DRAINAGE ASSESSMENT

ON

WOODSIDE GARDEN

SUBURB EXTENSION

ON BEHALF OF

THORNHILL ESTATES LIMITED

ARP ASSOCIATES
CHARTERED CONSULTING ENGINEERS
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Drainage Assessment on Woodside Garden, Suburb Extension 1641/03r1				
Revision/Date	**Initial Issue** **25th July 2018**	**Revision A**	**Revision B**	**Revision C**
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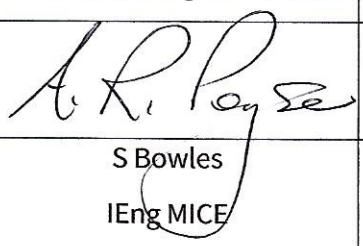
Signature				
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Signature				
Authorised By:	A Radcliffe BEng (Hons) CEng MIStructE			
Signature				

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1.0 INTRODUCTION

1.1 Thornhill Estates Limited are promoting a number of land holdings accessed at various points off Woodhouse Lane, Brighouse for development of residential, commercial and rural uses for submission within the Calderdale local plan. As part of the viability and to support the planning submission, a Drainage Strategy for the development was required.

1.2 It is with in the general development strategy of the Country that development in areas where there is a risk of flooding are to be assessed to avoid unnecessary increase in the requirement for flood defence. Any Drainage Strategy Report should be prepared considering the development proposals and make recommendations for any flood mitigate measures in accordance with the National Planning Policy Framework (NPPF) and the Planning Practice Guidance (PPG)

1.3 ARP Associates have been appointed to carry out an assessment of the site, implement appropriate consultations and prepare a Drainage Strategy Report, in accordance with the NPPF, to supplement a submission to the Planning Authority.

1.4 The consultations and investigations are being carried out in July 2018.

1.5 The report has been initially prepared for the use and reliance of the Client only. The report shall not be relied upon or transferred to any other parties without the written agreement of ARP Associates. For the avoidance of any doubt, where ARP Associates enters into a letter of reliance for the benefit of a third party, that third party will be permitted to rely on the report. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party without ARP Associates consent.

2.0 SITE WALKOVER

General

2.1 The site of the various holdings is an irregular shaped area of land equating to 63 Hectares. The site is situated on the edge of residential and commercial development of Brighouse and is centred at Ordnance Survey Grid Reference 415200, 421550.

2.2 A site location plan is presented in Appendix A.

Current Use

2.3 The site is generally used for agricultural purposes with various fields and other areas fenced off or bounded by trees. There are, however, some fields where these have been left fallow for some years and are not in use. There is also a recreational area used as a cricket pitch towards the eastern side of the site.

Boundaries

2.4 The northern boundary abuts the fences, walls and hedges of residential development fronting onto Woodhouse Lane whilst the southern boundary is formed by Bradley Park Dyke with Bradley Wood sloping up steeply beyond. The most westerly area abuts the A641 Huddersfield Road, whilst the eastern boundary is formed by a steep embankment down to the railway line.

Topography and Vegetation

2.5 The general site falls from northwest to southeast down to Bradley Park Dyke, although from the central area towards the east, the fall is from west to east towards the railway line. However, there are also some mounds from the central to the central eastern area creating small valleys within the site.

2.6 The site is being used for agricultural purposes and crops are present generally across the site, although there are numerous trees, bushes and other similar plant growth along field boundaries around the development.

Drainage

2.7 There is no indication of a positive drainage system on the site, although there are gutters and down water downpipes present to the buildings that are scattered sparsely along the site area. It is probable that land drainage is present and this will discharge to Bradley Park Dyke for the majority of the area, whilst the remaining areas may well discharge to drainage within railway land. However, as Bradley Park Dyke discharges to the River Calder just to the eastern side of the railway, it is probable that water drains to this location in any event.

2.8 In respect of foul drainage, there is no indication of sewers within the curtilage of the site that would receive foul drainage from the farm buildings and other similar dwellings. It is likely that septic tanks or foul drainage pump stations are present to deal with foul water flows.

3.0 CONSULTATIONS

Environment Agency

3.1 No formal consultation has been undertaken with the Environment Agency, but a review of the Environment Agency website shows the site falls within Flood Zone 1, although it would be advisable to ensure that development falls outside the edge of Bradley Park Beck.

3.2 A review of the surface water flood map shows that the site does not have any indication of standing water due to the sloping nature of the topography. Similarly, there is no flooding from reservoirs, and, on this basis, the Sequential Test is satisfied and all forms of development in this Flood Zone are satisfactory, subject to consideration of controlling surface water drainage to the existing run-off.

Water Authority

3.3 A consultation has been requested from Yorkshire Water, who is the Water Authority for this area, and a copy of their response, under reference U011827 dated 27th July 2018, is presented in Appendix B for reference.

3.4 There is a 375mm diameter public surface water sewer crossing the site and no buildings or trees are to be located within 5m of the public sewer. Furthermore, there are five overflow sewers varying in diameter from 600mm to 900mm within the site. Various off-sets where no buildings or trees can be located within distances of 4m, 5m, 6m and 6.5m, dependent upon the size and prominence of the overflows, are also present. It is not acceptable to raise or lower ground levels over the sewer, nor to restrict access to the manholes unless these are diverted under a Section 185 Agreement of the Water Industry Act 1991. If this is required appropriate applications should be made.

3.5 In respect of foul water, it is stated that the Brighouse Waste Water Treatment Works (WWTW) may have limited capacity and contact has been made with the respective Treatment Team for more information. This will be issued when an assessment has been made. Therefore, the public sewer network does not have capacity available to accommodate the anticipated foul water discharge from the proposal site, and it may be necessary to assess the impact of the additional flow and implement any upgrade work required along with an agreed phasing plan. Furthermore, it is possible that the site will require a foul pumping station to facilitate connections to the public sewer network.

3.6 In respect of surface water, reference is made to Requirement H3 of Building Regulations 2000. This establishes a preferred hierarchy for surface water disposal, with consideration firstly given to discharge to soakaway, infiltration system and watercourse in that priority order before consideration of connection to sewer. If Sustainable Drainage Systems are unsuitable, it is noted that there is a watercourse located along the southern boundary and this would be the obvious place for surface water disposal.

