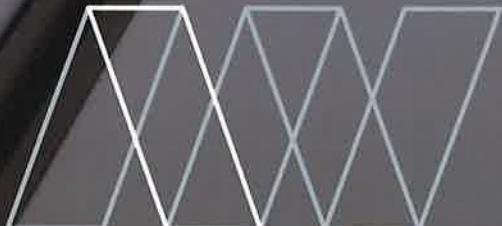


**Engineer/
Manage/
Deliver/**

**FLOOD RISK ASSESSMENT FOR
A PROPOSED RESIDENTIAL
DEVELOPMENT ON LAND OFF
GRANGE ROAD, HULL**



Alan Wood & Partners

**PROJECT NO. JAG/AD/JD/40840-
Rp001-Rev A**

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**FLOOD RISK ASSESSMENT FOR A PROPOSED RESIDENTIAL
DEVELOPMENT ON LAND OFF GRANGE ROAD, HULL**

Prepared by: A Dunn



Signed:
Date: 12th October 2018

Approved by: J Gibson, MEng (Hons), CEng, CWEM MCIWEM
Civil Engineering Director



Signed:
Date: 12th October 2018

Issue	Revision	Revised by	Approved by	Revised Date
A	Added 9 extra plots	CD	JAG	29.01.21

For the avoidance of doubt, the parties confirm that these conditions of engagement shall not and the parties do not intend that these conditions of engagement shall confer on any party any rights to enforce any term of this Agreement pursuant of the Contracts (Rights of third Parties) Act 1999.

The Appointment of Alan Wood & Partners shall be governed by and construed in all respects in accordance with the laws of England & Wales and each party submits to the exclusive jurisdiction of the Courts of England & Wales.

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1.0 INTRODUCTION

1.1 **Background**

- 1.1.1 Alan Wood & Partners were commissioned by Keepmoat Homes to prepare a Flood Risk Assessment for a proposed residential development on land off Grange Road, Hull.
- 1.1.2 A Flood Risk (FRA) for the proposed development is required to assess the development's risk from flooding.
- 1.1.3 This report should be read in conjunction with the Drainage Impact Assessment (DIA) which has been prepared for the development (ref: 40840-Rp002 DIA for Prop'd Resid'l Dev't at Grange Road, Hull).
- 1.1.4 This revision of the report includes for 9 extra plots which have added in the development layout.

1.2 **Layout of Report**

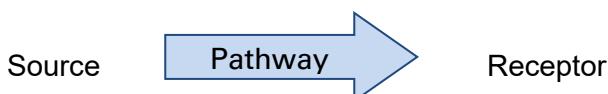
- 1.2.1 Section 1 provides an introduction to the FRA, explains the layout of this FRA and provides an introduction to flood risk and the latest guidance on development and flood risk in England.
- 1.2.2 Section 2 provides an introduction to the site. The site description is based upon a desktop study and information provided by the developer. In order to obtain further information on flood risk, consultation was undertaken with the Environment Agency.
- 1.2.3 Section 3 of this report details the information gathered through the consultation.
- 1.2.4 Section 4 of this report details the development proposals, and considers the development proposals in relation to the current planning policy on development and flood risk in England (and what type of development is considered appropriate in different flood risk zones). National Planning Policy Framework (NPPF): and its associated Technical Guidance (Communities and Local Government, March 2012) is the current planning policy on flood risk in England, and an introduction to NPPF is provided below.

- 1.2.5 Section 5 considers the drainage arrangements for the proposed development. The drainage assessment is based on NPPF, and outlines an indicative foul and surface water drainage strategy.
- 1.2.6 Section 6 of this report considers the flood risk to site, and the potential for the development proposals to impact on flood risk. The assessment of flood risk is based on the latest planning policy and uses all the information gathered as part of FRA. Based on all the work undertaken as part of the FRA.
- 1.2.7 Section 7 of this report provides details of any recommendations for further work to mitigate against possible flooding.
- 1.2.8 Section 8 of this report provides a summary of the report.

1.3 Flood Risk

- 1.3.1 Flood risk takes account of both the probability and the consequences of flooding.
- 1.3.2 Flood risk = probability of flooding x consequences of flooding
- 1.3.3 Probability is usually interpreted in terms of the return period, e.g. 1 in 100 and 1 in 200 year event, etc. In terms of probability, there is a 1 in 100 (1%) chance of one or more 1 in 100 year floods occurring in a given year. The consequences of flooding depends on how vulnerable a receptor is to flooding.

The components of flood risk can be considered using a source-pathway-receptor model.



- 1.3.4 Sources constitute flood hazards, which are anything with the potential to cause harm through flooding (e.g. rainfall extreme sea levels, river flows and canals). Pathways represent the mechanism by which the flood hazard would cause harm to a receptor (e.g. overtopping and failure of embankments and flood defences, inadequate drainage and inundation of floodplains). Receptors comprise the people, property, infrastructure and ecosystems that could potentially be affected should a flood occur.

1.4 National Planning Policy Framework

1.4.1 General

1.4.1.1 NPPF and its associated Technical Guidance replaces Planning Policy Statement 25 and provides guidance on how to evaluate plots with respect to flood risk.

1.4.1.2 A summary of the requirements of NPPF is provided below.

1.4.2 Sources of Flooding

1.4.2.1 NPPF requires an assessment to flood risk to consider all forms of flooding and lists six forms of flooding that should be considered as part of a flood risk assessment. These forms of flooding are listed in Table 1, along with an explanation of each form of flooding.

Table1: Forms of Flooding

Flooding From Rivers (Fluvial Flooding)
Watercourses flood when the amount of water in them exceeds the flow capacity of the river channel. Flooding can either develop gradually or rapidly, depending on the characteristics of the catchment. Land use, topography and the development can have a strong influence on flooding from rivers.
Flooding From the Sea (Tidal Flooding)
Flooding to low-lying land from the sea and tidal estuaries is caused by storm surges and high tides. Where tidal defences exist, they can be overtapped or breached during a severe storm, which may be more likely with climate change.
Flooding from Land (Pluvial Flooding)
Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems can run quickly off land and result in local flooding. In developed areas this flood water can be polluted with domestic sewage where foul sewers surcharge and overflow. Local topography and built form can have a strong influence on the direction and depth of flow. The design of development down to a micro-level can influence or exacerbate this. Overland flow paths should be taken into account in spatial planning for urban developments. Flooding can be exacerbated if development increases the percentage of impervious area.

Flooding from Groundwater
Groundwater flooding occurs when groundwater levels rise above ground levels (i.e. groundwater issues). Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). Chalk is the most extensive source of groundwater flooding.
Flooding from Sewers
In urban areas, rainwater is frequently drained into sewers. Flooding can occur when sewers are overwhelmed by heavy rainfall, and become blocked. Sewer flooding continues until the water drains away.
Flooding from Other Artificial Sources (i.e. reservoirs, canals, lakes and ponds)
Non-natural or artificial sources of flooding can include reservoirs, canals and lakes. Reservoir or canal flooding may occur as a result of the facility being overwhelmed and /or as a result of dam or bank failure.

1.4.3 Flood Zones

- 1.4.3.1 For river and sea flooding, NPPF uses four Flood Zones to characterise flood risk. These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences, and are detailed in Table 2.

Table 2: Flood Zones

Flood Zone	Definition
1	Low probability (less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).
2	Medium probability (between 1 in 100 and 1 in 1,000 annual probability of river flooding (1%-0.1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5%-0.1%) in any year).
3a	High probability (1 in 100 or greater annual probability of river flooding (>1%) in any year or 1 in 200 or greater annual probability of sea flooding (>0.5%) in any given year).
3b	This zone comprises land where water has to flow or be stored in times flood. Land which would flood with an annual probability of 1 in 20 (5%), or is designed to flood in an extreme flood (0.1%) should provide a starting point for discussions to identify functional floodplain.

1.4.4 Vulnerability

1.4.4.1 NPPF classifies the vulnerability of developments to flooding into five categories. These categories are detailed in Table 3.

Table 3: Flood Risk Vulnerability Classification

Flood Risk Vulnerability Classification	Examples of Development Types
Essential Infrastructure	<ul style="list-style-type: none">- Essential utility infrastructure including electricity generating power stations and grid and primary substations- Wind turbines
Highly Vulnerable	<ul style="list-style-type: none">- Police stations, ambulance stations, fire stations, command centres and telecommunications installations required to be operational during flooding.- Emergency dispersal points.- Basement dwellings.- Caravans, mobile homes and park homes intended for permanent residential use.
More Vulnerable	<ul style="list-style-type: none">- Hospitals.- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.- Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.- Non-residential uses for health services, nurseries and educational establishments.- Plots used for holiday or short-let caravans and camping.
Less Vulnerable	<ul style="list-style-type: none">- Building used for shops, financial, professional and other services, restaurants and cafes, hot foot takeaways, offices, general industry, storage and distribution, non-residential institutions not included in "more vulnerable" and assembly and leisure.- Land and buildings used for agriculture and forestry.
Water Compatible	<ul style="list-style-type: none">- Docks, marinas and wharves.- Water based recreation (excluding sleeping accommodation).- Lifeguard and coastguard stations.- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.

1.4.4.2 Based on the vulnerability of a development, NPPF states within what Flood Zones(s) the development is appropriate. The flood risk vulnerability and Flood Zone 'compatibility' of developments is summarised in Table 4.

Table 4: Flood Risk Vulnerability and Flood Zone Compatibility

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test	✓	✓
	3a	Exception Test	✓	x	Exception Test	✓
	3b	Exception Test	✓	x	x	x

1.4.5 The Sequential Test, Exception Test and Sequential Approach

1.4.5.1 The Sequential Test is a risk-based test that should be applied at all stages of development and aims to steer new development to areas with the lowest probability of flooding (Zone 1). This is applied by the Local Planning Authority by means of a Strategic Flood Assessment (SFRA).

1.4.5.2 The SFRA and NPPF may require the Exception Test to be applied to certain forms of new development. The test considers the vulnerability of the new development to flood risk and, to be passed, must demonstrate that:

- There are sustainability benefits that outweigh the flood risk and;
- The new development is safe and does not increase flood risk elsewhere.

1.4.5.3 The Sequential Approach is also a risk based approach to development. In a development site located in several Flood Zones or with other flood risk, the sequential approach directs the most vulnerable types of development towards areas of least risk within the site.

1.4.6 Climate Change

- 1.4.6.1 This is a planning requirement to account for climate change in the proposed design. The recommended allowances should be based on the most relevant guidance from the Environment Agency and the Lead Local Flood Authority.

1.4.7 Sustainable Drainage

- 1.4.7.1 The key planning objectives in NPPF are to appraise, manage and where possible, reduce flood risk. Sustainable Drainage Systems (SuDS) provide an effective way of achieving some of these objectives, and NPPF and Part H of the Building Regulations (DTLR 2002) direct developers towards the use of SuDS wherever possible.

2.0 EXISTING SITE DESCRIPTION

2.1 Location

- 2.1.1 The site occupies land to the south west of Grange Road and to the north of Wingfield Road, Hull.
- 2.1.2 The area of the proposed development currently comprises a vacant area of open grassland with a total area of approximately 4.13 hectares.
- 2.1.3 An aerial photograph and location plan are included in Figure 1 and Figure 2 below, which identify the location of the site.



