



Norden, Rochdale

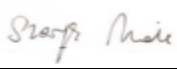
Flood Risk Assessment

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December 2019
Rev: 00



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1.0 INTRODUCTION

1.1 Purpose of this report

This site-specific Flood Risk Assessment (FRA) has been prepared for the proposed development sites in the proximity of Edenfield Road, Norden, Rochdale. The assessment investigates the potential risk and impacts of flooding for the proposed development in accordance with the National Planning Policy Framework (NPPF) and supporting Planning Practice Guidance.

This FRA is considered proportionate to the degree of flood risk and to the scale, nature and location of the development. This FRA has been prepared in accordance with non-statutory technical standards for sustainable drainage and NPPF climate change allowances.

It should be noted that the report, and its associated findings and recommendations, are based upon a limited topographical survey. It has been assumed that the scope and extent of the current survey is sufficient to identify significant and relevant topographical profiles and features. This, however, requires suitable review following the completion and submission of a complete and comprehensive survey.

Details of the proposed drainage strategy will be presented in a separate document.

2.0 THE SITE

2.1 Site Location

The proposed development site is located off Greenbooth Road in Rochdale.

The site location is described below:

- Post Code OL12 7TD
- OS X (Easting) 385736
- OS Y (Northing) 414705
- Nat. Grid SD857147

The site location is illustrated in Figure 2.1 below.



Figure 2.1: Site Location

2.1 Site Description

The site is circa 4.05 hectares and is located within a partially developed area, with the surrounding land being used for residential purposes.

The site forms an irregular shaped parcel of land, which can be divided into three distinct areas. The site includes: the remnants of the Tack Lea Works, occupying the central and northern portion of the site, the former Tenterhouse Mill, located in the western portion of the site and Shepherd Mill in the south eastern part of the site.

The topographical survey (Appendix A) indicates that the site slopes towards the south and south east.

2.2 Existing Site Drainage

The site is 40% impermeable, with associated existing drainage. The remaining area comprises permeable grassed or landscaped areas. The existing site drainage is understood to discharge into the existing foul water systems, with the site discharging to the United Utility sewer along Greenbooth Road. Surface water is assumed to discharge to the existing surface water sewer that also runs along Greenbooth Road.

Two sections of culvert have been identified on the site (refer to Appendix B). One exists beneath the main Tack Lea Works Mill building, with the other beneath the Shepherd Mill building. It is recommended that these culverts be inspected and traced as part of any future measured/topographical site surveys.

In accordance with EA and government policy, with regards to a watercourse which passes through private land, the land owner has riparian responsibilities under law which include:- to pass on water flow without obstruction, pollution or diversion which would affect the rights of others; to maintain the banks and bed of the watercourse, including any trees and shrubs growing on the banks, and any flood defences that exist on it; to maintain and manage any culverted sections of the watercourse, including carrying out all necessary maintenance and repairs; leave the development edge free on the banks next to the watercourse in case of EA or other maintenance or inspection is required.

In addition to the above, a well/spring was identified beneath the dye house in the central site area. The precise location of the well (and also the on-site existing sewers) will need to be established prior to the commencement of the proposed development works.

It is recommended, that a detailed drainage survey should be undertaken as the design develops, in order to verify the existing on-site drainage and connections to the surrounding sewer system. It should also be noted that diversion and re-connection may be required if any damage to the existing land drainage system is caused by foundation or sewer excavations.

2.3 Geology

British Geological Survey (BGS) maps indicate the site to be superficial deposits of Till, Devensian - Diamicton. The bedrock underlying the site is shown to be Rough Rock – Sandstone.

In the Shepherd Mill and Tack Lea areas, drift deposits were found to be absent in some locations. Where drift strata was encountered, it is stated to typically comprise gravelly clay with cobbles or sandstone and saturated, fine to coarse sand and gravel, extending vertically to depths of approximately 2.0m to 4.0m.

Drift deposits are shown to be more extensive, both laterally and vertically to the south and west of the Naden Brook (in the Tenterhouse Mill area). In this area, the drift strata appears to comprise interbedded gravelly clay with sandstone cobbles and medium dense saturated fine to coarse sand and gravel overlying “stiff” to “very stiff” sandy gravelly clay (Glacial Till). In this part of the site, the drift deposits are shown to extend to depths in excess of 15.0m.

It should be noted that a basement is located beneath part of the dye house in the north western part of the site. As such, strip/trench fill foundations will not be suitable in this part of the site. Instead, it is recommended that the basement could be backfilled using engineered fill, in order that raft or piled foundations can be adopted. In addition, it should be re-iterated that a culvert runs beneath this part of the site, which may also significantly influence foundation options.

Given the heritage of the site, contamination is anticipated. It is, therefore recommended that for all garden and landscaped areas a 600mm thick surface cover of “clean” soil comprising 150mm subsoil and 450mm topsoil be provided in order to eliminate any potential link between the underlying contaminated fill and future end-users of the site.

2.4 Hydrology

The site is located approximately 30m north of the Naden Brook that flows south.

Historically, there has been one Surface Water Abstraction recorded on site. The licence relates to industrial/commercial processes at Tack Lea Works. One surface water abstraction point for potable water supply has been recorded at Greenbooth Reservoir 474m to the north west (upstream) from the site.

Aquifer – Drift strata (Glacial Till) are classified by the Environmental Agency as ‘*low permeability non-aquifer*’. Solid strata are classified as a minor aquifer.

2.5 Proposed Development

The proposed redevelopment is for residential end use, comprising a combination of two and three storey townhouses (with and without separate garage/internal garages) with associated gardens, Public Open Space (P.O.S.), adoptable roads and sewers. The proposed Site Layout Plan is shown in Appendix B.

The proposals are to work within the existing site levels following complete demolition of existing buildings on the site.

3.0 SUITABILITY OF DEVELOPMENT PROPOSALS

3.1 Flood Risk Vulnerability

The Flood Risk Vulnerability Classification (FRVC) has been determined in accordance with 'Planning Practice Guidance, Flood Risk and Coastal Change'. For multi-occupancy sites, the FRVC should be based upon the most vulnerable part of the site. The FRVC for the Norden site is considered to be 'More Vulnerable', which includes 'Dwelling houses.'

3.2 Flood Zone Compatibility

The Flood Zone Compatibility (FZC) has been reviewed in accordance with Planning Practice Guidance, Flood Risk and Coastal Change, paragraph 067.

The flood maps for planning indicate that a portion of the site is located in flood Zone 2/3a. Flood data has therefore been obtained from the EA & reviewed. The resulting flood levels when considering a 1 in 100 year event +35% climate change (CC), plus a 600mm freeboard, are lower than the existing surrounding topography, based on the outline level data obtained to date. This is discussed in detail in section 4.0.

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*	✗	✗	✗	✓*

Table 3.1: Flood Risk Vulnerability and Flood Zone Compatibility Key

Key:

✓ Development is appropriate

✗ Development should not be permitted

According to Environment Agency flood maps, areas of the site are classified as in Flood Zone 3a. The vulnerability classification is consequentially 'More Vulnerable'.

