QM

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	Draft			
Date	April 2006	July 2006	October 2006	
Prepared by	V Jacot	B Cafferkey	M Wheeler	
Signature				
Checked by	M Wheeler	M Wheeler	B Cafferkey	
Signature				
Authorised by	R G Hutchings	R G Hutchings	R G Hutchings	
Signature				
Project number	11011546	11011546	11011546	
File reference	FRA&Drainage	1546/FRA and Drainage	1546/FRA and Drainage Rev 2	

WSP Development and Transportation
Mountbatten House
Basing View
Basingstoke
Hampshire
RG21 4HJ

Tel: +44 (0)1256 318800
Fax: +44 (0)1256 318700
http://www.wspgroup.com

Reg. No: 2382309

Contents

Appendix A	**PPG25 Appendix F Requirements of a Flood Risk Assessment Guidance Note**
Appendix B	**Environment Agency Correspondence and Flood Map Figure 3**
Appendix C	**General and Detailed Location Plans, Figure 1 and 2**
Appendix D	**Existing On-Site Hydrological Conditions -Figure 6 Proposed Site Layout - Drawing No. 1806.01/04 G**
Appendix E	**Topographical Survey - Drawing No. 1546/FRA/XS/001, Report on Field Visit to South West Bicester, Existing On-Site Water Flows Directions – Drawing No. 1546/FRA/D/001**
Appendix F	**Thames Water Records**
Appendix G	**InfoWorks Results for the 100 and 100 year +20% event and Table 3 Sensitivity Analysis Figure 7 – Modelled 100 year Flood Plain Extents Figure 8 – Pingle Brook Cross Section Locations Figure 9 – Proposed Flood Mitigation Works**
Appendix H	**British Geological Survey Map Average Annual Rainfall Map (SAAR) 1941-1970 Winter Rain Acceptance Potential (SOIL) Map Existing Greenfield Run-off Rates Calculations Pell Frischmann "Ground Investigation Factual and Interpretative Report" in part**
Appendix I	**Pipe Network - MicroDrainage Calculations, Proposed Designed Surface Water Drainage Strategy - Drawing No. 1546/FRA/D/002, Tanked Cellular Storage Details - Figure 4, Tanked Pavements Details - Figure 5, Ratio of M5-60 Minute to M5-2 Day Rainfall Map, Rainfall Depths (M5-60 Minute) Map**

Executive Summary

WSP undertook a study which assessed the risk of flooding associated with proposed development at Whitelands Farm to the southwest of Bicester, Oxfordshire. Consultation with the Environment Agency (EA), Thames Water and local Government bodies was undertaken to compile all relevant historic and associated events with respect to flooding.

Thames Water has confirmed that they have no record of flooding within the vicinity of the site. Oxfordshire County Council has verbally confirmed that they have no record of highway flooding within the vicinity of the site. The EA's Flood Map (FM) indicates that a part of the site lies within the Pingle Brook flood plain (Flood Zone 3).

The EA advised that they have no hydraulic model of the Pingle Brook. WSP undertook hydraulic modelling of the Pingle Brook for the 100 year and 100 year + 20% event. It was observed that water levels were out of bank for two sections during the 100 year and 100 year + 20% event. However the flood extent does not encroach on the planned development areas.

To reduce any residual risk of flooding of the proposed development, WSP propose the following works for the Pingle Brook:

- Carry out maintenance to the channel to reduce the chance of blockages exacerbating flooding.
- De-silt the existing box culvert under Oxford Road
- Realign the Pingle Brook to accommodate the proposed development which increases its length within the site by 32m. The new cross section will result in a two stage trapezoidal channel with a base width of 1m with 1 in 1 and 1 in 2 side slopes.
- Remove soft bed within the existing channel downstream of the Oxford Road culvert for a distance of approximately 15m.

The above work further ensures that the 100 year and 100 year +20% event does not encroach on the development area. Land drainage consent for the above work will be required from the Environment Agency under the Land Drainage Act 1991.

WSP propose that finished floor levels within the vicinity of the existing flood plain (shown on the EA's FM) 300 mm above the 100 year + 20% top water level on the Pingle Brook. In addition, it is proposed to raise finished slab levels 150 mm above the existing ground levels on site to prevent flooding in extreme events.

To address the EA's concerns with respect to assessing the run-off generated from the proposed development, the following works are proposed to reduce surface water run-off and accommodate the additional flood volumes on site:

- Restrict discharge from the site to the existing Greenfield run-off rate.
- Use a management train sustainable drainage systems (SUDS) approach in accordance with current guidance documents. Regional control will be provided by off-line ponds.

Infiltration drainage systems are to be utilised where possible following detailed site investigation works within individual plots to assess infiltration rates, to check for any contamination and determine groundwater levels.

The proposed works will ensure that the EA requirements are met with respect to containing the 100 year + 20% flows on-site, in addition to restricting discharge from the site to the existing Greenfield run-off rates for a given storm event up to and including the 100 year event.

The development proposals are robust and comply with the requirements at outline stage of the EA and PPG25 in terms of flood risks and drainage issues. There is therefore no reason on flooding grounds why development at this site should not take place.

1 Introduction

1.1 BACKGROUND

1.1.1 WSP were appointed by Countryside Properties (Bicester) Ltd in January 2006 to carry out a Flood Risk Assessment and Surface Water Drainage Strategy for a proposed development of approximately 108ha of Greenfield site to the south west edge of Bicester, Oxfordshire. The proposal comprise a mix of residential, commercial and community development with associated primary and secondary schools, informal and formal open spaces. WSP issued their original flood risk assessment in April 2006 and a revised FRA in July 2006.

1.1.2 The July report was prepared to address the Environment Agency comments following receipt of their letter dated 17 May 2006. This report has contains further minor amendments to clarify points raised by the Agency in September 2006.

1.1.3 This report will take the form of a formal Flood Risk Assessment in accordance with Appendix F of the DTLR publication “Planning Policy Guidance Note 25 Development and Flood Risk (PPG25)”. Refer to Appendix A. In addition, the report will address the Drainage Strategy proposed for the site, which is a requirement of recent EA guidance.

1.1.4 The drainage strategy was developed using the April 2006 Masterplan to demonstrate a worst case practicable scheme, with regional control provided by ponds sized assuming no infiltration. For this revision, the strategy has not been updated to reflect the latest layout, as the principles and calculated volumes are equally applicable.

2 Background

2.1 PROPOSED DEVELOPMENT

2.1.1 Countryside Properties Ltd is proposing to develop the 108ha existing greenfield site located along the south west edge of Bicester in Oxfordshire. This redevelopment will comprise of approximately 46.7ha of residential use, 2.9ha commercial use and / or a community hospital, 2.3ha of local centre use and 7.1ha of potential primary secondary schools. The remaining area will be allocated as open spaces (3.9ha approximately) along with associated balancing ponds. Refer to drawing No 1806.01/04 G in Appendix D.

2.1.2 PPG3 - Housing clearly identifies flood risk as a specific material consideration in the allocation and release of sites for new housing.

2.1.3 The Government's sustainable development strategy makes it a requirement to assess appropriate forms of development for areas at risk of flooding. This is to avoid an unnecessary increase in the requirements for flood defences.

2.1.4 A requirement of PPG25 is that developers making planning applications for sites that are potentially at risk of flooding should consult with the EA and produce a Flood Risk Assessment (FRA) for their proposals.

2.1.5 The Environment Agency's EA "Policy and Practice for the protection of floodplains" (1997), provides guidance to local authorities on the control of development. In addition, the EA have published Flood Maps (FM) which shows areas potentially at risk from flood events up to the 0.1% annual probability for tidal/coastal areas.