Figure 1: Aerial Photograph

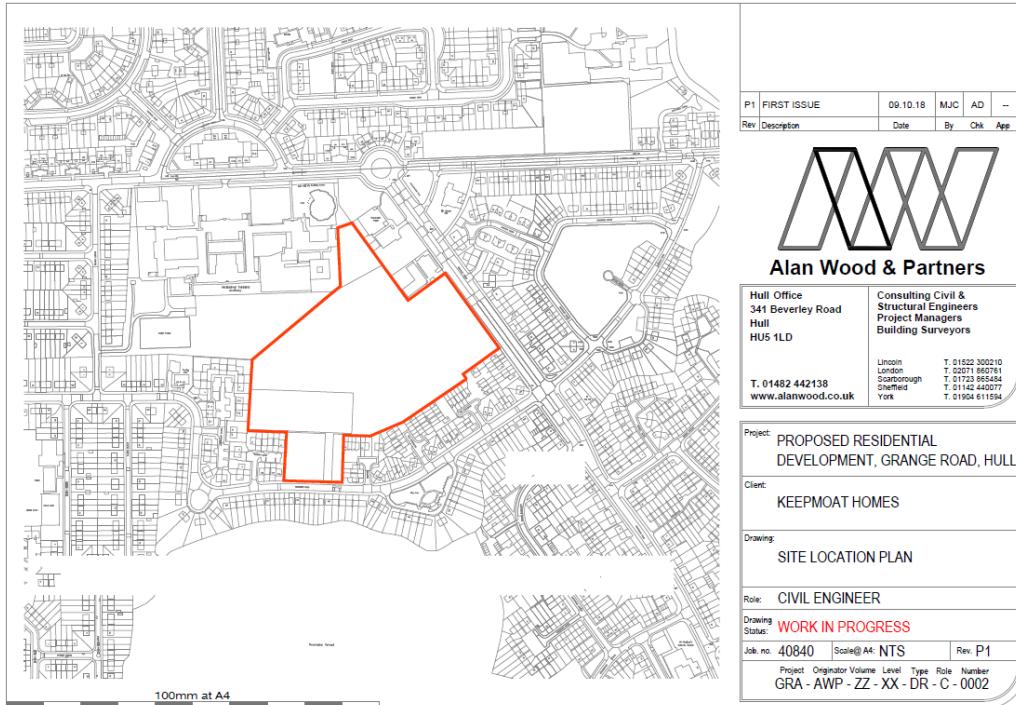


Figure 2: Site Location Plan

- 2.1.4 The Ordnance Survey grid reference for the centre of the site development is approximately 514785, 430990.

2.2 Surrounding Features

- 2.2.1 The site lies within a residential area of Hull.
- 2.2.2 A primary school is located to the north west of the development site.
- 2.2.3 There are existing residential properties adjacent to the western and southern site boundaries.
- 2.2.4 The southern link lies between existing residential properties and adjoins Wingfield Road.
- 2.2.5 The western boundary of the site adjoins two non-residential developments in the north, Grange Road in the central area and an area of open grassland in the south.

2.3 Topography

- 2.3.1 A topographic survey of the development site has been undertaken which shows that existing ground levels over the area of the site vary from approximately 1.73m to 2.35m OD(N).
- 2.3.2 Average road levels along Grange Road fronting the site were found to vary from approximately 1.87m to 2.15m OD(N).
- 2.3.3 Average road levels along Wingfield Road in proximity to the site were found to vary from approximately 1.87m to 1.95m OD(N).
- 2.3.4 A copy of the topographic survey drawing is included in Appendix A.

2.4 Ground Conditions

- 2.4.1 A desktop study of the British Geological Survey maps reveals that the local geology comprises superficial deposits of Alluvium – Clay, Silt and Sand overlaying bedrock comprising White Chalk Subgroup – Chalk.
- 2.4.2 A study of the Groundwater maps has revealed that the site overlays a Principal Aquifer but does not lie in a Groundwater Vulnerability Zone.
- 2.4.3 Intrusive investigations have confirmed that the site is underlain by typical geology and impermeable soils. The full Phase 2 geo-environmental report will be submitted as part of the planning application.

3.0 CONSULTATION

- 3.1 Consultation has taken place with the developer in order to obtain relevant information pertaining to the proposed development.
- 3.2 Consultation has taken place with the Environment Agency in order to obtain relevant information in respect of flood mapping and flood data, details of which are incorporated within this report.
- 3.3 Consultation has taken place with Hull City Council in respect of relevant flood information within the SFRA and in respect of surface water drainage.
- 3.4 Since the previous revision of this report we have had extensive consultation with the EA regarding house floor levels as shown in the EA correspondence in Appendix D. As a result of this agreement, we are proposing that floor levels of the 9 new plots are set at 2.95m as this section of the site is actually at the highest elevation of the site and consequently the lowest flood risk.

4.0 PROPOSED DEVELOPMENT

- 4.1 The original proposed development involved the construction of a new residential development comprising approximately 121 residential properties together with associated service supplies, infrastructure works and areas of public open space. 9 extra plots have now been added into the development boundary. The drainage from these plots will connect into the existing system.
- 4.2 An indicative layout drawing of the proposed development is included in Appendix B. A plan showing the extra 9 plots is also included in Appendix B.
- 4.3 In terms of flood risk, the development is classed as 'More Vulnerable' in terms of flood risk vulnerability (Table 3).
- 4.4 In terms of flood zone compatibility, the development is considered to require a Sequential Test and an Exception Test as it is located in Flood Zone 3 (Table 4).

5.0 DRAINAGE ASSESSMENT

5.1 Surface Water Drainage

- 5.1.1 From the aerial photograph included in Figure 3, it can be seen that the development site currently comprises an area of open grassland.



Figure 3: Aerial Photograph

- 5.1.2 The overall area of the site has been calculated at approximately 4.13 hectares.
- 5.1.3 Based upon a greenfield run-off rate of 1.4 litres per second per hectare, the current discharge from the site would equate to approximately 5.8 litres per second.
- 5.1.4 Based upon the layout drawing included in Appendix B the area of the site which will be impermeable in the form of roofs, roads and paving has been calculated at 1.982 hectares which includes for the extra 9 plots.
- 5.1.5 The site impermeable areas were increased by 10% to allow for urban creep.

- 5.1.6 Requirement H3 of the Building Regulations establishes a preferred hierarchy for disposal of surface water. Consideration should firstly be given to soakaway, infiltration, watercourse and sewer in that priority order.
- 5.1.7 Ground conditions in the area of the development are not suitable for soakaways/infiltration methods to be used due to the presence of glacial clays and a high water table.
- 5.1.8 The second preferred option is for the surface water run-off to be discharged to a watercourse.
- 5.1.9 Investigations reveal that there are no open watercourses in the vicinity into which surface water run-off from the development could be discharged.
- 5.1.10 It is therefore proposed that surface water run-off from the site will be discharged to a public sewer.
- 5.1.11 SuDS Guidance advises that developers should strive to attain a greenfield equivalent run-off from the site, which for this development would be approximately 5.8 litres per second.
- 5.1.12 However, Yorkshire Water Services have advised that the maximum discharge rate which can be accommodated within the public sewer network is 4 litres per second due to the limited capacity of the sewer and consequently this discharge rate has been used for design purposes.
- 5.1.13 The design of the surface water drainage will need to be based on a 100 year storm event including an additional allowance for climate change resulting from global warming (30%).
- 5.1.13 Based upon the above criteria, calculations have been undertaken in order to assess the volume of surface water storage which will need to be provided.
- 5.1.14 A summary of the results of the calculations is set out in Table 5 below.

Table 5: Volume of Surface Water Storage Required

Storm Event	2 Year Storm	30 Year Storm	100 Year Storm + 30%
Storage Volume Required	399m ³	706m ³	1362m ³
Additional Storage Volume Required	Nil	307m ³	656m ³

- 5.1.15 A copy of the surface water storage calculations is included in Appendix C. It is noted that the additional 9 plots can be accommodated in the existing scheme which has been designed for the initial 121 plots.
- 5.1.16 The calculated storage volumes have been updated to the detailed design stage for the previous larger development.
- 5.1.17 To comply with current design requirements the drainage system will need to contain the 30 year storm volume below ground within the drainage network in the form of oversized pipes or an adoptable storage system, which has been calculated at approximately 706m³.
- 5.1.18 For this development, it is proposed that the required storage for the 30 year storm event which has been calculated at approximately 706m³ will be provided within oversized drainage pipes and a precast concrete storage chamber which would be adopted under the Section 104 Agreement.
- 5.1.19 The required volume to accommodate a 100 year storm event plus climate change must be stored such that it remains within the confines of the site without posing a risk of flooding to the development or to other parties.
- 5.1.20 The additional storage volume required to accommodate the 100 year storm + 30% climate change can be stored on site providing it does not pose a risk of flooding to the development and does not leave the confines of the site. This storage volume has been calculated at approximately 656m³ (1362m³ minus 706m³).

5.1.21 For this development, it is proposed that the additional volume of storage required to accommodate the 100 year storm event including climate change will be stored in an attenuation lagoon located in the area of public open space.

5.2 Foul Water Drainage

- 5.2.1 Based upon a development of approximately 130 (121+9) dwellings and a peak rate of 4,000 litres per dwelling per day in accordance with Sewerage Sector Guidance Appendix C – March 2020 the peak foul water flow from the full development site would be approximately 6.0 litres per second. This is an extra 0.4 litres per second for the extra 9 plots.
- 5.2.2 Due to the relative levels between the new foul water drainage network and the existing public sewer in Grange Road it will be necessary to provide a pumped outfall from the development.
- 5.2.3 A foul water pumping station and rising main will therefore be required, which will be constructed to Yorkshire Water Services adoptable standards.
- 5.2.4 The pumped outfall will discharge to an adoptable manhole chamber which will in turn discharge to the public sewer in Grange Road by means of a gravity outfall.
- 5.2.5 For a pumped outfall Yorkshire Water Services have advised that the maximum discharge rate would be 2.8 litres per second, with an appropriate volume of storage being provided.

6.0 FLOOD RISK ASSESSMENT

6.1 Flood Zone

- 6.1.1 A copy of the Environment Agency Flood Map for Planning is included in Figure 4 below which identifies the development site to be located within an area designated as Flood Zone 3a, (high probability of flooding), comprising land assessed as having a 1 in 100 or greater annual probability of river flooding or a 1 in 200 year or greater annual probability of flooding from the sea.

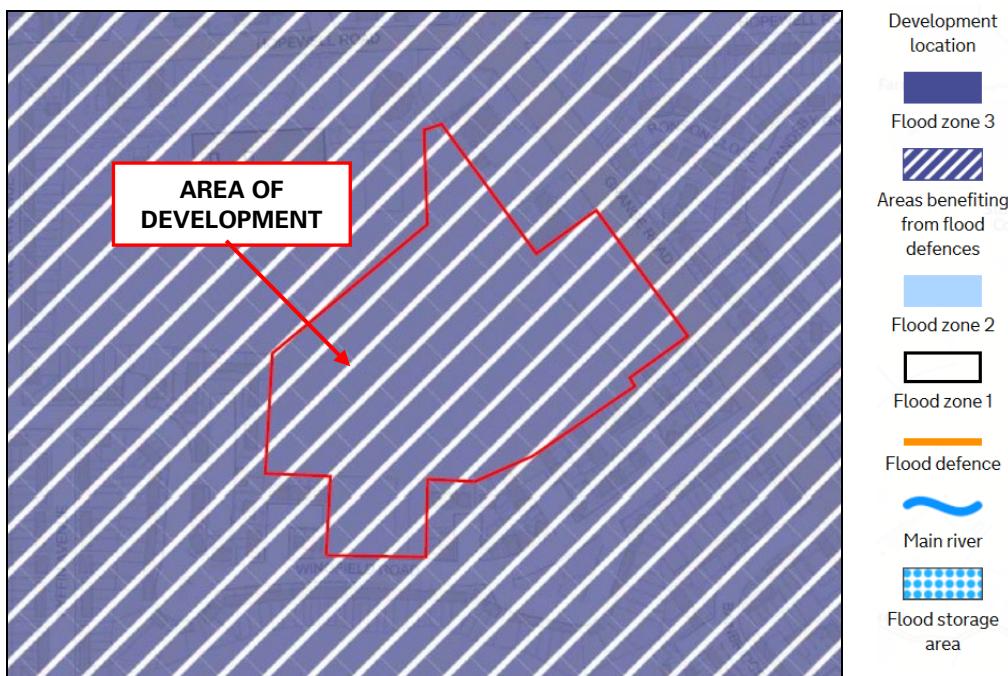


Figure 4: Environment Agency Flood Map for Planning dated October 2018

- 6.1.2 A revised strategic Flood Risk Assessment has been prepared for the city of Hull (2016), which has categorised areas of the city into likely flood depth areas.
- 6.1.3 An abstract from Figure 14 of the Hull SFRA is included in Figure 5 below which indicates that the site lies in an area classified as Flood Zone 3a iii (Medium Risk) and 3a iv (High Risk). However these extra 9 plots are situated in the eastern corner of the larger site, coloured green in figure 5 which is zone 3ai (Low)

