



civils ltd - consulting engineers



FLOOD RISK ASSESSMENT

4 Lake Lane, Barnham PO22 0AD

CLIENT

WGH Forecourt Building Services
Porwell Copse
Arundel Road
Arundel BN18 0QP

Ref: 5018/2.3F
Date: December 2013

CONSULTING ENGINEERS

GTA Civils Ltd
66a Church Walk
Burgess Hill
West Sussex RH15 9AS

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Issue	Date	Compiled	Checked
First Issue	09 December 2013	JP/CJ	MR
Second Issue	02 January 2014	JP	MR
Third Issue	13 July 2015	JP	MR

Report by: **John Pakenham BSc (Hons), Catherine Jenkins BEng, MSc**
Checked by: **Martin Roberts I Eng, ACIWEM, MCIHT**

1.0 INTRODUCTION

- 1.1 GTA Civils Ltd. was appointed by WGH Forecourt Building Services to provide a Flood Risk Assessment in support of a planning application for the demolition of a dwelling and erection of a pair of semi-detached dwellings at 4 Lake Lane, Barnham PO22 0AD. No responsibility is accepted to any third party for all or part of this study in connection with this or any other development.
- 1.2 This report will take the form of a formal Flood Risk Assessment in accordance with the 2012 National Planning Policy Framework (NPPF) and the associated Technical Guidance document.
- 1.3 It is assumed that any Sequential Testing and passing the 1st part of the Exception Test, if found to be needed, will have been undertaken by others. This report demonstrates the site will be safe, ie this passes the first part of the Exception Test.
- 1.4 The second Issue of this report has been written following a design change (due to planning refusal). The EA engineer commented on the original design and First Issue of this report. The letter from Ms Hutchins at the EA to Arun District Council (dated 11 April 2014) states that the EA has no objections to the proposal, subject to 3 listed conditions. This report outlines how these items are best addressed.
- 1.5 The third issue of this report has been written following a change in the design of the 2 units.

2.0 EXISTING SITE & FLOOD CONDITIONS

- 2.1 The application site lies within the area administered by Arun District Council (ADC). The site comprises a residential dwelling and its garden/amenity space. A site location plan and aerial view of the site are shown in Appendix A.
- 2.2 The Barnham Rife (designated as a ‘main river’ by the EA) flows in a broadly south-western direction along the northwest boundary of the site.
- 2.3 A topographic survey was undertaken – see Appendix B. The levels around the site range between 5.04m and 4.14m AOD approximately. The unit’s finished floor level (threshold) is 4.93m AOD.
- 2.4 The site’s solid geology, according to the BGS online map, is the London Clay Formation (clay, silt and sand), with superficial deposits of Alluvium (sand and gravel). The clay formation is considered highly unlikely for soakaways to be feasible, whilst the drift stratum, depending on its depth, is likely to afford good soakage.
- 2.5 A site investigation is proposed to determine the depth of each stratum. Once it is clear that there is a workable depth of porous soil, a BRE 365 soakage test will be carried out to determine the infiltration rate.
- 2.6 The total area of the site is approximately 661m². The site’s current impermeable area comprises the roof of the dwelling, which is approximately 92m².
- 2.7 According to the Environment Agency Flood Map in Appendix D, the site falls within fluvial flood zone 3 (FZ3), which is land designated as having a high probability of flooding from watercourses (greater than 1 in 100 or >5% annual chance of flooding.)
- 2.8 Flood data from the EA is shown in Appendix D. The NPPF states that the predicted effects of climate change should be taken into account. The modelled ‘1 in 100 years + climate change’ level at the nearest node (MN 47.SL) is 5.51m AOD. This is higher than the highest site level by 470mm. The range in flood depth across the site is 470mm to 1370mm. The internal depth of flooding is 580mm.
- 2.9 The EA’s groundwater vulnerability map (see Appendix D) shows the site lying in the ‘Minor Aquifer High’ zone. This would indicate good permeability in the drift strata.
- 2.10 It is not known how the current roof’s surface water drains, but it is assumed that the soil’s porosity is sufficiently high to make infiltration methods feasible.
- 2.11 Both Arun District Council and West Sussex County Council (WSCC) have commissioned Strategic Flood Risk Assessment (SFRA) reports, which include analyses of flood risk from all sources. Although the latter is more recent (2010), as the former SFRA covers a smaller area it is probably more relevant to this site and vicinity.
- 2.12 There is no indication in WSCC’s SFRA report that this area is liable to flooding from any source, other than fluvial, from the SFRA’s main text sections. Appendix C of WSCC’s SFRA shows the predicted flood extents in the ‘100 years + climate change’ and ‘200 years + climate change’ storms. It is liable to flood in the most extreme of events, however. Appendix E of this report shows an enlarged excerpt of this map.

- 2.13 Both SFRA's show that this site falls within the 'medium' risk area on its 'Indicative Risk of Groundwater Flooding' Map (G1) in Appendix E. This is the lowest risk zone in the district. Although this risk should not be discounted it is clearly not as great as the main (fluvial) risk.
- 2.14 The EA's surface water flood risk maps show that the majority of the site is clear of the 'Medium Chance' or 1 in 100 years flood pattern. In the 'Low Chance' storm (1 in 1000 years) scenario.
- 2.15 Historical records: there is no indication from the EA or SFRA that this site has suffered from flooding from *any* sources. There is no indication that the site is vulnerable to localised risks of flooding from sources other than the nearby Rife.

3.0 PROPOSED SITE, MITIGATION AND DRAINAGE STRATEGY

- 3.1 The application is to erect a pair of semi-detached dwellings – see the proposed scheme drawing in Appendix C.
- 3.2 The dwellings' combined roofed area totals approximately 202m².
- 3.3 All the external surfaces, including access driveway, will be permeable, eg porous paving, gravel or similar. Access stairs, ramps, and the juliet balconies will be open tread. Only the roof will be positively drained.
- 3.4 One of the NPPF's requirements is for ground floor levels to be set at 0.3m above the '1 in 100 years plus climate change' level of 5.51m AOD – see section 2.8 above. Due to access constraints it is not possible to raise the ground floor's FFL by this amount. This will be set (for both units) at **5.21m AOD** ie 0.28m higher than the existing dwelling's. Mitigation measures are proposed to offset this risk.
- 3.5 Mitigation: the predicted depth of flooding in the new units is (5.51 – 5.21) 0.3m. It is proposed that resilient measures will be provided up to **5.81m AOD**, this being 0.3m above the floodplain level. The document "Improving the Flood Performance of New Buildings - Flood Resilient Construction" published by DEFRA/Environment Agency is a good source of information on resilient techniques – see Appendix H. Such measures can include but are not limited to: routing the electrical supply and positioning sockets above this level, placing boilers and meter cupboards on the first floor, water-resistant plaster/tiles on the walls of the ground floor, solid stone or concrete floors with no voids underneath, covers for doors and airbricks and non-return valves on new plumbing works.
- 3.6 Access to safety: the predicted flood depth is approximately 5.51m AOD, 0.30m above the finished floor level. In order to mitigate this, it is proposed that a Floor Warning and an Evacuation plan is proposed - see Appendix G. It is recommended that the occupants register with the free flood warning service provided by the Environment Agency (called 'Floodline'), in order to facilitate evacuation of the premises prior to floodwaters surrounding the site. The site is covered by this service.
- 3.7 Hazard: Figure 13.1 of FD2320/TR2 (below) shows that if the maximum flood depth is no more than 0.5m the velocity can be up to 0.5m/s before there is 'danger to some'. Ms. Hutchins sent an email to ADC stating that the original objection was based on a flood depth of 0.58m. With the flood depth reduced to 0.3m there will be significantly less risk to occupants in these units.

$d \cdot (v+0.5) + DF$	Depth										
Velocity	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	
0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	1.13	1.25	
0.50	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	
1.00	0.38	0.75	1.13	1.50	1.88	2.25	2.63	3.00	3.38	3.75	
1.50	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	
2.00	0.63	1.25	1.88	2.50	3.13	3.75	4.38	5.00	5.63	6.25	
2.50	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50	
3.00	0.88	1.75	2.63	3.50	4.38	5.25	6.13	7.00	7.88	8.75	
3.50	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	
4.00	1.13	2.25	3.38	4.50	5.63	6.75	7.88	9.00	10.13	11.25	
4.50	1.25	2.50	3.75	5.00	6.25	7.50	8.75	10.00	11.25	12.50	
5.00	1.38	2.75	4.13	5.50	6.88	8.25	9.63	11.00	12.38	13.75	

Categories of flood hazard:

	From	To	
Class 1	0.75	1.50	Danger for some
Class 2	1.50	2.50	Danger for most
Class 3	2.50	10.00	Danger for all

Note: The table gives values of flood hazard ($= d \cdot (v+0.5) + DF$)

Flood Hazard Table, Figure 13.1 of DEFRA/Environment Agency's *Flood Risks to People, Phase 2, FD2320/TR2 Guidance Document*

