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FLOOD RISK ASSESSMENT

ON

LAND

at

**NEWSOME MILLS,
RUTH STREET / HART STREET
HUDDERSFIELD
HD4 6JF**

FOR

PANORAMA LIVING LTD

FEBRUARY 2020

REF: E20/7413/FRA01

Prepared By

T. Haigh. B.Sc., C.Eng., M.I.C.E.



1.0 INTRODUCTION

- 1.1 This report is commissioned to investigate and report on the Flood Risk for this site in accordance with Planning Practise Guidance- Flood Risk and Coastal Change April 2015 (PPG-FRCC). The report is based on information supplied by the client and from relevant authorities in both written and verbal format. Some of this information is in verbal form only. No liability can be accepted for information supplied by third parties which is subsequently found to be inaccurate or incorrect.

2.0 THE SITE

- 2.1 The site is located to the north of Ruth Street and Hart Street, in Newsome district of Huddersfield. It is situated around Ordnance Survey grid reference 414342,414885. There are residential developments to the north, south east and west of the site. The boundary to the north overlooks a small open field. A site location plan is included in Appendix A.
- 2.2 The site is almost rectangular and situated on the edge of a residential area. The site has previously been used for industrial mills together with mill buildings to the south of the site. The overall site area to be developed is approximately 1.1ha.
- 2.3 The site consists of now demolished mill buildings together with former hard standings around the mill buildings. There is sporadic tree growth noted to the north of the site and to the perimeter of the northernmost part of the site. Beyond this there is a very steep incline falling away from the site to the north. There is gated access to the site from Hart Street in the northern part of the site. There was an original access to the site from Ruth Street on the southern edge of the site but this is excluded from the development.
- 2.4 The site is quite flat but generally falls from west to east at a grade of approximately 1 in 40. The site high point of 160.50m AOD is located in the south west of the site, and a low point of 158.5m AOD is located in the North West corner of the site.



3.0 PROPOSED DEVELOPMENT AND CONSTRAINTS

- 3.1 It is understood that the proposed development is for a series of detached, semi-detached and terraced town houses with associated car parking and access roads. A preliminary site layout is attached in the appendices.
- 3.2 The BGS Digital Geological Map of Great Britain at 1:50,000 scale has been consulted and we would report as follows:-
- 3.3 The site is underlain by the Stanningley Sandstone and Lower Coal Measures, a recent site survey has shown cellars beneath the former buildings and a superficial deposit of clays. Mudstone was also found in the trial pits. Permeability tests on site did not prove the underlying materials to be suitable for infiltration systems. For this reason their use has been discounted for this site.
- 3.4 The historical plans indicate that there was a former mill ponds in the mill directly to the south east of the site
- 3.5 The bedrock underlying the site is classified as a Secondary (A) Aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers. There are no groundwater abstraction licences recorded within 250m of the site. There are no recorded licensed discharge consents within 250m of the site. There are no recorded surface water abstractions within 250m of the site. There are no recorded pollution incidents in controlled waters within 250m of the site. The site is not located in a Source Protection Zone. The nearest surface water feature is an un-named tertiary river located 156m south east of the site.
- 3.6 No groundwater was encountered during the excavation of the trial pits, although there was one trial pit that encountered a perched ground water influx which may be due to the cellars found on site



- 3.7 The existing surface water runoff from the site will have been channelled into the adjacent sewerage system but this would have to be proved on site before a discharge to the public sewers could take place. There are no watercourse shown crossing or abutting the site. Yorkshire Water have stated that they will accept run off from the site but proof of existing connection to the system will need to be proved by on site surveys and calculation. They would still require a 40% reduction in the annual discharge rate.

4.0 FLOOD RISK

- 4.1 The site currently falls within flood zone 1 according to the Flood Risk Map for Planning. The development is classified as More Vulnerable in Table 2 of the Planning Practise Guidance- Flood Risk and Coastal Change April 2015 (PPG-FRCC) and Table 3 of that document also states that the development is appropriate within zone 1.
- 4.2 The site does not fall within an area subject to surface water flooding according to the EA maps but there are two small areas showing along the edge of the site which relate to localised shallow depressions on adjacent land. The EA Flood Risk Map for Planning for flooding from fluvial sources does not show flood waters encroaching onto the site.
- 4.3 The site does not fall within an area subject to flooding from reservoirs according to the EA maps.
- 4.4 Due to the size of the development just over 1Ha it would be necessary to prepare a site Specific Flood Risk Assessment for the site.
- 4.5 There are a number of potential flooding mechanisms that PPG-FRCC now requires are evaluated for each proposed development site. Each method of flooding requires an assessment to be made on its probability relative to the site development. The normal requirement of the document is for no flooding of properties for storms up to a 1% probability or a once in a 100 years storm. The risk assessment also includes for flooding both on site and off site, and the effects of the development on the



downstream catchment or the flow regime of the watercourse. PPG-FRCC also requires that the effects of severe storms above the normal 1% probability are reviewed together with the effects of climatic change relating to the design life of the development. These relate to a 30% increase in allowances for climatic change when connected to an existing surface water drainage system.

- 4.6 It also requires that the effects of climate change are taken into account together with the impacts of extreme events and flood defence failures. Prior to this the Sequential Test or the Exceptions test as outlined in PPG-FRCC, must also be applied to each development site. These are not covered in this report.
- 4.7 NPPG – Flood risk and Coastal Change (2015) requires that each flooding mechanism is addressed and levels of risk evaluated. We consider there are three main risks of flooding to the site the alternative mechanisms are not applicable to this site.
 - 4.7.1 Inundation from floodwaters leaving watercourses or rivers entering the site. This can include the effects on culverted watercourses and where the risk of blockage can occur and from breach scenarios.
 - 4.7.2 Rainwater falling on the site and not being able to leave the site at sufficient rate to prevent flooding on the site.
 - 4.7.3 Overland flows from adjacent land sites due to surcharging of sewerage systems or other watercourses.
 - 4.7.4 The impact of the developed site on the existing drainage systems and off-site surface water systems must also be assessed as part of this flood risk assessment.



5.0 DISCUSSION OF FLOOD RISKS

5.1 Flood Risk from Watercourses, River & Tidal

5.1.1 The proposed development area does not fall within the 1% or 0.1% probability Flood Risk Maps (Zone 2 or 3) as published by the Environment Agency. The site is therefore considered not to be at risk from fluvial flooding for the once in 100 year flood event.

5.1.2 The DEFRA plans show some slight flooding on land away from the site but none on site. These depths of flooding are shown as being 300 to 900mm at the low risk scenario and do not affect the site.

High risk means that each year this area has a chance of flooding of greater than 3.3%. This takes into account the effect of any flood defenses in the area. These defenses reduce but do not completely stop the chance of flooding as they can be overtopped, or fail.

Medium risk means that each year this area has a chance of flooding of between 1% and 3.3%. This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped, or fail.

Low risk means that each year this area has a chance of flooding of between 0.1% and 1%. This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped, or fail.

5.1.3 The site map shows no significant flooding even on a low risk scenario on or adjacent to the site. There is some flooding in the low risk scenario some 50m to the north east of the site but only to a depth of 300mm. The layout shows all of the houses to fall in the areas outside of this. We therefore consider that the risk of flooding to the houses is low and the access road to the site would be passable up to the 1 in 100 year



scenario and therefore the development is acceptable and the level of flood risk is sufficiently low to allow it to proceed.

5.2 Risk of Flooding from overland flows from adjacent land.

5.2.1 The site lies on a very slightly sloping site from south east to North West, with a steep escarpment to the north of the site boundary. There is a very slight fall from south to north across the site. The residential development to the east and south that are at slightly higher levels than the site would tend to pass surface water towards the site but are of limited catchment. The surrounding residential areas are all served by public drainage systems and as such the level of risk of flooding from surcharged sewers or drains is considered to be less than 3%. There is always the risk of these systems blocking or being surcharged in extreme events. There is only a small catchment area to the south and west of the site that may produce some overland flows, in extreme conditions or if blockages occur, but these are likely to be small and slow flowing, if at all. We would therefore recommend that an overland flood route is provided through the site to cater for such events as is normal under the sewers for adoption criteria and floor levels are based a minimum of 300mm above existing ground levels.

5.3 Risk of Flooding from Rainwater Falling on Site

5.3.1 The risk of flooding from water falling on site and not being able to leave the site is relatively high. The impermeable area of the site will increase due to the development and this would increase the run off from the site if measures are not under taken to attenuate these flows. There are known flooding problems in the downstream catchment of the River Spen.

5.3.2 The normal hierarchy for surface water discharge is primarily the use of infiltration systems, in accordance with current policies of the EA and Kirklees MDC. There has been a site investigation for this site which indicates that there is no capacity at shallow depth for the site to use infiltration methods and that they are unlikely to be effective in the long-term. For the purposes of this report, the possibility of infiltration methods having to be discarded has been considered and an alternative system of attenuation also considered as a requirement.



5.3.3 The use of infiltration systems have been confirmed as not to be acceptable, then storm water attenuation systems will need be utilised to ensure the flows from the site, to a suitable watercourse, or surface water sewer. These will need to be reduced to acceptable levels, or even agricultural run-off rates. To avoid increasing the flood risk off site. At present Yorkshire water have agreed a discharge to the public water sewers can be utilised provided on site surveys can prove the onsite connections and areas served. The would have to incorporate a 40% reduction in the annual discharge rate to be acceptable. These will require attenuation storage systems to hold surface water. The can take the form of tanks, open swales, ponds, or detention basins but these do tend to take a substantial area of developable land. The system proposed utilises underground tanks and over-sized pipes to store storm-water before discharge at agreed rates to a suitable outfall.

5.3.4 These systems would all have to limit flows down to an acceptable level. At present there are areas of impermeable surface hidden by debris on site which previously served the building and the yard. Yorkshire Water will require proof of their existence and areas served before a discharge to the surface water system would be allowed. The discharge rate for the site would have to reduce to agreed rates of discharge with a 40% reduction in the annual discharge rate being the normally stipulated rate. If Not then agricultural rates of discharge would apply. The provision of open space on the site would be a premium and would probably not allow the use of open swales and ponds for such a purpose. If these cannot be provided then an underground storage facility would have to be provided. This would be in the form of a concrete tank or a series of oversized pipes. These may not provide a suitable level of treatment of the run off from the site and biological systems at source may be needed to ensure suitable discharge contaminants are dealt with. The use of open swales and ponds would allow the use of reed beds and other organic systems to be employed so should be considered in the final designs. Primary treatment for the roads would be the use of trapped gullies for all hard standings. Car park areas over 40 number cars may require the use of an interceptor to remove contaminants. The use of filter drains adjacent to private drives would also provide a first stage treatment of run off from drives.

5.3.5 The size of the storm water storage facilities would need to be determined accurately in the final detailed designs. This should also allow for a 10% increase in permeable area to cater for urban creep and building extensions. These should be all in accordance



with the Planning Practise Guidance- Flood Risk and Coastal Change April National issued in April 2015. The volumes of storage for the storms in excess of the 30 year storms can include flooding to roads and designated areas such as carpark areas or public open space, but must ensure that no buildings are flooded. The most sustainable and economical way of providing this would be in above surface systems such as detention basins, open swales and ponds but these do take up significant areas of land and can be problematical in terms of future maintenance and adoption by the relevant authorities.

5.3.6 Evaluating the original buildings and the areas of roof and hardstanding shows that the original roofed areas of the buildings would have been close to 1134 sq. m. without consideration of the yard areas. Taking this area as that which surface water would have to be catered for, which is a low estimation of the surface water discharge from the site then the annual storm discharge from the site would have been close to 16lit/s. Applying a 40% reduction would give an allowable discharge of 9,5 lit/s. It is therefore proposed to collect the flows from the site and to attenuate these flows to an agreed discharge rate of 9.5 lit/sec for the whole site.

5.3.7 The estimated volumes of storage required for each of the storm profiles based on not exceeding the current proposed discharge rate of 9,6lit/s. are 186cu.m for the 30 year storm, 268cu.m. for the 1 in 100 year storm which rises to 412 cu.m when 30% climate allowance is incorporated. This will have to be agreed with Yorkshire Water and Kirklees MDC Land Drainage Department. For this site, the final volumes of storage will be modelled using WinDES software and for the 1 in 100 year storm including a 30% increase due to climatic effects.

5.4 Impact on existing drainage systems.

5.4.1 If the site is to be developed with attenuation systems and an agreed discharge rate that has reduced the proposed run off to agricultural rates of discharge below those calculated for the site, so there would be no increase in the flood risk to properties off site or in the drainage networks downstream of the site. In real terms there would be slight reduction in flood risk due to the attenuation provided for the 1 in 100 year storms with the discharge rate cut to below the 1 in 1 year storm discharge rate.



6.0 CONCLUSIONS

- 6.1 The area of the site to be developed currently falls within Flood Zone 1 as defined by the EA Flood maps. The area of the site to be developed is not at risk of flooding from river or tidal water up to a 1% return period. The flood risk is considered to be acceptable for residential development.
- 6.2 The development of the site utilising infiltration techniques for the site is considered to be unfeasible. This being the case then attenuation systems to limit flows to proposed discharges of 9.5lit/s which approximates to 60% of the original run off from the site excluding the yard areas. Any such systems should be designed for the 100 year storms with due allowances for climatic change. The use of attenuation systems to reduce the run-off from the site to agreed discharge rates would be required in the final site designs to ensure there is no increase in flood risk to the downstream catchment.
- 6.3 The risk of overland flows entering the site is considered to be very low due to the topography of the area around the site, the drainage systems to the previously developed areas to the north and west, and the relatively small catchment area. The risk can be further minimised by providing a flood water route through the site to ensure flood water flows are directed away from the existing and proposed housing.
- 6.4 The site is shown to be at low risk of shallow flooding from surface water flows. The floor levels of the proposed houses should be a minimum of 300mm above the existing ground level in these areas.

Trevor Haigh B.Sc., C.Eng., M.I.C.E.

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APPENDIX A

LOCATION PLAN



Haigh Huddleston & Associates

Civil Structural Engineering Consultants

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e Trevor.haigh@haighhuddleston.co.uk

Firth Building
99-101 Leeds Road
Dewsbury
WF12 7BU

Client : Panorama Living

Job Title: Newsome Mills

Job Number : E19/7413

LOCATION PLAN

OS Grid Reference : SE 143148

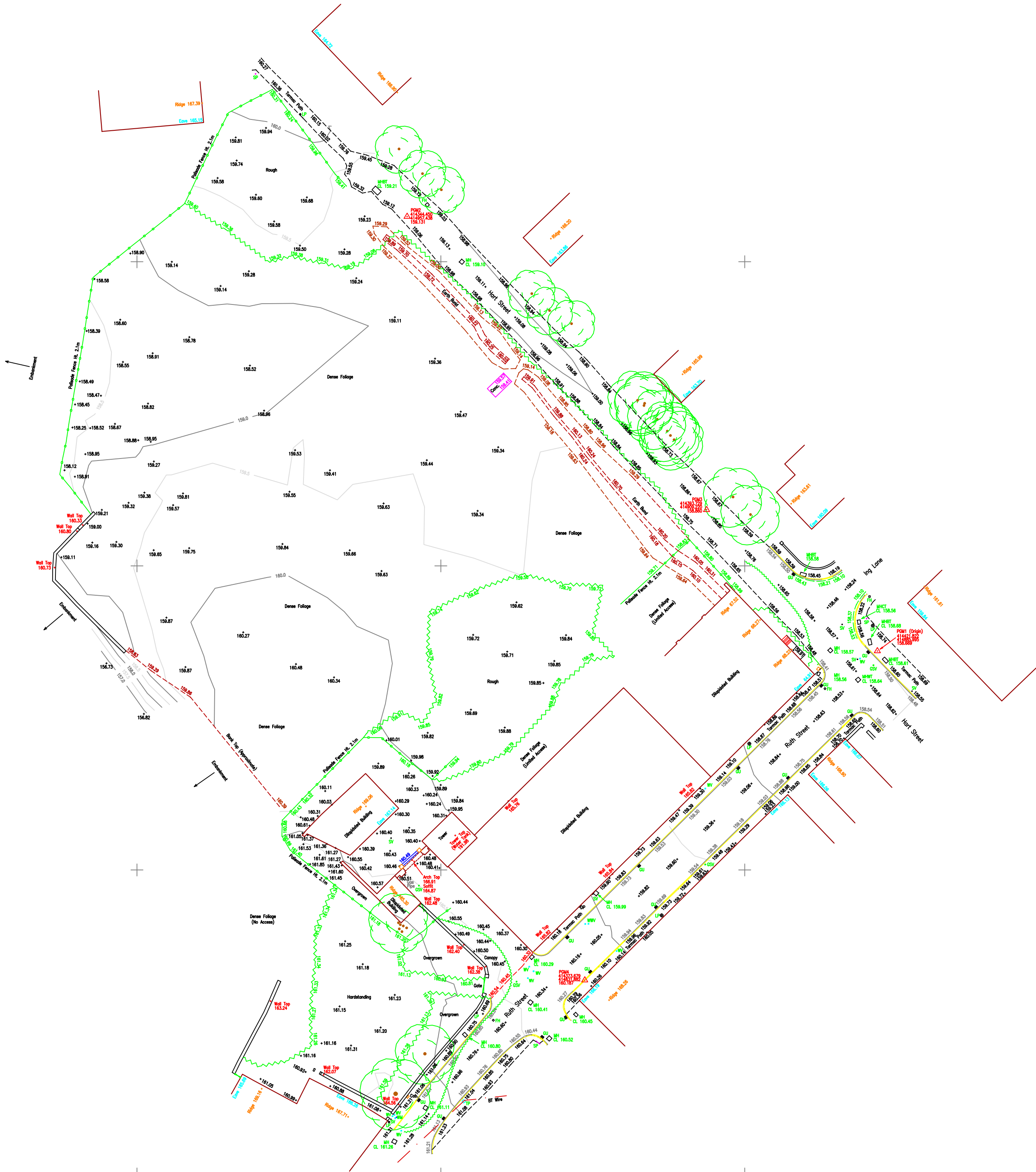
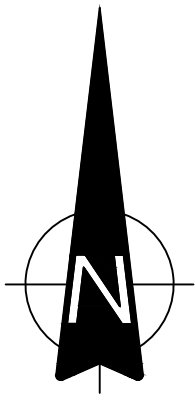
Easting : 414329

Northing : 414812

Topographical Survey carried out using
GPS.

Postcode: HD4 6JF





APPENDIX B

PROPOSED SITE LAYOUT



31 Crescent, Salford, Manchester, M5 4PF
T 0161 736 1447 E office@britch.co.uk

APPENDIX C

YORKSHIRE WATER DRAINAGE RECORDS & CORRESPONDENCE



YorkshireWater

Mr C McDonald
Haigh Huddleston & Associates
Firth Buildings
99-101 Leeds Road
Dewsbury
West Yorkshire
WF12 7BU
c.macdonald@haighhuddleston.co.uk

Yorkshire Water Services
Developer Services
Sewerage Technical Team
PO BOX 52
Bradford
BD3 7AY

Tel: 0345 120 8482
Fax: (01274) 372 834

Your Ref: 7413
Our Ref: V019526

Email:
technical.sewerage@yorkshirewater.co.uk

For telephone enquiries ring:
Chris Roberts on 0345 120 8482

27th November 2019

Dear Mr McDonald,

Land Off Ruth Street, Newsome, HD4 6JF - Pre-Planning Sewerage Enquiry - T631334
(RESIDENTIAL)

Thank you for your recent enquiry. Our charge of £164.00 (plus VAT) will be added to your account with us, reference MWA057. 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.

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

Foul water domestic waste should discharge to the 450 mm diameter public combined sewer recorded in Ruth Street, at a point to the south of site.

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.

If other methods of surface water disposal are not viable and subject to providing satisfactory evidence as to why they have been discounted, curtilage surface water discharges to the public sewer will be restricted to the level of run-off - i.e. same rate of discharge - to that from the existing use of the site less a 30% reduction in the existing discharge. Any discharge of surface water from the site should discharge to similar points of connection to that of the existing use of the site. You will need to demonstrate positive drainage, based on a 1 in 1 year storm, to the public sewer to Yorkshire Water by means of investigation and calculation carried out at your expense.



YorkshireWater

To do this, Yorkshire Water requires to see existing and proposed drainage layouts with pipe sizes, gradients and connection points, measured impermeable areas of the present and proposed use of the site, along with the calculations that show the existing and proposed discharge rate from the site to the public sewer.

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 apply on line or obtain an application form from our website (www.yorkshirewater.com) or by telephoning 0345 120 84 82.

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.

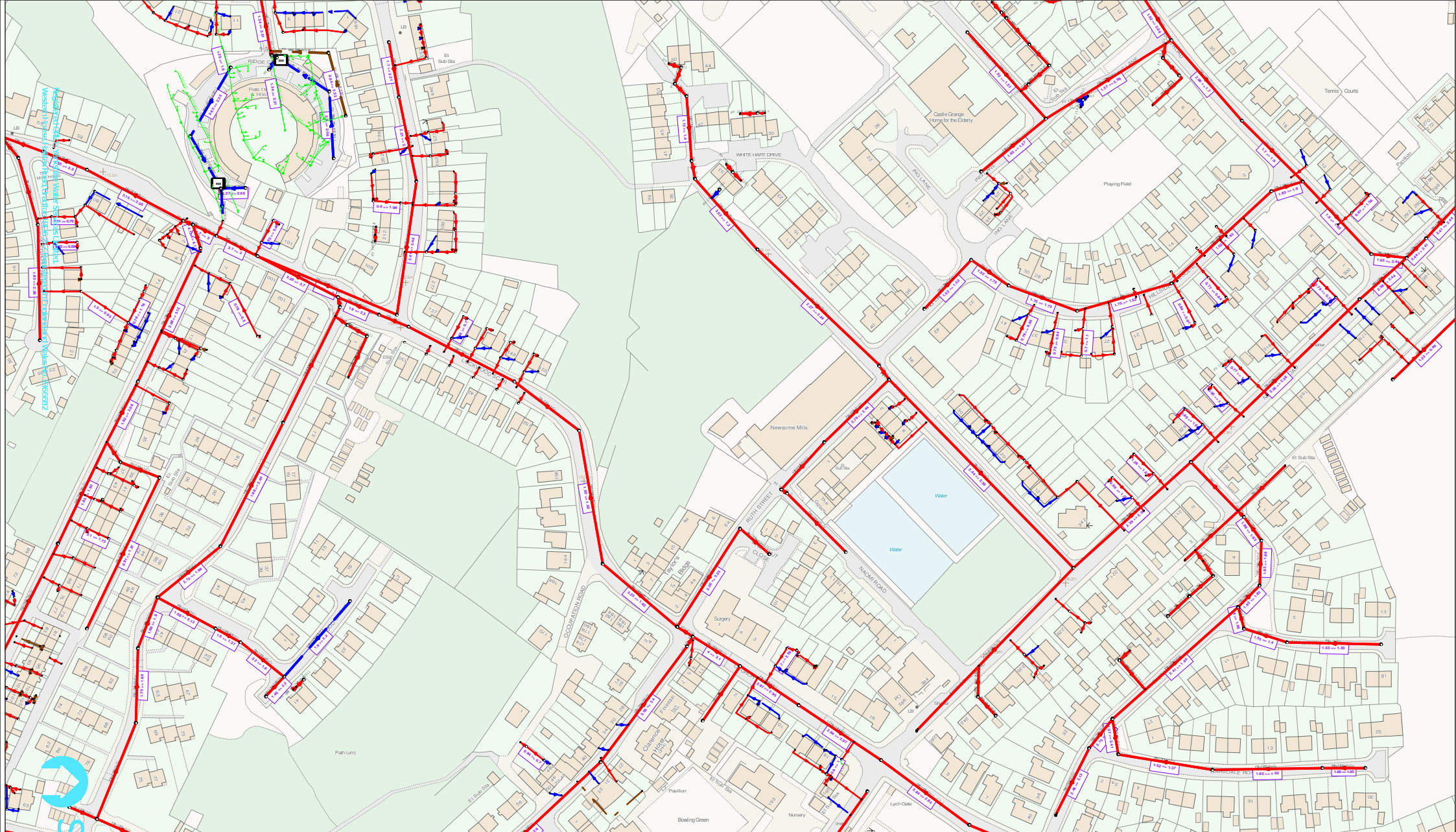
All the above comments are based upon the information and records available at the present time and is subject to formal planning approval agreement. The information contained in this letter together with that shown on any extract from the Statutory Sewer Map that may be enclosed is believed to be correct 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



We are open Monday to Friday
0800 – 1700
We are closed Bank Holidays and
Weekends

Chris Roberts
Sewerage Technical Team
Developer Services
Tel: 0345 1 20 84 82



413902 : 414612	Map Name : SE1314NE
 YorkshireWater	Yorkshire Water, PO Box 500, Halifax Road, Bradford BD6 2LZ Contact Name : Search Advisor L MULLOCK Contact Tel : 75 4506

Title
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

Partial Key
Foul Sewer = F Combined Sewer = C Surface Water Sewer = SW Trade Sewer = TD Partially Separate = PS
Date Req : 30/11/2018, 10:01:59
Source : Sewer Network Enquiry

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.
Date Gen : 30/11/2018, 10:02:03

APPENDIX D

FLOOD RISK MAPS

Flood map for planning

Your reference
panorama

Location (easting/northing)
414352/414889

Created
11 Feb 2020 12:19

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

This means:

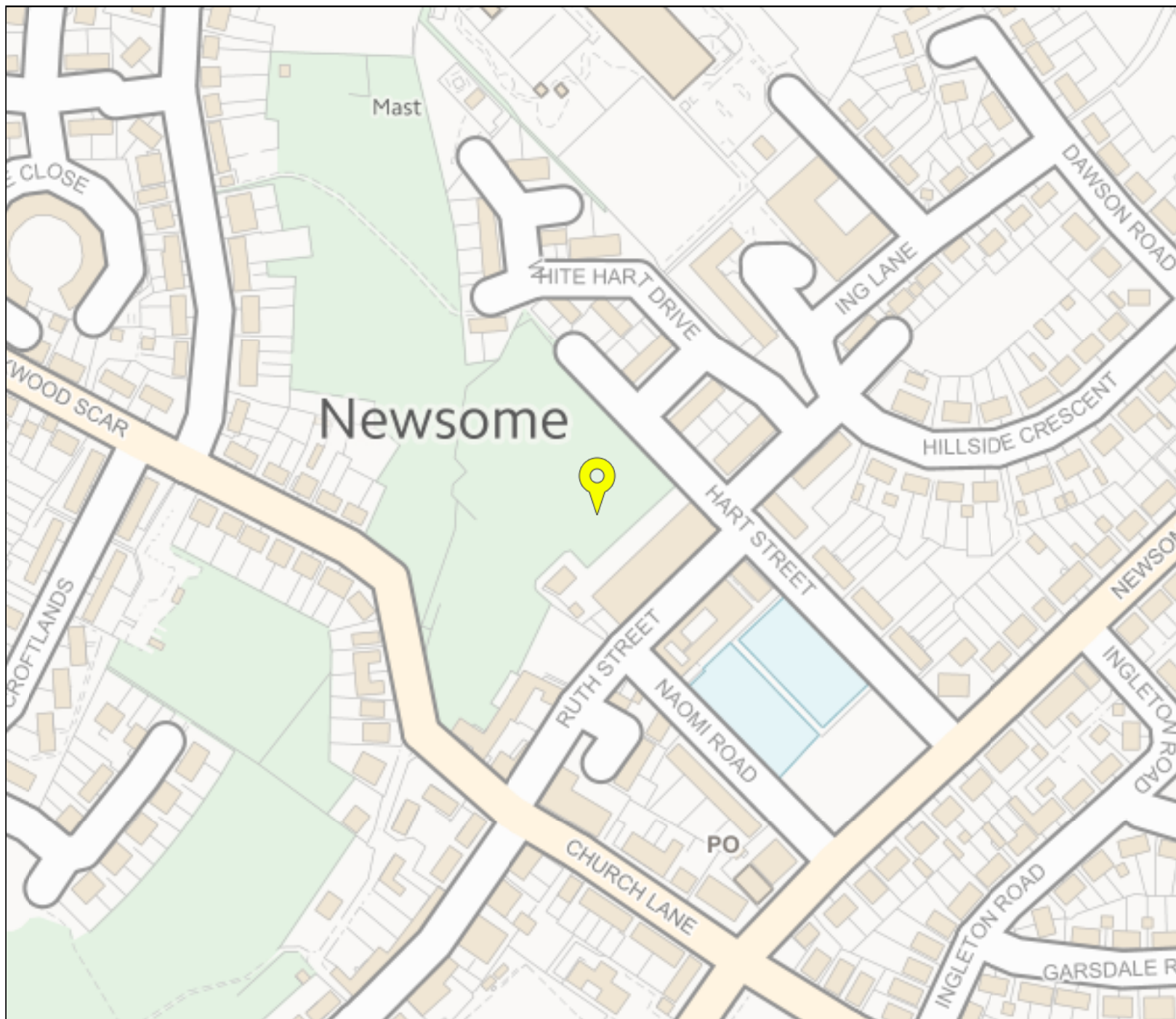
- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage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

Location (easting/northing)
414352/414889

Scale
1:2500

Created
11 Feb 2020 12:19

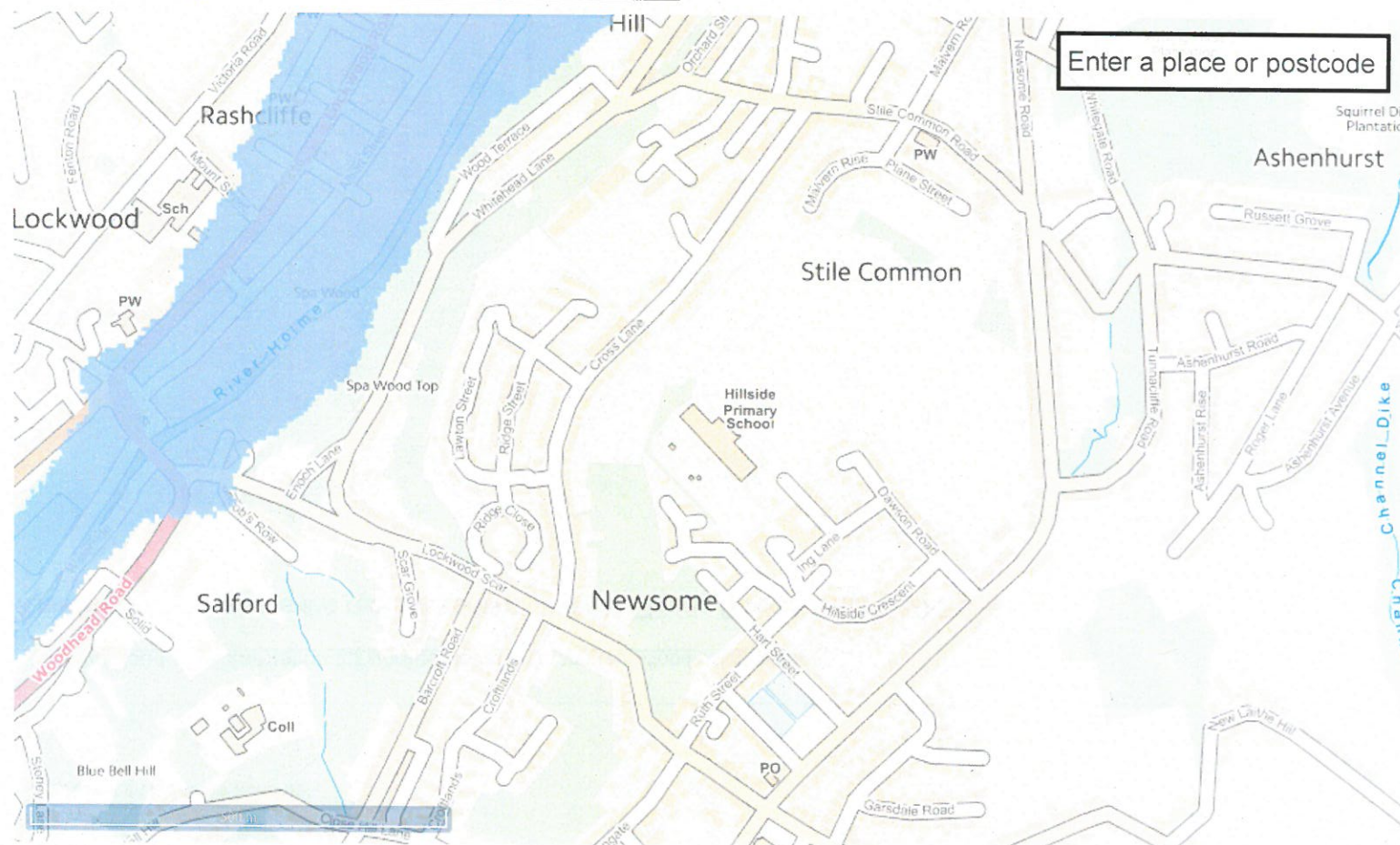
-  Selected point
-  Flood zone 3
-  Flood zone 3: areas benefiting from flood defences
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Flood storage area

0 20 40 60m

Learn more about flood risk

Select the type of flood risk information you're interested in. The map will then update.

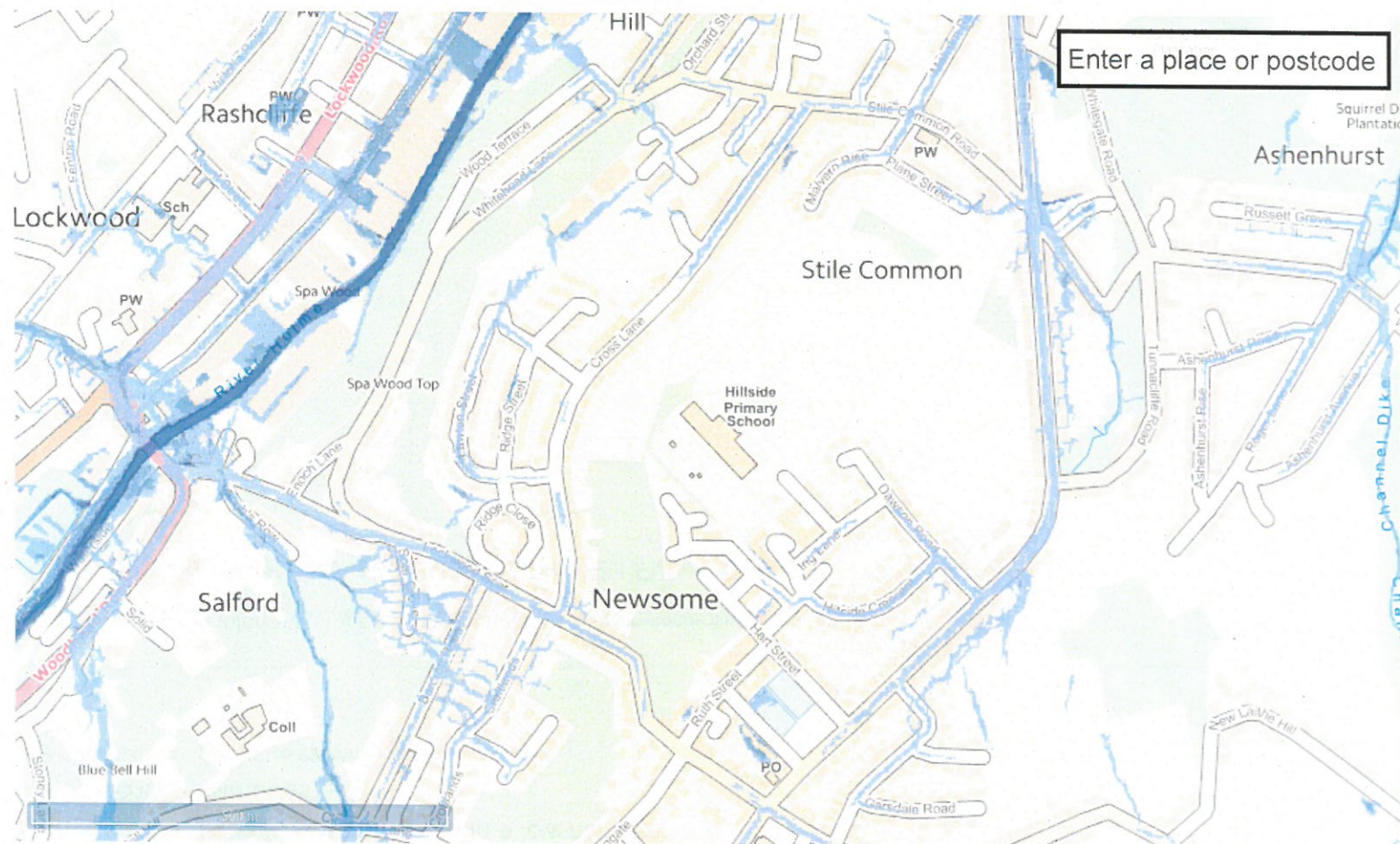
Extent of flooding



Learn more about flood risk

Select the type of flood risk information you're interested in. The map will then update.

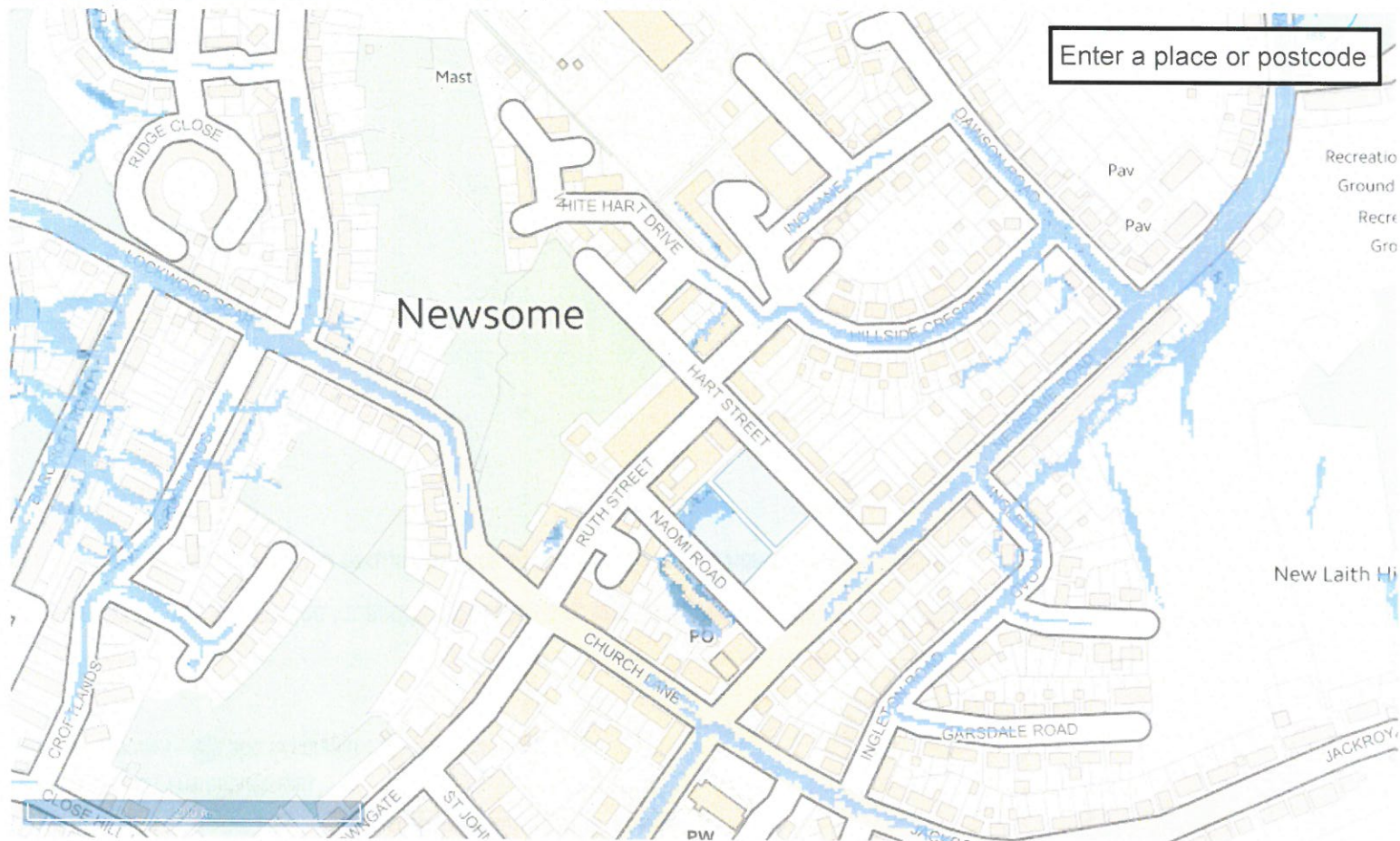
Low risk: depth



Learn more about flood risk

Select the type of flood risk information you're interested in. The map will then update.

Low risk: depth



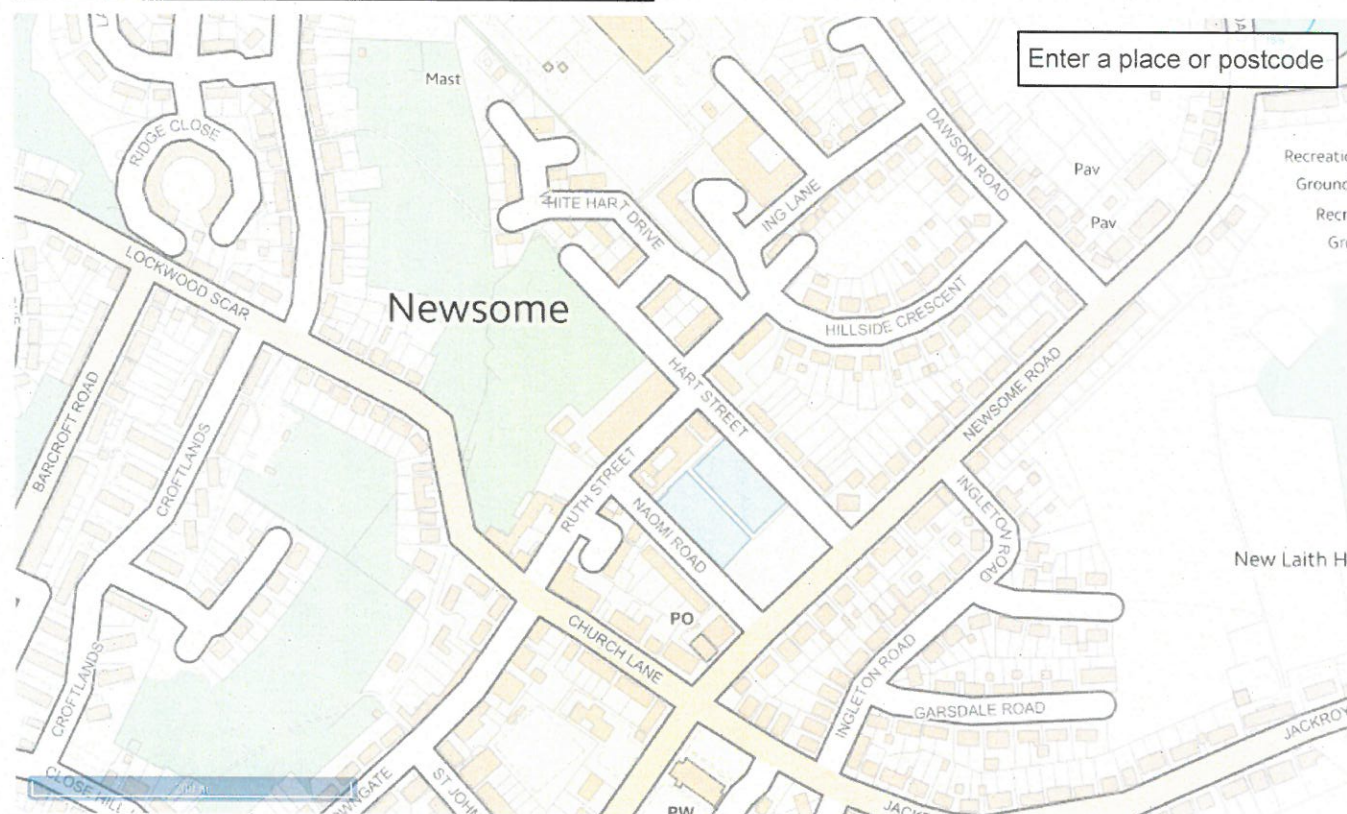
Learn more about flood risk

Select the type of flood risk information you're interested in. The map will then update.

Extent of flooding



Enter a place or postcode



Extent of flooding from rerservoirs

● Maximum extent of flooding

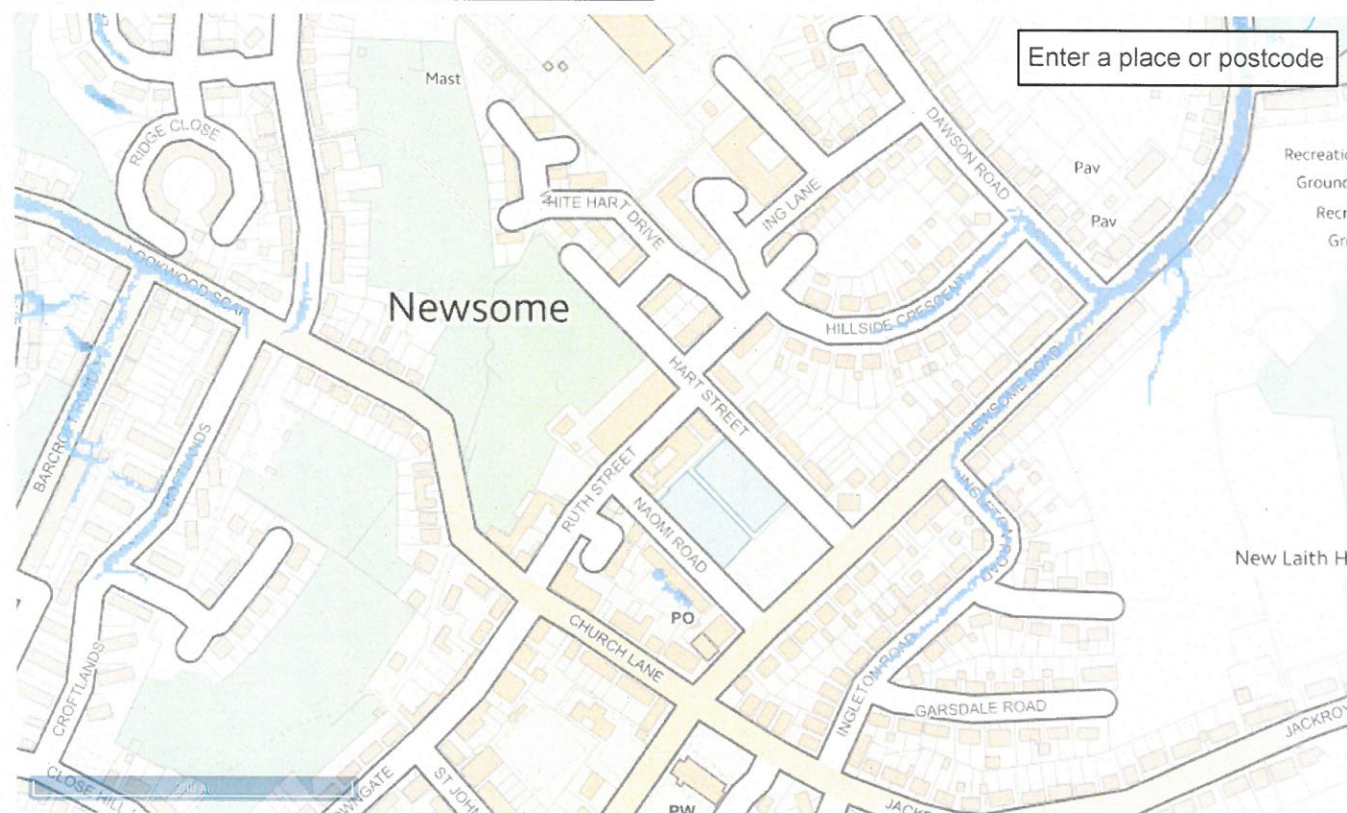
Learn more about flood risk

Select the type of flood risk information you're interested in. The map will then update.

Medium risk: depth



Enter a place or postcode



Surface water flood risk: water depth in a medium risk scenario

Flood depth (millimetres)

Over 900mm 300 to 900mm Below 300mm

Learn more about flood risk

Select the type of flood risk information you're interested in. The map will then update.

Extent of flooding



Enter a place or postcode



Extent of flooding from rivers or the sea

APPENDIX E

STORMWATER STORAGE CALCULATIONS

HAIGH HUDDLESTON ASSOCIATES

Stormwater Storage Calculations

Client **Panorama Living** (Discharge rate based on minimum practical of 12l/s/ha)

Site **Newsome Mills** **E20/**

Design storm 100 M5-60 20 mm
r 0.45
Site area sq m. 9033 orig imp area 1134
Imp Area sq m. 7104 Inc 10% urb flow 15.76
T of Conc min 4 Time to Flow 40% reduction 9.46
Allow Discharge 9.5 Lit / sec Imp Ratio 0.79

<u>Storm Duration</u>	<u>Intensity</u>	<u>Depth</u>	<u>Vol In</u>	<u>Vol Out</u>	<u>Storage</u>	<u>Q</u>	<u>t</u>
<u>Mins</u>	<u>mm/hr</u>	<u>mm</u>	<u>cu.m</u>	<u>cu.m</u>	<u>cu.m</u>		
10	81.8	13.63	96.85	7.85	89.01	161.55	0.2
20	59.8	19.93	141.61	13.50	128.11	118.10	0.3
30	47.6	23.80	169.08	19.15	149.93	94.01	0.4
50	34.4	28.67	203.65	30.46	173.19	67.94	0.6
60	30.3	30.30	215.25	36.12	179.13	59.84	0.6
120	18.7	37.40	265.69	70.09	195.60	36.93	1.0
180	14.1	42.30	300.50	104.10	196.40	27.85	1.4
240	11.5	46.00	326.78	138.13	188.66	22.71	1.7
300	9.8	49.00	348.10	172.16	175.94	19.35	2.0
360	8.7	52.20	370.83	206.22	164.61	17.18	2.2
420	7.9	55.30	392.85	240.29	152.56	15.60	2.4
480	7.5	60.00	426.24	274.42	151.82	14.81	2.6
540	6.9	62.10	441.16	308.49	132.67	13.63	2.8
600	6.38	63.80	453.24	342.56	110.67	12.60	3.0

<u>Storage</u>	<u>196.40</u>
Length of 1800	77.18
Length of 1500	111.15 Culvert
Length of 1200	173.65 culvert
Length of 1050	226.79
Length of 900	308.80
Length of 750	444.34
Length of 600	693.98

<u>Footprint Area</u>		
<u>(m)</u>		
Aquacell Storage Crates	516.834 30 year	172.28 sq.m
(400mm deep)	705.042 100 year	235.01 sq.m
	1083.087 100 year plus climatic	361.03 sq.m

100 year storm

<u>Intensity</u>	<u>Depth</u>	<u>Vol In</u>	<u>Vol Out</u>	<u>Storage</u>
<u>mm/hr</u>	<u>mm</u>	<u>cu.m</u>	<u>cu.m</u>	<u>cu.m</u>
101.27	16.88	119.90	7.85	112.06
74.03	24.68	175.31	13.50	161.81
58.93	29.46	209.32	19.15	190.17
42.59	35.49	252.12	30.46	221.66
37.51	37.51	266.48	36.12	230.36
23.15	46.30	328.92	70.09	258.83
17.46	52.37	372.02	104.10	267.92
14.24	56.95	404.56	138.13	266.43
12.13	60.66	430.94	172.16	258.78
10.77	64.62	459.09	206.22	252.87
9.78	68.46	486.35	240.29	246.06
9.29	74.28	527.69	274.42	253.27
8.54	76.88	546.15	308.49	237.66
7.90	78.98	561.11	342.56	218.54

<u>Storage</u>	<u>267.92</u>
Length of 1800	105.284
Length of 1500	151.622
Length of 1200	236.884
Length of 1050	309.37
Length of 900	421.25
Length of 750	606.14
Length of 600	946.70

100year plus 30% climate

<u>Intensity</u>	<u>Depth</u>	<u>Vol In</u>	<u>Vol Out</u>	<u>Storage</u>
<u>mm/hr</u>	<u>mm</u>	<u>cu.m</u>	<u>cu.m</u>	<u>cu.m</u>
131.65	21.94	155.87	7.85	148.03
96.24	32.08	227.90	13.50	214.40
76.61	38.30	272.11	19.15	252.96
55.36	46.14	327.75	30.46	297.29
48.76	48.76	346.43	36.12	310.31
30.10	60.19	427.60	70.09	357.51
22.69	68.08	483.62	104.10	379.52
18.51	74.03	525.93	138.13	387.80
15.77	78.86	560.23	172.16	388.06
14.00	84.01	596.81	206.22	390.59
12.71	89.00	632.25	240.29	391.96
12.07	96.56	685.99	274.42	411.57
11.10	99.94	710.00	308.49	401.51
10.27	102.68	729.44	342.56	386.88

<u>Storage</u>	<u>411.57</u>
Length of 1800	161.737
Length of 1500	232.922
Length of 1200	363.902
Length of 1050	475.258
Length of 900	647.127
Length of 750	931.161
Length of 600	1454.32