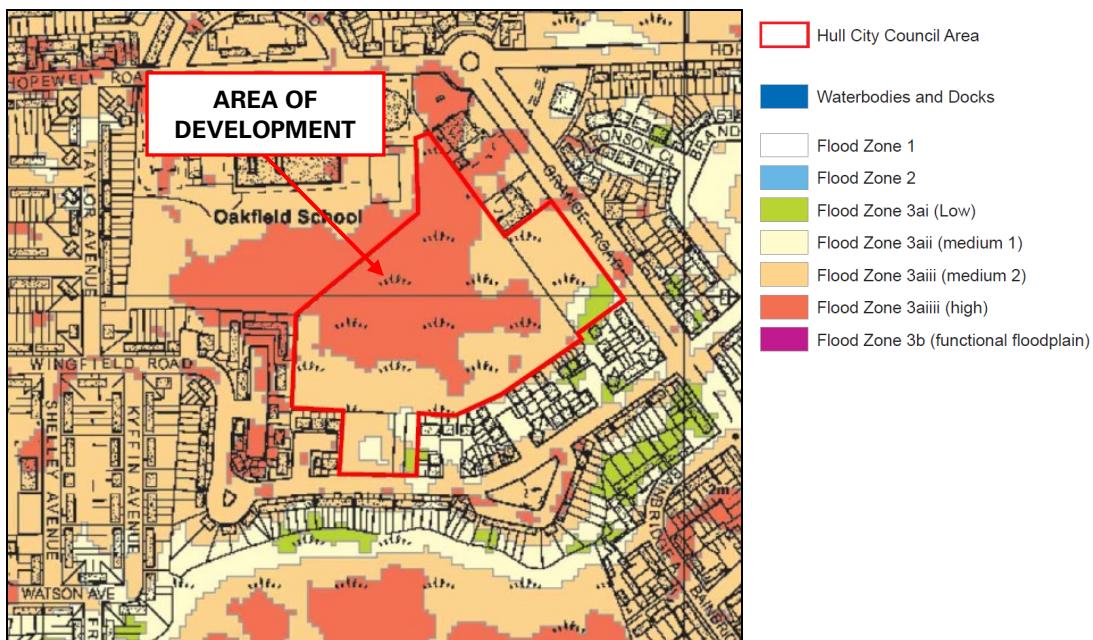


Figure 5: Abstract from Hull SFRA 2016 Figure 14 Flood Zone Map

6.2 Tidal Flooding – River Humber

- 6.2.1 A copy of the Flood Map (River and Sea) map produced by the Environment Agency is included in Figure 6 below. This shows the site lies in an area classed as being “Low Risk” from flooding.

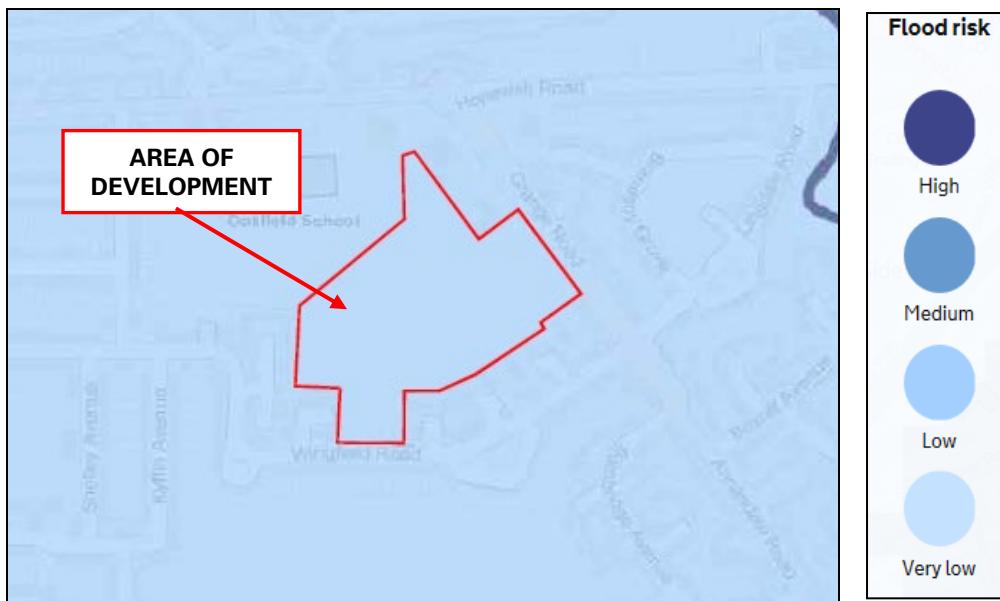


Figure 6: Environment Agency Detailed Flooding (Rivers and Sea)
dated October 2018

- 6.2.2 The 1 in 200 year predicted high water level for the River Humber in the region of the development has been calculated at 5.72m OD(N) by the Environment Agency.
- 6.2.3 An allowance needs to be made for climate change resulting from global warming, which is expected to result in increased global sea levels.
- 6.2.4 For residential developments with a design life of 100 years, the anticipated sea level rise in this region is 1105mm. This would project the predicted high water level to 6.83m OD(N).
- 6.2.5 In addition to the high water level there is the likelihood of wave action on the River Humber which historically has been at a maximum height of approximately 1.1m. However, at a distance of 3.2km from the coastline we consider that wave action can be discounted.
- 6.2.6 The river defences to the banks of the River Humber in proximity to the site are generally of steel sheet piled construction, which are generally maintained at a level of approximately 5.85m OD(N).
- 6.2.7 With a predicted water level of 6.83m, it can clearly be seen that the existing defences would be overtopped during periods of high tidal levels.
- 6.2.8 A study of the local topography shows that flood waters would gravitate northwards towards the lower-lying land where ground levels over a large area of the city are at approximately 2m OD(N) and the land further to the north lower than 0.5m OD(N).
- 6.2.9 The flood waters will dissipate as they flow northwards, generally channelling along the road network, spreading out and reducing in depth as the flood extends from the source of the flooding.
- 6.2.10 An abstract from Figure 0 of the Hull SFRA is included in Figure 7 below which provides an indication of ground levels.

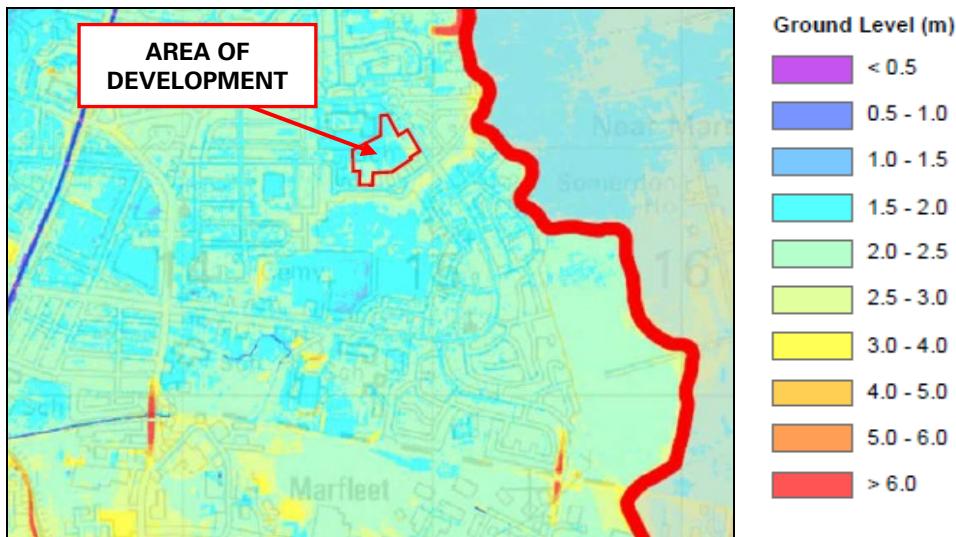


Figure 7: Abstract from Hull SFRA2016 Figure 0 showing Indicative Ground Levels

- 6.2.11 Flood waters are therefore not expected to accumulate at any significant depth over the area of the development.
- 6.2.12 An abstract from the Hull SFRA 2016 (Figure 6B) is included in Figure 8 below which shows the anticipated depth of flood waters over the area of the development.

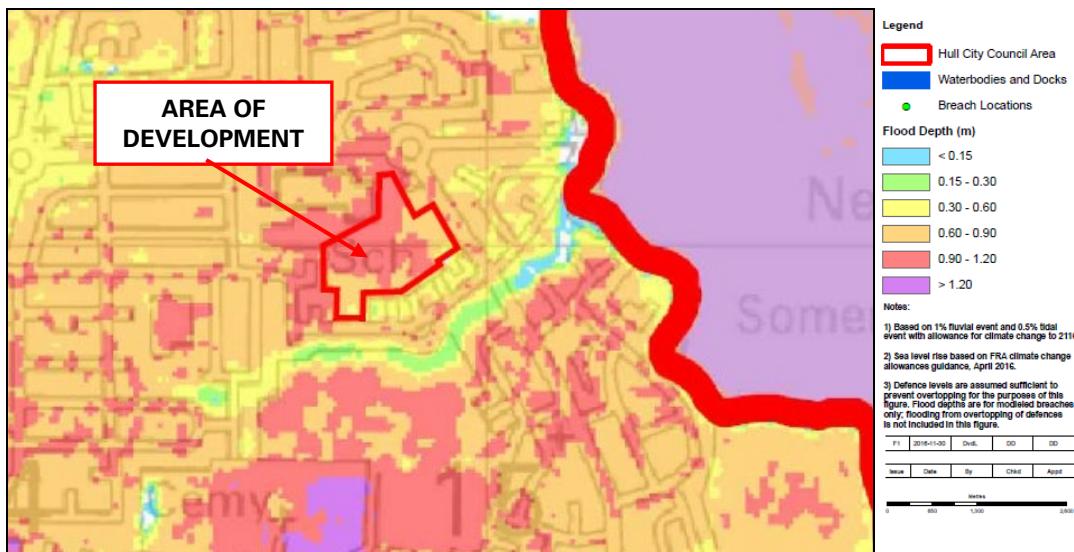


Figure 8: Abstract from Hull SFRA 2016 Figure 6B Flood Depth Map

- 6.2.13 This indicates a likely depth of flooding varying from 0.6m to 0.9m up to 0.90m to 1.20m. However, the extra 9 plots are situated in the eastern corner of the

site which is at the highest elevation. Flooding depths here are shown as 0.3m to 0.6m.

- 6.2.14 An abstract from Figure 7 of the Hull SFRA 2016 is included in Figure 9 below, which indicates a likely velocity of flood waters to be between <0.10 m/s up to 1.0 m/s for this particular development.

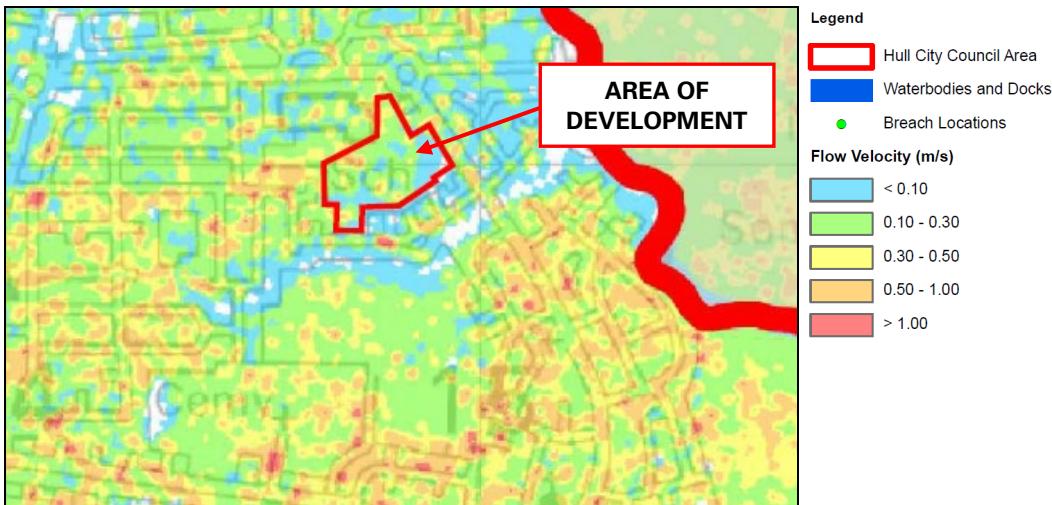


Figure 9: Abstract from Hull SFRA 2016 Figure 7 Velocity of Flood Waters

- 6.2.15 Due to the low velocity of the flood water it is evident that there will be sufficient time available to implement the required flood protection measures.
- 6.2.16 An abstract from the Figure 8 Flood Hazard map incorporated in the Hull SFRA 2016 is included in Figure 10 below. This identifies the development site to be located in an area in which the hazard of flooding is considered to be vary from "moderate" to "significant".

