)	15%	25%	30%

The upper end allowance shall be applied to the design of bridges spanning Kirkby Brook to determine span lengths and soffit heights.

Peak rainfall intensity climate change allowances are provided in Table 2.

Table 2: EA peak rainfall intensity allowances in small catchments (all of England)

Allowance Category	Total Potential Change Anticipated for the '2020s' (2015-2039)	Total Potential Change Anticipated for the '2050s' (2040-2069)	Total Potential Change Anticipated for the '2080s' (2070-2115)
Upper End (90 th percentile)	10%	20%	40%
Central (50 th percentile)	5%	10%	20%

Drainage systems shall be designed to ensure there is no increase in the rate of runoff discharged from the site for the upper end allowance during the life of the development.

² <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

6 Site Specific Flood Risk

6.1 Fluvial Flood Risk

6.1.1 Environment Agency (EA) Flood Data

Flood risk information (product 4 data) was provided by the EA on 30 September 2020 (see Appendix D).

The flood zone map (Figure 4) shows that most of the site is located within flood zone 1, with the exception of areas immediately adjacent to Kirkby Brook. There are no formal EA raised defences associated with Kirkby Brook.

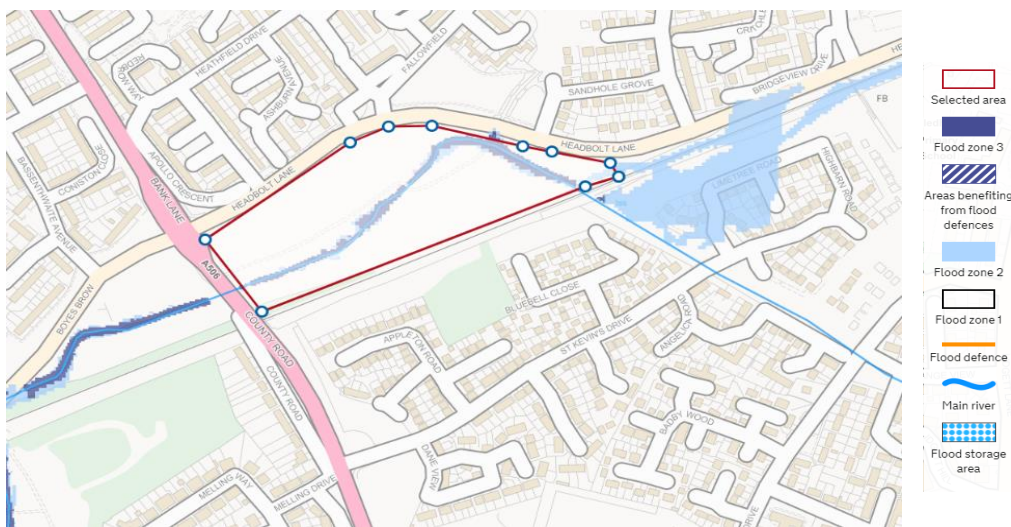


Figure 4 - EA Flood Zones

Hydraulic modelling data was also provided, showing flood flows and river levels for various node points along Kirkby Brook at different return periods.

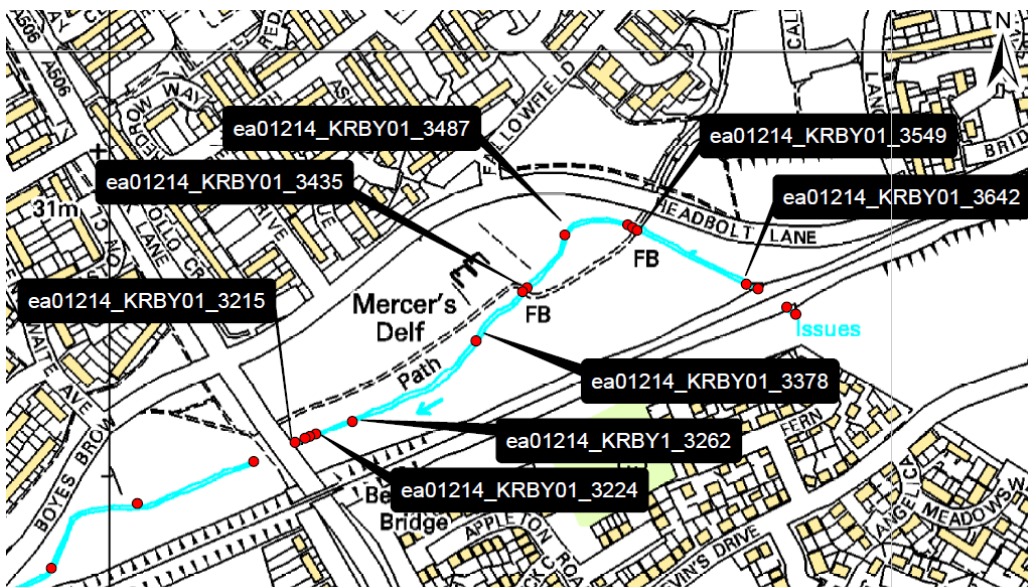


Figure 5 - Kirkby Brook Node Points

Node Point	Flood Flow (m ³ s ⁻¹) and Level (mAOD) data for a range of annual probability of flooding													
	0.1%+Climate change (+30%)		0.1%		1%+Climate Change (+70%)		1%+Climate Change (+35%)		1%+Climate Change (+30%)		1.0%		4.0%	
	Undefended		Undefended		Undefended		Undefended		Undefended		Undefended		Undefended	
Map ID	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
ea01214_KRBY01_3215	22.09	8.89	21.71	6.99	21.69	6.86	21.52	5.82	21.50	5.67	21.23	4.23	21.01	3.08
ea01214_KRBY01_3224	22.2	8.86	21.87	6.96	21.85	6.84	21.75	5.80	21.74	5.65	21.58	4.21	21.44	3.07
ea01214_KRBY01_3262	22.3	8.7	22.11	6.84	22.10	6.72	22.02	5.71	22.01	5.57	21.90	4.14	21.80	3.02
ea01214_KRBY01_3378	23.55	5.03	23.49	3.90	23.48	3.88	23.43	3.61	23.42	3.59	23.34	3.32	23.27	2.82
ea01214_KRBY01_3435	23.88	7.81	23.82	6.15	23.82	6.08	23.82	5.10	23.82	5.00	23.82	3.79	23.77	2.78
ea01214_KRBY01_3487	24.84	5.24	24.63	5.22	24.62	5.24	24.45	4.95	24.43	4.85	24.28	3.70	24.15	2.71
ea01214_KRBY01_3549	25.61	3.04	25.53	3.03	25.52	3.04	25.47	3.03	25.45	3.03	25.30	3.04	25.03	2.63
ea01214_KRBY01_3642	25.91	6.6	25.83	5.40	25.83	5.39	25.77	4.53	25.76	4.37	25.68	3.36	25.58	2.49
Level data in mAOD (metres above ordnance datum). Flow data in m ³ per second														
Data taken from 2017 Upper Alt Tributaries study														

Figure 6 - Kirkby Brook Node Point Data

The station building and substation are to be set at a level of approximately 30m AOD and 27m AOD respectively. The flood level at node point 3435 for the 0.1% annual exceedance probability with climate change (30%) is 23.88m AOD.

The risk of fluvial flooding to buildings and critical infrastructure is therefore considered to be negligible.

Furthermore, access routes and car parking are also to be positioned significantly higher than the maximum flood levels, resulting in negligible fluvial flood risk.

6.1.2 KMBC Strategic Flood Risk Assessment

As the Lead Local Flood Authority (LLFA), KMBC produced a Strategic Flood Risk Assessment (SFRA) in 2016. The report supports the EA data in confirming that the fluvial flood extents are confined within the immediate locality of Kirkby Brook. It also confirms that there is no risk to the site from tidal flooding.