- 3.8 There is a refuge at first floor in each of the dwellings. It is contended that, provided the occupants are aware of the nature of the flood risk and consider what their response would be well in advance of such an event occurring, this risk will have been mitigated.
- 3.9 Floodplain volume: the site is within FZ3, putting it at high risk of flooding, as outlined in section 2. Because the increase in building footprint will displace flood water there will be a negative impact on the floodplain's volume. This totals approximately 104m^3 . The external levels will be lowered by an average of 0.23m to compensate. This volume ($0.23\text{m} \times 455\text{m}^2$) will add 104.65m^3 , so the nett increase in volume is 0.65m^3 . Existing levels will be lowered by up to 0.45m to balance this out and to accommodate for areas that cannot be lowered e.g. around tree roots and driveway access from road.
- 3.10 Condition #2 in the EA's approval letter (see Appendix C) states that a 'safe route' into and out of the site must be identified before this condition is discharged. As the flood depths at the entrance to the site are in the order of $5.51 - 4.0 = 1.51\text{m}$ it is clear from the above table that, even with zero velocity, there is no such safe access route available. It is proposed that ADC's Emergency Planning Department is consulted in order to determine what additional measures, if any, are needed, to satisfy their requirement in this regard.
- 3.11 Although it is proposed to incorporate resilience measures it is also proposed to affix a demountable barrier system in front of each external doorway. Many systems are available with a few with no frame needed as long as the masonry opening is clean enough to provide a seal. The minimum height of the barriers is to be 600mm , ie to protect up to 58.81m AOD, the same level as the resilience measures.
- 3.12 Surface Water drainage strategy: It is contended that the depth of sand/gravel drift may be sufficiently deep for a soakaway to be dug into each garden. As set out in section 2 above this will be confirmed by undertaking a site investigation followed by a BRE Digest 365 soakage test, to determine the soil's

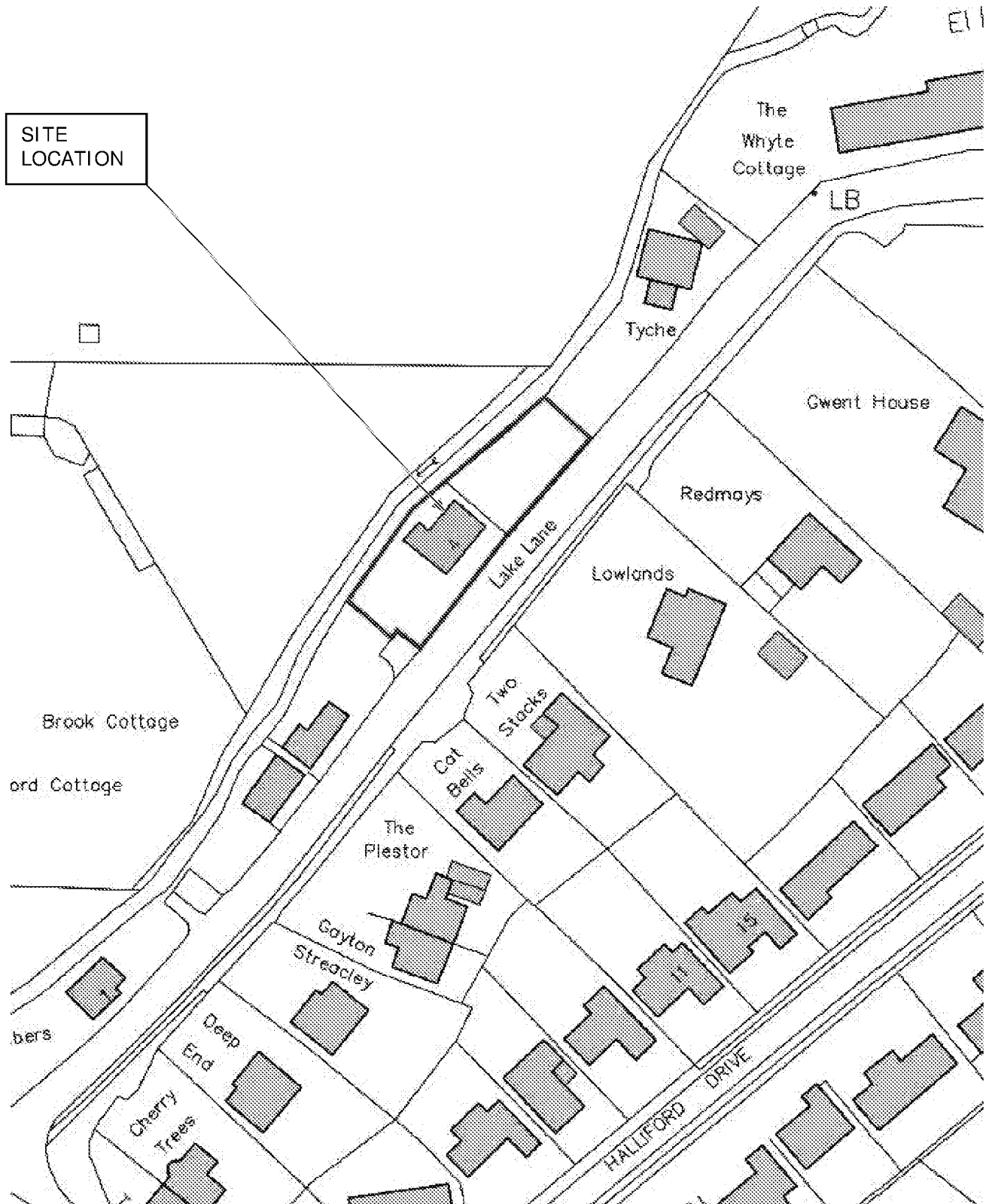
infiltration rate. In the likely event that the soakage test proves a soakaway unfeasible, it is proposed to discharge the surface water to the watercourse flowing north of the site boundary.

- 3.13 A Micro Drainage calculation (refer to Appendix F) showed that an area of porous paving, whose dimensions are 10m x 5m x 0.3m deep, can store the volume in the critical '1 in 100 year plus 30% climate change' storm event. The maximum depth within the paving's makeup is 223mm.
- 3.14 A 60mm diameter orifice plate vice is to be placed downstream of the porous paved area. This will limit the flow rate into the watercourse to 3.5l/s. As this is 1.75l/s per dwelling, this is clearly sustainable and in line with the NPPF/PPG. If this flow rate is restricted more there is increased risk of the orifice becoming clogged with debris, thereby *increasing* the flood risk of this site.
- 3.15 SUDS: the discharging of rain water from the roofs to the watercourse in this manner is sustainable as it does not add any extra load to the sewerage network.
- 3.16 In summary, the three items listed in the EA's letter dated 11/04/14, have been addressed as satisfactorily as physically possible. The floodplain storage issue has been covered in section 3.9 above. The lowest finished floor level will be set at 5.21m AOD and so complies with the 3rd item and it is apparent that there is no safe route to dry land – see section 3.10 above. This item will be discussed with ADC's Emergency Planning Department to see how this can be mitigated. As there is refuge at high level in each unit, resilience and resistance measures - and a Flood Warning and Evacuation Plan - it is contended that no more mitigation can be incorporated into this design.
- 3.17 The flood risk of the application site and the neighbouring vicinity will not increase as a result of this development. It is therefore considered that this development will comply with the 2012 NPPF.

– End of Report –

APPENDIX A

Site Location Map and Aerial View

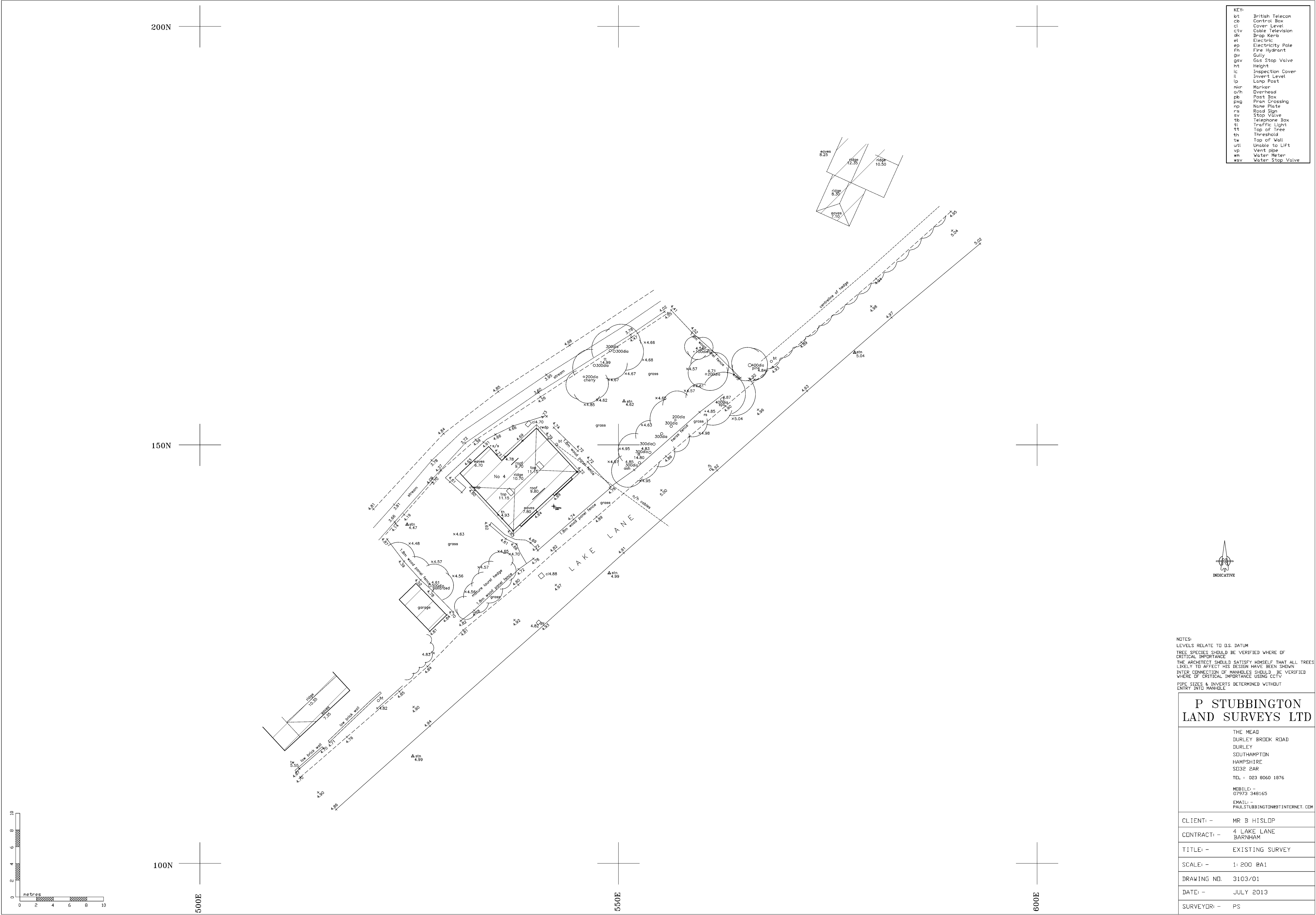


SITE
LOCATION



APPENDIX B

Topographic Survey



APPENDIX C

Proposed Scheme Drawings

Levels to site reworked in
accordance with requirements of
floor risk plan.