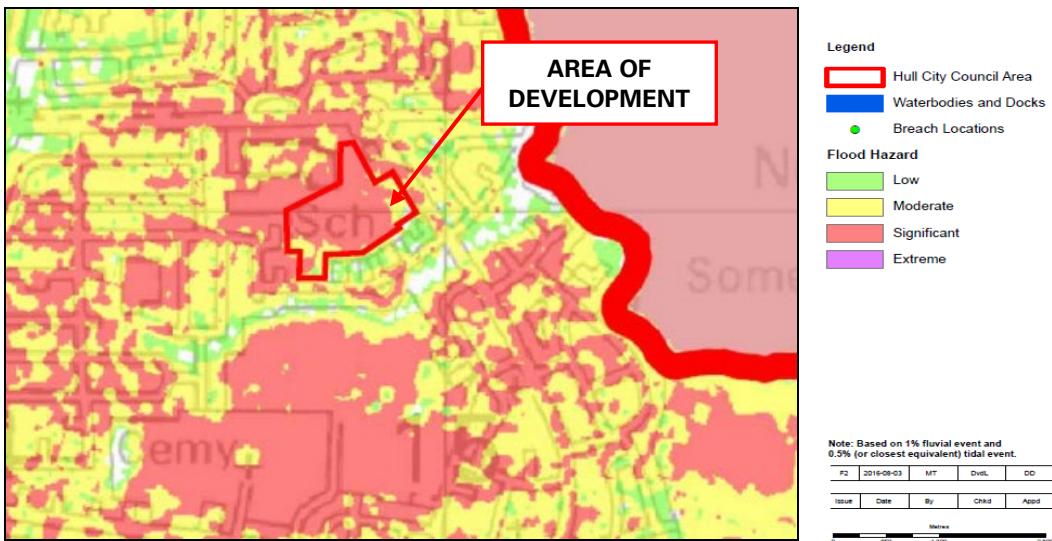


Figure 10: Abstract from Hull SFRA 2016 Figure 8 Flood Hazard Map

6.3 Fluvial Flooding

6.3.1 River Hull

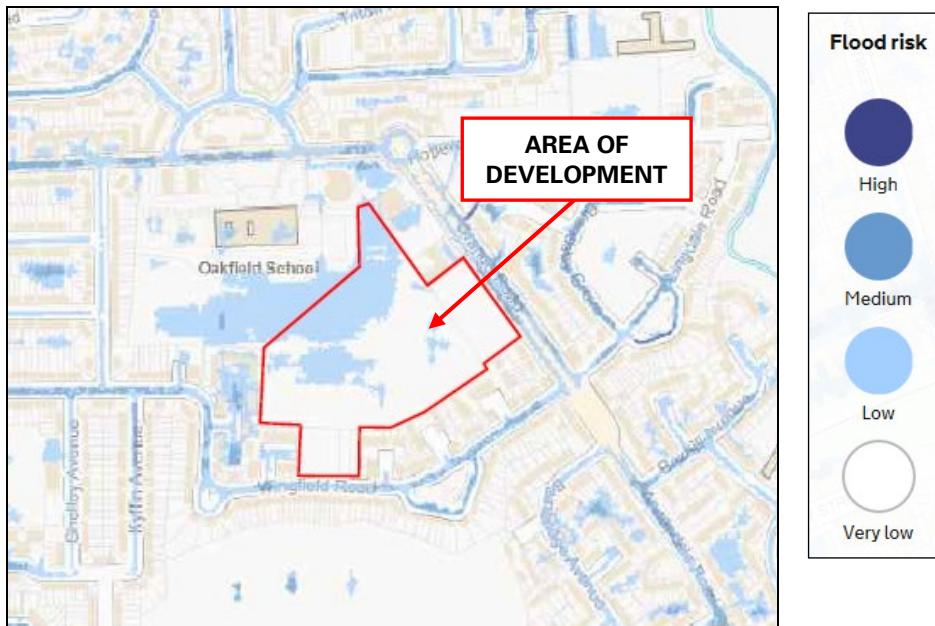
- 6.3.1.1 The highest predicted water level for a 1 in 200 year event in the vicinity of the development has been determined at 5.12m OD(N).
- 6.3.1.2 Recent changes in climate change modelling suggest that predicted future rainfall events may become more severe than had been previously anticipated, leading to a greater volume of water entering fluvial watercourses.
- 6.3.1.3 Due to the minor nature of the development, it is not practical to carry out further modelling to determine the likely water level which could be attained and it has therefore been assumed that water levels could rise a further 150mm, thus resulting in a predicted flood water level of 5.27m OD(N).
- 6.3.1.4 The River Hull is tidal and is subject to a variation in water levels due to a combination of fluvial flows and tide levels.
- 6.3.1.5 There is a tidal barrier at the mouth of the River Hull and, unless failure occurs, it can be assumed that consideration only needs to be taken of fluvial flood occurrence upstream of the barrier.
- 6.3.1.6 A study of the existing river defences along the eastern bank of the River Hull nearest to the development indicates that these are of hard surfaces, in the form of steel sheet piling and brick or concrete walling. Consequently, consideration of over-topping of the defences needs to be taken, rather than a breach of the defences.
- 6.3.1.7 Should a flood situation arise, flood waters would dissipate as they spread outwards from the source of the flooding and gravitate towards the lower-lying land in a similar manner to that for a tidal flooding event.
- 6.3.1.8 With the site lying approximately 330m from the River Hull at its nearest location, the flood waters are not likely to accumulate at any significant depth over the area of the development.

6.3.1.9 Flood mitigation measures will, however, need to be incorporated in the design of the development to reduce the likelihood of damage occurring should the development be affected by flood waters.

6.3.1.10 Such measures are incorporated in Section 7 of this report.

6.4 Surface Water Flooding

6.4.1 A copy of the Environment Agency map showing the extent of flooding from surface water is included in Figure 11 below.



*Figure 11: Environment Agency map dated October 2018
showing the Extent of Flooding from Surface Water*

- 6.4.2 The map indicates that the risk of surface water flooding to the areas of the development are considered to be very low. The 9 extra plots are situated in this area.
- 6.4.3 There are, however, areas of land in the central and northern areas of the site shown to be at risk of surface water flooding.
- 6.4.4 Copies of the maps produced by the Environment Agency showing anticipated depths of low, medium and high risk surface water flooding are included in Figures 12, 13 and 14 below.

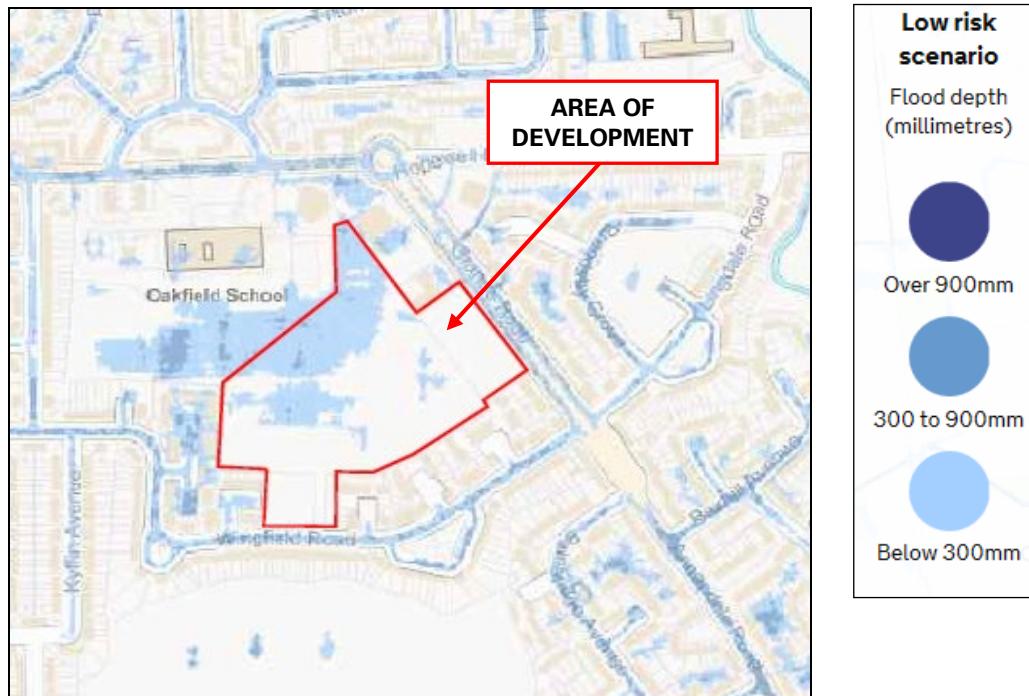


Figure 12: Environment Agency map dated October 2018 showing Anticipated Depths – Low Risk

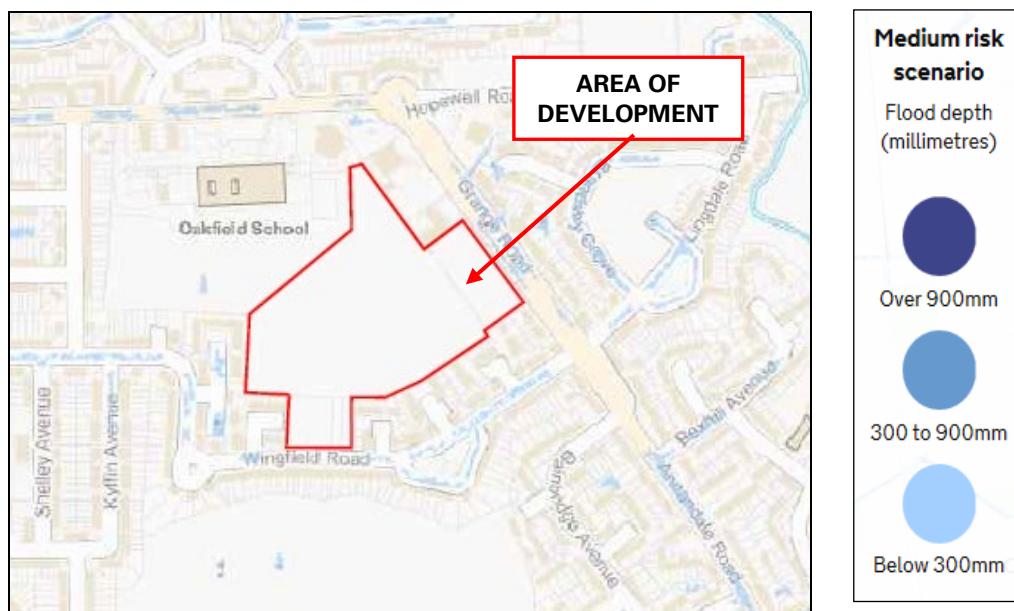
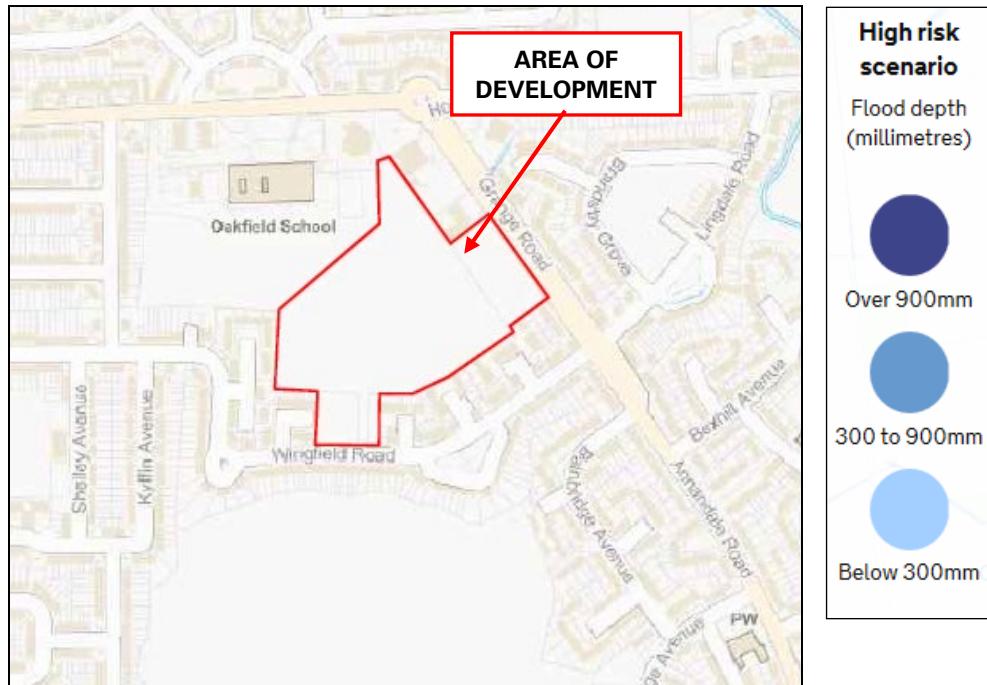


Figure 13: Environment Agency map dated October 2018 Showing Anticipated Depths – Medium Risk



*Figure 14: Environment Agency map dated October 2018
Showing Anticipated Depths – High Risk*

- 6.4.5 The maps show that in a low risk scenario the depth of flooding is likely to be less than 300mm, other than a small localised open area which is shown to be at risk of flooding to a depth of 300mm to 900mm.
- 6.4.6 For a medium risk scenario and for a high risk scenario, the maps show that there will be no surface water flooding.
- 6.4.7 An abstract from Figure 10 of the Hull SFRA showing the likely depth of surface water flooding is included in Figure 15 below.