When considering the FRVC, the site is graded as Zone 1, 2 and 3a and this is reflected in Table 3.1. However, the EA data indicates that the level of flooding commensurate with Zone 3a is not as widespread as the flood maps indicate and the areas are limited to the line of the watercourse.

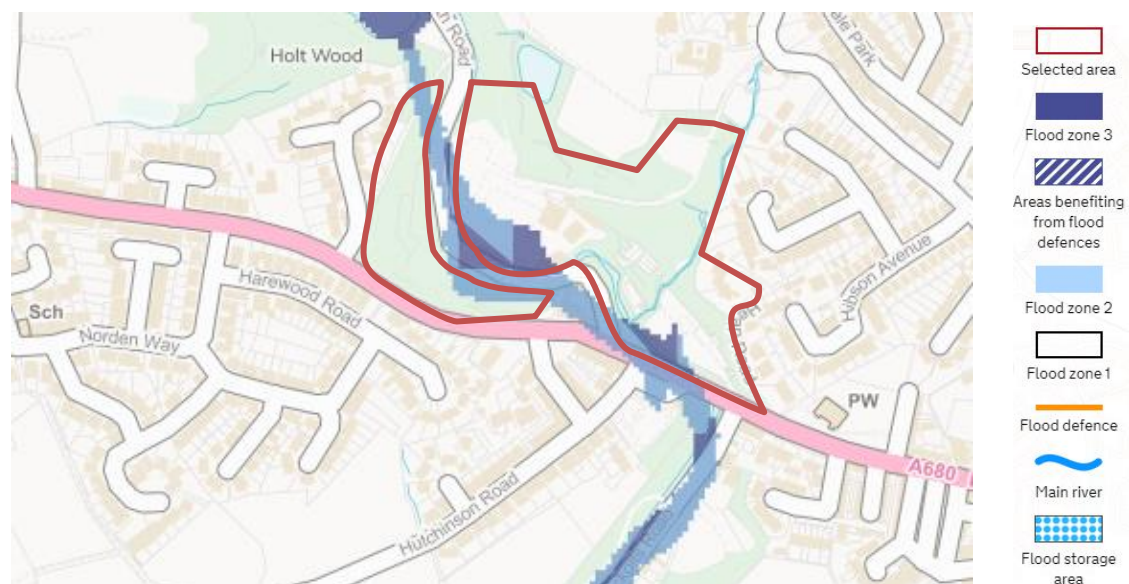
The proposal (Appendix A2) is therefore considered appropriate in accordance with Planning Practice Guidance.

4.0 SOURCES OF FLOODING

4.1 Flood Map for Planning (Rivers and Seas)

Fluvial flooding occurs when high flows exceed the capacity of the river channel and spill out on to the floodplain, usually after a period of prolonged or heavy rainfall.

The EA Flood Map for planning (rivers and sea) has been reviewed. The majority of the site falls into Flood Zone 1. However the maps indicate portions of the site that fall into Flood Zone 3a, as illustrated in the EA Rivers and Sea flood map (Figure 4.1). Flood Zone 3a comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.



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Figure 4.1: Risk of flooding from Rivers and Seas

The Environment Agency have modelled and published water levels for seven points within the vicinity of Naden Brook. These are presented in Appendix E. Node points 2, 3, 4 and 5 intersect the site and are therefore considered to be most appropriate. The flood zone 3 indicated on the flood maps appears to be from the Naden Brook that runs up to the Edenfield Road and appears to be culverted under the site.

From the topographical survey conducted, the ground level falls from the watercourse towards the west of the site.

Additionally, as the Environmental Agency data is based on 20% climate change, the stage-discharge relationship needs to be updated to reflect the current Environment Agency climate change guidance. The proposed buildings are classified as 'more vulnerable', where located in flood zone 3a. Further, the development is considered to be in the North West river basin district. As a consequence, the flood risk allowance should be assessed for the range of Central and Higher Central. Based on the total potential climate change anticipated for '2080s' the Central allowance is 30% and the Higher Central value of 35%. A 35% climate change allowance will therefore be adopted. The climate change allowances have been extrapolated between the 1% AEP + 20% climate change and 0.1% AEP values.

Table 4.1 provides a summary of the various stage-discharge data sets, for the flood risk scenario and events at node points 2, 3, 4 and 5, on the Naden Brook and corresponding event periods greater than 1 in 100 year event. All data received from the Environment Agency is contained in Appendix E.

Map reference	Data	1 in 100 year (1% AEP)	1 in 100 year + 20% CC (1% AEP + 20%)	1 in 100 year + 30% CC (1% AEP + 30%)	1 in 100 year + 35% CC (1% AEP + 35%)	1 in 1000 year
2	Level (mAOD)	165.80	165.88	165.92	165.95	166.05
3		162.21	162.30	162.35	162.37	162.48
4		160.92	161.06	161.12	161.15	161.29
5		157.56	157.71	157.78	157.81	157.96

Table 4.1: Stage-Discharge Data allowing for Climate Change

The topographical survey indicates that the existing ground levels for the site are a minimum 160.00m Above Ordnance Datum (AOD) at the south-eastern edge of the site, increasing to 184.06m AOD towards the north-east corner of the perimeter and 188.87m in the south-western direction. Ground levels surrounding the existing buildings are between 163.67m and 168.27m.

Most of the site is therefore above the 1 in 1000 year level for the given scenario.

The site is not located within the Environment Agency's Flood Warning Area. However, as a small section of the site is in a Flood Zone 3a, consideration of the Building Management for the site and occupiers signing up to the service should be considered. Refer to <https://flood-warning-information.service.gov.uk/warnings> for registration details.

The Environment Agency flood data is considered the most suitable estimate of areas of land at risk of flooding. The data is based on hydrological modelling and indicates the flood risk to areas of land to be less than the EA flood maps for planning. The data has allowed the site to be zoned & guidance on minimum levels for lowest finished flows provided. These minimum levels are lower than the surrounding topography.

4.2 Flooding from Land (Pluvial Flooding)

The Environment Agency Map showing risk of flooding from surface water is presented in Figure 4.2. This type of flooding can be difficult to predict, much more so than river or sea flooding, as it is hard to forecast exactly where or how much rain will fall in any storm.

As illustrated in Figure 4.2, the site is typically at very low (<0.1%) to low (0.1% to 1%) risk of surface water flooding. However, there is a significant section of the site that is at high risk (>3.3%) of flooding. The area relates to overtopping of the river at the point it becomes culverted and appears to lie within a localised depression across this area of the site.

This map is not definitive and is based on the best information available and published by the Environment Agency at the time the report was written.

To mitigate the risk, overland flood flow routing will be considered throughout the design process. This will be achieved by considering a more detailed topographical survey and developing the design to direct the flow routes and to locate the proposed buildings away from these routes.