Land Drainage Authority

3.7 A consultation has been requested from the Land Drainage Authority, but no response has been received at this time. It is anticipated that the consultation will identify that the development is within Flood Zone 1 and that surface water discharge should be restricted to greenfield run-off to the watercourse, unless it can be shown that there is a positive drainage system for the existing buildings on the site. If the circumstances can be proved, the existing 1 in 1 year discharge rate will need to be calculated less 30% to meet the requirements of the Pitt Review.

4.0 SOURCES OF FLOODING OTHER THAN FROM RIVERS AND THE SEA

General Sources

4.1 Flooding from the watercourse along the southern boundary of the site will need to be considered in the event that this becomes blocked and water floods to a greater extent than that shown on the Environment Agency flood map. This will be achieved by designing external levels to keep the water within the channel wherever possible.

4.2 The site is generally agricultural land with the land to a higher level occupied by residential development. Therefore, it is unlikely that surface water will run into the site, but, if this occurs, cut-off drains on the boundary taking water through to the watercourse to the south will alleviate any flooding from this source. Similarly, whilst no intrusive soil investigation has been carried out, a review of the Geological Survey of Great Britain shows that the site is located on either Elland Flags or undifferentiated siltstones, mudstones and sandstones of the Lower Coal Measures. The upper Stratum is likely to be weathered to a cohesive clay over a large part of the site. These soils will prevent issues of ground water on the site and flooding from this source is considered to be low risk.

4.3 There are no other reservoirs, canals or artificial sources which will cause flooding in the area, but a new drainage system will need to be introduced on the site and it is possible that any blockage will result in flooding from the lowest cover level of manholes or gullies. Therefore, this will need to be considered as part of any proposed development.

Climate Change

4.4 The NPPF and PPG has indicated that the Global sea level will continue to rise, depending on greenhouse gas emissions, and the sensitivity of the climate system and there will be an increase in rainfall across the country. The PPG makes reference to the Environment Agency guidance for Climate Change and Table 2 makes an assessment of the increase in peak rainfall intensity. The guidance was changed in February 2016, and increases in rainfall of up to 40% should be considered in certain areas of the country.

4.5 Whilst land to the north and west is higher than the site, the existing development will prevent overland run-off into the development area. However, if it is proved that there is a problem from surface water flow into the site, cut-off drains will be introduced on the boundary with the water directed through to the watercourse on the south. Therefore, only rainfall falling within the site boundaries will need to be considered in respect of climate change and it will be necessary to design any new positive drainage system with a 30% increase in capacity in this location to accommodate this requirement.

Flood Mitigation

4.6 As the development site will fall within Flood Zone 1 and the Sequential Test is satisfied, there are no requirements for mitigation measures for this particular site. However, in the event of a catastrophic storm and blockage of the watercourse or proposed drainage system, it would be advisable to consider some precautionary flood mitigation measures, as follows:-

4.6.1 Ground floor levels to properties should be raised above external levels by a minimum of 150mm.

4.6.2 Properties should be designed without any basements and ground floors should comprise solid concrete slabs or beam and block with screed construction.

4.6.3 Incoming electricity supply should be raised above ground floor level and ground floor electric sockets should be served by loops from above rather below ground level.

4.6.4 It will be necessary to ensure that there is a route for flood water through the site to the watercourse on the southern boundary without causing flooding to buildings.

5.0 DRAINAGE

Existing Surface Water Run-Off

5.1 As it is not possible to assess the outfall locations for positive drainage systems to the sparse buildings on the site, it has to be assumed that a greenfield run-off rate will apply to the whole of the site. Using the IHT124 formula for determining existing surface water run-off rates on greenfields and assuming that 26% of the site area (16.5ha) will become impermeable on completion of the development, the calculations show that a rate of 37.09l/s will be applicable for the proposed development. The calculations are presented in Appendix C.

Proposed Surface Water Drainage

5.2 The proposed surface water drainage system will need to be assessed in accordance with the hierarchy of surface water drainage, which involves consideration of discharge via soakaways or other infiltration systems before outfall to watercourse. There is no intrusive investigation on the site at this time, but the general geology shows that the solid strata is either Elland Flags or undifferentiated siltstones, mudstones and sandstones of the Lower Coal Measures. The upper Stratum is likely to be a weathered cohesive clay over a large part of the site. The remaining area is unlikely to be permeable unless fissures are present within the Sandstone. This, together with any high water table, would render soakaways unsuitable on this particular site. The presence of the watercourse passing along the southern boundary to the site confirms that natural soils are generally impermeable at this location.

5.3 Therefore, whilst an assessment of other sustainable drainage systems will need to be made as part of the detailed design, a positive drainage system is likely to be required with surface water discharge to the watercourse on the southern boundary, as exists at the present time. Any diversion of the watercourse or the construction of a head wall will require the consent of the Land Drainage Authority before construction on site.

5.4 A copy of the masterplan is presented in Appendix D for reference and this shows that the net developable area equates to 32.9ha. Using the WinDes Source Control Computer Programme for a greenfield discharge rate of 37.09l/s and assuming that the proposed impermeable area will be 16.5ha, the surface water attenuation for a 1 in 100 year storm plus 30% allowance for climate change is 14,270m^3. It is anticipated that the existing road system serving the new development will become adopted by the Highway Authority and, on this basis, the use of a dry detention basin would be the most practical and cost effective solution for surface water attenuation. Therefore, the attenuation requirement can be provided by a 1.0m deep basin with a 0.2m freeboard covering a top area of 16,348m^2 assuming 1 in 6 side slopes.

5.5 Indicative calculations showing the WinDes Source Control output are presented in Appendix E, but detailed calculations and proposals will need to be submitted to the Planning Authority for approval prior to construction on site.

5.6 It is anticipated that the varying phases shown on the masterplan in Appendix D may well be constructed in a sequence that would negate a Drainage Strategy for the whole development. In these circumstances, the allowable discharge rate should be a pro-rata of the total rate based on the net developable area. Attenuation will then need to be provided for each phase and calculations submitted to the Planning Authority for approval prior to construction on site.

Foul Drainage

5.7 It is anticipated that foul water from the proposed development can outfall to the combined sewers in Woodhouse Lane but this will require a foul pump station to be installed to achieve the outfall. Negotiations with Yorkshire Water regarding a discharge rate to the sewers is required and further information is awaited regarding the capacity of the Brighouse WWTW for the new development.

