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Project				Job Ref.	
Newbuild - Dyehouse Lane, Smallbridge				calc-tjba-newbuild-dyehouse ln-091020	
Section				Sheet no./rev.	
FLOOD RISK ASSESSMENT				1	
Calc. by	Date	Chk'd by	Date	App'd by	Date
DS	21/10/2020				

History.

Revision	Date	Reason
0	Nov-20	Original for planning.

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Background.

Newbuild Developments are currently in the processs of a planning application for the erection of 3No. industrial units on Dyehouse Lane, Smallbridge.

As part of the planning process, RMBC planners have asked for a flood risk assessment due to the Application Site being within a Flood Zone 2 & 3 area.

In October 2020, TJ Booth Associates enquired to the Environment Agency about local flood risk data. The Environment Agency responded indicating they did not currently have a working model for Ash Brook, and no flood risk data could be provided.

TJ Booth Associates have subsequently been employed by Newbuild Developments to assess the hydraulic characteristics of Ash Brook and to undertake a subsequent flood model & risk assessment for development purposes.

Purpose of Flood Risk Assessment.

The purpose of the assessment is to inform & accompany a planning application for a commercial development within a designated Flood Zone 2 area.

Reference.

National Planning Policy Framework and the Planning Practice Guidance (flood risk & coastal change notes).

EA mapping data identifies the Application Site as being in Flood Zone 3, refer to EA Flood Zone Map in appendix. Flood Zone 2 is defined as land assessed as having between a 1:100 & 1:1000 or greater annual probability of river flooding (0.1-1%) in any year (land shown in light blue on the EA Flood Map). Flood Zone 3 is defined as land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) in any year (land shown in dark blue on the EA Flood Map).

The Planning Practice Guidance indicates the Flood Risk Vulnerability Classification (Table 2) for the Application Site end use to be 'Less Vulnerable'. The Flood Risk 'Vulnerability' and Flood Zone 'Compatibility' matrix (Table 3) indicates that 'Less Vulnerable' development is acceptable in Flood Zone 3 areas.

Preliminary or Full Flood Risk Assessment.

Full to support planning application.

Location Plan.

Refer to Location & Catchment Area Plan in Appendix.

The Application Site is currently vacant land to the west side of Dyehouse Lane, Rochdale.

The local area is on the edge of the rural/urban fringe, surrounded generally by commercial development to the immediate local area, and by residential development beyond to the north/east/west. To the south is primarily agricultural land.

Ash Brook is located immediately to the west side of the Application Site, flowing south.

Ash Brook itself has its origins as Wardle Brook in the north of the local area, with the catchment starting just beneath Watergrove Reservoir. Prior to construction of Watergrove, the Wardle Brook catchment ran further up the valley, although this part of the catchment now flows into Watergrove, and out via Buckley Brook.

Site plan.

Refer to Proposed Plans in the appendix.

The Application Site comprises a vacant plot of land with a vegetated surface, surrounded by PCC post & timber panel fencing. It has most recently been used for animal grazing.

The Application Site has been artificially levelled historically, with the Ash Brook bank forming the immediate south east side of the site.

The proposal is for commercial development comprising 2No. industrial buildings with a car park to the east side fronting on to Dyehouse Lane.

The proposed buildings are of steel frame construction with cladded exterior.

Derivation of Data, Surveys and Models.

Due to the lack of Environment Agency data for Ash Brook and the local area flooding characteristics, a flood model of Ash Brook is required to assess the level of flood risk to the proposed development.

A flood model was undertaken comprising the following:

- Assess the rainfall & catchment characteristics of Ash Brook up to the Application Site in order to estimate flow data for flood return period events.
- Obtain topographical data of the local area to inform cross sections of Ash brook at the Application Site in critical locations.
- Use the above return period data with the cross sections to assess the impact on flood levels locally.

Ash Brook Existing Hydraulic Assessment.

Rainfall Analysis.

DESIGN RAINFALL (M5-1DAY)

DESIGN RAINFALL

In accordance with the Wallingford Procedure

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area;	Other		
Storm duration;	D = **24** hr;	Return period;	Period = **1** yr
Ratio 60 min to 2 day rainfall;	r = **0.300**;	Global warming increase;	$p_{climate}$ = **35** %
Factor Z1;	Z1 = **2.84**;	5yr return period storm;	$M5_24hr_I$ = **76.7** mm
Factor Z2;	Z2 = **0.76**;	1 yr return period storm;	M1_24hr = **58.4** mm
Design rainfall intensity;	I_{max} = **2.4** mm/hr		

Climate Change Impacts.

As identified in the Background Section, the vulnerability of the development is 'Less Vulnerable'.

The Application Site is primarily in Flood Zone 3, and the Environment Agency guidance indicates climate change allowances to be used according to the vulnerability rating of the development, are as follows:

- essential infrastructure – use the upper end allowance
- highly vulnerable – use higher central and upper end allowances to assess a range of allowances (development should not be permitted in flood zone 3a)
- more vulnerable – use the higher central and upper end allowances to assess a range of allowances
- less vulnerable – use the central and higher central allowances to assess a range of allowances
- water compatible – use the central allowance

- For less vulnerable development, use the higher central allowance as the basis for designing safe access, escape routes and places of refuge. This will ensure the safety of people using the development.

The % climate change allowances to be considered are stipulated in Table 1 below:

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
North west	H++	25%	45%	95%
	Upper end	20%	35%	70%
	Higher central	20%	30%	35%
	Central	15%	25%	30%

Given the 'Less Vulnerable' risk category, both the Higher Central & Upper End allowances should be assessed. With the development proposal for a commercial end use, the 2050s timeline would be appropriate, which indicates the 35% climate change allowance should be used. Note this also covers the '2080s' lifetime of the Higher Central allowance.

Reference Design Criteria.

Catchment data has been obtained through Wallingford Hydro Solutions Ltd (see appendix).

The Ash Brook catchment is shown in the Appendix and characteristics listed below:

Area	1.495 sq km.
Main stream length	3.49 km.
Standard Annual Average rainfall	1238 mm.
5 year 1 day rainfall	68.2 mm (**incl 35% CC allowance**).
Soil	glacial till (low permeability), catchment index 0.45.
Urban fraction	approx 22%.

Low Flows Data.

The catchment was analysed using the WHS Low Flows package (see Appendix).

This gave a range of monthly means and flows vs frequency as follows.

Percentile	**cumecs**
Q(0.1)	0.610
Q(1)	0.275
Q(10)	0.089
Q(20)	0.052
Q(30)	0.035
Q(40)	0.025
Q(50)	0.018
Q(60)	0.013
Q(70)	0.009
Q(80)	0.007
Q(90)	0.005
Q(99)	0.003
Q(mean)	**0.037**

FSR Flood Flow Analysis.