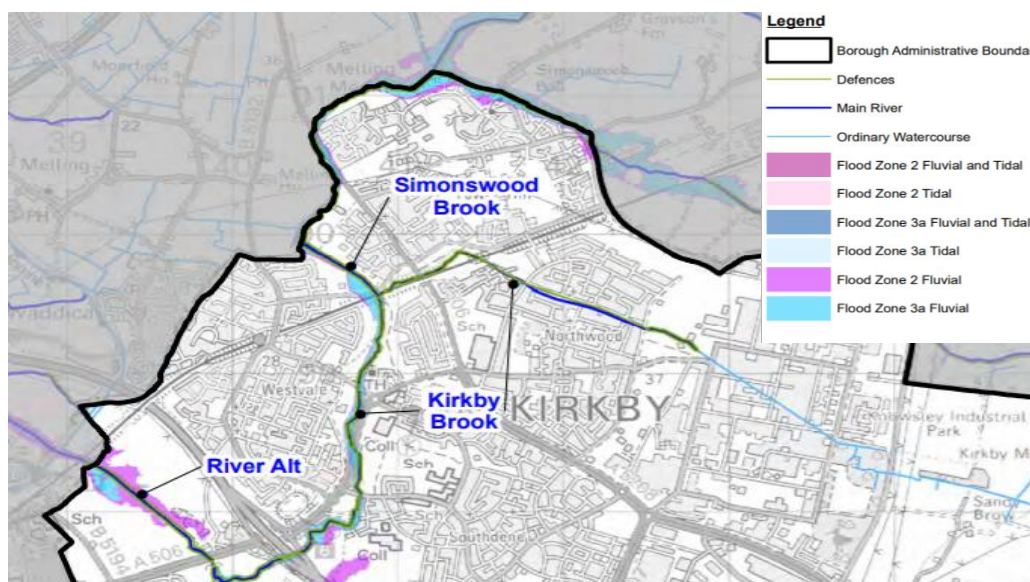


Figure 7 - KMBC Flood Risk Map - Extract from SFRA Figure B2-1 (2016)

6.1.3 Works adjacent to Kirkby Brook

To provide access to the new station, new crossings of Kirkby Brook are required. Works are also required in proximity to Kirkby Brook to provide the station car parks and supporting infrastructure.

A meeting was held with the Environment Agency on 9th September 2020 where the development proposals were discussed. The following points were noted:

- Activities within 8m of the banks of a main river are regulated activities under the Land Drainage Act 1991 requiring permits from the Environment Agency.
- Standard rules apply to some activities. Activities not included within the standard rules require bespoke permits.
- Bridges over Kirkby Brook are preferred over culverting.
- An unobstructed 8m corridor either side of the watercourse was requested for maintenance purposes.
- A blockage scenario should be considered for any bridges / culverts.
- A maintenance management plan is required.
- Temporary works permits may also be required, such as a Flood Risk Activity Environmental Permit for any temporary bridges or structures.

In response to the above meeting, an 8m buffer has been applied between the watercourse and the development proposals. Crossings of Kirkby Brook are also to be designed as bridges rather than culverts.

6.1.4 Bridge Design

Standard Rules SR2015 No28 for clear span bridges up to 8m span and 4.2m wide across a main river do not apply to this project.

The bridges crossing Kirkby Brook shall have a design life of 120 years. The minimum soffit levels have therefore been positioned above the 0.1% annual exceedance probability flood level of Kirkby Brook, with a further allowance for climate change. In accordance with CD 356³, an additional freeboard allowance of 600mm shall be applied above the maximum flood level to determine the minimum soffit level.

For the road bridge the nearest available node from the Product 4 data is 'ea012414_KRBY01_3435' which indicates a 0.1% + CC undefended value of 23.88m AOD. Figure 8 below shows a proposed section for the new road bridge.

As indicated on the section there is a clearance of approximately 3.4m from this indicated flood level. Additionally, the proposed abutments have been positioned outside of the 8m easement from the top of bank. As a result, the proposed abutments sit clear of the extent of the flood extents and the bridge poses no impact on the exist functional floodplain.

³ CD 356: Design of Highway Structures for Hydraulic Action, Rev01, Highways England, 2020

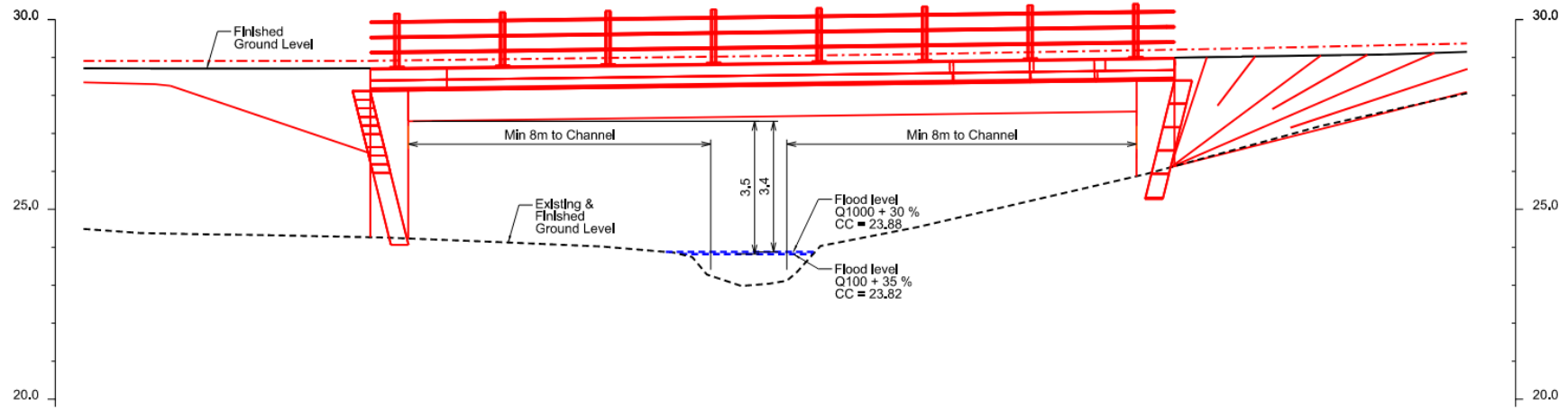


Figure 8 - Proposed Road Bridge Section

For the proposed footbridge the nearest available node from the Product 4 data is 'ea012414_KRBY01_3642' which indicates a 0.1% + CC undefended value of 25.91m AOD. Figure 9 below shows a proposed section for the new footbridge. As indicated on the section there is a clearance of approximately 1.3m from this indicated flood level. Additionally, the proposed abutments have been positioned outside of the 8m easement from the top of bank.

The two small concrete footbridges over Kirkby Brook are to be removed. It is not anticipated that this will have any detrimental effect on flood risk, either within the site or downstream.

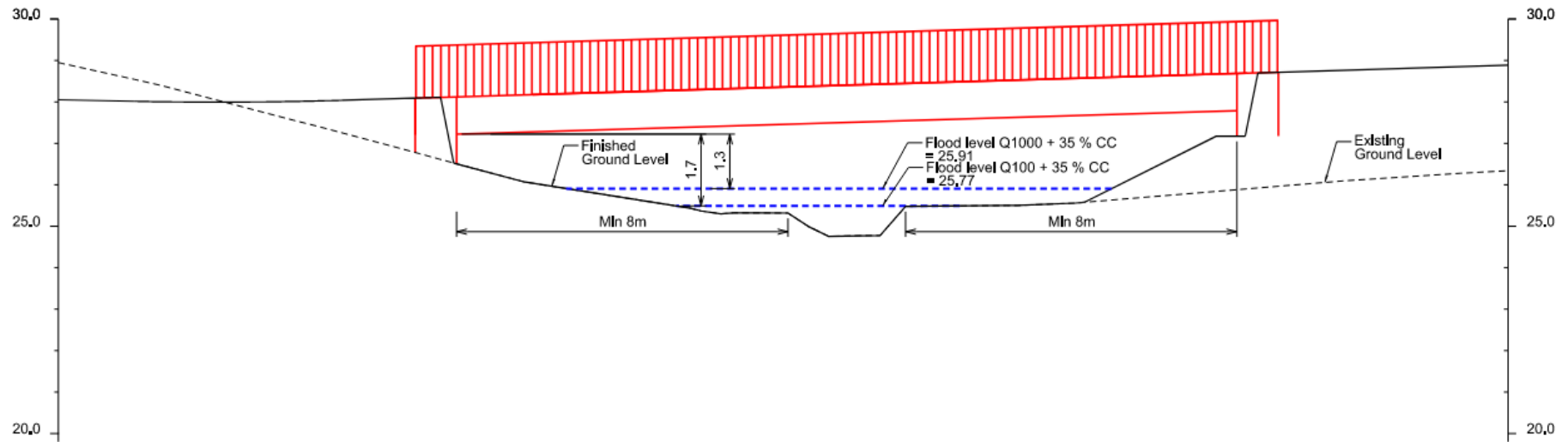


Figure 9 - Proposed Footbridge Section

6.2 Surface Water (Pluvial) Flood Risk

6.2.1 EA Flood Risk Data

The EA surface water flood map (Figure 10) indicates that there is a very low risk of surface water flooding across the majority of the site, with areas of increased flood risk constrained to the immediate vicinity of Kirkby Brook.