2.1.6 The current Environment Agency's (EA) FM shows that less than 2% of site area (1.35ha) lies within the flood plain of the Pingle Brook and falls partly in Flood Zone 3 where the indicative annual probability of fluvial flooding is of 1 in 100 years or less (i.e has 1% or greater chance of flooding in any given year). Refer to Appendix B, EA's Flood Map.

2.1.7 WSP consulted the EA who confirmed that while the majority of the site is located in Flood Zone 1 (little or no risk) which is outside the flood plain, however part of the site is shown on the Flood Map to be within Flood Zone 3 of the Pingle Brook. (Refer to the EA's facsimile dated 11 August 2005 in Appendix B).

2.1.8 The EA confirmed that they have coarse scale modelling in this area which shows sections in the north east corner of the site to lie within Flood Zone 3. The EA have confirmed that the Pingle Brook itself is not currently modelled. Refer to Appendix B, EA's letter dated 15 August 2005.

2.1.9 Following submission of WSP's FRA in April 2006, the Agency raised a number of issues which needed further clarification (refer to the Agency's letter of 17 May 2006 - Appendix B) which were as follows:

- *"There is insufficient detail regarding the modelling undertaken in order to accept the findings that the 100 year and 100 year plus 20% flows stay in bank"*
- *"There should not be any wholesale raising of ground levels within the 100 year plus 20% extent. Any compensation for loss of flood storage capacity must occur on a level for level volume basis"*
- *"There is also reference to the diversion of a watercourse, it is not clear from the drawings whether this is part of the proposed layout. No details have been provided, or principles establishing the way in which any diversion will be undertaken"*

- *"The key on Drawing 1546/FRA/D/002 Rev A is insufficient to allow us to be able to assess the strategy"*
- *"There is not adequate consideration of SUDS techniques within this FRA for a site of this size. The surface water strategy should provide guidance on the implementation of SUDS on this site and the specific constraints, in accordance with the management train approach which is fundamental to designing a successful SUDS scheme"*
- *"Although we appreciate that you have designed a drainage system based on the worst case scenario, and therefore has proposed underground storage, insufficient justification of the proposed techniques has been provided. Below ground storage tanks are a less sustainable option when compared with above ground or infiltration techniques and do not offer the water quality, ground water recharge, amenity and wildlife habitat benefits of above ground storage techniques"*
- *"The FRA makes statements regarding the constraints to surface water design in order to justify the use of a tank system, it provides insufficient information to substantiate these statements, such as the high water table in the north east of the site in paragraph 6.3.13 and areas contaminated 6.3.12"*

2.1.10 Following receipt of the Agency's letter in April 2006, WSP undertook hydraulic modelling using the InfoWorks RS software package[1] to assess the capacity of the existing channel. The 100 year flow was generated utilising the flood estimation handbook (rainfall run-off method – FEH Software) which generated flows of 1.27m³/s and 1.53m³/s for the 100 year and 100 year +20% events respectively.

2.1.11 WSP have updated the FRA to address the Agency's comments identified in their letter of 17 May 2006.

[1] InfoWorks RS River Modelling Software Package Produced by HR Wallingford Version 7.03

3 Hydrological and Hydraulic Modelling

3.1 INTRODUCTION

3.1.1 Following submission of WSP's FRA to the Environment Agency in April 2006, the Agency responded on 17 May 2006. One of the issues raised by the Agency was regarding the hand calculations undertaken to establish the 100 year and 100 year +20% (climate change) top water levels within the Pingle Brook. The Agency stated that *"There is insufficient detail regarding the modelling undertaken in order to accept the findings that the 100 year and 100 year +20% flows stay in bank. Further detail of the Method of Modelling used should be provided and blockage scenarios included"*.

3.1.2 To address the above issues by the Agency, WSP undertook Hydrological and Hydraulic Modelling of the Pingle Brook.

3.2 SITE VISIT

3.2.1 Prior to undertaking any hydrological and hydraulic modelling, WSP undertook a site visit on 23 June 2006. Refer to Appendix E – Report on Field Visit. The survey commenced at the box culvert which conveys the Pingle Brook under the Oxford Road (A41) and the following observations were made:

- The Brook runs parallel to the face of the box culvert entrance before being conveyed under Oxford Road. This is as a result of the Pingle Brook current route which flows around a portion of the site immediately upstream of the culvert which prevents a direct route to the culvert.
- The Oxford Road culvert is 1.6m wide by 1.2m high; however 0.4m of the culvert is silted up.
- The section of Pingle Brook immediately downstream of Oxford Road is well defined. The channel is trapezoidal with a base width of 2m and a side slope of 1 in 1. Approximately 30m downstream from the culvert sheet pile and a brick wall provide stability to the right hand side of bank.
- For a distance of 30m upstream of the Oxford Road culvert the Pingle Brook channel was not observed due to the dense vegetation which is made up of brush, shrubs and trees.
- Approximately 40m upstream of Oxford Road culvert there exists a 1.1m wide by 0.5m high culvert. The channel is poorly defined in this area.
- To the north of Middleton Stoney Road the Pingle Brook is conveyed via a concrete lined channel which has a base width of 2.0m wide 1.2m deep with a 1 in 1 side slope. The Brook is conveyed under Middleton Stoney Road via a 900mm diameter culvert.

3.2.2 The above observations together with the on-site measurements taken were incorporated within the existing InfoWorks model for the Pingle Brook. This information was then incorporated into the InfoWorks RS model for the pre development scenario.

3.3 HYDROLOGICAL ASSESSMENT

3.3.1 To establish the 100 year flows within the Pingle Brook the Flood Estimation Handbook (FEH) rainfall run-off method was used. The software used was the FEH CD Rom Version 1.0[2] used in conjunction with the InfoWorks Software Package. The catchment area serving the Pingle Brook equates to 3.45km² which results in a 100 year and 100 year +20% flow of 1.27m³/s and 1.53m³/s respectively. Refer to Appendix G for calculations.

3.3.2 It is proposed that the above flows be used to establish the existing flood plain extent.

3.4 HYDRAULIC MODELLING – EXISTING DRAINAGE SYSTEM

3.4.1 A section of the Pingle Brook has been modelled 90m upstream of Middleton Stoney Road to a distance 150m downstream of the Oxford Road. The Pingle Brook generally flows in a south easterly direction through the north east part of the site.

3.4.2 The aim of the modelling exercise is to establish the existing 100 year and 100 year +20% top water levels within the Pingle Brook.

3.4.3 An InfoWorks hydraulic model was constructed based on the existing topographical survey and field measurements taken on site. Refer to Appendix E for Topographical Survey and Report on Site Visit.

3.5 MODELLED RESULTS

3.5.1 To assess the existing flood plain the 100 year and 100 year +20% flows were simulated within the model. Refer to Table 1 below for Top Water Levels for the pre and post development models.

3.5.2 From the modelling work undertaken, the following was observed:

- At a distance of approximately 287m upstream of Oxford Road the Pingle Brook flooded over a stretch of 58m during the 100 year event. In addition the Pingle Brook flooding immediately upstream of Oxford Road for a distance of approximately 77m. Refer to Figure 7 – Existing 100 year Flood Plain Extent in Appendix G. However, the extent of flooding does not encroach on proposed development areas
- The main factor contributing to the flooding is the lack of capacity within the existing channel. The dense vegetation within the channel in addition to the channel route all combine to result in flooding at the said locations.