The existing watercourse is the main source of local flooding in extreme events.

As the Environment Agency do not have a working river model for Ash Brook, estimates have had to be made on return period events.

The catchment characteristics were input into the FSR IH124 model for small catchments in order to derive QBAR:

Flood Studies: Input Data														
project	***dyehouse ln, rochdale***													
client	***newbuild***													
element	***ash brook, flood modelling assessment***													
date / rev	***Oct-2020***													
Ref 1	*A guide to the flood studies report, Institute of Hydrology, No 49*													
determine storm rainfall return period	flood RP	1		design flood RP										
catchment area	AREA	1.495	sqkm		1:50000 maps									
main stream length	MSL	3.49	km		1:25000 maps									
stream level aD @ 85% length	H85%	206	m	ref 1	1:25000 maps									
stream level aD @ 10% length	H10%	152	m		1:25000 maps									
channel slope	S1085	20.6	m/km											
stream junctions	N	1.0	no		1:25000 maps									
stream frequency	STMFRQ	0.67		ref 1	N/AREA									
total catchment stream length	NETLEN	3.82	km	1:50000 OS maps										
standard average annual rainfall (1916-50)	SAAR	1238	mm	see tab SAAR						**QBAR urban (eqn 7.4 IH124)**				
M5 1day rainfall		77.6	mm	obtain from TEDDs M5 60 calc (**incl 35% CC allowance**)						QBARu=QBARrxURBT^2NC[1+URBAN((21/CIND)-0.3)]				
ratio of M5 60min to M5 2day	r	0.3		see tab or TEDDs M5-60 calc						CIND=102.4SOIL+0.28(CWI-125)				
areal reduction factor	ARF	0.99		ref 1, fig 6.58 & p41 IH FSR R.49						NC=0.92-0.00024SAAR			500<SAAR<1100	
mean soil moisture deficit	SMDBAR	12	mm	fig 4.9 FSR1, chap4 (also interpolate from RSMD map tab)						NC=0.74-0.000082SAAR			1100<SAAR<3000	
residual soil moisture deficit	RSMD	64.8	mm	M5 1day x ARF - SMDBAR (ref 1,app A, fig pp42 see tab)										
catchment wetness index	CWI	124		ref 1, fig 6.62, see tab CWI						QBARr			1.25	1.05
catchment soil index	SOIL	0.45		obtain from WINDES IH 124 module, but allow for urbanisation						soil type		soil	0.45	
catchment lake area		0	sqkm	1:25000 maps						catchment wetness		cwi	124	
proportional lake area	lake	0.00		1:25000 maps						urban proportion		urban	0.22	
area of urban catchment		0.33	sqkm	1:50000 OS maps						1+urban proportion		urbt	1.22	
urban development fraction of AREA	URBAN	0.22		urban area / catchment area						annual av rainfall		saar	1238	
	URBT	1.22		1+URBAN								nc	0.64	
hydrometric region		10		FSR fig 4.15, CIRIA 168								cind	45.8	
regional constant	C	0.0213		FSR fig 4.15, CIRIA 168						URBT^2NC[1+URBAN((21/CIND)-			1.335	
												QBARu	**1.66**	**1.40**

Flow rates for these events were then estimated using the Q/QBAR factor from river/catchment characterisitcs detailed above & using the appropriate UK growth curve in the Flood Studies Supplimentary Report.

Ash Brook falls in to hydrometric area 10 & the corresponding data is given in the tables below:

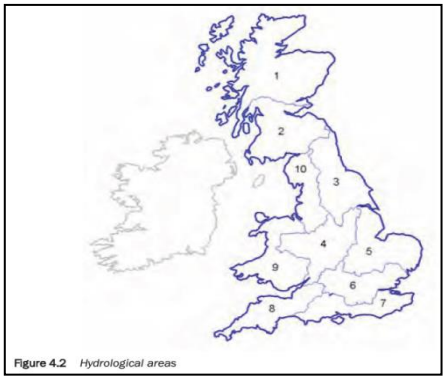


Figure 4.2 *Hydrological areas*

Figure 4.3 ***UK growth curves***

Table 4.3 *UK growth curve factors*

Region	Hydrometric Area	Return period						
		2	5	10	25	50	100	500
NW	1	0.90	1.20	1.45	1.81	2.12	2.48	3.25
	2	0.91	1.11	1.42	1.81	2.17	2.63	3.45
	3	0.94	1.25	1.45	1.70	1.90	2.08	2.73
	9	0.93	1.21	1.42	1.71	1.94	2.18	2.86
	10	0.93	1.19	1.38	1.64	1.85	2.08	2.73
SE	4	0.89	1.23	1.49	1.87	2.20	2.57	3.62
	5	0.89	1.29	1.65	2.25	2.83	3.56	5.02
	6/7	0.88	1.28	1.62	2.14	2.62	3.19	4.49
	8	0.88	1.23	1.49	1.84	2.12	2.42	3.41
Ireland		0.95	1.20	1.37	1.60	1.77	1.96	2.40

The flows were analysed using the IH 124 methodology (see Apppendix) which is applicable for catchments less than 2.0 sq km.

Results gave a range for Qbar from 1.25 (rural) to 1.66 cumecs (urban). A value of 1.66 cumecs is selected on conservative design estimates.

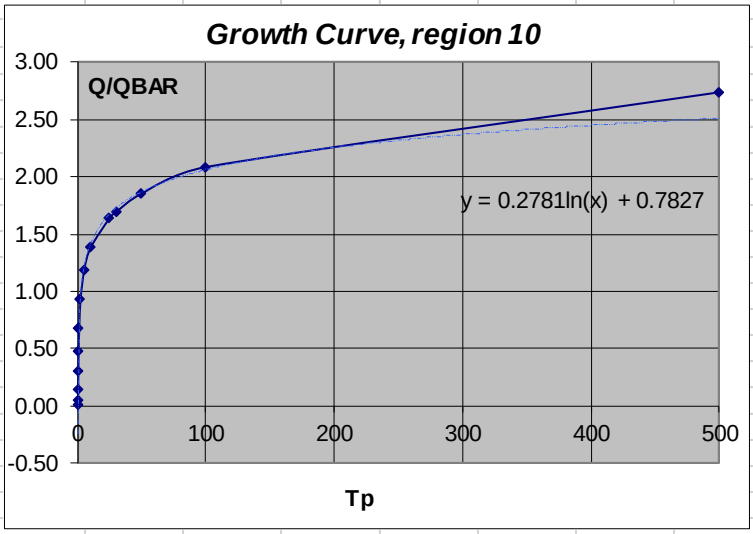
The Ash Brook return period events and corresponding flow estimates for the Application Site have beed calculated and tabulated below:

Region 10 Growth Curve Qbar / Qt

ref FSR, S Report 14, fig 2

QBAR **1.66** cumecs

prob	return perio Tp years	Q/QBAR region 10	Qtp cumecs	l/sec
0.002	500	2.73	**4.53**	4532
0.010	100	2.08	**3.45**	3453
0.020	50	1.85	**3.07**	3071
0.033	30	1.69	**2.81**	2805
0.040	25	1.64	**2.72**	2722
0.100	10	1.38	**2.29**	2291
0.200	5	1.19	**1.98**	1975
0.500	2	0.93	**1.54**	1544
1.000	1	0.68	**1.13**	1129
2.000	0.5	0.48	**0.80**	797
4.000	0.25	0.30	**0.50**	498
8.000	0.125	0.15	**0.25**	249
20.000	0.05	0.05	**0.08**	83
40.000	0.025	0.01	**0.02**	17



Design Flows.

The above section presents the following flow regime for the watercourse (**incl 35% CC allowance for rainfall**):

Event	Q	cumecs	Litres / sec	
Low Flow 95% ile	$Q_{(99)}$	**0.003**	**3**	
The mean annual daily flow	$Q_{(mean)}$	**0.037**	**37**	
1 yr RP year flood	Q1	**1.13**	**1129**	
2 yr RP year flood	Q2	**1.54**	**1544**	(Mean Annual Flood)
5 yr RP year flood	Q5	**1.98**	**1975**	
30 yr RP year flood	Q30	**2.81**	**2805**	
50 yr RP year flood	Q50	**3.07**	**3071**	
100 yr RP year flood	Q100	**3.45**	**3453**	
500 yr RP year flood	Q500	**4.53**	**4532**	

Ash Brook Flood Model.

Ash brook is a minor watercourse with part of upper catchment diverted into Watergrove reservoir.

The brook channel sides local to the site have been historically infilled with ash & mining waste from a former colliery, raising the banks higher than the natural levels.

Locally the in-bank channel is considered slow & relatively coarse, with the upper slopes & floodplain vegetated.

The Environment Agency Flood Zone polygons (refer to Environment Agency Flood Zone Map in Appendix), suggest impossible flooding profiles between 50m & 150m north of the Application Site around Wheelwright Drive. In reality ground levels indicate this is not feasible.

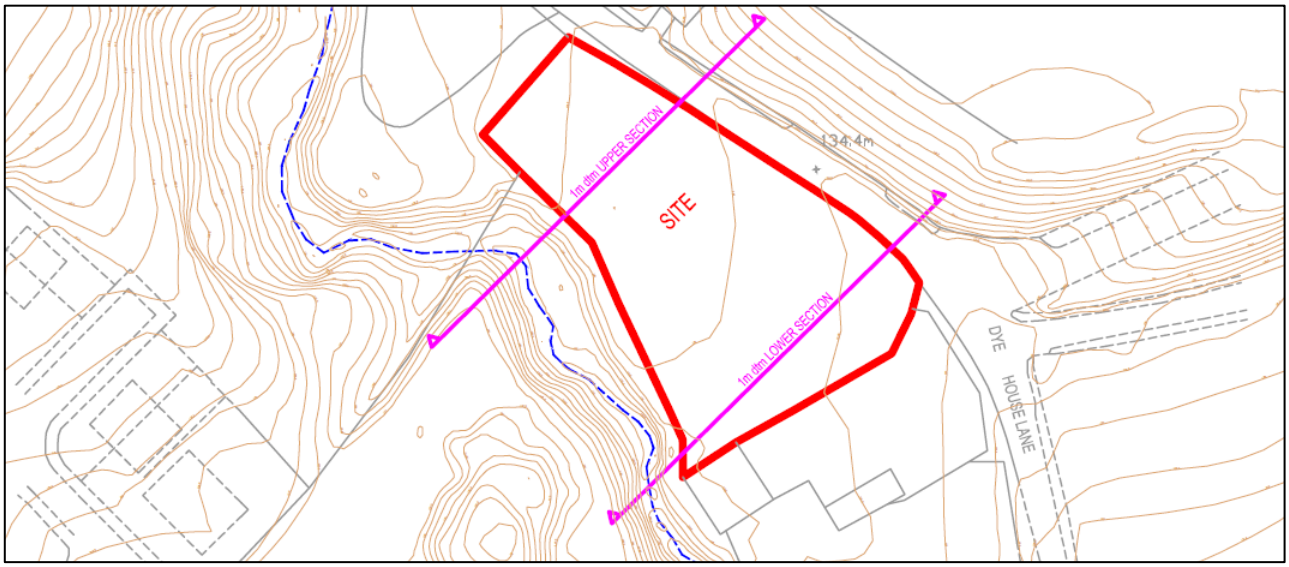
Similarly, flood zone polygons on & to the south side of the site again suggest highly disputable flood profiles and overland flow routes which are not feasible in reality due to local ground levels.

There is a culvert which may be prone to blocking 75m south-west fo the site, however, bank levels in this location are lower than bed level adjacent the south Application Site boundary, and would not cause flood waters to back up onto the Application Site.

It is assumed the uncertainty around the flood zone polygons is why the Enviornment Agency is not releasing flood data for Ash Brook, as the model is outdated.

To assess the potential for flood levels at the Application Site, cross sectional data was required. A survey of the site and watercourse was undertaken, however, due to dense vegetation, a topographical survey was not able to be completed.

Instead, 25cm & 1m Lidar DTM data was obtained for the local area. The 25cm Lidar dtm data was surveyed c2009-2015. The 1m Lidar dtm data was surveyed c2019. Although the 1m dtm data may have less resolution in survey points, it is a more recent data survey, which is a more accurate representation of the local area due to infilling in the local area over the last 20 years. Refer to Appendix for the 1m DTM Lidar Plan, and below for excerpt.



A model was created comprising of upper & lower sections through the Application Site (noted above), reproduced from the Lidar data at critical pinch points both in the watercourse and floodplain.

The FHWA Hydraulic Toolbox was used to calculate hydraulic analysis and design computations.