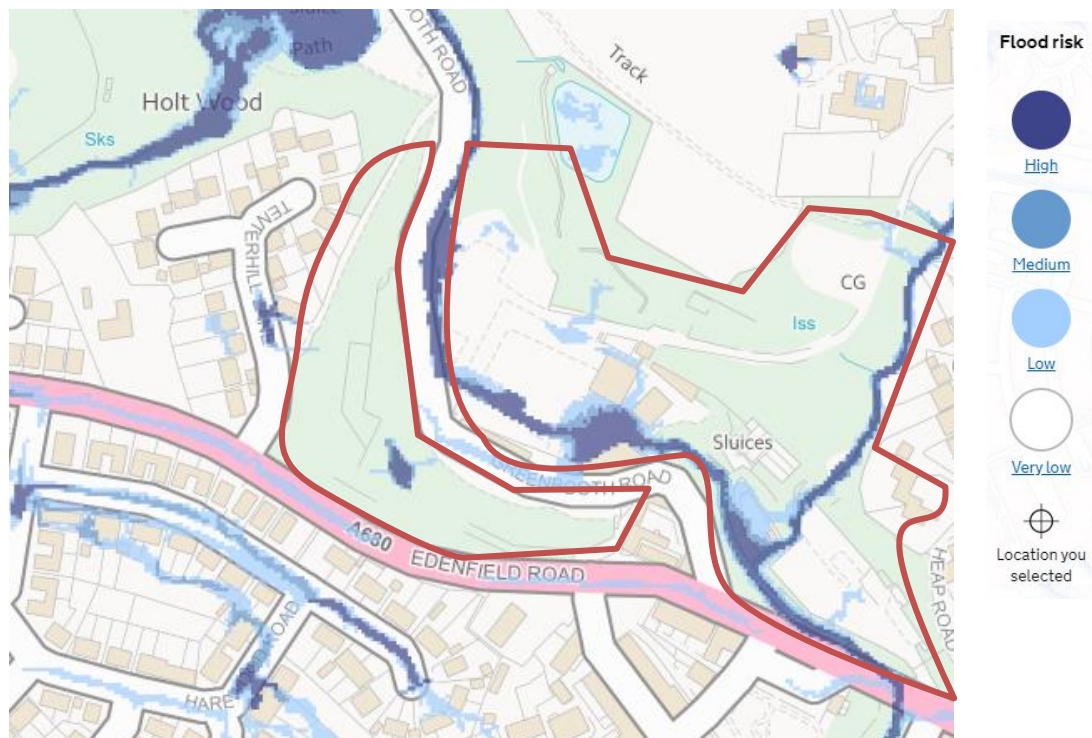


Figure 4.2: Risk of Flooding from Surface Water

4.3 Flooding from Groundwater

Groundwater flooding tends to occur sporadically in both location and time. When groundwater flooding does occur, it tends to mostly affect low-lying areas, below surface infrastructure and buildings (for example, tunnels, basements and car parks) underlain by permeable rock (aquifers).

The site lies outside the groundwater Source Protection Zone (SPZ). As such, no special measures for the protection of the groundwater will be required.

British Geological Survey² data indicates that the site has limited potential for groundwater flooding.

4.4 Flooding from Sewers

Sewer flooding occurs when urban drainage networks become overwhelmed and maximum capacity is reached. This can occur if there is a blockage in the network causing water to back up behind it, or if the sheer volume of water draining into the system is too great to be handled. This type of flooding tends to occur sporadically in both location and time. The majority of sewers are built to the guidelines within the 'Sewers for Adoption' guidance document. These sewers have a design standard for a 1 in 30-year flood event. Consequentially, it is likely that most sewer systems will surcharge during rainstorm events with a return period greater than 30 years.

United Utilities is responsible for the disposal of wastewater within the local area. They have a statutory obligation to maintain a register of properties/areas that are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register. This includes records of flooding incidents from public foul sewers, combined sewers and surface water sewers that are maintained by the Water Company. When an incident is reported, a decision chart is used to assess whether the properties/areas are 'at risk'. Subsequently, the record is added to the appropriate register.

The sewer network at the site is indicated as a foul network, however, has a combined system discharging into it. The proposed development will provide a separate foul & surface water network on site. In this way, the proposed development can be seen therefore to be unable to increase the flood risk of the sewer system.

4.5 Flooding from Reservoirs

The Environment Agency Reservoir flood risk map¹ appears to indicate the site to be within the maximum flood extent of a breach to a reservoir.

Greenbooth reservoir and Mill Pond reservoir are located in close proximity to the west of the site. It should be noted that, although, those reservoirs and area down-stream of the reservoir are classified as being at high risk of flooding, due to the local topography, the site is not considered to be at risk.

According to the *“Oldham and Rochdale Council Strategic Flood Risk Assessment”* Oldham Council no historical flood events have been identified in this area.

In summary, the risk of flooding from reservoirs is considered to be low.

4.6 Summary of Flooding Risks

Based on a review of the flood risk above, the primary cause of flooding to the site is caused by extreme rainfall over an extended period of time, causing the river to exceed in its capacity. Such an event could also be caused by heavy snow melt and ice jams. The risk of flooding from pluvial, surface water, groundwater, sewers, and reservoirs are all considered to be low to moderate.

¹<https://flood-warning-information.service.gov.uk/long-term-flood-risk/map>

²<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

5.0 FLOODING RISK MITIGATION

As parts of the site are designated within a Flood Zone 3a (flood risk from fluvial flooding), the following mitigation measures are required to be accommodated within the proposed scheme:

- **Minimum Residential Ground Floor Level:** The Environment Agency require the ground floor level to be at least 600mm above the 1% AEP +35% flood level. From Table 4.1 the 1% AEP +35% level is 165.95m. As such, the ground floor is to be set at a minimum 166.55m AOD for the area of node point 2, 163.0m, for the area relating to node point 3, 161.8m for the area associated with node point 4 and 158.4m for the region of node point 5. See Appendix B and Appendix C for more details.
- **Minimum Circulation Ground Floor Level:** The entrances to the properties will be set to suit the proposed levels. That is, they are to be raised by 600mm above the 1% AEP +35% level of 165.95m AOD.
- **Safe Access & Egress:** The external landscaped areas to the development will respect existing site levels and will be above the 1% AEP +35% flood level in the range of 157.71m and 165.95m AOD, therefore providing dry access and egress.
- **Flood Resilient Construction:** Rochdale Council require that new developments should be of flood resilient construction up to the 0.1% AEP (1 in 1000 year) flood level is at circa 157.96m AOD. This is more than 300mm below the proposed ground level (approximately 163.0m), therefore, there is no need to adopt a 'Water Exclusion Strategy'.
- **Flood Alerts:** The Building Management for the site and all occupiers are to sign up to the recommended flood warning advise service. Refer to <https://flood-warning-information.service.gov.uk/warnings> for registration details.
- **Flood Plan:** The Client and proposed facility's management team should produce a property specific flood plan. This should include practical steps to be taken in the event of a flood and can include items such as taking out the relevant insurance or using flood mitigation products. The Environment Agency have produced a 'Personal Flood Plan'³ template which provides a checklist and associated guidance to assist owners and residents.