3.5.3 It has been concluded from the modelling work undertaken for the existing watercourse that, capacity of the channel is the main contributing factor to flooding of the Pingle Brook. Refer to Table 1 and Figure 8 for the 100 year top water levels and cross section locations respectively.

[2] FEH CD Rom Version 1.0 produced by Centre of Ecology and Hydrology

Table 1 : 100 Year and 100 Year +20% Top Water Levels Pre-Development

X-Section Location	Ground Level (m AOD)	100 Year Top Water Level (m AOD)	100 Year +20% Top Water Level (m AOD)	Remarks
PIN-01	72.998	72.998	73.043	Culvert immediate u/s of this point
PIN-07	71.552	71.542	71.573	
PIN-08	70.837	70.742	70.778	
PIN-13	70.218	70.13	70.164	
PIN-15	69.85	69.839	69.883	
PIN-16	69.63	69.734	69.773	
PIN-17	69.49	69.649	69.693	
PIN-18	69.548	69.415	69.454	
PIN-28	68.93	68.836	68.887	
PIN-29	68.815	68.594	68.701	
PIN-30	68.572	68.573	68.693	
PIN-31	68.410	68.494	68.656	Culvert on the footway; around 12 m u/s of this section
PIN-32	68.410	68.472	68.646	
PIN-33	68.400	68.469	68.644	Culvert immediate d/s of this section
PIN_DEX-01	-	68.346	68.477	
PIN_DEX-03	-	68.173	68.303	

Flooding

Refer to Figure 7 – Modelled 100 year flood plain extent - Appendix G

Refer to Figure 8 – Cross Section Locations - Appendix G

3.6 HYDRAULIC MODELLING - PROPOSED FLOOD MITIGATION WORK

3.6.1 The mitigation work will allow for the proposed development which in part requires diversion of the Pingle Brook over a distance of 32m within the site. This will result in an increase in stream length from 771m to 803m.

3.6.2 To address the flooding associated with the Pingle Brook within the site the following mitigation works are proposed:

- Carry out maintenance to the existing channel to negate the risk of blockages exacerbating flooding.
- De-silt the existing box culvert under Oxford Road
- Realign the Pingle Brook to accommodate the proposed development which increases its length within the site by 32m. The new cross section will result in two stage trapezoidal channel with a base width of 1m with 1 in 1 and 1 in 2 side slopes. Refer to Figure 9 in Appendix G.
- Remove soft bed with the existing channel downstream of the Oxford Road culvert for a distance of approximately 15m

3.6.3 These works will be subject to a separate Land Drainage Application to the Agency under the Land Drainage Act 1991.

3.7 MODELLED RESULTS IMPLEMENTING THE PROPOSED FLOOD MITIGATION WORKS ON THE PINGLE BROOK

3.7.1 It is not now proposed to widen the channel throughout the site. However the modelling information and sensitivity analysis is relevant.

3.7.2 There was no increase in water level up or downstream of the site. Refer to Table 3 – Sensitivity Results in Appendix G.

3.8 MANNING'S 'N'

3.8.1 In line with current standards the following Mannings 'n' values were used:

- Manning 'n' for main channel is 0.04
- Mannings 'n' for flood plain 0.05

3.9 CALIBRATION AND VERIFICATION

3.9.1 No data was available to enable calibration or verification of the model. It was therefore concluded that to ensure a robust design that a sensitivity analysis be undertaken on the post development scenario.

3.10 SENSITIVITY ANALYSIS

3.10.1 Due to the lack of calibration and verification data it was necessary to carry out a sensitivity analysis to establish the robustness of the post development model. The aim is to establish upper and lower bands with respect to maximum top water levels during the 100 year event. The model was re-run for the 100 year event with the following changes:

- Model flow increased by 20% (climate change)
- Mannings roughness coefficients raised and lowered by 20%
- Increase downstream boundary by 0.15m.
- Blocking of culvert by 75%

3.10.2 Following completion of the 100 year +20% analysis it was observed that top water levels increased above the post development model by 304mm and 210mm up and downstream of the site respectively.

3.10.3 Following an increase in manning 'n' by 20% it was found that the water levels rose by 68mm and 8mm up and downstream of the site respectively. A reduction in Mannings 'n' by 20% resulted in water levels reducing by 86m and 83mm up and downstream of the site respectively.

3.10.4 Increasing the downstream boundary by 0.15m resulted in no change in top water levels.

3.10.5 To asses for blocking, 75% of the cross sectional area of the culvert was removed. The above blockage scenarios result in water level rising by 132mm upstream of the Oxford Road culvert. (Refer to Appendix G Table 3 for Sensitivity Analysis Results).

3.11 MODELLING CONCLUSION

3.11.1 The hydrological assessment undertaken by WSP is considered robust with respect to predicting top water levels.

3.11.2 It is intended that the proposed development can be accommodated within the vicinity of Pingle Brook area provided the following flood mitigation works are undertaken:

- Carry out maintenance to the existing channel to reduce the risk of blockages exacerbating the risk of flooding.
- Realign the Pingle Brook to accommodate development.
- De-silt the Oxford Road box culvert and;
- Remove soft bed with the existing channel downstream of the site for distance of approximately 15m

3.11.3 The flood extent for the 100 year and 100 year +20% event are outside the proposed development areas.

4 Requirements of the Flood Risk Assessment

4.1 REPORT STRUCTURE

4.1.1 PPG25 – Development and Flood Risk, Appendix F, sets out the requirements of a Flood Risk Assessment. Refer to Appendix A.

4.1.2 The PPG25 – Appendix F guidance specifies that the report shall contain the following:

- Location Plan – see Appendix C and Section 5 of this report
- Level Plan – see Section 6 of this report
- Drainage Strategy for the proposed development – see Appendix H and I and Sections 7, 8 and 9 of the report
- Existing Flood Alleviation Measures – see Section 10
- Source of flooding – see Section 11
- Flood Plain – see Appendix B and Section 12
- Structures influencing local hydraulics – see Section 13
- Flood Probabilities – see Section 14
- Cross section of proposed site – see Section 15 of this report
- Flood Progress – see Section 16
- Sewer Hydraulics – see Section 17
- Flood Volume Displaced – see Section 18
- Impact of Displaced Water – see Section 19
- Impact on Fluvial Morphology – see Section 20
- Climate change Impacts – see Section 21
- Flood Defence Residual Risk Assessment – see Section 22.

The following paragraphs address each of the points referring to the relevant paragraph in PPG25, Appendix F, paragraph 3.

4.1.3 The proposed on-site drainage strategy which promotes the use of infiltration Sustainable Drainage Systems (SUDS) is discussed in Sections 7, 8 and 9 of this report.

5 Site Location

5.1 SITE LOCATION AND CURRENT ACCESS

5.1.1 The site is located along the south western edge of Bicester, in Oxfordshire and is currently a greenfield agricultural site which is predominantly part of the Whitelands Farm Development. Refer to site location plans, Figure 1 and 2 in Appendix C.

5.1.2 Three main watercourses, Pingle Brook to the north, Whitelands Farm Brook in the centre and Gagle Brook to the south, run within or in the vicinity of the site area.

5.1.3 The site is bound to the north by Middleton Stoney Road (B4030, formerly the A4421) to the west by the A4095, to the east by Oxford Road, and to the south by Greenfield areas north of the Gagle Brook.

5.1.4 The site is currently an agricultural site with a footpath crossing the site north to south from Middleton Stoney Road to the Whitelands Farm located centrally.