Upper Section Profile 100yr + Climate Change Event:

Longitudinal Slope: 0.0110 m/m

Flow: 3.4500 cms

Model Results:

Depth: 0.62 m (133.52m aOD)

Area of Flow: 2.57 m^2

Wetted Perimeter: 7.03 m

Hydraulic Radius: 0.37 m

Average Velocity: 1.34 m/s

Top Width: 6.88 m

Froude Number: 0.70

Critical Depth: 0.53 m

Critical Velocity: 1.76 m/s

Critical Slope: 0.02 m/m

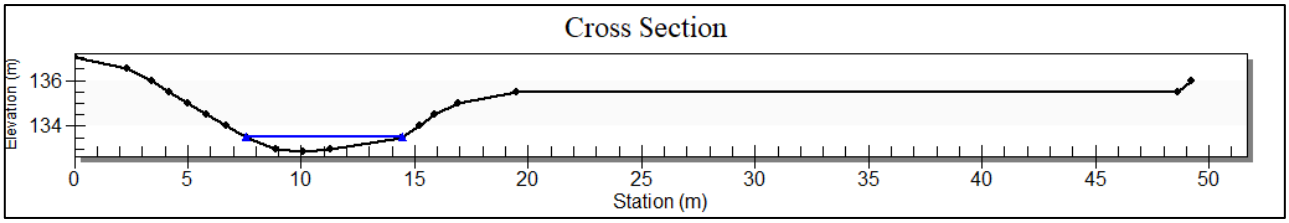
Critical Top Width: 6.17 m

Calculated Max Shear Stress: 67.09 N/m^2

Calculated Avg Shear Stress: 39.45 N/m^2

Composite Manning's n Equation: Lotter method

Manning's n: 0.0400



The cross section illustrated shows a vertical exageration of approx 2:1.

Lower Section Profile 100yr + Climate Change Event:

Longitudinal Slope: 0.0110 m/m

Flow: 3.4500 cms

Model Results:

Depth: 0.85 m (133.35m aOD)

Area of Flow: 2.18 m^2

Wetted Perimeter: 4.63 m

Hydraulic Radius: 0.47 m

Average Velocity: 1.58 m/s

Top Width: 4.25 m

Froude Number: 0.71

Critical Depth: 0.73 m

Critical Velocity: 2.06 m/s

Critical Slope: 0.02 m/m

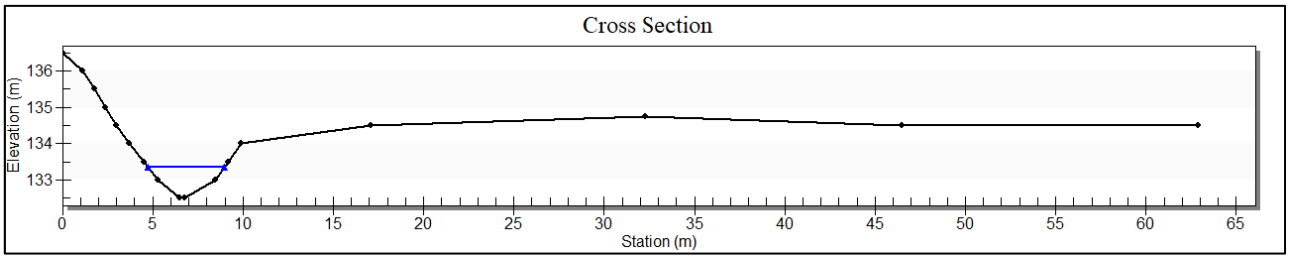
Critical Top Width: 3.88 m

Calculated Max Shear Stress: 91.60 N/m^2

Calculated Avg Shear Stress: 50.66 N/m^2

Composite Manning's n Equation: Lotter method

Manning's n: 0.0400



The cross section illustrated shows a vertical exageration of approx 2:1.

Flood Risk Assessments.

Existing Site Surface Water System.

The Application Site is currently vacant with a permeable ground surface and no on-site drainage system.

There is a 300vc combined sewer flowing through the site, depth unknown.

Dyehouse Lane to the east of the site is served by surface water gullies.

Proposed Site Surface Water System.

The planning proposal is for the construction of 3No industrial units, with car parking & yard areas between, accessed from the east side of the site via Dyehouse Lane.

The proposed development will be an additional source of surface water runoff. Surface water proposals will need to be designed to the national hierarchy for SUDS (*not covered in this report*).

Fluvial Morphological Impacts.

The proposed development will not impact fluvial morphology.

Potential Sources of Flooding.

a. Fluvial flooding from main rivers.

The flood model has indicated that up to and including the 100yr + climate change fluvial flood event, Ash Brook stays well within the capacity of the Ash Brook bank local to the site.

Due to historic infilling locally, the banks are artificially high, which acts to protect the local area from extreme flooding events.

The Application Site is nominally between 135.80m aOD to the west corner, to a low point of 134.25m aOD to the east corner. However, the south west side of the site forming the Ash Brook bank is a minimum of 134.50m aOD.

The maximum water level noted within the flood model is 133.52m aOD at the upper section, falling to 133.35m aOD in the lower section.

No site flooding occurs due to fluvial occurrences.

b. Surface Water Risk.

The is a minor surface water 'Low Risk' to Dyehouse Lane noted within the .gov surface water flood maps which suggests up to a maximum 300mm surface water flooding may be feasible on the site and Dyehouse Lane. In reality, Dyehouse Lane is approximately 300mm lower than the Application Site due to grass verges and kerbing, and subsequently no significant risk exists.

c. Fluvial flooding from minor watercourses / drainage channels.

Minor watercourses do not directly impact the development.

d. Artificial Watercourse/Canals.

The Rochdale Canal is approx. 900m distant from the Application Site.

e. Loss of overland flow.

Overland flow routes will not be affected as part of the development.

f. Loss of Floodplain.

Loss of floodplain will not be decreased as part of the development.

g. Springs and high groundwater levels.

Ground water levels are controlled primarily by river levels in the local area and therefore present no more of a risk.

h. Surcharging of local drainage & sewerage systems.

There is a combined overflow approximately 25m to the north of the site which discharges into Ash Brook. Due to this overflow, it is unlikely sewers will surcharge, instead overflowing to the watercourse once capacity is reached.

Urban areas have been incorporated into the fluvial flood model using the higher and more conservative urban QBAR runoff figure as the basis for model data, and thus the model is considered conservative including runoff from urban areas.

i. Reservoirs.

There is a risk of reservoir flooding in this area, however, the Environment Agency indicates the risk from of flooding is highly unlikely. In addition, flooding from reservoirs is thought to be a much lower risk than that from other sources described in detail above.

Design.

The proposed design is to comprise steel frames industrial units with dado brick walls and insulated sheet cladding to the upper wall & roof profiles.

Construction.

Finished floor level should be not less than 150mm above surrounding ground levels, except from ramps up to roller shutter doors.

Conclusion & Residual risks.

There has been no formal flood risk noted at the site, so no further action is required in this repect unless there are proposals to reduce ground levels below the flood levels noted.