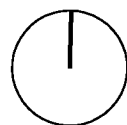
Open risers to stairs, no infill
beneath

Open risers to stairs, no infill beneath
Balustrade

x 4.80 Proposed Levels

Outline of previous scheme recommended for approval
Ref: BN/39/13/

01 PROPOSED SITE PLAN



Two Stacks

Scale: 1:200 @ A3

Dwg No: 052-D-01

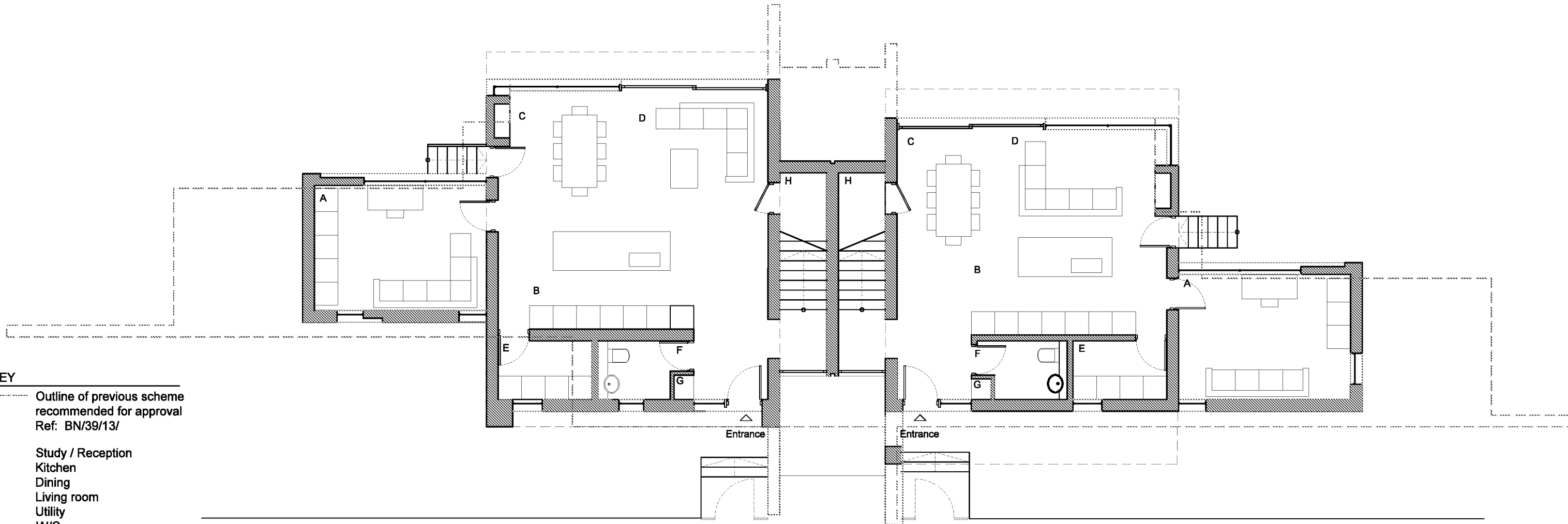
Address: 4 Lake Lane, Barnham, West Sussex

Client: Joanne Lee and Bill Hislop

obarchitecture

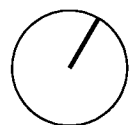
Suite 3, Talbot House
34 Sable Gardens,
Winchester
Hampshire, SO23 8SR
t: 01962 865344
e: info@obarchitecture.co.uk
w: www.obarchitecture.co.uk

NOTE: This drawing is to be scaled for planning purposes only



- KEY**
- Outline of previous scheme recommended for approval
Ref: BN/39/13/
- A Study / Reception
 - B Kitchen
 - C Dining
 - D Living room
 - E Utility
 - F W/C
 - G Coats
 - H Storage