6 Level Plan

6.1 SITE SURVEY

6.1.1 A full topographical survey of the site has been undertaken by Nationwide Surveys and is plotted at a scale of 1 in 2500. Refer to the Topographical Survey in Appendix E.

6.1.2 It can be seen from the survey that the site falls in an easterly direction. The highest point of the site is located to the northwest of the site at a level of approximately 82.76m AOD and the lowest point to the southeast corner of the site at the boundary with Oxford Road at a level of approximately 65.19m AOD. This represents a fall of 1 in 100.

6.1.3 The EA's Flood Map (FM) shows an area of 1.35ha in the northeast corner of the site (less than 2% of the total site area) lying within the predicted 1% annual flood plain of the Pingle Brook. (Refer to Appendix B).

6.1.4 Flood levels have been established by modelling. It is proposed to set all ground floor levels a minimum of 300mm above the 1 in 100 year + 20% water level.

6.1.5 It is also proposed for the remaining area, to raise finished floor levels by a minimum of 150 mm above existing ground levels on site to prevent flooding from extreme events that cause overland flow. It has been observed that no overland flood route exist between the existing flood plain of the Pingle Brook and the lowest point of the site (south east corner of the site).

6.1.6 All proposed developed areas will be outside the 100 year flood plain and safe dry access will be provided.

7 Existing Surface Water Drainage Regime and Base Line Conditions

7.1 EXISTING SURFACE WATER DRAINAGE FROM HIGHFIELD ESTATE

7.1.1 The Pingle Brook is the primary watercourse serving this area of southwest Bicester. The Brook originates from a location due south of Gowell Farm, which is located to the north of the Highfields Estate. The Brook then passes down through this estate collecting surface/storm water from much of the Highfields development.

7.1.2 The Highfields Estate would appear to be subjected to storm water discharge control measures as part of the development. These measures comprised of the canalisation of the Pingle Brook into an open concrete channel, which has a base width of 2.0m, 1.2m deep with 1 in 1 side slopes.

7.1.3 A 'dry' balancing pond, with a surface area of approx 6,500 square metres, has been constructed on the line of the Brook near Shakespeare Drive. This balancing pond has a crescent overflow weir associated with the attenuation system; this is approximately 1.5m high and therefore the pond would contain approximately 10,000 cubic metres of water when filled during a severe rainfall event. Historic evidence suggests that this pond has never been flooded.

7.1.4 The balancing pond discharges into the trapezoidal channel section that passes down through the estate before crossing Middleton Stoney Road.

7.1.5 Drainage records received from Thames Water Utilities (TWU) indicate that a piped network of storm water sewers exists to serve the western end of the Highfields Estate. The drainage system discharges into the storm water balancing system where it is regulated and attenuated by the outfall weir, before discharging to the Pingle Brook.

7.1.6 The TWU records indicate no formal storm water drainage network serving the eastern end of Highfields Estate; and discussions with Cherwell District Council confirm that this area of the estate is drained by soakaways which discharge surface water by infiltration to the Cornbrash sub-strata aquifer.

7.2 HIGHWAY DRAINAGE FROM MIDDLETON STONEY ROAD

7.2.1 In addition the TWU records do not indicate any formal, piped, surface water sewers serving Middleton Stoney Road. It is therefore presumed that the surface water gullies along Middleton Stoney Road connect directly into Pingle Brook via Highway drains. Refer to Appendix F for Thames Water Utilities Records.

7.3 EXISTING ON-SITE SURFACE WATER DRAINAGE AND BASELINE CONDITIONS

7.3.1 The existing 108ha site naturally drains in an easterly direction. It is currently a greenfield agricultural site with a farm located at its centre.

7.3.2 Storm Water run off within the site is captured by a succession of ditch watercourses across the site which falls towards Oxford Road.

7.3.3 There are 3 main watercourses in the vicinity of the site area, the Gagle Brook to the south, Pingle Brook to the north and Whitelands Farm Brook in the centre. They cross the Oxford Road and discharge to the River Langford. Refer to Figure 6 in Appendix D.

7.3.4 The topographical survey shows that the majority of the surface water run-off from the existing Greenfield site to the south of Whitelands Farm falls to Gagle Brook, the north of the farm to Pingle Brook and some of the centre section falls into the Whitelands Farm Brook. Refer to drawing No 1546/FRA/D/001 in Appendix E.

7.3.5 Pingle Brook runs from north of the site, passing through the north eastern corner of the site for approximately 700m. Within this section it is joined by two watercourses. One appears to be serving highway run-off from Highfields Estate and Middleton Stoney Road. The other watercourse appears to be fed by a spring which is probably issuing water from the aquifer. The Pingle Brook then discharges from the NE corner of the site via a rectangular concrete culvert, which passes under Oxford Road at a location approximately 120m south of the Middleton Stoney Road junction.

7.3.6 The Whitelands Farm Brook is a smaller watercourse which passes down a shallow ditch before crossing Oxford Road via a small diameter pipe. Approximately 18 to 24 inches in diameter.

7.3.7 The Gagle Brook flows north west to south east close to the south western edge of the main site. Although Gagle Brook is the most significant of the three watercourses within the vicinity of site, the proposed development is focussed on the area north of Whitelands Farm, which predominantly falls to Pingle Brook. Therefore the Gagle Brook is not considered to be an acceptable outfall for the development.

7.4 EXISTING GROUND CONDITIONS AND CONTAMINATION ISSUES

7.4.1 In October 2001 Pell Frischmann issued their "Ground Investigation, Factual and Interpretative Report" for the proposed development site. Refer to Appendix H for report in part.

7.4.2 Existing ground conditions have been established from boreholes and trial pits during a site investigation survey and the level of contamination on the site has been assessed. Following the site investigation survey the following observations have been made.

7.4.3 Made Ground was observed in the north west and north eastern areas of the site together with localised areas of fill in the central eastern areas of the site. Between 1.65m and 2.45m of granular made ground was identified in the north west of the site, while the north eastern area of the site was largely a fine sandy silty clayey gravel, although a 1.3m thick layer of soft to firm cohesive material with plant remains was encountered.

7.4.4 "Alluvial deposits were encountered in the south eastern area of the site comprising predominantly sand between 1m and 1.8m thick, and in the north eastern corner as a thin layer of soft clayey and peat to less than 1m depth below ground level".

7.4.5 "Kelleways Clay was encountered in much of the southern and south western area of the site. This comprised predominantly stiff clay (highly to completely weathered mudstone) between 0.5m and 2.5m thick".

7.4.6 "Cornbrash was encountered in much of the northern area of the site. This comprised predominantly coarse granular material (highly to completely weathered limestone) between 0.5m and 2.5m thick, and either was underlain by generally moderately weak to moderately strong limestone or a stiff to very stiff clay".

7.4.7 Forest Marble Formation was encountered in the north eastern area of the site and underlying the Cornbrash. The Forest Marble Foundation comprised either a moderately strong light grey limestone, or a predominantly stiff to very stiff clay. The clay was found to be between 0.5m and 2.5m thick.

7.4.8 "With respect to contamination, it was considered that the site will not present a significant hazard to the proposed end-uses. High results for arsenic, lead and phytotoxins within the quarry backfill were anticipated, elevated metals being common in ash fills".

7.4.9 It is proposed that Sustainable Drainage System (SUDS) be utilised where practicable on site. The majority of the site is overlaying cornbrash and Kelleways clay layers. The permeability of the Cornbrash has been investigated. It has been found that the permeability rate varies from $1x10^{-5}$mm/s (typical of a silt) to $9x10^{-3}$mm/s (typical of a fine sand / coarse silt).

"the layer for drainage to occur in is likely to be restricted to the relatively thin Cornbrash layer, this at least in part being bounded above and below by weathered mudstones, giving an essentially impermeable cap and base to this layer. The capacity of this layer could thus be severely restricted".

"It should be noted that groundwater levels may be subject to seasonal and other variation".

7.4.10 While it is proposed to utilise the Whitelands Farm Brook and Pingle Brook as a surface water outfall point, WSP advise that SUDS infiltration techniques be utilised wherever possible. These systems can take the form of shallow trench soakaways, permeable pavements, swales etc. However prior to any detail design being undertaken a comprehensive site investigation for each development plot should be undertaken to identify the various thicknesses of sub-strata together with identifying any contamination issues and groundwater level constraints (groundwater level monitoring) on site.

8 Surface Water Drainage Strategy Requirements

8.1 ENVIRONMENT AGENCY'S REQUIREMENTS

8.1.1 The proposed surface water drainage strategy should seek to replicate the sites existing hydrology. Changes in the volume and rate of surface water run-off from the development could increase the risk of flooding downstream unless sufficient steps are taken within the proposed development.

8.1.2 A fundamental principle of sustainable development in terms of flood defence is the reduction of surface water run-off from the new developments. The EA's policy for sustainability requires that rainfall run-off from new developments is limited to that of existing 'greenfield' run off rates. Any increase in run-off above the allowable discharge limit must be attenuated on site.

8.1.3 The EA also requires that the area currently drained to each of the nearby watercourses should be established and that these individual discharge rates should be replicated.

8.1.4 In addition, it is required to accommodate excess water and control its release into watercourses according to the following criteria:

- *The Drainage system must be designed to control run-off up to a 1 in 100 year storm event.*
- *The point at which surface water is discharged from the site may vary with the severity of the storm event but must not exceed the Greenfield run off rate for a given storm event.*
- *Excess surface water run-off must be stored on site and released to the watercourses at Greenfield rates. Surface water discharges to watercourses must not exceed a* velocity *of 1m/s.* Refer to the EA's letter dated the 15 August 2005 in Appendix B.

8.1.5 Sustainable Drainage Systems (SUDS) can be used to reduce the amount of rainfall collected at source and where appropriate, SUDS can be used to improve water quality.

8.1.6 It is therefore proposed that SUDS be used throughout the development wherever possible.

8.1.7 The EA 'encourage' the use of SUDS in addition to the balancing ponds proposed at the site. However, on-line storage ponds are not acceptable. Only off-line ponds will be accepted. Refer to the EA's letter dated 11 August 2005 in Appendix B.

9 Surface Water Drainage Strategy

9.1 GENERAL STRATEGY

9.1.1 It is proposed to discharge the run-off generated by the proposed development to the Pingle and Whitelands Farm Brooks using a management train SUDS approach. For the purpose of this study it has been assumed that no infiltration drainage systems will work on site to assess a worst case scenario and a mainly piped system was modelled to demonstrate that a drainage strategy is practicable. This scenario will also establish the maximum size the off-line regional control balancing ponds needed to be to serve the development.

It is likely that infiltration SUDS will work on site in some areas, but a detailed site investigation will need to be carried out for each phase of the development to confirm this. The use of infiltration drainage systems will reduce run-off from the site and improve water quality.

9.1.2 It is intended that the proposed surface water strategy replicates the existing site's hydrology. Therefore, it is proposed to limit the run-off generated by the proposed development site to existing greenfield run-off for a given storm event. It is intended that climate change will be assessed.

9.1.3 WSP have established the area that currently drains to each of the nearby watercourses. It has been estimated that an area of approximately 38ha to the north of the existing proposed development site currently drains to the Pingle Brook and approximately 70ha to the south of the proposed development site drains to the Whitelands Farm Brook. (Refer to drawing 1546/FRA/D/001 in Appendix E).

9.1.4 To assess Greenfield run-off rates to each watercourse for the 2, 30 and 100 year events, WSP undertook a set of calculations using the Institute of Hydrology Report (IoH 124). Refer to Appendix H for existing Greenfield run-off rates calculations.

9.1.5 The site was modelled using 6 positive drainage sewer networks which discharge to the Pingle and Whitelands Farm Brooks and which replicate the Greenfield discharge rates mentioned above. Refer to Appendix I for proposed drainage strategy, drawing 1546/FRA/D/002.

9.2 SOUTHERN CATCHMENT

9.2.1 Three surface water sewers networks serving the southern catchment of the proposed development site (approximately of 70 ha) will outfall to the Whitelands Farm Brook. Approximately 47% of the 70ha will be developed (area of 33ha).

9.2.2 It is intended that of the 33ha which will developed, approximately 15.6ha will be residential, 2.1ha commercial, 2.4ha will accommodate a proposed local centre development, 7.1ha will consist of education facilities (3.3ha primary schools, 3.8ha of secondary school) and the remainder will consist of roads.

9.2.3 The southern catchment of the proposed development was modelled by three surface water sewer networks. The surface water sewer network No. 1 will serve the proposed residential areas (15.6ha), the local centre (2.4ha), the commercial area (2.1ha) and the primary schools (3.3ha), and associated roads areas. The surface water sewer network No. 2 will serve the proposed secondary school (3.8ha) while surface water sewer network No. 3 will serve the perimeter road (3.8ha).

SURFACE WATER SEWER NETWORK NO.1

9.2.4 The surface water sewer network No.1 covers the southern catchment as detailed above, which comprises a total area of 25.3ha approximately.

9.2.5 It is anticipated that of the 25.3ha, 74.2% will be impermeable (approximately 18.8ha). A breakdown of the various contributory areas are outlined in the following chapter.

Residential Area

9.2.6 It is estimated that of the 15.6ha of residential area 65% will be impermeable (10.1ha approximately).

9.2.7 In addition, it is estimated that the proposed impervious residential area (10.1ha) will comprise 50% of roofs and 50% of parking/driveway areas.

9.2.8 It is assumed that of the 5.1ha of the roof area, 65% be drained to domestic tanked cellular storages (3.3ha) and the remainder to surface water sewers (1.8ha). It is also assumed that of the 5.1ha of parking/driveway area 60% be drained to tanked pavements (3.1ha) and the remaining 40% to surface water sewers (2ha).

Local Centre Area

9.2.9 It is estimated that of the 2.4ha of local centre area, 85% will be impermeable (2ha).

9.2.10 In addition, it is assumed that of the 2ha of proposed impervious area, 25% be drained to tanked pavements (0.5ha) and the remainder to surface water sewers (1.5ha)

Commercial Area

9.2.11 It is estimated that of the 2.1ha of the commercial area, 90% will be impermeable (1.9ha approximately)

9.2.12 In addition, it is assumed that of the 1.9ha of impervious area, 30% will be drained to tanked pavement (0.6ha) and the remainder to surface water sewers (1.30ha)

Primary Schools Area

9.2.13 It is estimated that of the 3.3ha of primary schools, 85% will be impermeable (2.8ha)

9.2.14 It is assumed that of the 2.8ha of impervious area, 20% will be drained to tanked porous pavements (0.6ha) and the remainder will be drained to surface water sewers (2.3ha)

Road Area

9.2.15 It has been assumed that 100% of the road area is impervious (2ha approximately) and will drain to surface water sewers.

9.2.16 Run-off drained to tanked pavements and to tanked cellular storages is then discharged to the surface water sewer network via a control orifice.

9.2.17 In order to contain excess surface water on-site up to and including the 100 year event, it is proposed that off-line balancing ponds be utilised.

9.2.18 WSP have estimated the Greenfield run-off rates for the 2, 30 and 100 year events using the loH 124 Report, Flood Estimation for Small Catchments. Calculations identified Greenfield run-off rates of 80 l/s, 205 l/s and 290 l/s for the 2, 30 and 100 year events respectively. Refer to Appendix H for Calculations.

9.2.19 In order to estimate the size of the balancing pond, WSP undertook the simulation of the worst case scenario, which is for the 100 year event.

9.2.20 The WinDes software package was utilised to assess the impact of the proposed drainage regime for the 100 year event and all storm durations. Storm durations ranging from 15 minutes to 1,440 minutes were simulated.

9.2.21 Following completion of the modelling exercise, it was observed that the provision of a 10,000m^3 pond would be necessary on-site to contain all excess surface water run-off generated by the impermeable catchment area (18.8ha) up to and including the 100 year event. Refer to Appendix I for MicroDrainage calculations, the proposed surface water drainage strategy and details of a tanked permeable paving and tanked cellular storage.

9.2.22 While network No. 1 was designed in accordance with Sewers for Adoption (30 year return period), it was observed that the surface water sewers accommodate flows for events up to and including the 100 year events adequately contained.

SURFACE WATER SEWER NETWORK NO. 2

9.2.23 A surface water sewer network will serve the proposed secondary school (3.8ha) and will outfall to the Whitelands Farm Brook. It is assumed that of the 3.8ha of secondary school area, 100% will be impermeable.

9.2.24 It is proposed that the impervious area generated by the secondary school will drain at existing Greenfield run-off rates for the 2, 30, 100 year events to the Whitelands Farm Brook via a positive sewer network. It is also proposed to design the surface water system for the 30 year event in accordance with Sewer for Adoption; however it has been shown that the system can accommodate flows adequately for events up to and including the 100 year. It is therefore proposed to use tanked pavements and tanked cellular storages. Refer to Appendix I for the proposed surface water drainage strategy and details of a tanked permeable paving and tanked cellular storage.

SURFACE WATER SEWER NETWORK NO. 3

9.2.25 A surface water sewer network will serve the proposed perimeter road.

9.2.26 It is assumed that of the 3.8ha of perimeter road, 100% will be impermeable.

9.2.27 It is proposed that 3.8ha drain to a positive surface water sewer and discharge to Whitelands Farm Brook.

9.2.28 It is envisaged that surface water drainage networks serving the perimeter road will be offered up for adoption under **s**38 of the Highway Act 1980.

9.2.29 It is therefore proposed that the surface water network be designed to accommodate flows up to and including the 5 year event. It is also proposed to limit discharge from the network to the Whitelands Farm Brook at the existing Greenfield run-off rates for the 2, 30 and 100 year event.

9.3 NORTHERN CATCHMENT

9.3.1 Three surface water sewer networks will serve the northern Catchment of the proposed development site (38ha) of which approximately 87.9% will be developed (33.4ha). The three networks will discharge to the Pingle Brook.

9.3.2 It is anticipated that of the 33.4ha area, 30.9ha will be residential, 0.8ha commercial and/or a hospital and 1.68ha roads.

9.3.3 It is proposed that the northern catchment be served by 3 positive surface water sewer networks. The sewer network No.4 will serve 29.1ha of residential area, the employment area (0.8ha) and roads located south of the Pingle Brook. Sewer network No. 5 will serve a residential area of 1.2ha approximately and associated roads located north of Pingle Brook west of the surface water highway ditch. Sewer Network No.6 will serve a residential area of 0.6ha and associated roads located in the North East Corner of the site, north of the Pingle Brook.

SURFACE WATER SEWER NETWORK NO.4

9.3.4 Surface Water Sewer Network No.4 will serve an area of 31.5ha as detailed above.

9.3.5 It is anticipated that of the 31.5ha, 67.4% will be impermeable (approximately 21.2ha) as detailed below.

Residential Area

9.3.6 It is estimated that of the 29.1ha of residential area, 65% will be impermeable (18.9ha approximately)

9.3.7 It is estimated that the 18.9ha of impervious area 50% will comprise of roofs and 50% of parking/driveway areas.

9.3.8 It is assumed that of the 9.5ha of roof areas, 65% drain to tanked cellular storages (6.2ha) and the remainder to surface water sewers (3.3ha). It is also proposed that of the 9.5ha of parking / driveway areas, 60% drain to tanked pavements (5.7ha) and the remainder (3.8ha) drain to surface water sewers.

Commercial/ Hospital Area

9.3.9 It is estimated that of the approximate 0.8ha of commercial/ Hospital area approximately 90% will be impermeable (0.7ha approximately).

9.3.10 It is assumed that of the 0.7ha, 30% will drain to tanked porous pavements (0.2ha) and the remainder will drain to the surface water sewer network (0.5ha).

Road Area

9.3.11 It is estimated that 100% of the road area (1.6ha) is impervious and will drain to the surface water sewer network.

9.3.12 Run-off drained to tanked pavements and tanked cellular storages is then discharged to the sewer network via a central orifice.

9.3.13 In order to contain excess surface water run-off on site, it is proposed to use an off-line balancing pond.

9.3.14 WSP have estimated the greenfield run-off rates for the 2, 30 and 100 year events using the IoH 124 report Flood Estimation for small catchments. Calculations identified Greenfield run-off rates of 90 l/s, 232 l/s, and 327 l/s for the 2, 30 and 100 year events respectively. Refer to Appendix H for Calculations.

9.3.15 In order to estimate the size of the balancing pond, WSP undertook the simulation of the worst case scenario which is for the 100 year event.

9.3.16 The WinDes software package was utilised to assess the impact on the proposed drainage for all storm durations. Storm durations ranging from 15 minutes to 1,440 minutes were simulated. Refer to Appendix I for MicroDrainage calculations, the proposed surface water drainage strategy and details of a tanked permeable paving and a cellular storage.

9.3.17 Following completion of the modelling exercise, it was observed that a provision of a 10,000m^3 pond would be necessary on-site to contain all excess surface water run-off generated by the 21.2ha impervious area up to and including the 100 year event.

SURFACE WATER SEWER NETWORKS NOS. 5 AND 6

9.3.18 Two separate positive surface water sewer networks will be serving two residential areas (approximately 1.2ha and 0.6ha located north of the Pingle Brook) and will discharge to the Pingle Brook.

9.3.19 Discharges from the surface water sewer networks to be limited to greenfield run-off rates.

9.3.20 It is also proposed to design the surface water sewer system for the 30 year event in accordance with Sewer for Adoption; however it has been shown that the system can accommodate flows adequately for events up to and including the 100 year.

9.3.21 In order to limit the discharge from the site to the Pingle Brook, it is also proposed to use tanked pavements and tanked cellular storages, which will contain flood waters on-site before discharging back to the sewer network.

9.3.22 It was observed that the surface water sewers adequately accommodate flows for events up to and including the 100 year event. Refer to Appendix I for the proposed surface water drainage strategy and details of a tanked permeable paving and a cellular storage.

9.4 OTHER RESULTS

Tanked porous Paving and Tanked Cellular Storages Systems

9.4.1 An assessment of the various systems (tanked porous pavement and tanked cellular storage systems) was made for return period up to the 100 year event with various storm durations ranging from 15 minutes to 1440 minutes. It was observed that no flooding of either system occurred for the events simulated. Refer to details of tanked porous paving and cellular storage in Appendix I.