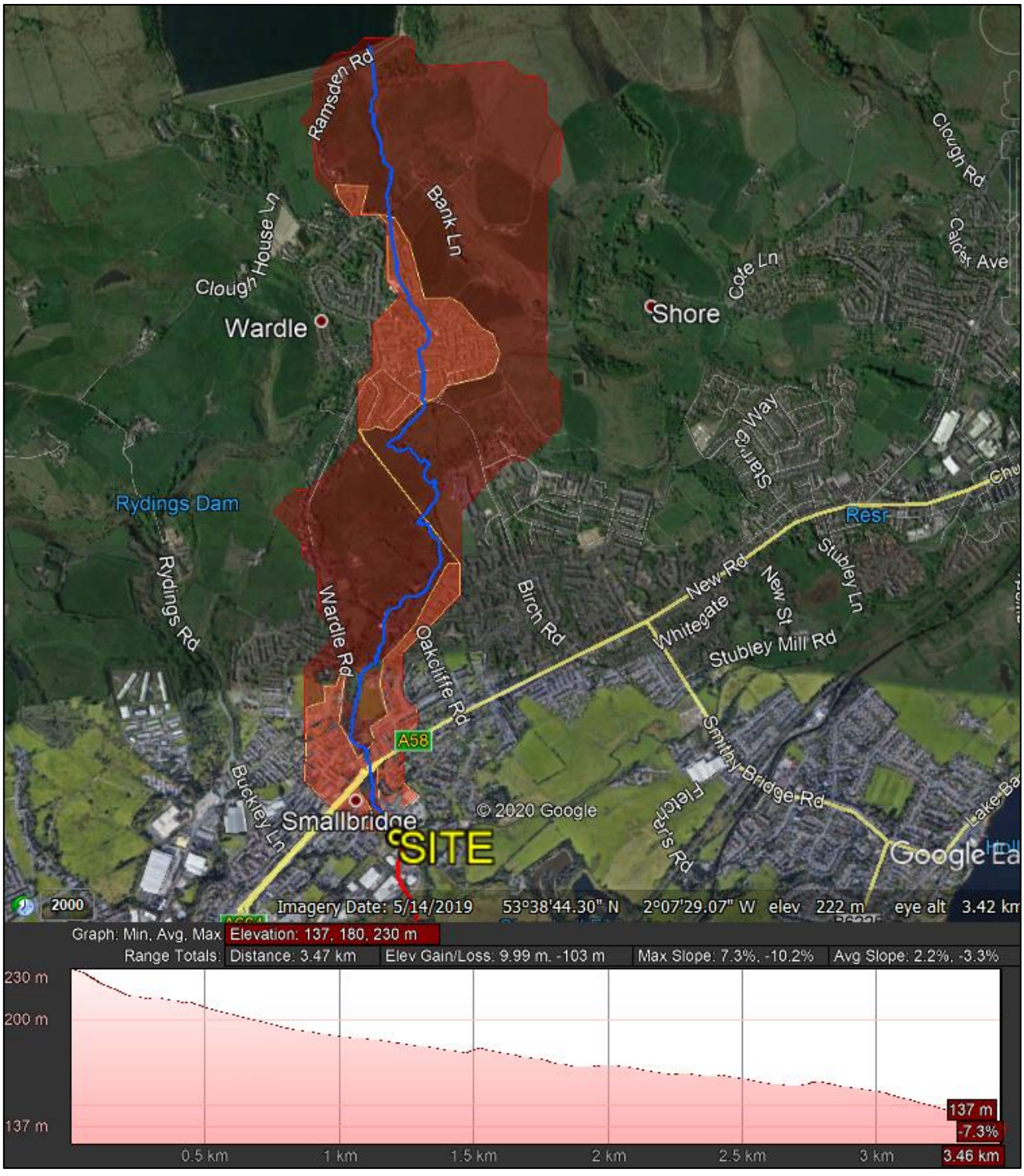
There is a 300mm dia combined sewer running through the centre of the site flowing north-west to south-east.

It would be prudent to speak to RMBC Building Control to enquire if the sewer is covered by the United Utilities-Building Control Protocol Agreement, whereby Building Control can act on behalf of United Utilities in agreeing build over arrangements; or, whether a formal Application to United Utilities for a build over agreement will be required.

This report should be submitted to planning for approval by the Environment Agency and/or the LLFA as applicable.

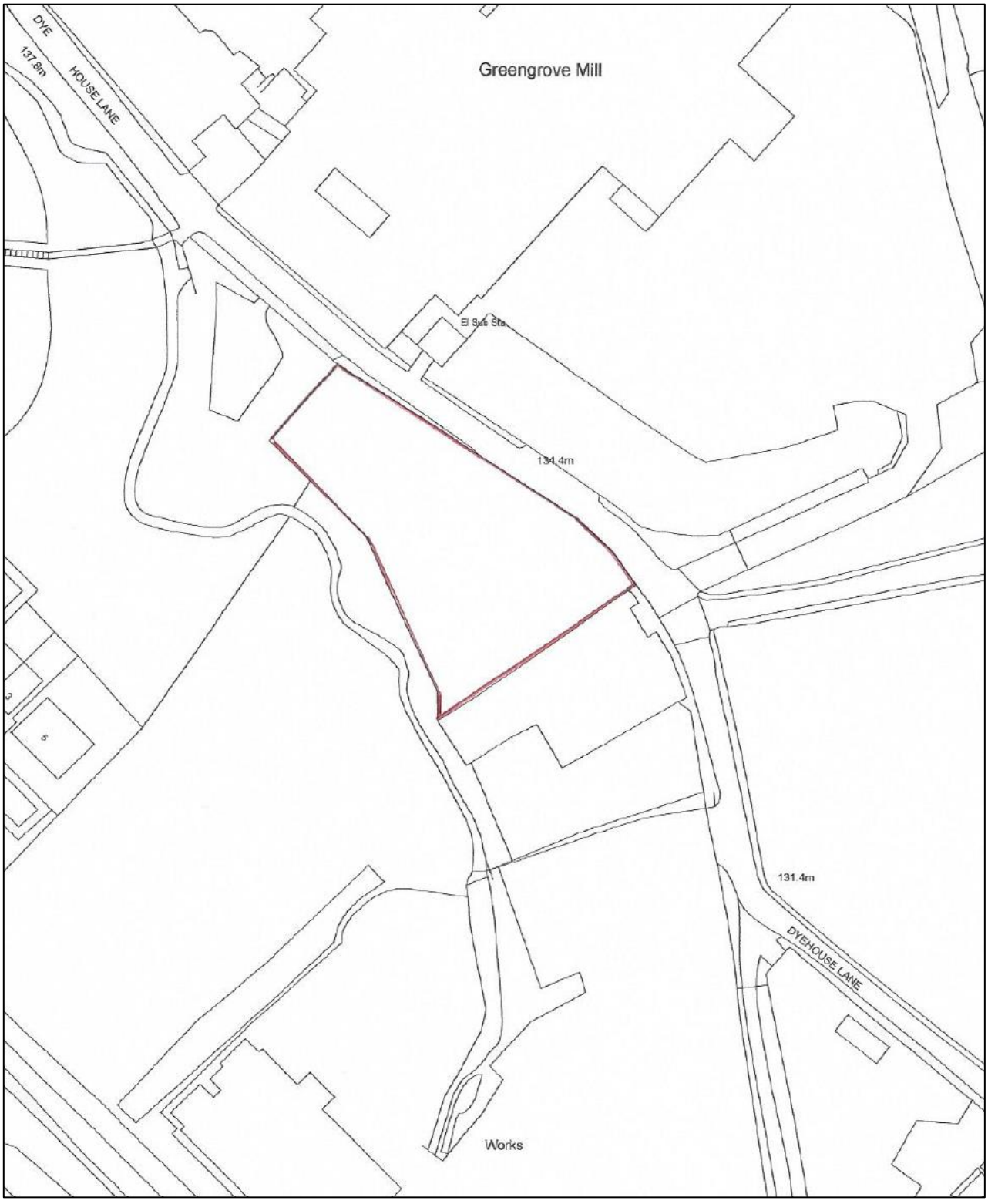
Appendix.