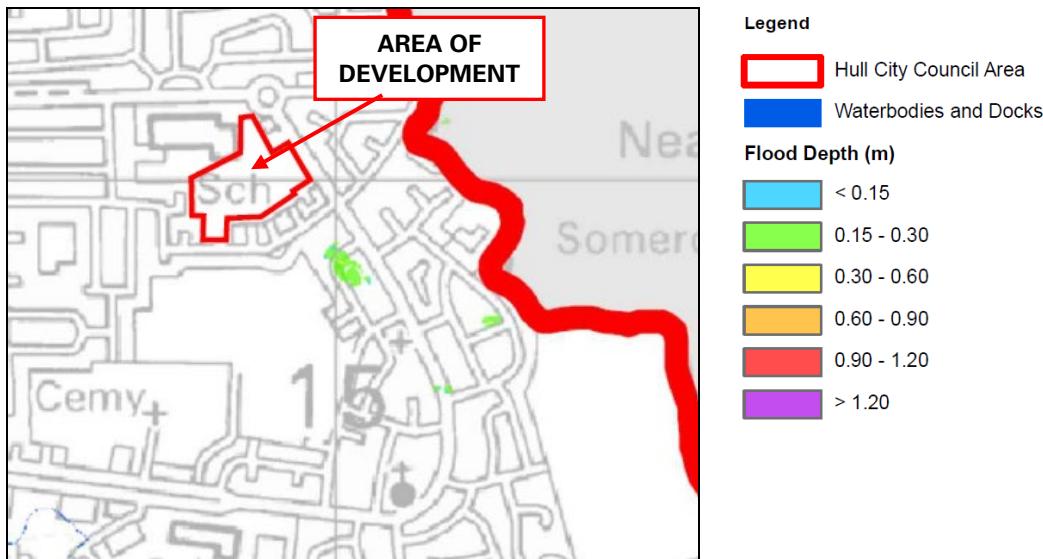


Figure 15: Abstract from Figure 10 Hull SFRA 2016 Surface Water Flood Depth Map

- 6.4.8 The map shows that the site is not considered to be at risk.
- 6.4.9 Ground levels will be re-profiled during the construction works and any low-lying areas of land will be infilled. On this basis, it is considered that no additional mitigation works will be required.
- 6.4.10 Based upon the above information the risk to the development from surface water flooding is considered to be low and acceptable.

6.5 Exception Test Information

- 6.5.1 An abstract from Figure 13 of the Hull SFRA is included in Figure 16 below, which indicates that the site is in an area likely to flood to a depth varying from 0m - 0.3m up to 0.9m - 1.2m accounting for accumulated flood events.
- 6.5.2 However the extra 9 plots are situated in the eastern corner of the site which is at the highest elevation and as can be seen from figure 16 likely flooding depth is shown as 0m-0.3m

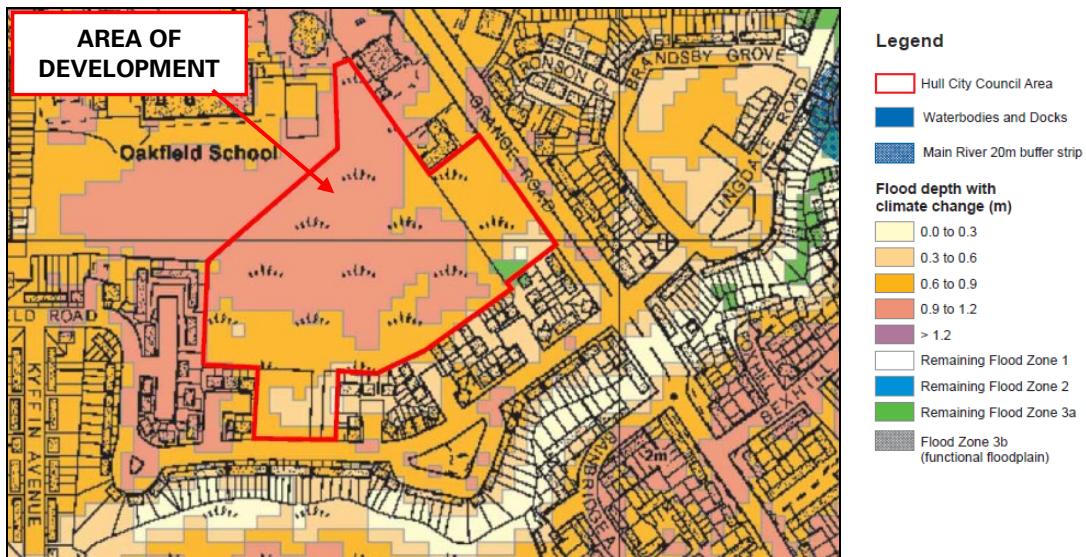


Figure 16: Abstract from Hull SFRA 2016 Figure 13
Exception Test Information

6.6 Flooding from Open Drainage Ditches

- 6.6.1 There are no open drainage ditches located in the vicinity of the development site.
- 6.6.2 The risk of flooding from this source is therefore considered to be low and acceptable.

6.7 Groundwater Flooding

- 6.7.1 Groundwater flooding can occur when the sub-surface water levels are high and emerges above ground level.
- 6.7.2 There are no proposals to create any basements within the development.
- 6.7.3 The site overlays a Principal Aquifer and lies within a groundwater vulnerability zone.
- 6.7.4 However, the construction works will not involve excessive deep excavation works and consequently the risk to the development from this potential flood source is considered to be low and acceptable.

6.8 Flood Risk from Water Mains

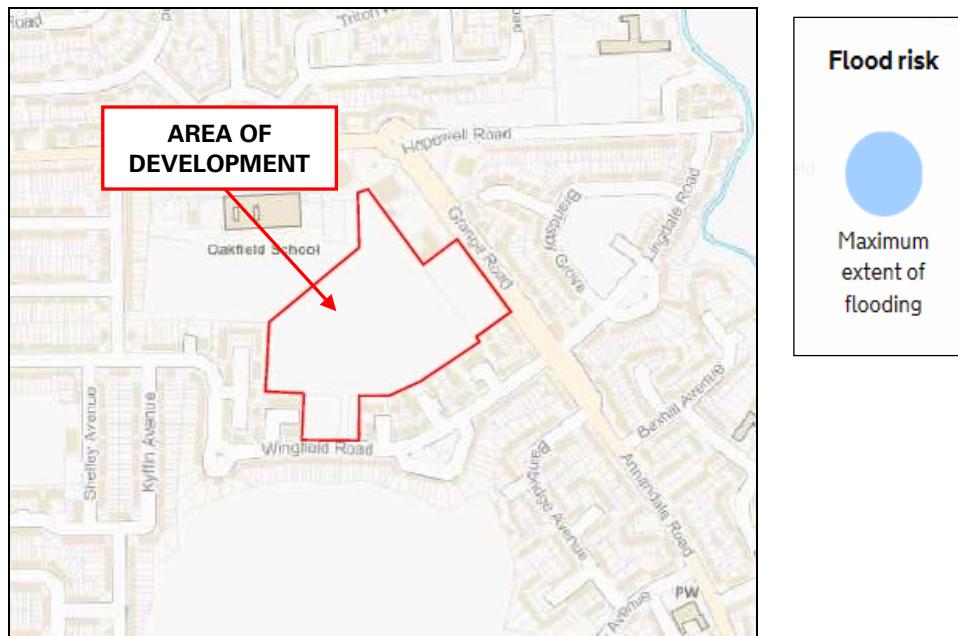
- 6.8.1 There are likely to be existing water mains present within the adjacent developments and within the public highways.
- 6.8.2 There are no known issues with the condition of the water mains.
- 6.8.3 The risk to the development from this potential flood source is therefore considered to be low and acceptable.

6.9 Flood Risk from Existing Drainage Services

- 6.9.1 There are likely to be existing drainage services present within the adjacent developments and within the public highways.
- 6.9.2 There are no known issues with regard to the capacity or condition of the existing drainage services.
- 6.9.3 The risk of flooding to the development from this potential source is considered to be low and acceptable.

6.10 Flooding from Reservoirs, Canals and Other Artificial Sources

- 6.10.1 Investigations indicate that there are no structures in the vicinity of the development likely to pose any risk of flooding.
- 6.10.2 A copy of the map produced by the Environment Agency showing the extent of flooding from reservoirs is included in Figure 17 below.



*Figure 17: Environment Agency map dated October 2018
showing the Extent of Flooding from Reservoirs*

- 6.10.3 The map shows that the development site is not considered to be at risk. The risk to the development from any such potential flood source is considered to be low and acceptable.

7.0 FLOOD MITIGATION MEASURES

7.1 Passive Flood Protection Works

- 7.1.1 With the development site lying in an area considered to be at high risk from flooding, it is recommended that flood protection measures are incorporated into the new development.
- 7.1.2 It is proposed that the floor level of the new dwellings should be elevated to a minimum height of 600mm above the existing ground level or adjacent road level, whichever is the highest.
- 7.1.3 However in discussion with the EA agreement was reached to set the floor levels of the 9 new houses to 2.95m AOD.
- 7.1.4 It is not practical to elevate the floor levels of the properties any further, as this would compromise the required access gradients to comply with Part M (Disabled Access) of the Building Regulations.
- 7.1.5 Existing ground levels vary across the site from approximately 1.73m to 2.35m OD(N), with road levels in proximity to the site varying from approximately 1.87m to 2.15m OD(N).
- 7.1.6 New road levels will be designed to Hull City Council' adoption standards, and therefore finished floor levels will be set a minimum 600mm above the finished ground levels.
- 7.1.7 At this level of construction, it is considered that the risk of flooding to the development has been adequately reduced.
- 7.1.8 Any new electrical sub-stations, pump control equipment or other essential infrastructure should be elevated to a minimum level of 600mm above the adjacent external ground level to ensure the risk of damage occurring during a flood situation is minimised.
- 7.1.9 Road levels within the area of the development should generally remain low in order to channel any flood waters which may arise away from the dwellings.

7.2 Flood Resilience

- 7.2.1 For new developments which lie within the flood zone it is a requirement to provide additional flood resilience above the ground floor construction level in order to minimise any flood damage and provide ease of reconstruction, should flood waters enter the building. For this development, we consider that flood resilience should be provided to a height of 600mm above finished floor level.
- 7.2.2 The following measures should therefore be adopted within the construction:-
- The ground floors should be of solid concrete or an appropriate precast concrete flooring system incorporating a waterproof membrane.
 - The external walls should be of water-resistant construction up to 600mm above ground floor level.
 - There should be no voids within the external walls, other than doorways within 600mm of finished floor level, which would allow flood waters to enter the dwellings.
 - All partition walls constructed at ground floor level should be of suitable robust construction or metal stud partitions fixed with plasterboard, with the lower boarding laid horizontally for ease of replacement.
 - All electrical apparatus or other flood sensitive equipment should be elevated to a minimum of 600mm above finished floor level to prevent damage occurring should flood waters enter the dwellings.
 - All cables should be routed at high level with vertical drops to the fittings.

7.3 Safe Refuge

- 7.3.1 It is a requirement for safe refuge to be provided within new developments at a minimum level of 4.0m OD(N) in this area of the city to ensure that there will be no requirement for evacuation measures by the emergency services.
- 7.3.2 The development is of two-storey construction and consequently safe refuge will be available on the upper floor of the dwellings which can be accessed by the internal staircase in an emergency situation.

7.3.3 The first floor construction levels will be vary depending on the FFL, but given the existing (average) site is around 2m OD(N), FFLs will be set 600mm above surrounding ground, and the first floor will be around 2.4m above the ground floor the first floors will be set around 5m OD(N), which is above the minimum level required.

