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FLOOD RISK ASSESSMENT

LAND AT

HOYLE MILL, THURLSTONE

NOVEMBER 2009

CROMWELL WOOD ESTATE COMPANY LIMITED
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CONTENTS

ISSUES REGARDING FLOOD RISK AND PLANNING AT HOYLE MILL, THURLSTONE NEAR PENISTONE WEST YORKSHIRE

APPENDICES:

APPENDIX A: PLANS

APPENDIX B: JBA REPORT

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INTRODUCTION

Cromwell Wood Estate Company Limited was instructed by Michael Townsend Planning and Development Consultants in September 2009, on behalf of South Yorkshire Home Improvements Limited, to undertake a risk assessment on the potential for flooding for the proposed development for a mixed housing at Thurlstone. Planning approval has been granted for housing in 2007 and the planning conditions were discharged for that scheme after additional information was submitted in March 2009. This flood risk assessment relates to the proposal to build 12 properties set back from the river bank and shown on drawing numbers H/C/163/1A AND H/C/163/2A. The flood risk assessment has considered the redevelopment on the site for housing from the present use which is as a window, conservatory and door manufacturing unit. The site is part of South Yorkshire Home Improvement's base in Thurlstone, on the north side of the upper reaches of the River Don. A report was submitted for the previous flood risk assessment which included a hydrological model for the River Don in March 2006, and the situation has not changed since the date of that report, a copy of which is included in appendix B. The JBA report concluded that the river would not overtop the bank in the area of the factory, and if any flooding did occur then the flood attenuation would occur to the north of the site in the lower lying pasture.

SITE LOCATION

The site is located on the north side of Manchester Road in Thurlstone at the end of Hoyle Mill Lane, between the River Don and the pasture to the north. The land is relatively flat and extends to the woodland to the north. The access to the site is situated near to the river crossing bridge which is a stone built arch bridge. The site is some 3 metres above the river and there is a stone wall on the opposite side of the river that supports the highway. There is a weir near to the factory buildings some 20 metres upstream and the fall in level is about 1.7 *metres over the weir.*

THE SITE

The site is at a level of 200m aod on the eastern end and 202 metres at the western end near the old mill. The bridge is at a level of 205.4 metres aod. The site has been surveyed and the survey is appended in Appendix B in the JBA report. The levels on the plan are to an ordnance datum but the level to Ordnance Datum has been adjusted for the new GPS control used by the EA in their modelling. Refer to plan number SYHI/CSP-001.

The site has buildings located either side of a central road to provide access to the buildings. There are two stone buildings, some brick built units and the portal frame buildings that were constructed in 1980. The site has been a woollen mill from about 1830 until 1920 when it became a chicken processing factory where chickens were slaughtered and then boiled.

The site lies in a river valley with steep valley sides to the south and to the north west and west. The dwellings and industry are concentrated along the river valley and the river itself, as was normal in the industrial revolution so that the river could provide power and a supply of water for washing.

There were woollen mills upstream and downstream of this site as shown on the earliest Ordnance Survey publications, and development continued along the valley sides at Thurlstone where the river has cut through the massive sandstone plinth at a fault. To the west at Millhouse Green and east at Penistone the valley is flatter and there is a greater area of flood plain.

WATER COURSES

The nearest watercourse to the site is the River (Little) Don which runs adjacent to the site in a river bed some 3 metres below the formation levels of the yard and buildings. There is a drain/culvert that runs from the fields to the north and runs into the river just east of the site near the footbridge.

The most important watercourses are the River Don and Little Don that meet at Stocksbridge to form the Don. The Little Don is situated in the valley to the south around Langsett and Midhopestones, and there are two reservoirs that store water named as Langsett and Underbank. The Don has Winscar reservoir at the head of the river near Snittlegate Moor, and then flows eastward through a wide valley near Catshaw and Millhouse Green until it reaches the steep sided valley at Thurlstone, then flowing through lower lying farmland to Stocksbridge. Refer to plan number FRA 1. The rivers are fed by streams and issues off the moorland to the west, around Thurlstone Moor and Langsett Moor that form the higher ground on the eastern edge of the Pennines. The ground is covered in peat and beneath the land is an alternating sequence of mudstone and shale which act as aquicludes and sandstone and gritstone which act as minor aquifers in the hydrogeological setting.

There are a number of reservoirs in the Pennine area which supply water to Sheffield that were built in the early 19th century as the city became the steel capital of the world. The Reservoirs are located in the upper regions of the Pennines around Langsett and the moorland towards Glossop

The rainfall in the Pennine region can be as much as 1500 mm per year on the eastern slopes and the water flow is regulated by the peat and sandstone underneath, together with the reservoirs and cloughs. There can be rapid run off where the geology is impermeable but the geological strata has been disturbed by faulting and there are pathways for recharge of the groundwater along the course of the river.

The reservoirs will regulate the flow in peak rainfall as they are filled after draw down. The pressure for supply now results in reservoirs rarely been at capacity and the rainfall replenishes the level until it reaches the over flow level.

There are no flood defences along the river in the vicinity of the site, to the east was a sewage farm, where there is meander in the river course.

The level at the sewage farm was at 653 feet (199.03m) aod and the mill is at a level of 201 to 205 metres aod. There is weir near to the stone building which is a remnant of the mill that existed on site previously when the water was used for power. The early edition of the Ordnance Survey map shows a weir and a mill race off a pond running through a mill which is orientated north to south and the other stone buildings behind. The mill has been demolished and the pond filled in by the turn of the last century.

ENVIRONMENT AGENCY DATA

The Environment Agency data, refer to figure 3 in appendix A shows the site to lie on the edge of the zone 3 flood plain, this gives the probability of the site flooding as 1 in 100 year event. The Environment Agency had concerns about the flood risk when the application was submitted for the use of the site for housing and the hydrological modelling exercise was carried out at their request. The flood plans produced by the EA do not use site specific survey data unless supplied and the flood plain can be accurately assessed using flood modelling.

The site does not appear to have suffered from poor drainage due to restricted flow in the drain or the river, and the site will drain to the east with the lie of the land where the ground levels are only slightly higher than the river bed. There is a road bridge over the river to carry the highway into Thurlstone, that forms the western section of the river near the site, but the clearance is sufficient for dispersal of water in a flood event. There is small footbridge at the eastern end but this will not impede flow. Flood levels were recorded in 1965 upstream and downstream of the weir, and the flood data is included in appendix C of this report. The owner cannot recall there being any flooding of the mill even in 2002, 2007 and 2008 when the river levels were high after persistent rain. The weir is 1.7 metres high and the river bed is fairly wide near the mill due to the former pond.