01 PROPOSED GROUND FLOOR PLAN



0 5 m

Status: Preliminary

Scale: 1:100 @ A3

NOTE: This drawing is to be scaled for planning purposes only

Drawing: Proposed Ground Floor Plan

Dwg No: 052-D-02

Date: 22.06.2015

Project: 4 Lake Lane

Address: 4 Lake Lane, Barnham, West Sussex

Client: Joanne Lee and Bill Hislop

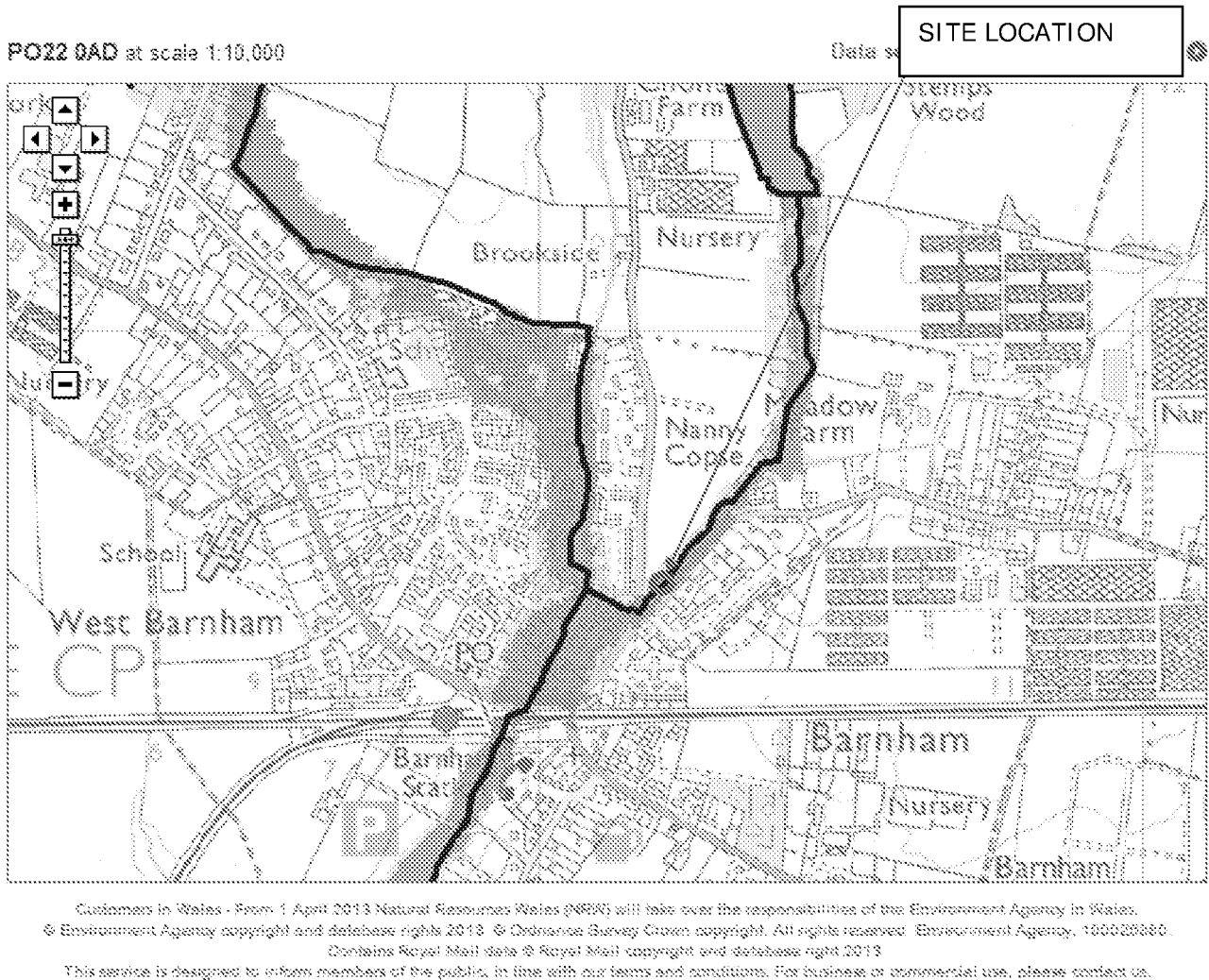
obarchitecture

Suite 3, Talbot House
34 Staple Gardens,
Winchester
Hampshire, SO23 8SR

t: 01962 865344
e: info@obarchitecture.co.uk
w: www.obarchitecture.co.uk

APPENDIX D

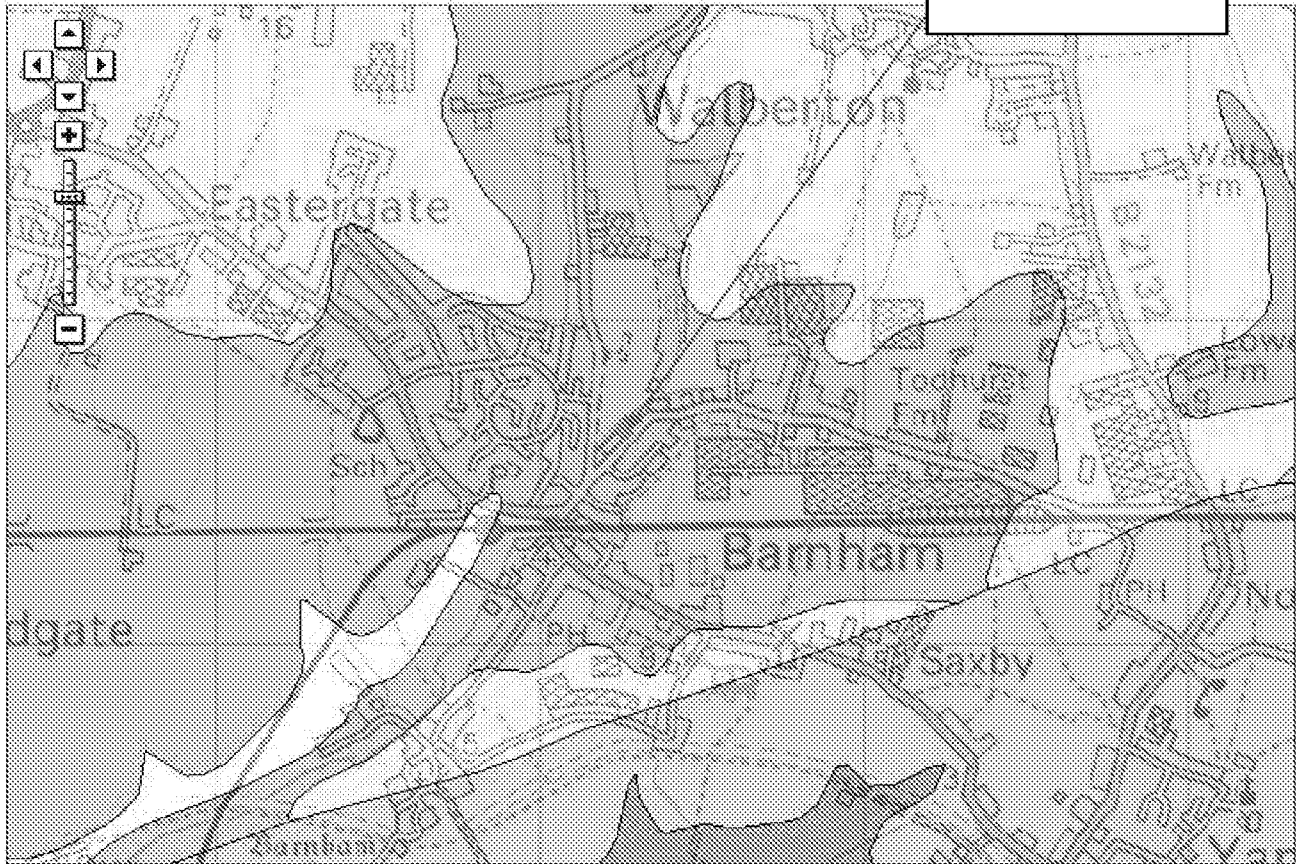
Environment Agency's Data and Correspondence



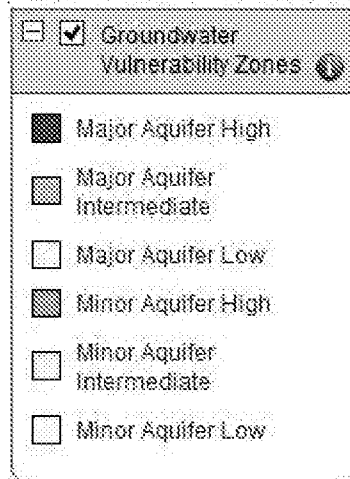
EA's 'Risk of Flooding from Rivers and Seas' Map

PO22 0AD at scale 1:20,000

Date: 10/10/15 **SITE LOCATION**



Customers in Wales - From 1 April 2013 Natural Resources Wales (NRW) will take over the responsibilities of the Environment Agency in Wales.
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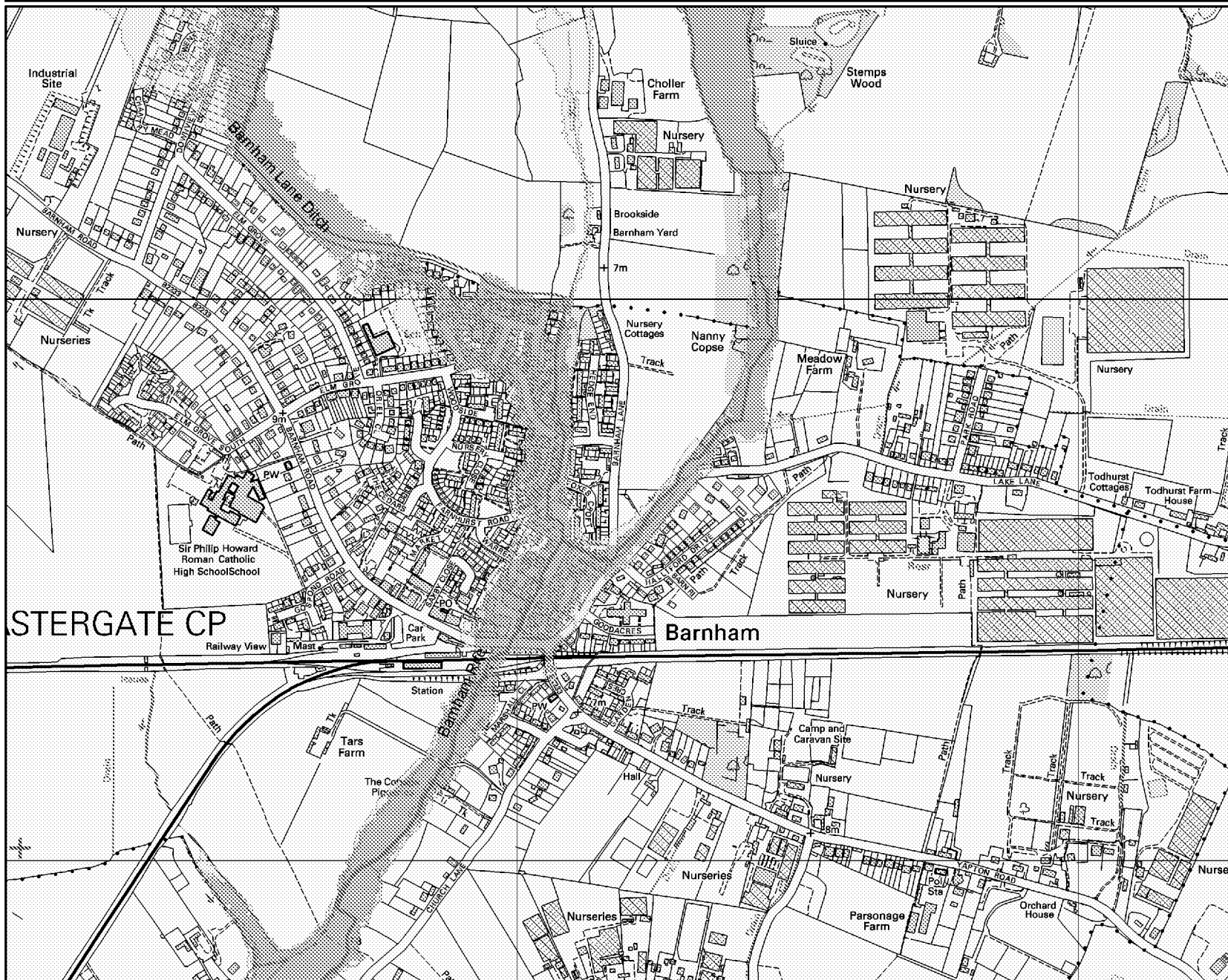


EA's 'Groundwater Vulnerability Zones' Map

The site falls within the 'Minor Aquifer High' category

Flood Map for Planning Centred on 4 Lake Lane, Barnham, West Sussex PO22 0AD

- Created 23/01/2015 [Ref: SSD/5617/CW]



- Main River
-  Flood Zone 3
-  Flood Zone 2

Flood Map Areas (assuming no defences)

Flood Zone 3

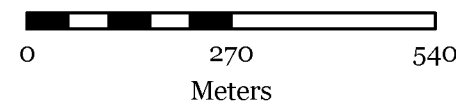
Shows the area that could be affected by flooding:
 - from the sea with an 1 in 200 or greater chance of happening each year.
 - or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2

Shows the extent of an extreme flood from rivers of the sea with up to a 1 in 1000 chance of occurring each year.

1:10,000 *

*when printed at A4.