6.0 SUMMARY

6.1 The proposed development is located within Flood Zone 1 and the Sequential Test is satisfied. However, precautionary flood mitigation measures are recommended, as follows:-

6.1.1 Floor levels to the property shall be set above external levels by a minimum of 150mm.

6.1.2 Properties shall be designed without any basements and ground floors shall comprise solid concrete slabs or beam and block with screed construction.

6.1.3 Incoming electricity supplies should be raised above ground floor and ground floor electric sockets should be served by loops from above as opposed to below ground level.

6.1.4 The external alignment of hard paved areas shall be designed to direct any flood water through the site to the southern boundary, as exists at the present time, without causing ponding or flooding to buildings. Levels on the site shall also be raised to ensure that any flood water from Bradley Park Beck on the southern boundary is retained within the channel.

6.2 A 30% increase in rainfall shall be incorporated into any new positive drainage system to satisfy the requirements of climate change.

6.3 Sustainable drainage systems of infiltration techniques are considered to be unsuitable on the site, but appropriate on-site testing in accordance with BRE Digest 365 “Soakaway Design” may be necessary to prove that soakaways are inappropriate at this development.

6.4 Surface water discharge shall be restricted to the greenfield run-off rate, subject to an agreement with the Land Drainage Authority.

6.5 The proposed surface water drainage system shall be restricted to the agreed discharge rate with appropriate attenuation for a 1 in 100 year storm plus climate change incorporated into the design, prior to discharge into the watercourse. The detailed design and calculations shall be submitted to the Planning Authority for approval prior to construction on site.

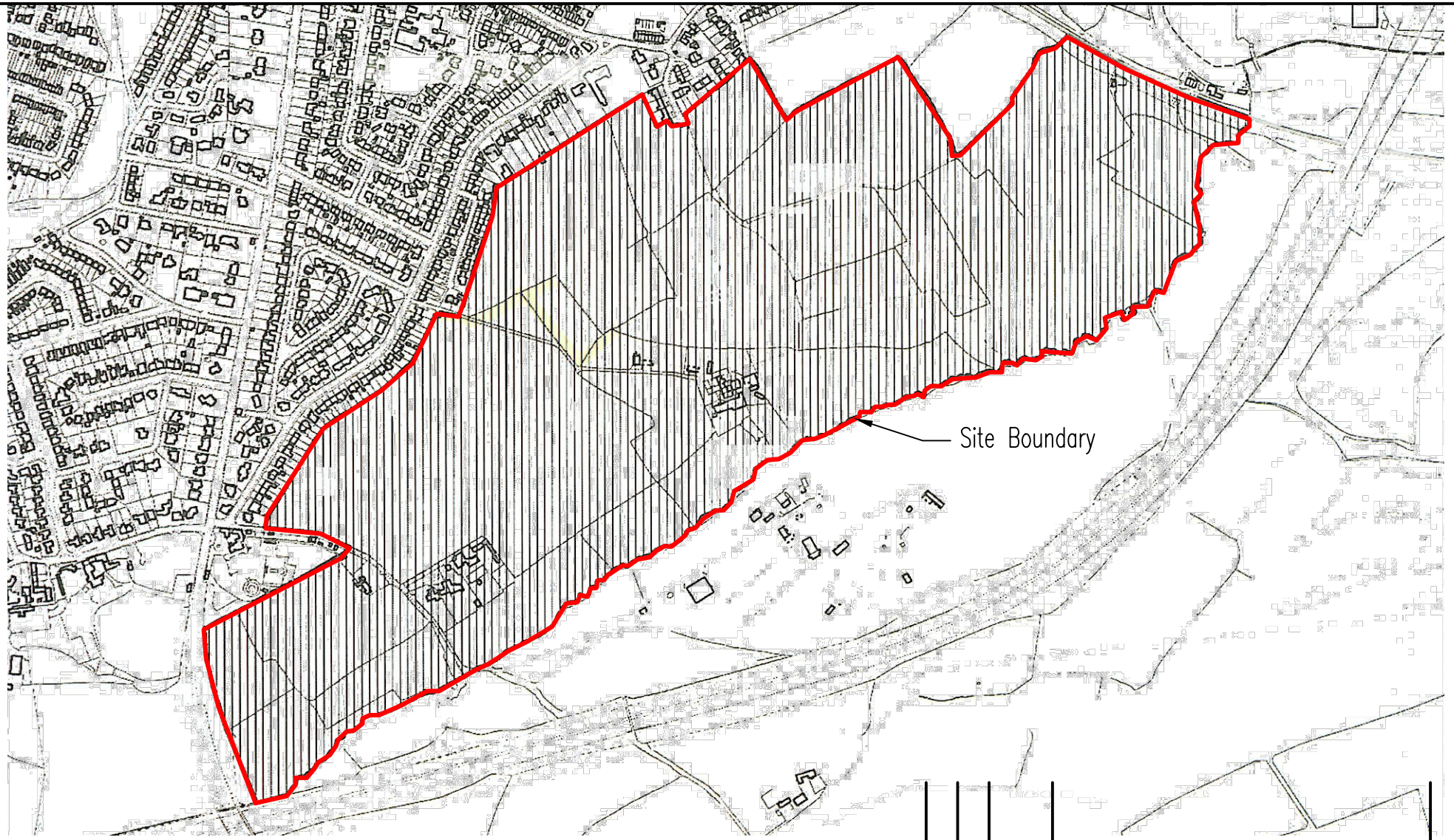
6.6 Any regrading or diversion of the watercourse or the introduction of a head wall for surface water discharge will need the approval of the Land Drainage Authority prior to construction on site.

6.7 Foul water drainage is likely to be accepted to the existing combined sewers in Woodhouse Lane, although a foul pumping station and rising main will be required within the development. Further information relating to the capacity of the Brighouse WWTW to receive discharge from the development is awaited.

6.8 Subject to compliance with the above, the proposed development can satisfy the requirements of the National Planning Policy Framework and the Planning Practice Guidance in relation to flood risk and surface water drainage strategies.