ISSUES RELATED TO PLANNING

Although the site is of a low lying nature and it is placed on the 1 in 100 year risk of flooding by the Environment Agency, being inside the zone 3 of flooding from the surrounding watercourses, it is unlikely the EA will require further information before agreeing to the redevelopment of the land due to the previous flood risk work, and the conclusion of the JBA report that any increase in river levels from heavy rain are unlikely to over top the banks alongside the factory curtilage. The land has been occupied for over 200 years and there has been a consistent human presence through work in that time.

The proposed development is for a residential accommodation with up to 12 houses on the site with hard standing and soft landscaping to the front of the houses facing the river, and car parking to the rear where the current buildings stand. The development is situated at least 6.5 metres from the river bank whereas the existing mill is on the river bank. Please refer to the plans in appendix A.

The roof water should be collected for discharge via a soakaway or into the river. The current factory drains water from the roofs and hard standing via a storm water drain to the river at this present time. The culvert on the eastern end of the factory and the storm water drains will discharge to the river and there is a foul water line to the former sewage works that must have connected Thurlstone village to the sewage works.

RAINWATER CALCULATIONS

The rainwater falling in a 30 minute event on a 30 year return period is 44 mm and with climate change is 52 mm. If each roof is 50 square metres in area then the area for storm water is 300 square metres which equates to 15 cubic metres or 8.6 litres per second. The hard standing areas can be equated as the same in area and the rate of water flow, not considering wetting of the surface and time to flow through the pipe work will be the same. Therefore the amount of water to a sustainable drainage system will be 17.2 litres per second.

From our investigations of the geological map, the site is covered by drift but on our site inspection the weir runs over a bed of flag and the mill looks to stand on the sandstone associated with the Penistone Flags. This rock will allow water to be discharged via a soakaway.

The water from the ground caused by rainfall is unlikely to be contaminated and will soak into the grassed areas on site. If there are any hard standings, the water run off from these areas is unlikely to be contaminated with components from the development such as oils or fuel as could be the case in a parking area or road. Parking areas or where vehicles are to be kept will have to be drained via an oil interceptor prior to discharge.

The site is situated near a water course, and it is likely that the strata below the ground surface will be a thin veneer of drift deposit on sandstone which will be permeable to water percolation. It is unlikely the surface water on the present land will discharge via a soak away as the site is sealed and drained via gullies and it should run to the storm water sewer.

A comparison has been made between the existing run off and the run off from the proposed development of houses and car parking. The run off from a 30 minute storm based on returns over 30 years with climate change is 52 mm in total. This rainfall figure has been used to calculate the run off of storm water over the existing site and the proposal.

The present roof area of the mill is 1,537 square metres, and the road between the buildings is 280 square metres. The water volume from a similar 30 minute storm event with climate change added of 20% would be 94 cubic metres or 52 litres per second.

In a 10 minute storm event taken from BRE 365, the amount falling in this area is 20 mm. The volume of water falling on the site would be 36 cubic metres if it was drained instantaneously would be 61 litres per second.

Some of this water currently drains into the sewer with the additional foul water which has been assessed at 600 litres per day, or 60 litres per hour during the working day based on the number of employees. The remaining water runs off the roofs and directly flows off the roof areas into the river. The sealed areas between the factory buildings and the customer car park also flow to the river.

The current owner and land use has a right to place foul and storm water into the sewer, and this should still be the case if there is no increase in the amount of water drained from the new development. As discussed the storm water could go to ground and follow the principle of Sustainable Urban Drainage Systems. The foul water make for the past use as a chicken processing unit would have been large, but the buildings have been used as a home improvement manufacturing base for over 25 years and the foul water make will have reduced. The only foul water will be from the toilets and wash rooms on site, and therefore if the storm water is discharged to a watercourse or to ground the foul system can take the quantity from the proposed housing development.

If the proposal for 12 units is granted, then the foul water could be placed in the foul sewer and the amount per day, if based on 105 litres per day per person if we take four people will live in one house, would equate to between 3,250 and 4,000 litres per day. The foul water sewer should be able to accommodate the additional foul water make, but a scheme will be submitted to Yorkshire Water for them to assess the foul water disposal scheme for adoption. YWA will improve the foul water disposal system if need be.

Some of the current storm water runs into the foul water system and takes between 40 and 50 litres per second when there is heavy rain. The likelihood of this amount of storm water being drained when the site is redeveloped is remote due to there being less area of hard standing. On the present use the proposed houses would have to occupy a roof area of 1,000 square metres with 800 square metres of hard landscaping before there would be an equivalent amount of water into the existing system.

If we take each house at 70 square metres of roof area, and the road and car parking as 80 metres long by 4 metres wide with the road being 4 metres wide, then the drained area is 1,300 square metres. The run off from a 30 minute storm with climate change for a 30 year return period of rainfall data is:–

1,300 square metres x 0.052 metres = 67.6 cubic metres or 37.6 litres per second.

In a ten minute storm based on rainfall levels from the Design of Soakaways, BRE 365 of 20 mm the rainfall to drain would be 26 cubic metres or 43 litres per second.

The proposal reduces drained rainfall to the river by 43 litres per second divided by 61 litres per second = 70 % of the existing run off. This is a reduction of 30 % of rainfall to the river. There is ample area to incorporate storm water drainage within the site to lessen the risk and attenuate flow in times of heavy rain. A sustainable drainage system could be designed into the development to store water in over size pipes or in underground tanks that resemble plastic milk crates surrounded by plastic sheeting. There are a number of suppliers of sustainable drainage systems that are manufactured in recycled plastic.

CONCLUSIONS TO THE INVESTIGATION

The site is set in the zone 3 of the floodplain and is described by the Environment Agency as been at risk of 1 in 100 year flood. The flood risk assessment and the JBA hydrological report confirm that with the available survey data and the present drainage system, the land will not flood and the historical data seems to confirm this. The highest recorded flood in 1965 was 200.83 m on the upstream side of the weir and 199.78m on the downstream side. At the eastern end of the site near the footbridge the level was 199.43m aod. The site is 1.5 metres above the recorded level of the river at the western end of the buildings and 650 mm above the recorded level at the eastern end. The river level at the footbridge when surveyed was 198.01m aod. There is no record of there been any flooding in the two latest storm events in 2007 and 2008.

The present use will provide a significant amount of water run off to the drainage system, and the housing development will reduce this by 30% and therefore decrease the risk of flooding in the area. The proposed development will provide for water to go to ground, to soak into the soil and to drain into the river without adding to the capacity of the sewer from this development. The sewer should be able to accept the increase in foul water make as currently all water goes to the drainage system. The mill does not suffer from flooding and the houses can be built at the same level for the floors as the present buildings. The houses are more likely to built 600 mm above the present level due to the over site concrete and the modern construction of floors in houses. The increase in formation levels should accommodate any climate change addition on the existing rainfall data and provide flood attenuation in the front gardens. The road and the car park should not be flooded and emergency vehicles and residents should be able to evacuate the development in times of heavy rain.