To mitigate the risk of flooding elsewhere, resulting from the site redevelopment, the following risk mitigation measures will be adopted:

- **SUDs:** Sustainable urban drainage systems will be incorporated into the scheme where viable. Refer to the renaissance Outline Drainage Strategy report for further details.
- **Overland Flood Routing:** The levels local to the watercourse are to be reviewed to provide directional overland flood routing away from the residential buildings. This will ensure that the existing overland surface water flood routes are maintained during exceedance events. The adjusted levels will be minor and will be set to ensure that the existing flood storage capacity is maintained.
- **On-site Flood Storage:** Site levels will generally be raised, where necessary by 600mm to maintain on-site flood storage.

³<https://www.gov.uk/government/publications/personal-flood-plan>

6.0 CONCLUSION

The site is partially located within flood zone 3a and therefore at risk of fluvial flooding based on the Environmental Agency flood maps⁴.

However, the proposed site use (residential) is compatible with the flood zone.

Environment Agency data⁵, allowing for climate change, indicates that the site is above the 1% (1 in 100 year) plus 35% climate change flood level of 165.95m AOD for the given risk scenario and above this 1% AEP +35% CC + 600mm freeboard.

Therefore, the risk to the proposed development buildings from fluvial flooding is low.

Flooding risk from pluvial flooding is considered to be 'low' to 'moderate' and is to be managed by reviewing the site levels, maintaining a flood flow route and directing this from the developed area.

Flooding risk from surface water, groundwater, sewers, and reservoirs are all considered to be 'low' to 'moderate'.

Guidance for flood risk mitigation measures are required to address the fluvial flooding risk and are outlined in detail in Section 5.0. A summary of the key items includes:

- Ground Floor Level to residential accommodation to be between 157.71m and 166.55m AOD, dependent on location on site.
- External levels to be reviewed to allow for safe access and egress.
- The Building Management for the site and all occupiers are to consider signing up to the Environment Agency flood alert service. A flood plan should also be produced, communicated and managed.
- Surface water discharge rate from the site is to be restricted to a maximum 50% of the existing brownfield run-off plus greenfield.
- Sustainable Urban Drainage Systems to be incorporated within the development where suitable and appropriate.
- Site levels to be designed to manage and maintain overland flooding.

Based on the flood risk assessment for the site and adoption of the proposed flood risk mitigation measures it is considered that the proposed redevelopment of the site is appropriate and in line with NPPF.

Further Works

A more detailed topographical survey is required to inform the development of the proposals. Further, liaison with the EA will also be required to agree the necessary easements on the watercourse.

⁴<https://flood-map-for-planning.service.gov.uk>

⁵<http://apps.environment-agency.gov.uk>

7.0 REFERENCES

National Planning Policy Framework, Ministry of Housing Communities & Local Government (February 2019)

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<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

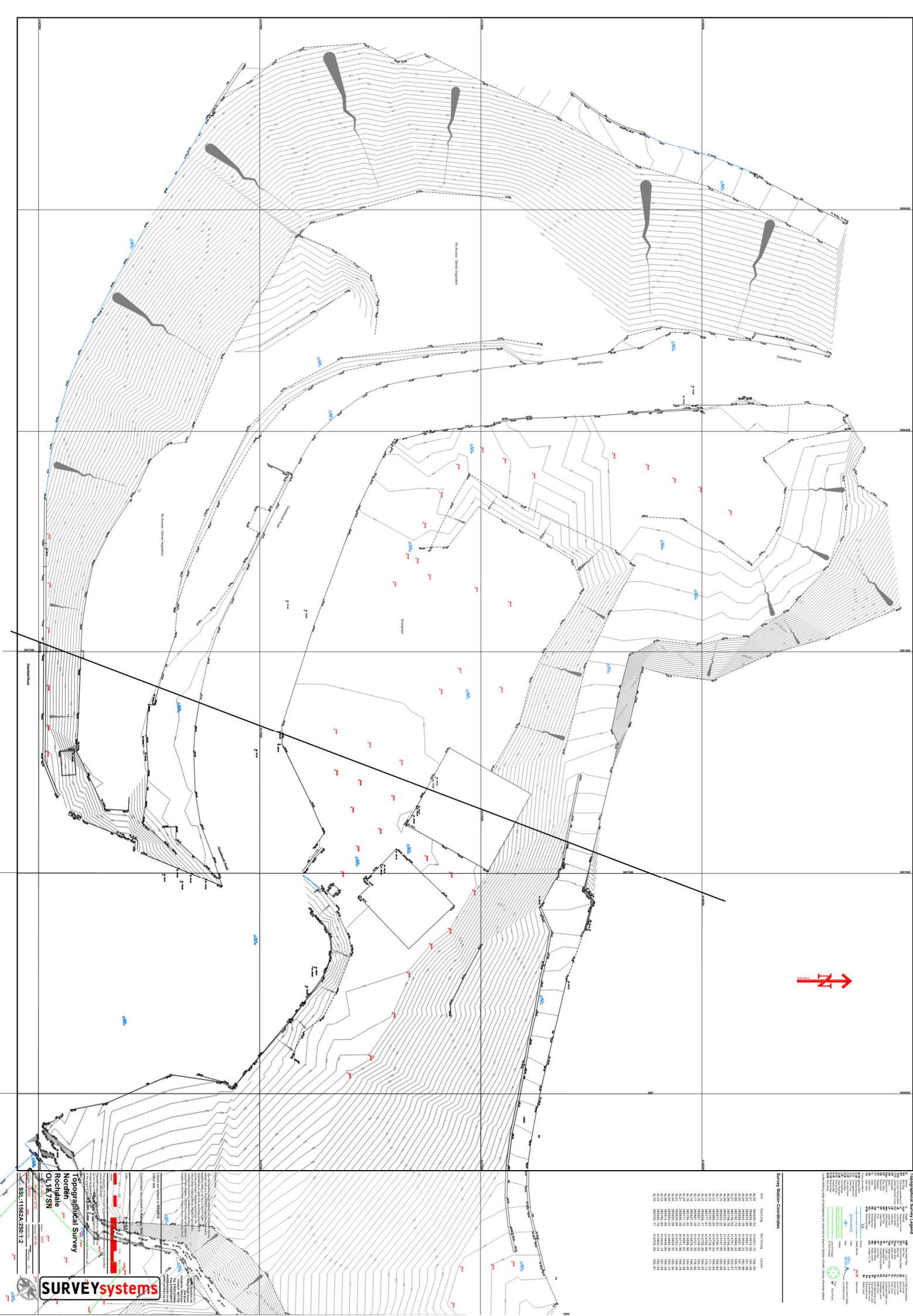
Long term flood risk information <https://flood-warning-information.service.gov.uk/long-term-flood-risk/map>