9.5 CONCLUSIONS AND RECOMMENDATIONS FOR THE STRATEGY

9.5.1 It is envisaged that surface water drainage networks serving the proposed development site be adopted under **s**104 of the Water Industry Act 1991 where this is possible. SUDS that Thames Water is unable to adopt will be offered for adoption to the local authority.

9.5.2 This does exclude surface water sewers serving the proposed perimeter road located to the west of the proposed development site. It is envisaged that any surface water sewers serving the proposed perimeter road infrastructure be adopted under **s**38 of the Highway Act 1980.

9.5.3 It is proposed that assessment for climate change (100 year +20% event) be made for each sewer network. (Refer to Section 20 Climate Change)

9.5.4 It is also proposed that further infiltration and contamination tests be undertaken wherever it is envisaged to use Infiltration drainage systems (i.e. throughout the site).

9.5.5 The proposed works restrict surface water run-off from the site to existing Greenfield run off rates replicating the existing conditions.

10 Existing Alleviation Measures

10.1 FLOOD MITIGATION WORKS

10.1.1 The EA has advised that the Flood Map indicates that the site lies partly within the 1 in 100 year flood plain of the Pingle Brook.

10.1.2 However, there are no alleviation measures within the vicinity of the site. Refer to EA's Flood Map in Appendix B.

11 Source of Flooding

11.1 FLUVIAL FLOODING REGIME

11.1.1 The Gagle Brook, which runs north west to south east close to the western boundary of the proposed development site at a distance of approximately 400m, is unlikely to be a potential source of flooding which could affect the site.

11.1.2 The Whitelands Farm Brook, which runs west to east in the centre of the site from Whitelands Farm down a shallow ditch before crossing Oxford Road, is unlikely to be a potential source of flooding which could affect the site.

11.1.3 The current Environment Agency's Flood Map indicates that less than 2% of the site area (1.35ha) lies within the flood plain of the Pingle Brook (Flood Zone 3) where the indicative annual probability of fluvial flooding is of 1 in 100 years or less (i.e. has a greater chance of flooding in any given year).

11.1.4 The Pingle Brook's tendency to back up is predominantly due to blockage of the culvert passing beneath the Oxford Road, caused by a build up of natural materials and vegetation.

11.1.5 The EA confirmed that they have coarse modelling in this area that shows sections in the north east corner of the site to lie within Flood Zone 3. However, the Pingle Brook itself does not have a hydraulic model.

11.1.6 WSP assessed Top Water Levels within Pingle Brook for the 100 year and 100 year + 20% events. Following hydraulic modelling of the Pingle Brook, it was observed that Top Water Levels within the Pingle Brook for the 100 year and 100 year + 20% events are out of bank. However, the flood extent does not encroach on the proposed development area.

11.1.7 The EA verbally confirmed they would probably not be averse to clearing out the culvert beneath Oxford Road to improve flows in the Pingle Brook.

11.1.8 The possible realignment of Pingle Brook has been put forward to the EA (see Section 3.0). The proposal to realign the Brook was deemed acceptable by the EA, providing that the other adjoining watercourses remain connected and the bed's length is maintained.

11.1.9 In addition, it is proposed to raise Finished Floor Levels 300mm above the Top water Level for the 100 year + 20% event in the vicinity of the Pingle Brook flood plain.

11.1.10 Therefore, it is unlikely that the Pingle Brook will be a possible source of flooding.

11.1.11 The EA's groundwater map shows groundwater is unlikely to be a source of flooding. Groundwater Investigations tests, show that the occurrence of water is intermittent across the site.

11.2 OVERLAND FLOWS FROM ADJACENT AREAS

11.2.1 Flooding of the site as a result of overland flow is unlikely to be a possible source of flooding. The main risk of overland flow is to the north from the Highfields Estate. However overland flow will be intercepted by Middleton Stoney Road and conveyed in an easterly direction.

11.3 EXISTING DRAINAGE NETWORK CAPACITY

11.3.1 Thames Water Utilities (TWU) record plans show a number of surface water sewers within the vicinity of the site. TWU records indicate storm water sewers in the western end of the Highfields Estate.

11.3.2 Thames Water has no record of historic flooding in the vicinity of the site.

11.3.3 Oxfordshire County Council has verbally confirmed that they have no records of historic flooding of highways sewers within the vicinity of the site.

11.4 PROPOSED DRAINAGE NETWORK CAPACITY

11.4.1 It has also been demonstrated that the site is not at risk of flooding as a result of the capacity of surface water sewers being exceeded for events up to and including the 100 year.

12 Flood Plain

12.1 FLOOD PLAIN EXTENT

12.1.1 The extent of predicted 1% annual probability of the Pingle Brook's flood plain is shown on the EA's Flood Map (FM). Refer to Appendix B, EA's Flood Map.

12.1.2 The EA's FM shows the site at South West Bicester to be within the Pingle Brook 1% annual probability flood plain extent. It should be noted that FM are indicative only, to be used as a basis for assessing planning policy. (Refer to Appendix A, PPG25, paragraph 24).

12.1.3 The Pingle Brook has a tendency to back up which is predominantly due to a significant blockage of the culvert passing beneath Oxford Road.

12.1.4 The EA confirmed that although they have coarse modelling in this area, the Pingle Brook itself is not currently hydraulically modelled.

12.1.5 Therefore, WSP assessed top water levels within the Pingle Brook for the 100 year and 100 year +20% event to assess for climate change.

12.1.6 Following hydraulic modelling it has been shown that current top water levels are out of bank up to and including the 100 year and 100 year +20% event for fluvial events on the Pingle Brook and that the site does lie within the flood plain of the Pingle Brook, but that this extent does not encroach on the proposed development areas.

12.1.7 It is proposed to raise finished floor levels within the vicinity of the Pingle Brook flood plain 300 mm above the 100 year +20% event top water level within the Pingle Brook.

12.1.8 It is also proposed that built development be restricted to the area outside the 1 in 100 year event flood plain.

12.1.9 Safe, dry access will be provided within the Development.

13 Hydraulic Structures

13.1 HYDRAULIC STRUCTURES CONTROLLING THE FLOW OF THE PINGLE BROOK

13.1.1 There are a number of hydraulic structures which control the flow of the Pingle Brooks.

13.1.2 A 'dry' balancing pond, with surface area of approx 6,500 square meters, has been constructed on the line of the Brook near Shakespeare Drive. This balancing pond has a crescent outfall weir associated with the attenuation system; this is approximately 1.5m high.

13.1.3 The balancing pond discharges into the trapezoidal channel section that passes down through the estate before crossing Middleton Stoney Road.

13.1.4 Pingle Brook passes through the north eastern corner of the site for approximately 700m (through a culvert) from the junction with the A41.

13.1.5 Pingle Brook discharges from the NE corner of the site via a rectangular concrete culvert, which passes under Oxford Road at a location approximately 120m south of the Middleton Stoney Road junction.

13.2 HYDRAULIC STRUCTURES CONTROLLING THE FLOW OF THE WHITELANDS FARM BROOK.

13.2.1 The Whitelands Farm Brook crosses Oxford Road via a pipe culvert under the road. Refer to Appendix D, Figure 6.

14 Flood Probabilities

14.1 FLOOD RISK

14.1.1 It has been demonstrated that the proposed development will not be at risk of flooding during the 100 year and 100 year +20% event on the Pingle Brook.

14.1.2 Flooding of the site will not occur as a result of the capacity of the surface water sewers being exceeded up to and including the 100 year event.

14.1.3 Flooding of the site will occur as a result of the capacity of the surface water sewers being exceeded during the 100 year + 20% event. However these flood volumes will be accommodated on site. (Refer to Section 20 of this report).

15 Cross Section and Finished Floor Levels

15.1 PROPOSED SITE LEVELS

15.1.1 All details of the finished floor slab levels are not available at outline stage for such as development. However, it is proposed that finished floor levels be set at a minimum level of 300mm above the 100 year +20% top water levels within the Pingle Brook in the vicinity of the Pingle Brook flood plain. It is also proposed to raise finished slab levels by a minimum of 150mm above existing ground levels on site. The topographical survey demonstrates that no overland flood routes exist between the existing flood plain and the lowest point of the site (south east corner of the site).

16 Flood Progress

16.1 FLOOD REGIME

16.1.1 It has been demonstrated that the proposed development is not at risk from flooding during the 100 year and the 100 year +20% event on the Pingle Brook.

16.1.2 For rainfall events up to and including the 100 year, the capacity of sewers will not be exceeded and surface water run-off will be contained on-site through the use of three balancing ponds.

16.1.3 For events above the 100 year event, which will result in the capacity of sewers being exceeded, it is anticipated that flood volumes will be contained on site up to 100 year + 20% event (Climate Change).

17 Sewer Hydraulics

17.1 SURFACE WATER SEWER SYSTEMS

17.1.1 The Thames Water Utilities records indicate no formal storm water drainage sewers serve the eastern end of Highfields Estate.

17.1.2 Thames Water Utilities (TWU) Record plans show a number of surface water sewers within the vicinity of the site.

17.1.3 In addition, the Thames Water Utilities records do not indicate any formal, piped surface water sewers serving Middleton Stoney Road.

17.2 FOUL SURFACE WATER SYSTEMS

17.2.1 Thames Water Utilities Records show foul water sewers within the vicinity of the site, along Middleton Stoney Road, the east bank of Oxford Road (Northern area) before the roundabout with Pingle Drive. Refer to Appendix F for TWU Records.

18 Flood Volume Displaced

18.1 IMPACT ON FLOOD PLAIN

18.1.1 No development is proposed within the Pingle Brook modelled flood extent.

18.1.2 Therefore, there is no flood volume displaced as a result of the proposed development.

19 Impact of Displaced Water

19.1 OFF-SITE FLOODING

19.1.1 The proposed development will not displace water and therefore there is no impact up or downstream of the site.

20 Impacts on Fluvial and Coastal Morphology

20.1 CHANNEL WORKS

20.1.1 The proposed works to the Pingle Brook will be carried out in a manner to minimise any affects on local fluvial morphology. A SUDS management train approach will be used to maintain Greenfield flow rates and provide barriers to the discharge of any contaminants entering the drainage system.

21 Climate Change Impacts

21.1 FLUVIAL AND DRAINAGE NETWORKS

21.1.1 PPG25, Appendix A, paragraph A8 states, *"initial research has suggested that for the Thames and Severn catchments, increases in peak flow of up to 20% for a given return period could be experienced within 50 years".*

21.1.2 The EA's FM shows the site at South West Bicester to be partly within the Pingle Brook 1% annual probability of flooding plain extent.

21.1.3 To assess the impact of climate change, WSP undertook a hydraulic modelling exercise which estimated top water levels within the Pingle Brook for the 100 year and 100 year +20% events. The model for the Pingle Brook showed that the 100 and 100 year +20% events were out of bank, but the extent does not encroach on proposed development areas.

21.1.4 The surface water drainage design will allow for the predicted climate change extra 20% flows.

22 Flood Defence Residual Assessment

22.1 FLOOD RISK ASSESSMENT

22.1.1 There are no new modified flood defence proposals required for this development.

23 Conclusions and Recommendations

23.1 CONCLUSIONS AND RECOMMENDATIONS

23.1.1 The current EA's Flood Map indicates that a part of the site lies within the flood plain of the Pingle Brook (Flood Zone 3) where the annual probability of fluvial flooding is 1 in 100 years or less (i.e it has a 1% or greater chance of flooding in any given year). Refer to Appendix B, EA Flood Map.

23.1.2 The culvert on the Pingle Brook beneath Oxford Road is heavily silted up.

23.1.3 The EA confirmed that they have no hydraulic model of the Pingle Brook. Therefore, WSP undertook hydraulic modelling which assessed top water levels within Pingle Brook for the 100 year and 100 year + 20% events.

23.1.4 It was shown that while top water levels were out of bank, top water levels will not affect the proposed developed up to and including the 100 year and 100 year + 20% events.

23.1.5 It is proposed to carry out maintenance and realignment of the Pingle Brook and the desilting of the culvert under the A41. The EA duly advised that they would not object to the clearance of the culvert beneath Oxford Road.

23.1.6 The development proposals promote a sustainable surface water drainage scheme which utilises the management train approach to the use of SUDS. This will ensure that run-off discharge from the site to the Pingle and Whitelands Farm brooks is limited to the existing Greenfield run-off rate for a given storm event up to and including the 100 year event. As a result, this will ensure that the proposed surface water drainage strategy replicates the existing run-off regime as required by the EA. Hence, there will be no increase in the flood levels up or downstream of the site as a result of the development.

23.1.7 An assessment of the worst-case scenario on-site surface water sewer networks was undertaken, which addressed the 100 year + 20% flood events.

23.1.8 Safe dry access routes are available to and from the development and also to the local and wider highway networks.

23.1.9 It is proposed that finished floor levels be set within the vicinity of the Pingle Brook flood plain 300 mm above the 100 year + 20% Pingle Brook top water level. In addition, it is proposed to raise all slabs levels 150 mm above existing ground levels. No overland flood routes have been identified between the Pingle Brook flood plain and the lowest point of the site (south east of the development site).

23.1.10 In summary the proposed development site is unlikely to be at risk of fluvial flooding from the Pingle Brook or be affected by the currently predicted effects of climate change. Finished floor levels within the vicinity of the flood plain should be set at 300 mm above the calculated 100 year + 20% event. The proposed road networks will provide safe, dry access in times of severe floods. The development proposals are robust and compliant with PPG25 in terms of flood risk and surface water drainage strategy.

.

Appendices, Figures & Tables

Appendix A PPG25 Appendix F Requirements of a Flood Risk Assessment Guidance Note

Appendix B Environment Agency Correspondence and Flood Map Figure 3

Appendix C General and Detailed Location Plans, Figure 1 and 2

Appendix D Existing On-Site Hydrological Conditions -Figure 6
Proposed Site Layout - Drawing No. 1806.01/04 G

Appendix E Topographical Survey - Drawing No. 1546/FRA/XS/001, Report on Field Visit to South West Bicester, Existing On-Site Water Flows Directions – Drawing No. 1546/FRA/D/001

Appendix F Thames Water Records

Appendix H British Geological Survey Map Average Annual Rainfall Map (SAAR) 1941-1970
Winter Rain Acceptance Potential (SOIL) Map
Existing Greenfield Run-off Rates Calculations
Pell Frischmann "Ground Investigation Factual and Interpretative Report" in part

Appendix I Pipe Network - MicroDrainage Calculations,
Proposed Designed Surface Water Drainage Strategy - Drawing No. 1546/FRA/D/002,
Tanked Cellular Storage Details - Figure 4,
Tanked Pavements Details - Figure 5,
Ratio of M5-60 Minute to M5-2 Day Rainfall Map,
Rainfall Depths (M5-60 Minute) Map

[Click here and type Appendix text.]