The EA surface water flood risk map is based on a rainfall modelling applied to the site topography. It is therefore expected that accumulations of surface water will occur along the lowest site levels coincident with Kirkby Brook. When assessing flood risk from Kirkby Brook, it is however considered more appropriate to use the fluvial flood modelling described in section 7.1.

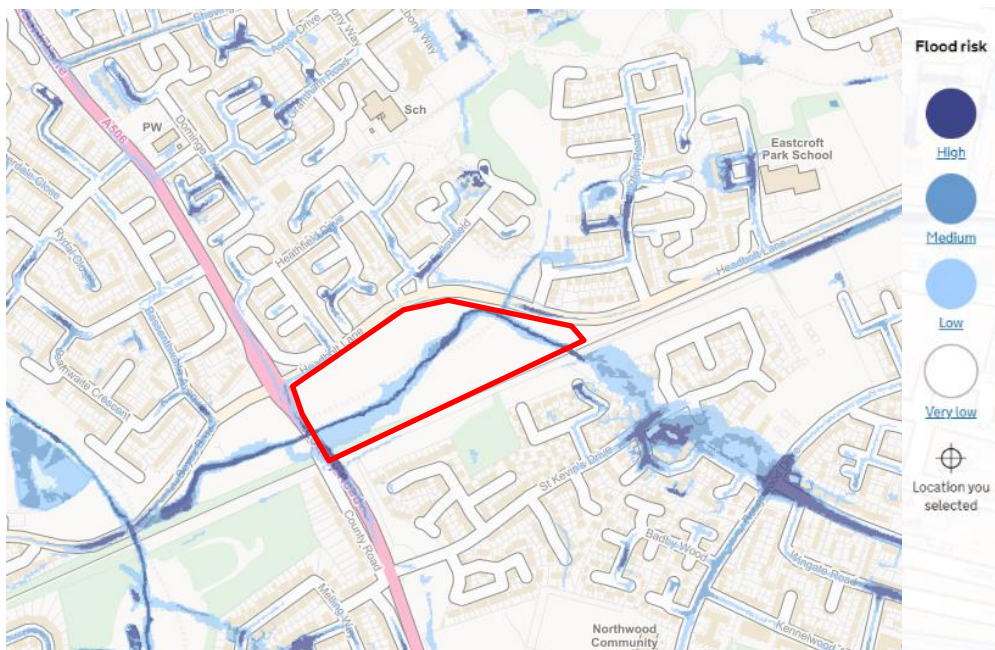


Figure 10 - Environment Agency Surface Water Flooding (site boundary shown in red).

6.2.2 KMBC Flood Risk Data

Within the Preliminary Flood Risk Assessment Report produced by KMBC in June 2011, a surface water flood event is recorded at the A506 County Road, adjacent to the Headbolt Lane site.

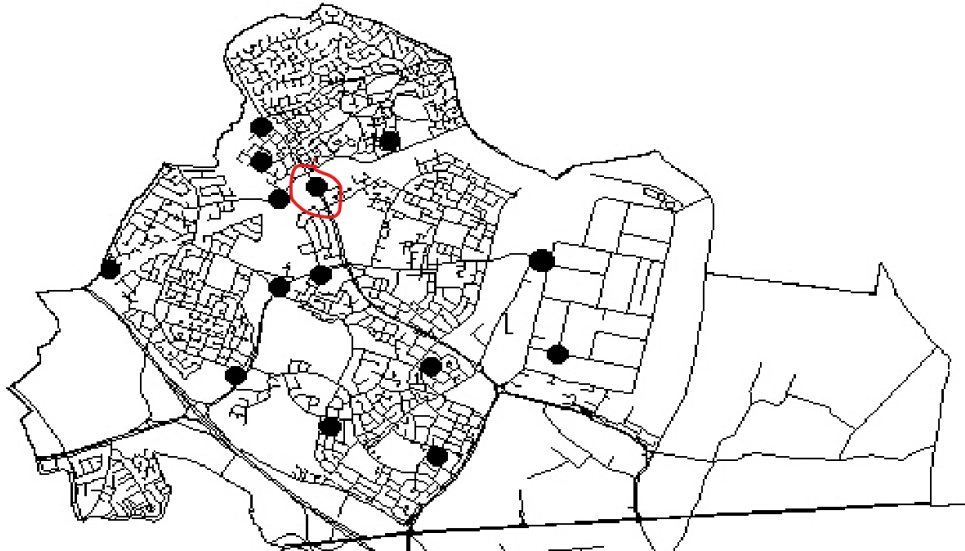


Figure 11 - Extract of Historic Surface Water Flooding Incidents from PFRA

KMBC were contacted to ascertain if any historic flooding records were kept for the proposed development site and surrounding area. The LLFA stated that historic records of flooding were not kept (see Appendix E).

Surface water flood risk posed by the new development shall be mitigated by ensuring surfaces drain away from buildings and critical infrastructure, and that exceedance paths are created to divert flows towards Kirkby Brook in the event of a failure of the drainage systems.

6.3 Sewer Flood Risk

United Utilities were contacted for records of any historic sewer flooding in the area. At the time of writing, no response had been provided (see Appendix F).

KMBC were contacted for records of highway drainage flooding in the area. There were no records of highway drainage flooding (see Appendix E).

6.4 Groundwater Flood Risk

Data within the KMBC Preliminary Flood Risk Assessment (PFRA) indicates that the Headbolt Lane site is not at risk from groundwater flooding.

Furthermore, no groundwater was encountered in trial pit excavations undertaken as part of the ground investigations, and borehole monitoring identified limited groundwater above the base of the boreholes during the monitoring period.

The risk from groundwater flooding is therefore considered to be very low.

6.5 Other Sources of Flood Risk

The risk of flooding from reservoirs considers the inundation predicted to occur following failure of major water retention structures.

Environment Agency data does not identify any flood risk to the Headbolt Lane site from reservoirs.

6.6 Flood Risk Summary

Fluvial flood risk associated with Kirkby Brook is constrained within the immediate vicinity of the watercourse and is unlikely to pose a risk to the development based on the proposed elevations.

All other sources of flood risk are considered to be negligible.

Bridges over Kirkby Brook should be designed in accordance with EA requirements to ensure flood risk is not increased and maintenance operations are not adversely impacted.

Surface water should be managed in accordance with EA and LLFA requirements to ensure flood risk is not increased (see Section 7).

7 Surface Water Management

7.1 Existing Surface Water Drainage

There are currently no artificial drainage systems providing drainage for the site. Surface water is assumed to infiltrate and travel over land to Kirkby Brook.

7.2 Proposed Surface Water Drainage

7.2.1 Design Basis

Surface water run-off shall be collected, conveyed, treated (where appropriate) and discharged in accordance with the following hierarchy:

1. Infiltration to ground,
2. Discharge to watercourse,
3. Discharge to surface water sewer,
4. Discharge to combined water sewer.

Due to the severance imposed by Kirkby Brook, the site has been divided into two catchment areas:

- Northern catchment; incorporating car parking and access routes.
- Southern catchment; incorporating parking, drop-off facilities, station building, substation, platforms, public realm and track drainage.

Although some infiltration may be possible, it is anticipated that an outfall will still be required for each catchment into Kirkby Brook.

In accordance with KMBC requirements⁴ the site is considered to be 'greenfield'. Peak surface water run-off rates and volumes are therefore to be limited as close as reasonably practicable to greenfield runoff rates.

The theoretical greenfield run-off rates for each catchment are provided in Table 3 (based on the IH124 method. SAAR=856mm, SOIL Type 2, SPR=0.3).

Table 3: Catchment area greenfield run-off rates

Catchment	Area (Ha)	Greenfield Run-off Rates (l/s)			
		QBar	Q1yr	Q30yr	Q100yr
Northern	0.71	1.64	1.42	2.78	3.41
Southern	1.41	3.25	2.83	5.53	6.76

⁴ Knowlsey MBC Sustainable Drainage & Surface Water Management Technical Guidance for Developers, Knowlsey MBC, August 2016

Following a meeting with KMBC on 4th September 2020, it was agreed that in order to reduce the risk of blockages which may increase flood risk, discharge rates to Kirkby Brook should be limited to the greenfield run-off rate applicable to the catchment or 5l/s; whichever is greater (see Appendix E).

KMBC technical guidance requires the flows up to the 1 in 30-year critical rainfall event are retained within the drainage system. However, in the absence of detailed proposals to understand exceedance flows resulting from 100-year return period rainfall events, it has been assumed that 100-year return period volumes shall also be contained within the site drainage systems.

The attenuation volumes required to achieve the agreed discharge rates for each catchment are presented in Table 4 based on Microdrainage Quick Storage Estimates, both with and without infiltration. Volumes are based on an M5-60 of 19.700 and a Ratio R of 0.382. A 40% uplift in rainfall rates to allow for climate change (see section 5) has also been included.

Table 4 - Catchment Attenuation Estimates

Catchment	Area (Ha)	Required Attenuation for different scenarios (m ³) (100-year return period +40% climate change allowance)		
		No infiltration	1x10 ⁻⁵ m/s	1x10 ⁻⁵ m/s
		5l/s outfall	Infiltration Rate 5l/s outfall	Infiltration Rate No outfall
Northern	0.71	418 – 577	217 – 492	228 – 577
Southern	1.41	1003 – 1360	442 – 1051	453 – 1147

The volumes shown in Table 4 may be reduced during detailed design to accommodate only the 30-year return period if it can be demonstrated that exceedance flows for the 100-year return period can be safely managed within the curtilage of the site with minimal risk to people or property.

The feasibility of infiltration systems will be investigated further during detailed design, and will be dependent on:

- Spatial constraints.
- Presence of rock strata or areas of lower infiltration potential.
- Proximity of buildings, railway infrastructure and Kirkby Brook.
- Long term groundwater levels.

Measures to control water quality will be incorporated into the design. Where SuDS features can provide both an attenuation and treatment function these will be considered. Where attenuation does not provide a treatment function (e.g. storage tanks) a secondary treatment system may be required (e.g. petrol interceptors).

7.2.2 Drainage Strategy

An outline drainage strategy has been developed for the two catchments as shown in drawing 170248-15854-ZZ-ZZZ-DRG-Z-MF-243009 (see Appendix G)

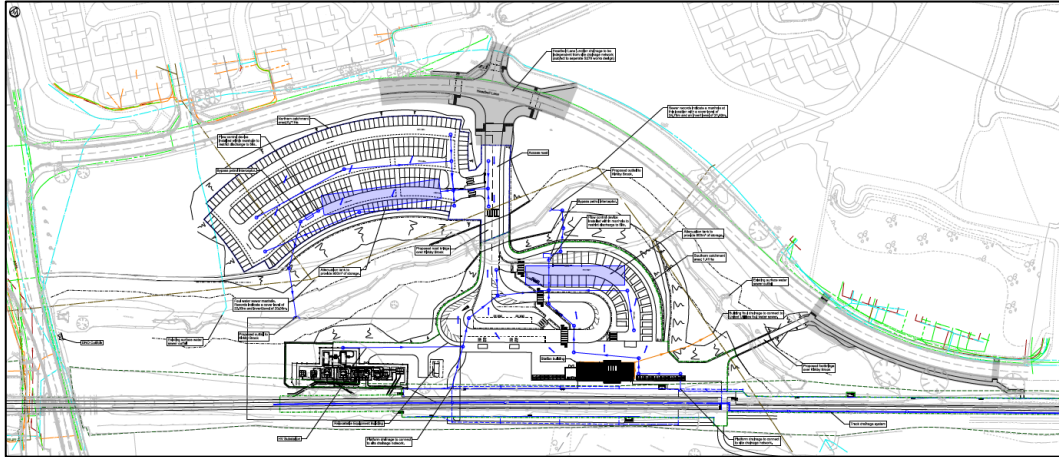


Figure 12 - Outline Drainage Strategy

The northern catchment consists of the main 270 space car park and northern portion of the access road up to the road bridge. This area will be drained to an attenuation tank beneath the car park, discharging into Kirkby Brook via a flow control device and petrol interceptor. An allowance has been made in the sizing of the northern catchment attenuation tank to allow for potential future expansion of the car park.

The southern catchment consists of the southern access roads, drop off area, public realm, station building, platforms and track drainage. An under-track crossing (UTX) is required to connect the southern Merseyrail platform into the downstream drainage network. Some attenuation within the track drainage catchment is anticipated, reducing the size of the car park attenuation system.

The proposed sustainable drainage system components will all be maintained by Merseytravel for the design life of the development.

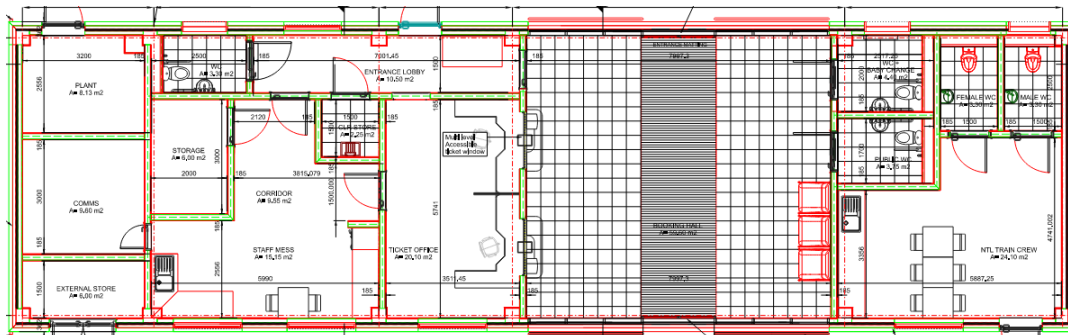
A Knowsley CC SuDS pro-forma has been completed for the site based on the current level of design and is provided in Appendix H. An updated pro-forma or reserved matters pro-forma shall be submitted following detailed design.

7.2.3 Highway Drainage

A new signalised junction is to be provided on Headbolt Lane to provide access to the site. Alterations to the highway drainage systems are to be designed under a separate design package implemented under Section 278/38 agreements. Drainage systems shall be designed in accordance with the Highway Authority and LLFA technical and sustainability requirements.

8 Foul Drainage

Station building foul flows have been determined based on the sanitary appliances shown on architectural layout 170248-15854-ZZ-ZZZ-DRG-A-AR-013002 A02.



The estimated peak foul discharge rate has been determined using the Discharge Unit Method (System III) in accordance with *BS EN 12056-2: Gravity drainage systems inside buildings – Part 2: Sanitary pipework, layout and calculation*.

Table 5 - Calculated Station Building Discharge Units

Appliance	Discharge Units (DU) per appliance	Quantity	ΣDU
Wash Basin	0.3	5	1.5
WC with 6.0l cistern	1.5	5	7.5
Kitchen Sink	1.3	2	2.6
Dishwasher	0.2	2	0.4
Cleaner's Sink	1.3	1	1.3
Total			13.3

Table 6: Estimated Peak Foul Flow Rate

ΣDU	Frequency Factor	Discharge Rate (l/s)
13.3	0.7	2.55

The external foul drainage network is proposed to discharge into the United Utilities foul sewer running through the site (subject to application).

An indicative discharge route is shown on drawing 170248-15854-ZZ-ZZZ-DRG-Z-MF-243009 (see Appendix G).

9 Residual Flood Risk

The residual flood risk from all sources is considered to be very low.

Fluvial risk to the development is negligible, and any potential increases in flood risk off site will be mitigated through effective surface water management.

During Kirkby Brook flood events the flood extents shall be contained within the immediate vicinity of the watercourse and pose little risk to users of the site. However, should the bridge routes be deemed unsafe for any reason during a flood event, alternative egress routes are available to the south of the station.

Blockages beneath the bridge structures can be mitigated by providing clear spans over the watercourse and applying freeboard above the maximum flood levels to account for debris. The likelihood of large items of debris occurring is however low, given the throttling effect of the upstream culvert under the railway and minimal trees and vegetation along the watercourse within the site.

Should the site drainage infrastructure fail, exceedance routes would channel flows away from buildings and critical infrastructure and into Kirkby Brook. The probability of failure can be managed and reduced by effective and routine maintenance of the site drainage systems.

10 Conclusions

This Flood Risk Assessment has been prepared by Arup on behalf of BGCL to assess the risk of flooding both to and as a result of the proposed development at the time of writing.

Proposals have been considered in relation to the NPPF and the sequential test is deemed not to apply, as all development is to be within Flood Zone 1.

Information relating to historical and potential future flooding has been obtained, and the risk to the site from fluvial, pluvial, sewer, groundwater, tidal and reservoir flooding has been assessed.

The risk of fluvial flooding from Kirkby Brook is considered to be very low. All buildings and railway infrastructure are to be significantly higher than the maximum predicted flood level.

The risk of flooding from other sources is negligible.

Bridges and surface water drainage system designs should be undertaken in accordance with EA and LLFA requirements to ensure flood risk is not increased, both on and off-site.

An outline drainage strategy has been presented which demonstrates how surface water can be attenuated and infiltrated (if possible) to achieve the allowable discharge rates agreed with KMBC. Highway drainage systems shall be designed as a separate S278/38 package in agreement with KMBC.

The residual risks associated with fluvial and pluvial flooding can be mitigated through effective and ongoing maintenance of the drainage systems and bridges.

Appendix A

EA Flood Map

Flood map for planning

Your reference
Headbolt Lane

Location (easting/northing)
341362/399767

Created
12 Nov 2020 12:35

Your selected location is in flood zone 1, an area with a low probability of flooding.

This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

The Open Government Licence sets out the terms and conditions for using government data.
<https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>



Flood map for planning

Your reference
Headbolt Lane

Location (easting/northing)
341362/399767

Scale
1:2500

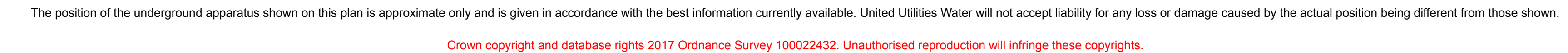
Created
12 Nov 2020 12:35

-  Selected point
-  Flood zone 3
-  Flood zone 3: areas benefiting from flood defences
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Flood storage area

0 20 40 60m

Appendix B

UU Sewer Records

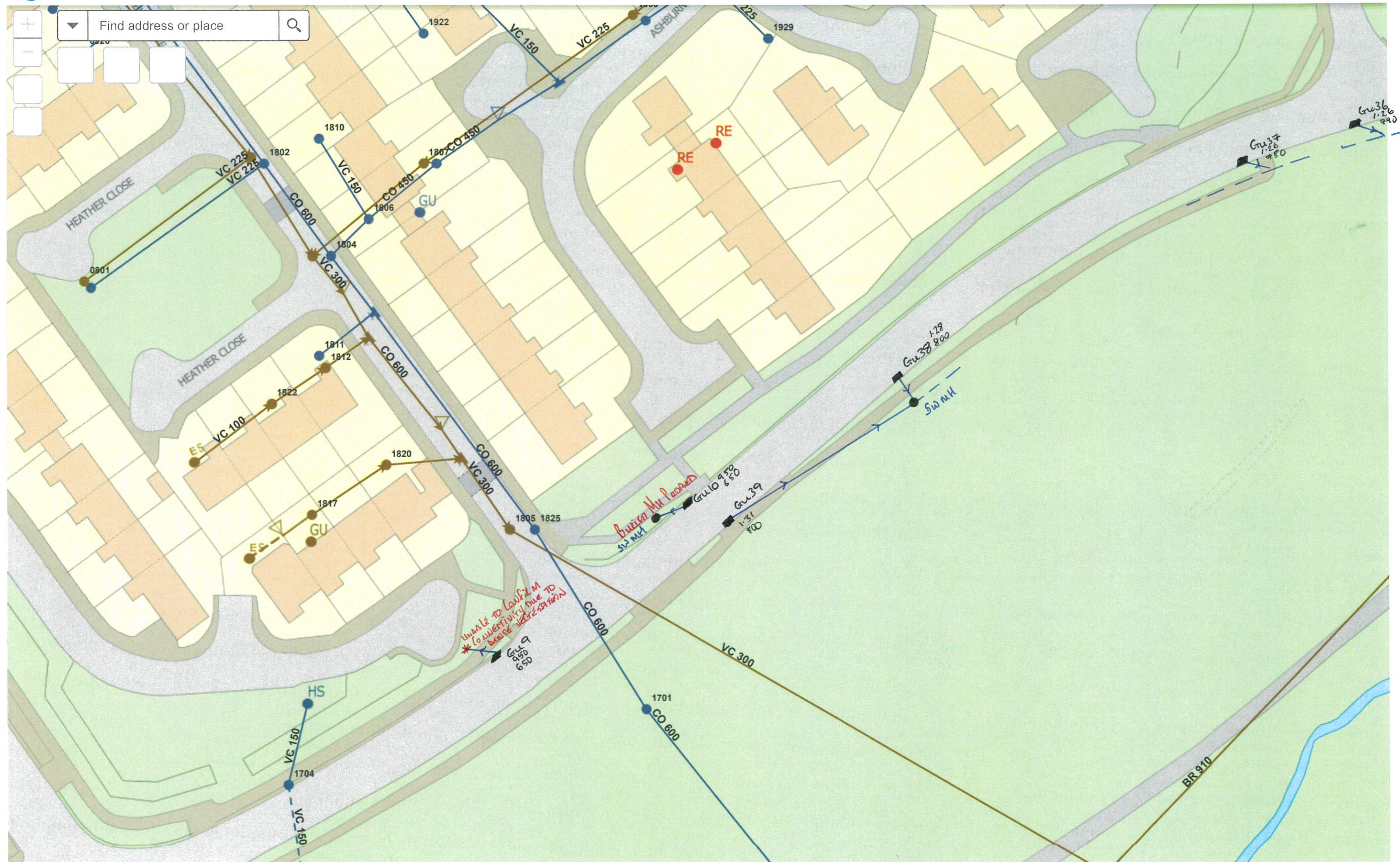
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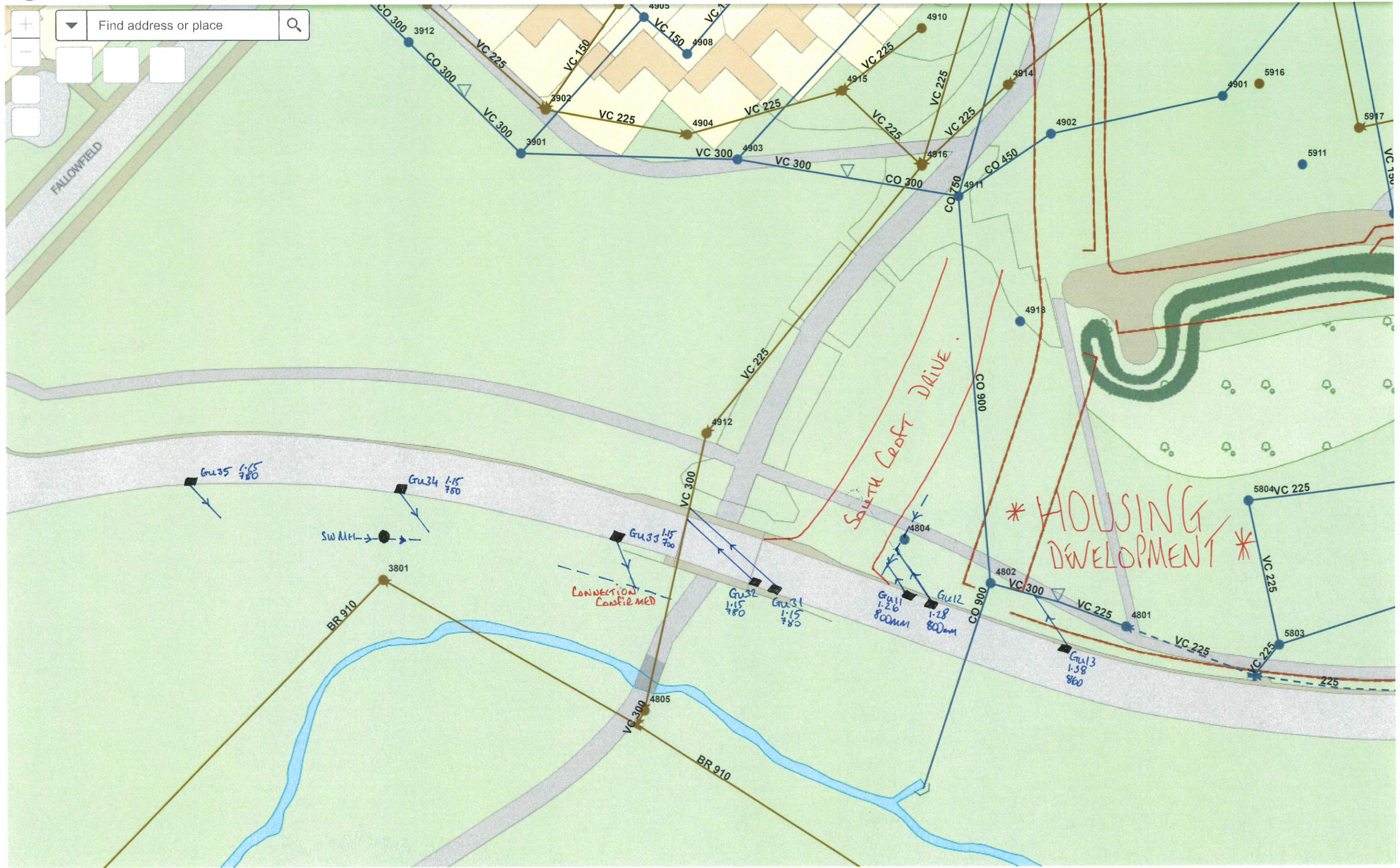
SEWER RECORDS  United Utilities

Appendix C

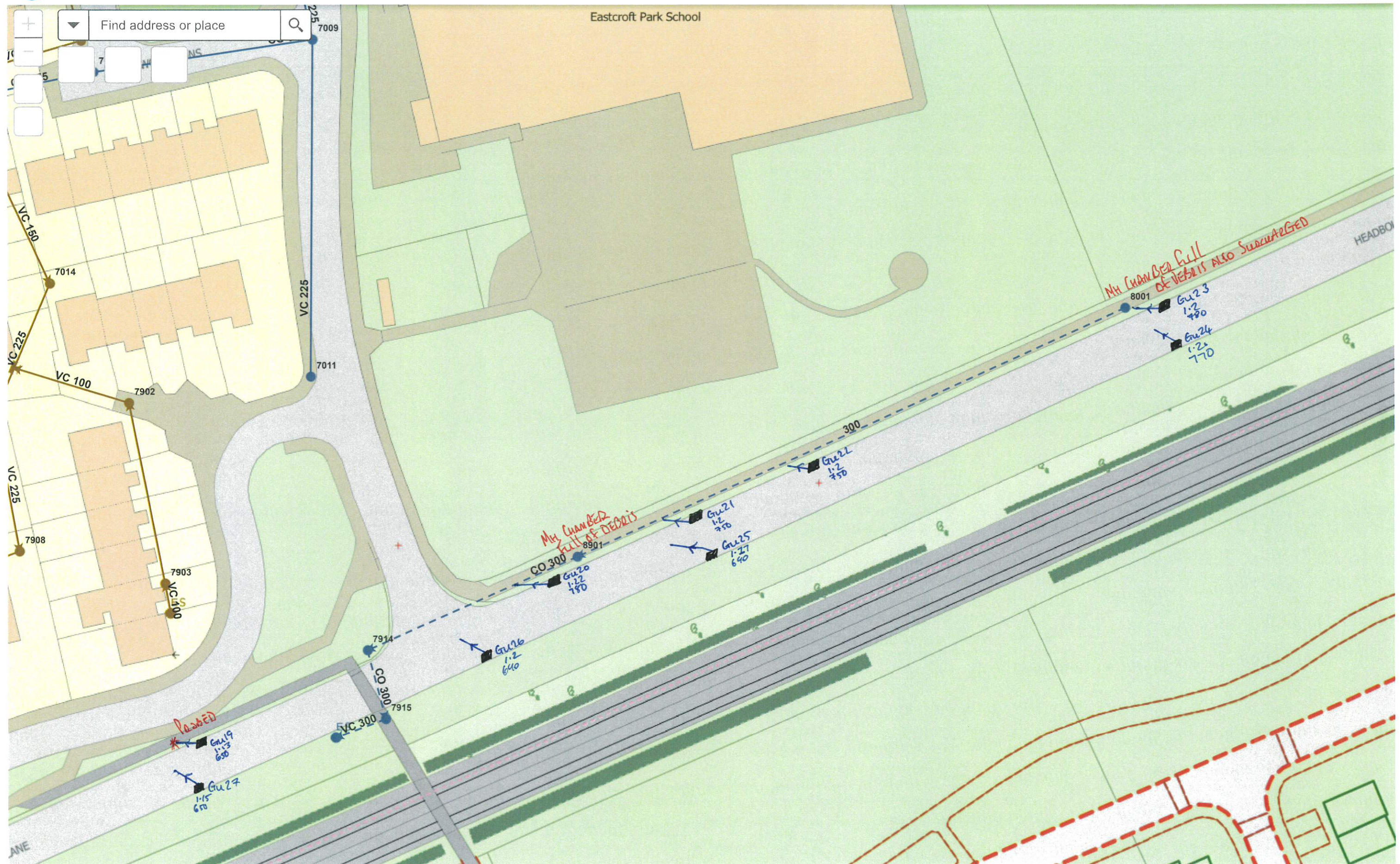
Highway Drainage Records











Appendix D

EA Flood Data

Flood Zones Map: new station and car park Facility at Headbolt Lane, Kirkby

Produced: 18 September 2020

Our Ref: CL183228

NGR: 341289,399800

Key

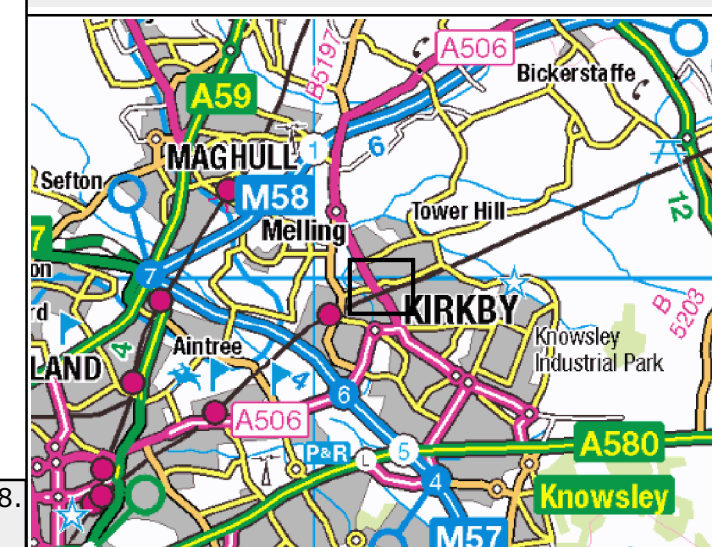
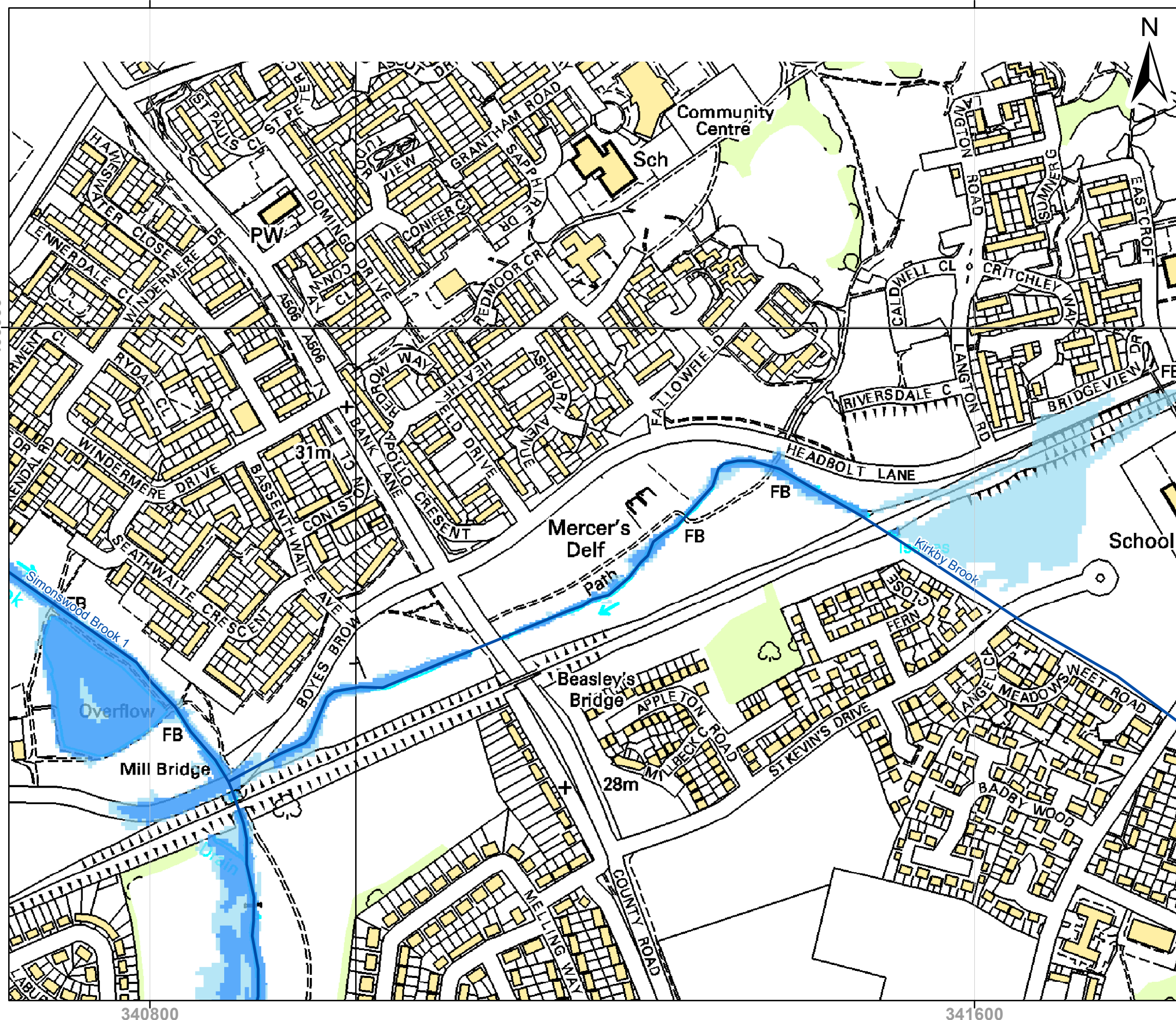
-  Main River
-  Areas Benefitting from Defences
-  Flood Zone 3
-  Flood Zone 2

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 0.5% or greater chance of happening each year
- or from a river with a 1.0% or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to 0.1% chance of occurring each year.

ABDs (Areas Benefitting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.

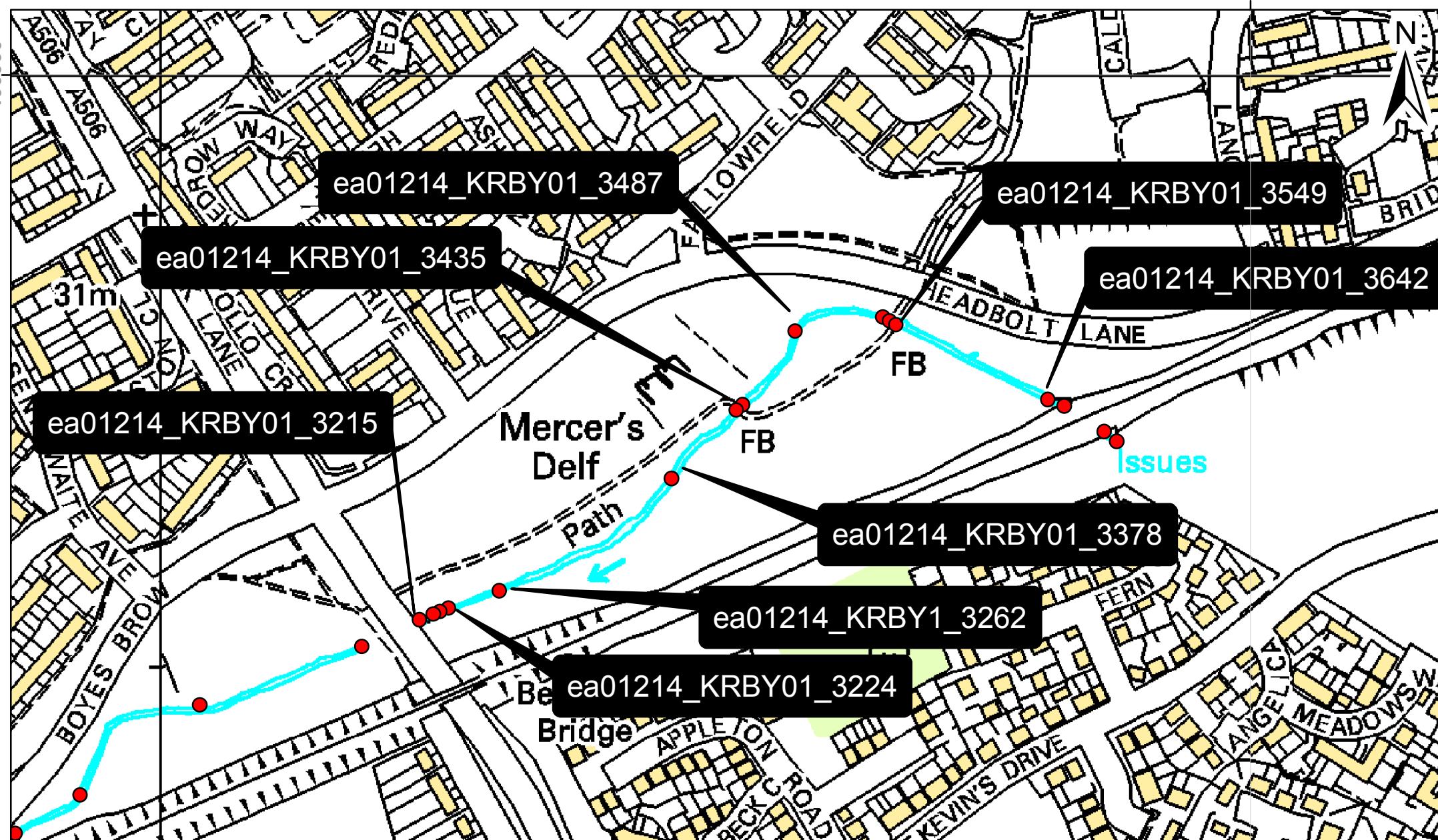


Fluvial flood levels Map: new station and car park Facility at Headbolt Lane, Kirkby