The footpath and area to the front of the house will provide some attenuation, and the ground floor levels should be set 600 mm above the river bank levels to reduce the risk of flooding the properties and also provide attenuation for the river if it does over top the bank.

Signed

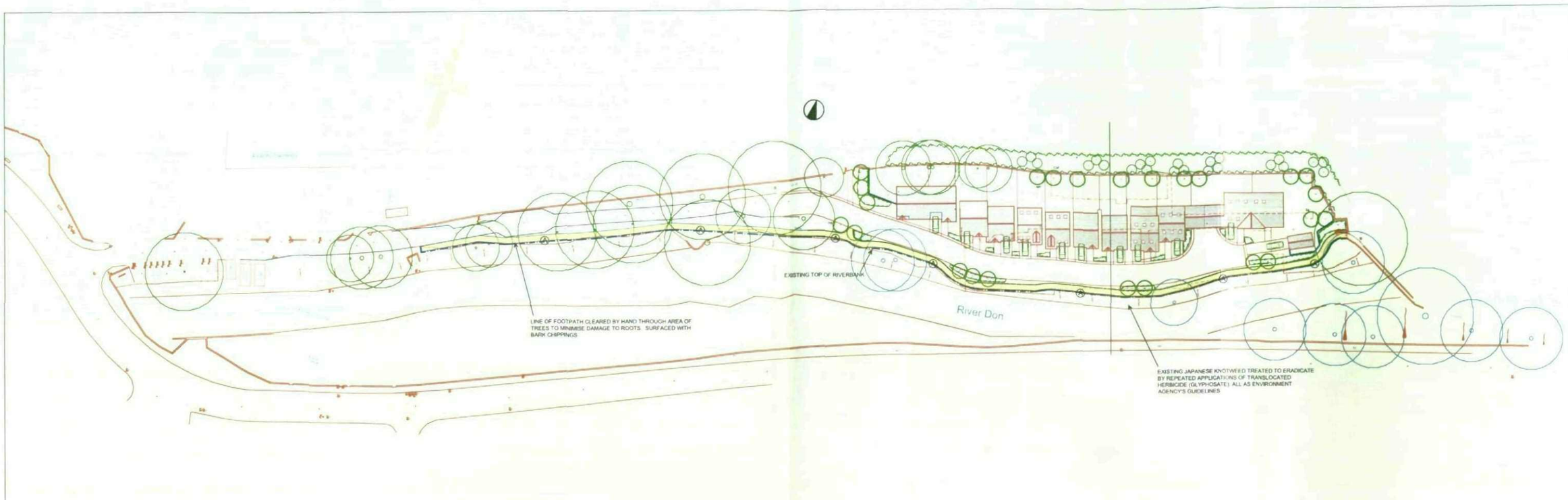


Eur Ing John Carlon B.Eng C.Eng MIMM MRICS MIQ MCIWM

November 20th 2009

APPENDIX A

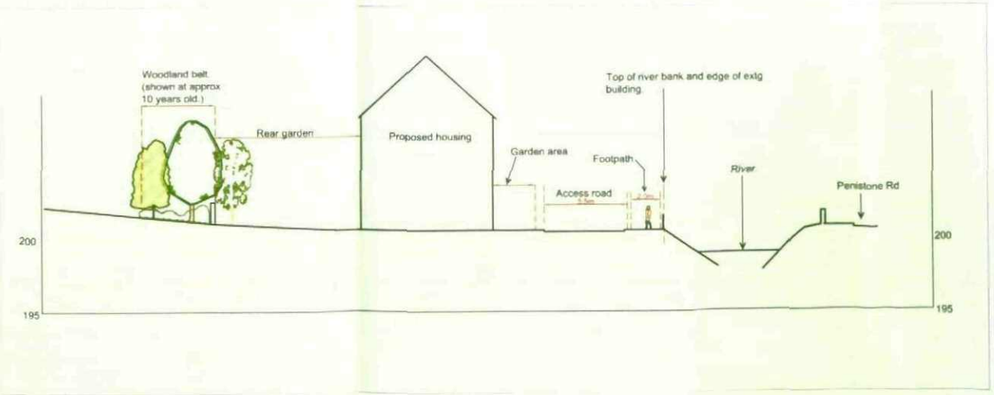
PLANS



REFERENCE

- Existing trees to remain. As surveyed
- Existing trees to remain. Approx size and position only
- Proposed standard trees. 10-12cm girth
- Proposed ornamental shrub planting. For details see dwg no H/T/163/2a
- Proposed native tree and shrub mix. For details see dwg no H/T/163/2a
- Proposed grass seeding. BSH mix A22, or similar, sown @ 35gms/m²
- Proposed 1m high ms railing painted black gloss 2 horizontal rails. 50mm diam. on posts at 1.8m centres. (A) represents access points of removable sections of railing
- Proposed informal footpath. 1.5m wide surfaced with bark chippings
- Existing building footprint

TYPICAL SECTION THRU RIVER
scale 1:200



Rev A. 18 Nov 09. Amendments to comply with new layout, architects dwg no 0961/110 rev A

cf landscape design

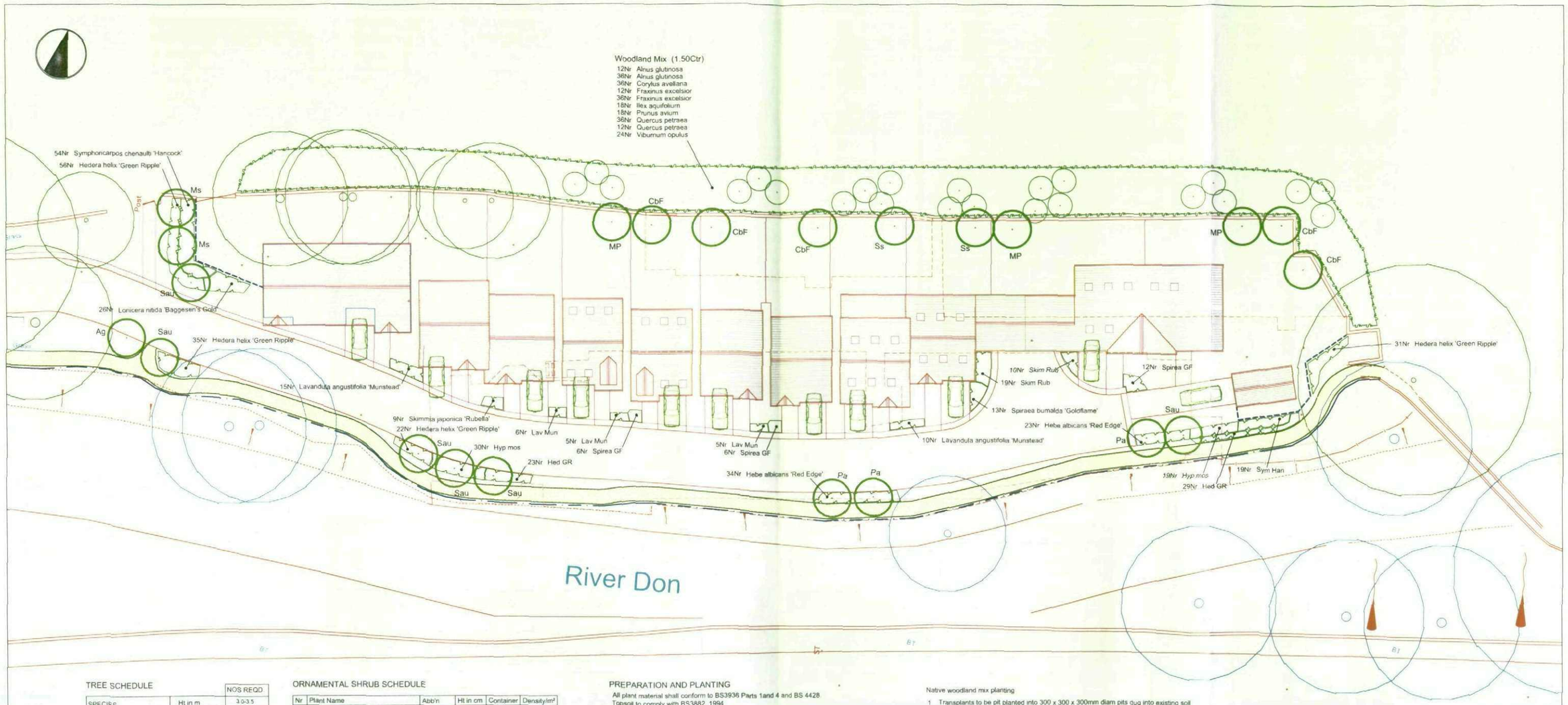
Oakleigh, Henley Road, Otley, West Yorkshire LS21 3LN
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Client: Mr J Hutchins