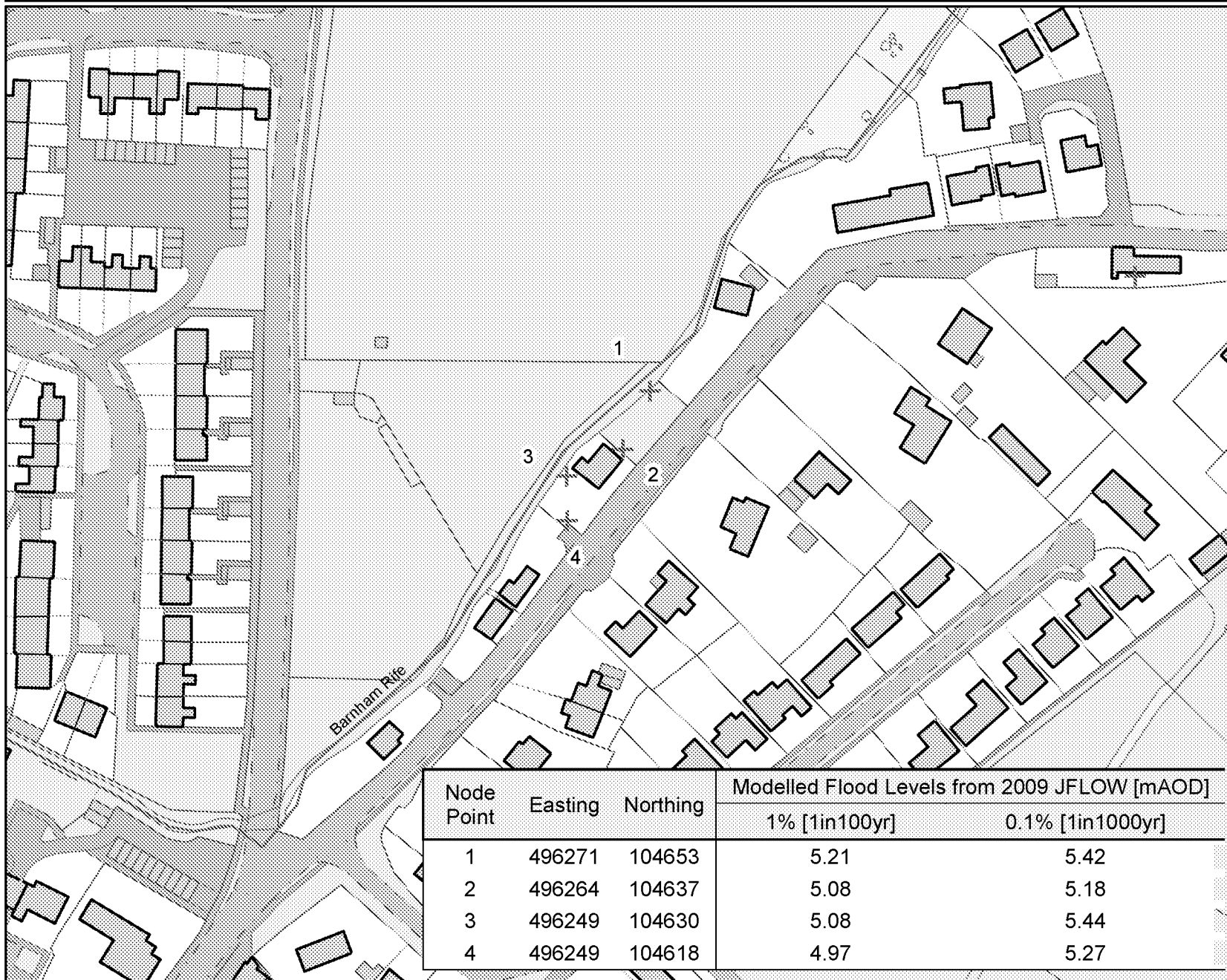


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Contact Us: National Customer Contact Centre, PO BOX 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Modelled Flood Levels Centred on 4 Lake Lane, Barnham, West Sussex PO22 0AD

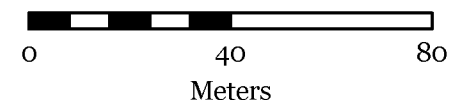
- Created 23/01/2015 [Ref: SSD/5617/CW]



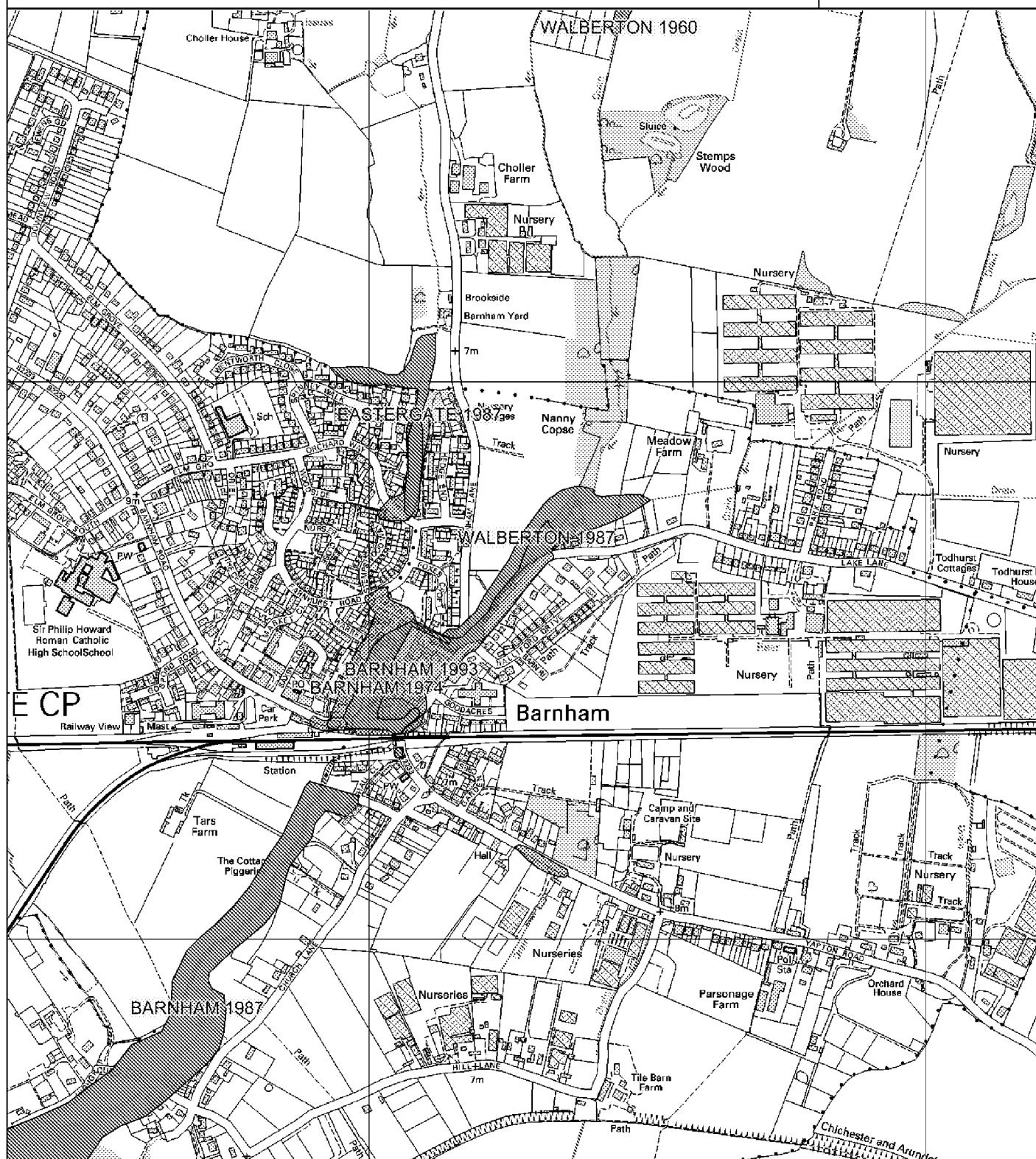
----- Main River
 + Node Point
 1

Node Point	Easting	Northing	Modelled Flood Levels from 2009 JFLOW [mAOD]	
			1% [1in100yr]	0.1% [1in1000yr]
1	496271	104653	5.21	5.42
2	496264	104637	5.08	5.18
3	496249	104630	5.08	5.44
4	496249	104618	4.97	5.27

1:1,500 *
 *when printed at A4.