A P P E N D I X A

SITE LOCATION PLAN



Rev	By	Date	Amendment	Chk
/	JFR	27.07.18	Issued for approval	ARP

Title

SITE LOCATION PLAN

Project/Client

WOODSIDE GARDEN, BRIGHOUSE
THORNHILL ESTATES LTD

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Scale	1:5000 @ A4
Drawn	JFR
Date	JULY 18
Chk.	ARP
Drg. No.	1641/03/FR01
Rev	/

APPENDIX B

YORKSHIRE WATER CONSULTATION

YorkshireWater

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Leeds
LS6 2QH

Yorkshire Water Services
Developer Services
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Technical.Sewerage@yorkshirewater.co.uk

For telephone enquiries ring:
Chris Roberts on 0345 120 8482

Your Ref:
Our Ref: U011827

27th July 2018

Dear Mr Carter,

Thornhill Estates, Woodside Suburban Village, Rastrick, Brighouse, HD6 3TX - PPSE on T072838 (Residential)

Thank you for your recent enquiry. Our charge of £158.93 (plus VAT) will be added to your account with us, reference ARP013. You will receive an invoice for your account in due course.

Please find enclosed a complimentary extract from the Statutory Sewer Map which indicates the recorded position of the public sewers. Please note that as of October 2011 and the private to public sewer transfer, there are many uncharted Yorkshire Water assets currently not shown on our records. The following comments reflect our view, with regard to the public sewer network only, based on a 'desk top' study of the site and are valid for a maximum period of twelve months.

Existing Infrastructure

There is a 375 mm diameter public surface water sewer recorded crossing the site. No buildings, or other obstructions, are to be erected within 5 (five) metres, nor trees planted within 5 (five) metres of this public sewer. It may not be acceptable to raise or lower ground levels over the sewer, nor to restrict access to the manholes on the sewer.

There is a 900 mm diameter overflow sewer recorded crossing the site. No buildings, or other obstructions, are to be erected within 6.5 (six point five) metres, nor trees planted within 5 (five) metres of this public sewer. It may not be acceptable to raise or lower ground levels over the sewer, nor to restrict access to the manholes on the sewer.

There is a 900 mm diameter overflow sewer recorded crossing the site. No buildings, or other obstructions, are to be erected within 4 (four) metres, nor trees planted within 5 (five) metres of this public sewer. It may not be acceptable to raise or lower ground levels over the sewer, nor to restrict access to the manholes on the sewer.

There is a 600 mm diameter overflow sewer recorded crossing the site. No buildings, or other obstructions, are to be erected within 4 (four) metres, nor trees planted within 5 (five) metres of this public sewer. It may not be acceptable to raise or lower ground levels over the sewer, nor to restrict access to the manholes on the sewer.

There is a 600 mm diameter overflow sewer recorded crossing the site. No buildings, or other obstructions, are to be erected within 6 (six) metres, nor trees planted within 5 (five) metres of this public sewer. It may not be acceptable to raise or lower ground levels over the sewer, nor to restrict access to the manholes on the sewer.

There is a 900 mm diameter overflow sewer recorded crossing the site. No buildings, or other obstructions, are to be erected within 6.5 (six point five) metres, nor trees planted within 5 (five) metres of this public sewer. It may not be acceptable to raise or lower ground levels over the sewer, nor to restrict access to the manholes on the sewer.

If you wish to have any of these sewers diverted under Section 185 of the Water Industry Act 1991 an application should be made in writing. To discuss this matter, please telephone 0345 120 84 82.

The local Waste Water Treatment Works (WWTW) is Brighouse. It is understood that this WWTW may only have limited spare capacity, if any, available. We have contacted the respective treatment team for more information regarding the impact of proposed development and will contact you when an assessment has been made.

Development of the site should take place with separate systems for foul and surface water drainage. The separate systems should extend to the points of discharge to be agreed.

Foul Water

The public sewer network does not have adequate capacity available to accommodate the anticipated foul water discharge from this proposal site. A model will need to be run at the developer cost to understand the impact of these additional flow and any upgrade work required along with an agreed phasing plan. Please note final agreement to discharge will be needed via formal planning.

From the information supplied, it is not possible to determine if the whole site will drain by gravity to the public sewer network. If the site, or part of it, will not drain by gravity, then it is likely that a sewage pumping station will be required to facilitate connection to the public sewer network.

Surface Water

The developer's attention is drawn to Requirement H3 of the Building Regulations 2000. This establishes a preferred hierarchy for surface water disposal. Consideration should firstly be given to discharge to soakaway, infiltration system and watercourse in that priority order.

Sustainable Drainage Systems (SuDS), for example the use of soakaways and/or permeable hardstanding etc, may be a suitable solution for surface water disposal appropriate in this situation. You are advised to seek comments on the suitability of SuDS in this instance from the appropriate authorities.

As the proposal site is currently undeveloped no surface water is known to have previously discharged to the public sewer network

As such, the local public sewer network does not have capacity to accept any surface water from the proposed site. If SuDS are not viable, the developer is advised to contact the Environment Agency/local Land Drainage Authority/Internal Drainage Board with a view to establishing a suitable watercourse for discharge.

It is understood that a watercourse is located through the site. This appears to be the obvious place for surface water disposal (if SuDS are not viable).

Please note further restrictions on surface water disposal from the site may be imposed by other parties. You are strongly advised to seek advice/comments from the Environment Agency/Land Drainage Authority/Internal Drainage Board, with regard to surface water disposal from the site.

Other Observations

Any new connection to an existing public sewer will require the prior approval of Yorkshire Water. You may obtain an application form from our website (www.yorkshirewater.com) or by telephoning 0345 120 84 82.

YorkshireWater

An off-site foul and surface water sewer may be required which may be provided by the developer and considered for adoption under Section 104 of the Water Industry Act 1991. Please telephone 0345 120 84 82 for advice on sewer adoptions. Alternatively, the developer may in certain circumstances be able to requisition off-site sewers under Section 98 of the Water Industry Act 1991 for which an application must be made in writing. For further information, please telephone 0345 120 84 82.

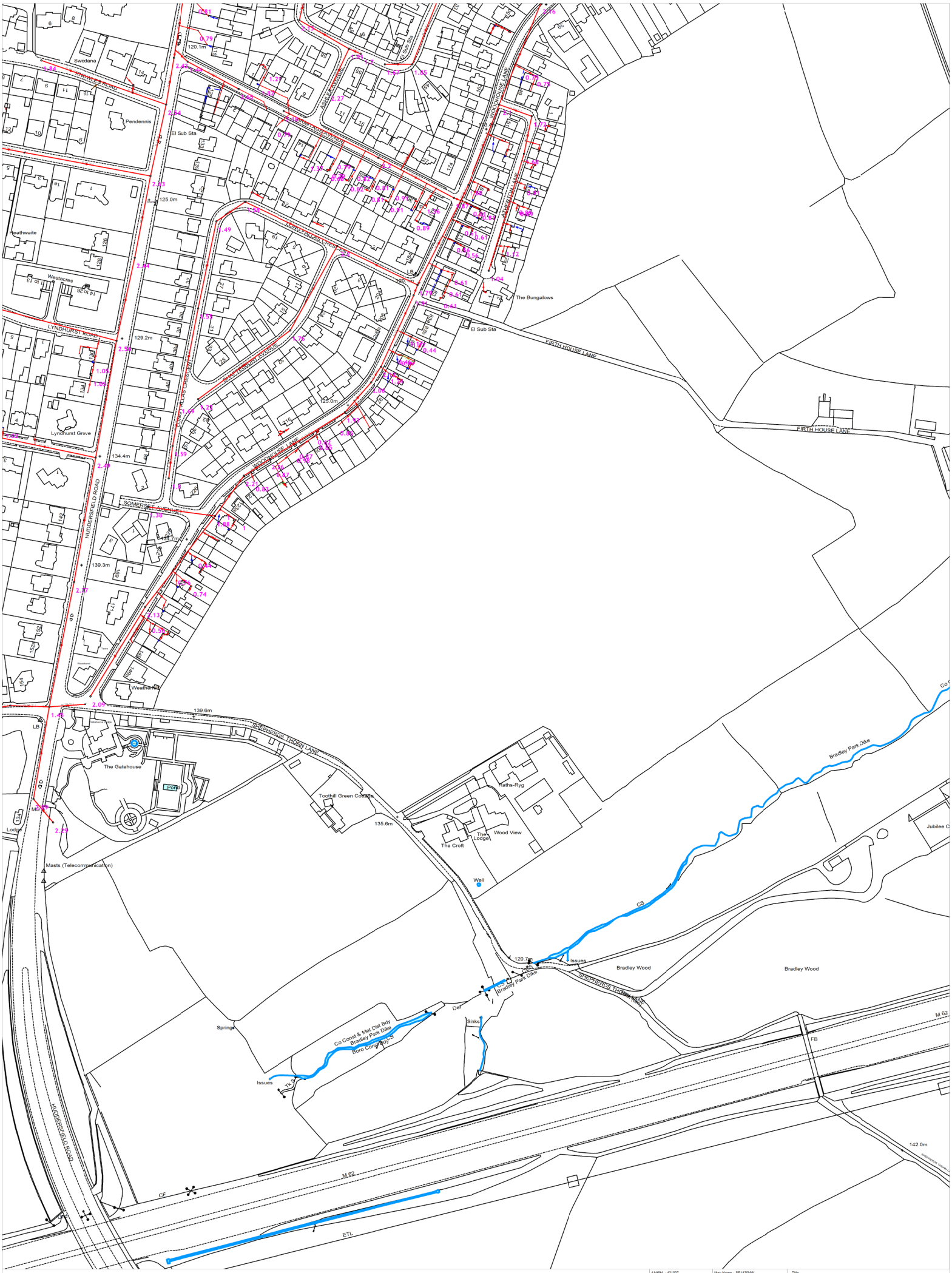
Prospectively adoptable sewers and pumping stations must be designed and constructed in accordance with the WRc publication "Sewers for Adoption - a design and construction guide for developers" 6th Edition as supplemented by Yorkshire Water's requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site. Please contact our Developer Services Team (telephone 0345 120 84 82) for further information.

The site is within an area that may be affected by river, coastal or estuarine flooding. We would advise you to contact the Environment Agency for details.

All the above comments are based upon the information and records available at the present time. The information contained in this letter together with that shown on any extract from the Statutory Sewer Map that may be enclosed is believed to be correct and is supplied in good faith. Please note that capacity in the public sewer network is not reserved for specific future development. It is used up on a 'first come, first served' basis. You should visit the site and establish the line and level of any public sewers affecting your proposals before the commencement of any design work.

Yours sincerely

Chris Roberts
Sewerage Technician
Developer Services



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YorkshireWater

Yorkshire Water,
PO Box 500,
Halifax Road,
Bradford BD6 2LZ
Contact Name :
YorMap Advisor C ROBERTS
Contact Tel : 87 2582

Notes

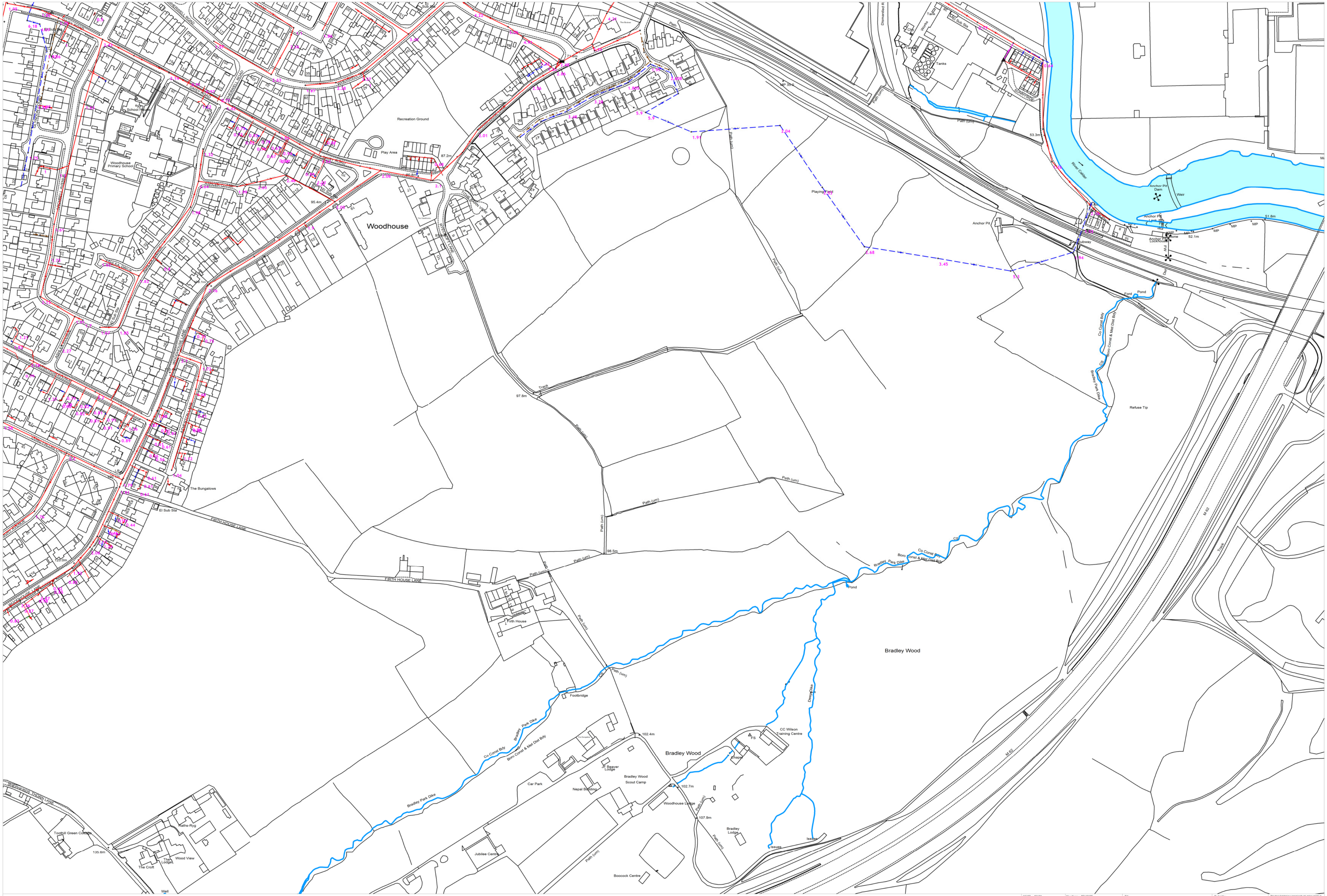
Partial Key
Foul Sewer = F
Combined Sewer = C
Surface Water Sewer = SW
Trade Sewer = TD
Partially Separate = PS

This plan is furnished as a general guide only and no warranty as to its accuracy is given or implied. The Company accepts no liability upon in the event of excavations or other works made in the vicinity of public sewers. No house or property connections are shown.

Date Req : 27/07/2016, 10:24:50 | Date Gen : 27/07/2016, 10:31:35

Source : Sewer Network Enquiry

UPN: Undefined | Originator: C ROBERTS, YorMap, 87 2582



415187 : 421401	Map Name : SE1421SE	Title	Partial Key	This plan is furnished as a general guide only and no warranty as to its correctness is given or implied. This plan must not be relied upon in the event of excavations or other works made in the vicinity of public sewers. No house or property connections are shown.
YorkshireWater	Yorkshire Water, PO Box 500, Halifax Road, Bradford BD6 2LZ Contact Name : YorMap Advisor C ROBERTS Contact Tel : 87 2582	Notes (Ody) COPYRIGHT STATEMENTS: Reproduced by permission of Ordnance Survey on behalf of HMSO © Crown copyright and database 2014. All rights reserved Ordnance Survey Licence number 100022432	Foul Sewer = F Combined Sewer = C Surface Water Sewer = SW Trade Sewer = TD Partially Separate = PS	
			Date Req : 27/07/2018, 09:52:08	Date Gen : 27/07/2018, 10:11:38
			Source : Sewer Network Enquiry	

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APPENDIX C

INDICATIVE GREENFIELD RUN-OFF CALCULATIONS

IH 124 Mean Annual Flood

Input

Return Period (years)	1	Soil	0.300
Area (ha)	50.000	Urban	0.000
SAAR (mm)	953	Region Number	Region 3

Results l/s

QBAR Rural	130.7
QBAR Urban	130.7
Q1 year	112.4
Q1 year	112.4
Q2 years	123.4
Q5 years	163.4
Q10 years	189.6
Q20 years	214.7
Q25 years	223.0
Q30 years	229.8
Q50 years	247.6
Q100 years	271.9
Q200 years	308.5
Q250 years	320.3
Q1000 years	397.4

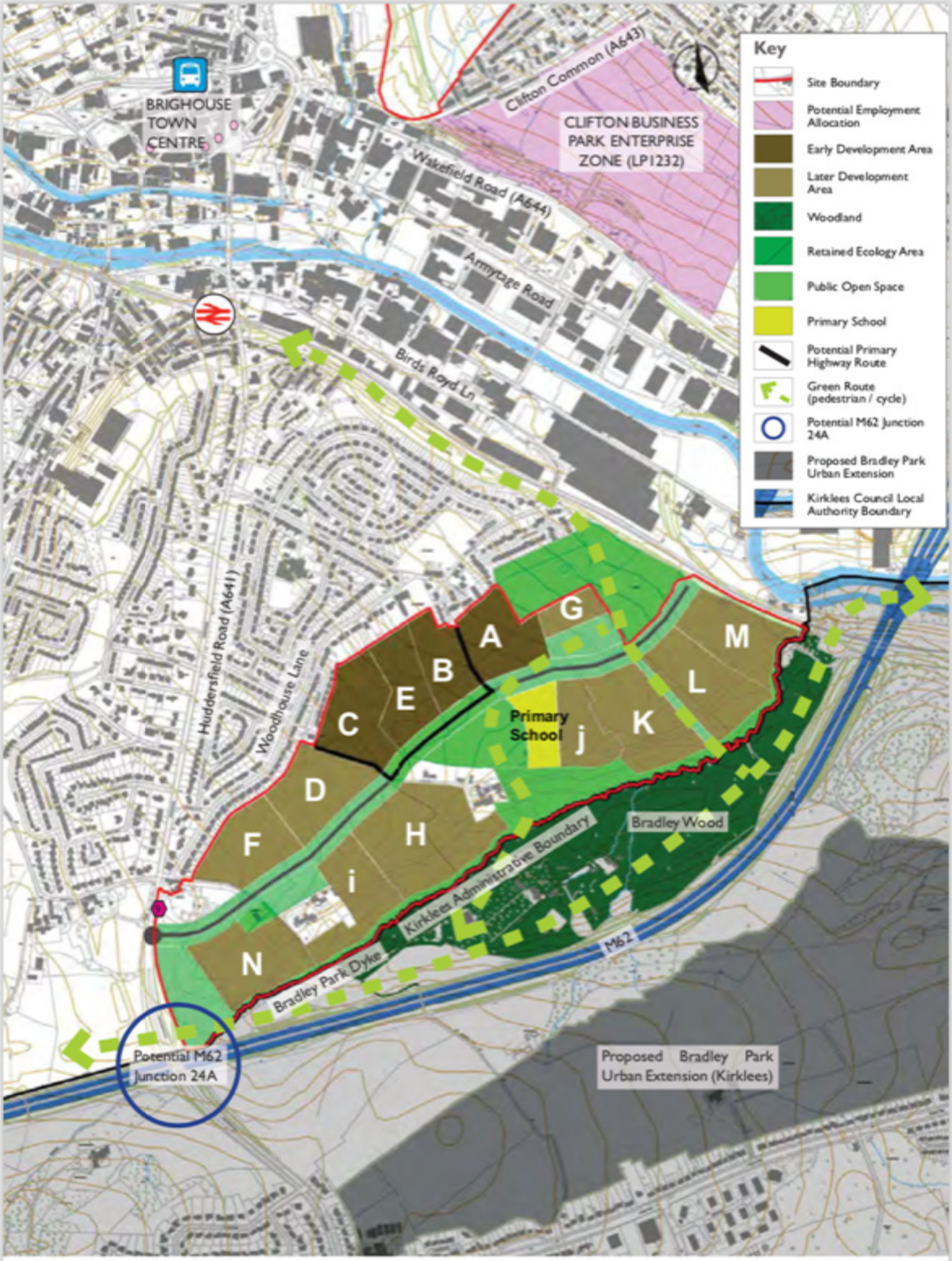
Pro Rata for Area = 16.5 ha.

$$Q1 = 112.4 \times \frac{16.5}{50}$$

$$Q1 = 37.09 \text{ l/s.}$$

APPENDIX D

MASTERPLAN



LP1451 - Woodhouse Site - Indicative Development Area Masterplan

Scale 1:10,000

LP1451 - Woodhouse Site - Indicative Development Area Masterplan
Scale 1:10,000

Proposed Woodhouse Strategic Urban Extension

Whilst it is likely that access to the Woodhouse site could be gained using existing roads, turning-heads and tracks there will be a limit to the number of housing units which can be served this way due to the constraints of the existing residential streets and on-street parking. There are several locations where access can be achieved from the north-west side of the site via accesses which emerge on to Woodhouse Lane. These include Shepherds Thorn Lane, Firth House Lane and Ryecroft Lane. There may be a need to acquire Third Party land to provide access at these locations.

It is therefore proposed that the main access to the Woodhouse site will be located on the A641 i.e. the western frontage of the site. This junction is likely to take the form of a traffic signalled junction. It is acknowledged that there is a possibility of J24A being implemented although the design work on the scheme is still at the feasibility stage. Due to the strategic importance of the J24A scheme, it is proposed that the access to the Woodhouse site from the A641 will not be implemented until there is greater certainty about the future of J24A. Hence, there is flexibility in the proposals to ensure that the development access can take account of the proposed J24A layout or to provide an alternative, less constrained junction in the event that J24A does not proceed. The routes through from Woodhouse Lane would connect to the A641 through the site. Improvements along the A641 to accommodate the proposed development traffic are likely to be required.

An access from the A641 is likely to improve how attractive the site is to potential developers as it will provide them with a visible frontage from which to advertise their development. This improved attractiveness is likely to increase the rate of delivery of homes within the site as a greater number of developers may be enticed to the site.

The development will also respect the existing rights of way across the site and into Bradley Woods to south of the development and accommodate these within the routes through the site for pedestrians and cyclists to provide sustainable means of travel.

The proposed open space within the masterplan meets the requirements of the 'Open Space, Sport and Recreation SPD' within the site however it may the heart of the site it is proposed to provide half of the 4.7ha Outdoor Sports requirement. This will complement the existing listed buildings which lie in the centre of the site. The masterplan has also sought to protect the ecology area alongside Bradley Park Dyke.

As with the Thornhills Lane site, it has been assumed that there will not be capacity within the existing schools in the area to accommodate the pupils associated with the new housing. The number of houses indicated in the schedule will create 294 primary and 208 secondary places. This will require a new primary school within the site (1.5ha site for 1.5 form entry school) It is proposed that secondary education is accommodated on the Thornhills Lane site.

It has been assumed that the site will deliver at an average housing density of 34 dwellings per hectare and allows for 10% of the gross area to provide SUDs.

Indicative Woodhouse Housing Development Schedule				
Total Site Area				63 ha
Open Space (Inc Vehicular Routes)				15 ha
Retained Ecology Area				5 ha
Area	Gross Area (ha)	Assumed 10% SUDS Allowance (ha)	NET Developable Area (ha)	Approx. number of housing units
A	2.60	0.26	2.34	80
B	1.96	0.19	1.76	60
C	2.95	0.29	2.66	91
D	2.97	0.29	2.67	91
E	2.36	0.23	2.13	72
F	2.70	0.27	2.43	83
G	0.91	0.09	0.82	28
H	5.35	0.53	4.82	164
I	2.76	0.27	2.48	85
J	1.92	0.19	1.73	59
K	3.70	0.37	3.33	113
L	3.45	0.34	3.10	106
M	2.93	0.29	2.63	90

APPENDIX E

INDICATIVE SURFACE WATER DRAINAGE CALCULATIONS

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	100.237	0.237	35.8	0.0	35.8	3383.9	O K
30 min Summer	100.325	0.325	36.2	0.0	36.2	4632.5	O K
60 min Summer	100.424	0.424	36.5	0.0	36.5	6043.3	O K
120 min Summer	100.530	0.530	36.5	0.0	36.5	7560.4	O K
180 min Summer	100.591	0.591	36.5	0.0	36.5	8437.7	O K
240 min Summer	100.632	0.632	36.5	0.0	36.5	9020.1	O K
360 min Summer	100.692	0.692	36.5	0.0	36.5	9876.9	O K
480 min Summer	100.733	0.733	36.5	0.0	36.5	10464.7	O K
600 min Summer	100.764	0.764	36.5	0.0	36.5	10898.3	O K
720 min Summer	100.787	0.787	36.5	0.0	36.5	11227.8	O K
960 min Summer	100.819	0.819	36.5	0.0	36.5	11680.6	O K
1440 min Summer	100.848	0.848	36.5	0.0	36.5	12104.1	O K
2160 min Summer	100.849	0.849	36.5	0.0	36.5	12119.9	O K
2880 min Summer	100.825	0.825	36.5	0.0	36.5	11771.6	O K
4320 min Summer	100.782	0.782	36.5	0.0	36.5	11159.8	O K
5760 min Summer	100.750	0.750	36.5	0.0	36.5	10699.0	O K
7200 min Summer	100.720	0.720	36.5	0.0	36.5	10277.9	O K
8640 min Summer	100.691	0.691	36.5	0.0	36.5	9858.0	O K
10080 min Summer	100.661	0.661	36.5	0.0	36.5	9436.4	O K
15 min Winter	100.266	0.266	35.8	0.0	35.8	3794.8	O K
30 min Winter	100.364	0.364	36.4	0.0	36.4	5196.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	110.664	0.0	1744.0	0.0	23
30 min Summer	76.033	0.0	2517.8	0.0	38
60 min Summer	49.937	0.0	4601.4	0.0	68
120 min Summer	31.622	0.0	5649.4	0.0	128
180 min Summer	23.790	0.0	6064.3	0.0	188
240 min Summer	19.279	0.0	6199.5	0.0	248
360 min Summer	14.354	0.0	6197.2	0.0	368
480 min Summer	11.621	0.0	6152.7	0.0	486
600 min Summer	9.854	0.0	6103.2	0.0	606
720 min Summer	8.607	0.0	6056.5	0.0	726
960 min Summer	6.944	0.0	5994.9	0.0	966
1440 min Summer	5.119	0.0	5966.5	0.0	1446
2160 min Summer	3.763	0.0	12190.8	0.0	2164
2880 min Summer	3.020	0.0	12180.5	0.0	2744
4320 min Summer	2.210	0.0	11711.5	0.0	3420
5760 min Summer	1.773	0.0	19973.9	0.0	4160
7200 min Summer	1.495	0.0	20781.2	0.0	4976
8640 min Summer	1.301	0.0	21222.1	0.0	5800
10080 min Summer	1.156	0.0	21128.0	0.0	6656
15 min Winter	110.664	0.0	2012.3	0.0	23
30 min Winter	76.033	0.0	2780.5	0.0	38

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	100.475	0.475	36.5	0.0	36.5	6784.9	O K
120 min Winter	100.596	0.596	36.5	0.0	36.5	8501.7	O K
180 min Winter	100.666	0.666	36.5	0.0	36.5	9503.2	O K
240 min Winter	100.713	0.713	36.5	0.0	36.5	10171.2	O K
360 min Winter	100.783	0.783	36.5	0.0	36.5	11166.5	O K
480 min Winter	100.831	0.831	36.5	0.0	36.5	11861.7	O K
600 min Winter	100.868	0.868	36.5	0.0	36.5	12382.7	O K
720 min Winter	100.896	0.896	36.5	0.0	36.5	12786.6	O K
960 min Winter	100.937	0.937	36.5	0.0	36.5	13366.6	Flood Risk
1440 min Winter	100.981	0.981	36.5	0.0	36.5	13997.8	Flood Risk
2160 min Winter	101.000	1.000	36.5	0.0	36.5	14270.0	Flood Risk
2880 min Winter	100.991	0.991	36.5	0.0	36.5	14136.0	Flood Risk
4320 min Winter	100.933	0.933	36.5	0.0	36.5	13309.9	Flood Risk
5760 min Winter	100.886	0.886	36.5	0.0	36.5	12641.3	O K
7200 min Winter	100.844	0.844	36.5	0.0	36.5	12041.1	O K
8640 min Winter	100.799	0.799	36.5	0.0	36.5	11405.2	O K
10080 min Winter	100.753	0.753	36.5	0.0	36.5	10751.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	49.937	0.0	5115.1	0.0	68
120 min Winter	31.622	0.0	6043.3	0.0	126
180 min Winter	23.790	0.0	6205.2	0.0	186
240 min Winter	19.279	0.0	6179.5	0.0	244
360 min Winter	14.354	0.0	6075.0	0.0	364
480 min Winter	11.621	0.0	5978.8	0.0	482
600 min Winter	9.854	0.0	5925.0	0.0	600
720 min Winter	8.607	0.0	5897.3	0.0	718
960 min Winter	6.944	0.0	5884.5	0.0	950
1440 min Winter	5.119	0.0	5952.8	0.0	1416
2160 min Winter	3.763	0.0	11999.9	0.0	2100
2880 min Winter	3.020	0.0	11940.1	0.0	2768
4320 min Winter	2.210	0.0	11839.7	0.0	3984
5760 min Winter	1.773	0.0	22037.0	0.0	4504
7200 min Winter	1.495	0.0	22567.0	0.0	5408
8640 min Winter	1.301	0.0	22361.1	0.0	6320
10080 min Winter	1.156	0.0	21797.9	0.0	7264

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.308	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 16.500

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	16.500

Model Details

Storage is Offline Dividing Weir Level (m) 101.000
Cover Level (m) 101.200

Tank or Pond Structure

Invert Level (m) 100.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	14270.0	0.700	14270.0	1.400	0.0	2.100	0.0
0.100	14270.0	0.800	14270.0	1.500	0.0	2.200	0.0
0.200	14270.0	0.900	14270.0	1.600	0.0	2.300	0.0
0.300	14270.0	1.000	14270.0	1.700	0.0	2.400	0.0
0.400	14270.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	14270.0	1.200	0.0	1.900	0.0		
0.600	14270.0	1.300	0.0	2.000	0.0		

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0257-3710-1050-3710
Design Head (m)	1.050
Design Flow (l/s)	37.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	257
Invert Level (m)	100.000
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.050	36.6
Flush-Flo™	0.409	36.5
Kick-Flo®	0.787	31.9
Mean Flow over Head Range	-	30.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.3	1.200	39.1	3.000	60.8	7.000	91.8
0.200	26.4	1.400	42.1	3.500	65.5	7.500	94.9
0.300	35.9	1.600	44.9	4.000	69.9	8.000	97.9
0.400	36.5	1.800	47.5	4.500	74.0	8.500	100.9
0.500	36.3	2.000	50.0	5.000	77.9	9.000	103.7
0.600	35.5	2.200	52.3	5.500	81.6	9.500	106.5
0.800	32.2	2.400	54.6	6.000	85.1		
1.000	35.8	2.600	56.7	6.500	88.5		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.500 Invert Level (m) 101.050