Project: Proposed residential development at Hoyle Mill, Thurlstone.

Drawing title: Outline Landscape Proposals

Scale	Date	Drawn by	Drawing no.
1:500 @ A1	Dec 05	CTF	H/C/163/1A



TREE SCHEDULE

SPECIES	Ht in m / Girth in cm	NOS REQD 3.0-3.5 / 10-12
Alnus glutinosa (Ag)		1
Carpinus betulus 'Fastigiata' (CbF)		5
Malus 'Profusion' (MP)		3
Malus sylvestris (Ms)		2
Prunus avium 'Plena' (PaP)		3
Sorbus aucupana (Sa)		6
Sorbus aucupana 'Sheerwater Seedling' (Ss)		2

Foundation design of new buildings shall accommodate proposed tree planting in accordance with NHBC guidelines

ORNAMENTAL SHRUB SCHEDULE

Nr	Plant Name	Abb'n	Ht in cm	Container	Density/m²
57	Hebe albicans 'Red Edge'	Heb RE	20-40cm	3L	4.00
196	Hedera helix 'Green Ripple'	Hed GR	40-60cm	2L	5.00
49	Hypericum moserianum	Hyp mos	30-40cm	3L	4.00
41	Lavandula angustifolia 'Munstead'	Lav Mun	20-40cm	3L	4.00
26	Lonicera nitida 'Baggesen's Gold'	Lon BG	30-40cm	3L	4.00
38	Skimmia japonica 'Rubella'	Skim Rub	30-40cm	3L	4.00
37	Spiraea bumalda 'Goldflame'	Spirea GF	30-40cm	3L	4.00
73	*Symphoricarpos chenaulti 'Hancock'*	*Sym Han*	*40-60cm*	3L	4.00

NATIVE WOODLAND MIX

%age	Nr	Plant Name	Ht (cm)	Root	Form
15.00	36	Alnus glutinosa	40-60cm	B	Transplant
5.00	12	Alnus glutinosa	175-200cm	B	Feathered
15.00	36	Corylus avellana	40-60cm	B	
15.00	36	Fraxinus excelsior	40-60cm	B	Transplant
5.00	*12*	*Fraxinus excelsior*	*175-200cm*	*B*	*Feathered*
7.50	18	Ilex aquifolium	40-60cm	C	
7.50	18	Prunus avium	40-60cm	B	Transplant
5.00	12	Quercus petraea	175-200cm	RB	Feathered
15.00	36	Quercus petraea	40-60cm	B	Transplant
10.00	24	Viburnum opulus	40-60cm	B	

PREPARATION AND PLANTING

All plant material shall conform to BS3936 Parts 1and 4 and BS 4428.
Topsoil to comply with BS3882, 1994
Organic matter to be proprietary shrub planting compost, or approved compost derived from recycled organic matter
Slow release fertiliser to be 'Enmag' or similar.

Standard tree planting

1 Trees shall be planted into pits of an appropriate size to accomodate the root system without restriction and shall be secured to a machine rounded stake using 1 no. tree tie with rubber spacer. Finished height of *stake shall not exceed* 1/3 height of staked tree above ground.
Tree pits to be back-filled with imported topsoil mixed with compost at a
2 ratio of 3 parts soil to 1 part compost.

Ornamental planting

1 Shrubs to be planted into 300mm depth of high quality topsoil complying with BS3882, 1994
2 Organic matter to be spread over planting area and cultivated into soil to a min 400mm depth
3 Shrubs to be planted into prepared soil in pits large enough to accomodate full rootball
4 Finished beds to be lightly forked over and dressed with 75mm depth coarse forest bark mulch

Native woodland mix planting

1 Transplants to be pit planted into 300 x 300 x 300mm diam pits dug into existing soil Backfill for each pit to be 1 part compost: 3 parts topsoil, with slow-release fertiliser added at 50gms per pit.
2 Feathered trees to be planted at 3m centres in groups of 3-6, into pits 600 x 600 x 600mm, backfilled with 1part compost:3parts topsoil with 100gms slow release fertiliser added per pit.
3 All trees to be staked with 75mm diam round stake secured by 1 no tree tie with rubber spacer. Finished height of stake shall not exceed 1/3 height of staked tree above ground.
4 All shrubs and trees to be fitted with rabbit protection. Spiral guards supported by a *stout cane or stake, mesh shrub* guards supported by a stout cane for bushier species. Alternatively, rabbit proof fencing erected around the whole area of planting.

AFTERCARE - 5 YEARS

1 Keep ornamental shrub areas free from weeds by means of 3 herbicide applications per year or by hand weeding.
2 In native woodland planting keep an area 600mm diam around each plant free from weed growth by means of 3 herbicide applications per year.
3 Annually apply a slow release fertiliser to each plant in spring in the first three years
4 Replace all failures in the first year.
5 Replace all failures to achieve 80% stocking rate in subsequent years.
6 Prune all damaged or broken branches. Hard prune all shrubs after planting *and in* year 3.
7 Top up mulch annually to 75mm depth.

NOTE

Drawing to be read in conjunction with dwg no H/T/163/1a

Rev A 18 Nov 09 Amendments to comply with new layout, architects dwg no 0961/110 rev A

cf landscape design

Oakbank, Hoyle Road, Oxshott, Surrey KT22 0LN
Tel 01372 [illegible] Mobile 07[illegible]

Client: Mr J Hutchins

Project: Proposed residential development at Hoyle Mill, Thurlstone.

Drawing title: Landscape Details

Scale	Date	Drawn by	Drawing no
1:200 @ A1	Dec 05	CTF	H/C/163/2a

APPENDIX B

JBA CONSULTING REPORT

J & H M Hutchings

Land at Hoyle Mill Thurlestone

Hydrological Modelling of River Don

March 2006

FINAL REPORT

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REVISION HISTORY

Revision Ref./ Date Issued	Amendments	Issued to
Final Report March 2006		John Carlon – Cromwell Wood Estate Co. Ltd. Number of copies 2

CONTRACT

This report describes work commissioned by J & H M Hutchings under their letter of instruction dated 8 February 2006. J & H M Hutchings' representative for the contract was John Carlon of Cromwell Wood Estates Co. Ltd. Paul Jones and Chris Wright of JBA Consulting carried out the work.

Prepared by: ..... Christopher Wright BSc, CEng, MICE
Principle Engineer

Reviewed by: ..... Geoffrey Heald EngTech, TMICE
Senior Engineer

Approved by: ..... Richard Buck BEng, CEng, MICE, MCIWEM
Director

PURPOSE

This document has been prepared solely as a report on the hydrological modelling of the River Don for J & H M Hutchings. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to J & H M Hutchings. If the site is sold, the scope of the development changed, or this report is provided to third parties then any liability or explicit or implied warranty is voided

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EXECUTIVE SUMMARY

Executive Summary Heading

Following submission of a planning application by J & H M Hutchings for redevelopment for housing of the South Yorkshire Home Improvements factory at Thurlestone, the Environment Agency has requested that hydrological modelling is carried out on the adjacent River Don to predict peak water levels in the river and compare those with the site levels.

This report describes that modelling and the results.

The results show that in the 1 in 100 year flood event on the river, including a 20% increase in flow for the effects of future climate change, the site ground levels are between 0.4m and 2.6m above the peak water levels. In addition, it is proposed that the floor levels of the dwellings will be 0.6m above existing ground levels.

It is proposed that this report will be submitted to the Environment Agency as part of the existing flood risk assessment.

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CONTENTS

	Page
REVISION HISTORY	*i*
CONTRACT	*i*
PURPOSE	*i*
ACKNOWLEDGEMENTS	*ii*
EXECUTIVE SUMMARY	*iii*
CONTENTS	*v*

1 BACKGROUND ---- 1
1.1 Existing Site ---- 1
1.2 Proposed Development ---- 1

2 SURVEYS ---- 3
2.1 Site Visit ---- 3
2.2 Topographic Survey ---- 3

3 HYDROLOGICAL MODELLING ---- 5
3.1 Overview ---- 5
3.2 FEH Modelling ---- 5
3.3 HEC-RAS Modelling ---- 5

4 CONCLUSIONS ---- 7
4.1 Flood Risk to Development ---- 7

APPENDICES:

APPENDIX A: - LOCATION PLAN

APPENDIX B: - SURVEYED CROSS SECTION LOCATIONS

APPENDIX C: - TOPOGRAPHIC SURVEY OF EXISTING SITE

APPENDIX D: - FEH MODELLING REPORT

APPENDIX E: - HEC-RAS MODEL RESULTS

LIST OF TABLES

Table 3-1: Predicted Peak Water Levels ---- 6

ABBREVIATIONS

ACE	Association of Consulting Engineers
BCR	Benefit Cost Ratio

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1 BACKGROUND

1.1 Existing Site

The existing site on Hoyle Mill Lane Thurlestone is in use as a home improvements manufacturing facility. The site has the River Don as its southern boundary. To the north are open fields, part of which form a natural flood plain for the river and tributaries. The factory is situated on ground which is higher than the fields to the north.

Site levels range from 202m AOD in the car park on the western edge of the site to 199m AOD at the eastern end of the site. Ground levels on the flood plain to the north are approximately 198m AOD.

An access road from Manchester Road to the factory runs at a level of between 204m AOD at the Manchester Road end to 202m AOD at the factory car park.

The River Don runs in a steep sided valley between the Thurlestone Road to the south and the access road and the factory. To the east of the factory, the north bank is at a reduced level. The river then turns north away from Thurlestone Road before turning east towards Penistone.

The river runs over a weir adjacent to the factory car park at which the bed drops by approximately 1.7m.

It is likely that the weir was originally constructed to raise water levels in order to divert water from the river into a mill on the site of the factory. There appears to be the remains of a mill race to the east of the factory running back to the river at the lower level.

According to Mr Hutchings, the fields to the north have flooded in the past, probably from a combination of the river overtopping the banks downstream of the factory and water from tributaries held up due to high river water levels.

1.2 Proposed Development

It is proposed to develop the site for housing.

A flood risk assessment has been prepared by the Cromwell Wood Estate Company Ltd. to accompany a planning application for the development. The Environment Agency has requested that a hydrological modelling exercise is carried out on the River Don as it passes the site to predict the peak water levels in the river during a 1 in 100 year flood event, including an allowance for future climate change.

JBA Consulting has been engaged to carry out the modelling.

Fennell, Green & Bates have carried out a topographic survey to provide geometric data on the river and flood plain as input to the modelling.

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2 SURVEYS

2.1 Site Visit

A site visit was made in order to view the site, the river and flood plain.

It is apparent that the river, upstream of the factory, runs in a deep steep sided channel.

A weir is situated in the river adjacent to the car park, to the west of the factory buildings. The river bed drops by approximately 1.7m across the weir. The river continues within a deep steep sided channel to the downstream side of the factory where the gradient slackens and the banks on both sides are relatively lower compared with upstream. A raised pipeline is partly visible on the north bank parallel to the river. Further away from the river on the north bank the land is relatively low lying and land to the north of the factory is at a lower level than the river bank, 198m AOD compared with 200m AOD at the river.

It was reported that the low land to the north of the factory floods during periods of high flows in the river.

2.2 Topographic Survey

A survey was requested from Fennell Green & Bates in the form of cross sections of the river bed and banks and including the flood plain to the north of the river. The survey was carried out to Ordnance Datum. A plan showing the cross section locations is included at Appendix B.

A topographic survey of the factory site and access road from Thurlestone Road was made available by Fennell, Green and Bates and is included at Appendix C

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3 HYDROLOGICAL MODELLING

3.1 Overview

The purpose of the modelling was to predict peak water levels in the River Don as it passes the development site and compare these with the ground levels on the site.

The Environment Agency requested that the water levels be predicted for the 1 in 100 year flood flow, plus an allowance for future climate change. The allowance used was an additional 20% of the flow.

The peak flow was estimated using the Flood Estimation Handbook (Institute of Hydrology, 1999) (FEH) statistical method. The associated Windows Frequency Analysis Package (WINFAP) was used to improve the reliability of the FEH statistical method.

The results of the topographic survey were input to a HEC-RAS model of the river. HEC-RAS is a backwater curve analysis package which predicts water levels for a peak flow. It is an industry standard software package generally used for predicting river water levels.

3.2 FEH Modelling

A report on the record of the calculations and decisions made during the FEH modelling is attached at Appendix D. It includes the data required to repeat the modelling.

It also records the pooling group catchments used in the statistical analysis to refine the estimated peak flow. These are provided to allow that analysis to be repeated.

The resulting predicted 1 in 100 year peak flow including a 20% increase for future climate change on the River Don at the development site is 41m^3/s.

3.3 HEC-RAS Modelling

The cross section data from the survey was entered into HEC-RAS to produce a model of the river, from 60m upstream of the A628 Thurlestone Road bridge over the river, which is 250m upstream of the centre of the factory site, to a point 400m downstream of the centre of the factory site. The factory site extends for approximately 130m along the river.

Cross sections were surveyed at approximately 50m intervals with additional sections at bridges. The sections extended across the flood plain.

The structures modelled were the Thurlestone Road bridge, two footbridges and the weir.

As the proposed development will not impact on the river bed and banks, one model, as surveyed was analysed.

The full length of the cross sections across the flood plain to the north of the factory was included in the model.

The 1 in 100 year plus an allowance for future climate change peak flow was simulated in the HEC-RAS model of the river. The results showing peak water levels are at Appendix E.

The HEC-RAS model did not model flows across the flood plain. The peak water levels calculated by the model did not exceed the surveyed bank levels at the cross section locations. It is possible that there are bank levels between the cross section locations which would be low enough to allow overtopping on to the flood plain. It is clear from the site survey that this is not the case in the length of river adjacent to the factory and car park site and upstream of the site to the Thurlestone Road.

If the river does overtop its banks downstream of the factory site, the resultant flooding would be confined to the low lying land to the north of the factory site at levels no greater than those predicted by the model in the river. The effect of flooding of the flood plain would be to reduce peak water levels in the river adjacent to the site.

The peak water levels predicted by the modelling are summarised below.

Table 3-1: Predicted Peak Water Levels

Location	Existing Site Ground Level	Peak River Water Level
Downstream extent of site	199	198.6
Centre of site	199.7	198.9
Upstream extent of the site	202	199.4* 200.6**

Table-Notes
Levels are in m AOD
Peak River Levels are for the 1 in 100 year +an allowance for future climate change (20%)
* downstream of the weir
** upstream of the weir

It can be seen that the existing site ground levels are at between 0.4m and 2.6m above the 1 in 100 year plus climate change peak water level.

4 CONCLUSIONS

4.1 Flood Risk to Development

The modelling has shown that the existing site levels are a minimum of 0.4m above the peak water level in the River Don which would occur during a flood event having a 1 in 100 chance of occurring in any year, including a 20% increase in the flow rate for the effect of future climate change.

It is proposed that the finished floor levels of the dwellings on the site will be 0.6m above existing ground levels.

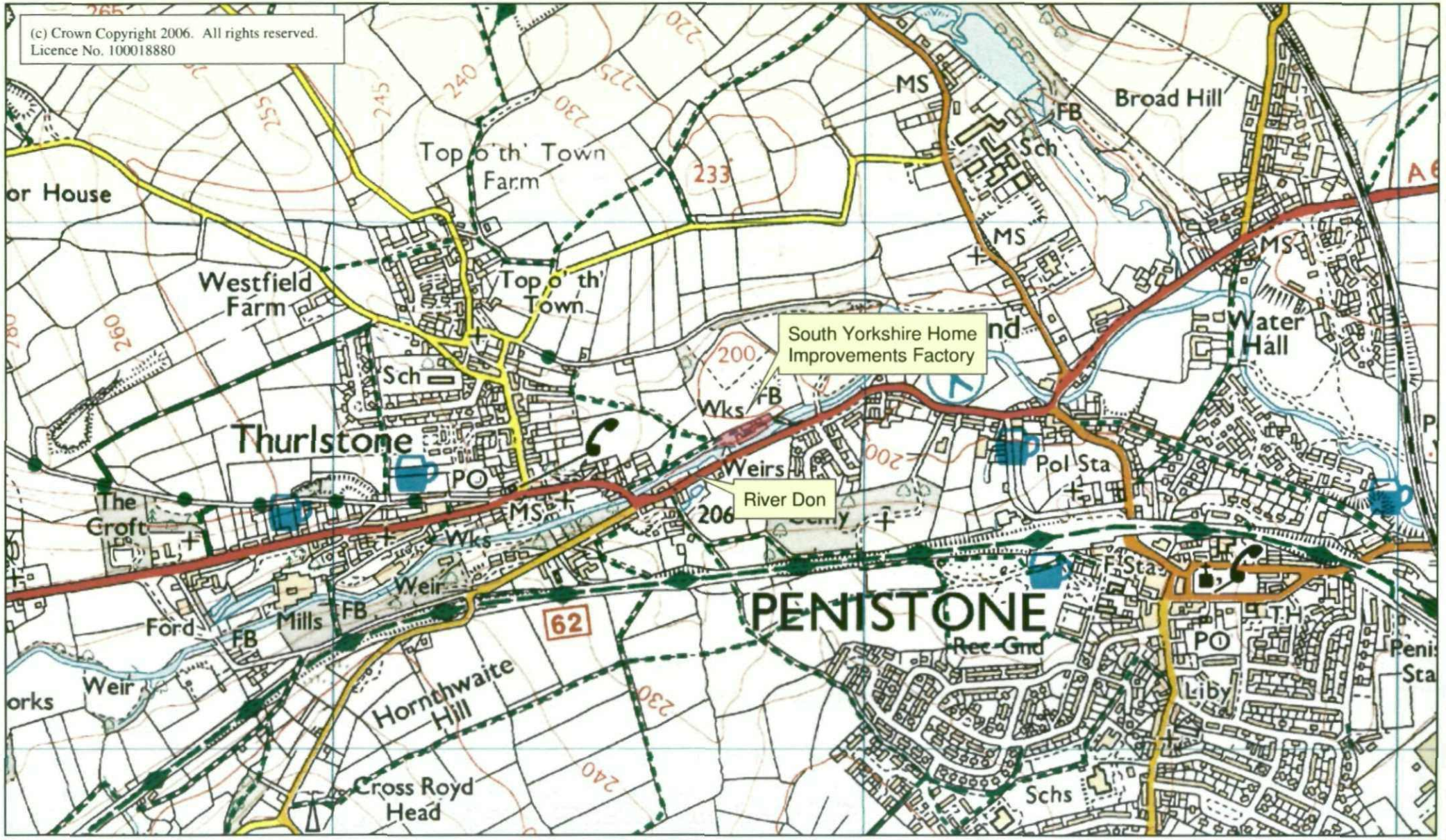
The finished floor levels will therefore be a minimum of 1m above the flood level described above.

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APPENDICES

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Appendix A: - Location Plan



N

1:10,000

Proposed Development Site

Client: J & H M Hutchings

Scheme: Land at Hoyle Mill, Thurlestone

Title: Location Plan - Appendix A

jba

Denison House
Hexthorpe Road
Doncaster DN4 0BF

Map No. 1

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Appendix B: - Surveyed Cross Section Locations

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Appendix C: - Topographic Survey of Existing Site

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Appendix D: - FEH Modelling Report

INTRODUCTION

This appendix provides a record of the calculations and decisions made during design flood estimation using the techniques of the Flood Estimation Handbook (Institute of Hydrology, 1999). It is intended to complement the more general hydrological information given in the main report. The information given in this appendix should enable the work to be reproduced in the future.

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CONTENTS

Page

1 METHOD STATEMENT ---- 2

2 LOCATIONS WHERE FLOOD ESTIMATES REQUIRED ---- 4

3 STATISTICAL METHOD ---- 5

4 RAINFALL-RUNOFF METHOD ---- 8

5 SUMMARY OF RESULTS ---- 9

6 ANNEX – COMPOSITION OF POOLING GROUPS ---- 10

ABBREVIATIONS

AM	Annual Maximum
AREA	Catchment area (km^2)
BFI	Base Flow Index
BFIHOST	Base Flow Index derived using the HOST soil classification
CFMP	Catchment Flood Management Plan
CPRE	Council for the Protection of Rural England
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
FES	Flood Estimation Software, developed by JBA
HOST	Hydrology of Soil Types
ISIS	Hydrology and hydraulic modelling software – used for FEH rainfall-runoff method
NWA	National Water Archive
POT	Peaks Over a Threshold
QMED	Median Annual Flood (with return period 2 years)
SAAR	Standard Average Annual Rainfall (mm)
SPR	Standard percentage runoff
SPRHOST	Standard percentage runoff derived using the HOST soil classification
Tp(0)	Time to peak of the instantaneous unit hydrograph
URBEXT	FEH index of fractional urban extent
WINFAP-FEH	Windows Frequency Analysis Package – used for FEH statistical method

1 METHOD STATEMENT

Note: This section should be completed and if possible agreed with the client at the inception of the project.

1.1 Overview of requirements for FEH estimates

Item	Comments
Flood estimates required Peak flows or hydrographs? Return periods, locations.	The 1in100 year peak flow, including an allowance (20%) for future climate change, is required to investigate a Flood Risk Assessment for the above project.

1.2 Source of flood peak data

Was the HiFlows UK dataset used? If so, which version?	Yes – Version 1.1, August 2005

1.3 Gauging stations (flow or level)

(at the sites of flood estimates or for nearby donor catchments)

Watercourse	Station name	Gauging authority number	NWA number (used in FEH)	Grid reference	Catchment area (km²)	Flow or level	Period of record
N/A							

1.4 Data available at each flow gauging station

Station name	Period of flood peak data in Hiflows-UK	Suitable for pooling?	Suitable for QMED?	Other comments on station and flow data quality
N/A				

1.5 Other data available and how it has been obtained

Item	Comments
Flow gaugings (if planned to update rating curve)	N/A
Historic flood data	N/A
Flood event data (if planned to use rainfall-	N/A

Item	Comments
runoff method)	
Rainfall event data (if planned to use rainfall-runoff method)	N/A
Results from previous studies (e.g. CFMPs, Strategies)	N/A

1.6 Initial choice of approach

Item	Comments
Is FEH appropriate? (may not be for very small or urban catchments)	FEH would be most suited to this study as the subject site has a large rural catchment of 40km^2.
If so, statistical, rainfall-runoff or hybrid approach?	The statistical method shall be used for the flood peak required.
Any unusual factors to take into account? e.g. ○ highly permeable (SPRHOST<25%) – use permeable catchment adjustment for statistical method ○ highly urbanised – consider not using FEH methods ○ pumped watercourse – consider lowland catchment version of rainfall-runoff method ○ major lake/reservoir influence (FARL<0.90) – consider flood routing	

2 LOCATIONS WHERE FLOOD ESTIMATES REQUIRED

The table below lists the locations of subject sites and three key catchment descriptors, i.e. AREA, SPRHOST and URBEXT1990. Values of other catchment descriptors can be found from the FEH CD-ROM, by entering the grid reference of the subject site. Any adjustment to the default catchment descriptors provided by the FEH CD-ROM 1999 should be listed.

2.1 Summary of subject sites

Site code	Watercourse	Site	Easting	Northing	AREA (km²)	SPR-HOST	URB-EXT 1990
RD01	River Don	Hoyle Mill	424650	403850	39.73	44.5	0.008
Record how catchment boundary was checked	Ordnance survey contour plans.						
Record how other catchment descriptors were checked	N/A						
Updating of URBEXT	Using CPRE model from FEH	To update to 2006					
Describe any other changes to the catchment descriptors.	N/A						

3 STATISTICAL METHOD

3.1 Estimation of QMED at each subject site

Site code	Method: AM – Annual maxima POT – Peaks over threshold DT – Data transfer CD – Catchment descriptors alone	Initial estimate of QMED (m^3/s)	If AM or POT, any adjustment for climatic variation?	If DT, numbers of donor/analogue sites used (see 3.4) and reasons for choice	Final estimate of QMED (m^3/s)
RD01	CD				
Are the values of QMED consistent, for example at confluences?					

3.2 Search for donor or analogue sites for QMED

Comment on donor sites available	N/A
Method for seeking out analogue sites	N/A

3.3 Characteristics of potential donor and analogue sites

Subject sites needing donors or analogues						
Site code	AREA	SPRHOST	BFIHOST	SAAR	URBEXT	FARL
N/A						

Potential donors and analogues								
NWA no.	Watercourse	Station	AREA	SPRHOST	BFIHOST	SAAR	URBEXT	FARL
N/A								

3.4 Final choice of donor and analogue sites and adjustment ratios

NWA no.	Reasons for choice	Method (AM or POT)	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)
N/A					

3.5 Derivation of pooling groups

The composition of the pooling groups is given in the Annex.
Note that several subject sites may use the same pooling group

Target return period (years) for all pooling groups			100	
Name	**Site code for which group derived**	**Changes made to default pooling group. Note also any sites that were investigated but retained in the group.**	**Distribution**	**Parameters (before urban adjustment) Note any permeable catchment adjustments**
Hoyle Mill	RD01	Station 203039 added to make the years of data. Station 28041 removed as originally highlighted red and investigated. It was found that the station was closed in 2000 and that there was a poor approach to flat V weir. Added 22003 to make up years of data.	GEV	Location: 0.906 Scale: 0.261 Shape: 0.078

3.6 Derivation of flood growth curves at each subject site

Site code	Method: SS = Single site P = Pooled A = Average of the two	If P or A, code of pooling group? (see Section 3.3)	If SS, distribution used and reason for choice If A, details of averaging	If SS, parameters of distribution
RD01	P	Hoyle Mill		

Any relevant frequency plots from WINFAP-FEH, particularly showing any comparisons between single-site and pooled growth curves, should be shown here or in the main report.

3.7 Flood estimates from the statistical method at each subject site

Site code	Flood peak (m^3/s) for the following return periods (in years)						
	2	5	10	25	50	100	20% Climate Change
RD01	18	23	26	30	32	34	41

4 RAINFALL-RUNOFF METHOD

4.1 Derivation of parameters for rainfall-runoff model

Methods: FEA : Flood event analysis
LAG : Catchment lag
DT : Catchment descriptors with data transfer from donor catchment
CD : Catchment descriptors alone
BFI : SPR derived from baseflow index calculated from flow data

Site code	Rural (R) or urban (U)	Tp(0): method	Tp(0): value (hours)	SPR: method	SPR: value (%)	BF: method	BF: value (m^3/s)	If DT, numbers of donor sites used (see Section 4.2) and reasons
N/A								

4.2 Donor sites for rainfall-runoff parameters

No	Watercourse	Station	Tp(0) from data (A)	Tp(0) from CDs (B)	Adjustment ratio for Tp(0) (A/B)	SPR from data (C)	SPR from CDs (D)	Adjustment ratio for SPR (C/D)
1	N/A							
2								
3								
4								

A description of the flood event analysis or lag analysis used to derive the rainfall-runoff parameters should be given here or in the main report.

4.3 Inputs to and outputs from rainfall-runoff model

Site code	Design storm duration (hours)	Storm area (if not individual catchment area)	Flood peaks (m^3/s) for the following return periods (in years)						Ratio of rainfall-runoff over statistical estimate	
									2 yrs	100 yrs
N/A										
Software used for rainfall-runoff analysis (ISIS/FES / MIKE 11)										

5 SUMMARY OF RESULTS

5.1 Overview of results and sensitivity checks

Item	Comments
Final choice of method and reasons	Statistical Method was chosen as the subject site was a large rural catchment.
Are the results consistent, for example at confluences?	N/A
What do the results imply regarding the return periods of key floods during the period of record?	N/A
How do the results compare with those of other studies?	N/A

6 ANNEX – COMPOSITION OF POOLING GROUPS

This section lists the gauging stations included in each pooling group, and their periods of record.

72007 (Brock @ U/s a6)	25	0.204	0.301	0.086	1.106	0.404
47010 (Tamar @ Crowford Bridge)	31	0.078	0.117	0.102	1.507	0.408
203049 (Clady @ Clady Bridge)	21	0.159	-0.047	0.126	0.358	0.419
84009 (Nethan @ Kirkmuirhill)	33	0.202	0.266	0.141	0.473	0.424
47018 (Thrushel @ Hayne Bridge)	15	0.132	-0.079	0.198	1.026	0.441
54025 (Dulas @ Rhos-y-pentref)	34	0.174	0.225	0.230	1.034	0.517
203028 (Agivey @ Whitehill)	31	0.152	0.223	0.231	1.279	0.555
24006 (Rookhope Burn @ Eastgate)	20	0.152	0.117	0.117	0.102	0.555
72014 (Conder @ Galgate)	37	0.187	0.059	0.079	0.461	0.558
76014 (Eden @ Kirkby Stephen)	32	0.176	-0.015	0.028	1.364	0.623
23011 (Kielder Burn @ Kielder)	32	0.172	0.088	0.128	0.016	0.657
203042 (Crumlin @ Cidercourt Bridge)	24	0.174	0.253	0.182	0.596	0.658
50009 (Northlew @ Norley Bridge)	15	0.169	-0.230	0.182	2.700	0.660
50012 (Yeo @ Veraby)	33	0.136	-0.087	0.095	0.559	0.674
6008 (Enrick @ Mill of Tore)	24	0.219	0.139	0.130	0.382	0.680
84020 (Glazert Water @ Milton of Campsie)	34	0.133	0.057	0.205	0.681	0.683
72016 (Wyre @ Scorton)	36	0.150	0.068	0.158	0.092	0.684
203039 (Clogh @ Tullynewey)	22	0.056	-0.051	0.018	2.458	0.684
22003 (Usway Burn @ Shillmoor)	22	0.316	0.334	0.140	2.807	0.685
Total 521						
Weighted means		0.162	0.121	0.136		

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Appendix E: - HEC-RAS Model Results

LAND AT HOYLE MILL, THURLSTONE 2006s1674

HEC-RAS Plan: 1in100+20% River: River Don Reach: 01 Profile: PF 1

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	LOB Elev (m)	ROB Elev (m)
1	23	PF 1	41	199.97	202.08	203	201.99
1	22	PF 1	41	199.9	201.79	205	203.68
1	21.5		Culvert				
1	21	PF 1	41	199.52	201.37	203.73	206.43
1	20	PF 1	41	199.3	201.04	201.33	203
1	19	PF 1	41	199.14	200.71	202.82	203
1	18	PF 1	41	199.16	200.69	202.47	203.58
1	17	PF 1	41	199.45	200.59	202.02	202
1	16	PF 1	41	198.19	200.61	201.84	202
1	15.5		Inl Struct				
1	15	PF 1	41	197.75	199.38	201.68	202
1	14	PF 1	41	197.06	198.9	200.98	201
1	13	PF 1	41	196.47	198.62	200.3	200.44
1	12	PF 1	41	195.99	198.74	199.14	200.41
1	11	PF 1	41	196.55	198.65	200.25	200.19
1	10	PF 1	41	196.67	198.39	200.62	202.91
1	9	PF 1	41	196.16	198.41	199.85	202.03
1	8	PF 1	41	195.86	198.27	198.6	200.56
1	7	PF 1	41	196.02	198.23	198.59	201.09
1	6	PF 1	41	196.38	198.2	198.31	201.44
1	5	PF 1	41	195.77	197.58	198	199.73
1	4	PF 1	41	195.83	197.3	197.88	199.2
1	3	PF 1	41	195.24	197.15	197.41	197.32
1	2	PF 1	41	195.41	196.59	197.88	197.34
1	1	PF 1	41	194.88	196.32	196.76	197.26

KEY

Min Ch EL	Lowest river channel level at the section
W.S. Elev	Water surface elevation
LOB Elev	Highest left bank level
ROB Elev	Highest right bank level
	NB Sections are viewed looking downstream

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