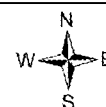
Recorded Flood Events - Barnham



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Legend

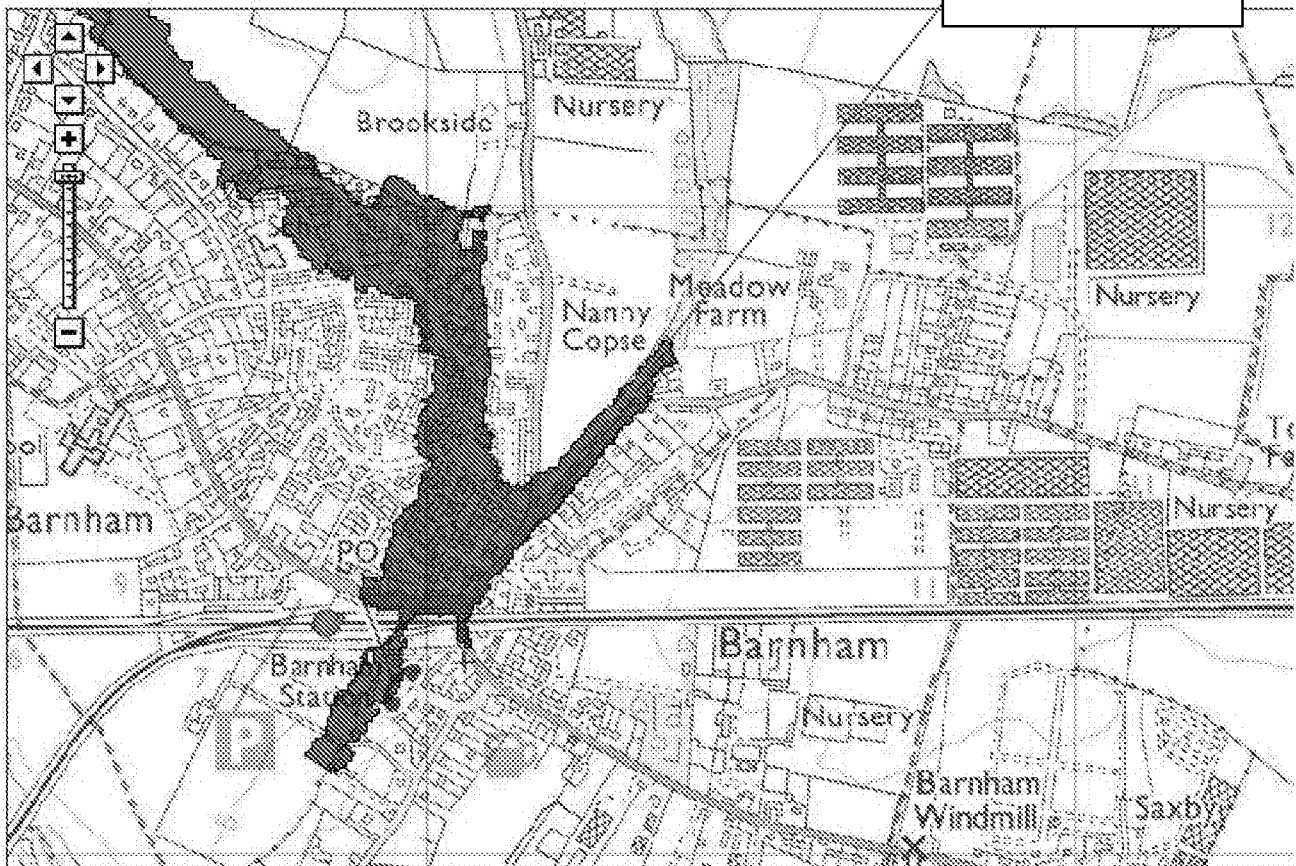
Flood Event Outlines



0 120 240 360 480 m.

PO22 0AD at scale 1:10,000

Data SITE LOCATION



Customers in Wales - From 1 April 2013 Natural Resources Wales (NRW) will take over the responsibilities of the Environment Agency in Wales.
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EA's 'Flood Warning Areas' Map

7 April 2014 15:46

Dear Susan

We received the below email in relation to the above planning application. I can confirm that our formal consultation response was based on an internal flood depth of 0.58m. We consider that with a depth of 0.30m the risk to future occupants will be significantly reduced.

I'll send you a revised response by the end of this week formally removing our objection.

Kind regards
Catherine

We have introduced a new charging scheme for our planning advice

Dear Hannah,

It has been suggested I contact you directly following the absence of Ms C. McLeod. I was advised to contact Ms C. McLeod directly by Mrs S. Leeson, Planning Officer for Arun District Council. I am the architect and Agent of the Applicant for planning application BN/39/13 for which the Environment Agency have had correspondence. A recommendation of refusal was the outcome.

I have had a look over the documents uploaded in response to planning permission BN/39/13. This email is concerned primarily with objections raised regarding flooding and mitigation measures.

The Environment Agency (EA) have objected based on an internal flood depth of 0.58m.

The EA objected on the internal flood depth but I think this may have been read from the 'Existing Site Conditions' section of the Flood Risk Assessment. Below please find a conclusive breakdown of the existing and proposed levels.

Existing

Existing site levels: 5.04 to 4.14mAOD

Existing FFL: 4.93m AOD

Estimated flood level for critical storm: 5.51m AOD

Flood depths on site: 0.47m to 1.37m

Estimated Existing internal flood depth: 0.58m

Proposed

Proposed FFL: 5.20m AOD (**0.27m above existing**)

Estimated Proposed internal flood depth: 0.31m

From table 13.1 in FD2320/TR2 for a flood depth of **0.30m**:

Danger for Some for a velocity from 0 to 0.5m/s

Danger for Most for a velocity from 0.5 to 3m/s

Danger for All for a velocity >3m/s

Therefore, the FFL of the proposed dwellings will be +0.01m above the tolerances of 'danger for most'. It is proposed that with minimal effort the FFL can be raised to bring the FFL within the 0.30m 'danger for some'

To mitigate flood risk to people there is high level refuge, and a flood evacuation plan.

For property, there are proposed resilience measures up to 0.3m above the predicted flood level – occupants can move straight back into the house after a flood in accordance with the evacuation plan and the agreement of the emergency services.

The main flood risk to the site is fluvial from the river Rife. Any mitigation measures put in place, such as excavations, would decrease the risk of fluvial and surface water flooding.

My understanding is that the local council have also objected based on historical evidence of flooding to the site from the Rife and surface water.

I have checked the new surface water maps on the Environment Agency (EA) website which shows the site to be at 'low' risk of surface water flooding.

An EA data letter obtained for this site reads:

'Our records show that this location suffered flooding in 1993. During this event approximately 98 properties flooding to a depth of up to 1 metre as a result of runoff exceeding the capacity of the Barnham railway culvert. There are no formal raised defences in this area. However, in response to the 1993 flood event, improvement works were carried out on the twin railway culvert at Barnham in the mid 1990's to increase its capacity'.

I believe other Environment Agency data has been referred to for the Flood Risk Assessment figures that also account for climate change.

It was also noted on later correspondence (containing photographs) that 'a local resident and ex-employee of the Environment Agency is of the opinion that he felt the photos show a capacity issue in the stream and therefore mitigation on the site is unlikely to work. He believes the building itself would need to be flood proof'. I do not imply that this view is that of the Environment Agency.

It is made quite clear in the Flood Risk Assessment, sections 3.4 and 3.5, that mitigation measures to property will be implemented. The inclusion of the photographs only of course present the current site and its levels. Proposed levels are much higher than those existing and without levels and data of this flooding shown on site, comment should be restrained.

Surface water run off is designed to 3.1l/s for the entire site, most likely lower than the Greenfield run of rate. In addition to this a green / sedum roof has been proposed with the potential for rainwater harvesting to hold excess run off.

KInd Regards

Grant Freeman

obarchitecture ltd
architecture + design

Susan Leeson
Arun District Council
Development Control
1, Arun Civic Centre Maltravers Road
Littlehampton
West Sussex
BN17 5LF

Our ref: HA/2014/115338/02-L01
Your ref: BN/39/13
Date: 11 April 2014

Dear Susan

**DEMOLITION OF EXISTING 2 STOREY DETACHED HOUSE & CONSTRUCTION OF
2 NO. SEMI- DETACHED DWELLINGS WITH FLOOD PREVENTATIVE MEASURES.
4 LAKE LANE BARNHAM PO22 0AD**

Thank you for consulting the Environment Agency on the above planning application. Following our previous response it has been highlighted to us that our advice incorrectly referred to the existing site conditions section of the submitted Flood Risk Assessment.

Environment Agency Position

Having considered the risk posed by the estimated flood depth with the proposed finished floor levels, I can confirm we have no objections to the proposal as submitted on flood risk grounds.

The proposed development will only meet the requirements of the National Planning Policy Framework if the following measures as detailed in the Flood Risk Assessment submitted with this application are implemented and secured by way of a planning condition on any planning permission.

Condition

The development permitted by this planning permission shall only be carried out in accordance with the following mitigation measures detailed within the approved Flood Risk Assessment (FRA):

1. Provision of compensatory flood storage
2. Identification and provision of safe route(s) into and out of the site to an appropriate safe haven.
3. Finished floor levels are set no lower than 5.2 m above Ordnance Datum (AOD).

The mitigation measures shall be fully implemented prior to occupation and subsequently in accordance with the timing / phasing arrangements embodied within the scheme.

Reason

To prevent flooding by ensuring the satisfactory storage of/disposal of surface water from the site in accordance with the NPPF.

Environment Agency
Guildbourne House Chatsworth Road, Worthing, West Sussex, BN11 1LD.
Customer services line: 03708 506 506

[Redacted signature block]

Cont/d..

If you have any queries or require further information regarding our advice please contact me.