Location & Catchment Area Plan.

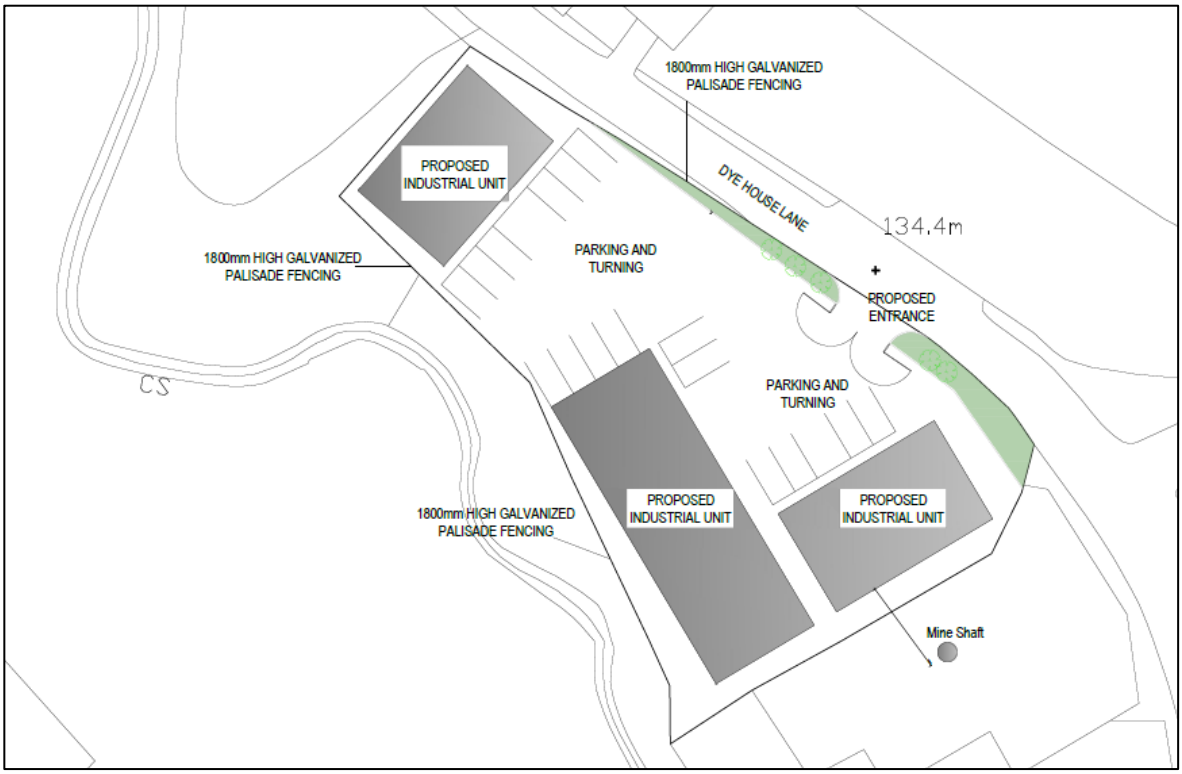


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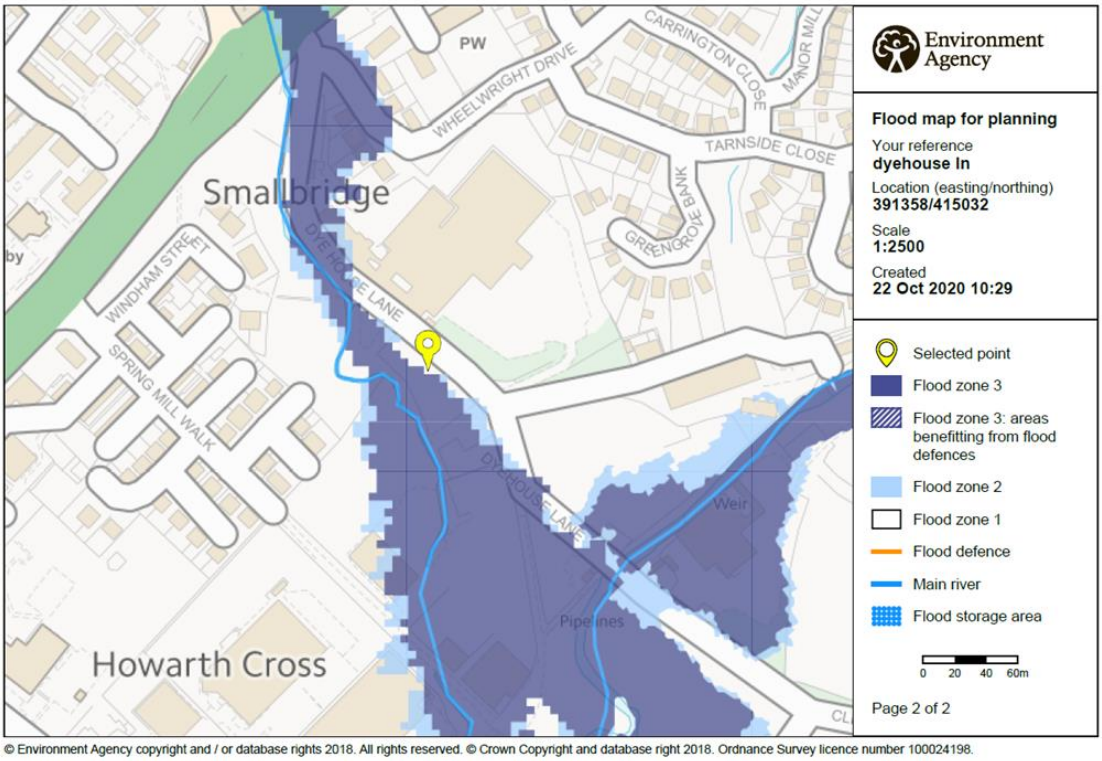
Existing Site Plan.