7.3.4 The requirement for safe refuge provision has therefore been satisfied.

7.3 Access/Egress

7.4.1 Safe access to or egress from the properties will be restricted during the peak time of a major flood scenario. However, as adequate warning will be given and the timescale of the flood will be limited due to tidal conditions. Safe access will therefore be predominantly available.

7.4.2 There should therefore be no requirements for evacuation of occupants of the development by the Emergency Services during a major flood situation.

7.5 Management

7.5.1 The development should be connected to the Environment Agency's early 'Flood Direct' warning service to ensure there is sufficient time available for flood protection measures to be put in place should this prove necessary and for the ground floor accommodation to be vacated should the need arise.

7.5.2 The householders should have a Flood Risk Evacuation Plan in place in order to ensure that all occupants understand the procedures in place in the event of flood situation and where to escape to safety.


8.0 SUMMARY

- 8.1 The report has been prepared to assess the flood risk implications for a new residential development which is located to the south west of Grange Road and to the north of Wingfield Road, Hull.
- 8.2 The development involves the construction of a new residential development with associated infrastructure.
- 8.3 The site falls in Flood Zone 3a (high flood risk) on the Environment Agency maps and in an area subject to flooding between 0.3m to 1.2m on the latest Hull SFRA maps. The proposals are considered to be 'More Vulnerable' development.
- 8.4 The primary risk to the site is from tidal flooding from the River Humber resulting from the river defences being breached or overtapped during an extreme flood event.
- 8.5 The primary focus for flood risk assessment is to protect life, and then consideration should be given to buildings, contents, operation and re-use. As the scheme is progressed the design should consider exceedance and routing of flows away from the buildings.
- 8.6 Mitigation works are proposed which we consider will reduce the risk to the development from flooding down to an acceptable level.
- 8.7 This report has considered other potential sources of flooding to the site, including groundwater, surface water, existing sewers, water mains and other artificial sources.
- 8.8 Overall, this report demonstrates that the flood risk to the development is reasonable and acceptable.
- 8.9 It is our opinion that the development is fully compliant with the updated Hull SFRA 2016 Standing Advice.



APPENDIX A

Topographic Survey Drawing





APPENDIX B

Indicative Layout Drawing



Scale Check:
1:500
10m 0 10m 20m 30m 40m 50m

DESIGN CRITERIA - PRIVATE PLOTS

- Traditional Construction
- Building Regulations Part A 2013, Part B1 2013, Part C 2013, Part D 2013, Part E 2013, Part F 2013, Part G 2013, Part H 2010, Part I 2010, Part J 2013, Part K 2013, Part L 2013, Part M 2013, Part P 2013, Part Q 2013, Part R 2016
- Code for Sustainable Homes Level 3 November 2009 Technical Guidance NOT APPLICABLE
- Lifetime Homes (July 2010) NOT APPLICABLE
- Design Quality Standards (Edition 2) NOT APPLICABLE
- Housing Quality Indicators (HQI) NOT APPLICABLE
- Secured By Design (full accreditation) NOT APPLICABLE
- Secured By Design (part accreditation) NOT APPLICABLE
- Building for Life (2 part assessment) NOT APPLICABLE
- English Partnership Standards NOT APPLICABLE
- Mobility Standards NOT APPLICABLE
- Wheelchair Design Guide Standards NOT APPLICABLE
- NHF Standards NOT APPLICABLE

DESIGN CRITERIA - AFFORDABLE PLOTS

- Traditional Construction
- Building Regulations Part A 2013, Part B1 2013, Part C 2013, Part D 2010, Part E 2010, Part F 2013, Part G 2010, Part H 2010, Part I 2010, Part J 2013, Part M 2013, Part P 2013
- Code for Sustainable Homes Level 3 November 2009 Technical Guidance NOT APPLICABLE
- Lifetime Homes (July 2010) NOT APPLICABLE
- Design Quality Standards (Edition 2) NOT APPLICABLE
- Housing Quality Indicators (HQI) NOT APPLICABLE
- Secured By Design (full accreditation) NOT APPLICABLE
- Secured By Design (part accreditation) NOT APPLICABLE
- Building for Life (2 part compliance) NOT APPLICABLE
- English Partnership Standards NOT APPLICABLE
- Mobility Standards NOT APPLICABLE
- Wheelchair Design Guide Standards NOT APPLICABLE
- NHF Standards NOT APPLICABLE

KEY

	SITE BOUNDARY (3.71 HA)
	450 TIMBER KNEE RAIL
	450 TIMBER KNEE RAIL (REMOVABLE)
	1500 DIVISION TIMBER FENCE WITH 300MM TRELLIS
	1800 CLOSE BOARDED TIMBER FENCE
	2000 LONG 1800 HIGH CLOSE BOARDED TIMBER PRIVACY FENCE PANEL
	BIN STORE AREA
	BIN COLLECTION POINT TO SHARED DRIVES SERVING MULTIPLE PLOTS (TARMAC) (PLEASE REFER TO PLAN P18-0609.054)
	AFFORDABLE DWELLINGS (10%)
	ADDITIONAL WINDOW
	SUB STATION OFFSET (3M)
	EXISTING TREES
	EXISTING TREES (TO BE REMOVED)
	BOLLARD
	PROPOSED LANDSCAPING (REFER TO DWG P18-0609.038-042 FOR DETAILED LANDSCAPE PROPOSALS)

ACCOMMODATION SCHEDULE

AH	13/11/20	Plots 112, 113, 114 & 115 Updated to Bamburgh Type
AG	18/02/20	New timber knee rail added for removable maintenance access, key amended
AF	20/01/20	Amendment to plot 1 parking arrangement
AE	10/01/20	Adjustment to plot 1 and red line
AD	16/12/19	Re-location of sub-station
AC	27/11/19	Plot 109 House Type updated for plot 30
AB	03/07/19	Plot 109 House Type updated for plot 30 and 115 swapped to Homely
AA	01/01/19	Access road to plot 109 and 115 swapped to Homely
Z	04/06/19	Access road to plot 109 and 115 swapped to Homely
Y	07/05/19	Highwater drainage pipework between plots 51 & 52. Pump station removed and attenuation basin removed from in front of plots 1-4.
X	29/04/19	Re-contour of plot 109 to south west corner of site. Plots 92-99 moved towards plot 109 by 2.5m
W	22/03/19	Central reservation crossing at site entrance moved north
V	19/02/19	Re-contour of plot 109 to south west corner of site. Plots 92-99 moved towards plot 109 by 2.5m
U	12/02/19	Timber kick rail added to the side of plot 30
T	08/02/19	Amendment of key annotation

Rev	Date	Details	Date	By	Chk
	10/12/2020		1:500 @ A1		CHK

Grange Road, Hull

PLANNING LAYOUT

Dwg No	P18-0609.001	Rev
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Keepmoat, The Waterfront, Lakeside Boulevard, Doncaster, DN4 5PL.

Tel: 01302 346620 www.keepmoat.com



House Type Schedule								
Code	House Type	Beds	SQFT	SQ M	Storey Height	TOTAL	FT ² TOTAL	% MIX
Halstead	2B/4P	2 Bed	651.39	60.52	2 Storey	2	1,302.78	22
Bamburgh	3B/4P	3 Bed	1,051.40	97.68	2.5 Storey	6	6,308.40	67
Hardwick (Det)	4B/5P	4 Bed	1,251.29	116.25	2.5 Storey	1	1,251.29	11
	TOTAL					9	8,862.47	100.00

Scale Check:

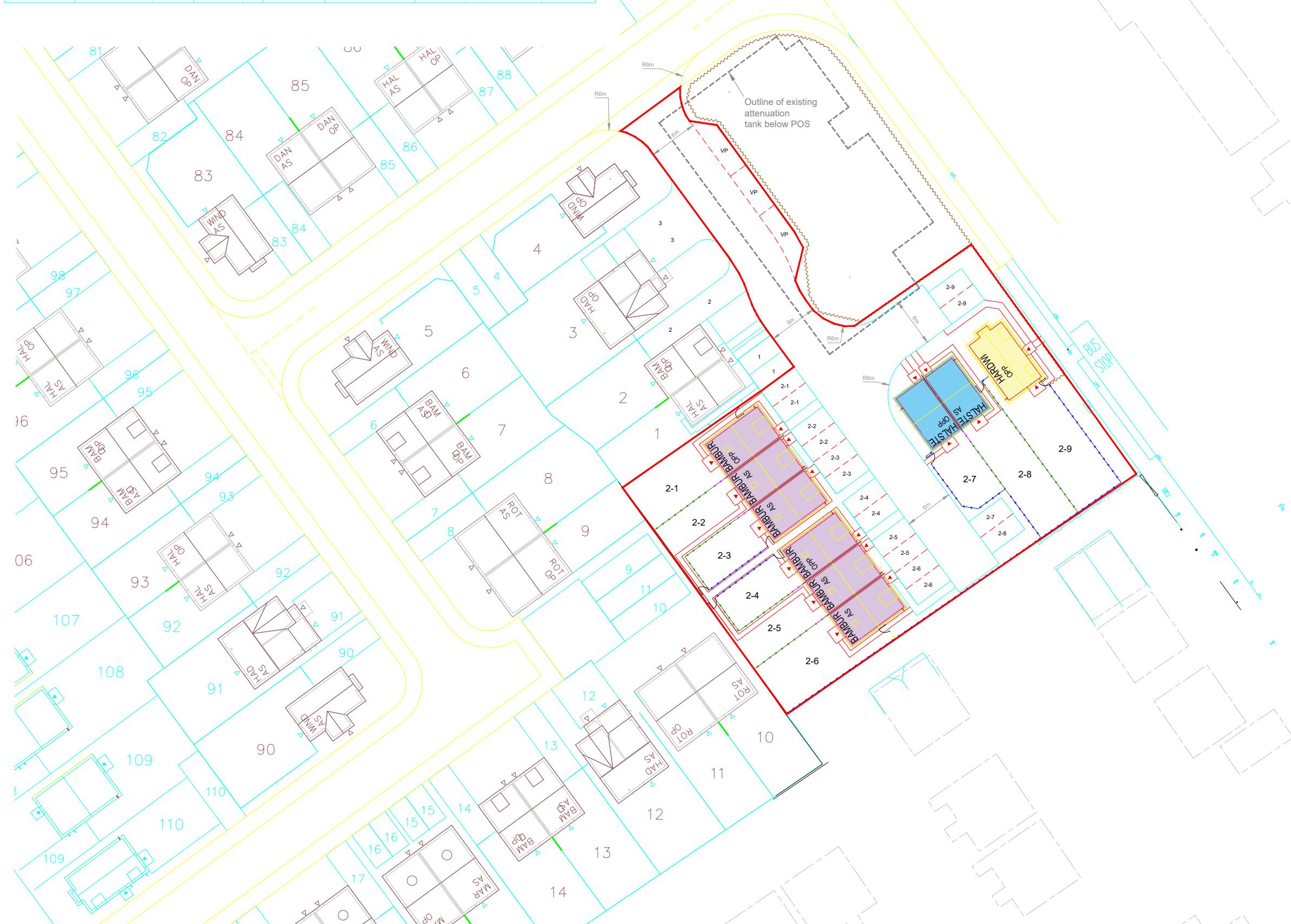
A scale bar diagram showing ratios 1:20, 1:100, 1:50, and 1:5, with corresponding metric and imperial measurements.