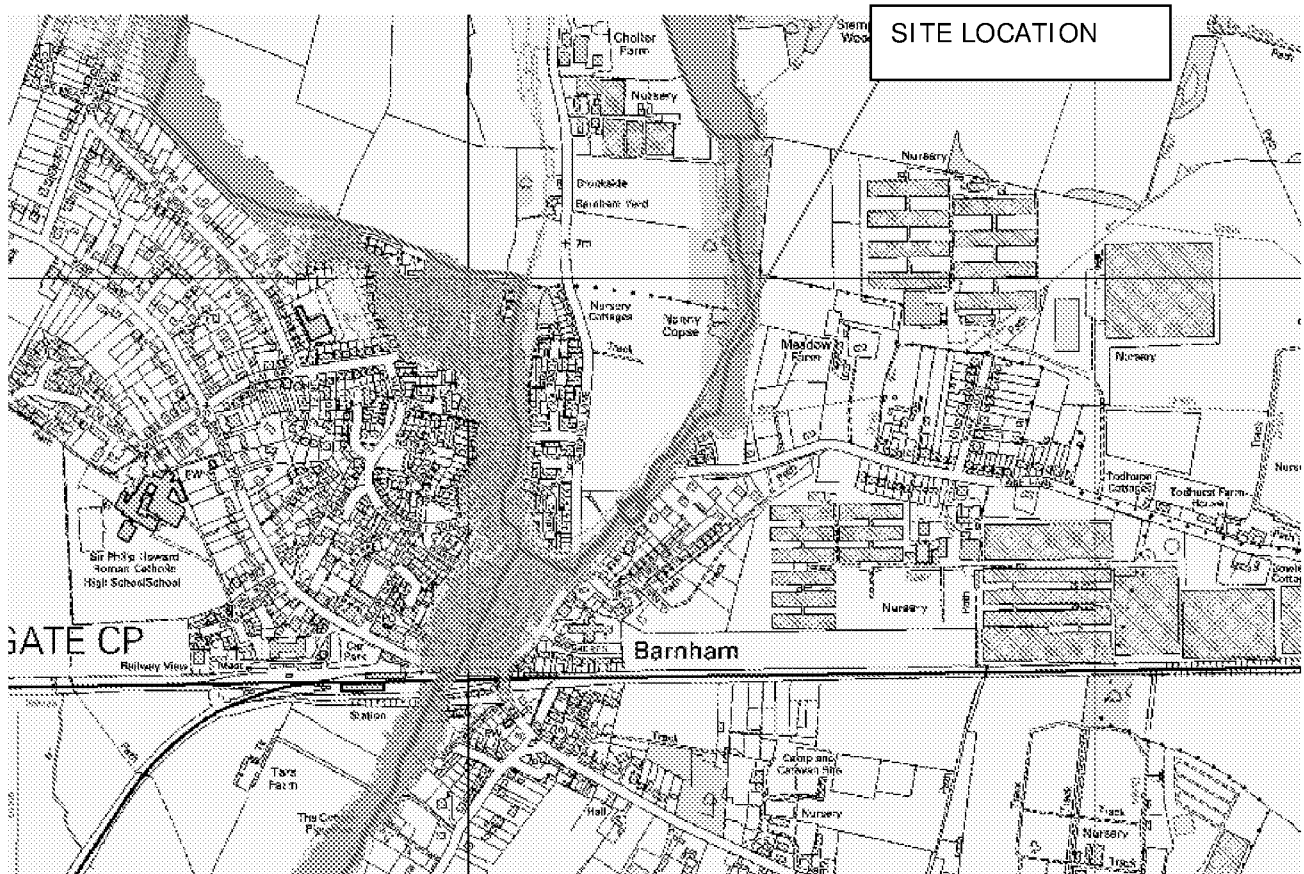
Yours sincerely

Catherine Hutchins
Sustainable Places Planning Advisor
Environment Agency

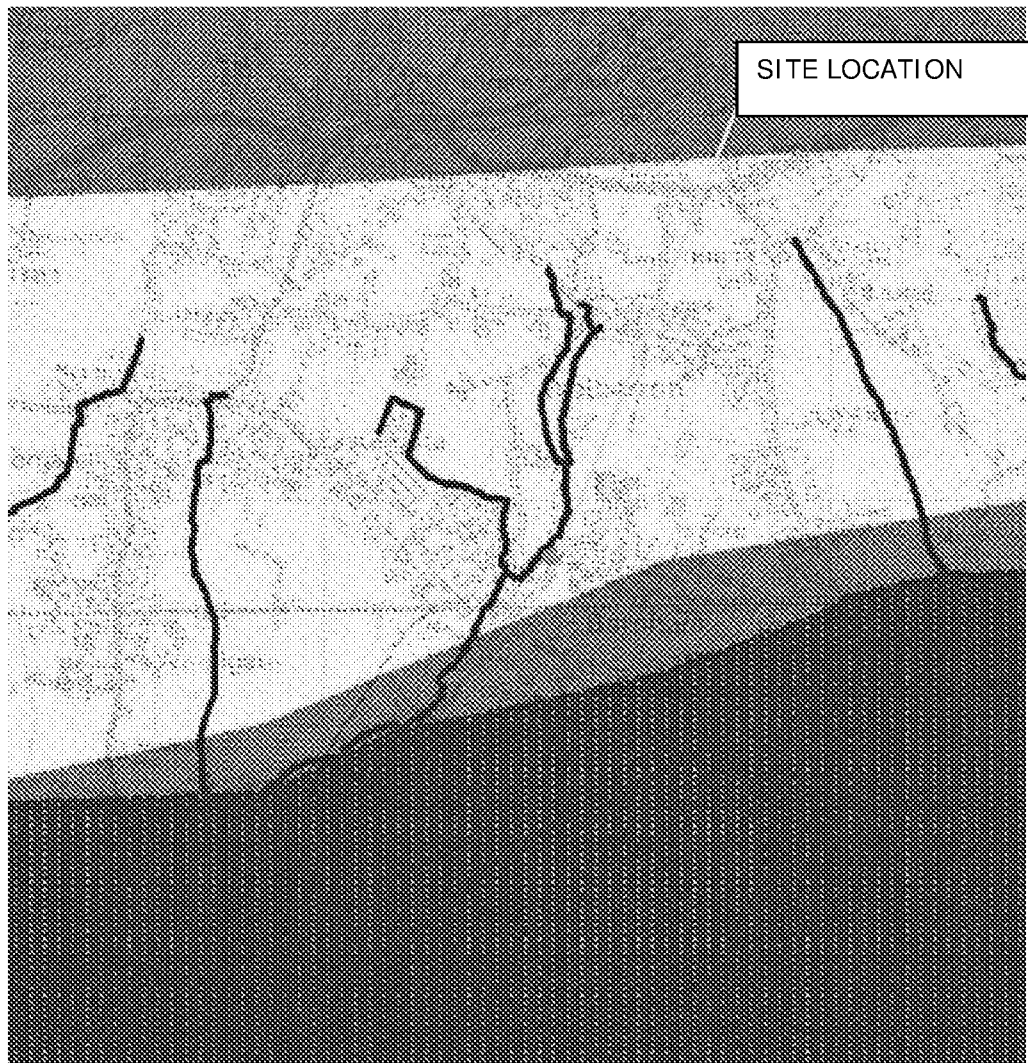


APPENDIX E

SFRA Maps



SFRA's Appendix C Flood Map: '1 in 100 years' and '1 in 200 years + Climate Change' Patterns