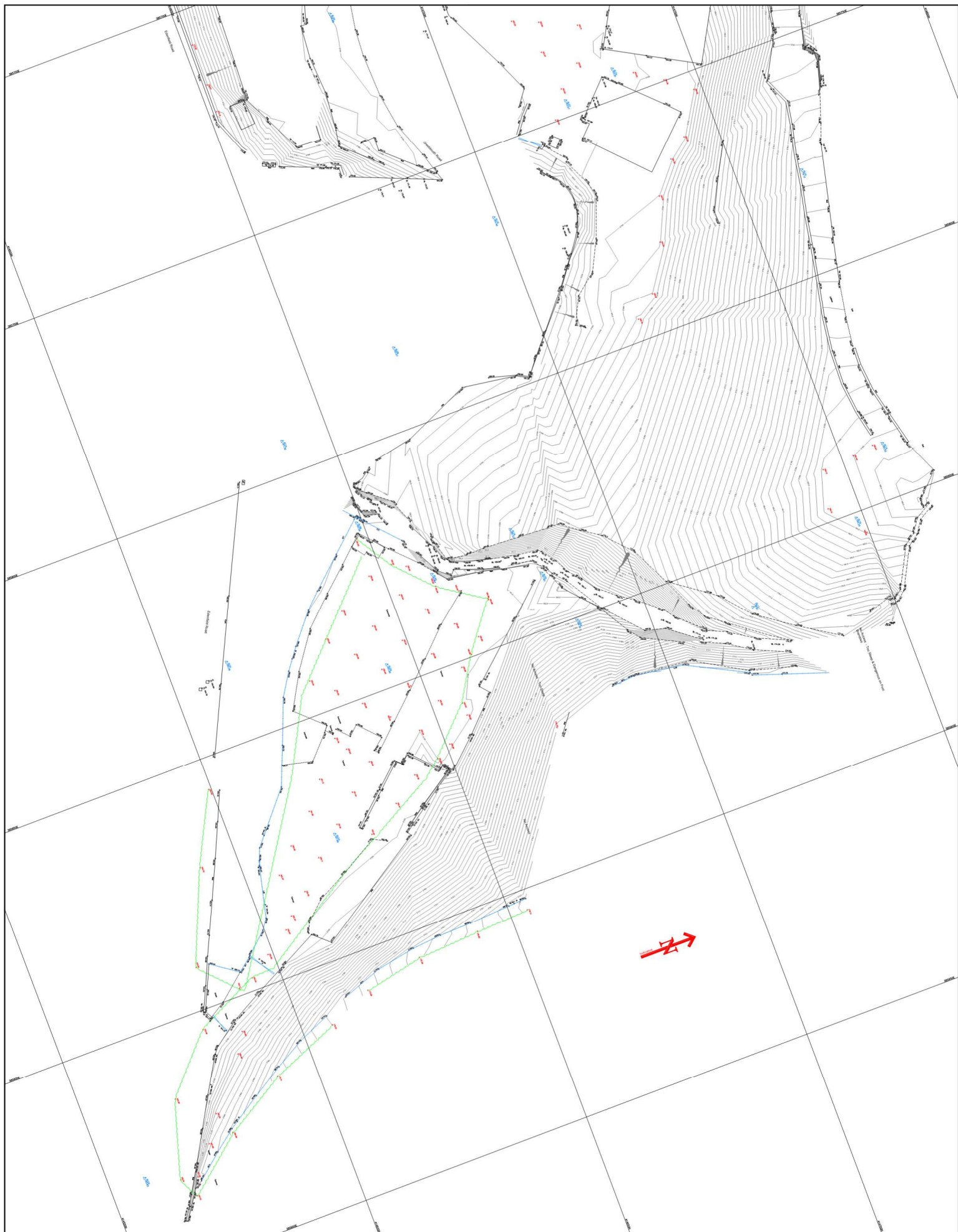
Improving the Flood Performance of New Buildings, Flood Resilient Construction, Department for Communities and Local Government, (May 2007)



APPENDIX A

Existing Topographical Survey





Site	Excavating	Monitoring	Level
As 1	300070.03	61001.74	100.0
As 2	300070.03	61001.74	100.0
As 3	300070.03	61001.74	100.0
As 4	300070.03	61001.74	100.0
As 5	300070.03	61001.74	100.0
As 6	300070.03	61001.74	100.0
As 7	300070.03	61001.74	100.0
As 8	300070.03	61001.74	100.0
As 9	300070.03	61001.74	100.0
As 10	300070.03	61001.74	100.0
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As 78	300070.03	61001.74	100.0

Survey Station Coordinates[illegible][illegible]

stand and improved data
Survey Systems Ltd
Wotton Bassett, Wiltshire
Salisbury, Wiltshire

Topographical Survey
Norden
Rochdale
OL12 7SN

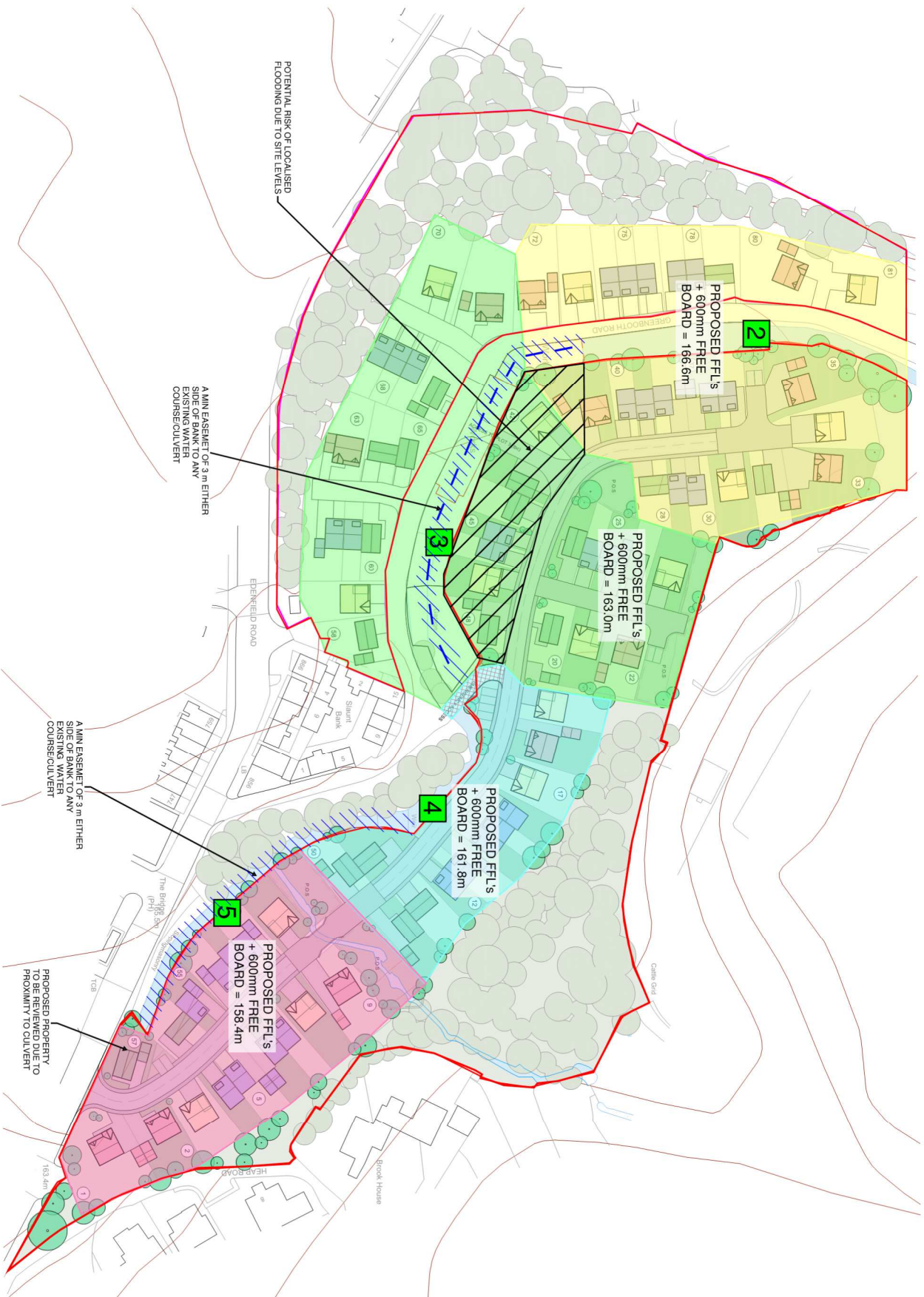
SURVEYsystems





APPENDIX B

Proposed Site Layout Plan



POTENTIAL RISK OF LOCALISED
FLOODING DUE TO SITE LEVELS

A MIN EASEMENT OF 3 m EITHER
SIDE OF BANK TO ANY
EXISTING WATER
COURSE/CULVERT

A MIN EASEMENT OF 9 m EITHER
SIDE OF BANK TO ANY
EXISTING WATER
COURSE/CULVERT

PROPOSED PROPERTY
TO BE REVIEWED DUE TO
PROXIMITY TO CULVERT



Renalissence Associates Ltd
Chimes Way
77 Manchester
M1 2HG

REV	DATE	FOR INFORMATION	MS	GR	PROJECT NO.
00	06.12.19				1906-21
PROJECT	PURPOSE	OPEN	CHK	TITLE	
				PROPOSED SITE LAYOUT-MARKUP	

DRAWING	REV	SCALE	STATUS	FOR INFORMATION
S-XX	00	1:1250 @ A3		

NOTES: FOR INFORMATION



APPENDIX C

Comparison of Flood Levels vs Spot Levels

NOTE:

THE STRATEGIC FLOOD RISK ASSESSMENT FROM MANCHESTER CITY, SALFORD CITY AND TRAFFORD COUNCIL'S LEVEL 2 HYBRID SFRA, DATED MARCH 2011, STATED THAT: "THE VULNERABILITY OF RESIDENTIAL LAND USES IS HIGHER DUE TO THE INCREASED RISK TO PEOPLE. THEREFORE, IT IS RECOMMENDED THAT FLOOD LEVELS FOR HABITABLE USES (DEFINED AS LIVING ROOMS, DINING ROOMS, KITCHENS, HUSBAND AND BEDROOMS) ARE RAISED IN ORDER TO REDUCE THE RISK OF AN ADVERSE FLOOD RISK ABOVE THE MAXIMUM WATER LEVEL DURING A 1 IN 100 YEAR FLOOD EVENT PLUS CLIMATE CHANGE. THE DIFFERENCE BETWEEN THIS LEVEL AND THE 1 IN 1000 YEAR DEFENDED LEVEL SHOULD BE CONSIDERED. IT MAY BE PRACTICAL TO RAISE FLOOD LEVELS TO THE 1 IN 1000 YEAR LEVEL TO ACCOUNT FOR RESIDUAL RISK IN AN EXTREME EVENT. AN ALTERNATIVE WOULD BE TO SET FLOOD LEVELS SO THAT A LOW DEPTH OF FLOODING COULD BE EXPECTED DURING A 1 IN 1000 YEAR EVENT (UP TO 0.6M)."

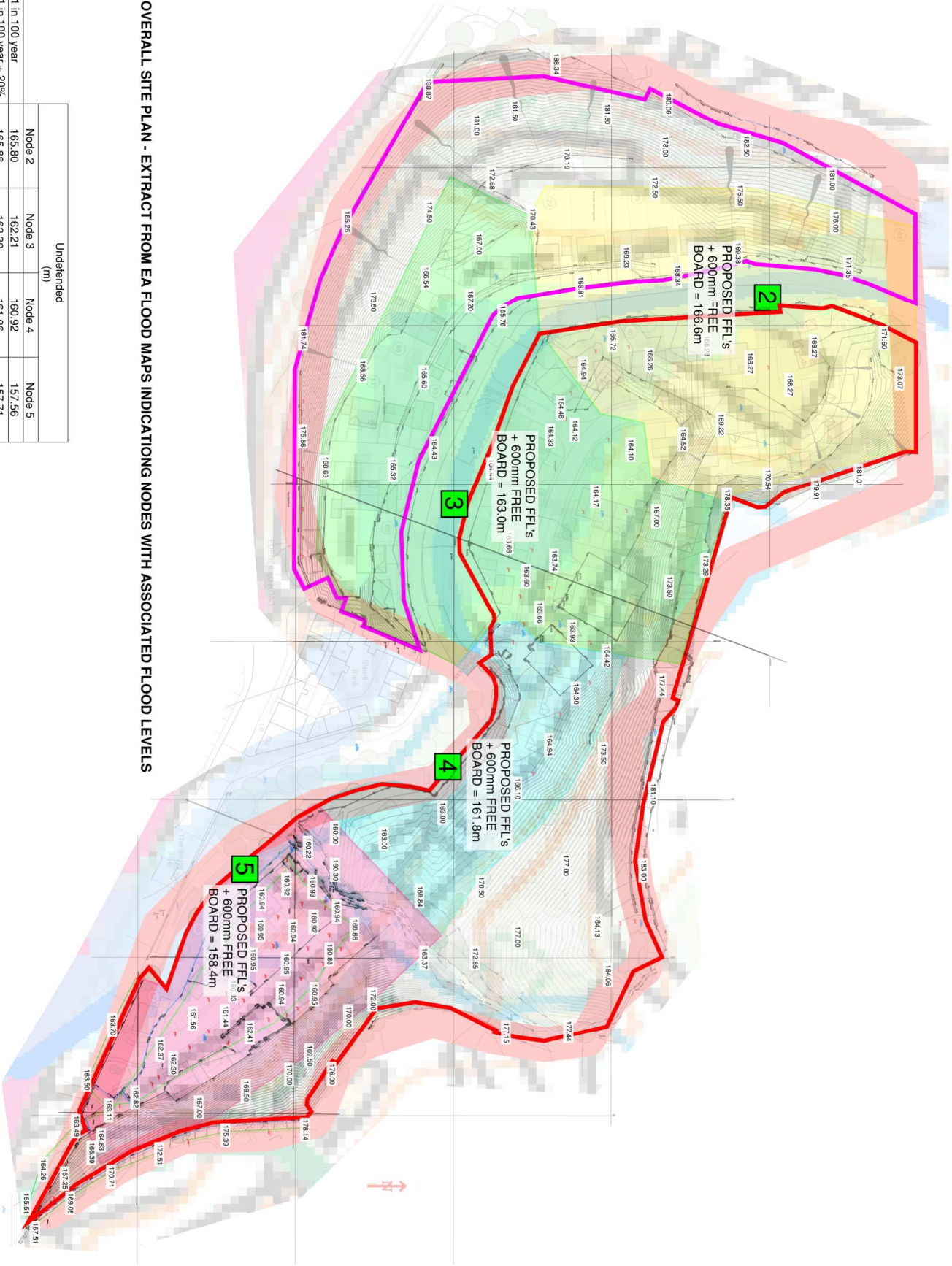
THEREFORE, THE MINIMUM FFL REQUIRED FOR RESIDENTIAL DEVELOPMENT IS THE MAXIMUM WATER LEVEL DURING 1 IN 100 YEAR FLOOD EVENT PLUS CLIMATE CHANGE PLUS 600mm (36.01m/aod), HENCE, BASEMENT IS NOT VIALBE FOR THIS DEVELOPMENT.

KEY

34.00 EXISTING SITE LEVEL.

EA NODE WITH ASSOCIATED FLOOD LEVEL.

FLOOD ZONE 2
FLOOD ZONE 3
MAIN RIVER



OVERALL SITE PLAN - EXTRACT FROM EA FLOOD MAPS INDICATING NODES WITH ASSOCIATED FLOOD LEVELS

Undeveloped (m)	
Node 2	Node 3
Node 4	Node 5

1 in 100 year	165.80	162.21	160.92	157.56
1 in 100 year + 20%	165.88	162.30	161.06	157.71
1 in 100 year + 30%	165.92	162.35	161.12	157.78
1 in 100 year + 35%	165.95	162.37	161.15	157.81
1 in 1000 year	166.05	162.48	161.29	157.96

Proposed FFL's + 600mm free board	166.55	162.97	161.75	158.41
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MODEL NODE DATA

REV	DESCRIPTION	DATE	BY	CHECK
1	PRELIMINARY DRAFT	11/11/20	MS	DN

NORDEN, ROCHDALE
COMPARISON OF FLOOD LEVELS VS SPOT LEVELS

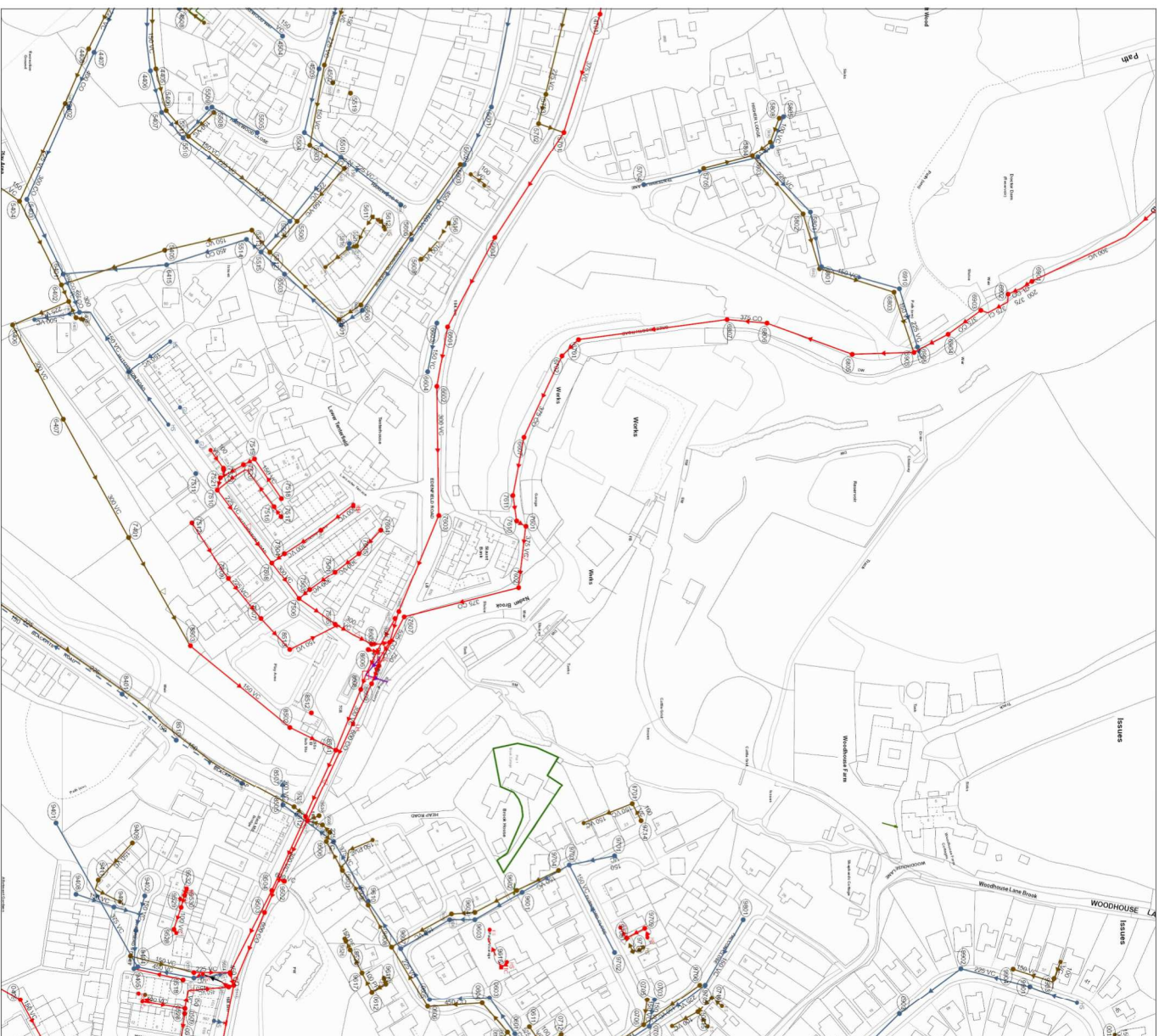
PRELIMINARY

Scale	1:1250	Drawn By	MS	Checked By	DN
Project	NR-REN-00-ZZ-DR-C-0000-P01	Location	1806-21	Drawn By	MS



APPENDIX D

United Utilities Sewer

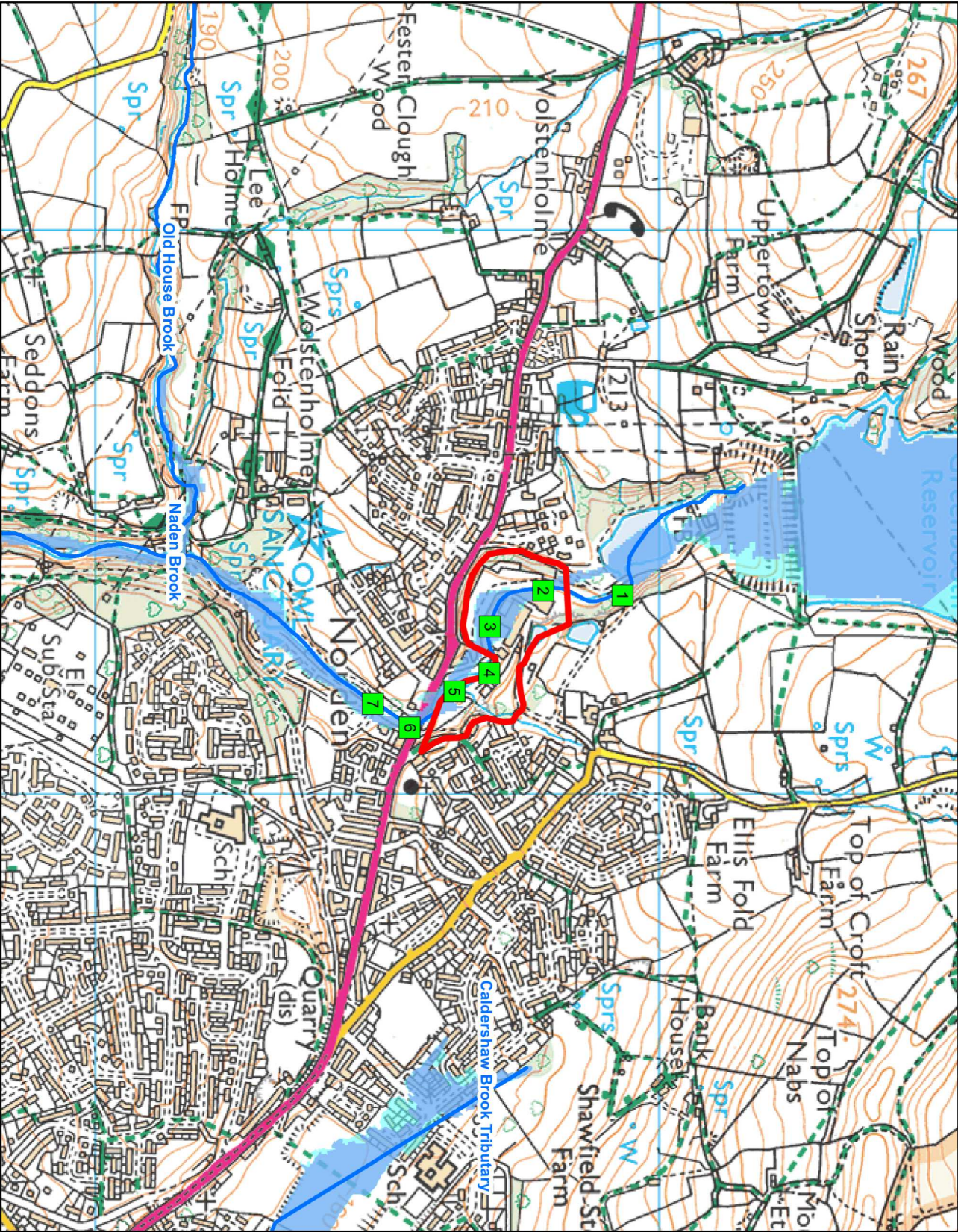
[illegible][illegible]



APPENDIX E

Water Level modelled by Environmental Agency

Detailed Flood Map centred on Greenbooth Road, Rochdale, OL12 7TD. Created on 26/09/2019 [GMMC143424AB]



1:10,001



Legend

- Site Location
- Model Measurements
- Main River
- Flood Zone 3
- Flood Zone 2

Map Reference	Model Node Reference	Existing	Hurting	Data	Undisturbed							
					20 % AEP (1 in 5 year)	18 % AEP (1 in 10 year)	5 % AEP (1 in 20 year)	2 % AEP (1 in 50 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + Climate Change	0.1 % AEP (1 in 1000 year)
1	ea013_0217_MADE01_3096d	386449	414832	Modelled Water Level (m asph)	171.11	171.16	171.20	171.28	171.31	171.34	171.43	171.58
				Modelled Flow (cumecs)	6.36	7.56	8.64	10.74	11.60	12.39	14.87	19.64
2	ea013_0217_MADE01_3080s	386008	414794	Modelled Water Level (m asph)	165.45	166.61	168.66	168.73	168.77	168.80	168.88	168.05
				Modelled Flow (cumecs)	6.86	7.82	9.15	11.11	12.00	12.82	16.38	20.31
3	ea013_0217_MADE01_3875s	386702	414699	Modelled Water Level (m asph)	161.99	162.02	162.07	162.14	162.16	162.21	162.28	162.48
				Modelled Flow (cumecs)	6.86	7.82	9.14	11.11	12.00	12.82	16.38	20.31
4	ea013_0217_MADE01_3360s	386797	414688	Modelled Water Level (m asph)	160.23	160.64	160.70	160.82	160.84	160.82	161.06	161.29
				Modelled Flow (cumecs)	6.52	7.82	9.15	11.11	12.00	12.82	14.38	20.31
5	ea013_0217_MADE01_3306s	386818	414630	Modelled Water Level (m asph)	167.14	167.24	167.32	167.46	167.51	167.56	167.71	167.86
				Modelled Flow (cumecs)	6.02	6.59	11.22	13.83	14.83	15.72	18.87	24.78
6	ea013_0217_MADE01_3386d	386862	414561	Modelled Water Level (m asph)	165.20	165.59	165.69	165.84	165.91	165.95	166.13	166.39
				Modelled Flow (cumecs)	6.07	9.59	11.21	13.83	14.83	15.72	18.87	24.79
7	ea013_0217_MADE01_3313u	386845	414492	Modelled Water Level (m asph)	165.20	165.32	165.46	165.62	165.71	165.77	165.87	166.27
				Modelled Flow (cumecs)	6.08	9.59	11.21	13.83	14.82	15.72	18.87	24.78

Model data taken from Nalden Brook 2016 (Draft)
AEP - Annual Exceedance Probability
m asph - metres above ordnance datum Newlyn
cumecs - cubic metres per second

Notes:

Climate Change Scenario - We only had climate change measurements based on the previous climate change guidance (20% increase in flow). The new climate change guidance is available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/644444/Climate_Change_Guidance.pdf. The location of the site and the type (vulnerability) of development determine the climate change allowance to consider in any flood risk assessment.