Ratio	0	1m	2m	3m	4m	5m	6m
1:20 - 0	200mm	400mm	600mm	800mm	1000	1200	
1:100 - 0		1m	2m	3m	4m	5m	6m
1:50 - 0			1m		2m		3m
1:5 - 0			100mm		200mm		300mm



Boundary Key

- = 2m x 1.8m High Close Boarded Timber Privacy Fence Panel
 - = 1.5m High division fence with 0.3m Trellis
 - = 1.8m High Close Boarded Timber Fence
 - = 0.45m High timber Knee Rail



Rev	Details		Date	By	Chk
DATE	04/01/2021		DRAWN	JP	
SCALE	1:500 @ A3		CHK	--	
Grange Road Hull					
BDW1 - Planning Layout					
Dwg No		2040-BDW1-01		Rev	
Keepmoat, The Waterfront, Lakeside Boulevard, Doncaster, DN4 5PL. Tel: 01302 346620 www.keepmoat.com					
 Keepmoat® Homes					



APPENDIX C

Surface Water Storage Calculations

Alan Wood & Partners		Page 1
Omega 2 Monks Cross Drive York YO32 9GZ	Grange Road - Hull Keepmoat Homes Includes 9 Extra Sites	
Date 21/01/2021 File 40840 S104 Rev 3.1.MDX	Designed by S. Grayson/CD Checked by JAG	
Innovyze	Network 2020.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	18.600	Add Flow / Climate Change (%)	10
Ratio R	0.392	Minimum Backdrop Height (m)	0.500
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

- Indicates pipe length does not match coordinates

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	9.607	0.039	246.3	0.053	5.00	0.0	0.600	o	300	Pipe/Conduit	✖
1.001	52.597	0.128	410.9	0.106	0.00	0.0	0.600	o	450	Pipe/Conduit	✖
1.002	42.528	0.104	408.9	0.141	0.00	0.0	0.600	o	450	Pipe/Conduit	✖
2.000	13.487	0.046	293.2	0.000	5.00	0.0	0.600	o	450	Pipe/Conduit	✖
1.003	13.303	0.032	415.7	0.131	0.00	0.0	0.600	o	450	Pipe/Conduit	✖
1.004	12.353	0.030	411.8	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	✖
1.005	59.061	0.144	410.1	0.208	0.00	0.0	0.600	o	450	Pipe/Conduit	✖
1.006	47.785	0.098	487.6	0.169	0.00	0.0	0.600	o	525	Pipe/Conduit	✖

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	49.76	5.16	1.114	0.053	0.0	0.0	0.7	1.00	70.5	7.9
1.001	46.33	6.04	0.925	0.159	0.0	0.0	2.0	1.00	158.5	21.9
1.002	43.94	6.75	0.797	0.300	0.0	0.0	3.6	1.00	158.9	39.3
2.000	49.64	5.19	1.400	0.000	0.0	0.0	0.0	1.18	188.0	0.0
1.003	43.24	6.97	0.693	0.431	0.0	0.0	5.0	0.99	157.6	55.5
1.004	42.62	7.18	0.661	0.431	0.0	0.0	5.0	1.00	158.3	55.5
1.005	39.91	8.17	0.631	0.639	0.0	0.0	6.9	1.00	158.7	76.0
1.006	38.00	8.96	0.412	0.808	0.0	0.0	8.3	1.01	218.1	91.5

Alan Wood & Partners										Page 2	
Omega 2 Monks Cross Drive York YO32 9GZ				Grange Road - Hull Keepmoat Homes Includes 9 Extra Sites							
Date 21/01/2021 File 40840 S104 Rev 3.1.MDX				Designed by S. Grayson/CD Checked by JAG							
Innovyze Network 2020.1											

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
3.000	76.142	0.238	319.9	0.260	5.00	0.0	0.600	o	375	Pipe/Conduit	✖
3.001	57.937	0.141	410.9	0.257	0.00	0.0	0.600	o	450	Pipe/Conduit	✖
4.000	34.035	0.105	324.1	0.135	5.00	0.0	0.600	o	375	Pipe/Conduit	✖
3.002	51.923	0.208	249.6	0.120	0.00	0.0	0.600	o	525	Pipe/Conduit	✖
1.007	5.969	0.020	298.5	0.090	0.00	0.0	0.600	o	525	Pipe/Conduit	✖
1.008	59.005	0.120	491.7	0.123	0.00	0.0	0.600	o	1200	Pipe/Conduit	✖
1.009	5.861#	0.012	488.4	0.189	0.00	0.0	0.600	o	1200	Pipe/Conduit	✖
1.010	3.605#	0.006	600.8	0.000	0.00	0.0	0.600	o	1200	Pipe/Conduit	✖
1.011	14.143	0.141	100.3	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	✖

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.000	45.56	6.26	1.051	0.260	0.0	0.0	3.2	1.01	111.3	35.3
3.001	42.48	7.23	0.738	0.517	0.0	0.0	5.9	1.00	158.5	65.4
4.000	48.11	5.57	0.777	0.135	0.0	0.0	1.8	1.00	110.5	19.3
3.002	40.76	7.84	0.522	0.772	0.0	0.0	8.5	1.41	305.9	93.7
1.007	37.83	9.03	0.314	1.670	0.0	0.0	17.1	1.29	279.5	188.2
1.008	36.56	9.62	-0.381	1.793	0.0	0.0	17.8	1.68	1900.4	195.3
1.009	36.44	9.68	-0.501	1.982	0.0	0.0	19.6	1.69	1906.9	215.2
1.010	36.36	9.72	-0.565	1.982	0.0	0.0	19.6	1.52	1717.8	215.2
1.011	35.88	9.95	-0.621	1.982	0.0	0.0	19.6	1.00	17.7	215.2

Alan Wood & Partners						Page 3
Omega 2 Monks Cross Drive York YO32 9GZ		Grange Road - Hull Keepmoat Homes Includes 9 Extra Sites				
Date 21/01/2021 File 40840 S104 Rev 3.1.MDX		Designed by S. Grayson/CD Checked by JAG				
Innovyze		Network 2020.1				



Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	Gross (%)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.053	0.053
1.001	-	-	100	0.106	0.106
1.002	-	-	100	0.141	0.141
2.000	-	-	100	0.000	0.000
1.003	-	-	100	0.131	0.131
1.004	-	-	100	0.000	0.000
1.005	-	-	100	0.208	0.208
1.006	-	-	100	0.169	0.169
3.000	-	-	100	0.260	0.260
3.001	-	-	100	0.257	0.257
4.000	-	-	100	0.135	0.135
3.002	-	-	100	0.120	0.120
1.007	-	-	100	0.090	0.090
1.008	-	-	100	0.123	0.123
1.009	-	-	100	0.189	0.189
1.010	-	-	100	0.000	0.000
1.011	-	-	100	0.000	0.000
				Total	Total
				1.982	1.982

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (mm)	D,L (mm)	W (m)
1.011	Outfall	2.200	-0.762	-0.762	1200	0

Simulation Criteria for Storm

Volumetric Runoff Coeff 0.750 Additional Flow - % of Total Flow 0.000
Areal Reduction Factor 1.000 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Flow per Person per Day (l/per/day) 0.000
Manhole Headloss Coeff (Global) 0.500 Run Time (mins) 60
Foul Sewage per hectare (l/s) 0.000 Output Interval (mins) 1

Number of Input Hydrographs 0 Number of Storage Structures 2
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region England and Wales		Cv (Winter)	0.840
M5-60 (mm)	18.600	Storm Duration (mins)	30
Ratio R	0.392		

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Innovyze	Network 2020.1	

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 15 (FC), DS/PN: 1.011, Volume (m³): 12.0

Unit Reference	MD-SHE-0076-4000-2700-4000
Design Head (m)	2.700
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	76
Invert Level (m)	-0.621
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.700	4.0
Flush-Flo™	0.331	2.6
Kick-Flo®	0.680	2.1
Mean Flow over Head Range	-	2.9

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)						
0.100	2.1	1.200	2.7	3.000	4.2	7.000	6.2
0.200	2.5	1.400	2.9	3.500	4.5	7.500	6.4
0.300	2.6	1.600	3.1	4.000	4.8	8.000	6.6
0.400	2.6	1.800	3.3	4.500	5.1	8.500	6.8
0.500	2.6	2.000	3.5	5.000	5.3	9.000	7.0
0.600	2.4	2.200	3.6	5.500	5.6	9.500	7.2
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		

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Offline Controls for Storm

Pipe Manhole: 9, DS/PN: 3.001, Loop to PN: 2.000

Diameter (m)	0.450	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	300.0	Coefficient of Contraction	0.600
Length (m)	13.235	Upstream Invert Level (m)	1.400

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Storage Structures for Storm

Tank or Pond Manhole: POND 1, DS/PN: 2.000

Invert Level (m) 1.400

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1180.3	0.700	1546.0

Tank or Pond Manhole: 14d, DS/PN: 1.010

Invert Level (m) -0.565

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	588.3	1.200	588.3	1.201	0.0

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 2
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.390
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s)
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600,
720, 960, 1440, 2160, 2880, 4320, 5760,
7200, 8640, 10080

Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	1	15 Winter	2	+0%	100/15 Summer			
1.001	2	15 Winter	2	+0%	30/15 Winter			
1.002	3	15 Winter	2	+0%	30/15 Summer			
2.000	POND 1	15 Summer	2	+0%	100/2160 Winter			
1.003	4	15 Winter	2	+0%	30/15 Summer			
1.004	5	15 Winter	2	+0%	30/15 Summer			
1.005	6	15 Winter	2	+0%	30/15 Summer			
1.006	7	15 Winter	2	+0%	30/15 Summer			
3.000	8	15 Winter	2	+0%	100/15 Summer			
3.001	9	15 Winter	2	+0%	30/15 Winter		100/15 Summer	36
4.000	10	15 Winter	2	+0%	30/15 Summer			
3.002	11	15 Winter	2	+0%	30/15 Summer			
1.007	12	15 Winter	2	+0%	30/15 Summer			
1.008	13	1440 Winter	2	+0%	30/1440 Winter			
1.009	14	1440 Winter	2	+0%	30/960 Winter			
1.010	14d	1440 Winter	2	+0%	30/960 Winter			
1.011	15 (FC)	1440 Winter	2	+0%	2/15 Summer			

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

US/MH PN	Name	Water	Surcharged	Flooded	Half Drain			Pipe	Status
		Level (m)	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Time (mins)	Flow (l/s)	
1.000	1	1.195	-0.219	0.000	0.16			8.8	OK
1.001	2	1.058	-0.317	0.000	0.16			22.8	OK
1.002	3	0.990	-0.257	0.000	0.27			38.8	OK
2.000	POND 1	1.400	-0.450	0.000	0.00			0.0	OK
1.003	4	0.943	-0.200	0.000	0.53			52.6	OK
1.004	5	0.915	-0.196	0.000	0.52			52.0	OK
1.005	6	0.890	-0.191	0.000	0.50			73.1	OK
1.006	7	0.843	-0.094	0.000	0.39			75.8	OK
3.000	8	1.219	-0.207	0.000	0.38			40.2	OK
3.001	9	0.968	-0.220	0.000	0.50	0.0		72.2	OK
4.000	10	0.898	-0.254	0.000	0.22			22.0	OK
3.002	11	0.832	-0.215	0.000	0.35			96.0	OK
1.007	12	0.780	-0.059	0.000	1.00			157.0	OK
1.008	13	0.098	-0.721	0.000	0.01			15.8	OK
1.009	14	0.098	-0.601	0.000	0.02			16.6	OK
1.010	14d	0.098	-0.537	0.000	0.01			5.0	OK
1.011	15 (FC)	0.114	0.585	0.000	0.16			2.6	SURCHARGED

US/MH PN	Level Exceeded
1.000	1
1.001	2
1.002	3
2.000	POND 1
1.003	4
1.004	5
1.005	6
1.006	7
3.000	8
3.001	9
4.000	10
3.002	11
1.007	12
1.008	13
1.009	14
1.010	14d
1.011	15 (FC)

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 2
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.390
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s)
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600,
720, 960, 1440, 2160, 2880, 4320, 5760,
7200, 8640, 10080

Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	1	15 Winter	30	+0%	100/15 Summer			
1.001	2	15 Winter	30	+0%	30/15 Winter			
1.002	3	15 Winter	30	+0%	30/15 Summer			
2.000	POND 1	15 Summer	30	+0%	100/2160 Winter			
1.003	4	15 Winter	30	+0%	30/15 Summer			
1.004	5	15 Winter	30	+0%	30/15 Summer			
1.005	6	15 Winter	30	+0%	30/15 Summer			
1.006	7	15 Winter	30	+0%	30/15 Summer			
3.000	8	15 Winter	30	+0%	100/15 Summer			
3.001	9	15 Winter	30	+0%	30/15 Winter		100/15 Summer	36
4.000	10	15 Winter	30	+0%	30/15 Summer			
3.002	11	15 Winter	30	+0%	30/15 Summer			
1.007	12	15 Winter	30	+0%	30/15 Summer			
1.008	13	1440 Winter	30	+0%	30/1440 Winter			
1.009	14	1440 Winter	30	+0%	30/960 Winter			
1.010	14d	1440 Winter	30	+0%	30/960 Winter			
1.011	15 (FC)	1440 Winter	30	+0%	2/15 Summer			

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

PN	US/MH	Water Surcharged Flooded			Cap.	Flow / Overflow	(1/s)	Half Drain Time	(mins)	Pipe Flow (l/s)	Status
		Name	Level (m)	Depth (m)							
1.000		1	1.398	-0.016	0.000	0.30				16.4	OK
1.001		2	1.378	0.003	0.000	0.32				46.5	SURCHARGED
1.002		3	1.295	0.048	0.000	0.44				62.9	SURCHARGED
2.000	POND	1	1.400	-0.450	0.000	0.00				0.0	OK
1.003		4	1.251	0.108	0.000	0.90				89.5	SURCHARGED
1.004		5	1.222	0.111	0.000	0.91				90.7	SURCHARGED
1.005		6	1.193	0.112	0.000	0.89				130.1	SURCHARGED
1.006		7	1.073	0.136	0.000	0.83				160.2	SURCHARGED
3.000		8	1.307	-0.119	0.000	0.72				76.1	OK
3.001		9	1.213	0.025	0.000	0.89	0.0			129.1	SURCHARGED
4.000		10	1.207	0.055	0.000	0.40				39.9	SURCHARGED
3.002		11	1.121	0.074	0.000	0.62				168.7	SURCHARGED
1.007	12	1.002	0.163	0.000	2.20					345.4	SURCHARGED
1.008		13	0.901	0.082	0.000	0.02				27.5	SURCHARGED
1.009		14	0.901	0.202	0.000	0.03				27.5	SURCHARGED
1.010		14d	0.905	0.270	0.000	0.01				6.4	SURCHARGED
1.011		15 (FC)	0.910	1.381	0.000	0.19				3.0	SURCHARGED

US/MH	Level	
PN	Name	Exceeded
1.000	1	
1.001	2	
1.002	3	
2.000	POND 1	
1.003	4	
1.004	5	
1.005	6	
1.006	7	
3.000	8	
3.001	9	
4.000	10	
3.002	11	
1.007	12	
1.008	13	
1.009	14	
1.010	14d	
1.011	15 (FC)	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
 Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 2
 Number of Online Controls 1 Number of Time/Area Diagrams 0
 Number of Offline Controls 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.390
 Region England and Wales Cv (Summer) 0.750
 M5-60 (mm) 18.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status OFF
 DVD Status ON
 Inertia Status ON

Profile(s)
 Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600,
 720, 960, 1440, 2160, 2880, 4320, 5760,
 7200, 8640, 10080

Return Period(s) (years) 2, 30, 100
 Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	1	15 Winter	100	+30%	100/15 Summer			
1.001	2	15 Winter	100	+30%	30/15 Winter			
1.002	3	15 Winter	100	+30%	30/15 Summer			
2.000	POND 1	2160 Winter	100	+30%	100/2160 Winter			
1.003	4	15 Winter	100	+30%	30/15 Summer			
1.004	5	15 Winter	100	+30%	30/15 Summer			
1.005	6	2160 Winter	100	+30%	30/15 Summer			
1.006	7	2160 Winter	100	+30%	30/15 Summer			
3.000	8	15 Winter	100	+30%	100/15 Summer			
3.001	9	2160 Winter	100	+30%	30/15 Winter		100/15 Summer	36
4.000	10	1440 Winter	100	+30%	30/15 Summer			
3.002	11	1440 Winter	100	+30%	30/15 Summer			
1.007	12	1440 Winter	100	+30%	30/15 Summer			
1.008	13	1440 Winter	100	+30%	30/1440 Winter			
1.009	14	1440 Winter	100	+30%	30/960 Winter			
1.010	14d	1440 Winter	100	+30%	30/960 Winter			
1.011	15 (FC)	1440 Winter	100	+30%	2/15 Summer			

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water	Surcharged	Flooded	Half Drain			Pipe
		Level (m)	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Time (mins)	Flow (l/s)
1.000	1	2.160	0.746	0.000	0.49			26.8 SURCHARGED
1.001	2	2.125	0.750	0.000	0.51			73.7 SURCHARGED
1.002	3	2.075	0.828	0.000	0.95			135.0 SURCHARGED
2.000	POND 1	1.861	0.011	0.000	0.42			58.6 SURCHARGED
1.003	4	1.963	0.820	0.000	1.31			130.9 SURCHARGED
1.004	5	1.946	0.835	0.000	1.35			133.4 SURCHARGED
1.005	6	1.960	0.879	0.000	0.33			48.3 SURCHARGED
1.006	7	2.027	1.090	0.000	0.20			37.9 SURCHARGED
3.000	8	2.127	0.701	0.000	1.17			124.1 SURCHARGED
3.001	9	1.873	0.685	0.000	0.22	63.9		31.8 SURCHARGED
4.000	10	2.017	0.865	0.000	0.06			6.4 SURCHARGED
3.002	11	2.017	0.970	0.000	0.10			26.7 SURCHARGED
1.007	12	2.047	1.208	0.000	0.32			50.0 FLOOD RISK
1.008	13	2.059	1.240	0.000	0.03			42.8 FLOOD RISK
1.009	14	2.062	1.363	0.000	0.05			43.0 FLOOD RISK
1.010	14d	2.062	1.427	0.000	0.02			16.2 FLOOD RISK
1.011	15 (FC)	2.062	2.533	0.000	0.24			4.0 FLOOD RISK

US/MH	Level	
PN	Name	Exceeded
1.000	1	
1.001	2	
1.002	3	
2.000	POND 1	
1.003	4	
1.004	5	
1.005	6	
1.006	7	
3.000	8	
3.001	9	
4.000	10	
3.002	11	
1.007	12	
1.008	13	
1.009	14	
1.010	14d	
1.011	15 (FC)	



APPENDIX D

EA Correspondence

Colin Driver

Subject: FW: Grange Road, Hull: 18/01431/FULL

From: Griffiths, Lizzie R <lizzie.griffiths@environment-agency.gov.uk>
Sent: 11 January 2019 14:48
To: James Gibson <James.Gibson@alanwood.co.uk>
Cc: Clarke-Wood, Rachel S <Rachel.Clarke-Wood@environment-agency.gov.uk>
Subject: FW: Grange Road, Hull: 18/01431/FULL

Hi James,

I've consulted with our flood risk advisor and the following properties are slightly under the 1.2m floor level raising that we'd hoped for:

Plot 70: FFL: 2.95 – what we would ask for: 2.98. Raised 1170mm (missing 30mm)

Plot 71: FFL: 2.95 – What we would ask for: 2.98. Raised 1170mm (missing 30mm)

Plot 66: FFL: 3.15 – what we would ask for: 3.20. Raised 1150mm (missing 50mm)

Plot 64: FFL: 2.95 – What we would ask for: 2.97. Raised 1180mm (missing 20mm)

Plot 65: FFL: 2.95 – What we would ask for: 2.97. Raised 1180mm (missing 20mm)

This is very positive improvement and while we'd like you to consider raising the above properties to the full 1.2m, if it's not possible, we're not likely to maintain an objection on that, given the proximity to the border of the 600-900mm depths.

Hope this is useful.

Lizzie

Lizzie Griffiths

Sustainable Places – Planning Specialist

Environment Agency | Lateral, 8 City Walk, Leeds, LS11 9AT

lizzie.griffiths@environment-agency.gov.uk

Tel: 020 302 58439



**Creating a better place
for people and wildlife**



From: Griffiths, Lizzie R
Sent: 10 January 2019 11:51
To: 'James Gibson' <James.Gibson@alanwood.co.uk>
Cc: Andrew Bradley <Andrew.Bradley@keepmoat.com>
Subject: RE: Grange Road, Hull: 18/01431/FULL

Hi James,

To you too.

I've chased the flood risk officer for a response – I think he's still catching up from over the Christmas period, but should have an answer soon.

Lizzie

Lizzie Griffiths

Sustainable Places – Planning Specialist

Environment Agency | Lateral, 8 City Walk, Leeds, LS11 9AT

lizzie.griffiths@environment-agency.gov.uk

Tel: 020 302 58439



**Creating a better place
for people and wildlife**



From: James Gibson [<mailto:James.Gibson@alanwood.co.uk>]

Sent: 09 January 2019 12:09

To: Griffiths, Lizzie R <lizzie.griffiths@environment-agency.gov.uk>

Cc: Andrew Bradley <Andrew.Bradley@keepmoat.com>

Subject: RE: Grange Road, Hull: 18/01431/FULL

Hi Lizzie

Happy New Year to you.

Further to my message yesterday I wondered if you'd had chance to review the details?

Regards

James Gibson

T: 01482 442138

T: 01904 611594

Mob: 07808940756

For and on behalf of Alan Wood & Partners

• HULL • LINCOLN • LONDON • SCARBOROUGH • SHEFFIELD • YORK •

• 341 Beverley Road • Hull • HU5 1LD •

• Omega2 Monks Cross Drive • York • YO32 9GZ



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From: Griffiths, Lizzie R [<mailto:lizzie.griffiths@environment-agency.gov.uk>]
Sent: 28 December 2018 08:25
To: James Gibson <James.Gibson@alanwood.co.uk>
Cc: Andrew Bradley <Andrew.Bradley@keepmoat.com>; Clarke-Wood, Rachel S <Rachel.Clarke-Wood@environment-agency.gov.uk>
Subject: RE: Grange Road, Hull: 18/01431/FULL

Hi James,

I trust you've had a good Christmas?

I understand your approach, although technically the 1.2m should be added to the average site level, not the lowest. Going to run this past our flood risk advisor for their thoughts and then I'll be in touch.

Kind regards

Lizzie

Lizzie Griffiths
Sustainable Places – Planning Advisor
Environment Agency | Lateral, 8 City Walk, Leeds, LS11 9AT

lizzie.griffiths@environment-agency.gov.uk

Tel: 020 302 58439



**Creating a better place
for people and wildlife**



From: James Gibson [<mailto:James.Gibson@alanwood.co.uk>]
Sent: 21 December 2018 17:08
To: Griffiths, Lizzie R <lizzie.griffiths@environment-agency.gov.uk>
Cc: Andrew Bradley <Andrew.Bradley@keepmoat.com>
Subject: FW: Grange Road, Hull: 18/01431/FULL

Lizzie

In Rachel's absence are you able to assist?

Regards

James Gibson
Director

Tel: 01482 442138
Mob: 07808 940756



For and on behalf of Alan Wood & Partners
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From: James Gibson
Sent: 21 December 2018 17:06
To: 'Clarke-Wood, Rachel S' <Rachel.Clarke-Wood@environment-agency.gov.uk>
Cc: 'Jamie Moran' <Jamie.Moran@keepmoat.com>; Andrew Bradley <Andrew.Bradley@keepmoat.com>; Emma Ridley <Emma.Ridley@pegasusgroup.co.uk>; Stuart Grayson <Stuart.Grayson@alanwood.co.uk>
Subject: [Pending]Grange Road, Hull: 18/01431/FULL

Rachel

Further to my message, we have received your objection to the flood risk mitigation for Keepmoat's scheme at Grange Road in Hull (ref 18/01431/FULL).

We have undertaken some more analysis and in the past few weeks we have been developing the engineering layouts and external works for the site. As a consequence, we have had to raise the Finished Floor Levels, which will also increase the level of flood protection that was originally proposed within the FRA.

To explain further, I attach two drawings, the first shows the SFRA Figure 13 overlaid onto the topographic survey for the site. Whilst the imported Figure 13 image is pixelated, the flood depth bandings are reasonably consistent with the variance in site levels. As you can see, the lowest site surveyed level is around 1.73mAOD, which coincides with the 900mm to 1200mm flood depth band. Taking the flood depth at its highest (1200mm) it results in a potential flood level of around 2.93mAOD. Obviously, Figure 13 is the worst-case scenario, with the effects of overtopping/breach/climate change and the 1 in 1000 year rainfall event. Other mapping within the Hull SFRA shows less flood depths (for example, Figure 3B shows a maximum flood depth 600mm, which equates to a flood level of around 2.33mAOD). I think it is reasonable to suggest that chances of the Figure 13 flood depths occurring are remote, but I understand that it is a key plan in assessing the risk.

The second drawing shows the proposed finished floor levels for the site, all of which are set at, or above, a level of 2.95mAOD.

Setting the minimum FFL to 2.95mAOD is therefore above the worst-case flood level, and, we trust, is acceptable. This is a betterment compared to the current FRA mitigation and I hope that this new information is sufficient for you to remove your objection.

As per my message, I am out of the office until 07 January, but I am contactable on my mobile if you have any questions.

Regards

James Gibson
Director

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For and on behalf of Alan Wood & Partners

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