Main River

Groundwater Emergence Zones

Groundwater Flood Risk

High

Medium

SFRA's Appendix G1 Groundwater Map

This shows the site is in the lowest risk zone in the district

APPENDIX F

Micro Drainage Calculation

GTA Civils Ltd			Page 1				
Gloucester House 66a Church Walk Burgess Hill RH15 9AS		4 Lake Lane Barnham					
Date 13-07-15 File porous pavings.srcx		Designed by JP Checked by					
Micro Drainage		Source Control 2013.1					
<u>Summary of Results for 100 year Return Period (+30%)</u> Half Drain Time : 11 minutes.							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	4.358	0.178	0.0	3.1	3.1	2.7	Flood Risk
30 min Summer	4.383	0.203	0.0	3.3	3.3	3.1	Flood Risk
60 min Summer	4.379	0.199	0.0	3.3	3.3	3.0	Flood Risk
120 min Summer	4.342	0.162	0.0	2.9	2.9	2.4	Flood Risk
180 min Summer	4.311	0.131	0.0	2.6	2.6	2.0	Flood Risk
240 min Summer	4.288	0.108	0.0	2.3	2.3	1.6	Flood Risk
360 min Summer	4.259	0.079	0.0	2.0	2.0	1.2	Flood Risk
480 min Summer	4.243	0.063	0.0	1.7	1.7	1.0	Flood Risk
600 min Summer	4.235	0.055	0.0	1.5	1.5	0.8	Flood Risk
720 min Summer	4.229	0.049	0.0	1.3	1.3	0.7	Flood Risk
960 min Summer	4.221	0.041	0.0	1.1	1.1	0.6	Flood Risk
1440 min Summer	4.210	0.030	0.0	0.8	0.8	0.5	Flood Risk
2160 min Summer	4.201	0.021	0.0	0.6	0.6	0.3	Flood Risk
2880 min Summer	4.195	0.015	0.0	0.5	0.5	0.2	Flood Risk
4320 min Summer	4.191	0.011	0.0	0.3	0.3	0.2	Flood Risk
5760 min Summer	4.188	0.008	0.0	0.3	0.3	0.1	Flood Risk
7200 min Summer	4.185	0.005	0.0	0.2	0.2	0.1	Flood Risk
8640 min Summer	4.183	0.003	0.0	0.2	0.2	0.0	Flood Risk
10080 min Summer	4.182	0.002	0.0	0.2	0.2	0.0	Flood Risk
15 min Winter	4.381	0.201	0.0	3.3	3.3	3.0	Flood Risk
30 min Winter	4.403	0.223	0.0	3.5	3.5	3.3	Flood Risk
60 min Winter	4.384	0.204	0.0	3.3	3.3	3.1	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	115.887	0.0	4.1	13			
30 min Summer	78.283	0.0	5.6	22			
60 min Summer	50.485	0.0	7.3	38			
120 min Summer	31.420	0.0	9.2	70			
180 min Summer	23.440	0.0	10.3	100			
240 min Summer	18.895	0.0	11.1	130			
360 min Summer	13.936	0.0	12.3	190			
480 min Summer	11.217	0.0	13.1	248			
600 min Summer	9.470	0.0	13.9	308			
720 min Summer	8.242	0.0	14.5	370			
960 min Summer	6.614	0.0	15.5	490			
1440 min Summer	4.840	0.0	17.0	734			
2160 min Summer	3.534	0.0	18.6	1100			
2880 min Summer	2.823	0.0	19.8	1456			
4320 min Summer	2.053	0.0	21.5	2184			
5760 min Summer	1.636	0.0	22.7	2864			
7200 min Summer	1.372	0.0	23.7	3624			
8640 min Summer	1.189	0.0	24.5	4296			
10080 min Summer	1.054	0.0	25.3	5136			
15 min Winter	115.887	0.0	4.6	14			
30 min Winter	78.283	0.0	6.3	23			
60 min Winter	50.485	0.0	8.2	40			
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GTA Civils Ltd			Page 2				
Gloucester House 66a Church Walk Burgess Hill RH15 9AS		4 Lake Lane Barnham					
Date 13-07-15		Designed by JP					
File porous pavings.srcx		Checked by					
Micro Drainage		Source Control 2013.1					
<u>Summary of Results for 100 year Return Period (+30%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	4.329	0.149	0.0	2.8	2.8	2.2	Flood Risk
180 min Winter	4.290	0.110	0.0	2.4	2.4	1.6	Flood Risk
240 min Winter	4.264	0.084	0.0	2.0	2.0	1.3	Flood Risk
360 min Winter	4.240	0.060	0.0	1.6	1.6	0.9	Flood Risk
480 min Winter	4.229	0.049	0.0	1.3	1.3	0.7	Flood Risk
600 min Winter	4.222	0.042	0.0	1.1	1.1	0.6	Flood Risk
720 min Winter	4.217	0.037	0.0	1.0	1.0	0.6	Flood Risk
960 min Winter	4.210	0.030	0.0	0.8	0.8	0.5	Flood Risk
1440 min Winter	4.201	0.021	0.0	0.6	0.6	0.3	Flood Risk
2160 min Winter	4.194	0.014	0.0	0.4	0.4	0.2	Flood Risk
2880 min Winter	4.190	0.010	0.0	0.3	0.3	0.2	Flood Risk
4320 min Winter	4.186	0.006	0.0	0.2	0.2	0.1	Flood Risk
5760 min Winter	4.183	0.003	0.0	0.2	0.2	0.0	Flood Risk
7200 min Winter	4.181	0.001	0.0	0.2	0.2	0.0	Flood Risk
8640 min Winter	4.180	0.000	0.0	0.1	0.1	0.0	O K
10080 min Winter	4.180	0.000	0.0	0.1	0.1	0.0	O K
Storm Event	Rain (mm/hr)		Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)		
120 min Winter	31.420		0.0	10.3	74		
180 min Winter	23.440		0.0	11.5	104		
240 min Winter	18.895		0.0	12.4	132		
360 min Winter	13.936		0.0	13.8	190		
480 min Winter	11.217		0.0	14.8	248		
600 min Winter	9.470		0.0	15.6	308		
720 min Winter	8.242		0.0	16.3	368		
960 min Winter	6.614		0.0	17.4	492		
1440 min Winter	4.840		0.0	19.1	732		
2160 min Winter	3.534		0.0	20.9	1088		
2880 min Winter	2.823		0.0	22.2	1412		
4320 min Winter	2.053		0.0	24.1	2204		
5760 min Winter	1.636		0.0	25.5	2928		
7200 min Winter	1.372		0.0	26.7	3624		
8640 min Winter	1.189		0.0	27.6	0		
10080 min Winter	1.054		0.0	28.4	0		
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GTA Civils Ltd		Page 3																														
Gloucester House 66a Church Walk Burgess Hill RH15 9AS	4 Lake Lane Barnham																															
Date 13-07-15 File porous pavings.srcx	Designed by JP Checked by																															
Micro Drainage Source Control 2013.1																																
Rainfall Details <table><tr><td>Rainfall Model</td><td>FSR</td><td>Winter Storms</td><td>Yes</td></tr><tr><td>Return Period (years)</td><td>100</td><td>Cv (Summer)</td><td>0.750</td></tr><tr><td>Region</td><td>England and Wales</td><td>Cv (Winter)</td><td>0.840</td></tr><tr><td>M5-60 (mm)</td><td>19.200</td><td>Shortest Storm (mins)</td><td>15</td></tr><tr><td>Ratio R</td><td>0.340</td><td>Longest Storm (mins)</td><td>10080</td></tr><tr><td>Summer Storms</td><td>Yes</td><td>Climate Change %</td><td>+30</td></tr></table> Time Area Diagram Total Area (ha) 0.020 <table><tr><td>Time (mins)</td><td>Area</td></tr><tr><td>From: To:</td><td>(ha)</td></tr><tr><td>0 4</td><td>0.020</td></tr></table>			Rainfall Model	FSR	Winter Storms	Yes	Return Period (years)	100	Cv (Summer)	0.750	Region	England and Wales	Cv (Winter)	0.840	M5-60 (mm)	19.200	Shortest Storm (mins)	15	Ratio R	0.340	Longest Storm (mins)	10080	Summer Storms	Yes	Climate Change %	+30	Time (mins)	Area	From: To:	(ha)	0 4	0.020
Rainfall Model	FSR	Winter Storms	Yes																													
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0 4	0.020																															
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GTA Civils Ltd		Page 4																								
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Micro Drainage		Source Control 2013.1																								
<u>Model Details</u> Storage is Online Cover Level (m) 4.480 <u>Porous Car Park Structure</u> <table style="width: 100%; border: none;"> <tr> <td style="width: 33%;">Infiltration Coefficient Base (m/hr)</td> <td style="width: 33%;">0.00000</td> <td style="width: 33%;">Width (m)</td> <td style="width: 33%;">5.0</td> </tr> <tr> <td>Membrane Percolation (mm/hr)</td> <td>1000</td> <td>Length (m)</td> <td>10.0</td> </tr> <tr> <td>Max Percolation (l/s)</td> <td>13.9</td> <td>Slope (1:X)</td> <td>0.0</td> </tr> <tr> <td>Safety Factor</td> <td>2.0</td> <td>Depression Storage (mm)</td> <td>5</td> </tr> <tr> <td>Porosity</td> <td>0.30</td> <td>Evaporation (mm/day)</td> <td>3</td> </tr> <tr> <td>Invert Level (m)</td> <td>4.180</td> <td>Cap Volume Depth (m)</td> <td>0.000</td> </tr> </table> <u>Orifice Outflow Control</u> Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 4.160			Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0	Membrane Percolation (mm/hr)	1000	Length (m)	10.0	Max Percolation (l/s)	13.9	Slope (1:X)	0.0	Safety Factor	2.0	Depression Storage (mm)	5	Porosity	0.30	Evaporation (mm/day)	3	Invert Level (m)	4.180	Cap Volume Depth (m)	0.000
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0																							
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Invert Level (m)	4.180	Cap Volume Depth (m)	0.000																							
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APPENDIX G

Flood Warning & Evacuation Plan

A permanently affixed durable sign shall be affixed adjacent to the electrical distribution board in each unit.

Its letters shall be no less than 3mm high in a simple, clear font and the lettering shall be black on a white background or white on a black background for maximum contrast.

Each sign should read:

Flood Warning

This building is at high risk of flooding.

The site is liable to flood only in the most extreme of storm events. This means that you may be forced to remain here until the flood waters recede.

You are strongly advised to sign up to the Environment Agency's (free) flood warning system, 'Floodline Warnings Direct'. This is explained on the EA's website: <http://www.environment-agency.gov.uk/homeandleisure/floods/38289.aspx>. You should also monitor the weather and keep informed of storm/flood developments as they arise. You are advised to keep informed by listening to the radio or watching the TV news bulletins.

Evacuation

Well in advance of any such threat you should plan ahead. Consider who you can visit (friends/family), further away from the coast. You should also plan the means of transport, e.g. by car, walking or other means.

If there are any occupants with physical disabilities then these should be incorporated into this plan.

The site may flood prior to you evacuating: you should ensure that you have sufficient provisions (food and sanitary/ cleaning materials etc.) for at least 3 days.

APPENDIX H

Extract from “Improving the Flood Performance of New Buildings – Flood Resilient Construction”

Aim of the Guidance

This document aims to provide guidance to developers and designers on how to improve the resilience of new properties in low or residual flood risk areas by the use of suitable materials and construction details. These approaches are appropriate for areas where the probability of flooding is low (e.g. flood zone 1 as defined by PPS 25) or areas where flood risk management or mitigation measures have been put in place. The guidance will also be useful to planners, building control officers and loss adjusters.

Specifically this guidance document provides:

- practical and easy-to-use guidance on the design and specification of new buildings (primarily housing) in low or residual flood risk areas in order to reduce the impacts of flooding
- recommendations for the construction of flood resistant and resilient buildings.

Services

General advice for resilient design

Where possible, all service entries should be sealed (e.g. with expanding foam or similar closed cell material).

Pipework: Closed cell insulation should be used for pipes which are below the predicted flood level.

Drainage services: Non-return valves are recommended in the drainage system to prevent back-flow of diluted sewage in situations where there is an identified risk of the foul sewer surcharging. Maintenance of these valves is important to ensure their continued effectiveness.

Water, electricity and gas meters: should be located above predicted flood level.

Electrical services: electrical sockets should be installed above flood level for ground floors to minimise damage to electrical services and allow speedy re-occupation (see Figure 6.13. Note a dado rail which provides a limit for replacement of any wall covering). Electric ring mains should be installed at first floor level with drops to ground floor sockets and switches.

Heating systems: boiler units and ancillary devices should be installed above predicted flood level and preferably on the first floor of two-storey properties. Underfloor heating should be avoided on ground floors and controls such as thermostats should be placed above flood level. Conventional heating systems, e.g. hot water pipes are unlikely to be significantly affected by flood water unless it contains a large amount of salts. The less common, hot air duct heating would remain effective provided it is installed above the design flood level.

Communications wiring: wiring for telephone, TV, internet and other services should be protected by suitable insulation in the distribution ducts to prevent damage. Any proposed design solution for flood insulation on all potentially vulnerable wiring should be discussed with the relevant service providers.

The full document can be downloaded from:

http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf