Bicester Office Park

Flood Risk Assessment

040031

17 April 2018

Revision 04

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02	For Planning	CJ	26/09/2017	DKR
03	For Planning, updated for 2017 topographic survey	CJ	14/12/2017	ADT
04	For Planning, updated for 2018 topographic survey	CJ	17/04/2018	MVS

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Abbreviations

Term	Definition
AEP	Annual Exceedance Probability
EA	Environment Agency
FRA	Flood Risk Assessment
LLFA	Lead Local Flood Authority
mOD	Metres above Ordnance Datum
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage System

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Glossary

Term	Definition
Annual Exceedance Probability (AEP)	The Probability that a storm event will be exceeded in any given year
Attenuation	A method to reduce a flood peak to prevent flooding, often utilising temporary storage, but increasing the duration of the flow
Design Flood Level	This is the level of flooding that flood defences or mitigation measures are designed against. This is typically the 1% (1 in 100) flood level with climate change allowance.
Discharge	The rate of flow of water measured in terms of volume per unit time
Flood Defence	A natural or man-made infrastructure used to prevent certain areas from inundation from flooding, and / or the provision of flood warning systems
Floodplain	Area of land adjacent to a water course which water flows or is stored during a flood event, or would otherwise be flooded in the absence of flood defences
Flood Risk	The level of risk to personal safety and damage to property resulting from flooding due to the frequency or likelihood of flood events
Flood Risk Assessment (FRA)	An assessment of the flood risks to the proposed development over its expected lifetime and the possible flood risks to the surrounding areas, assessing flood flows, flood storage capacity and runoff
Flood Warning Systems (FWS)	A system by which to warm the public of the potential of imminent flooding. This is typically linked to a flood forecasting system
Fluvial Flooding	Related or connected to a watercourse (river or stream)
Functional Floodplain	Greater than a 1 in 20 annual probability of flooding in any year
Groundwater	Water present within underground strata known as aquifers
Groundwater Flooding	Water occurring below ground in natural formations (typically rocks, gravels and sands)
Impermeable Surface	A surface that does not permit the infiltration of water and, therefore, generates surface water runoff during periods of rainfall
Mitigation	Actions taken to reduce either the probability of flooding or the consequences of flooding or a combination of the two
Red line boundary	Boundary drawn to indicate the site area on which the planning application is based
Residual Risk	The risk that remains after risk management and mitigation measures have been implemented
Return Period	The average frequency of a specified condition. An ‘n’ year event is one that occurs on average over the long term, once every ‘n’ years
Risk	Risk is the probability that an event will occur and the impact (or consequences) associated with that event
Runoff	Water flow over surfaces to the drainage system. Runoff occurs if the ground is impermeable or if permeable ground is saturated.
Strategic Flood Risk Assessment (SFRA)	An SFRA is the assessment and ‘categorisation’ of flood risk on an area-wide basis in accordance with PPS25
Surface Water Flooding	Surface water flooding occurs when the volume of water is unable to filtrate through the ground to enter drainage systems, and therefore runs quickly off land and results in localised flooding. This type of flooding is usually associated with intense rainfall.
Sustainable Drainage Systems (SuDS)	SuDS are used as a strategy to manage surface water in a sustainable manner or least damaging solution through management practices and physical structures.

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1 Executive Summary

BuroHappold Engineering (BHE) has prepared this FRA on behalf of Scenic Land Developments Limited to support the Outline Planning Application for new office buildings and car parking at the Bicester Office Park site. This FRA has been undertaken in accordance with the National Planning Policy Framework (NPPF) and demonstrates that with the proposed mitigation measures, the development is considered safe up to the 1 in 100 flood event with allowance for climate change and does not increase flood risk elsewhere for the lifetime of the development. A summary of the key findings of the Flood Risk Assessment are provided in **Table 1-1.**

Table 1-1 Summary of the key findings

Subject	Element	Findings
Site Flood Risk	Fluvial	The majority of the site lies in Flood Zone 1. However, along the south eastern boundary, the site lies within 2, 3a and 3b.
	Ground Water	Low risk of flooding. Further ground investigation recommended.
	Surface Water	The majority of the site is at very low risk of surface water flooding. There are areas of low to high risk of flooding along the northern and eastern boundary, south east corner and adjacent to the drainage ditch which has now been infilled.
	Sewers and Artificial Sources	Low risk of flooding
Planning Requirements	Vulnerability Classification	Office buildings are classified as 'less vulnerable', appropriate for Flood Zone 1, 2 and 3a. Car parking located in Flood Zone 3b is considered appropriate provided no ground raising.
	Sequential Test and Exception Test	As the site is allocated within the Adopted LDP, the Sequential Test is considered to have passed. An Exception Test is not required for the site.
	Sequential Approach	The Sequential Approach has been applied within the site boundary by locating buildings outside the 1 in 100 + 35% climate change flood extent. During detailed design, apply Sequential Approach to locate office parking to areas of lower risk of flooding.
Mitigation measures	Design Flood Event	1 in 100 year +25% climate event.
	Climate change	25% to 35% allowance to be considered for the site in accordance with the latest guidance.
	Finished Floor Levels	Finished Floor Levels are proposed to be set at a minimum of the 1 in 100 year + 35% climate change plus 300mm freeboard.
	Safe access and egress	Safe access and egress to be provided from all buildings via Lakeview Drive at or above the 1in 100 year +35% climate change level.
	Floodplain compensation	No ground level raising is permitted within the Functional Floodplain. Ground raising is permitted between the 1 in 20 year flood extent and the 1 in 100 year + 25% climate change flood extent if flood compensation provided on a level for level and volume for volume basis on site.
	Construction Phase	Contractor will need to sign up to EA's flood warning service and to locate stockpiles outside the 1 in 1000 year flood extent.
	Surface water drainage strategy	Primary infrastructure constructed on the site, sized for the Proposed Development. Discharge rates limited to greenfield rates. SuDS techniques to be implemented. Exceedance routes will need to be considered to route flood water away from the threshold of buildings.
	Residual Risk	A flood evacuation and management plan should be considered during detailed design to manage the residual risk of surface water and fluvial flooding on the site posed to both people and vehicles.

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2 Introduction

2.1 Background

This site specific Flood Risk Assessment (FRA) has been prepared by BuroHappold Engineering on behalf of Scenic Land Developments Limited as part of an Outline Planning Application for the Bicester Office Park development, hereafter referred to as the 'Proposed Development'. The application is in outline with all matters reserved except for access. This assessment has been carried out in accordance with the National Planning Policy Framework (NPPF).

Since the submission of the FRA for planning in December 2017, BuroHappold has undertaken hydraulic modelling to better inform the fluvial flood risk at the site. This has involved updating the EA's 2010 hydraulic model with 2017 and 2018 topographic survey for the site and adjacent floodplain. The details of the hydraulic modelling undertaken are provided in Appendix E. This FRA has been updated to reflect the revised flood extents and flood levels derived in the hydraulic modelling.

2.2 Site Description

The Proposed Development site is located to the south of Bicester in the Cherwell District of Oxfordshire, Ordnance Survey grid reference (NGR) SP 579 215. The site is bounded by the A41 Oxford Road to the west, the new Tesco foodstore to the north, to the east by open fields and to the south by Bicester Avenue shopping centre. A sewage treatment works is located to the south east of the site. The agricultural field drainage ditch that ran north/ south across the site towards the south eastern boundary has subsequently been backfilled with a perforated pipe (refer to section 4.1.1.1 for more details). The site area is approximately 13.1ha and is currently agricultural land.

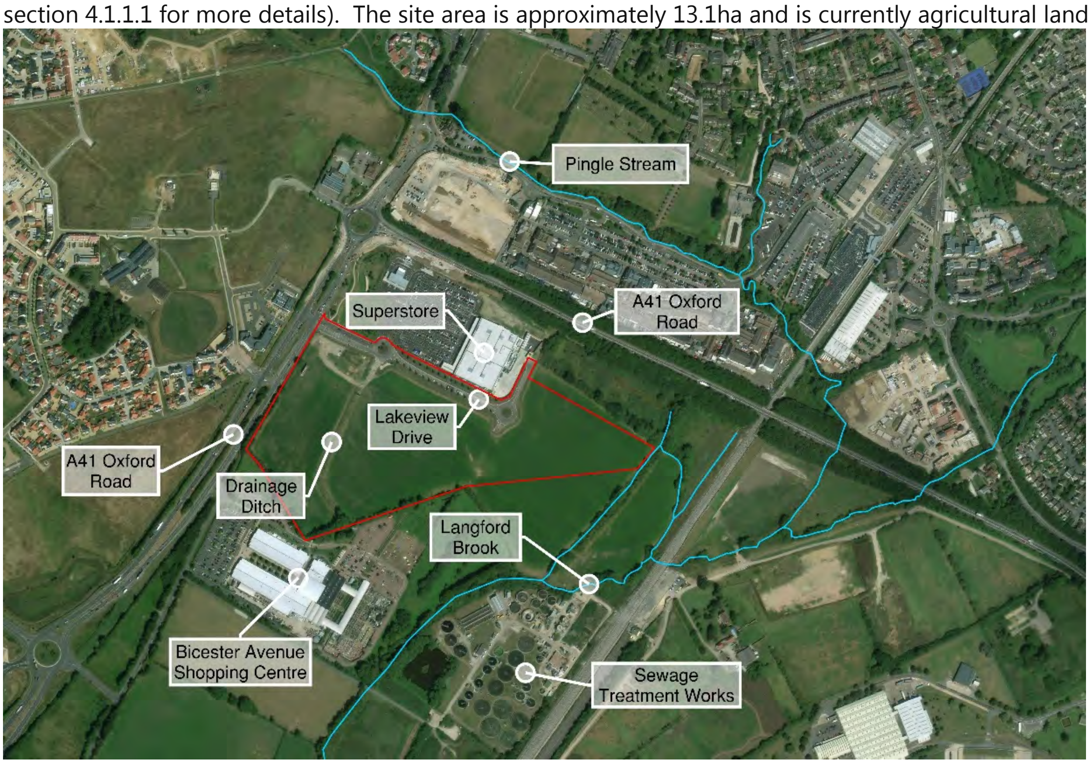

Figure 2-1 shows the location of the Proposed Development.

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The Langford Brook is located approximately 180m to the south east of the Proposed Development and flows in a south westerly direction to the north of the sewage treatment works before cutting beneath the railway line. A land drain connecting into the Langford Brook is adjacent to the north east corner of the site.

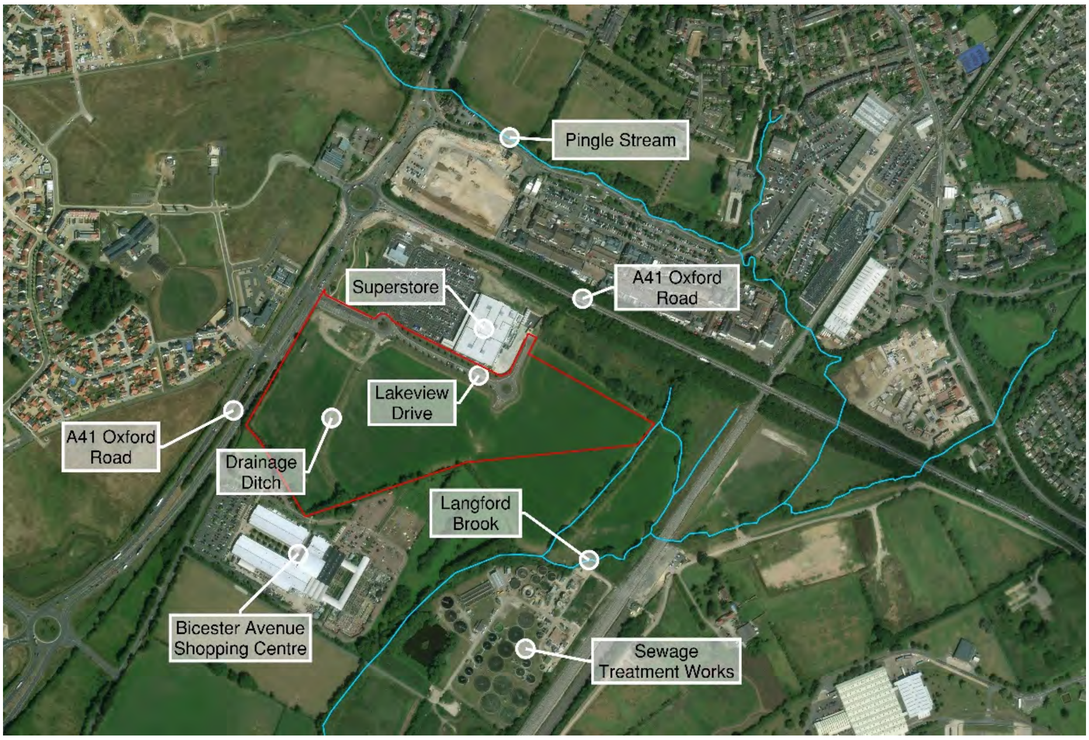

Figure 2-1: Site Location Plan with indicative red line boundary (Site Aerial received from Hyland Edgar Driver on 26/5/2017)

The site levels fall from Lakeview Drive in the north, and slopes down towards the south and south east boundary of the site towards the Langford Brook. Topographic survey data from 2017 and 2018 (Greenhatch Group) is available for the site and adjacent floodplain. These surveys indicate that land levels along Lakeview Road in the north of the site are typically between 66.5m AOD, increasing in the west to 67.7m AOD. Along the south of Lakeview Road, there is a 0.5m to 1.5m high bund and an area of material storage. Land slopes downwards from the road to the south boundary where land levels vary from 66.1m AOD to 64.8AOD and to south east where levels are typically between 64.4m AOD and 64.9m AOD. Refer to **Appendix A** for site survey information.

2.3 Proposed Development

The Proposed Development comprises between 55,000 and 60,000m^2 (gross external area) office use (B1(a) and B1(b)), parking for approximately 2,000 cars, associated highway, infrastructure and earthworks. The office park will be made up of differently sized buildings which will vary in height between two and four storeys and located with associated landscaping. **Figure 2-2** shows the Proposed Development parameters plan for the site and drawings are provided in Error! Reference source not found..

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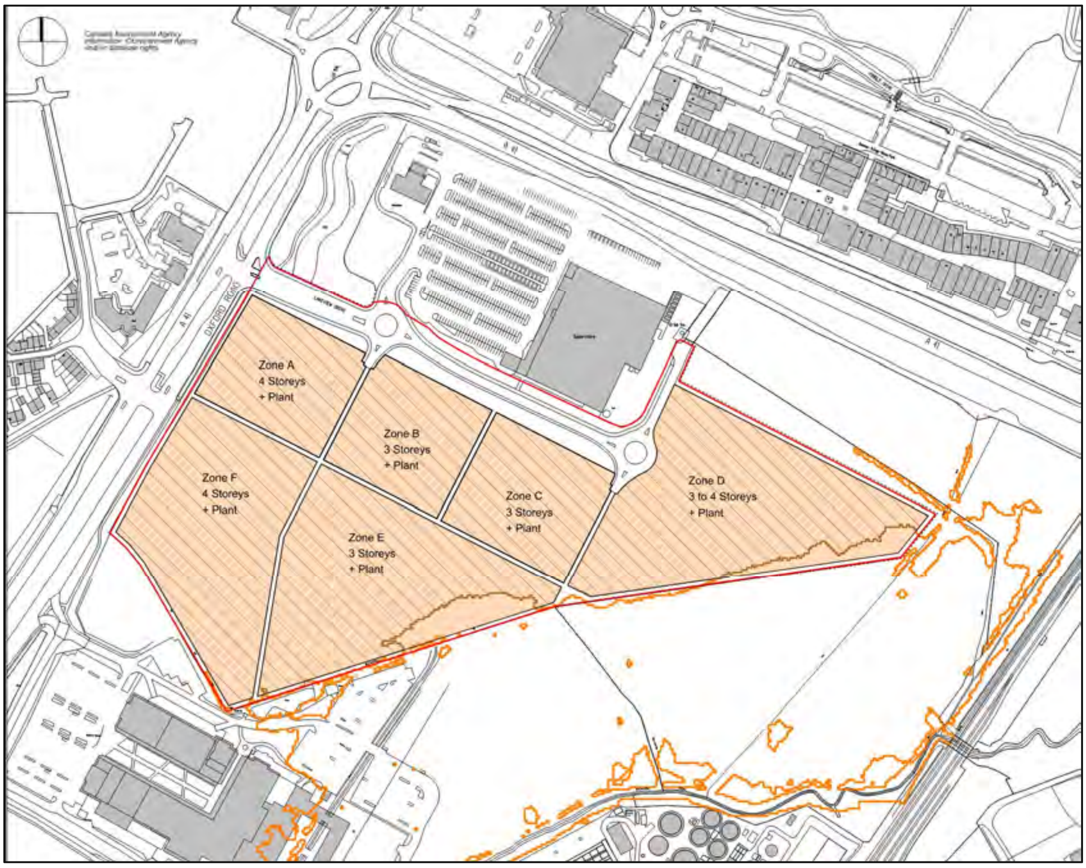

Figure 2-2: Proposed Development Parameters Plan (Drawing 1105_P_005 rev F, Bennetts Associates 13/4/18)

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3 Planning Context

3.1 Overview

This FRA has been prepared in accordance with policies and guidance applicable to the Proposed Development outlined within the following publications:

- National Planning Policy Framework (March 2012)
- National Planning Policy Framework Planning Practice Guidance (March 2014)
- Flood Risk Assessments: climate change allowances (February 2016, updated February 2017)
- Thames Area Climate Change Allowances. Guidance for their use in flood risk assessments (January 2017)
- Cherwell and West Oxfordshire Level 1 Strategic Flood Risk Assessment (April 2009)
- Cherwell District Council Level 2 SFRA (March 2012)
- Oxfordshire County Council Preliminary Flood Risk Assessment Preliminary Assessment Report (June 2011)
- The Cherwell Local Plan 2011-2031. Part 1 Adopted 20 July 2015 (July 2015)

3.2 National Planning Policy Framework

3.2.1 Flood Zone Assessment

The National Planning Policy Framework[1] (NPPF) aims to avoid inappropriate development in areas at highest risk of flooding. The Planning Practice Guidance to the NPPF[2] contains a series of tables that help identify the risk of flooding to a development.

- Table 1 defines four Flood Zones based on the annual probability of river or sea flooding;
- Table 2 identifies specific land use types for each of the five flood risk vulnerability classifications (Essential Infrastructure, Highly Vulnerable, Less Vulnerable and Water Compatible Uses). For example, office buildings are classified as *less vulnerable*; and
- Table 3 identifies where development is appropriate for each flood risk vulnerability classification and whether the Exception Test is required.

The Flood Zones defined in the NPPF are as follows:

Flood Zone 1 Low probability

< 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).

Flood Zone 2 Medium probability

Between 1 in 100 and 1 in 1,000 annual probability of river flooding in any year (1% - 0.1%), or

between 1 in 200 and 1 in 1,000 annual probability of sea flooding in any year (0.5% - 0.1%).

Flood Zone 3a High probability

[1] Department for Communities and Local Government (2012). *National Planning Policy Framework*.
[2] Department for Communities and Local Government (2014). *National Planning Policy Framework Planning Practice Guidance*. [online] Available at: *https://www.gov.uk/guidance/flood-risk-and-coastal-change*. [Accessed 22 March 2017].

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> 1 in 100 annual probability of river flooding in any year (>1%), or

> 1 in 200 annual probability of sea flooding in any year (>0.5%).

Flood Zone 3b Functional floodplain

> 1 in 20 annual probability of flooding in any year (5%).

The Proposed Development consists of office buildings which are classified as 'less vulnerable' in accordance with the NPPF Planning Practice Guidance and are considered appropriate for Flood Zone 1, 2 and 3a. The Environment Agency has confirmed that as the site is allocated in the Cherwell District Council Local Plan under Policy Bicester 4, car parking is considered acceptable within Flood Zone 3b. This is provided there is no ground raising within Flood Zone 3b.

3.2.2 Sequential and Exception Test

The NPPF states that *'inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere'*. The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. If this cannot be achieved, the Exception Test is required if indicated by the conditions specified in NPPF Table 3.

The Cherwell Local Development Plan (LDP) 2011-2031 Part 1 was adopted in July 2015 and re-adopted in December 2016. As the site is allocated under Policy Bicester 4 for Employment, the Sequential Test for the development is considered to be passed and justification is provided in Cherwell District Local Plan Sequential Test and Exception Test (Flooding) Document[3]. The Exception Test is not required for the Proposed Development as 'More Vulnerable' uses are not proposed on the site.

In accordance with NPPF and Policy Bicester 4 in the LDP, a Sequential Approach should be followed. The LDP policy requires '*where possible, buildings should be located away from areas at high risk of flooding but where it is necessary development should be made safe without measures increasing flood risk elsewhere*[4]'. For the Proposed Development, all the office buildings are to be located outside the 1 in 100 year + 35% climate change flood extent.

Policy Bicester 4 requires a site specific Flood Risk Assessment (FRA) to be undertaken for the Proposed Development. The Policy Bicester 4 also requires the following:

- Consideration of all sources of flooding for the site;
- 'Flood mitigation of flood risk in compliance with Policy ESD 6'[4];
- The Proposed Development should be 'safe and remain operational (where necessary)'[4];
- Consideration of the Strategic Flood Risk Assessment for the Proposed Development;
- Incorporation of Sustainable Drainage Systems (SUDs) for managing surface water on site which seek to 'reduce flood risk, reduce pollution and provide landscape and wildlife benefits'[4];
- Reduction of surface water run off to greenfield discharge rates for the Proposed Development;
- Development is not within 8m of the watercourse banks.

The following site specific FRA has been prepared to meet the Policy Bicester 4 requirements.

[3] Cherwell District Council. Sequential Test and Exception Test (Flooding) Strategic Sites (August 2012, updated October 2013).
[4] Cherwell District Council. The Cherwell Local Plan 2011- 2031. Part 1 Adopted 20 July 2015. Policy Bicester 4: Bicester Business Park. (July 2015)

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3.3 Consultation

3.3.1 Environment Agency

The EA has provided BuroHappold with the following information[5] which was used to inform the assessment of flood risk to the Proposed Development:

- Flood map for planning;
- Modelled floodplain flood levels;
- Historical Flood data information;
- Flood defence information;
- Hazard Flood map;
- Bicester Flood Risk Mapping Study, Final Modelling Report (December 2009);
- Model Output data;
- Langford Brook (Bicester) & Pingle-Back-Bure 2010 ISIS-TUFLOW Model.

In addition to this, the Environment Agency has provided pre-application advice in June and July 2017 on their requirements for the Flood Risk Assessment including the approach to defining the flood extents, finished floor levels, development in Functional Floodplain and approach to floodplain compensation. In summary, the EA confirmed the following:

- The 1 in 20 year flood extent is classified as Functional Floodplain (Flood Zone 3b);
- The approach taken by BHE to define the flood extents for the 1 in 20, 1 in 100 and 1 in 1000 year using the EA's flood levels against the topographic survey and LiDAR data is acceptable*;
- Hydraulic modelling is required to define the flood levels for the 1 in 100 year + 25% and + 35% climate change scenarios required by the new 2016 climate change guidance[6]. Once defined, the same approach as above, using the topographic survey information and where unavailable, LiDAR was acceptable to define the flood extents*;
- The Design Flood Event (DFE) for the Proposed Development is the 1 in 100 year + 25% climate change allowance;
- A Sequential Approach should be taken to locating development on site. The EA advised that buildings should be located outside the 1 in 100 year + 35% climate change extent;
- Car parking within Flood Zone 3b is acceptable provided there is no ground raising;
- Minimum finished floor levels should be set at or above the DFE flood level plus 300mm freeboard, i.e. the 1 in 100 year + 25% climate change plus freeboard. For additional protection the EA has requested that the finished floor levels are set at 1 in 100 year +35% level plus 300mm freeboard.
- Ground raising outside the Functional Floodplain is not advised but would be acceptable provided floodplain compensation is provided up to the 1 in 100 year + 25% flood extent. The requirements for floodplain compensation would need to be considered through detailed design and could be dealt with through a planning condition.

A full copy of the data received and information provided by the EA is included in **Appendix C**.

[5] Environment Agency Products 4, 5, 6 and 7

[6] Flood Risk Assessments: climate change allowances (February 2016, updated February 2017)

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* This approach has now been refined since hydraulic modelling has been undertaken with site specific topography. This is discussed further in section 4.1.1.1.

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4 Appraisal and Management of Flood Risk

4.1 Fluvial Flooding

Fluvial flooding occurs when sustained or intense rainfall events increase the flow in rivers causing water level to rise above the level of the banks and into surrounding areas.

4.1.1 Baseline

4.1.1.1 Flood Zone Assessment

The Flood Zone map produced by the EA shows that the majority of the site lies within Flood Zone 1 which is considered at low risk of flooding. However, land along the south east boundary lies within Flood Zone 2 and 3a, considered at a medium and high risk of flooding respectively, due to the Langford Brook approximately 180m from the site. There are also localised areas of Flood Zone 3b, classified as functional floodplain which has more than a 1 in 20 annual probability of flooding in any one year.

The flood extents are defined as the following:

Flood Zone 1 Low probability

< 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).

Flood Zone 2 Medium probability

Between 1 in 100 and 1 in 1,000 annual probability of river flooding in any year (1% - 0.1%), or

between 1 in 200 and 1 in 1,000 annual probability of sea flooding in any year (0.5% - 0.1%).

Flood Zone 3a High probability

> 1 in 100 annual probability of river flooding in any year (>1%), or

> 1 in 200 annual probability of sea flooding in any year (>0.5%).

Flood Zone 3b Functional floodplain

> 1 in 20 annual probability of flooding in any year (5%).

BuroHappold Engineering has overlaid the 1 in 20, 1 in 100 and 1 in 1000 year flood extents provided as part of the Product 6 information with the red line boundary as shown in **Figure 4-1.** This indicates that the site partially lies within the 1 in 20 year flood extent. The EA has confirmed that the 1 in 20 year extent is Functional Flood plain i.e. Flood Zone 3b. The EA has no records of historical flooding on the site.

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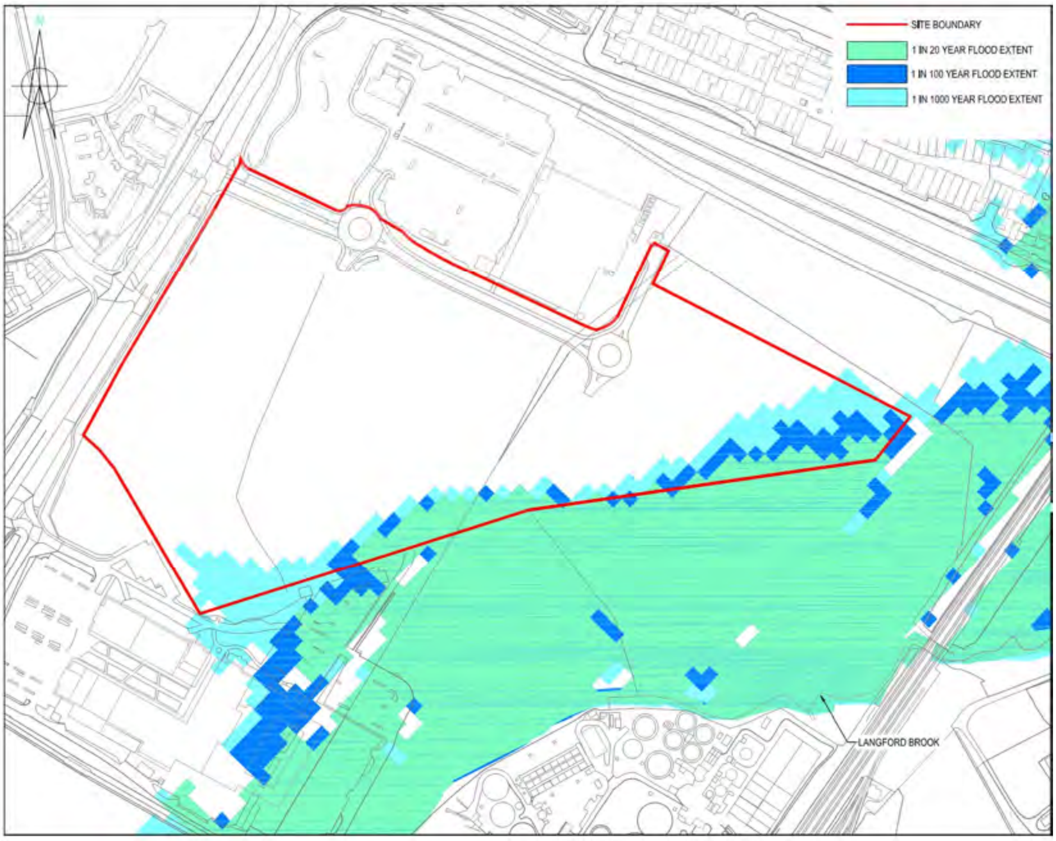

Figure 4-1 Flood Zone Extents overlaid with the red line boundary provided as part of the product 6 information from the Environment Agency on the 23rd June 2017. ***(Contains Environment Agency Information © Environment Agency and/or database right).***

The EA produced a hydraulic model in 2010 for the Langford Brook, Pingle Stream, Bure Book and Back Brook watercourses which has derived the flood extents in Figure 4-1. Since the submission of the FRA in December 2017, BHE has undertaken hydraulic modelling to better inform the fluvial flood risk at the site. BHE has updated the EA's 2010 hydraulic model to create a hydraulic model which has been named BuroHappold BOP 2018 model. The updates include:

- Topographic Survey undertaken by GreenHatch Group issued on 28/09/17 – used to represent 2D floodplain within site boundary;
- Topographic Survey undertaken by GreenHatch Group issued on 19/02/18 – used to represent 1D in-channel cross sections and 2D floodplain between the site and Langford Brook;
- Most recent available LiDAR (combined dataset from 2003 and 2011 from data.gov.uk);
- Modified 2D boundary;
- Increase in grid resolution to capture the drainage ditches (from 10m x 10m to 2m x 2m);
- Model simulated for the 1 in 20yr, 100yr, 100yr +25% CC, 100yr + 35% CC and 1000yr flood events.

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Drawings showing the topographic survey and LiDAR extents are provided in Appendix A. A copy of the hydraulic modelling report detailing the methodology and results is provided in Appendix E.

The revised flood extents are provided in **Figure 4-2** and provided in **Appendix D**. These have been used to inform the assessment of fluvial flood risk on the site and mitigation measures.

The drainage ditch that previously ran north/ south across the site towards the south eastern boundary functioned as an agricultural field drainage feature and was originally provided on the boundary of two different land ownerships. The adjoining land has been purchased by the applicant and the ownerships amalgamated into a single agricultural operation. The owners have filled this ditch for agricultural operations. Oxfordshire County Council confirmed that an Ordinary Watercourse Consent was not required. As it may have provided a limited field drainage function, a perforated drainage pipe has been installed as a precautionary measure to convey any flow to the pond. It is considered that the ditch does not provide a wider drainage function.

For the purposes of this Flood Risk Assessment, the drainage ditch has been assumed to have been filled in.

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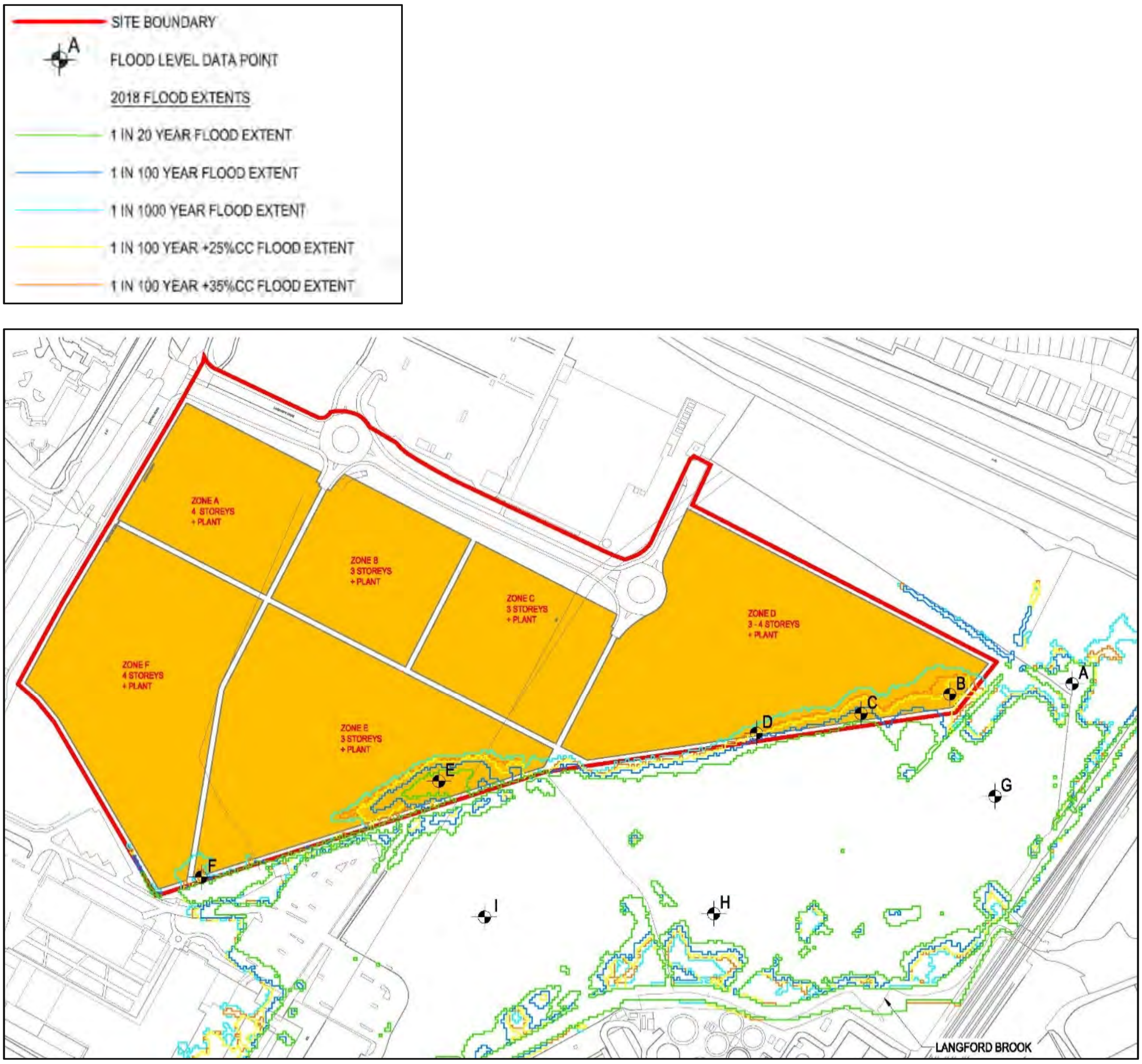

Figure 4-2– Revised Flood Zone Extents overlaid with the red line boundary *(Contains Environment Agency Information © Environment Agency and/or database right). For full copyright details, refer to the drawing in Appendix D.*

4.1.1.2 Flood Levels

BHE has extracted the flood level results for points along the extent of the south eastern boundary of the site from the BuroHappold BOP 2018 model results. These are provided for Points A to H in **Table 4-1**.

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Table 4-1: Flood Levels extracted from the ISIS-TUFLOW within the floodplain *(Contains Environment Agency Information © Environment Agency and/or database right).*

Point	X Co-ordinate	Y Co-ordinate	Fluvial Flood Levels (mAOD)		
			1 in 20 year	1 in 100 year	1 in 1000 year
A	458310.6	221537.4	64.91	64.94	64.99
B	458224.2	221529.9	N/A*	N/A*	64.89
C	458161.6	221516.1	N/A*	64.77	64.87
D	458087.7	221502.4	N/A*	N/A*	64.85
E	457863.6	221468.6	64.51	64.58	64.70
F	457695.8	221400.9	N/A*	N/A*	64.67
G	458256.2	221457.9	64.90	64.93	64.99
H	458057.7	221375.2	64.64	64.72	64.82
I	457895.8	221372.8	64.46	64.56	64.69

*Flood water does not reach the point within the hydraulic model

4.1.1.3 Climate Change Allowance

Allowances for the predicted effects of climate change should be taken into account when preparing site-specific flood risk assessments. The guidance[7] published by the EA in February 2016 to support the NPPF contains sensitivity ranges that are recommended to be applied to peak rainfall intensities, peak river flows, sea level rise, offshore wind speeds and extreme wave heights. The recommended allowances for increases in peak river flow rate in the Thames river basin district are given in **Table 4-2**.

Table 4-2: Climate change allowances for peak river flow in the Thames river basin district (Contains Environment Agency information © Environment Agency and database right)

Allowance category	Total potential change anticipated for 2015 to 2039	Total potential change anticipated for 2040 to 2069	Total potential change anticipated for 2070 to 2115
Upper end	25%	35%	70%
Higher central	15%	25%	35%
Central	10%	15%	25%

The EA guidance for the use of peak river flow allowances notes that the allowance category to be used depends on the land use vulnerability and the Flood Zone in which the site is located. Since the Proposed Development includes *less vulnerable* land uses, both the central and higher central allowances should be used. Considering a 60 year design life for the Proposed Development, the central peak river flow climate change allowance is 25% and the upper end allowance is 35%.

As the Proposed Development is classified as 'Large-Major' development, a vulnerability classification of *'Less vulnerable'* and partially in Flood Zone 3, the EA has requested that hydraulic modelling is undertaken to determine the flood levels for 25% and 35% as these have not been modelled by the Environment Agency. This is in accordance with the Thames Area Climate Change guidance.

[7] Environment Agency, (2016). *Flood risk assessments: climate change allowances*. [online] Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [Accessed 27th July 2017].

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BHE has undertaken hydraulic modelling using the BuroHappold BOP 2018 model to establish the flood extents and flood levels for 1 in 100 event with 25% and 35% allowances for climate change. A summary of the flood level results are provided in **Table 4-3** and flood extents in **Figure 4-2**. For further information, refer to the hydraulic modelling report provided in **Appendix E**.

Table 4-3: Flood Levels extracted from the ISIS-TUFLOW within the floodplain (Contains Environment Agency information © Environment Agency and database right)

Point	X Co-ordinate	Y Co-ordinate	Fluvial Flood Levels (mAOD)	
			1 in 100 year + 25% climate change	1 in 100 year + 35% climate change
A	458310.6	221537.4	64.95	64.96
B	458224.2	221529.9	64.82	64.84
C	458161.6	221516.1	64.81	64.83
D	458087.7	221502.4	N/A*	64.80
E	457863.6	221468.6	64.63	64.65
F	457695.8	221400.9	64.61	64.63
G	458256.2	221457.9	64.95	64.96
H	458057.7	221375.2	64.76	64.78
I	457895.8	221372.8	64.62	64.64

*Flood water does not reach the point within the hydraulic model

4.1.1.4 Fluvial Flood Hazard

The fluvial flood hazard map for the 1 in 100 year + 35% climate change event has been provided in **Figure 4-3**. The map shows the hazard rating across the site (defined in **Table 4-4**). This is based on the following calculation which takes into consideration velocity (v) and depth of the floodwater (d) and debris factor (DF):

$$HR = d * (v+0.5) + DF$$

Figure 4-3 shows that along the south eastern boundary, there are areas that are defined at 'Very low hazard'.

Table 4-4 Flood Hazard Classifications[8]

Flood Hazard	Hazard to People Classification	
Less than 0.75	Very Low Hazard	Caution
0.75 to 1.25	Danger for some	Includes children, the elderly and the infirm
1.25 to 2.0	Danger for most	Includes the general public
More than 2.0	Danger for all	Includes the emergency services

[8] HR Wallingford and Environment Agency (May 2008) Supplementary note of flood hazard ratings and thresholds for development planning and control purpose – Clarification of the Table 113.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1

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Figure 4-3 Fluvial flooding hazard map for 1 in 100 year storm event + 35% climate change *(Contains Environment Agency Information © Environment Agency and/or database right*) *Imagery © Google 2017, Map data © Google 2017)*

4.1.2 Proposed Development

For the Proposed Development, ground levels within the Functional Floodplain (i.e. within the 1 in 20 year flood extent) are not to be raised in accordance with NPPF guidance and the EA's pre-application advice. At grade car parking within this zone is considered acceptable by the Environment Agency provided there is no raising of ground levels.

A sequential approach should be taken to locating development within areas of lower risk of flooding. The office buildings are to be located outside of the 1 in 100 + 35% climate change flood extents, with minimum floor levels applied. Car parking should be located, where possible, towards areas of lower risk of flooding (i.e. away from the south eastern boundary).

Finished floor levels for the office buildings are to be set at the 1 in 100 year + 35% climate change flood level with an additional 300mm freeboard.

During detailed design of the site, if ground raising is required between the 1 in 20 year flood extent and the 1 in 100 year + 25% climate change flood extent, then flood compensation will be required to be provided. This will need to be provided on a level for level and volume for volume basis on site in accordance with the Level 2 SFRA Table 5-3 guidance for the site.

4.1.2.1 Construction Phase

During the construction phase, the Contractor will need to sign up to the EA's flood warning service which covers the site and produces a construction flood and evacuation plan for managing flood risk on site during the construction phase.

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During construction, stockpiles of material should not be stored within the Functional Floodplain as land raising is not permitted. It is recommended that stockpiles are located outside the 1 in 1000 year flood extent.

4.2 Flooding from Surface Water

Surface water flooding occurs when intense rainfall is unable to naturally soak into the ground due to impermeable ground covering such as concrete or tarmac, or low permeability ground conditions preventing infiltration. This excess surface water can flow through built-up areas and open space and pond in lower-lying areas causing localised flooding.

4.2.1 Baseline

The Environment Agency surface water map shows that the majority of the site is at very low risk of surface water flooding (i.e. less than 1 in 1,000 annual probability of surface water flooding in any year). **Figure 4-4** has been reproduced using the EA flood extent data. The map shows that there is an area at high risk of flooding (less than a 1 in 30 annual probability of surface water flooding) from the north to the south of the site. This corresponds to the location of the drainage ditch which has been infilled.

There are areas of low to medium risk of surface water flooding (between a 1 in 30 and 1 in 100 and between a 1 in 100 and 1 in 1000 annual probability respectively) adjacent to the drainage ditch, along the eastern boundary and south eastern corner of the site. The predicted depths from the EA's modelling are less than 300mm for the 1 in 100 annual probability event as shown in **Figure 4-5**.

The area along the northern boundary of the site shows areas of low, medium and high surface flood risk. This area has been re-configured as part of the 2015 superstore works which may not be reflected in the modelling. Depths for the 1 in 100 annual probability event are predicted as below 300mm.

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Figure 4-4 Environment Agency's surface water flood extents map with indicative red line boundary. Accessed 16/8/17 (© Environment Agency copyright and/or database right 2015. All rights reserved. Some features of this map are based on digital spatial data from the Centre for Ecology & Hydrology, © NERC (CEH). Soils Data © Cranfield University (NSRI) and for the Controller of HMSO 2013. Imagery © Google 2017, Map data © Google 2017)

Figure 4-5 EA's surface water flood depth map for 1 in 100 annual probability event with indicative red line boundary. Accessed 16/8/17 (© Environment Agency copyright and/or database right 2015. All rights reserved. Some features of this map are based on digital spatial data from the Centre for Ecology & Hydrology, © NERC (CEH) and © Lead Local Flood Authorities. Soils Data © Cranfield University (NSRI) and for the Controller of HMSO 2013. Imagery © Google 2017, Map data © Google 2017)

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Figure 4-6 shows that for the 1 in 100 annual probability event, the flooding in the locality of the drainage ditch has areas which pose a 'Danger for most', 'Danger for some' and areas 'Very Low Hazard – Caution'. However, the ditch has now been infilled and therefore the flood hazard will be reduced in this part of the site.

There are 'Very Low Hazard – Caution' areas along the south eastern northern boundary and to the west of the drainage ditch with localised spots of 'Danger for some' on Lakeview Drive and to the west of the drainage ditch.

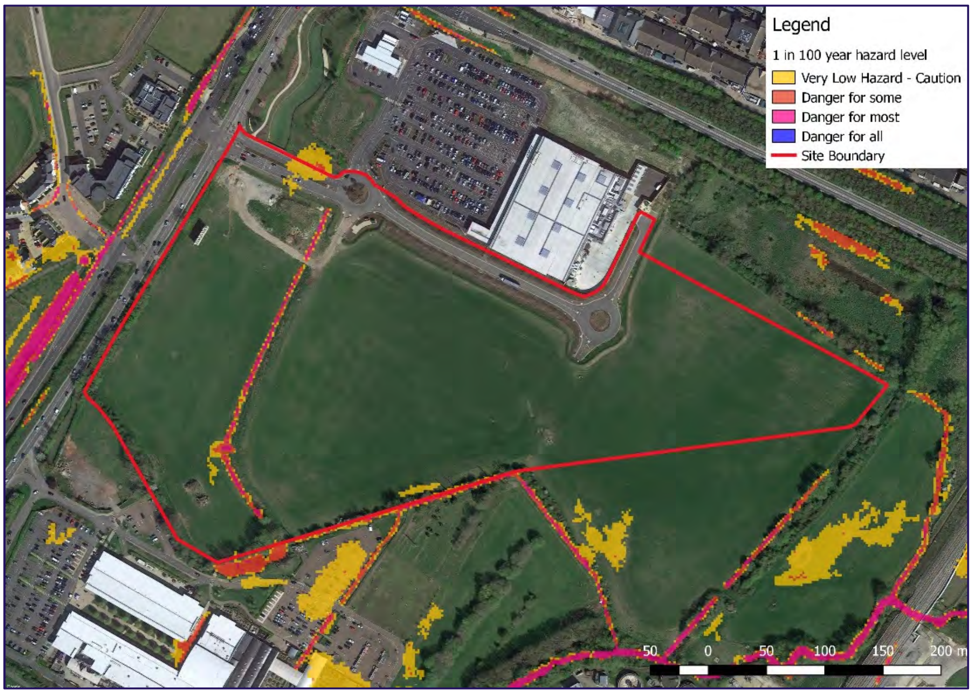

Figure 4-6 Environment Agency's surface water flood hazard map for the 1 in 100 annual probability event with indicative red line boundary. Accessed 16/8/17 (© Environment Agency copyright and/or database right 2015. All rights reserved. Some features of this map are based on digital spatial data from the Centre for Ecology & Hydrology, © NERC (CEH). Soils Data © Cranfield University (NSRI) and for the Controller of HMSO 2013. Imagery © Google 2017, Map data © Google 2017)

The 2011 Preliminary Flood Risk Assessment (PFRA) Map 1 and Map 2 show no recorded surface water flood events during July 2007 and other past events. The Level 2 SFRA also reports that the EA and Cherwell District Council have no records of surface water flooding on site.

In January 2014, following a period of major winter storms which brought widespread heavy and extended rainfall to the UK, BHE undertook a site visit to Bicester. BHE observed localised surface water ponding at the then recently excavated superstore construction site to the north of the development site where the underlying soil was identified as clay with poor permeability, as well as localised ponding at lower ground level areas in the vicinity of the manhole structures and overhead power line posts near the eastern boundary. BHE estimated that the rainfall over the 16 day period from 23rd December 2013 to 7th January 2014 was equivalent to a 1 in 17 year event.

4.2.2 Proposed Development

The primary surface water drainage infrastructure to serve the Proposed Development has already been constructed as part of the primary infrastructure contract for the site. The drainage was designed to provide capacity to serve the development proposals covered by the 2007 outline planning application.

The surface water infrastructure was installed along Lakeview Drive with spurs left to facilitate drainage connections from the masterplan. A 600mm diameter surface water pipe crosses the Proposed Development site and outfalls into the drainage ditch upstream of the confluence with the Langford Brook as shown in **Appendix F**.

The primary surface water sewer was designed with a capacity to serve the proposed 60,000m^2 B1 development. In accordance with the previously agreed drainage strategy, surface water runoff from the developed site will be limited to current 'greenfield' runoff rates and onsite storage will be required. The greenfield runoff rate will be estimated using the HR Wallingford *uksuds* tool. The sewer capacity of the constructed surface water drainage has been designed on this basis.

Attenuation measures for the developed site will be designed to accommodate the increased rainfall intensities in accordance with the climate change recommendations issued by the Environment Agency in February 2016.

The drainage system to serve the development site will incorporate the recommendations of Sustainable Drainage Systems (SuDS) good practice. The current Good Practice Guidance is contained in CIRIA Report C753 issued in 2015. This will be used to design the onsite drainage network unless superseded in the future.

In accordance with Policy Bicester 4, the site is not permitted to flood from surface water up to and including the 1 in 30 year event. Surface water flooding above this event up to a 1 in 100 year event with allowance for climate change is permitted provided it is safely contained within the site. During detailed design, exceedance routes will need to be considered to route flood water away from the threshold of buildings.

Refer to **Appendix F** for the surface water drainage strategy.

4.3 Flooding from Sewers

Flooding from sewers is typically associated with blockage, failure or overloading of the sewer network.

4.3.1 Baseline Flood Risk

The Level 2 SFRA Thames Water DG5 database map showed no recorded sewer flooding incidents within or in the vicinity of the site for the period during 2000-2010 from public foul, combined or surface water sewers. The SFRA also reported that Cherwell District were not aware of any historical incidents on the site but *'are aware of the limited sewer capacity in Bicester'*.

There are two existing combined public sewers which are to the south east of the proposed development site. These sewers run parallel to the existing ditch (tributary of the Langford Brook) from Bicester village to the sewage treatment plant as shown in **Figure 4-7** which is taken from the 2011 BuroHappold Drainage Strategy for the Tesco Development[9]. The BHE site report from 2014 showed evidence of localised sewer flooding however, these were related to manholes outside of the site boundary as shown in **Figure 4-7**.

[9] Buro Happold 028858 Bicester Business Park Drainage Strategy (Pre Development Application for Tesco) Revision 02 (September 2011)

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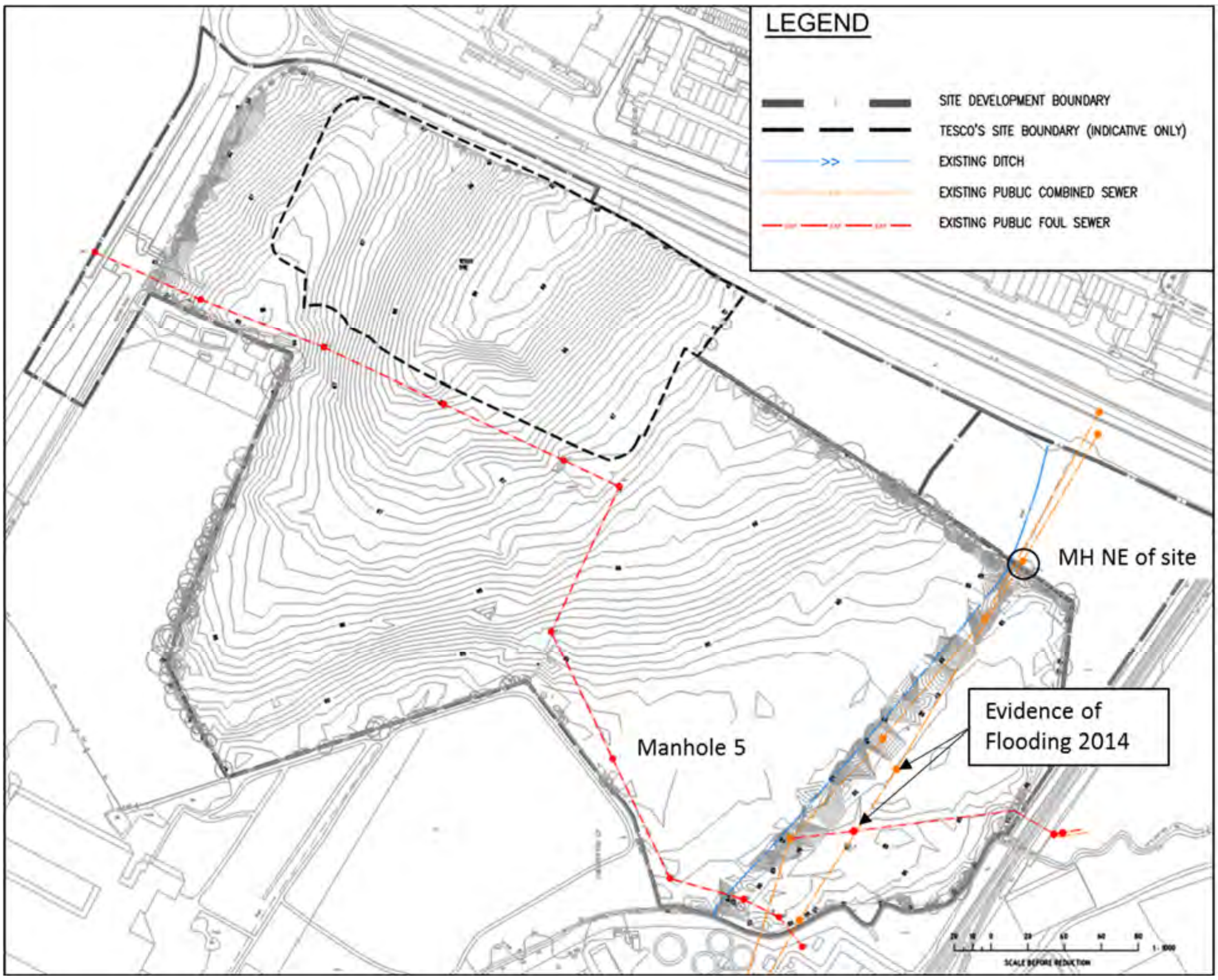

Figure 4-7 Existing Services Information from 2011 Tesco Drainage Strategy[10].

There is also an existing 600mm diameter foul sewer which crosses the site from the A41 Oxford Road east along Lakeview Drive before turning south and then south east towards the sewage treatment works. This was installed as part of the primary infrastructure works to support the Tesco foodstore and masterplan works.

In December 2014/ January 2015, it was reported that there was localised foul flooding at Manhole 5 and the two combined sewers to the south east of the site. It is understood that this was associated with an issue downstream at the sewage treatment works rather than a capacity issue.

[10] Buro Happold 028858 Bicester Business Park Drainage Strategy (Pre Development Application for Tesco) Revision 02 (September 2011)

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There are no known sewer flood incidents on site however, there have been incidents of sewer flooding in the vicinity of the site due to downstream issues. During a site visit in November 2017, there was evidence of sewer flooding from the two combined sewer manholes and the manhole north east of the site (circled on **Figure 4-7**) by the presence of detritus. From a review of the topographic survey and LiDAR data in combination with a review on site, flood water from the north east manhole would likely flow along the drainage ditch to the east away from the site. BuroHappold are led to believe that the offsite foul sewer flooding at MH5 was as a result of a combination of unusual events which led to surcharging rather than a pipe capacity issue.

Overall the risk of sewer flooding to the site is therefore considered low. However, further consultation will be needed with Thames Water during detailed design.

4.3.2 Proposed Development

The primary foul water drainage infrastructure to serve the proposed development has already been constructed as part of the primary infrastructure contract for the site in 2011. The drainage was installed with connection points to facilitate the future connection of the masterplan site. The flow rates from the proposed development have been estimated based on the benchmarks for B1 uses. The total flow rate from the completed development will be very low in comparison with the capacity of the public sewer. It is not anticipated that there will be any flow restrictions placed on the connections by Thames Water. For further information refer to **Appendix F**.

4.4 Groundwater Flooding

Flooding from groundwater occurs when the water table in permeable rocks or soils such as chalk and limestone rises to enter underground spaces such as basements and cellars or reaches a sufficient level to emanate from the ground surface itself. Groundwater flooding is not necessarily directly linked to a specific rainfall event and is generally of longer duration than other causes of flooding (possibly lasting for weeks or months).

4.4.1 Baseline

The Cherwell District Council Level 2 SFRA provides the Environment Agency's Area Susceptibility to Groundwater Flooding map. The map shows that the eastern half of the site lies within a 1km square which has up to 25% of its area susceptible to groundwater flooding and the western site between or equal to 25% and less than 50%.

The anticipated site geology is summarised in **Table 4-5** - Summary of Anticipated Geology. This has been determined with reference to the relevant BGS map (1:50,000 series, sheet 219, Buckingham. BGS 2002); BGS borehole logs; the Groundsure report and historic site investigation data.

Table 4-5 - Summary of Anticipated Geology

Strata	Description	Depth to top [Thickness] (m)	Aquifer status
Alluvium	Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present.	GL [<3m]	Secondary
River Terrace Deposits	Sand and gravel, locally with lenses of silt, clay or peat.	GL [<3]	Secondary
Kellaways Formation	Siltstone and mudstone.	GL – 3 [2-3]	Unproductive

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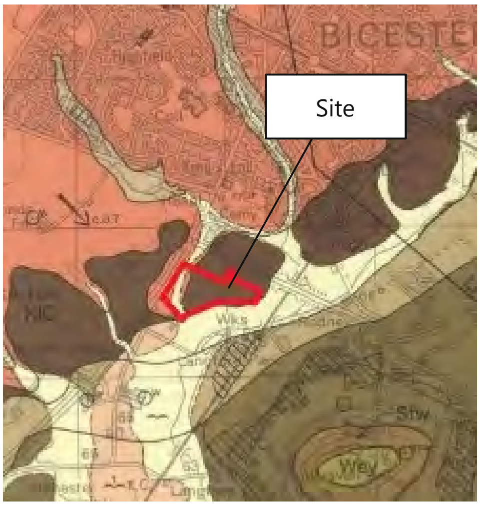
Cornbrash Formation	Limestone, medium- to fine-grained, generally and characteristically intensely bioturbated and consequently poorly bedded. Generally bluish grey when fresh, but weathers to olive or yellowish brown. (Regionally between 1 to 4m thick)	<5 [2]	Secondary
Forest Marble Formation	Silicate-mudstone, greenish grey, variably calcareous. A variety of limestone types occur, of which grey, weathering brown and flaggy, variably sandy medium to coarsely bioclastic grainstone or less commonly, packstone predominates, especially at the base. (Regionally between 2 to 7m thick).	2.5 - >5 [7]	Unproductive
White Limestone Formation	A pale grey to off-white or yellowish limestone, peloidal wackestone and packstone with subordinate ooidal and shell fragmental grainstones. (Regionally between 7 and 18m thick)	9 [base not proven]	Principle

Figure 4-8 Extract of the BGS geology map for the area.



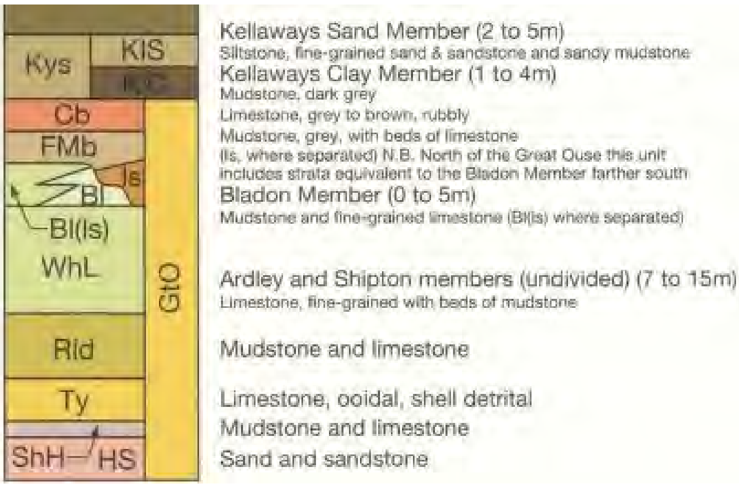


Figure 4-9 Key of the geological bedrock in the area.

Figure 4-8 shows that a band of alluvium (cream) and the Combrash Formation (pink) underlies the western part of the site at the surface. Both of these are permeable formations and are classified as Secondary Aquifers which could potentially pose a risk of groundwater flooding. However, given the permeability of the alluvium, it is likely that an increase in groundwater level in the Combrash formation, is likely to be dissipated by the alluvium towards the river.

The alluvium band extends from the Langford Brook to the site as shown in Figure 4-8 and is likely to be in hydraulic connectivity with the river. The ground levels within the alluvium band in the south corner of the site are typically above 64.7m AOD with the lowest level at 64.54mAOD. The lowest ground levels on site are similar to the estimated 1 in 100 year + 35% climate change flood level within the river at 64.53mAOD (ISIS Flood Model Node LA 0762). As there is a lag for groundwater to respond to rising river levels, the primary flooding mechanism for the site is likely to be from water overtopping the banks of the Langford Brook upstream of the site rather than from rising groundwater levels.

Overall there is a low risk of groundwater flooding to the western part of the site. However, there may be a risk if groundwater rises and is unable to drain through the alluvium layer towards the river. This will need to be considered during the detailed ground investigation.

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Ground investigation was undertaken on site in 2008 and 2014 for the proposed trunk sewer, access road and ornamental lake. Boreholes (BHs) BH2, BH 3 and Trial Pit (TP) TP1 shown in the site plan on the western part of the site in **Appendix G** show that groundwater was either not encountered or was an artesian groundwater level at depth between 8.9, and 11.7m within the Forest Marble Formation. This formation is considered a confined aquifer with low permeability.

The Eastern part of the site is underlain immediately by the Kellaways Formation which is classified as an Unproductive Aquifer with the Forest Marble Formation at depth. Boreholes and Trial Pits (BH 4 and 5, TPs 2, 3, 6 and 7) showed groundwater levels were within the superficial deposits between 0.6m and 1.4m. Given the low permeability of the Kellaways Formation geology, it is considered that there is a low risk of groundwater flooding for the Eastern part of the site. Overall the site is considered to be at low risk of groundwater flooding.

4.4.2 Proposed Development

The Proposed Development does not include development below ground level that could be affected by high ground water levels such as basement car parking. Although the risk of groundwater flooding to the Proposed Development is considered low, further ground investigation during detailed design will be undertaken and consideration through the design of foundations to minimise the impact of groundwater.

To minimise any risk from groundwater flooding during excavation of the new development, cut levels will be limited to at least 0.5m above groundwater level. Where this is not possible, dewatering and other groundwater control measures will be required. Any such groundwater control measures will also require pollution control measures in accordance with EA guidance.

4.5 Flooding from Artificial Sources

The Environment Agency map shows that there are no reservoirs located within the vicinity of the site and that the site does not lie within a breach flood flow path of a reservoir. The Preliminary Flood Risk Assessment Map 4 shows that there are no canals within the vicinity of the site and therefore the site is not at risk of canal flooding.

There is a pond to the north of the site as part of the Tesco foodstore development. This is an ornamental pond which forms part of the landscaping works and has an overflow into the drainage network. The pond is lower than the surrounding ground levels so the risk to the site resulting from breach of the pond is considered to be very low.

There is also a small pond along the south east boundary of the site which forms part of the surface water drainage strategy for the garden centre. The Level 2 SFRA advises that *'LiDAR has shown that it lies at a lower elevation to the site and therefore is not considered to pose a risk of flooding from breach'*[11].

The site is therefore at low risk of flooding from artificial sources.

4.6 Other considerations

4.6.1 Safe access and egress

A safe access and egress route for the site for vehicles and pedestrians will be via Lakeview Drive which is within Flood Zone 1 to the A41 Oxford Road to the west of the site. A safe access and egress route will need to be provided at a minimum of 1 in 100 year + 35% climate change flood level from each of the office buildings.

[11] Cherwell District Council. Cherwell District Council Level 2 SFRA (March 2012)

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4.6.2 Residual Risk

There is a residual flood risk to the site as there are areas which flood in a 1 in 20 year event. A sequential approach should be taken to locating development within areas of lower risk of flooding. Office buildings are to be located outside the 1 in 100 year +35% climate change flood extent. The finished floor levels for the buildings will be set at or above the 1 in 100 year + 35% climate change plus 300mm, which is above the flood level in the 1 in 1000 year event. However, there is a residual risk of flooding for 1 in 1000 year to the external areas of the site, potentially impacting the access to the buildings.

During detailed design, office car parking will need to be located on the site and this may need to be located in areas of the site at greater annual probability of flooding.

A flood evacuation and management plan will be required during detailed design to manage the residual risk of flooding on the site posed to both people and vehicles. The plan will consider:

- Signing up to the EA's flood warning service to provide early warning of a flood event on site;
- Closing of parts of the site predicted to be affected by flooding to prevent people entering the floodwater;
- Moving cars within car parking areas predicted to be affected by flooding to other areas on site or offsite;
- Methodology to establish how the flood levels are monitored and what/ when actions are taken on site.

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5 Summary and Conclusions

BHE has prepared this FRA on behalf of Scenic Land Developments Limited to support the Outline Planning Application for the Bicester Office Park site. This FRA has been undertaken in accordance with the National Planning Policy Framework (NPPF) and demonstrates that with the proposed mitigation measures, the Proposed Development is considered safe up to the 1 in 100 flood event with allowance for climate change and does not increase flood risk elsewhere for the lifetime of the Proposed Development. A summary of the key findings of the Flood Risk Assessment are provided in **Table 5-1**.

Table 5-1 Summary of the key findings

Subject	Element	Findings
Site Flood Risk	Fluvial	The majority of the site lies in Flood Zone 1. However, along the south eastern boundary, the site lies within 2, 3a and 3b.
	Ground Water	Low risk of flooding. Further ground investigation recommended.
	Surface Water	The majority of the site is at very low risk of surface water flooding. There are areas of low to high risk of flooding along the northern and eastern boundary, south east corner and adjacent to the drainage ditch which has now been infilled.
	Sewers and Artificial Sources	Low risk of flooding
Planning Requirements	Vulnerability Classification	Office buildings are classified as 'less vulnerable', appropriate for Flood Zone 1, 2 and 3a. Car parking located in Flood Zone 3b is considered appropriate provided no ground raising.
	Sequential Test and Exception Test	As the site is allocated within the Adopted LDP, the Sequential Test is considered to have passed. An Exception Test is not required for the site.
	Sequential Approach	The Sequential Approach has been applied within the site boundary by locating buildings outside the 1 in 100 + 35% climate change flood extent. During detailed design, apply Sequential Approach to locate office parking to areas of lower risk of flooding.
Mitigation measures	Design Flood Event	1 in 100 year +25% climate event.
	Climate change	25% to 35% allowance to be considered for the site in accordance with the latest guidance.
	Finished Floor Levels	Finished Floor Levels are proposed to be set at a minimum of the 1 in 100 year + 35% climate change plus 300mm freeboard.
	Safe access and egress	Safe access and egress to be provided from all buildings via Lakeview Drive at or above the 1in 100 year +35% climate change level.
	Floodplain compensation	No ground level raising is permitted within the Functional Floodplain. Ground raising is permitted between the 1 in 20 year flood extent and the 1 in 100 year + 25% climate change flood extent if flood compensation provided on a level for level and volume for volume basis on site.
	Construction Phase	Contractor will need to sign up to EA's flood warning service and to locate stockpiles outside the 1 in 1000 year flood extent.
	Surface water drainage strategy	Primary infrastructure constructed on the site, sized for the Proposed Development. Discharge rates limited to greenfield rates. SuDS techniques to be implemented. Exceedance routes will need to be considered to route flood water away from the threshold of buildings.
	Residual Risk	A flood evacuation and management plan should be considered during detailed design to manage the residual risk of surface water and fluvial flooding on the site posed to both people and vehicles.

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Appendix A Topographic and LiDAR survey

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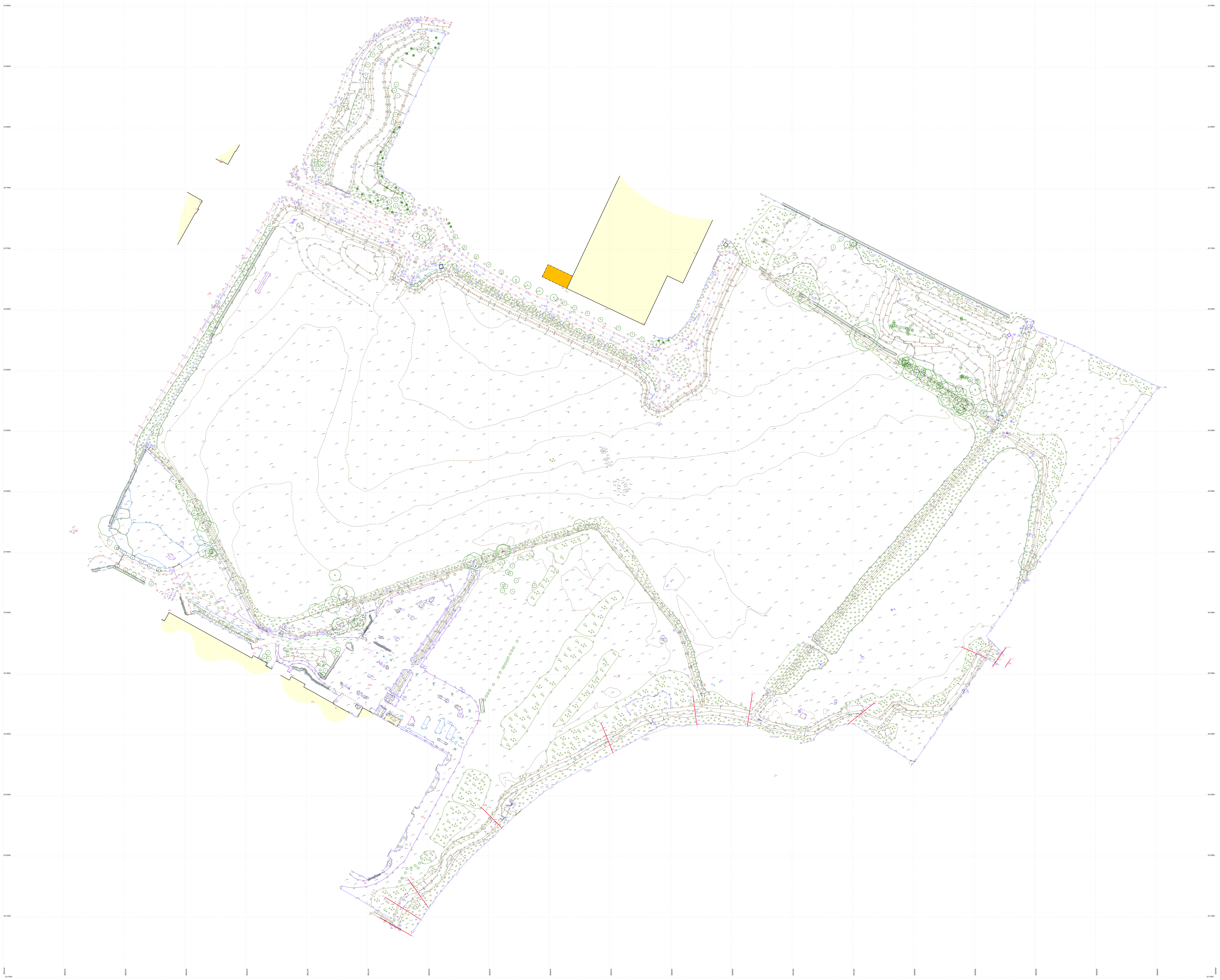

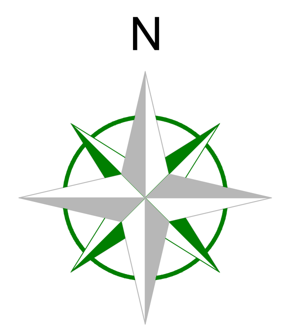

Station Information:

Station	Easting (m)	Northing (m)	Level (m)
GH1	458049.908	221684.512	67.095
GH2	458016.141	221588.821	67.325
GH3	457918.706	221648.867	67.729
GH4	457813.990	221701.959	67.358
GH5	457769.668	221703.759	66.947
GH6	457715.541	221753.903	67.049
GH7	457723.838	221818.099	68.544
GH8	457783.068	221886.926	69.454
GH9	457618.945	221662.947	67.808
TA16	457841.170	221311.839	64.373
TA17	457751.130	221341.429	64.375
TA18	457665.165	21373.9880	65.364
TA19	457597.196	221422.121	66.110
TA20	457508.503	221468.539	67.041
TA21	457624.739	221652.797	67.471

OS Note:

Some services may have been omitted due to parked vehicles. The Ordnance Survey tile is to be used as a guide only.

OS Buildings *Surveyed Buildings*

This survey has been orientated to the Ordnance Survey (O.S) National Grid OSGB36(15) via Global Navigational Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN15GB & OSGM15GB transformation models.

The survey has been correlated to this point and a further one or more OSGB36 (15) points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Buildings; Wall; Kerb line; Line marking; Drop kerb; Centre line

Overhead Cable; Concrete edge; Tarmac edge; Grass verge; Canopy/Overhang; Verge

1 Station and Name
100.000 Station Level

Tree / Bush / Sapling
Area of Undergrowth
Woodland

R: Ridge Level
E: Eaves Level
F: Flat Roof Level
Gate

Fence types:

I\W	Interwoven
I\R	Iron Railings
W\M	Wire Mesh
P\R	Post & Rail
P\W	Post & Wire
C\L	Chain Link
W\P	Wooden Panels
C\P	Concrete Panels
S\P	Steel Palisade

IC	Inspection chamber	Bo	Bollard
PInv	Pipe invert	IB	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Grl	Ground light
Pipe	Pipe above ground	Lbox	Letter box
MH	Manhole	Ldr	Ladder
WL	Water level	Sty	Stile
SL	Silt level	IFL	Internal floor level
Lp	Lamp post	THL	Threshold level
Tp	Telegraph post	Sp	Sign post
Ep	Electricity post	TH	Trialhole
Tl	Traffic light	BH	Borehole
Bus	Bus stop	ELC	Electric
Sv	Stop valve	BT	British Telecom
St	Stop tap	C'box	Control box
Er	Earth rod	TT	Tactile
Wm	Water meter	BP	Brick paved
Gas	Gas valve	CPS	Concrete paving slabs
Av	Air valve	CVR	Cover
ICU	Undentified inspection	IC	Inspection chamber
Wo	Wash out	R/wall	Retaining wall
Re	Rodding eye	UTL	Unable to lift
BB	Belisha beacon	TCL	Tree canopy level
CTV	Cable tv	G:	Girth
Mkr	Marker post	MG	Multi girth
Gmkr	Gas marker post	Stmp	Tree Stump
So	Soffit	CL:	Cover level
		IL:	Invert level

Rev	Date	Description	Drawn	Q. Ref
1	19.02.18	Additional works	TA	GH2478

greenhatch group

- Topographical Surveys
- Site Engineering
- Utility / CCTV Surveys
- Measured Building Surveys
- 3D Laser Scanning
- Revit & BIM Models

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CLIENT
BuroHappold Engineering

PROJECT
Bicester Office Park
Lakeview Drive
Bicester

TITLE
Topographical Survey

SCALE	DATE
A0@ 1: 1000	28.09.17
DRAWN	**QUALITY REF**
TC	GH1622

Level datum	See note
Grid orientation	See note
Job number	28207

Drawing No.	Rev.
28207_T_S	1

Comments
This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions should be checked on site prior to design and construction.

Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Notes:

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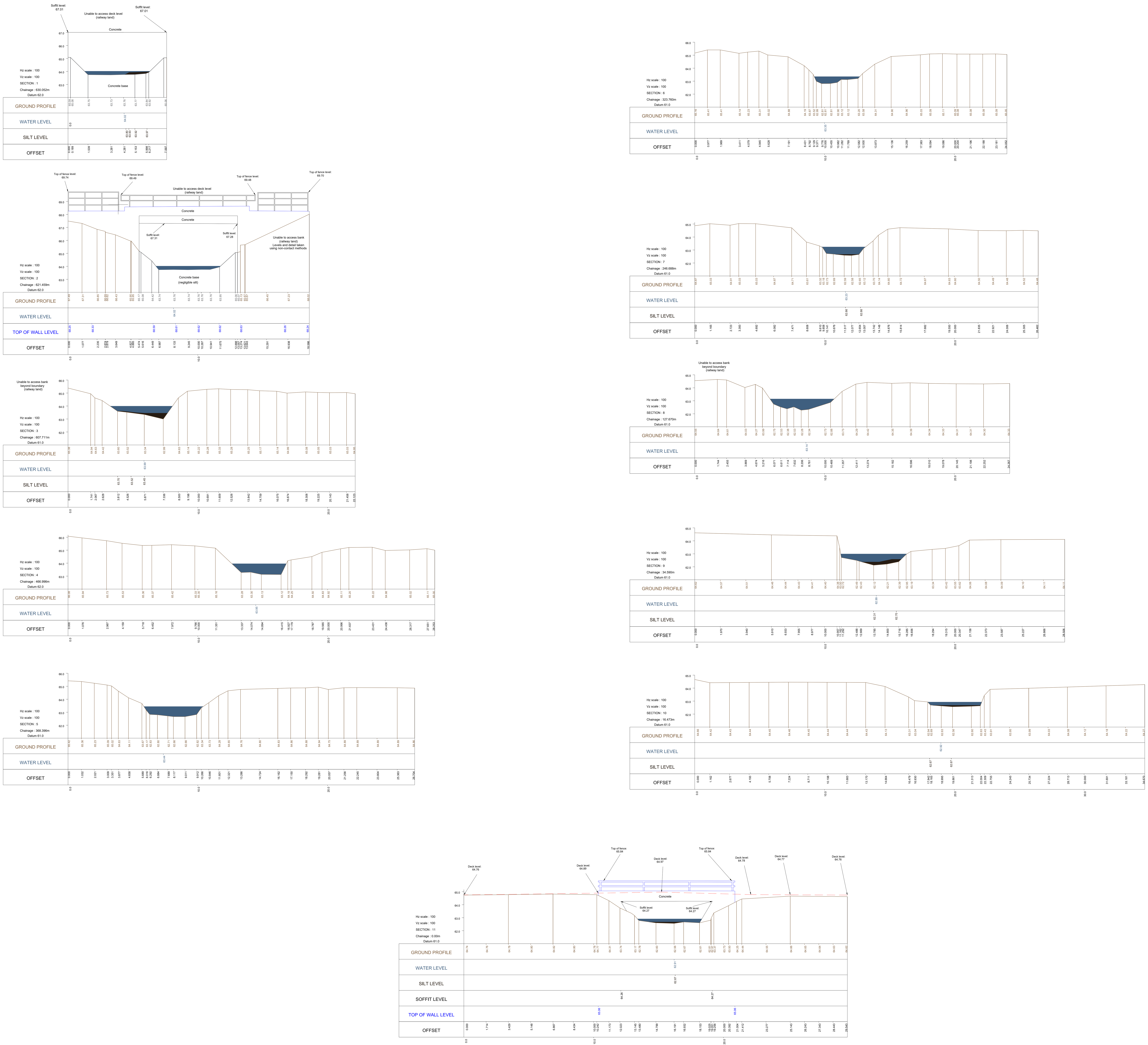

N

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GH4	457813.990	221701.959	67.358
GH5	457769.668	221703.759	66.947
GH6	457715.541	221753.903	67.049
GH7	457723.838	221818.099	68.544
GH8	457783.068	221886.926	69.454
GH9	457618.945	221662.947	67.808
TA16	457841.170	221311.839	64.373
TA17	457751.130	221341.429	64.375
TA18	457665.165	21373.9880	65.364
TA19	457597.196	221422.121	66.110
TA20	457508.503	221468.539	67.041
TA21	457624.739	221652.797	67.471

OS Note:

Some services may have been omitted due to parked vehicles. The Ordnance Survey tile is to be used as a guide only.

OS Buildings *Surveyed Buildings*

This survey has been orientated to the Ordnance Survey (O.S) National Grid OSGB36(15) via Global Navigational Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN15GB & OSGM15GB transformation models.

The survey has been correlated to this point and a further one or more OSGB36 (15) points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Buildings, Wall, Kerb line, Line marking, Drop kerb, Centre line, Overhead Cable, Concrete edge, Tarmac edge, Grass verge, Canopy/Overhang, Verge, Station and Name, Station Level

IC	Inspection chamber	Bo	Bollard
PInv	Pipe invert	IB	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Grl	Ground light
Pipe	Pipe above ground	Lbox	Letter box
MH	Manhole	Ldr	Ladder
WL	Water level	Sty	Stile

Fence types: P\R Post & Rail; P\W Post & Wire; C\L Chain Link; W\P Wooden Panels; C\P Concrete Panels; S\P Steel Palisade

Wo	Wash out	R/wall	Retaining wall
Re	Rodding eye	UTL	Unable to lift
BB	Belisha beacon	TCL	Tree canopy level
CTV	Cable tv	G:	Girth
Mkr	Marker post	MG	Multi girth
Gmkr	Gas marker post	Stmp	Tree Stump
So	Soffit	CL:	Cover level
		IL:	Invert level

Rev	Date	Description	Drawn	Q. Ref
1	19.02.17	Additional works	TA	GH2478

greenhatch group

Topographical Surveys / Site Engineering / Utility / CCTV Surveys / Measured Building Surveys / 3D Laser Scanning / Revit & BIM Models

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CLIENT: **BuroHappold Engineering**

PROJECT: **Bicester Office Park Lakeview Drive Bicester**

TITLE: **Cross-sections Survey**

SCALE	DATE
A0@ 1: 100	28.09.17

DRAWN	QUALITY REF
TC	GH1622

Level datum: See note
Grid orientation: See note
Job number: 28207
Drawing No.: 28207_T_S — Rev. 1

Comments
This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions should be checked on site prior to design and construction.

Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Notes:

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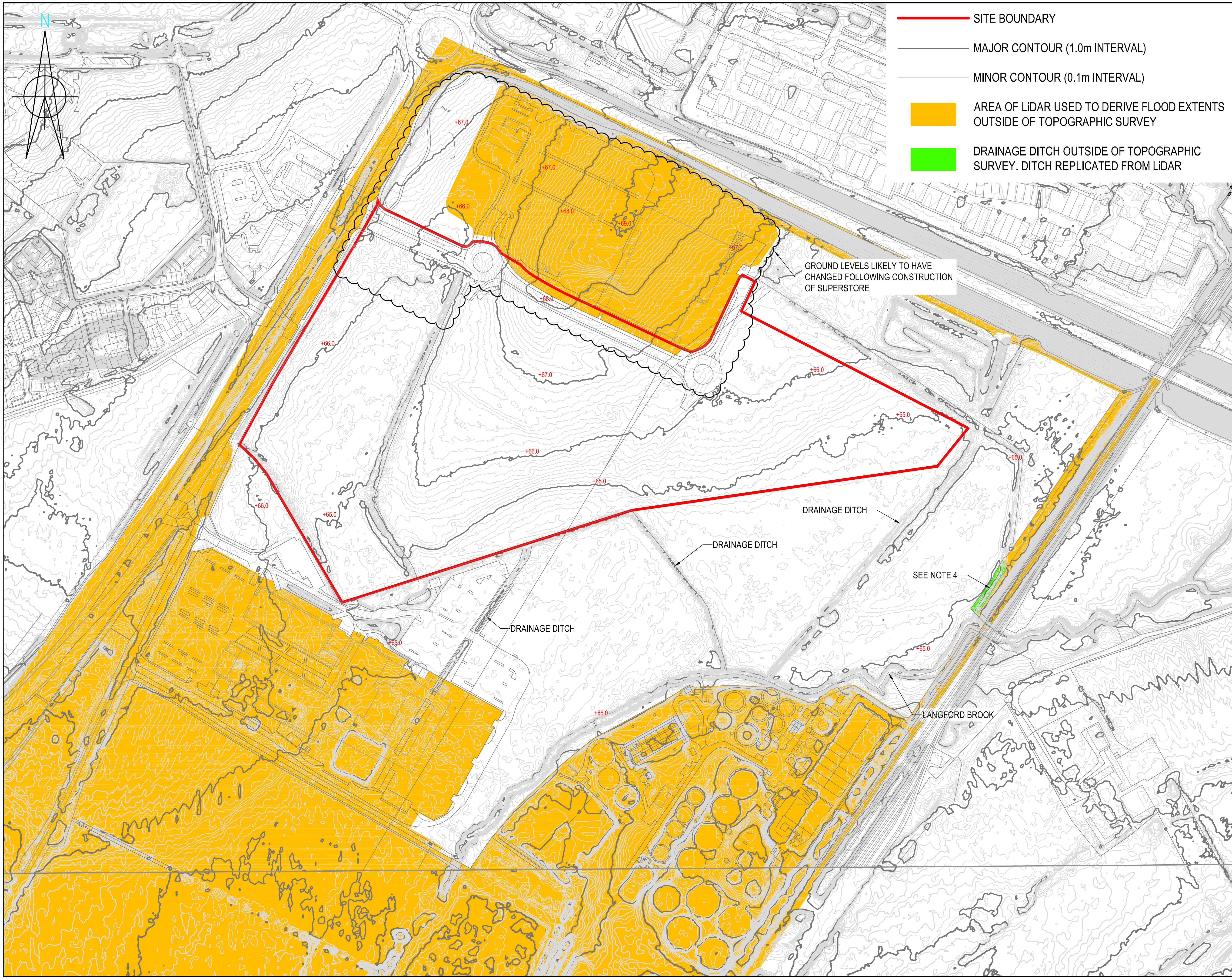

Notes

1. BACKGROUND OS TILE Ref. 100019980
2. COMBINED LiDAR (2M RESOLUTION) DIGITAL TERRAIN MODEL DOWNLOADED FROM http://environment.data.gov.uk. CONTAINS PUBLIC SECTOR INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE v3.0. LiDAR COMBINES DATA FROM 2003 AND 2011
3. CONTOURS DERIVED FROM LiDAR SURVEY POINT LEVEL DATA
4. SECTION OF DRAINAGE DITCH UNABLE TO BE SURVEYED DURING THE 2018 TOPOGRAPHIC SURVEY DUE TO BEING INACCESSIBLE. PLAN LOCATION BETWEEN LANGFORD BROOK AND DRAINAGE DITCH TAKEN FROM LiDAR WITH BANK LEVELS BEING INTERPOLATED USING LEVELS RECORDED IN THE 2018 TOPOGRAPHIC SURVEY.

Rev	Description/Date	Drn/Chk
03	NEW TOPO SURVEY EXTENT INFORMATION / 29.03.18	SM/CJ
02	NEW TOPO SURVEY EXTENT INFORMATION / 17.10.17	SM/CJ
01	AMENDED PROJECT NAME INFORMATION / 12.09.17	SM/CJ
00	INFORMATION / 16.08.17	SM/CJ

INFORMATION

Status of drawing

BUROHAPPOLD ENGINEERING

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Email: 0040031@burohappold.com
Web: www.burohappold.com

Architect *Bennett Associates*

Project **Bicester Office Park**

Drg Title LiDAR SURVEY WITH 100mm INTERVAL CONTOURS

Scales@A3 NTS

Drawn by SM

Checked by CJ

Date AUGUST 2017

Job No. 0040031

Drg No. WSK007

Rev 03

Simon Mudd \\srv-london05\CAD\0040031 Bicester Business Park- Planning Support\F34 Water\Sheet\Sketches\WSK007.dwg

Appendix B Proposed Development

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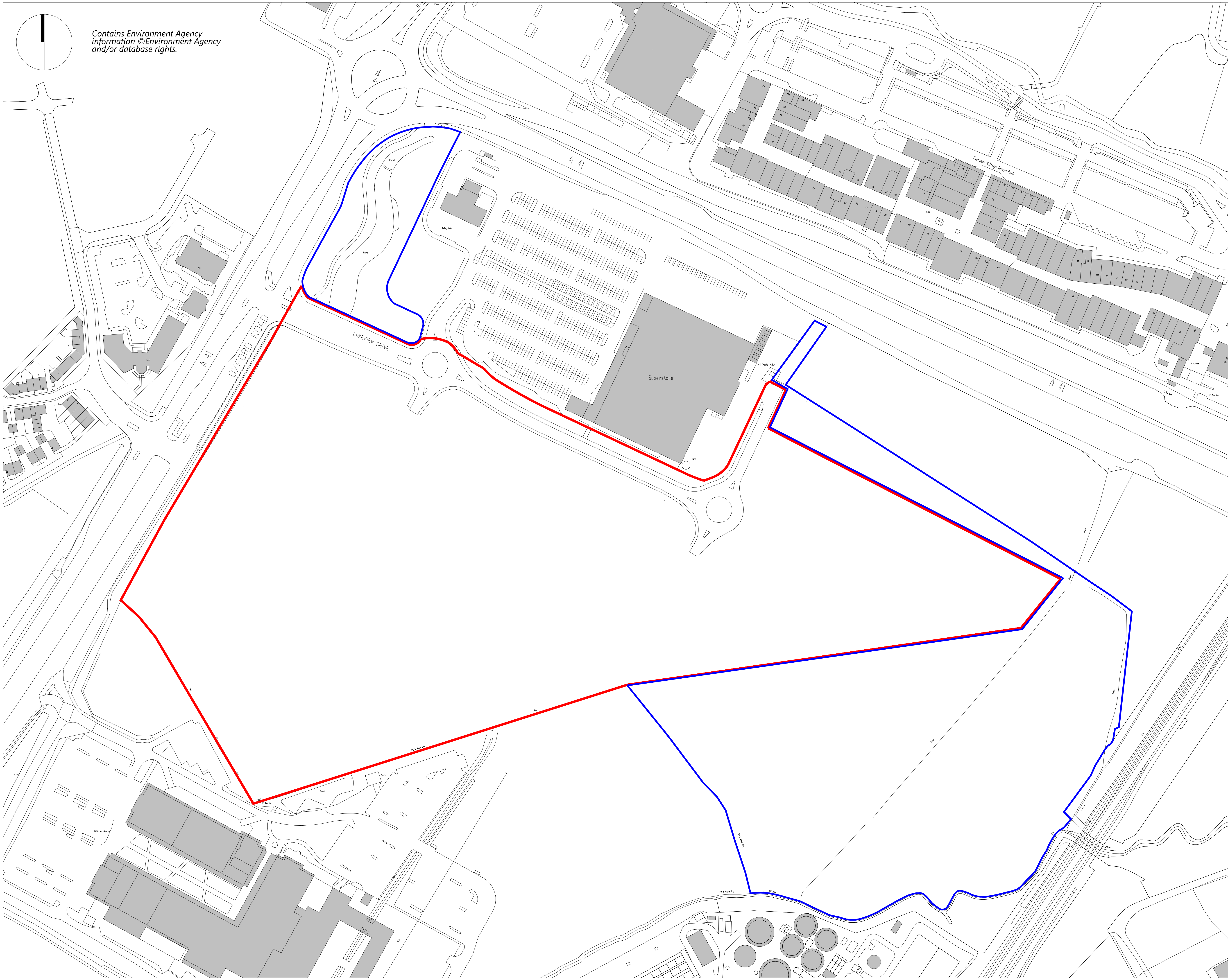

Revisions

	By	Chk
\ 170815 First Issue	DW	LS
A 170925 Title block amended	DW	LS

Notes

Land within planning application boundary

Land within applicant's ownership

Site application area: 13.1 Hectares

BENNETTS ASSOCIATES

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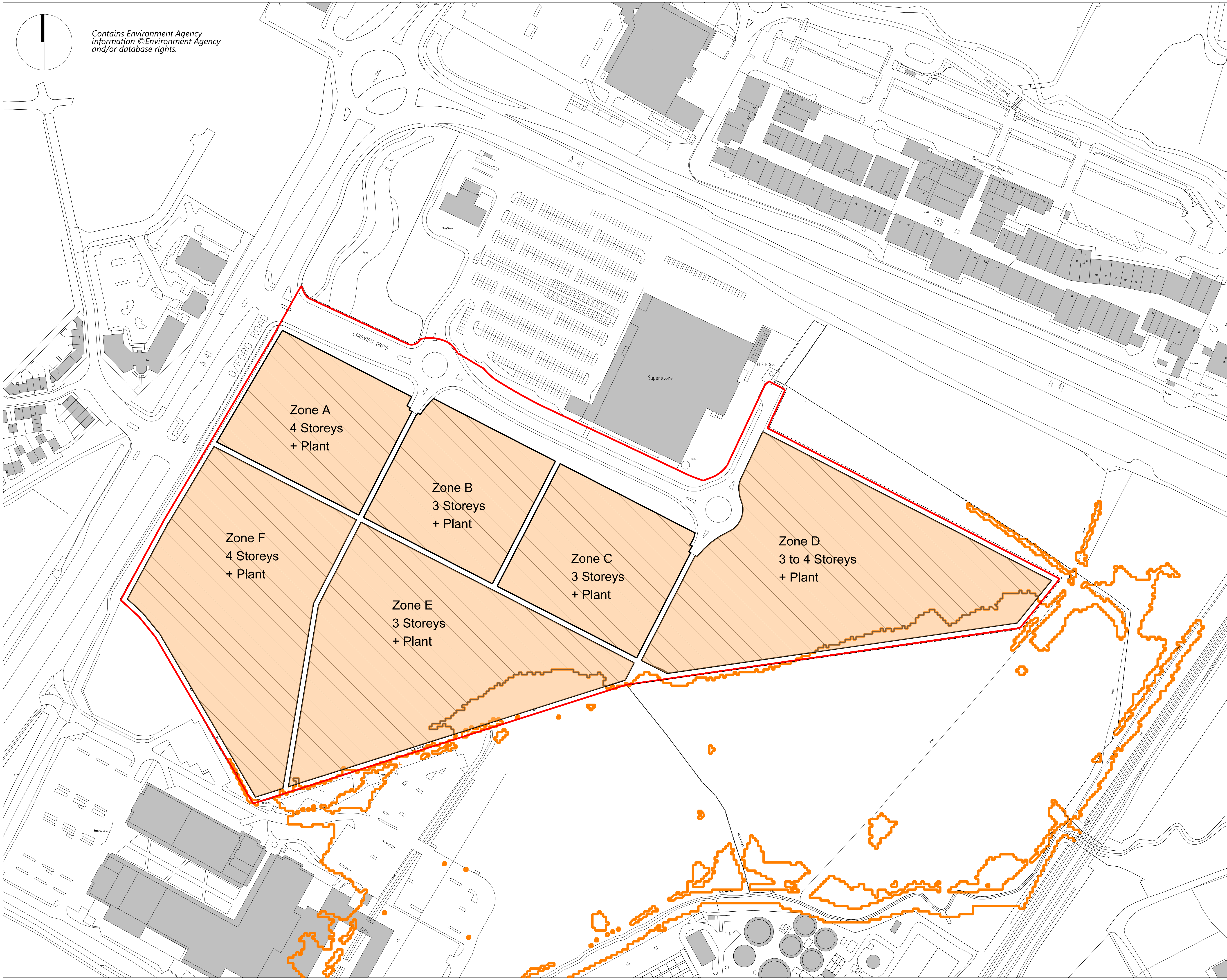
Project: Bicester Office Park

Project No. 1105

Scenic Land Developments Limited

Drawing Title: Planning Application Boundary

Drawing Number		Revision/Suitability
1105_P_004		A
Scale @ A3	Scale @A1	Revision Date
1 : 2500	1 : 1250	170925
		YY MM DD



Revisions			By	Chk
\	170809	Issued for Comment	TP	DW
A	170814	Development Zones Amended	DW	LS
B	170815	Hatch Amended	DW	TP
C	170925	Title Block amended	DW	LS
D	171129	Flood line amended	DW	TP
E	171130	Flood lines amended	DW	TP
F	180413	Flood lines amended	DW	LS

Key

- Development Zone
- Zone in which B1(a) / B1(b) class buildings can be built
- Site Application Area
- 1 in 100 year flood + 35%

Notes

Area Summary (GEA)

Zone A	
Development Area	10,875
Building Area	10,875
Maximum floor area	5,460
Zone B	
Development Area	10,745
Building Area	10,745
Maximum floor area	7,740
Zone C	
Development Area	11,650
Building Area	11,650
Maximum floor area	7,740
Zone D	
Development Area	27,730
Building Area	26,000
Maximum floor area	14,390
Zone E	
Development Area	25,000
Building Area	22,540
Maximum floor area	11,610
Zone F	
Development Area	22,470
Building Area	22,470
Maximum floor area	13,060
Total	
Site Area	13.1 Ha
Development Area	108,470 sq.m
Building Area	104,280 sq.m
Maximum Floor Area	60,000 sq.m

Please Note:
The areas included here are for guidance only and should be re-measured by a Chartered Surveyor prior to any valuation or feasibility exercise.

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Project — Project No. 1105

Bicester Office Park

Scenic Land Developments Limited

Drawing Title

Parameters Plan

Drawing Number	Revision/Suitability
1105_P_005	F

Scale @ A3	Scale @A1	Revision Date
1 : 2500	1 : 1250	180413
		YY MM DD

Appendix C Environment Agency Consultation

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Product 4 (Detailed Flood Risk) for Bicester Office Park, Oxfordshire,OX26 1DE
Our Ref: THM48041

Product 4 is designed for developers where Flood Risk Standing Advice FRA (Flood Risk Assessment) Guidance Note 3 Applies. This is:

i) "all applications in Flood Zone 3, other than non-domestic extensions less than 250 sq metres; and all domestic extensions", and
ii) "all applications with a site area greater than 1 ha" in Flood Zone 2.

Product 4 includes the following information:

Ordnance Survey 1:25k colour raster base mapping;
Flood Zone 2 and Flood Zone 3;
Relevant model node locations and unique identifiers (for cross referencing to the water levels, depths and flows table);
Model extents showing *defended* scenarios;
FRA site boundary (where a suitable GIS layer is supplied);
Flood defence locations (where available/relevant) and unique identifiers; (supplied separately)
Flood Map areas benefiting from defences (where available/relevant);
Flood Map flood storage areas (where available/relevant);
Historic flood events outlines (where available/relevant, not the Historic Flood Map) and unique identifiers;
Statutory (Sealed) Main River (where available within map extents);

A table showing:

i) Model node X/Y coordinate locations, unique identifiers, and levels and flows for *defended* scenarios.
ii) Flood defence locations unique identifiers and attributes; (supplied seperately)
iii) Historic flood events outlines unique identifiers and attributes; and
iv) Local flood history data (where available/relevant).

Please note:

If you will be carrying out computer modelling as part of your Flood Risk Assessment, please request our guidance which sets out the requirements and best practice for computer river modelling.

This information is based on that currently available as of the date of this letter. You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/ improvements have been made. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

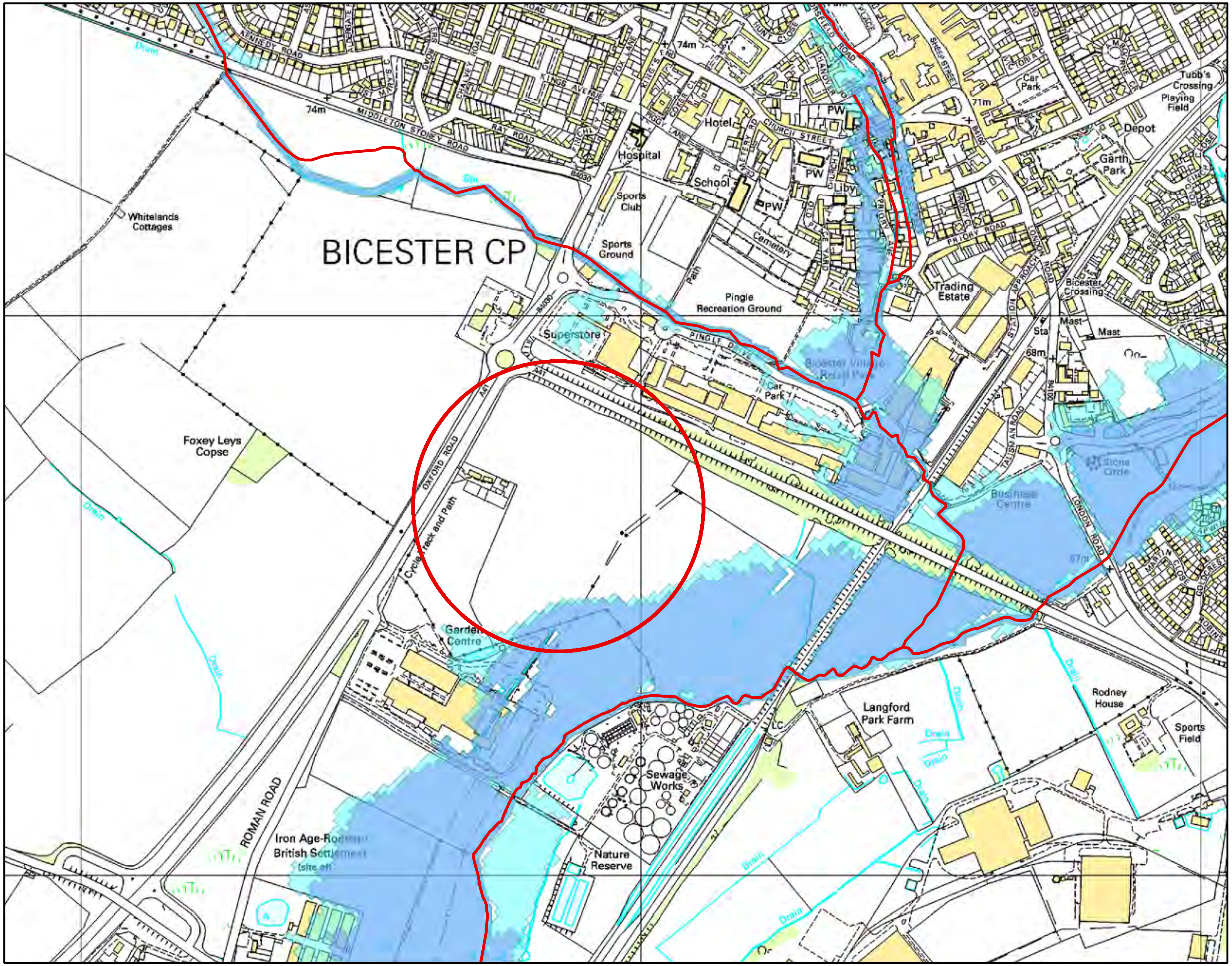
This information is provided subject to the enclosed notice which you should read.
This letter is not a Flood Risk Assessment. The information supplied can be used to form part of your Flood Risk Assessment. Further advice and guidance regarding Flood Risk Assessments can be found on our website at:

https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities

If you would like advice from us regarding your development proposals you can complete our pre application enquiry form which can be found at:

https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Flood Map for Planning centred on Lakeview Drive Bicester OX26 1DE
Created on 23/05/17 REF: THM48041



Environment Agency

Kilometres

0 0.25 0.5

Legend

- Main River
- Flood defences
- Areas benefiting from flood defences
- Flooding from rivers or sea (FZ3)
- Extent of extreme flood (FZ2)
- Flood Map - flood storage areas

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:
- from the sea with a 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.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

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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

Defence information

THM48041

Defence Location:	No defences on Main River
Description:	This location is not currently protected by any formal defences and we do not currently have any flood alleviation works planned for the area. However we continue to maintain certain watercourses and the schedule of these can be found on our internet pages.

© Environment Agency 2013

Model information

THM48041

Model: Langford Brook (Bicester) & Pingle-Back-Bure 2010

Description: The information provided is from the Langford Brook (Bicester) & Pingle-Back-Bure 2010 detailed mapping project. The study was carried out using 2D modelling software (ISIS-Tuflow).

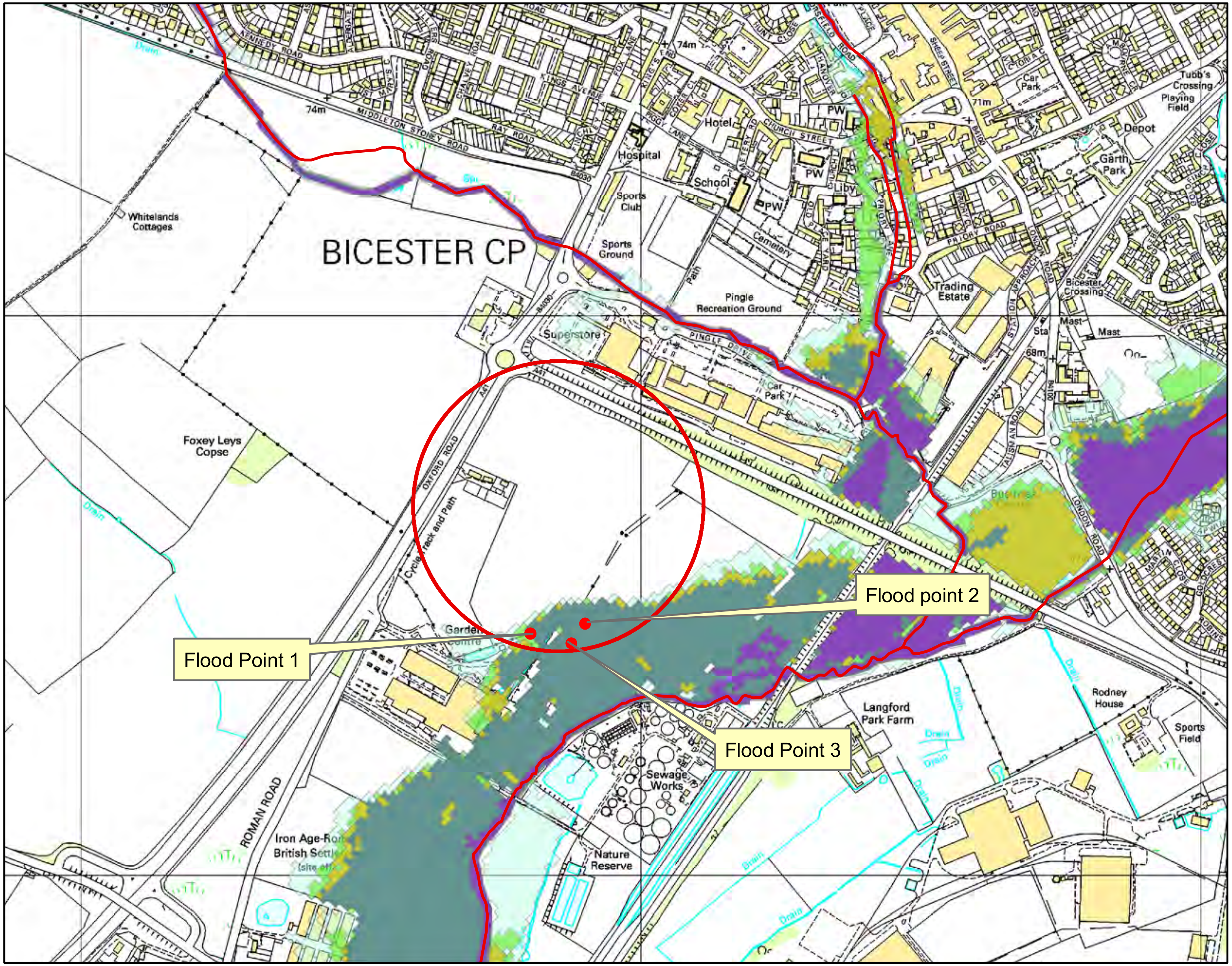
Model design runs:
1 in 5 / 20% Annual Exceedance Probability (AEP); 1 in 20 / 5% AEP; 1 in 50 / 2% AEP; 1 in 100 / 1% AEP; 1 in 100+20% / 1% AEP plus 20% increase in flows and 1 in 1000 / 0.1% AEP

Mapped Outputs:
1 in 5 / 20% AEP; 1 in 20 / 5% AEP; 1 in 50 / 2% AEP; 1 in 100 / 1% AEP and 1 in 1000 / 0.1% AEP

Model accuracy:
Levels ± 250mm

© Environment Agency 2013

Detailed FRA centred on Lakeview Drive Bicester OX26 1DE
Created on 23/05/17 REF: THM48041



Environment Agency

Kilometres

0 0.25 0.5

Legend

- Main River
- 20% AEP
- 5% AEP
- 2% AEP
- 1% AEP
- 0.1% AEP

AEP = Annual Exceedance Probability
The probability of a flood of a particular magnitude, or greater, occuring in any given year

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Modelled floodplain flood levels

THM48041

The modelled flood levels for the closest most appropriate model grid cells for your site are provided below:

2D grid cell reference	Model	Easting	Northing	flood levels (mAOD) 20% AEP	5% AEP	2% AEP	1% AEP	1% AEP (+20% increase in flows)	1% AEP (+25% increase in flows)	1% AEP (+35% increase in flows)	1% AEP (+70% increase in flows)	0.1% AEP
Flood Point 1	Langford Brook (Bicester) & Pingle-Back-Bure 2010	457,806	221,434		64.66	64.70	64.74	64.78				64.85
Flood Point 2	Langford Brook (Bicester) & Pingle-Back-Bure 2010	457,904	457,904		64.67	64.72	64.76	64.80				64.90
Flood Point 3	Langford Brook (Bicester) & Pingle-Back-Bure 2010	457,876	221,413		64.64	64.70	64.73	64.78				64.86

This flood model has represented the floodplain as a grid.
The flood water levels have been calculated for each grid cell.

Note:
Due to changes in guidance on the allowances for climate change, the 20% increase in river flows should no longer to be used for development design purposes. The data included in this Product can be used for interpolation of levels as part of an intermediate level assessment.

For further advice on the new allowances please visit
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

© Environment Agency 2013

Historic flood data

THM48041

Our records show that the area of your site has been affected by flooding.
Information on the floods that have affected your site is provided in the table below:

Flood Event Code	Flood Event Name	Start Date	End Date	Source of Flooding	Cause of Flooding
We hold no records of historic flooding for this location					

Please note the Environment Agency maps flooding to land not individual properties. Floodplain extents are an indication of the geographical extent of a historic flood. They do not provide information regarding levels of individual properties, nor do they imply that a property has flooded internally.

Start and End Dates shown above may represent a wider range where the exact dates are not available.

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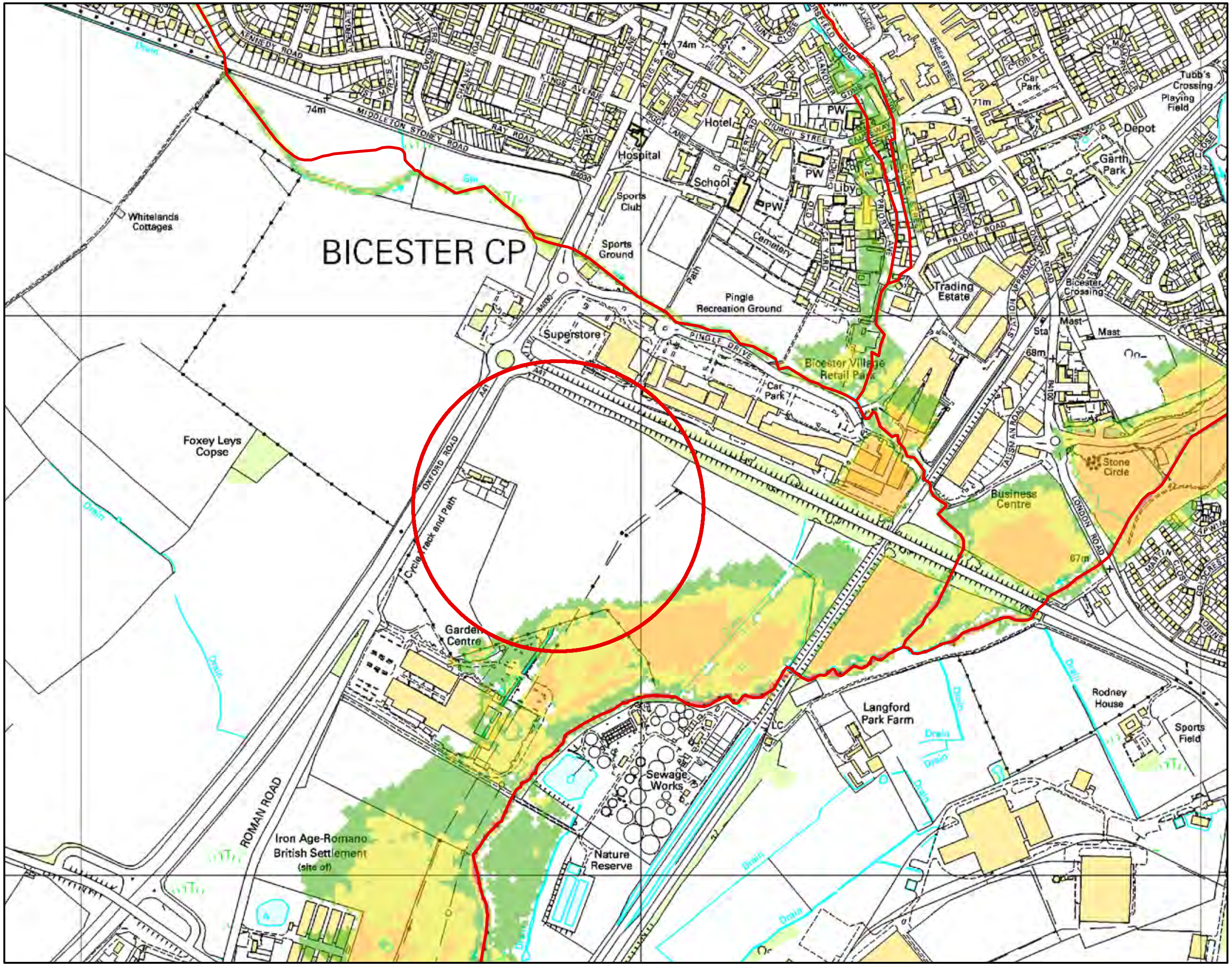
Hazzard Map centred on Lakeview Drive Bicester OX26 1DE
Created on 23/05/17 REF: THM48041



Environment Agency

Kilometres

0 0.25 0.5

Legend

- Main River
- Very low hazard
- Danger for some
- Danger for most
- Danger for all

For hazard and debris factor we used HR Wallingford and Environment Agency (May 2008) supplementary note on flood hazard ratings and thresholds for development planning and control purpose.
The following calculation is used:

HR = d x (v+0.5) + DF

HR = flood hazard rating

d = depth of flooding (m)

v = velocity of floodwaters (m/sec)

DF = debris factor calculated (0, 0.5, 1 depending on probability that debris will lead to a hazard)

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Hazard Mapping

THM48041

Hazard Mapping methodology:

To calculate flood hazard with the debris factor we have used the supplementary note to Flood Risk to People Methodology (see below).
The following calculation is used:

HR = d x (v+0.5) + DF

Where HR = flood hazard rating
d = depth of flooding (m)
v = velocity of floodwaters (m/sec)
DF = debris factor calculated (0, 0.5, 1 depending on probability that debris will lead to a hazard)

The resultant hazard rating is then classified according to:

Flood Hazard	**Colour**	**Hazard to People Classification**	
Less than 0.75		Very low hazard	- Caution
0.75 to 1.25		Danger for some	- includes children, the elderly and the infirm
1.25 to 2.0		Danger for most	- includes the general public
More than 2.0		Danger for all	- includes the emergency services

REF: HR Wallingford and Environment Agency (May 2008) Supplementary note of flood hazard ratings and thresholds for development planning and control purpose – Clarification of the Table 113.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1

Red Kite House, Howbery Park, Wallingford, Oxon OX10 8BD
Customer services line: 08708 506 506
Email: WTenquiries@environment-agency.gov.uk

www.environment-agency.gov.uk

Thames Area Climate Change Allowances

Guidance for their use in flood risk assessments

Jan 2017

We recently updated our national guidance on climate change allowances for Flood Risk Assessments. The following information provides additional local guidance which applies to developments within our Thames area boundary.

Climate change allowances - overview

The National Planning Practice Guidance refers planners, developers and advisors to the Environment Agency to our guidance on considering climate change in Flood Risk Assessments. We updated this guidance in February 2016 and it should be read in conjunction with this document to inform planning applications, local plans, neighbourhood plans and other projects. It provides:

- Climate change allowances for peak river flow, peak rainfall, sea level rise, wind speed and wave height
- A range of allowances to assess fluvial flooding, rather than a single national allowance
- Advice on which allowances to use for assessments based on vulnerability classification, flood zone and development lifetime

Updated climate change allowances guidance:

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

National Planning Practice Guidance:

http://planningguidance.communities.gov.uk/

Assessing climate change impacts on fluvial flooding

Table A below indicates the level of technical assessment of climate change impacts on fluvial flooding appropriate for new developments depending on their scale and location (flood zone). Please note that this should be used as a guide only. Ultimately, the agreed approach should be based on expert local knowledge of flood risk conditions, local sensitivities and other influences.

Applicants and consultants may contact the Environment Agency at the pre-planning application stage to confirm the assessment approach on a case-by-case basis. We provide standard guidance free of charge or bespoke advice for a fee for developments for which we are a statutory consultee. If your development is instead covered by Flood Risk Standing Advice, we recommend you contact the relevant Local Planning Authority for their guidance and confirmation of the assessment approach. Flood Risk Standing Advice can be found here:

https://www.gov.uk/flood-risk-assessment-local-planning-authorities

Table A defines three possible approaches to account for flood risk impacts due to climate change in new development proposals:

1. **Basic -** Developer can add an allowance to the 'design flood' (i.e. 1% annual probability) peak levels to account for potential climate change impacts. The allowance should be derived and agreed locally by Environment Agency teams.
2. **Intermediate -** Developer can use existing modelled flood and flow data to construct a stage-discharge rating curve, which can be used to interpolate a flood level based on the required peak flow allowance to apply to the 'design flood' flow.
3. **Detailed -** Perform detailed hydraulic modelling, through either re-running Environment Agency hydraulic models (if available) or construction of a new model by the developer.

Table A – Indicative guide to assessment approach

Vulnerability classification	Flood zone	Assessment by development type		
		Minor	Small-Major	Large-Major
Essential infrastructure	Zone 2	Detailed		
	Zone 3a	Detailed		
	Zone 3b	Detailed		
Highly vulnerable	Zone 2	Intermediate/Basic	Intermediate/Basic	Detailed
	Zone 3a	Not appropriate development		
	Zone 3b	Not appropriate development		
More vulnerable	Zone 2	Basic	Basic	Intermediate/Basic
	Zone 3a	Basic	Detailed	Detailed
	Zone 3b	Not appropriate development		
Less vulnerable	Zone 2	Basic	Basic	Intermediate/Basic
	Zone 3a	Basic	Basic	Detailed
	Zone 3b	Not appropriate development		
Water compatible	Zone 2	None		
	Zone 3a	Intermediate/Basic		
	Zone 3b	Detailed		

Definitions of terms in Table A

Minor

1-9 dwellings/less than 0.5 ha; office/light industrial under 1ha; general industrial under 1 ha; retail under 1 ha; travelling community site between 0 and 9 pitches.

Small-Major

10 to 30 dwellings; office/light industrial 1ha to 5ha; general industrial 1ha to 5ha; retail over 1ha to 5ha; travelling community site over 10 to 30 pitches.

Large-Major

30+ dwellings; office; light industrial 5ha+; general industrial 5ha+; retail 5ha+; gypsy/traveller site over 30+ pitches; any other development that creates a non-residential building or development over 1000 sqm.

Further info on vulnerability classifications:

http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/flood-zone-and-flood-risk-tables/table-2-flood-risk-vulnerability-classification/

Further info on flood zones:

http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/flood-zone-and-flood-risk-tables/table-2-flood-risk-vulnerability-classification/

Specific local considerations

Where the Environment Agency and the applicant or their consultant has agreed that a basic level of assessment is appropriate, the figures in Table B below can be used as an allowance for potential climate change impacts on peak design (i.e. 1% annual probability) fluvial flood level rather than undertaking detailed modelling.

Table B – Local allowances for potential climate change impacts

Watercourse	Central	Higher central	Upper
Thames	500mm	700mm	1000mm

Use of these allowances will only be accepted after discussion with the Environment Agency.

Fluvial food risk mitigation

Please use the national guidance to find out which allowances to use to assess the impact of climate change on flood risk.

For planning consultations where we are a statutory consultee and our Flood Risk Standing Advice does not apply, we use the following benchmarks to inform flood risk mitigation for different vulnerability classifications.

These benchmarks are a guide only. We strongly recommend you contact us at the pre-planning application stage to confirm this on a case-by-case basis. Please note you may be charged for pre-planning advice.

For planning consultations where we are not a statutory consultee or where our Flood Risk Standing Advice does apply, we recommend local planning authorities and developers use these benchmarks but we do not expect to be consulted.

Essential Infrastructure

For these developments, our benchmark for flood risk mitigation is for it to be designed to the **upper end** climate change allowance for the epoch that most closely represents the lifetime of the development, including decommissioning.

Highly Vulnerable

For these developments in flood zone 2, the **higher central** climate change allowance is our minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the **upper end** allowance.

More Vulnerable

For these developments in flood zone 2, the **central** climate change allowance is our minimum benchmark for flood risk mitigation. In flood zone 3 the **higher central** climate change allowance is our minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the **higher central** (in flood zone 2) and the **upper end** allowance (in flood zone 3).

Water Compatible or Less Vulnerable

For these developments, the **central** climate change allowance for the epoch that most closely represents the lifetime of the development is our minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the **higher central** to inform built in resilience, particularly in flood zone 3.

Further info on our Flood Risk Standing Advice:

https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities

There may be circumstances where local evidence supports the use of other data or allowances. Where you think this is the case we may want to check this data and how you propose to use it.

For more information

Please contact our Thames area Customers and Engagement team:

Enquiries_THM@environment-agency.gov.uk

Ms Clare Jones
Buro Happold Ltd.
Infrastructure Water
17 Newman Street
London
W1T 1PD

Our ref: ENVPAC/WTHAMS/00432 (WA/2017/124029/01-L01)

Date: 27 June 2017

Dear Ms Jones

The proposed development, includes the construction of a business park comprising between 55,000 and 60,000m2 office use (B1), parking for approximately 2,000 cars, associated highway, infrastructure and earthworks.

Bicester Office Park, Oxfordshire, OX26 1DE

Thank you for consulting us. We received confirmation to proceed with the work on 22 June and we are now in a position to respond.

We have reviewed the following documents:

- Emails from Clare Jones (Buro Happold), dated 02, 22, 27 June 2017
- Pre-application Enquiry Form
- Draft EIA Scoping Report produced by TRIUM Environmental, dated 15 May 2017
- Drawing 1105(SK)058 Rev A – Site Plan
- Drawing 1105(SK)065 Rev B – Parking Provision
- Drawing WSKL001 Rev 01 – Flood Extents 2017
- Drawing WSKL002 Rev 01 – 2007 and 2017 Flood Extents
- Drawing WSKL003 Rev 00 – Flood Extents Derived From Topographic Levels
- Drawing WSKL004 Rev 00 – Flood Extents Derived From 2011 LiDAR Data

We have reviewed the draft EIA Scoping report in relation to Flood Risk only as confirmed under our charging agreement. We disagree that the Flood Risk topic area should be scoped out of the EIA. Flood risk to this site is surely one of the most significant environmental impacts affecting this site and therefore should warrant assessment within the EIA. The reasoning given within the Scoping Report for scoping out this topic is frankly misinterpreting the level of risk on site. It fails to acknowledge that there are areas of this site at the highest level of flood risk (Flood Zones 3a and 3b). We would therefore be likely to object if an EIA was submitted for this site that did not include a chapter on flood risk.

We can confirm that the site is affected by the 1 in 20 year modelled flood extent and we consider this to be the functional floodplain (Flood Zone 3b). In normal circumstances we would not accept development of this type in areas at this high risk.

Cont/d..

However, this site has been allocated (Bicester 4) within the Cherwell District Council Local Plan and has been sequentially tested. We therefore have no in principle objection on flood risk grounds to this site coming forward for development.

To ensure that Policy Bicester 4 clearly states that a sequential approach should be followed and that where possible buildings should be located away from the highest risk of flooding. We are pleased to see from the drawings you have provided that no buildings are proposed within the 1 in 20 (functional floodplain) extents. We would accept car parking within this area of highest risk providing that there was no raising of ground levels.

However, we would expect that a sequential approach is taken to ensure that no built development is located in areas up to the 1 in 100 year plus climate change (plus 35%) flood level. We note that you have carried out an intermediate assessment to establish a new climate change level and then mapped it on a topographic survey. This shows buildings located in the 1 in 100 year plus climate change (plus 35%) flood extent which we feel is not in line with the principles of Bicester Policy 4.

We strongly advise that any master plan is re-orientated so that there is no built development or ground raising in areas within the 1 in 100 year plus climate change (plus 35%) flood extent. There appears to be plenty of car parking in areas at much lower risk and so we see no need to place any buildings within this area of risk.

We also have concerns that the 1 in 100 year plus climate change (plus 35%) flood level has been established by using the intermediate approach. Please find attached the Thames Climate Change Guidance which clearly states that a detailed assessment is required for 'Large-Major' development in Flood Zone 3a or 3b.

In summary, the scoping report is inadequate as it fails to represent the true level of flood risk affecting this site and makes recommendations that are flawed. The 1 in 100 year plus climate change flood level needs to be established by carrying out a detailed assessment as outlined in our guidance. The site must be developed in accordance with the principles as set out in Bicester Policy 4. This clearly stipulates that built development should be located in areas of the site at least flood risk.

Yours sincerely,

Mr Jack Moeran
Planning Specialist

Direct dial 02030259655
Direct e-mail planning-wallingford@environment-agency.gov.uk

End

Clare Jones

From: Moeran, Jack
Sent: 24 July 2017 14:20
To: Clare Jones
Subject: RE: THM48041 Product 4 Bicester Office Park, Oxfordshire,OX26 1DE

** External E-Mail **

Hi Clare,

Yes I'm happy that this is an accurate reflection of our conversation.

One point I would just like to clarify is the following:

- The EA confirmed it was acceptable to have car parking with Functional Floodplain (1 in 20 year extent), providing it wasn't increasing the level of 'use vulnerability' from what is existing and that there was no ground raising.

Thanks,

Jack Moeran
Planning Specialist

FCRM Planning Specialist - PSO - Thames Area

From: Clare Jones
Sent: 27 June 2017 17:13
To: 'Moeran, Jack'

Subject: RE: THM48041 Product 4 Bicester Office Park, Oxfordshire,OX26 1DE

Jack,

Thank you for your quick response to the pre-application enquiry. As a record of our earlier conversation today, please find below a summary of the items discussed:

EIA Water Chapter

- The EA has confirmed that they will require an EIA Water Chapter to be written for the site to accompany the Flood Risk Assessment for the Outline Planning Application. They explained that a site lying in Flood Zone 3(a and b) would be considered to be a significant environmental effect which would need to be assessed under an EIA. The EA advised that whilst an FRA was proposed, they would also expect to see the EIA Water Chapter.

Flood Extents

- The EA confirmed that the approach taken to define the flood extents for the 1 in 20, 1 in 100 and 1 in 1000 year using the flood levels against the topographic survey information was acceptable. Whilst the topographic survey information was available for most of the site, BHE explained that there was an area to the west where topo survey information was not available. The EA confirmed that it was acceptable to use LiDAR to define the flood extents in this area and to combine this with the flood extent derived from the topographic survey, provided this was explained on the drawings.
- The EA confirmed that they require hydraulic modelling to be undertaken to define the flood levels for the 1 in 100 + 25% and 1 in 100 + 35% climate change events. The same approach of deriving the flood extents based on

the topographic survey should be adopted. For the hydraulic modelling, the EA would expect to see an appendix to the FRA detailing the method adopted for the modelling and the results with a short summary in the FRA.
- The EA recommended that the flood extent plans submitted are overlaid with the parameter plan rather than the illustrative masterplan which could change in the future.

Development in the Flood Zones
- The EA confirmed it was acceptable to have car parking with Functional Floodplain (1 in 20 year extent), provided that there was no ground raising.
- The EA would seek that all buildings were located outside the 1 in 100 year + 35% extent.
- If ground raising is required between the 1 in 20 year and 1 in 100 year + climate change level (25%) then floodplain compensation would be required. BHE advised that parameter plans would be submitted for Outline planning and the need for flood compensation would not be known until detailed design. The EA agreed that this could be dealt with at a later date through a planning condition.

Finished Floor Levels
- The EA confirmed that the design flood event for the site is the 1 in 100 year +25% climate change event. The EA anticipate that the levels will be very close to the 1 in 100 year + 35% climate change event. The EA would seek that we adopt the 1 in 100 year +35% level with 300mm freeboard to define finished floor levels. The EA would review this if there was a significant difference in levels between the 1 in 100 year +25% climate change and 1 in 100 year +35% levels.

We would appreciate if you can review the above and confirm if this is an accurate record of the conversation.

Kind Regards
Clare

Clare Jones CEng MICE
Senior Engineer
BuroHappold Engineering | Water
T: +44 (0)1225 320600
www.burohappold.com | @burohappold

From: Moeran, Jack
Sent: 27 June 2017 12:05
To: Clare Jones
Subject: RE: THM48041 Product 4 Bicester Office Park, Oxfordshire,OX26 1DE

** External E-Mail **

Hi Clare,

Please find attached our response.

If you wish to chat any of the content through with me then please don't hesitate to give me a call.

Kind regards,

Jack Moeran
Planning Specialist

FCRM Planning Specialist - PSO - Thames Area

From: Clare Jones [mailto:Clare.Jones@BuroHappold.com]
Sent: 27 June 2017 10:04
To: Planning_THM <Planning_THM@environment-agency.gov.uk>

Subject: RE: THM48041 Product 4 Bicester Office Park, Oxfordshire,OX26 1DE

Jack,

Further to my email below, please find attached drawings showing the flood extents derived from survey data from both topographic survey information (2007) and LiDAR Data (2011, 1m resolution) with the illustrative masterplan. We would propose to refine the modelled flood extents to those defined from the topographic survey information. Unfortunately as the topo survey does not cover a section west of the site so for this section, we would propose to defer back to the LiDAR contour. The methodology for defining the flood extents is summarized below. We are intending to write this up in more detail for the FRA but before we do, we would appreciate the EA's view on this methodology. Also attached, are drawings showing the current EA extents overlaid with the illustrative masterplan and showing the flood extents from the 2007 OPA FRA for the site for information.

The flood extents have been derived by the following means:

- Flood model level information has been extracted from the Langford Brook (Bicester) & Pingle-Back- Bure 2010 ISIS-TUFLOW Model for Points A to G in the floodplain. It has been assumed that the levels within the floodplain are the same as within the corresponding point in the river channel. Using 3D modelling software, a flood level surface for each return period event has been created by interpolating between the flood level points defined in the floodplain and the channel.
- The survey information used (topographic survey or LiDAR) has been used to create a ground level surface by interpolating between the LiDAR contours/ topographic survey points.
- 3D modelling software has then been used to determine where the flood level meets the ground level surface. The model has defined a contour for each of the flood level extents which is provided on the attached drawings.

In addition to the 1 in 20, 1 in 100 and 1 in 1000 flood extents, the climate change allowance has been calculated. In accordance with February 2016 climate change guidance, for office developments (defined as Less Vulnerable) in Flood Zone 3a, the central and higher central allowances are required to be assessed. For the Thames region, this would require the 25% and 35% climate change allowances to be considered. We have defined these using the Intermediate approach as follows:

1. 1D flood levels and flows have been extracted out of the Langford Brook (Bicester) & Pingle-Back- Bure 2010 ISIS-TUFLOW Model for Points LA.0865, LA.0957 and LA.1350 for the 1 in 5, 1 in 20, 1 in 100, 1in 100+20% and 1 in 1000
2. The above flow (Q) data was plotted against flood level (H) data and a line of best fit derived.
3. For the 1 in 100 year + 25% and 1 in 100 year + 35%, the flood flows were calculated using the below relationship, with the 35% value used as an example:

$$\left(\frac{100yr+20\%CC-100yr}{20}\times(35-20)\right)+100yr+20\%CC$$

4. Using the line of best fit HQ relationship, the flood levels for the 1D flood levels at A, B, C and G for the 1 in 100 year + 25% and 1 in 100 year + 35% have been calculated.
5. The 1 in 100 year + 25% and 1 in 100 year + 35% in the 2d domain have then been calculated based on scaling the level differences between the 1d and 2d domains from the other return periods.
6. For the remaining points (i.e. D,E and F, the levels have been interpolated)

Hopefully the above illustrates that we have taken an appropriate approach to defining the flood extents in this location. Please give me a call if you have any queries.

Kind Regards,

Appendix D Flood Extents Drawing

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N

POINT ID	X	Y	1 in 20 (mAOD)	1 in 100 (mAOD)	1 in 100 + 25%CC (mAOD)	1 in 100 + 35%CC (mAOD)	1 in 1000 (mAOD)
A	458310.6	221537.4	64.91	64.94	64.95	64.96	64.99
B	458224.2	221529.9	N/A	N/A	64.82	64.84	64.89
C	458161.6	221516.1	N/A	64.77	64.81	64.83	64.87
D	458087.7	221502.4	N/A	N/A	N/A	64.80	64.85
E	457863.6	221468.6	64.51	64.58	64.63	64.65	64.70
F	457695.8	221400.9	N/A	N/A	64.61	64.63	64.67
G	458256.2	221457.9	64.90	64.93	64.95	64.96	64.99
H	458057.7	221375.2	64.64	64.72	64.76	64.78	64.82
I	457895.8	221372.8	64.46	64.56	64.62	64.64	64.69

SITE BOUNDARY

A FLOOD LEVEL DATA POINT

2018 FLOOD EXTENTS

1 IN 20 YEAR FLOOD EXTENT

1 IN 100 YEAR FLOOD EXTENT

1 IN 1000 YEAR FLOOD EXTENT

1 IN 100 YEAR +25%CC FLOOD EXTENT

1 IN 100 YEAR +35%CC FLOOD EXTENT

Notes

BACKGROUND OS TILE Ref. 10019980

COMBINED LiDAR (2M RESOLUTION) DIGITAL TERRAIN MODEL DOWNLOADED FROM http://environment.data.gov.uk. CONTAINS PUBLIC SECTOR INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE v3.0.

TOPOGRAPHIC SURVEY BY GREENHATCH (FEBRUARY 2018)

ARCHITECT PARAMETER PLAN Ref. 1105_P_005

FLOOD LEVEL INFORMATION DERIVED FROM THE BICESTER OFFICE PARK 2018 HYDRAULIC MODEL CREATED BY BUROHAPPOLD BASED ON THE ENVIRONMENT AGENCY'S PRODUCT 6 DATA JUNE 2017 (LANGFORD_BROOK_BICESTER_&_PRINGLE BACK BURE_2010 MODEL). CONTAINS ENVIRONMENT AGENCY INFORMATION © ENVIRONMENT AGENCY AND/OR DATABASE RIGHT.

THE FLOOD EXTENTS HAVE BEEN DERIVED BASED ON THE 2018 TOPOGRAPHIC SURVEY INFORMATION WHERE THIS EXISTS AND THE LiDAR DIGITAL TERRAIN MODEL WHERE THE TOPOGRAPHIC SURVEY DOES NOT EXIST.

Rev	Description/Date	Drn/Chk
06	UPDATED FLOOD EXTENTS FROM MODEL / 29.03.18	SM/CJ
05	MINOR CHANGES TO FLOOD EXTENTS / 29.11.17	SM/CJ
04	UPDATED FLOOD EXTENTS FOR NEW TOPO SURVEY / 17.10.17	SM/CJ
03	AMENDED PROJECT NAME INFORMATION / 12.09.17	SM/CJ

INFORMATION

Status of drawing

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Architect *Bennett Associates*

Project **Bicester Office Park**

Drg Title FLOOD EXTENTS DERIVED FROM COMBINED LiDAR AND 2018 TOPO SURVEY

Scales@A3 1:2500

Drawn by SM

Checked by CJ

Date JULY 2017

Job No. 0040031

Drg No. WSK005

Rev 06

Simon Mudd \\srv-london05\CAD\0040031 Bicester Business Park- Planning Support\F34 Water\Sheet\Sketches\WSK005.dwg

Appendix E Hydraulic Modelling Note

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BUROHAPPOLD ENGINEERING

Design Note

Project	Bicester Office Park
Subject	Hydraulic Modelling Note for updated topographic survey
Project no	0040031
Date	9 April 2018

Revision	Description	Issued by	Date	Approved (signature)
00	For Planning	NV	09/04/18	[redacted]

1 Introduction

In December 2017 Scenic Land Developments Ltd. submitted an Outline Planning Application (Planning Ref 17/02534/OUT) for new office buildings and car parking at Bicester Office Park, south of Bicester (NGR SP579 215). To support the planning application, BuroHappold Engineering (BuroHappold) completed a Flood Risk Assessment (FRA) for the proposed site.

Since submission of the planning application, BuroHappold has undertaken hydraulic flood modelling for the site. This has involved updating the EA's 2010 hydraulic model with site specific topographic survey data to better inform the fluvial flood risk at the site.

BuroHappold has produced this Technical Note to provide details of the hydraulic modelling and the flood levels estimated at the site. The site specific flood level information will be used to update the FRA issued for Planning in December 2017.

This TN has been issued to the Environment Agency (EA) for the purposes of gaining their formal approval to adopt the flood levels and flood extents produced from the site specific hydraulic model within the Flood Risk Assessment. Once formal EA approval has been provided this information will be used to inform the Bicester Office Park design proposals.

1.1 Hydraulic Modelling Summary

The table below provides a summary of the hydraulic flood models used in the assessment and the main differences between them.

Model Description	Model Reference Name in Report	Comments
EA Langford_Brook_Bicester_&_Pingle-Back-Bure_2010	EA 2010 model	- ISIS-TUFLOW Model issued to BH 31/05/17 - Final Design Model Ref Name: 'Bicester_012_17hr' - Model simulated for the 1 in 5yr, 20yr, 50yr, 100yr, 100yr+20%CC and 1000yr flood events.

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		- Based on survey data undertaken February to April 2007 and 2003 LiDAR data. - Simulated using a 10m x 10m grid resolution - ISIS-TUFLOW 1D-2D model (ISIS version 3.1 and TUFLOW version 2008-08-AH-iSP).
EA 2010 model with climate change	BH 2017 model	- Model inflows increased to simulate the 1 in 100yr+25%CC and 1 in 100yr+35%CC events (see BH Technical Note in Appendix A). - Simulated using a 10m x 10m grid resolution - ISIS-TUFLOW 1D-2D model (ISIS version 3.6 and TUFLOW version 2016-03-AE-iSP-w64).

Bicester Office Park (BOP) model	BH BOP 2018 model	- Model updated to include the following:
		  - Modified 2D boundary
		  - Topographic Survey undertaken by GreenHatch Group issued on 28/09/17 – used to represent 2D floodplain within site boundary.
		  - Topographic Survey undertaken by GreenHatch Group issued on 19/02/18 – used to represent 1D in-channel cross sections and 2D floodplain between the site and Langford Brook.
		  - Most recent available LiDAR (combined dataset from 2003 and 2011 from data.gov.uk)
		- Simulated using a 2m x 2m grid resolution rather than 10m x 10m.
		- Model simulated for the 1 in 20yr, 100yr, 100yr+25%CC, 100yr+35%CC and 1000yr flood events.
		- ISIS-TUFLOW 1D-2D model (ISIS version 3.6 and TUFLOW version 2016-03-AB-iSP-w64).

Table 1.1 Summary of hydraulic models undertaken at the proposed site

1.2 Purpose of Hydraulic Modelling Study

Since the submission of the planning application in December 2017, further topographic survey has been undertaken for the site and the adjacent floodplain. To more accurately assess the flood risk at the proposed Bicester Office Park, the EA 2010 model has been updated to create a hydraulic model (BuroHappold BOP 2018 model) with the latest topographic survey information.

The predominant flood risk identified at the site is due to overtopping of the right bank of the Langford Brook after it passes through the railway embankment. The ground levels are generally flat between the site and the river (approximately 1 in 1000 gradient) and therefore, relatively sensitive to changes in flood level. A series of ditch networks and ponds surround the site, which may have an impact on the flood mechanism not currently represented in the EA 2010 model. As such, a higher resolution of the floodplain has been defined in the BuroHappold BOP 2018 model to better represent the ditches within the model and therefore the flood mechanism at the site. This is discussed further in section 2.1.

2 Hydraulic Modelling Methodology

2.1 Model Set-Up

As discussed in section 1.2, the purpose of the modelling was to more accurately depict the ditches and variations in topography in and around the site. The ditches surveyed varied in width between 3m and 6m. It was considered that a 2m x 2m grid resolution in the 2D domain would be more representative than the EA 2010 model's 10mx 10m resolution. In order to simulate the hydraulic model over an appropriate run time based on a higher resolution, a reduced 2D domain was required compared to the EA 2010 model which was based on a 10m x 10m grid resolution.

The A41, north of the site, and the railway line to the east of the site, form an embankment preventing overland flow reaching the site from upstream areas. Therefore, it was considered that the location at which the Langford Brook flows through the railway embankment, immediately upstream of the site, was an appropriate location to truncate the EA 2010 model and use as the start location for the site specific model.

Figure 2.1 below indicates the 2D domain extent in the EA 2010 model and the BuroHappold Bicester Office Park (BOP) 2018 model.

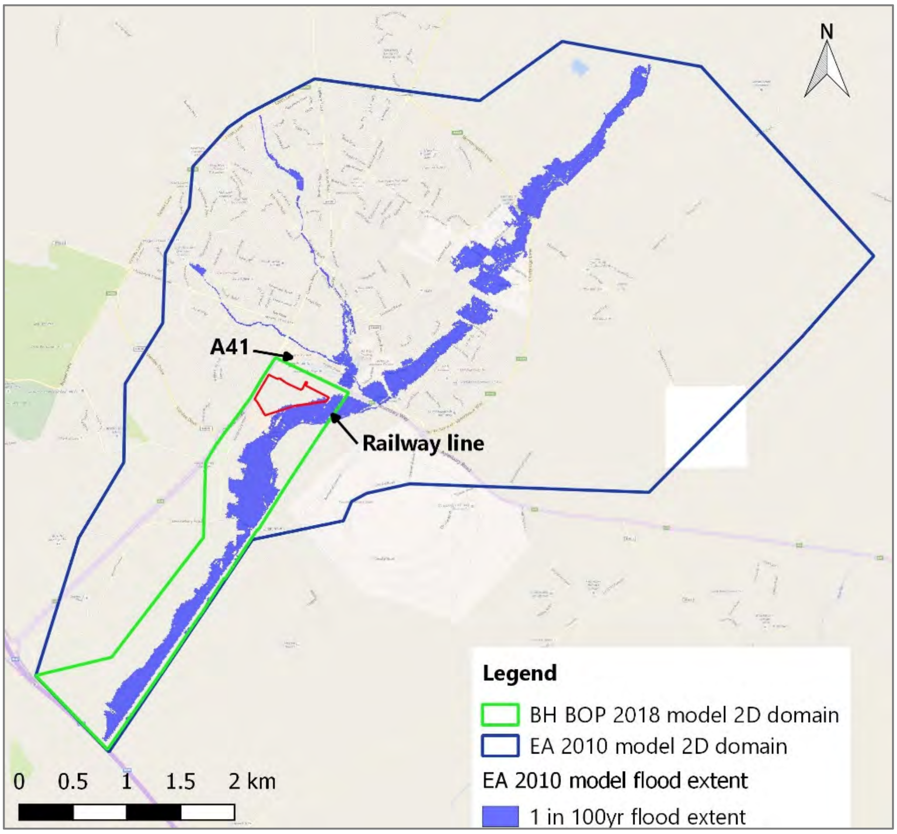

Figure 2.1 BuroHappold BOP 2018 model 2D domain extent compared to EA 2010 model 2D domain and 1 in 100 year flood extent. Site boundary shown in red.

2.2 Model Testing

Prior to creating the BuroHappold BOP 2018 model, BuroHappold undertook modelling test runs of the EA 2010 model and the truncated model to ensure suitability of use in the study. The table below provides a summary of the two models.

Model Description	Model Reference Name in Report	Comments
EA 2010 model re-run (test model)	BH re-run 2018 model	- EA model re-run on more recent software versions before site specific model created. - Model run to assess impact of software versions on results. - EA 2010 model run for 1 in 20yr event, and 1 in 100 year event. - Simulated using a 10m x 10m grid resolution - ISIS-TUFLOW 1D-2D model (ISIS version 3.6 and TUFLOW version 2016-03-AB-iSP-w64).
EA 2010 model truncated (test model)	BH truncated 2018 model	- EA model truncated at the railway embankment (NGR 458277, 221357) to reduce size of model extent. - A test simulation for the 1 in 20yr event and 1 in 100 year event created to compare to EA 2010 results. - Simulated using a 10m x 10m grid resolution - ISIS-TUFLOW 1D-2D model (ISIS version 3.6 and TUFLOW version 2016-03-AB-iSP-w64).

Table 2.1 Summary of elements included in test model runs

The BH truncated 2018 model (model C in Table 2.2) was set up based on the EA 2010 model set-up (model A in Table 2.2), except for the 2D domain which was reduced (as shown in Figure 2.1) and the corresponding 1D layers edited to enable the model to be simulated from the railway embankment. The BH truncated 2018 model was created to test whether truncating the model would be appropriate to assessing any topographic changes at the site as part of the site specific model.

The model was also simulated using more up-to-date software versions, therefore a re-run of the EA 2010 model (model B in Table 2.2) was also undertaken to determine any effects on flood levels that may be caused by the software alone. Test runs were undertaken for both the 1 in 20 year event and 1 in 100 year event.

The results of the flood extents are shown below in Figure 2.2 and Table 2.2 below.

1 in 20yr event

ID Ref	EA 2010 model (mAOD) (A)	BH re-run 2018 model (mAOD) (B)	Diff of B from A (mm)	BH truncated 2018 model (C)	Diff of C from B (mm)
1D Node					
LA.1350D	65.268	65.273	5	65.275	2
LA.0957	64.548	64.540	-8	64.533	-7
LA.0865	64.438	64.430	-8	64.424	-6
LA.0767	64.302	64.294	-8	64.290	-4
LA.0737	64.221	64.217	-4	64.214	-2
LA.0726	64.217	64.213	-4	64.211	-2
2D Point					
1	64.832	64.821	-11	64.819	-2
2	64.666	64.649	-18	64.647	-1
3	65.026	65.014	-13	65.013	-1
4	64.817	64.810	-7	64.808	-2
5	64.368	64.372	4	64.372	1
6	64.636	64.624	-12	64.623	-1

1 in 100yr event

ID Ref	EA 2010 model (mAOD) (A)	BH re-run 2018 model (mAOD) (B)	Diff of B from A (mm)	BH truncated 2018 model (C)	Diff of C from B (mm)
1D Node					
LA.1350D	65.367	65.378	11	65.373	-5
LA.0957	64.632	64.622	-10	64.607	-15
LA.0865	64.526	64.525	0	64.512	-13
LA.0767	64.388	64.382	-6	64.369	-13
LA.0737	64.266	64.265	-1	64.258	-8
LA.0726	64.259	64.258	-1	64.251	-7
2D Point					
1	64.946	64.935	-12	64.925	-10
2	64.740	64.735	-5	64.725	-10
3	65.120	65.113	-7	65.104	-9
4	64.911	64.904	-6	64.893	-11
5	64.433	64.440	6	64.430	-10
6	64.720	64.721	1	64.710	-11

Table 2.2 Flood level data extracted from the EA 2010 model and compared to the re-run and truncated models (BH re-run 2018 model and BH truncated 2018 model respectively) for the 1 in 20 year event and 1 in 100 year event

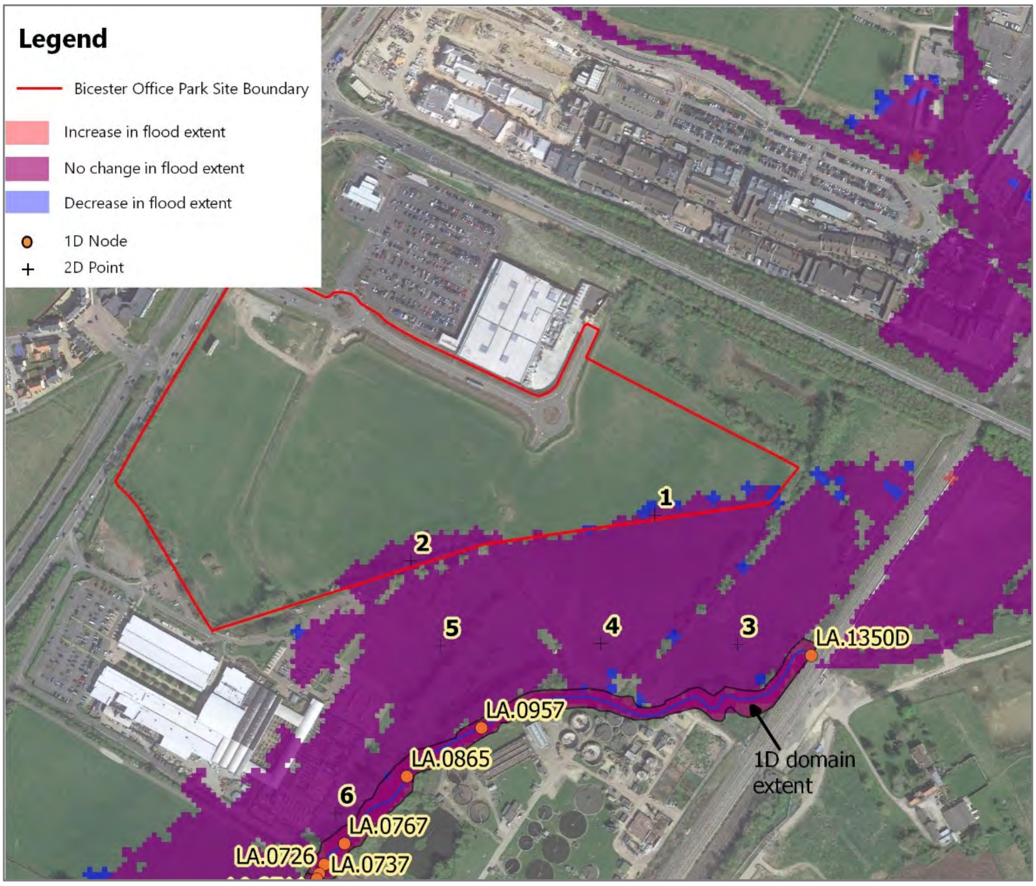

Figure 2.2 Result location map showing change in 1 in 20 year event flood extent between EA 2010 model and re-run of the model (BH re-run 2018 model). Result location points indicated.

The results indicate a minor change in flood level, less than 20mm when the EA 2010 model was re-run using more recent software (BH re-run 2018 model). Truncating the model at the railway embankment also showed minor changes in flood level, with changes in the 2D domain observed at less than 2mm. These variations in flood levels are considered to be within modelling tolerances.

Therefore, truncating the model is considered appropriate for the site specific hydraulic model.

2.3 Model Topography

The updated 2017 and 2018 topographic survey for the site was based on the following parameters:

- Elevation data recorded every 15m across the site
- Cross sections along the ditch network and pond recorded every 15m along the length, picking up top of bank and bed levels.
- 10 Nr cross sections surveyed within the river channel recording bed level and top of bank level.

Both the 1D and 2D components of the BuroHappold BOP 2018 model have been updated to better represent the ground conditions in the river and surrounding site. 3D point data was received by Greenhatch Group of the ground elevation levels. This data was read into 12d software and interpolated to derive a topographical surface. The data was stitched to the most recent 2m resolution filtered LiDAR data for the surrounding area to form a Digital Elevation Model (DEM) file that could be read into the TUFLOW software. The Composite Digital Terrain Model LiDAR data was obtained from the open source government website (https://environment.data.gov.uk). This is based on data collected from the area in the years 2003 and 2011. The LiDAR data was also used for the remaining area within the model (outside the site). Appendix B illustrates the surveyed topography and the extent of the LiDAR data used in proximity of the site.

The figure below provides an illustration of the differences between the survey data and the topographic data used in the EA 2010 model (based on a 2m resolution output). Parts of the floodplain between the site and the Langford Brook are lower by up to 200mm in the updated topographic survey compared to the LiDAR data.

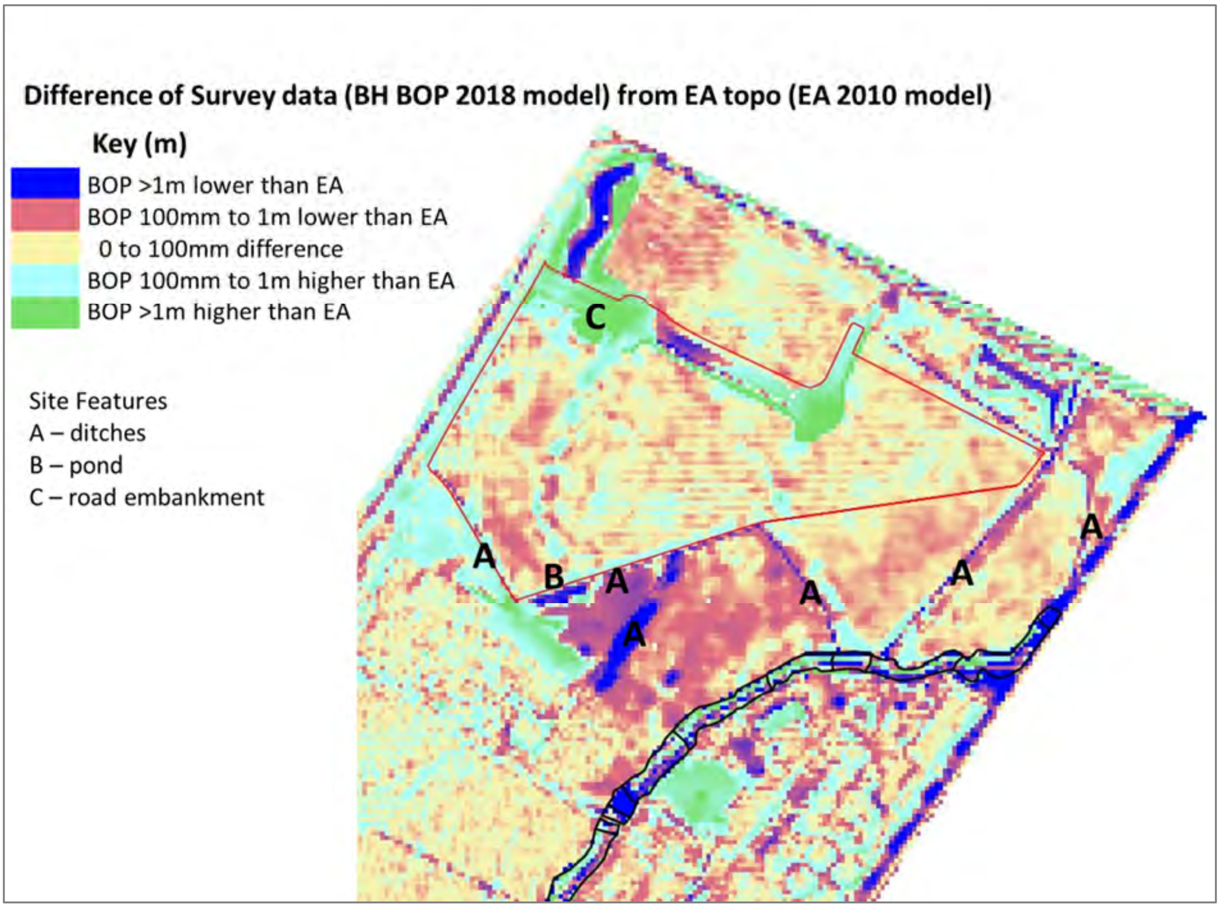

Figure 2.3 Topographic data in BuroHappold BOP 2018 model compared to topographic data used in EA 2010 model

Updated cross section survey data have also been incorporated into the BuroHappold BOP 2018 model. The distance from the upstream 1D Node LA.1350D in the EA 2010 model to the next downstream cross section was almost 400m. Additional cross sections were included to reduce the distance between sections, to approximately 100m or where changes in the channel section were observed. Where possible, updated levels were taken at the locations of the EA 2010 cross sections.

The figure below indicates the locations of the new 1D Nodes (blue) within the BuroHappold BOP 2018 model compared to the EA 2010 model (orange). Cross section survey data was recorded between the railway embankment at the upstream end (LA. 1350D) and the road crossing (LA.0726). The remaining 1D cross sections downstream of the road crossing in the BuroHappold BOP 2018 model were based on the EA 2010 model.

To ensure that the connection between 1D and 2D appropriately modelled out of bank flooding, the elevation was extracted every 2m along the bank edge either from the survey data or the LiDAR and incorporated in the 2d_bc_HX layer. This enabled the low points where the ditches outfall into the Langford Brook to be picked up more accurately within the model.

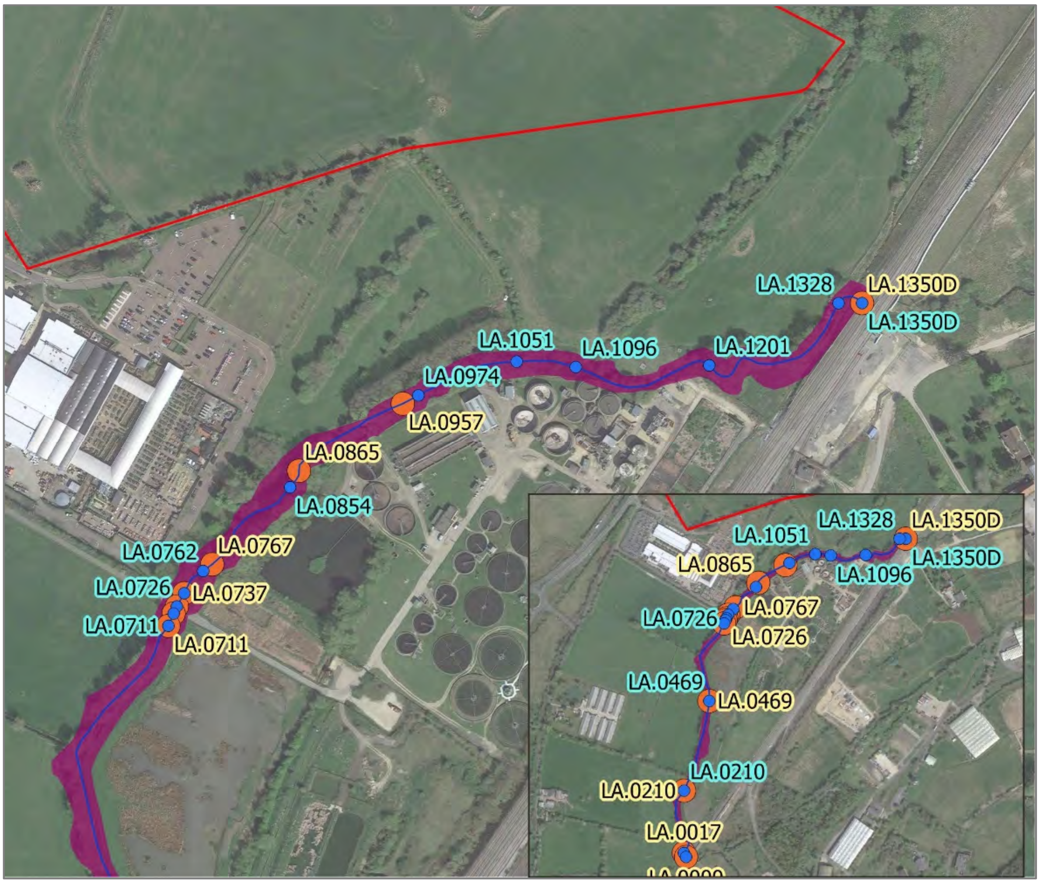

Figure 2.4 Location of 1D Nodes in the EA 2010 model (orange dot) and the BuroHappold BOP 2018 model (blue dot). Inset shows full extent of 1D model.

2.4 Ground Condition

The varying ground conditions were represented in the model using Manning's roughness value. The EA 2010 model included different values for the channel bed and bank edge roughness to differentiate the dense vegetation along the bank edge. The same values were used in the updated 1D cross sections and in the 2D domain along the river edge. This ensured that instability issues were reduced during out-of-bank flooding. The EA 2010 model used the default value of 0.05 for the floodplain. This was amended in the BuroHappold BOP 2018 model to differentiate ground conditions between the location of the ditches and vegetation within the site. The remainder of the site observed as grass cover was represented using a lower value where the roughness is less. The table and figure below summarises the values used in the BuroHappold BOP 2018 model.

Feature	Manning's roughness value (n)
Channel bed	0.05
Channel bank	0.06
Ditches and vegetation	0.06
Grass cover	0.035

Table 2.3 Manning's roughness values used in the 1D and 2D component of the BuroHappold BOP 2018 model.

Figure 2.5 Illustration of the extent that different Manning's roughness values were applied in the 2D component of the BuroHappold BOP 2018 model.

2.5 Hydraulic Structures

Within the ditch network surrounding the site, circular culverts connect flow through the ditches where paths and roads cross the ditch. This was represented in the 2D domain using a 1d_nwk layer. Figure 2.6 indicates the location of the pipes included in the model. Invert levels and pipe dimensions were incorporated based on those surveyed in the 2018 topographic survey. Ground elevations were locally modified where required to incorporate the pipe details.

Figure 2.6 Location of pipes within ditch network shown by red squares

2.6 Model Boundaries

Hydrological analysis was not undertaken for this study. The EA 2010 model underwent a detailed study of estimating rainfall runoff in the wider catchment area and used five storm events to calibrate the hydraulic model. In 2017 BuroHappold undertook an additional analysis to estimate flood flows during different climate change events based on

EA guidance that was published subsequent to the construction of the EA 2010 model. Details of the BuroHappold 2017 study are provided in Appendix A.

The estimated flow from both the EA 2010 model and the BuroHappold 2017 model was extracted and included as hydrographs in a QT (flow-time) unit boundary in the 1D ISIS model at Node LA.1350D. Table 2.4 and Figure 2.7 illustrate the hydrographs used in the assessment and the hydraulic models from which the data was extracted.

Storm Event (Return Period)	Hydraulic Model Hydrograph Extracted
1 in 20 year	EA 2010 model
1 in 100 year	EA 2010 model
1 in 100 year + 25% Climate Change	BH 2017 model
1 in 100 year + 35% Climate Change	BH 2017 model
1 in 1000 year	EA 2010 model

Table 2.4 Return periods assessed in study and the hydraulic model from which the data was extracted

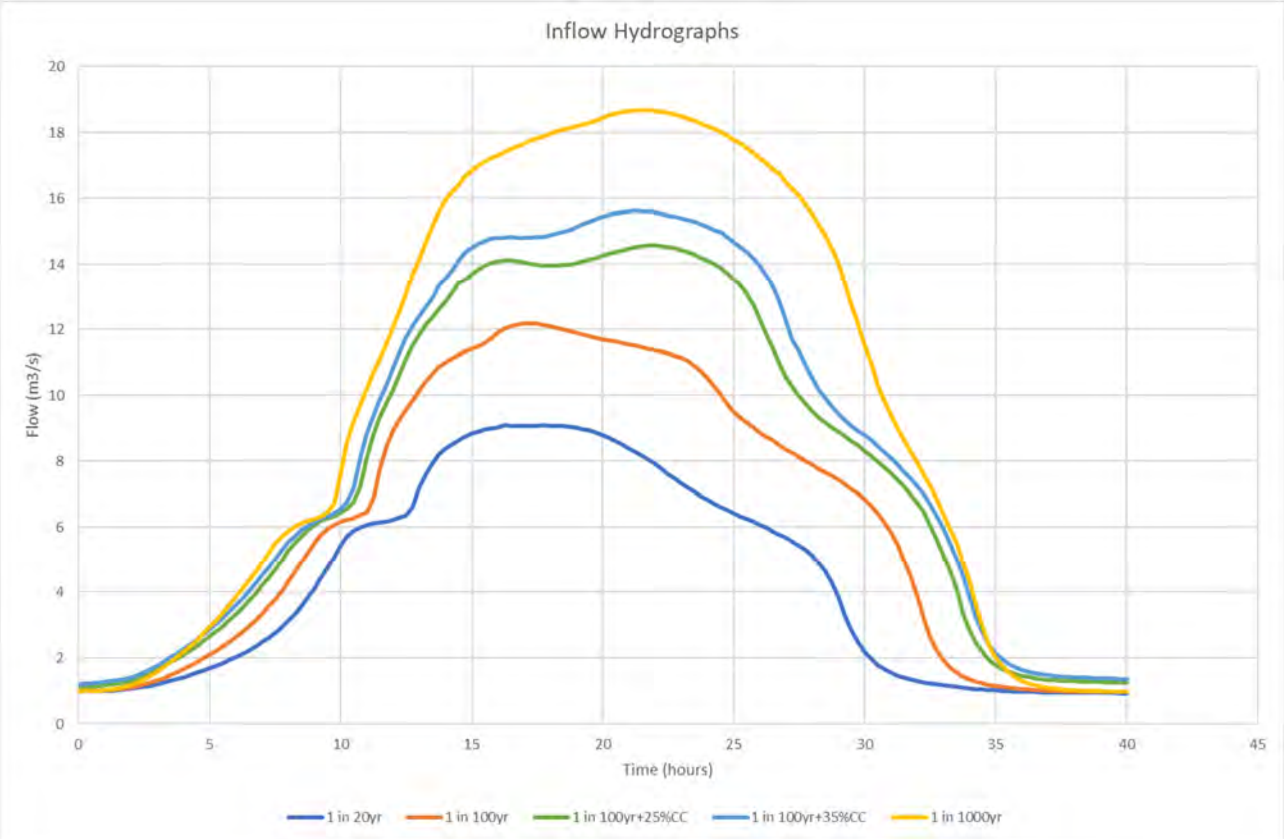

Figure 2.7 Inflow hydrographs used in the BuroHappold BOP 2018 model

The downstream boundary remained as that in the EA 2010 model; an HQ (stage-discharge) boundary in the 2D domain. This is located on the downstream side (east side) of the railway embankment to capture flow discharging through the four circular culverts in the railway embankment.

Two lateral inflows were linked to the final two cross sections in the 1D model (Nodes LA.0210 and LA.0017) in the EA 2010 model. These inflows were also included in the BuroHappold BOP 2018 model as lateral inflow units.

Surface water discharging from the ditches surrounding the site into the Langford Brook are not considered to be significant and therefore were not included in the model. However, standing water is understood to be present year-round within the pond (labelled B in Figure 2.3). This was included in the BuroHappold BOP 2018 model using an initial water level set at 64.26mAOD. A site visit confirmed that the upstream section of the pond has an informal weir and would therefore restrict the flow of water further downstream along the ditch and reduce the amount of flood storage available. The weir was represented in the model at the pond inlet location by locally modifying the bed elevation to match the pond water level.

3 Design Storm Event

Consultation with the EA undertaken for the Flood Risk Assessment identified the storm events presented in Table 3.1 as being required for assessment when setting design levels at the proposed Bicester Office Park site.

Storm Event (Return Period)	Design Implication
1 in 20 year	Classified as Functional Floodplain (Flood Zone 3b). Car parking considered acceptable provided no ground raising.
1 in 100 year + 25% Climate Change	Design Flood Event for proposed development. Any ground raising within the flood extent (outside 1 in 20 year extent) would require flood compensation.
1 in 100 year + 35% Climate Change	Buildings to be located outside of flood extent.
1 in 100 year + 35% Climate Change + 300mm freeboard	Minimum elevation finished floor levels should be set at.
1 in 1000 year	Area outside extent considered at a low risk from fluvial flooding

Table 3.1 Storm events and their implications on design at the proposed site.

The BuroHappold BOP 2018 model provides a refinement to the flood extents observed at the proposed site based on the latest and most up-to-date topographic data for the site and surrounding area. The next section indicates the estimated flood levels at the site at key locations within the site boundary.

4 Modelling Results

The flood mechanism observed from the model outputs indicate that the ditch network is being depicted more accurately in the BuroHappold BOP 2018 model than in the EA 2010 model, which has a lower resolution. Out-of-bank flooding along the ditch network occurs earlier in the storm event and extends north before flowing westwards towards the site. The image below illustrates the movement of water in the vicinity of the site between the EA 2010 and BuroHappold BOP 2018 models. The flow mechanism in both models is similar, with main differences likely being attributed to the differences in ground topography and model grid resolution. Flood flows that pass the site, re-enter the Langford Brook upstream of the road crossing, or overtop the road in both models.

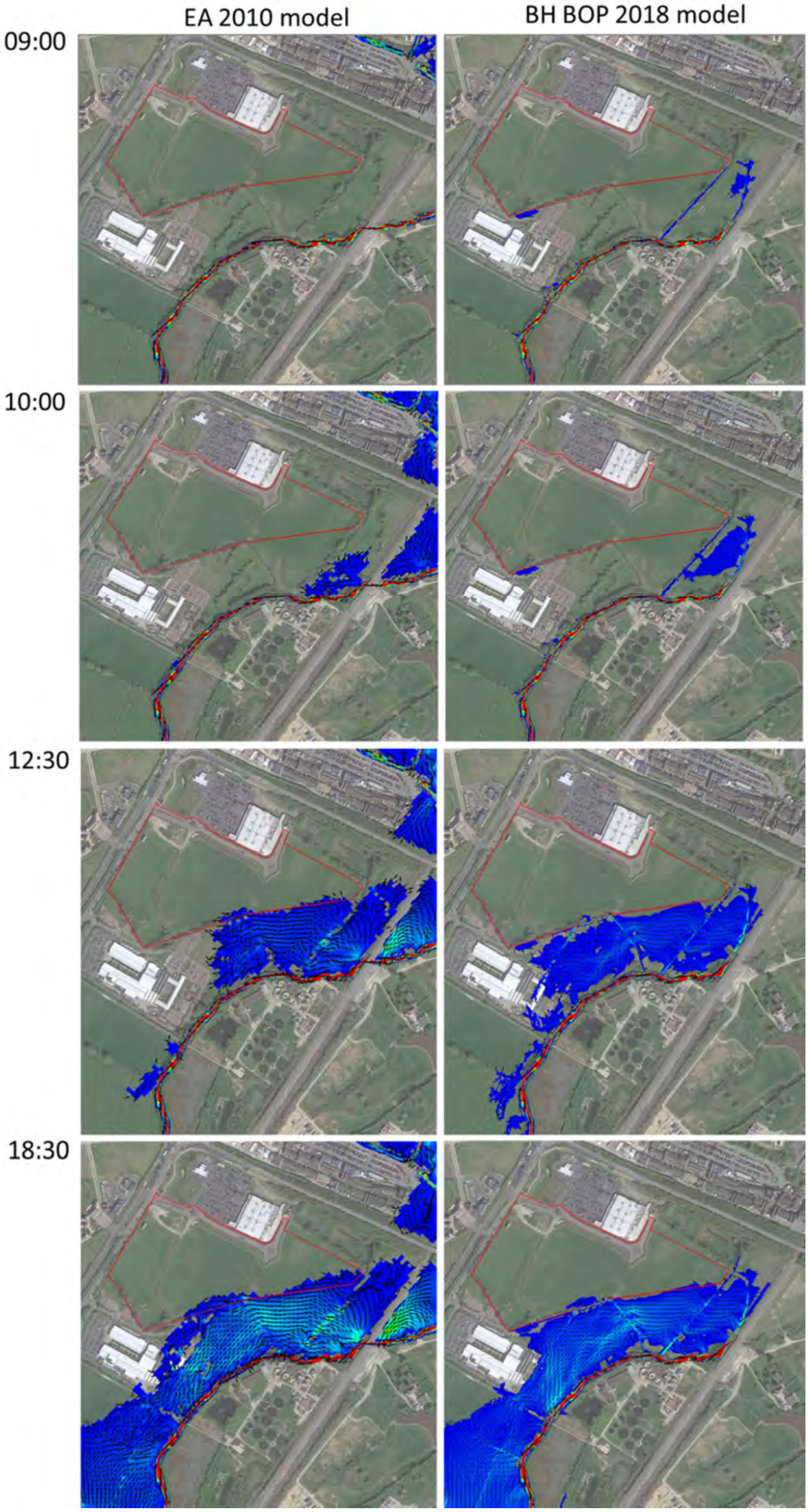

Figure 4.1 Images illustrating the flood mechanism in the EA 2010 model compared with the BuroHappold BOP 2018 model at different time outputs (shown on the left) within the 1 in 100year + 35% allowance for climate change model run. Images show flow output with arrows indicating direction of flow. The last image (time 18.30) shows the maximum extent observed at the site.

A sensitivity test was undertaken for the 1 in 100 year plus 35% allowance for climate change event varying the Manning's 'n' value in both the 1D and 2D components by +/- 20%. The results show the following:

- 20% increase in Manning's value = ~40mm increase in flood level
- 20% decrease in Manning's value = ~20mm decrease in flood level

ID Ref	BH BOP 2018 model (mAOD)	BH BOP 2018 model +20% Manning's (mAOD)	Diff of BH +20% Manning's from BH BOP 2018 (mm)	BH BOP 2018 model - 20% Manning's (mAOD)	Diff of BH -20% Manning's from BH BOP 2018 (mm)
1D Node					
LA.1350D	65.260	65.326	66	65.240	-20
LA.1328	65.291	65.333	42	65.275	-15
LA.1201	64.982	65.016	34	64.965	-17
LA.1096	64.844	64.866	23	64.825	-19
LA.1051	64.759	64.793	34	64.739	-20
LA.0974	64.662	64.702	40	64.639	-23
LA.0854	64.574	64.613	39	64.557	-17
LA.0762	64.527	64.562	35	64.512	-14
LA.0743	64.488	64.528	40	64.469	-19
LA.0726	64.444	64.484	40	64.425	-20
2D Node					
1	64.810	64.857	47	64.788	-22
2	64.651	64.695	44	64.625	-25
3	64.968	64.996	28	64.960	-8
4	64.775	64.820	45	64.753	-23
5	64.540	64.575	36	64.525	-15
6	64.636	64.683	47	64.611	-25

Table 4.1 Comparison of flood levels derived for the sensitivity tests +/- 20% Manning's value

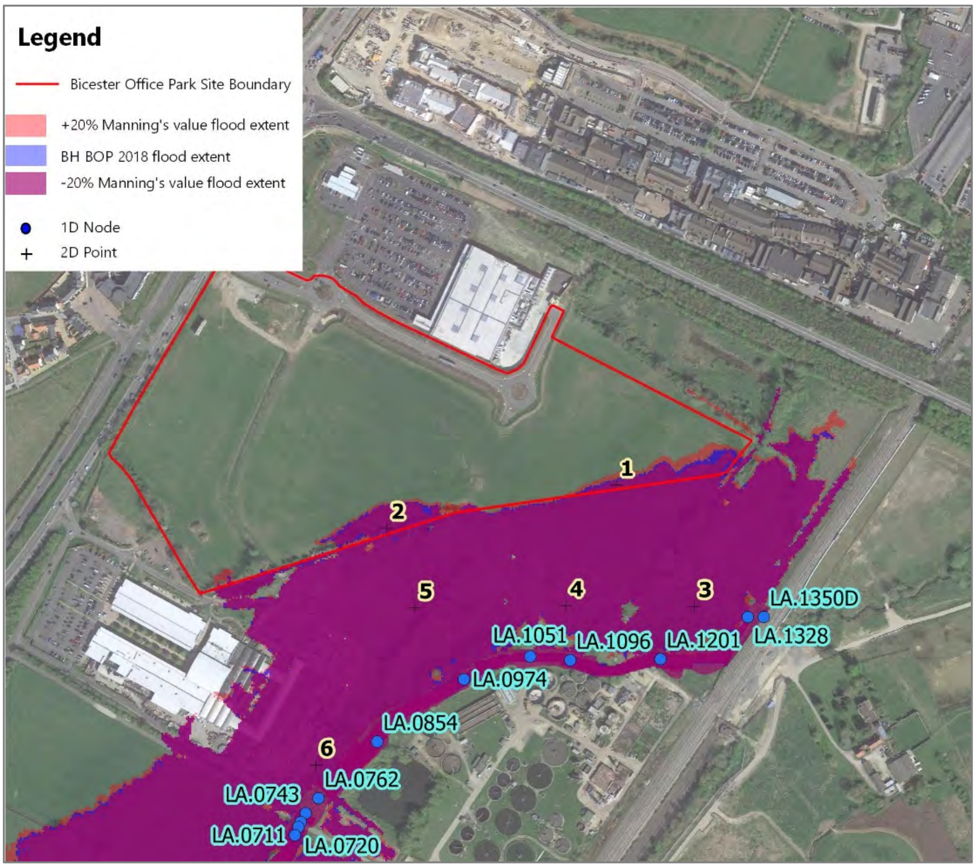

Figure 4.2 Change in flood extent from BuroHappold BOP 2018 model extent for the 1 in 100 year plus 35% allowance for climate change due to +/- 20% in Manning's value.

Table 4.1 and Figure 4.2 indicate that by adjusting the Manning's value slight changes are observed in flood level and extent. These changes are generally consistent across the area producing very similar flood extents within the site boundary. The results indicate that the model sensitivity in the BuroHappold BOP 2018 model is relatively consistent and therefore, appropriate for its use in this study.

The flood extents observed from the site specific BuroHappold BOP 2018 model are presented in Figure 4.3 and Table 4.2 below. The results indicate that parts of the south eastern boundary of the site is within the functional floodplain (1 in 20 year event) and at risk from events including the 1 in 1000 year event. Further flood level data is provided in Appendix C.

It is recommended that the flood levels in Table 4.2 are used for future development proposals within the site boundary, in line with the recommendations in Table 3.1.

An assessment of the flood hazard, based on EA Defra guidance[1], indicates that the hazard is considered very low within the site boundary during a 1 in 100 year event with a 35% allowance for climate change (see Figure 4.4).

Due to the smaller 2D grid size compared to the EA 2010 model, the timestep in 2D was decreased from 4s to 2s and from 2s to 1s in 1D. This improved the stability of the model run. The performance of the model is considered appropriate and a healthy model, with the maximum cumulative mass error being less than 0.12% for all design simulations.

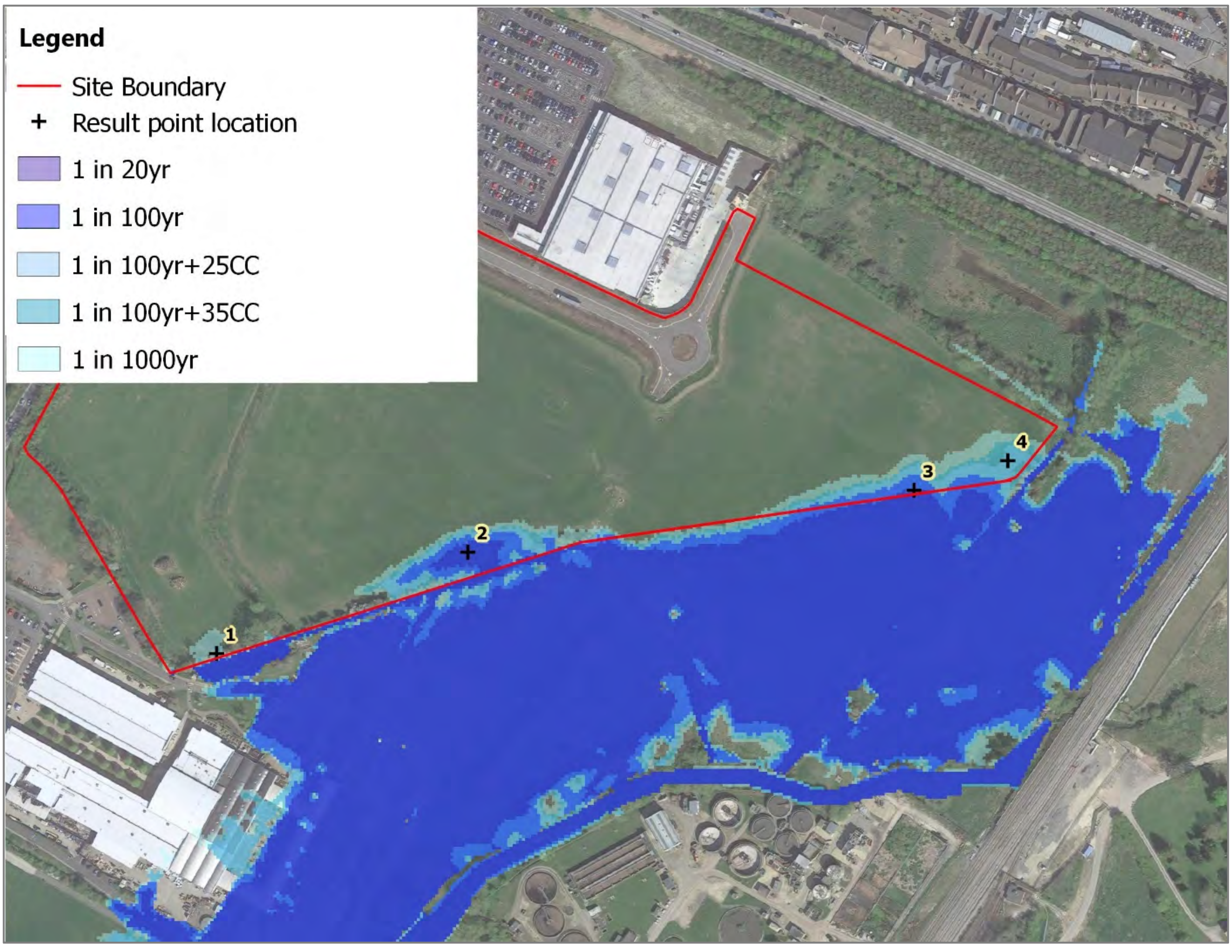

Figure 4.3 Flood map extent for different return periods as simulated in the BH Bicester Office Park 2018 model. See Table 4.2 for flood levels at the location points identified.

ID	Easting	Northing	Flood Level (mAOD)				
			1 in 20yr	1 in 100yr	1 in 100yr+25%CC	1 in 100yr+35%CC	1 in 1000yr
1	457695.8	221400.9	No flooding	No flooding	64.61	64.63	64.67
2	457863.6	221468.6	64.51	64.58	64.63	64.65	64.70
3	458159.0	221509.0	64.71	64.77	64.81	64.83	64.87
4	458224.2	221529.9	No flooding	No flooding	64.82	64.84	64.89

Table 4.2 Flood levels at four locations along the site boundary

[1] HR Wallingford and Environment Agency, May 2008, Supplementary note on flood hazard ratings and thresholds for development planning and control purpose – Clarification of the Table 113.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1

Figure 4.4 Flood hazard map for the 1 in 100 year including 35% allowance for climate change

5 Conclusion and Recommendations

Hydraulic modelling has been undertaken to assess the fluvial flood risk at the proposed Bicester Office Park site. The EA produced a hydraulic model in 2010 for the Langford Brook, Pingle Stream, Bure Brook and Back Brook watercourses in Bicester to inform strategic flood management in the area by the EA and Local Authority.

The EA hydraulic model has been modified and updated to include topographic survey information in and around the vicinity of the site, obtained in 2017 and 2018. The updated hydraulic model is referred to as the BuroHappold Bicester Office Park 2018 model (BuroHappold BOP 2018 model). The main changes made in the BuroHappold BOP 2018 model compared to the EA 2010 model include the following:

- Topographic Survey undertaken by GreenHatch Group issued on 28/09/17 – used to represent 2D floodplain within site boundary.
- Topographic Survey undertaken by GreenHatch Group issued on 19/02/18 – used to represent 1D in-channel cross sections and 2D floodplain between the site and Langford Brook.
- Most recent available LiDAR (combined dataset from 2003 and 2011 from data.gov.uk).
- Modified 2D boundary.
- Model simulated at a higher grid resolution using a 2m x 2m grid rather than 10m x 10m.
- Model simulated for the 1 in 20yr, 100yr, 100yr+25%CC, 100yr+35%CC and 1000yr flood events.

The Flood Risk Assessment issued for Planning in December 2017 has been updated based on the findings from this study and it is recommended that the flood levels derived from the BuroHappold BOP 2018 model are used for future development proposals, including informing flood risk design mitigations within the site boundary.

Appendix A Hydraulic Modelling Summary Technical Note (December 2017)

BUROHAPPOLD ENGINEERING

Design Note

Project	Bicester Office Park
Subject	Hydraulic Modelling Summary
Project no	0040031
Date	17 July 2017

Revision	Description	Issued by	Date	Approved
00	Summary of hydraulic modelling to define flood extents	DKR	24/07/17	CEJ
01	Appendix B added	DKR	11/08/17	CEJ
02	Appendix A updated	CEJ	17/08/17	DKR
03	Final for Planning	CEJ	11/09/17	DKR
04	For Planning (updated survey)	CEJ	14/12/17	[redacted]

1 Introduction

BuroHappold Engineering has produced the following note to summarise the work carried out to define the flood extents for the 1 in 100 year event including the effects of climate change using the latest Environment Agency (EA) guidance for climate change allowances.

Through the pre-planning application enquiry process, the EA confirmed that hydraulic modelling was required to define the flood levels for the 1 in 100 year with the new climate change allowances using the existing ISIS- TUFLOW model. This note provides a summary of the hydraulic modelling undertaken, the model output results and the derived flood extents.

The note is intended to support the flood risk assessment being carried out for the Bicester Office Park development, located to the south of Bicester.

2 Modelling Methodology

2.1 Hydraulic Model

The EA provided a hydraulic model built by Peter Brett Associates in 2009 which covers the Langford Brook, Pingle Stream, Bure Brook and Back Brook watercourses in Bicester, Oxfordshire. The model has been built using detailed topographic survey and LiDAR topographic data and the model calibrated based on five recent (at time of model construction) flood events.

The model simulations were carried out using the following software versions:

- ISIS – version 3.1
- TUFLOW – version 2008-08-AH-iSP

This version of the hydraulic model will be referred to as the EA model to distinguish it from the models re-run by BuroHappold.

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2.2 Re-baselining the Model 1 – Model Version

On receipt of the EA model BuroHappold re-ran the model to attempt to replicate the results from the EA model which were provided separately by the EA.

Since the model was originally run, both ISIS and TUFLOW have updated their software. Since the versions listed above have been superseded it was not possible to re-run the models using the same software versions as the original models. To determine what the effect of changing the software versions would have on the model results a number of test simulations were carried out.

Following this investigation, it was decided to run the models using the following software versions:

- ISIS – version 3.7 using the backwards compatibility options to match the version 3.1 defaults.
- TUFLOW – version 2016-03-AE-iSP-w64

The results of these investigations showed that the flood levels predicted by the re-baselined model were lower than the flood levels provided by the Environment Agency. In the vicinity of the site the reductions in the modelled flood levels were of the order of 5mm and were therefore considered to be within modelling tolerances.

2.3 Modelling the Effects of Climate Change

The results provided by the Environment Agency included one climate change scenario, the 1 in 100 year event plus an allowance for climate change through increasing the inflow hydrographs by 20%. Following completion of the modelling process in 2009 the EA has updated its recommended allowances for how climate change should be represented.

The latest guidance for the Thames catchment recommends that climate change be considered through an uplift to the inflow hydrographs of 25%, 35% or 70%. The choice of climate change allowance depends on the land uses, and for the development site the EA has confirmed that the two scenarios to be tested are the 25% and 35% climate change scenarios.

The inflow hydrographs for the 1 in 100 year +25% and 1 in 100 year + 35% scenarios were developed by increasing the 1 in 100 year flow multiplier in ISIS by 25% or 35% in a similar manner to the way that the 1 in 100 year + 20% climate change scenario has been represented.

2.4 Other changes to the Model

No other changes to the model were made apart from those described in order to carry out the simulations using the latest software versions and to increase the flows for two new climate change scenarios.

3 Model Results

3.1 Comparison against Previous Results

The model results in the vicinity of the site were evaluated for eight locations in the 2d domain, referred to as locations A-H. These locations can be seen on the drawing provided in Appendix A along with the peak flood levels observed at these locations. A summary of the results are provided in Table 3-1below and the hydraulic model outputs.

Table 3-1 ISIS-TUFLOW Model levels at points on the site

Point ID	1 in 100 year + 20% climate change (mAOD)	1 in 100 year + 25% climate change (mAOD)	1 in 100 year + 35% climate change (mAOD)
A	64.73*	64.74*	64.75*
B	64.73	64.74	64.75
C	64.79	64.79	64.81
D	64.94	64.94	64.96
E	65.00	65.00	65.03
F	65.02	65.02	65.05

G	65.04	65.04	65.07
H	65.16	65.16	65.18

* Flood Levels based on Point B due to flood water not reaching the point within the hydraulic model.

The results showed that the peak water levels for the 1 in 100 year + 25% allowance for climate change event were overall similar to those reported for the 1 in 100 + 20% allowance for climate change event with differences of between 0-5mm.

Results from the 1 in 100 year + 35% run show increases in peak flood levels of approximately 15-35mm from the 1 in 100 year + 20% run in the floodplain to the south of the site.

3.2 Generation of Flood Extents

The peak flood levels from all of the models provided by the EA and simulated by BH were used to create 3d flood level surfaces for the section adjacent to the site.

A 3d topographic model was constructed using 12d software from the topographical survey for the site from 2017 and LiDAR information for the section of the site not covered by the topographic survey. The intersection of the flood level surface and the topographic surface was used to define the flood extent within the site for each of the flood events modelled.

Since there are differences between the levels measured during the topographic survey and the LiDAR survey, due to the respective tolerances, there were some discontinuities between the flood extent lines at the boundary between the topographic survey and LiDAR surfaces. At these locations the flood extent line has been interpolated between the flood extents on either side of the discontinuity at the point where there is the least difference between the two surveys. A drawing showing the flood extent lines shown in Appendix A, with the locations where the flood extent line defined by the LiDAR and topographic survey clearly marked.

4 Conclusions

A hydraulic model constructed by PBA in 2009 has been rerun by BuroHappold using updated software versions to determine the peak flood levels in the 1 in 100 year event, including a 25% and 35% uplift in the hydrographs to allow for the effects of climate change based on the most recent guidance from the EA.

The peak flood levels from these simulations are shown in Appendix A and the model outputs provided in Appendix B.

Appendix A – Flood Extent Map

			LANGFORD BROOK (BICESTER) & PINGLE-BACK-BURE 2010 ISIS-TUFLOW MODEL LEVELS				
POINT ID	X	Y	1 in 20 (mAOD)	1 in 100 (mAOD)	1 in 100 + 25%CC (mAOD)	1 in 100 + 35%CC (mAOD)	1 in 1000 (mAOD)
A	457650.7	221442.2	64.63*	64.70*	64.74*	64.75*	64.81
B	457751.0	221387.3	64.63	64.70	64.74	64.75	64.81
C	457866.9	221481.9	64.67	64.74	64.79	64.81	64.88
D	457994.7	221488.1	64.81	64.89	64.94	64.96	65.04
E	458082.6	221503.4	64.83	64.93	65.00	65.03	65.13
F	458121.7	221517.1	64.84	64.95	65.02	65.05	65.16
G	458235.5	221532.3	64.84	64.96	65.04	65.07	65.19
H	458323.1	221550.5	65.02	65.11	65.16	65.18	65.27

* FLOOD LEVELS BASED ON POINT B DUE TO FLOOD WATER NOT REACHING THE POINT WITHIN THE HYDRAULIC MODEL

SITE BOUNDARY

A FLOOD LEVEL DATA POINT

2017 FLOOD EXTENTS

1 IN 20 YEAR FLOOD EXTENT

1 IN 100 YEAR FLOOD EXTENT

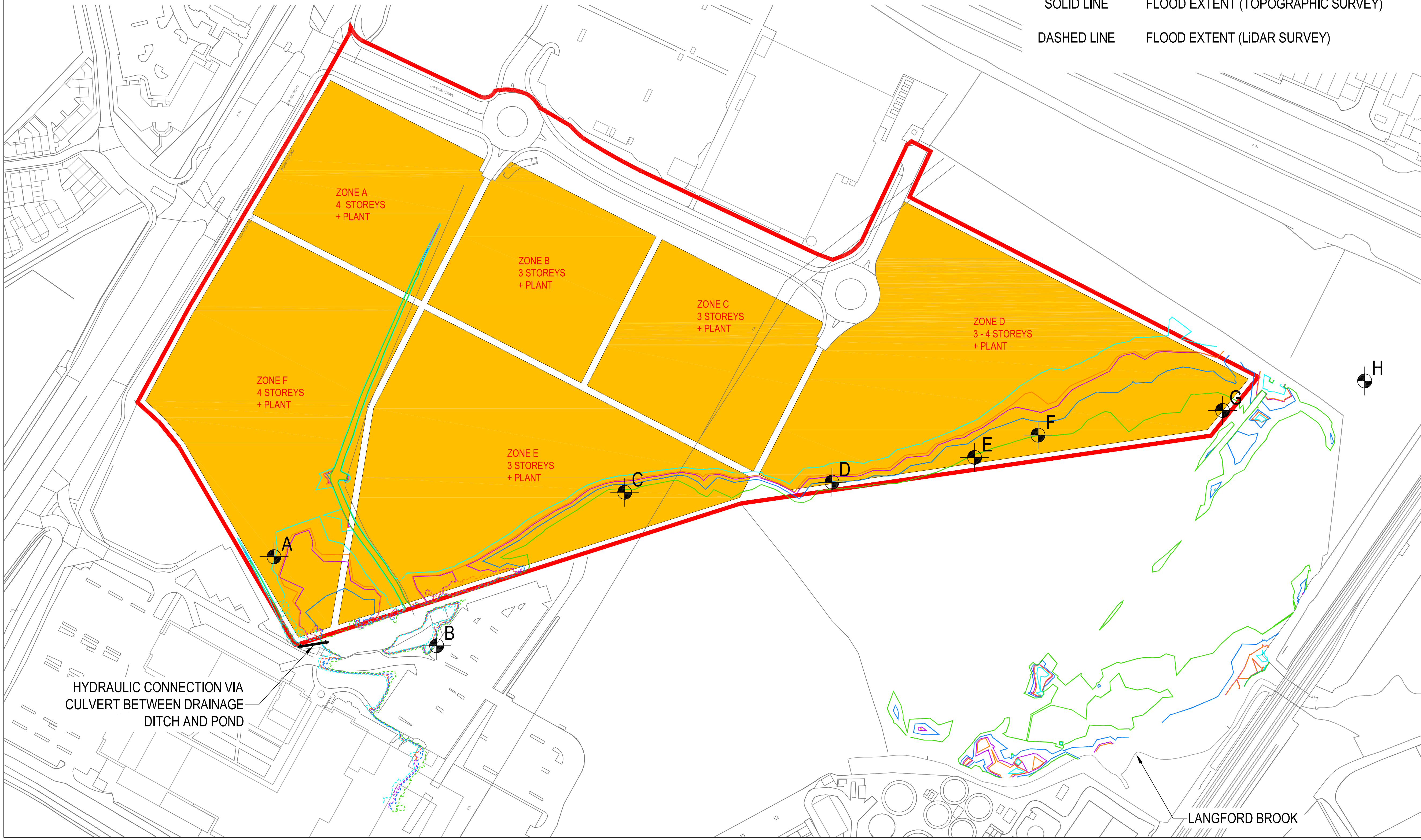
1 IN 1000 YEAR FLOOD EXTENT

1 IN 100 YEAR +25%CC FLOOD EXTENT

1 IN 100 YEAR +35%CC FLOOD EXTENT

SOLID LINE — FLOOD EXTENT (TOPOGRAPHIC SURVEY)

DASHED LINE — FLOOD EXTENT (LiDAR SURVEY)



Notes

BACKGROUND OS TILE Ref. 10019980

2011 LiDAR (1M RESOLUTION) DIGITAL TERRAIN MODEL DOWNLOADED FROM http://environment.data.gov.uk. CONTAINS PUBLIC SECTOR INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE v3.0.

TOPOGRAPHIC SURVEY BY GREENHATCH (SEPTEMBER 2017)

ARCHITECT PARAMETER PLAN Ref. 1105_P_005

FLOOD LEVEL INFORMATION PROVIDED AS PART OF ENVIRONMENT AGENCY'S PRODUCT 6 DATA JUNE 2017. CONTAINS ENVIRONMENT AGENCY INFORMATION © ENVIRONMENT AGENCY AND/OR DATABASE RIGHT. BUROHAPPOLD HAS RE-RUN THE ISIS-TUFLOW HYDRAULIC MODEL TO DERIVE THE 1 IN 100 YEAR +25%CC AND 1 IN 100 YEAR +35%CC EVENT CLIMATE CHANGE SCENARIOS.

THE FLOOD EXTENTS HAVE BEEN DERIVED BASED ON THE 2017 TOPOGRAPHIC SURVEY INFORMATION WHERE THIS EXISTS, THE 2011 LiDAR DIGITAL TERRAIN MODEL WHERE THE TOPOGRAPHIC SURVEY DOES NOT EXIST AND THE 2010 ISIS-TUFLOW MODEL FLOOD LEVELS USING 3D MODELLING SOFTWARE. INTERPOLATION HAS BEEN REQUIRED BETWEEN THE LiDAR AND TOPOGRAPHIC SURVEY EXTENTS.

Rev	Description/Date	Drn/Chk
05	MINOR CHANGES TO FLOOD EXTENTS / 29.11.17	SM/CJ
04	UPDATED FLOOD EXTENTS FOR NEW TOPO SURVEY / 17.10.17	SM/CJ
03	AMENDED PROJECT NAME INFORMATION / 12.09.17	SM/CJ
02	UPDATED REDLINE BOUNDARY & MASTERPLAN / 16.08.17	SM/CJ

INFORMATION

Status of drawing

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Architect *Bennett Associates*

Project **Bicester Office Park**

Drg Title FLOOD EXTENTS DERIVED FROM COMBINED 2011 LiDAR AND TOPO SURVEY

Scales@A3 1:2500

Drawn by SM

Checked by CJ

Date JULY 2017

Job No. 0040031

Drg No. WSK005

Rev 05

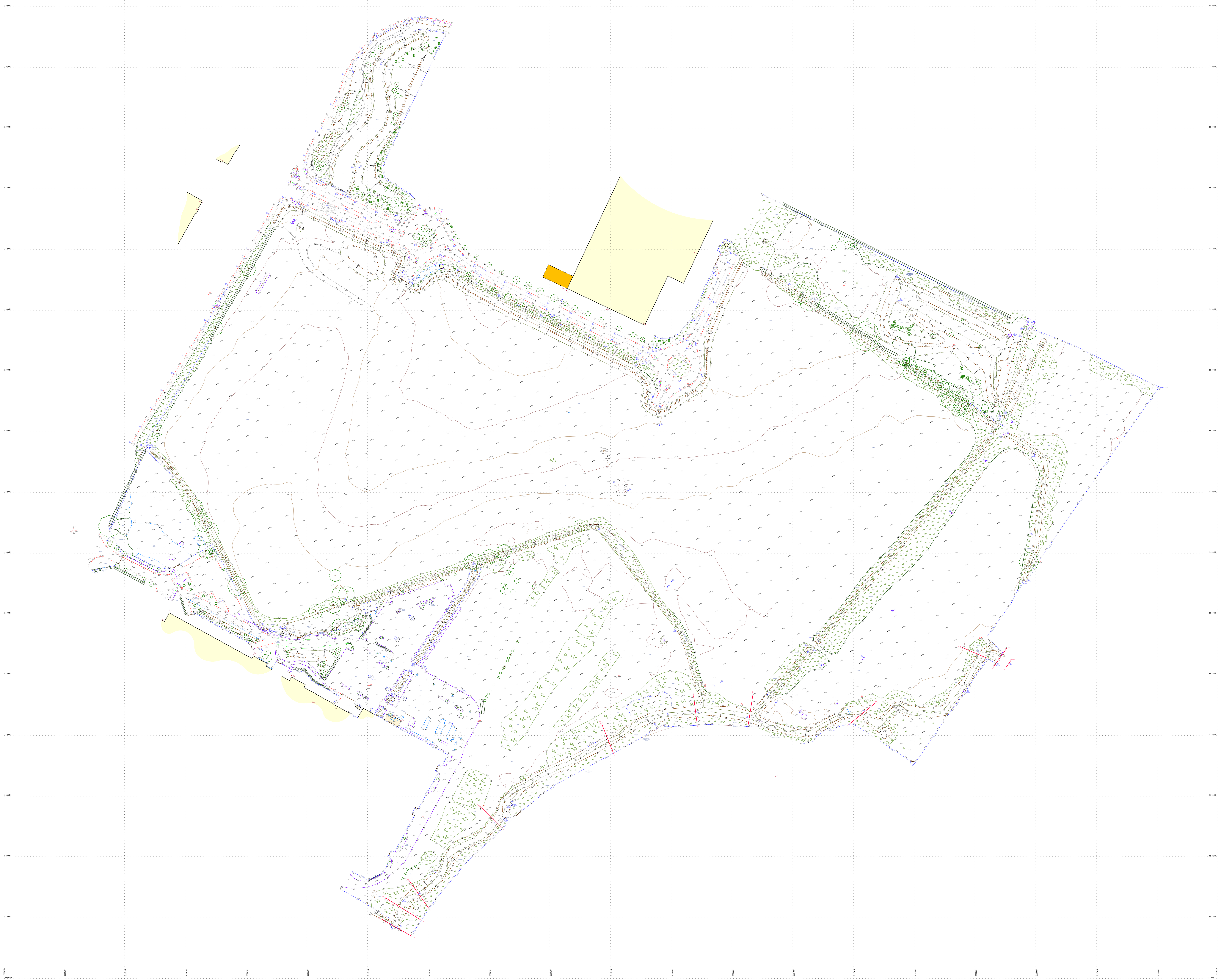
Simon Mudd \\srv-london03\CAD\0040031 Bicester Business Park- Planning Support\F34 Water\Sheet\Sketches\WSK005.dwg

Appendix B – Flood Model Outputs

The table below provides the maximum flood levels from the 1d model at each of the nodes in the vicinity of the site. The levels are to ordnance datum.

Node	1 in 20	1 in 100	1 in 100 + 20%	1 in 100 + 25%	1 in 100 + 35%	1 in 1000
LA.1408	65.454	65.640	65.728	65.759	65.809	65.954
LA.1362	65.299	65.429	65.491	65.515	65.557	65.684
LA.1350	65.268	65.378	65.424	65.442	65.473	65.572
LA.1350BU	65.268	65.378	65.424	65.442	65.473	65.572
LA.1350BD	65.268	65.378	65.424	65.442	65.473	65.571
LA.1873CU	65.832	65.996	66.128	66.138	66.165	66.257
LA.1350D	65.268	65.378	65.424	65.442	65.473	65.571
LA.0957	64.548	64.623	64.660	64.666	64.680	64.714
LA.0865	64.438	64.525	64.571	64.580	64.599	64.640
LA.0767	64.302	64.382	64.466	64.479	64.501	64.550
LA.0737	64.221	64.266	64.374	64.387	64.409	64.461
LA.0726	64.217	64.258	64.364	64.376	64.397	64.445
LA.0726BU	64.217	64.258	64.364	64.376	64.397	64.445
LA.0720BD	64.215	64.255	64.272	64.280	64.295	64.332
LA.0720	64.215	64.255	64.272	64.280	64.295	64.332
LA.0711	64.208	64.251	64.269	64.278	64.296	64.337

Appendix B Topographic and LiDAR Information



N

Station Information:

Station	Easting (m)	Northing (m)	Level (m)
GH1	458049.908	221684.512	67.095
GH2	458016.141	221588.821	67.325
GH3	457918.706	221648.867	67.729
GH4	457813.990	221701.959	67.358
GH5	457769.668	221703.759	66.947
GH6	457715.541	221753.903	67.049
GH7	457723.838	221818.099	68.544
GH8	457783.068	221886.926	69.454
GH9	457618.945	221662.947	67.808
TA16	457841.170	221311.839	64.373
TA17	457751.130	221341.429	64.375
TA18	457665.165	21373.9880	65.364
TA19	457597.196	221422.121	66.110
TA20	457508.503	221468.539	67.041
TA21	457624.739	221652.797	67.471

OS Note:

Some services may have been omitted due to parked vehicles. The Ordnance Survey tile is to be used as a guide only.

OS Buildings — *Surveyed Buildings*

This survey has been orientated to the Ordnance Survey (O.S) National Grid OSGB36(15) via Global Navigational Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN15GB & OSGM15GB transformation models.

The survey has been correlated to this point and a further one or more OSGB36 (15) points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Buildings
Wall
Kerb line
Line marking
Drop kerb
Centre line
Overhead Cable
Concrete edge
Tarmac edge
Grass verge
Canopy/Overhang
Verge
1 100.000 — Station and Name / Station Level
Tree / Bush / Sapling
Area of Undergrowth
Woodland
R: Ridge Level
E: Eaves Level
F: Flat Roof Level
Gate

Fence types:
I\W Interwoven
I\R Iron Railings
W\M Wire Mesh
P\R Post & Rail
P\W Post & Wire
C\L Chain Link
W\P Wooden Panels
C\P Concrete Panels
S\P Steel Palisade

IC	Inspection chamber	Bo	Bollard
PInv	Pipe invert	IB	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Grl	Ground light
Pipe	Pipe above ground	Lbox	Letter box
MH	Manhole	Ldr	Ladder
WL	Water level	Sty	Stile
SL	Silt level	IFL	Internal floor level
Lp	Lamp post	THL	Threshold level
Tp	Telegraph post	Sp	Sign post
Ep	Electricity post	TH	Trialhole
Tl	Traffic light	BH	Borehole
Bus	Bus stop	ELC	Electric
Sv	Stop valve	BT	British Telecom
St	Stop tap	C'box	Control box
Er	Earth rod	TT	Tactile
Wm	Water meter	BP	Brick paved
Gas	Gas valve	CPS	Concrete paving slabs
Av	Air valve	CVR	Cover
ICU	Undentified inspection	IC	Inspection chamber
Wo	Wash out	R/wall	Retaining wall
Re	Rodding eye	UTL	Unable to lift
BB	Belisha beacon	TCL	Tree canopy level
CTV	Cable tv	G:	Girth
Mkr	Marker post	MG	Multi girth
Gmkr	Gas marker post	Stmp	Tree Stump
So	Soffit	CL:	Cover level
		IL:	Invert level

Rev	Date	Description	Drawn	Q. Ref
1	19.02.18	Additional works	TA	GH2478

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Poland
t. 0048 32 202 2292
www.greenhatch.pl

CLIENT
BuroHappold Engineering

PROJECT
Bicester Office Park
Lakeview Drive
Bicester

TITLE
Topographical Survey

SCALE	DATE
A0@ 1: 1000	28.09.17
DRAWN	**QUALITY REF**
TC	GH1622

Level datum	See note
Grid orientation	See note
Job number	28207

Drawing No.	Rev.
28207_T_S	1

Comments

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Notes:

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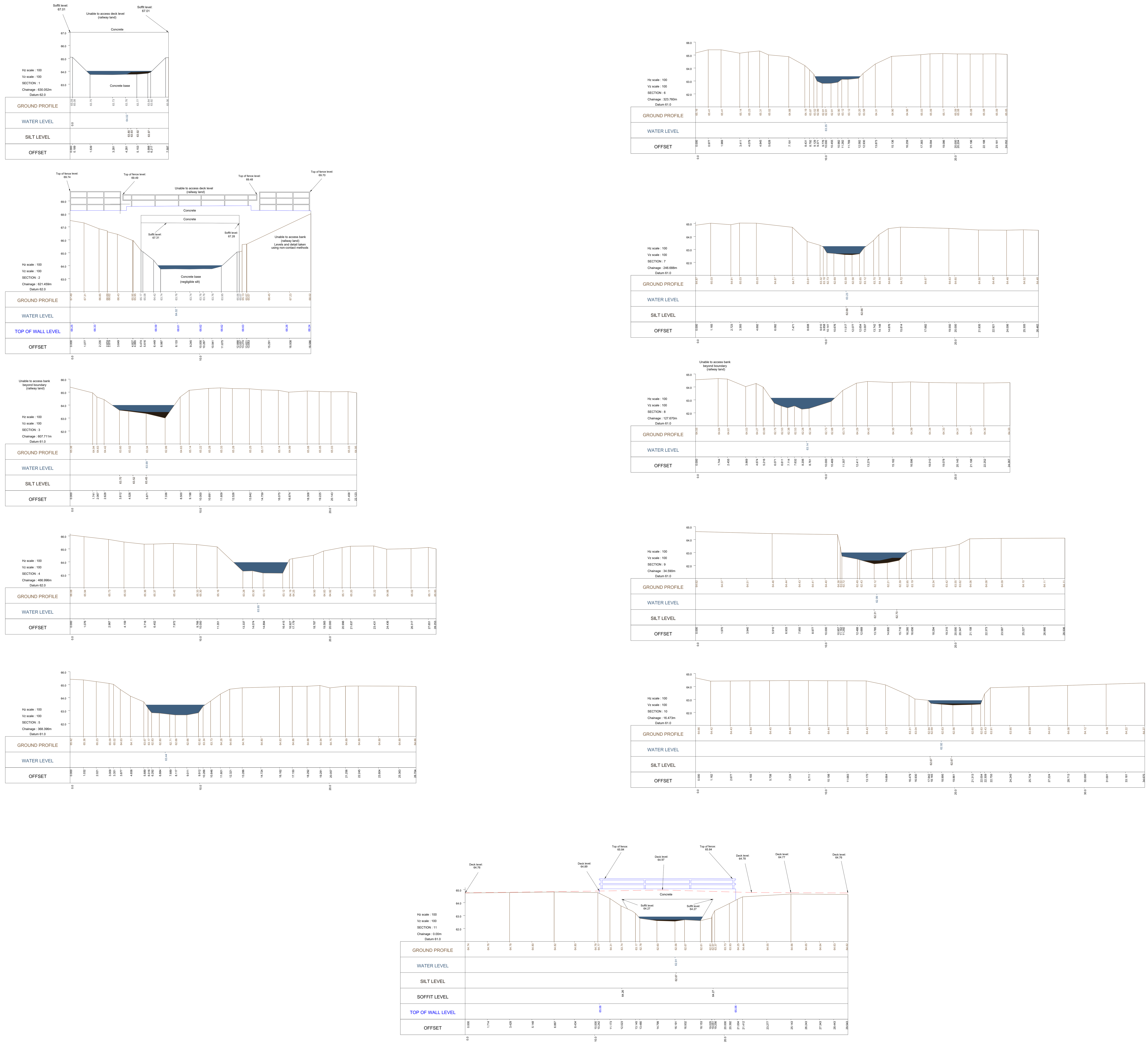

N

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GH4	457813.990	221701.959	67.358
GH5	457769.668	221703.759	66.947
GH6	457715.541	221753.903	67.049
GH7	457723.838	221818.099	68.544
GH8	457783.068	221886.926	69.454
GH9	457618.945	221662.947	67.808
TA16	457841.170	221311.839	64.373
TA17	457751.130	221341.429	64.375
TA18	457665.165	21373.9880	65.364
TA19	457597.196	221422.121	66.110
TA20	457508.503	221468.539	67.041
TA21	457624.739	221652.797	67.471

OS Note:

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OS Buildings *Surveyed Buildings*

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No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Buildings, Wall, Kerb line, Line marking, Drop kerb, Centre line, Overhead Cable, Concrete edge, Tarmac edge, Grass verge, Canopy/Overhang, Verge, Station and Name, Station Level

IC	Inspection chamber	Bo	Bollard
PInv	Pipe invert	IB	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Grl	Ground light
Pipe	Pipe above ground	Lbox	Letter box
MH	Manhole	Ldr	Ladder
WL	Water level	Sty	Stile

Fence types:

P\R	Post & Rail
P\W	Post & Wire
C\L	Chain Link
W\P	Wooden Panels
C\P	Concrete Panels
S\P	Steel Palisade

Wo	Wash out	R/wall	Retaining wall
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CTV	Cable tv	G:	Girth
Mkr	Marker post	MG	Multi girth
Gmkr	Gas marker post	Stmp	Tree Stump
So	Soffit	CL:	Cover level
		IL:	Invert level

Rev	Date	Description	Drawn	Q. Ref
1	19.02.17	Additional works	TA	GH2478

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CLIENT
BuroHappold Engineering

PROJECT
Bicester Office Park
Lakeview Drive
Bicester

TITLE
Cross-sections Survey

SCALE	DATE
A0@ 1: 100	28.09.17
DRAWN	QUALITY REF
TC	GH1622

Level datum	See note
Grid orientation	See note
Job number	28207

Drawing No.	Rev.
28207_T_S	1

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Notes:

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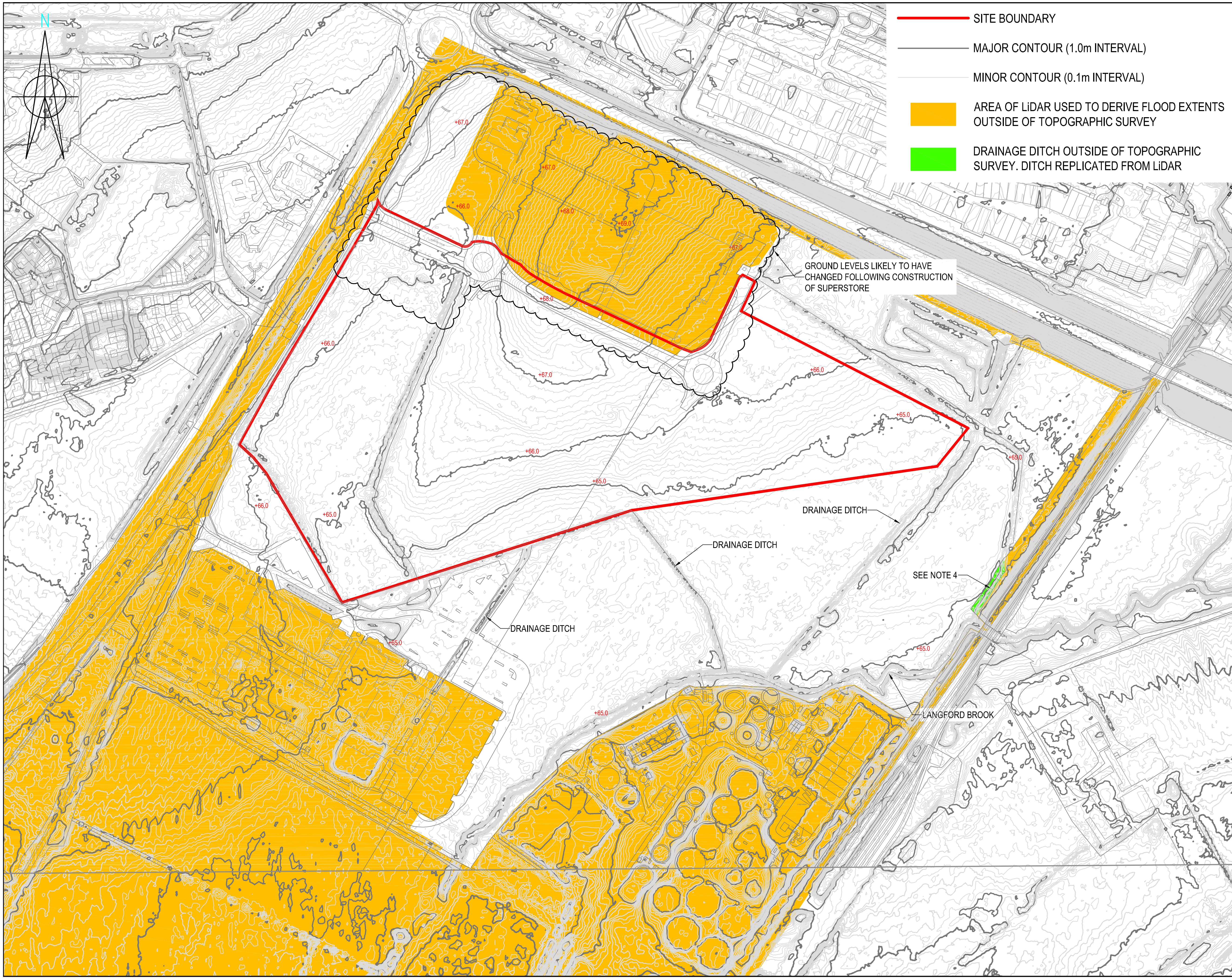

Notes

1. BACKGROUND OS TILE Ref. 100019980
2. COMBINED LiDAR (2M RESOLUTION) DIGITAL TERRAIN MODEL DOWNLOADED FROM http://environment.data.gov.uk. CONTAINS PUBLIC SECTOR INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE v3.0. LiDAR COMBINES DATA FROM 2003 AND 2011
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Rev Description/Date	Drn/Chk
03 NEW TOPO SURVEY EXTENT INFORMATION / 29.03.18	SM/CJ
02 NEW TOPO SURVEY EXTENT INFORMATION / 17.10.17	SM/CJ
01 AMENDED PROJECT NAME INFORMATION / 12.09.17	SM/CJ
00 INFORMATION / 16.08.17	SM/CJ

INFORMATION

Status of drawing

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Web: www.burohappold.com

Architect *Bennett Associates*

Project **Bicester Office Park**

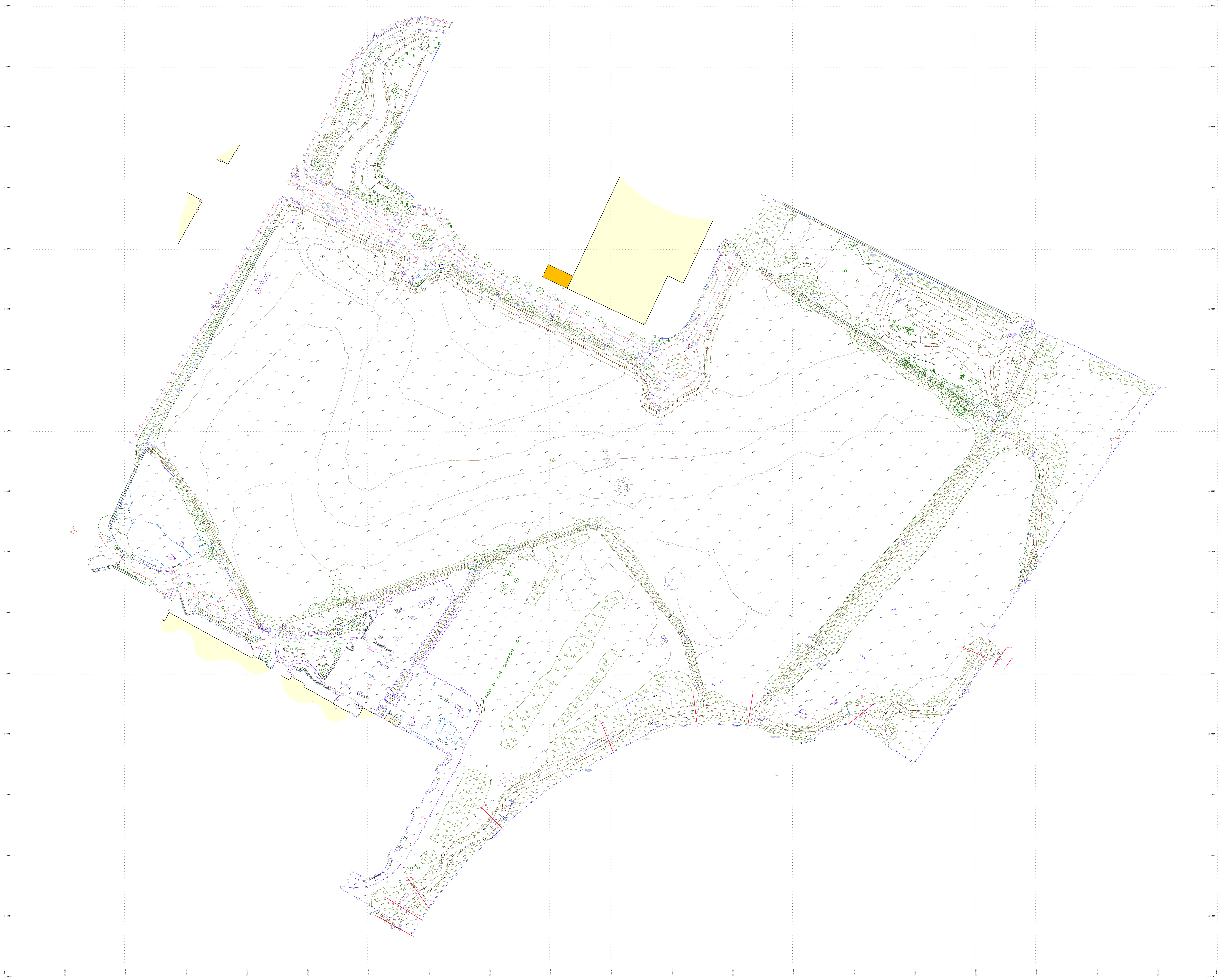
Drg Title LiDAR SURVEY WITH 100mm INTERVAL CONTOURS

Scales@A3 NTS
Drawn by SM
Checked by CJ
Date AUGUST 2017

Job No. 0040031
Drg No. WSK007

Rev 03

Simon Mudd \\srv-london05\CAD\0040031 Bicester Business Park- Planning Support\F34 Water\Sheet\Sketches\WSK007.dwg



N

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Legend:

Buildings	Overhead Cable	IC	Inspection chamber
Wall	Concrete edge	PInv	Pipe invert
Kerb line	Tarmac edge	Gy	Gully
Line marking	Grass verge	Bg	Back gully
Drop kerb	Canopy/Overhang	Dp	Down pipe
Centre line	Verge	Pipe	Pipe above ground
1	Station and Name	MH	Manhole
100.000	Station Level	WL	Water level
		SL	Silt level
	Tree / Bush / Sapling	Lp	Lamp post
		Tp	Telegraph post
	Area of Undergrowth	Ep	Electricity post
	Woodland	Tl	Traffic light
R:	Ridge Level	Bus	Bus stop
E:	Eaves Level	Sv	Stop valve
F:	Flat Roof Level	St	Stop tap
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Rev	Date	Description	Drawn	Q. Ref
1	19.02.18	Additional works	TA	GH2478

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www.greenhatch.pl

CLIENT

BuroHappold Engineering

PROJECT

Bicester Office Park
Lakeview Drive
Bicester

TITLE

Topographical Survey

SCALE	DATE
A0@ 1: 1000	28.09.17
DRAWN	QUALITY REF
TC	GH1622

Level datum	See note
Grid orientation	See note
Job number	28207

Drawing No.	Rev.
28207_T_S	1

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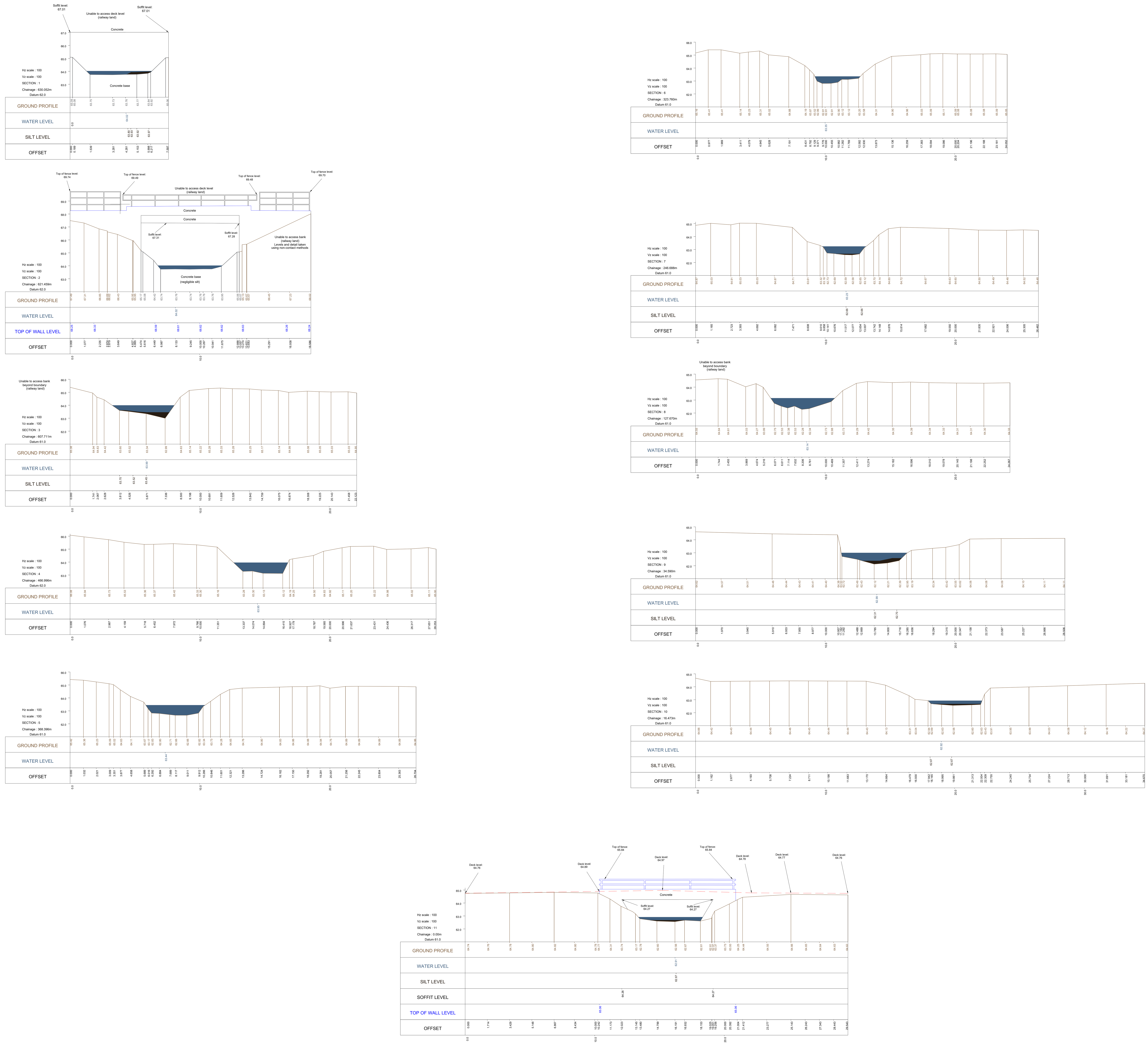

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Legend:

Rev	Date	Description	Drawn	Q. Ref
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CLIENT

BuroHappold Engineering

PROJECT

Bicester Office Park Lakeview Drive Bicester

TITLE

Cross-sections Survey

SCALE	DATE
A0@ 1: 100	28.09.17
DRAWN	QUALITY REF
TC	GH1622

Level datum: See note

Grid orientation: See note

Job number: 28207

Drawing No.: 28207_T_S — Rev.: 1

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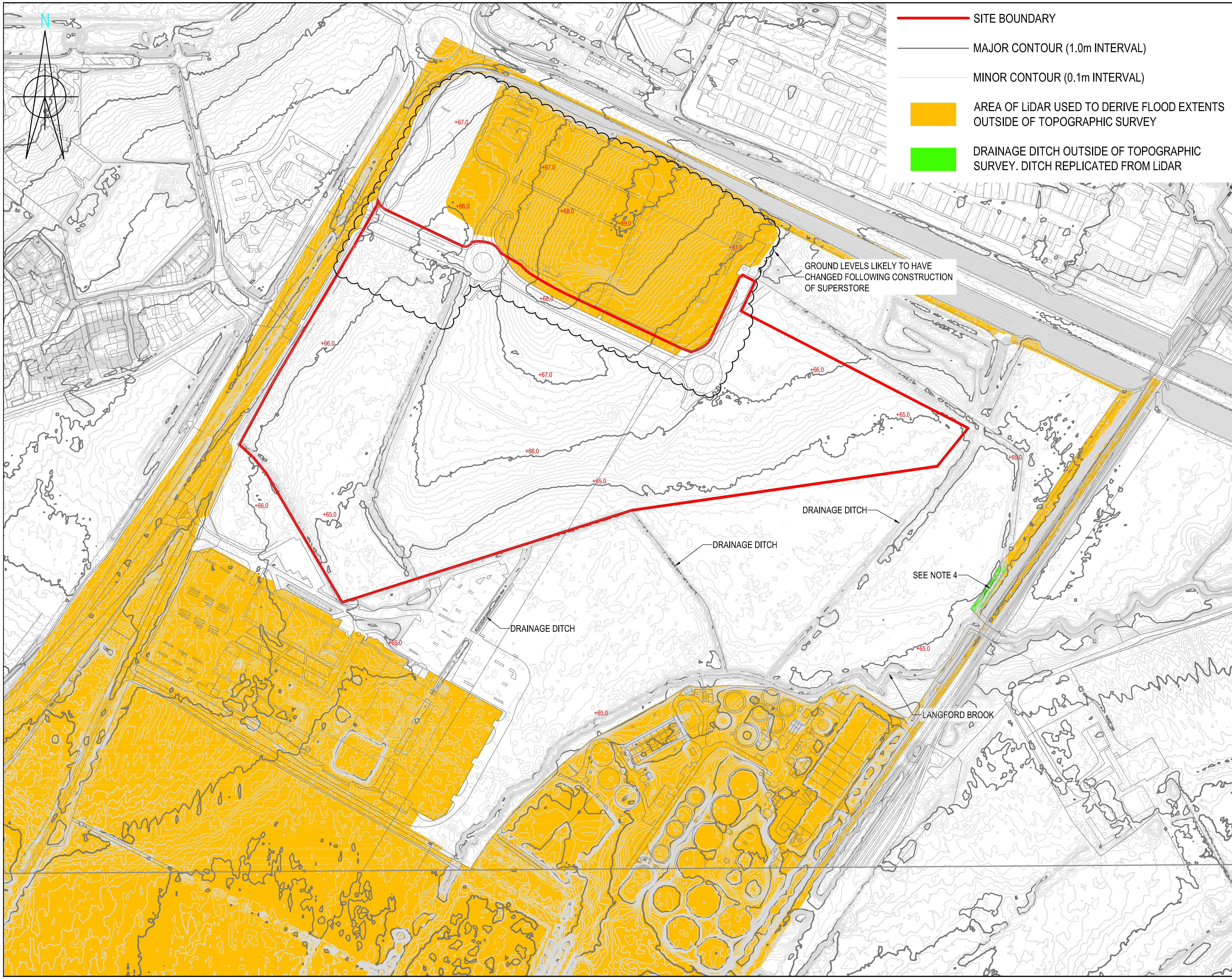

Notes
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Rev Description/Date	Drn/Chk
03 NEW TOPO SURVEY EXTENT INFORMATION / 29.03.18	SM/CJ
02 NEW TOPO SURVEY EXTENT INFORMATION / 17.10.17	SM/CJ
01 AMENDED PROJECT NAME INFORMATION / 12.09.17	SM/CJ
00 INFORMATION / 16.08.17	SM/CJ

INFORMATION

Status of drawing

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Web: www.burohappold.com

Architect *Bennett Associates*

Project **Bicester Office Park**

Drg Title LiDAR SURVEY WITH 100mm INTERVAL CONTOURS

Scales@A3 NTS
Drawn by SM
Checked by CJ
Date AUGUST 2017

Job No. 0040031
Drg No. WSK007
Rev 03

Simon Mudd \\srv-london05\CAD\0040031 Bicester Business Park- Planning Support\F34 Water\Sheet\Sketches\WSK007.dwg

Appendix C Flood Extents and Flood Levels Plan

POINT ID	X	Y	1 in 20 (mAOD)	1 in 100 (mAOD)	1 in 100 + 25%CC (mAOD)	1 in 100 + 35%CC (mAOD)	1 in 1000 (mAOD)
A	458310.6	221537.4	64.91	64.94	64.95	64.96	64.99
B	458224.2	221529.9	N/A	N/A	64.82	64.84	64.89
C	458161.6	221516.1	N/A	64.77	64.81	64.83	64.87
D	458087.7	221502.4	N/A	N/A	N/A	64.80	64.85
E	457863.6	221468.6	64.51	64.58	64.63	64.65	64.70
F	457695.8	221400.9	N/A	N/A	64.61	64.63	64.67
G	458256.2	221457.9	64.90	64.93	64.95	64.96	64.99
H	458057.7	221375.2	64.64	64.72	64.76	64.78	64.82
I	457895.8	221372.8	64.46	64.56	64.62	64.64	64.69

SITE BOUNDARY

A FLOOD LEVEL DATA POINT

2018 FLOOD EXTENTS

1 IN 20 YEAR FLOOD EXTENT

1 IN 100 YEAR FLOOD EXTENT

1 IN 1000 YEAR FLOOD EXTENT

1 IN 100 YEAR +25%CC FLOOD EXTENT

1 IN 100 YEAR +35%CC FLOOD EXTENT

Notes

BACKGROUND OS TILE Ref. 10019980

COMBINED LiDAR (2M RESOLUTION) DIGITAL TERRAIN MODEL DOWNLOADED FROM http://environment.data.gov.uk. CONTAINS PUBLIC SECTOR INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE v3.0.

TOPOGRAPHIC SURVEY BY GREENHATCH (FEBRUARY 2018)

ARCHITECT PARAMETER PLAN Ref. 1105_P_005

FLOOD LEVEL INFORMATION DERIVED FROM THE BICESTER OFFICE PARK 2018 HYDRAULIC MODEL CREATED BY BUROHAPPOLD BASED ON THE ENVIRONMENT AGENCY'S PRODUCT 6 DATA JUNE 2017 (LANGFORD_BROOK_BICESTER_&_PRINGLE BACK BURE_2010 MODEL). CONTAINS ENVIRONMENT AGENCY INFORMATION © ENVIRONMENT AGENCY AND/OR DATABASE RIGHT.

THE FLOOD EXTENTS HAVE BEEN DERIVED BASED ON THE 2018 TOPOGRAPHIC SURVEY INFORMATION WHERE THIS EXISTS AND THE LiDAR DIGITAL TERRAIN MODEL WHERE THE TOPOGRAPHIC SURVEY DOES NOT EXIST.

Rev	Description/Date	Drn/Chk
06	UPDATED FLOOD EXTENTS FROM MODEL / 29.03.18	SM/CJ
05	MINOR CHANGES TO FLOOD EXTENTS / 29.11.17	SM/CJ
04	UPDATED FLOOD EXTENTS FOR NEW TOPO SURVEY / 17.10.17	SM/CJ
03	AMENDED PROJECT NAME INFORMATION / 12.09.17	SM/CJ

INFORMATION

Status of drawing

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Bath BA2 3DQ
UK

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Fax: +44 (0)870 787 4148
Email: 0040031@burohappold.com
Web: www.burohappold.com

Architect *Bennett Associates*

Project **Bicester Office Park**

Drg Title FLOOD EXTENTS DERIVED FROM COMBINED LiDAR AND 2018 TOPO SURVEY

Scales@A3 1:2500

Drawn by SM

Checked by CJ

Date JULY 2017

Job No. 0040031

Drg No. WSK005

Rev 06

Simon Mudd \\srv-london05\CAD\0040031 Bicester Business Park- Planning Support\F34 Water\Sheet\Sketches\WSK005.dwg

Appendix F Drainage Strategy

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Bicester Office Park

Drainage Strategy

040031

3 July 2017

Revision 04

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Revision	Description	Issued by	Date	Checked
00	Initial Issue	JW	9/8/17	LJ
01	Client name amended	JW	10/8/17	LJ
02	Red line plan amended	JW	16/8/17	LJ
03	Minor amendments	JW	08/9/17	LJ
04	Red line plan amended	JW	26/09/17	LJ

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author	**John Waiting**
date	**8/8/17**
approved	**Les Johnson**
signature	[redacted]
Date	**9/8/17**

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Contents

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1 Executive summary

1.1 This report has been prepared to set out the drainage strategy in support of an outline planning application for 60,000 m^2 B1 development at Bicester Office Park.

1.2 The majority of the site area covered by the current planning application was subject to an outline planning application submitted in 2007. It subsequently received approval.

1.3 In 2011 a detailed application was submitted for a the primary infrastructure and a retail development. To accompany this a revised drainage strategy document was prepared to show how the relevant planning conditions that were attached to the outline permission were to be discharged.

1.4 As part of the primary infrastructure contract both foul and surface water sewers have been constructed to serve the proposed development. These have capacity for the foul and surface water flow rates from the proposed 60,000 m^2 B1 development.

1.5 The surface water runoff from the development will be limited to greenfield flow rates and the primary infrastructure has been design to reflect this. The on-site surface water drainage network will incorporate the recommendations of Sustainable Drainage Systems (SuDS) good practice.

1.6 The proposed development density of the masterplan will allow the incorporation of a significant area of green infrastructure. This will facilitate the provision of a number of different SuDS components within the detailed design of the surface water network

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2 Introduction

2.1 This drainage strategy has been produced in support of an outline planning application for a 13Ha site known as the Bicester Office Park. BuroHappold has been involved with the development since 2007 when the first outline planning application was submitted, and have produced both Flood Risk Assessments and Drainage Strategies in support of the initial phases of development.

2.2 The site is located on the western side of Bicester, adjacent to the Bicester Outlet Shopping Village. An aerial view of the site is shown in figure 1 below.

Figure 1

2.3 It can be seen in figure 1 that a spine road (Lakeview Drive) to serve the development has been constructed in addition to a Tesco store. As part of the primary infrastructure contract both surface water and foul water drainage networks were constructed. These were designed to provide capacity to serve the development proposals covered by the outline planning application.

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3 Planning history

3.1 An outline planning application which covered most of the area of the current application was submitted in 2007. It subsequently received approval.

3.2 In 2011 a detailed application was submitted for a the primary infrastructure and a retail development (Tesco Store). To accompany this, a revised drainage strategy document was prepared to show how the relevant planning conditions that were attached to the outline permission were to be discharged.

3.3 As part of the current application a new Flood Risk Assessment has been prepared and this assumes that the surface water runoff from the undeveloped part of the site will be limited to 'Greenfield' run of rates i.e. the runoff will not exceed the flow rates that occur at present. In addition the associated attenuation measures for the developed site will be designed to accommodate the increased rainfall intensities in accordance with the climate change recommendations issued by the Environment Agency in February 2016.

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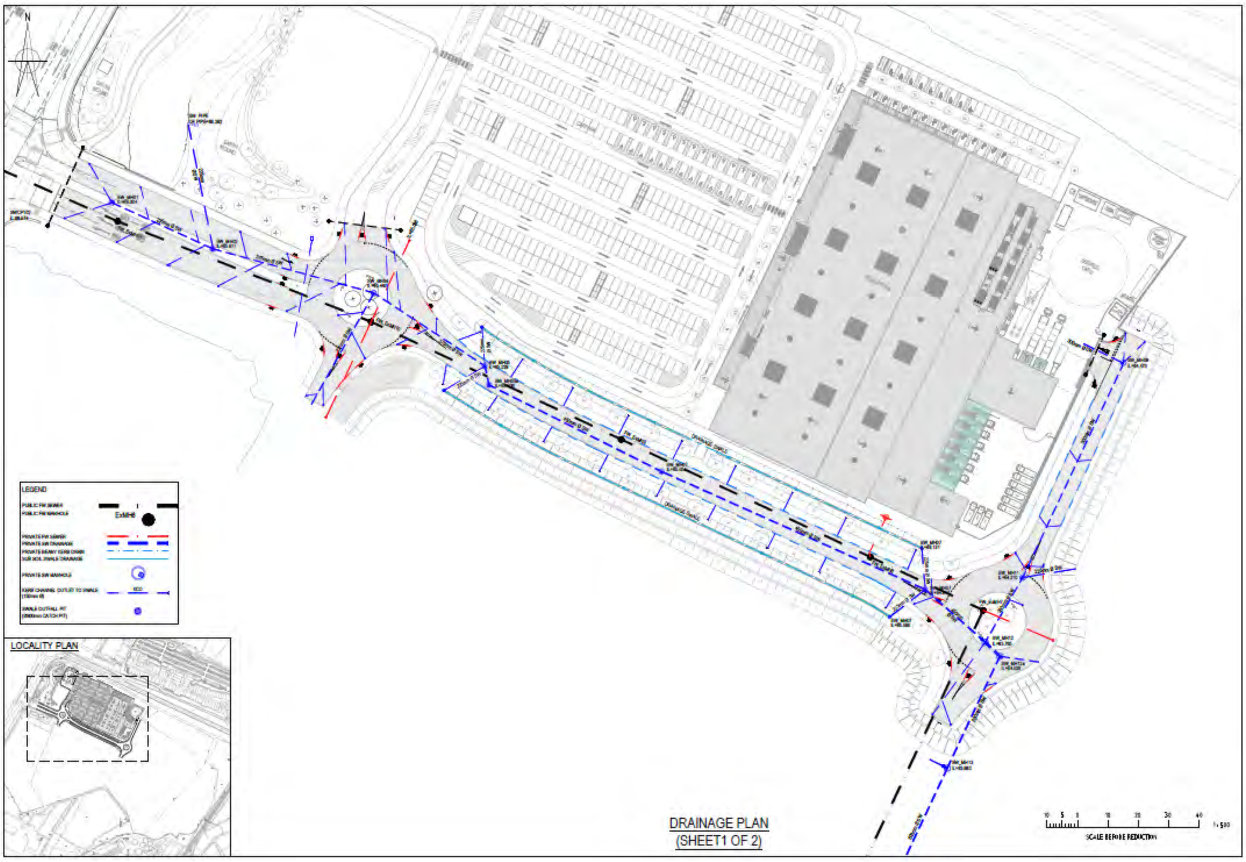
4 Existing drainage networks

4.1 Surface Water

4.1.1 A surface water sewer network was constructed as part of the primary infrastructure works. The network associated with the access road is shown on the plan below.



The surface water infrastructure is shown by the blue dotted lines. Spurs have been left to facilitate drainage connections from the masterplan proposals.

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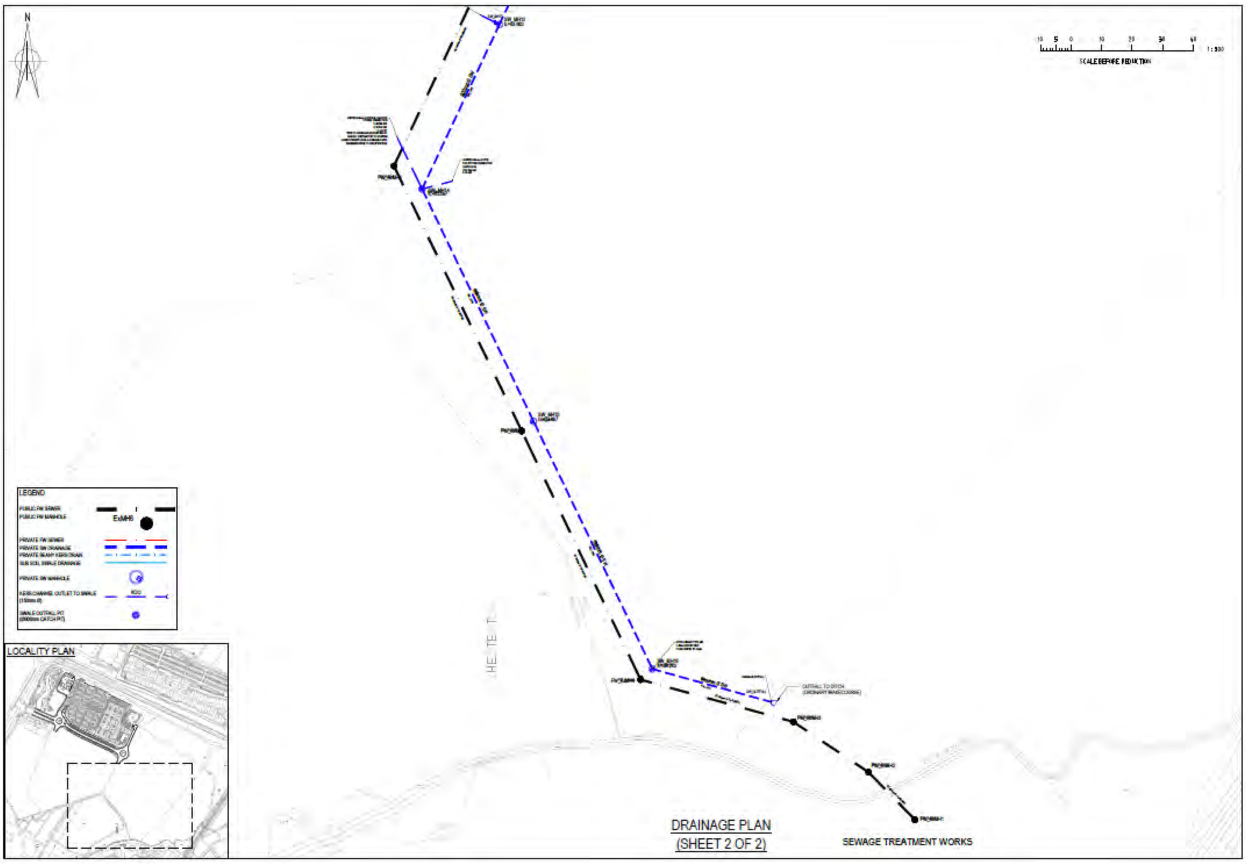
4.1.2 The plan below shows the route of the surface water sewer as it transverses the masterplan area before connecting to the ditch which then connects a stream known as the Langford Brook .



The surface water sewer is shown as a blue dotted line. As it will remain a private sewer in the ownership of the landowner there is no easement associated with it.

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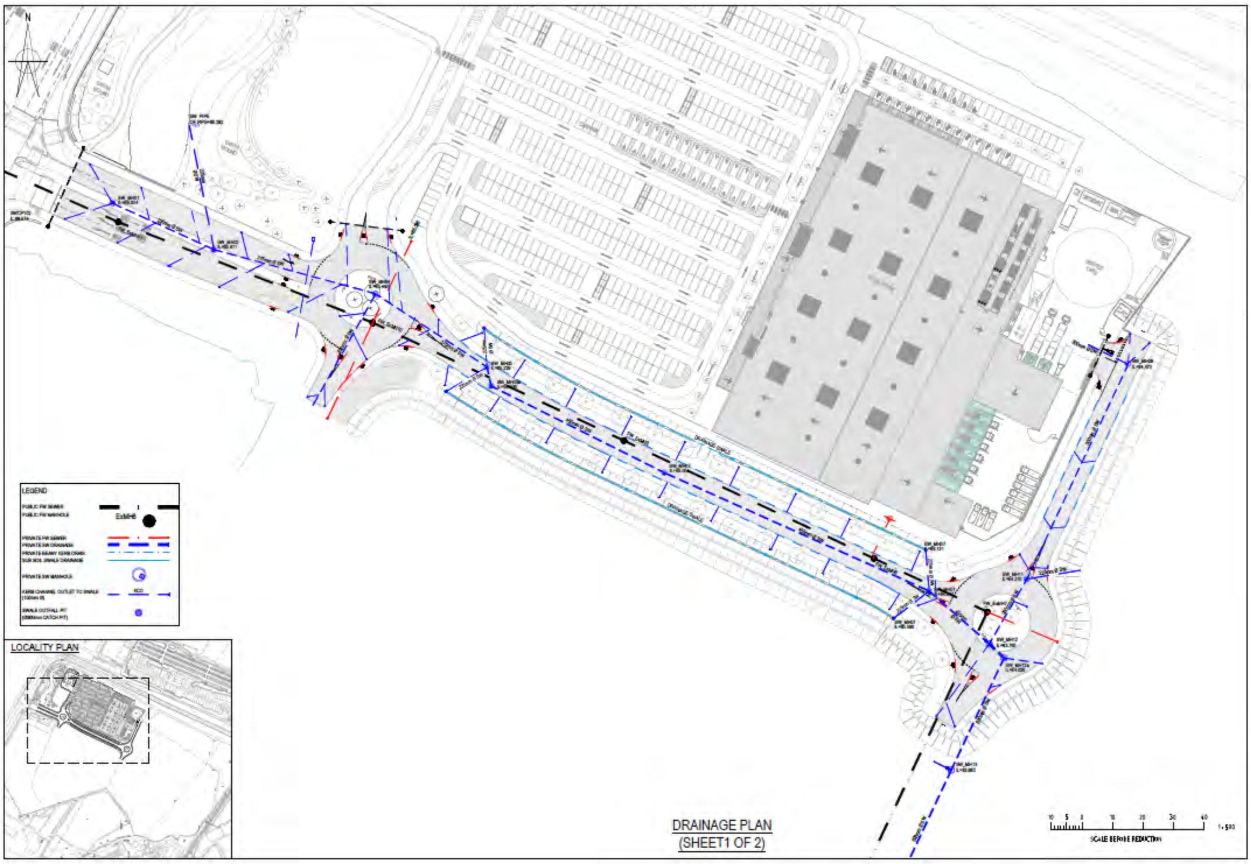
4.2 Foul Water

4.2.1 The route of the 600mm diameter public foul sewer under the access road is shown on the plan below



The foul sewer is shown by the dotted black line. The red lines show connection points that have been left to facilitate the future connection to serve the masterplan proposals.

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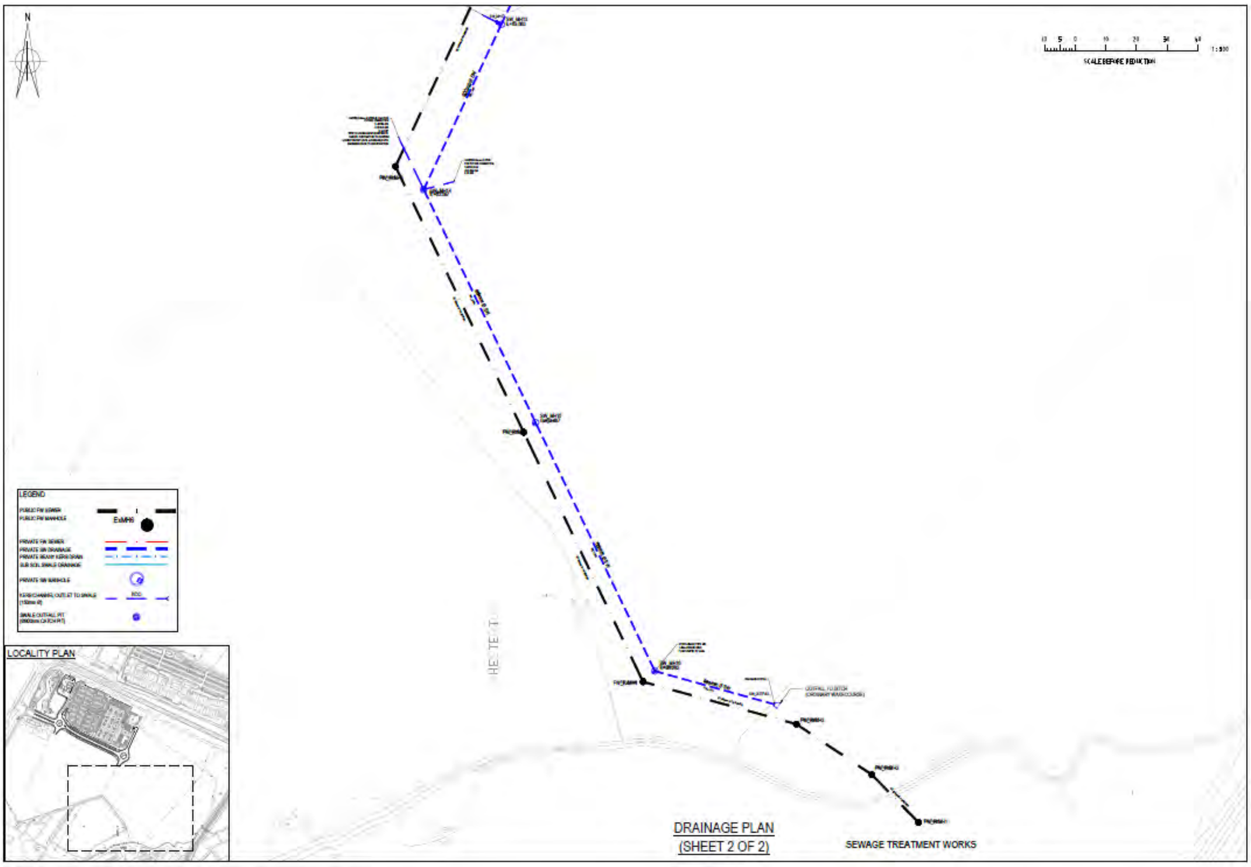
4.2.2 The plan below shows the route of the public foul sewer as it transverses the masterplan area before connecting to the sewage treatment works.



The black dotted line shows the line of the public foul sewer it should be noted that there will be a 6 metre easement centred on the line of the sewer.

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5 Drainage strategy

5.1 Surface Water

5.1.1 Design parameters to be adopted

The surface water sewer was designed with a capacity to serve the masterplan proposals. In accordance with the previously agreed drainage strategy that surface water runoff from the developed site will be limited to current 'greenfield' runoff rates and onsite storage will be required. When carrying out the detailed design, the greenfield runoff rate will be estimated using the HR Wallingford *uksuds* tool. The sewer capacity of the constructed surface water drainage has been designed on this basis.

Surface water attenuation will be required to store the runoff from 1 in 100 year storm event + 20% climate change balanced against current Greenfield runoff rate for a 1 in 100 year storm. When the drainage strategy for the Tesco store was approved a Greenfield runoff rate for the site of 9.47 l/s/ha was agreed by the Local Drainage Authority (Oxfordshire County Council). When detailed planning application is made for the area within the red line the Greenfield runoff rate will need to be reconfirmed with the local Drainage Authority. The on-site attenuation/storage will be in accordance with Sustainable Drainage System (SuDs) design requirements.

5.1.2 Sustainable Drainage Systems (SuDS)

In order to limit the runoff of the current 'Greenfield' rates the drainage system to serve the development will incorporate the recommendations within the current good practice guidance for SuDS contained in CIRIA Report C753, issued in 2015. This will be used to design the onsite drainage network unless superseded in the future.

The current guidance has been reviewed and the table in section 6 indicates which SuDS methods may be applicable for the Bicester Office Park Development.

5.1.3 Water demand management.

As part of the primary infrastructure works a 150mm water main was laid under the access road and Thames Water have confirmed that this has sufficient capacity to meet the water demand requirements of the development proposals covered by the new outline planning application. However it is anticipated that rainwater harvesting may be suitable for the development and this would allow the water demand to be reduced as well providing attenuation in accordance with BS 8515:2009+A1 2013.

5.2 Foul Water

5.2.1 General

A 600 mm public foul sewer constructed as part of the primary infrastructure works with blank connection points to serve the proposed development. The flow rates from the proposed development has been estimated based on the benchmarks for B1 uses. The total flow rate is from the completed development will be very low in comparison with the capacity of public sewer. It is not anticipated that there will be any flow restrictions placed on the connections by Thames Water.

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5.2.2 Design Criteria

The foul sewer network to serve the development will be designed in accordance with Sewers for Adoption 7th Edition or subsequent revisions.

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6 Sustainable Drainage Systems (SuDS)

6.1 Sustainable Drainage Systems (SUDS)

SUDS will be utilised in the surface water drainage system in line with current good practice.

SUDS take account of the quality and quantity of surface water runoff together with the amenity value of surface water in the urban environment. These systems aim to provide a more sustainable solution than conventional drainage and should:

- Manage runoff flow rate, reducing the impact of urbanisation on flooding;
- Protect enhance water quality; and
- Be sympathetic to the environment setting and the needs of the local community.

There are several advantages to using SUDS that include:

- Effective control of peak flows;
- Improved water quality;
- Reduction in surface erosion;
- Reduced sewer surcharging and flooding as discharge flow rates are reduced; and
- Water conservation through rainwater harvesting and re-use.

The pollutants of concern that have been identified to include:

- Oils and Fuels. Sourced from leaks and spills;
- Suspended Solids. Sourced from traffic wear, and landscaping features;
- Chemicals. Typically detergents from washing activities;
- Litter. Sourced from bins and bin overflows, particularly within the public domain.

The surface water approach will incorporate various SUDS controls into the drainage system. It will include both source controls and larger downstream site (catchment) controls. These controls will work in series along the drainage system and it is envisaged they could include:

- Source Controls:
    - Provision of rainwater harvesting for individual buildings.
    - Use of green roofs.

      Note Green roofs and rainwater harvesting would not be used in combination
- Catchment Controls including:
    - Trapped gullies as initial silt traps
    - End of line petrol interceptors.
    - Use of swales and ponds (see table 2)

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SUDS Systems	Suitability	Remarks
Ground Infiltration	×	Existing site constraints severely limit the application to this development area. These include: • Low design infiltration rate of 2.4 x 10^{-6} m/s; and • Majority of the site is underlain by clay.
Ponds/Wetlands	✓	A ponds or water features can be incorporated into the landscape proposals. The system would provide temporary storage required during storm events and promote pollutant removal.
Swales	✓	The swales were constructed adjacent to the access road to convey highway drainage. The system helps to reduce the rate of runoff provide infiltrations to the ground, and a degree of cleansing. These may be suitable for inclusion in the proposed landscaping.
French drains/Infiltration trenches	✓	An alternative to swales. The system helps to reduce the runoff, provide some infiltration or convey the storm water in pipes, and can be sited adjacent to the highways with little land take.
Below Ground Attenuation	✓	If insufficient storage can be provided above aground below ground storage tanks can be used. Note these can be used in combination with rainwater harvesting tanks see 5.1.3
Permeable Pavement	✓	Permeable pavement is recommended for all car parking areas. It is not suitable for servicing/waste storage areas

Table 2 SuDS Components

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7 Conclusions.

7.1 Primary drainage infrastructure has been constructed to serve the development proposed within the outline planning application. It has sufficient capacity to accept the proposed surface water and foul flows from the quantum and type of development proposed, without requiring any reinforcement.

7.2 The surface water network will incorporate SuDS good practice and the runoff will be limited to the current greenfield runoff rates. The rate will need to be confirmed with the Local Drainage Authority when detailed planning application(s) are submitted. The 1 in 100 year Greenfield runoff rate agreed for the Tesco development was 9.47 l/s/ha.

7.3 Green infrastructure will be provided which will facilitate a wide range of SuDS components and it is anticipated that providing the required onsite surface water storage will not present a significant challenge.

7.4 The public foul sewer located under the access road has sufficient capacity to serve proposed development and connections have been left to serve the development.

7.5 The development can incorporate rainwater harvesting as part of the SuDS strategy. In addition to providing surface water storage it also would contribute to a reduction in potable water demand as part of a water resource management strategy.

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Appendix A As built drainage network drawings

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DRAINAGE PLAN
(SHEET1 OF 2)

DRAINAGE PLAN
(SHEET 2 OF 2)

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F: +44 (0)870 787 4145
Email: John.Waiting@BuroHappold.com

Appendix G Ground Investigation Location Plan

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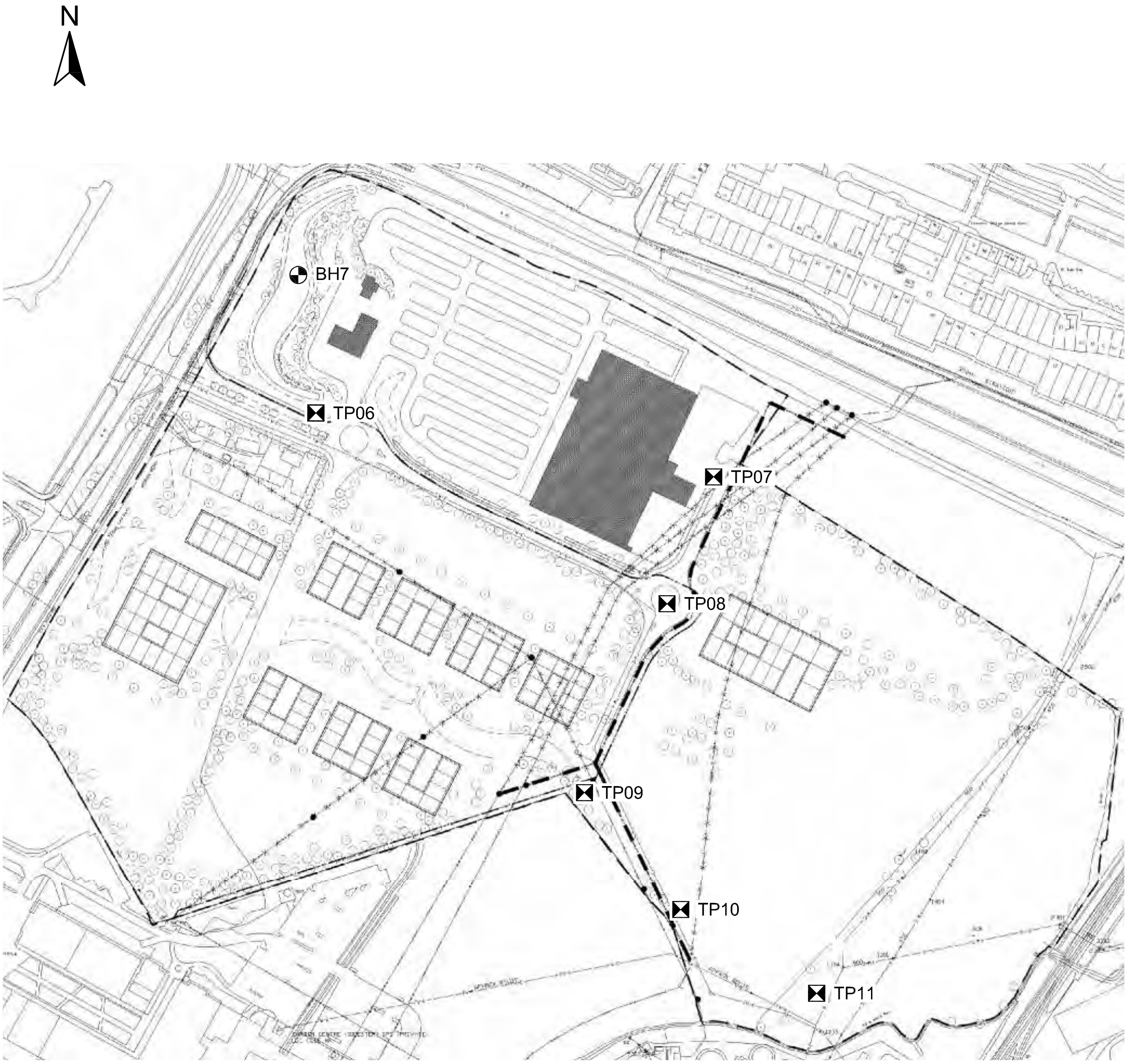

LEGEND

- Borehole Location
- Trial Pit Location

STRUCTURAL SOILS LIMITED

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Stillhouse Lane
Bedminster
Bristol BS3 4EB

Tel: 0117 947 1000
Fax: 0117 947 1004
ask@soils.co.uk
www.soils.co.uk

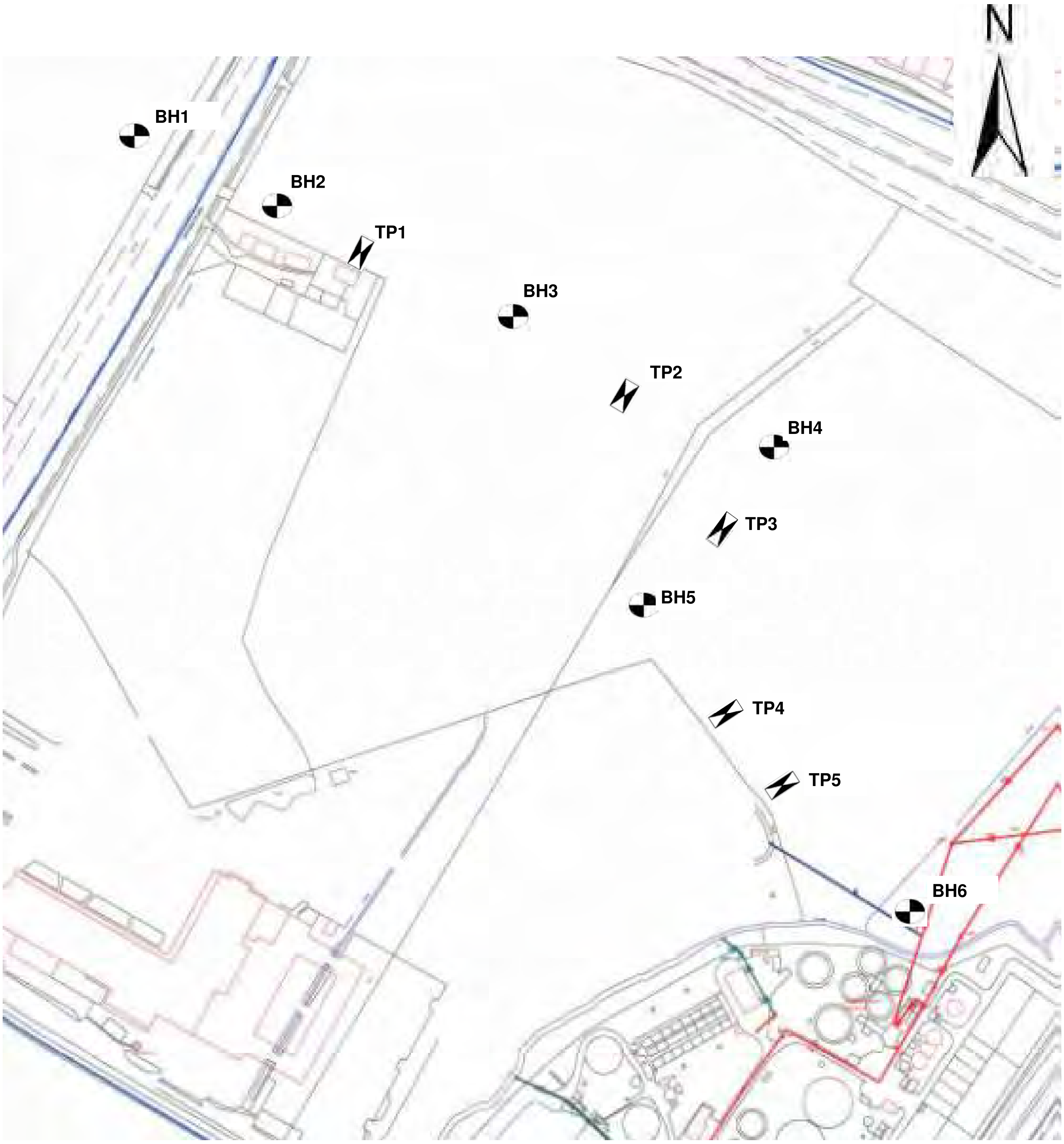
CLIENT: London and Metropolitan International Developments LTD

PROJECT: Bicester Business Park

TITLE: EXPLORATORY HOLE LOCATION PLAN

REV.	DATE	DESCRIPTION	BY	CHD.	APR.
00	29.01.2014	-	MW	WH	-

DIMENSION	SCALE	DRAWING STATUS	JOB NO.	SCALE BAR	ORIGIN SIZE	FIGURE
m	NTS	-	728724	Not To Scale	A4	2



Borehole symbol	Borehole
Trial pit symbol	Trial Pit

EXPLORATORY HOLE LOCATION PLAN

Structural Soils Limited
The Old School
Stillhouse Lane
Bedminster
BS3 4EB

Site	**7RWG - Whitelands Farm Oxford Road FAS Diversion, Bicester**
Client	**Thames Water Utilities Ltd**
Job no.	721026
Drawing no.	2
Date	Feb-08
Drawn by	TB

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