Proposed Plans.



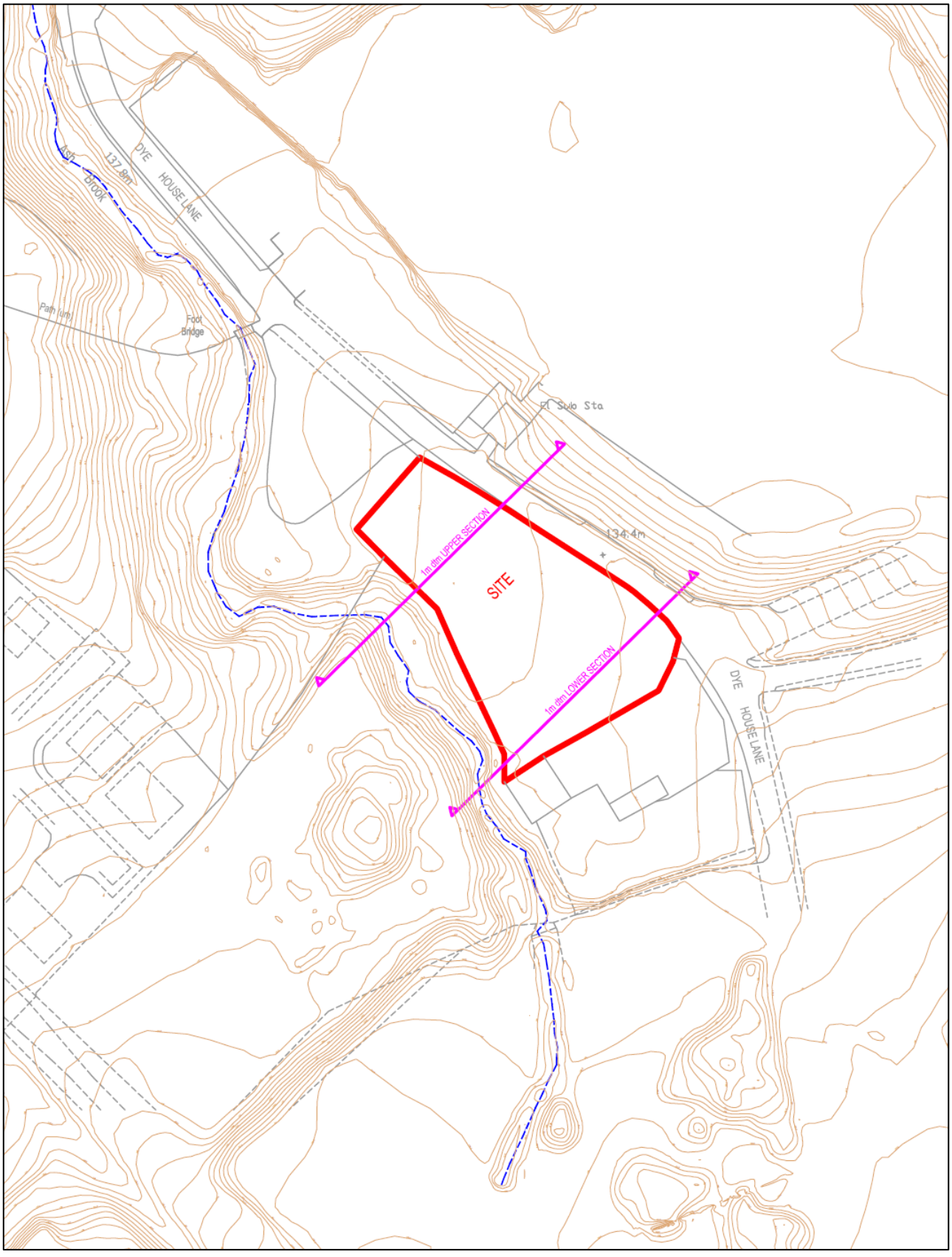
Environment Agency Flood Zone Map.



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	Calc. by: DS	Date: 21/10/2020	Chk'd by:	Date:	App'd by:	Date:

1m DTM Lidar Plan.



NPPF Planning Practice Guidance Table 1.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.(Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

NPPF Planning Practice Guidance Table 2.

Less vulnerable

- Police, ambulance and fire stations which are not required to be operational during flooding.
- Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure.
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill* and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do not need to remain operational during times of flood.
- Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.

Environment Agency Climate Change Allowances.

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
North west	H++	25%	45%	95%
	Upper end	20%	35%	70%
	Higher central	20%	30%	35%
	Central	15%	25%	30%

In flood zone 2

- essential infrastructure – use the higher central and upper end to assess a range of allowances
- highly vulnerable – use the higher central and upper end to assess a range of allowances
- more vulnerable – use the central and higher central to assess a range of allowances
- less vulnerable – use the central allowance
- water compatible – use none of the allowances

In flood zone 3a

- essential infrastructure – use the upper end allowance
- highly vulnerable – development should not be permitted
- more vulnerable – use the higher central and upper end to assess a range of allowances
- less vulnerable – use the central and higher central to assess a range of allowances
- water compatible – use the central allowance

NPPF Planning Practice Guidance Table 3.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓*

Key:

✓ Development is appropriate

✗ Development should not be permitted.

Notes to table 3:

- This table does not show the application of the Sequential Test which should be applied first to guide development to Flood Zone 1, then Zone 2, and then Zone 3; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;
- The Sequential and Exception Tests do not need to be applied to minor developments and changes of use, except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site;
- Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.

† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

* In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

Mean Annual Flood.

Flood Studies Report, rural (Large and small catchments)

The mean annual flood is determined using the regional constant, catchment area, stream frequency, soil index, soil moisture deficit, stream gradient (m/km) and proportional lake area.

Flood Studies Report, rural (<25km2)

The mean annual flood is calculated in avery similar manner to the IH124 equation, though the soil index variable is instead changed to a SPR (Standard Percentage Runoff) variable.

Flood Estimation Handbook

The FEH calculates the median annual flood instead of the mean. This means that a conversion is factored into the eqution after. The Qmed is calculated using the catchment area, standard annual average rainfall (mm), BFIHOST which is the base flow index derived from the hydrology of soil types. and FARL. FARL is a reservoir reduction aspect, set at 1.0 and can effectively be ignored. This means that areas with waterbodies that reduce runoff will cause the greenfield runoff rate to be overestimated. The Qmed then undergoes a conversion factor to produce the Qbar.

Methodology Conclusion

The most appropriate methodology for this catchment appears to be the IH124 calculation. This is primarily because of it's middle ground between the results given by the FEH and the FSR rural for <25Km2. The 'FSR rural for large and small catchments' is omitted due to it's tendancy to overestimate. This is shown in IH124-Flood Studies Supplementary Reports.

Google maps was used to obtain the catchment height data by transcribing the Low Flows watercourse and contributing area.

WHS Low Flow Analysis (LowFlows Report 455/16).

LowFlows Report 736/21

October 2020

Flow estimate for Ash Brook at NGR: 391347, 415009



WHS

T J Booth Associates

Flow estimate for Ash Brook at NGR: 391347, 415009

For and on behalf of Wallingford HydroSolutions Ltd.

Client	T J Booth Associates
Prepared by	Sam Pucknell
Approved by	Daniel Hamilton
Position	*Senior Consultant*
Invoice value	195 (excl. VAT)

This report has been prepared by WHS with all reasonable skill, care and diligence within the terms of the Contract with the client and taking account of both the resources allocated to it by agreement with the client and the data that was available to us. We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above. This report is confidential to the client and we accept no responsibility of any nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.

The WHS Quality & Environmental Management system is certified as meeting the requirements of ISO 9001:2015 and ISO 14001:2015 providing environmental consultancy (including monitoring and surveying), the development of hydrological software and associated training.

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4 LowFlows Results for Ash Brook at NGR: 391347, 415009

4.1 Catchment Characteristics

The catchment characteristics and map for this catchment are presented in the table and figure below. The catchment is underlain by sandstones, mudstones, and siltstones with superficial deposits of till and alluvium. Small areas of glaciofluvial deposits and peat are also present.

As this catchment is below 5 km² in size, the guidance associated with small catchments in section 7 should be considered.

Table 4.1 Catchment Characteristics

Basin Details	
Outlet grid reference	391347, 415009
Hydrometric area	69 (Central and South)
Catchment definition method	Digital
Basin area (km²)	1.495
Base-Flow Index	0.39

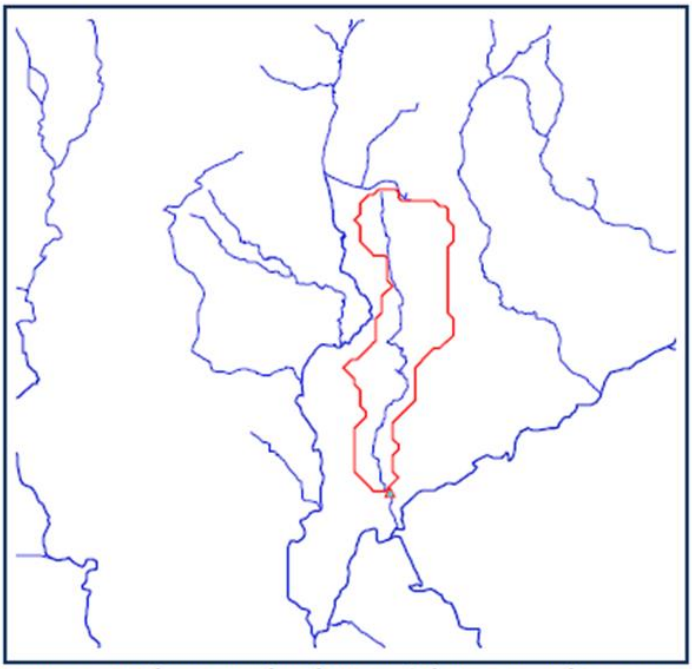


Figure 4.1 Catchment Boundary (Contains Ordnance Survey data © Crown copyright and database right 2020)

4.2 Long Term Natural Flow Statistics

This section presents the long-term natural flow statistics. The table below presents both the monthly mean flows and the annual flow duration statistics. The annual flow duration curve is also presented in the figure below, followed by a table displaying the monthly flow duration statistics.

Table 4.2 Mean Flows and Annual Flow Duration Curve Statistics

Mean Flows	Flow (m³/s)	Percentile	Flow (m³/s)
Annual	**0.037**	5	0.135
January	0.062	10	0.089
February	0.054	20	0.052
March	0.045	30	0.035
April	0.030	40	0.025
May	0.019	50	0.018
June	0.017	60	0.013
July	0.015	70	0.009
August	0.023	80	0.007
September	0.024	90	0.005
October	0.046	95	0.004
November	0.050	98	0.003
December	0.063	99	0.003

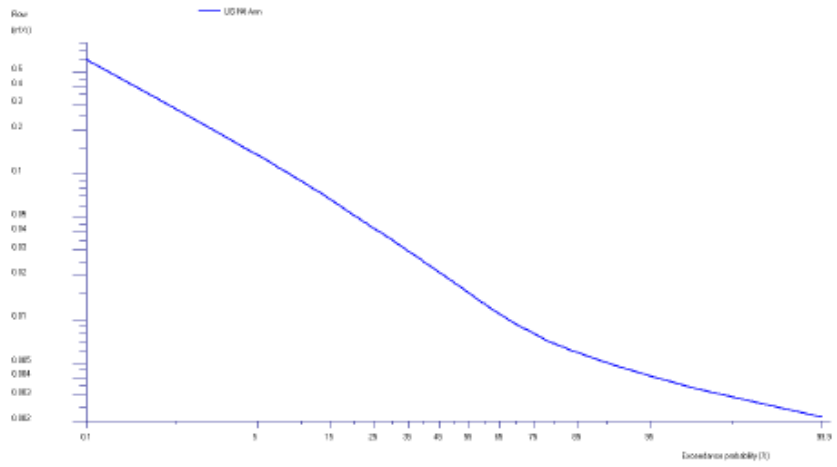


Figure 4.2 Annual Flow Duration Curve

T J Booth Associates. Consulting Engineers 20A Eastgate St, Rochdale OL16 1DH	Project Newbuild - Dyehouse Lane, Smallbridge			Job Ref. calc-tjba-newbuild-dyehouse ln-091020	
	Section FLOOD RISK ASSESSMENT			Sheet no./rev. 21	
	Calc. by DS	Date 21/10/2020	Chk'd by	Date	App'd by	Date

United Utilties Wastewater Plan.