Produced: 18 September 2020

Our Ref: CL183228

NGR: 341289,399800



Node Point	Flood Flow (m ³ s ⁻¹) and Level (mAOD) data for a range of annual probability of flooding													
	0.1%+Climate change (+30%)		0.1%		1%+Climate Change (+70%)		1%+Climate Change (+35%)		1%+Climate Change (+30%)		1.0%		4.0%	
	Undefended	Undefended	Undefended	Undefended	Undefended	Undefended	Undefended	Undefended	Undefended	Undefended	Undefended	Undefended	Undefended	Undefended
Map ID	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
ea01214_KRBY01_3215	22.09	8.89	21.71	6.99	21.69	6.86	21.52	5.82	21.50	5.67	21.23	4.23	21.01	3.08
ea01214_KRBY01_3224	22.2	8.86	21.87	6.96	21.85	6.84	21.75	5.80	21.74	5.65	21.58	4.21	21.44	3.07
ea01214_KRBY01_3262	22.3	8.7	22.11	6.84	22.10	6.72	22.02	5.71	22.01	5.57	21.90	4.14	21.80	3.02
ea01214_KRBY01_3378	23.55	5.03	23.49	3.90	23.48	3.88	23.43	3.61	23.42	3.59	23.34	3.32	23.27	2.82
ea01214_KRBY01_3435	23.88	7.81	23.82	6.15	23.82	6.08	23.82	5.10	23.82	5.00	23.82	3.79	23.77	2.78
ea01214_KRBY01_3487	24.84	5.24	24.63	5.22	24.62	5.24	24.45	4.95	24.43	4.85	24.28	3.70	24.15	2.71
ea01214_KRBY01_3549	25.61	3.04	25.53	3.03	25.52	3.04	25.47	3.03	25.45	3.03	25.30	3.04	25.03	2.63
ea01214_KRBY01_3642	25.91	6.6	25.83	5.40	25.83	5.39	25.77	4.53	25.76	4.37	25.68	3.36	25.58	2.49

Level data in mAOD (metres above ordnance datum). Flow data in m³ per second

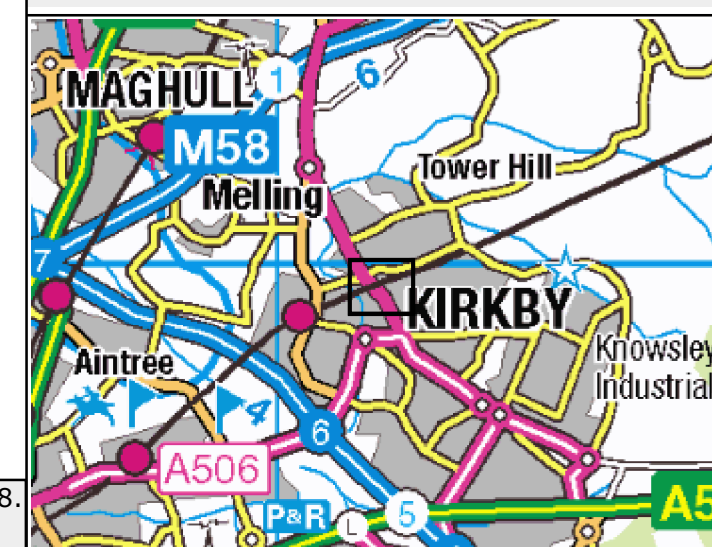
Data taken from 2017 Upper Alt Tributaries study

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 0.5% or greater chance of happening each year
- or from a river with a 1.0% or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to 0.1% chance of occurring each year.

ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.



Fluvial flood levels Map: new station and car park Facility at Headbolt Lane, Kirkby

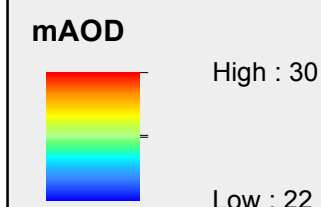
Produced: 18 September 2020

Our Ref: CL183228

NGR: 341289,399800

Key

**Fluvial 0.1% AEP Undefended + 30%
Climate Change (largest extent)**

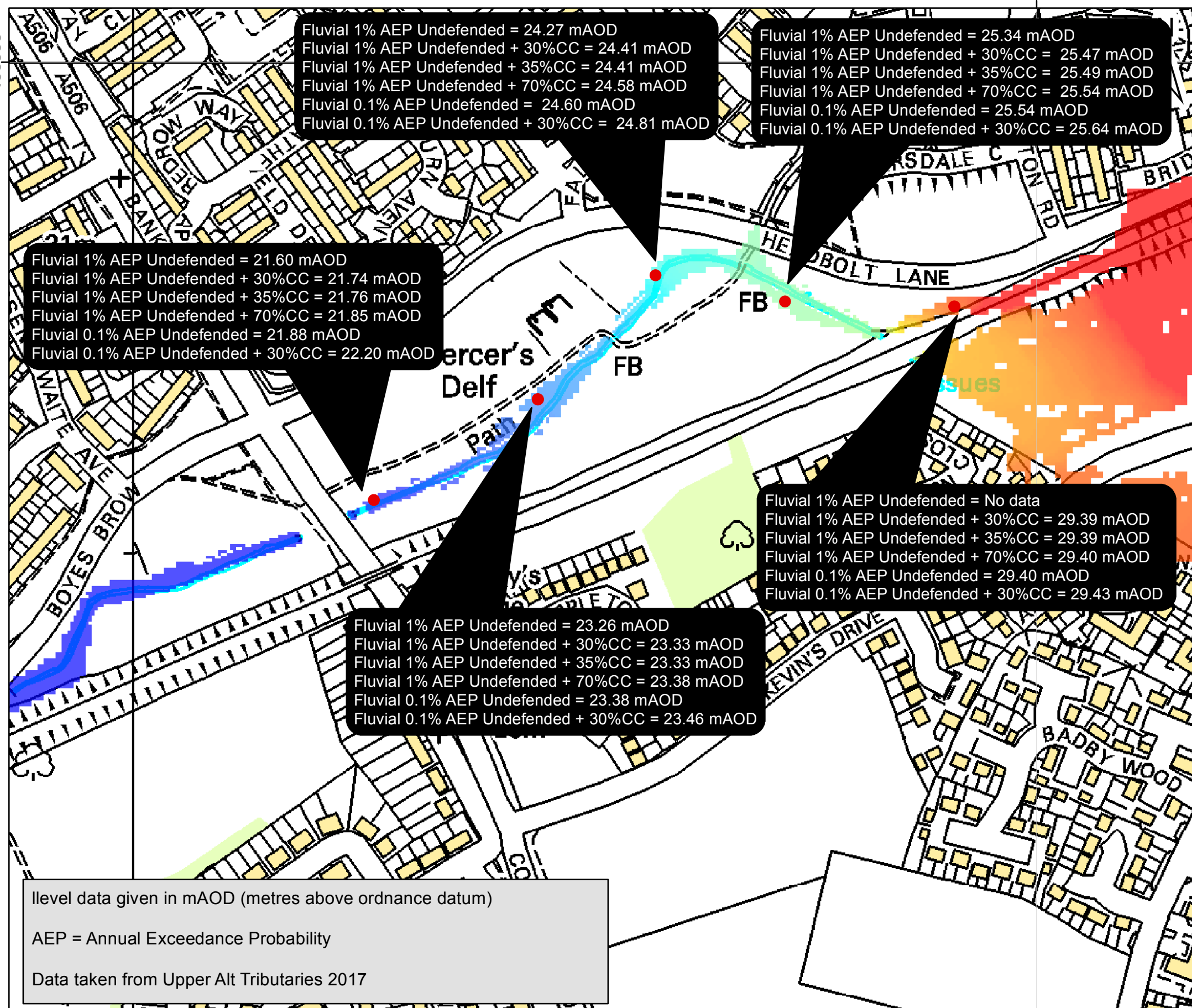
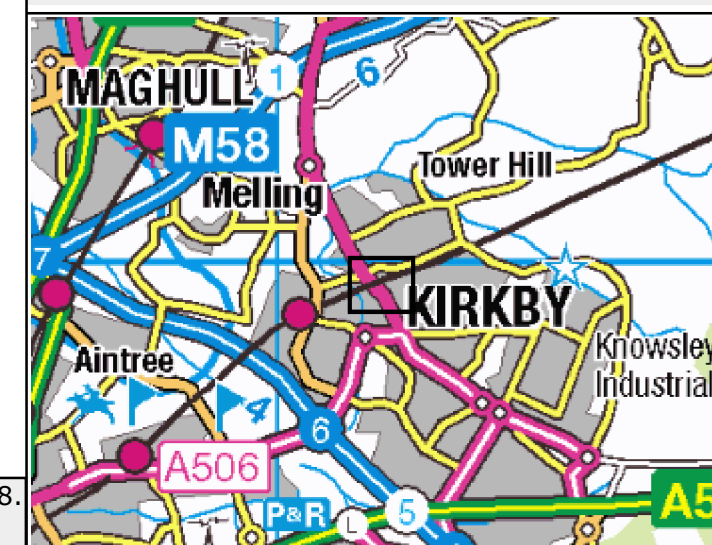


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ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.



Appendix E

KMBC Correspondence