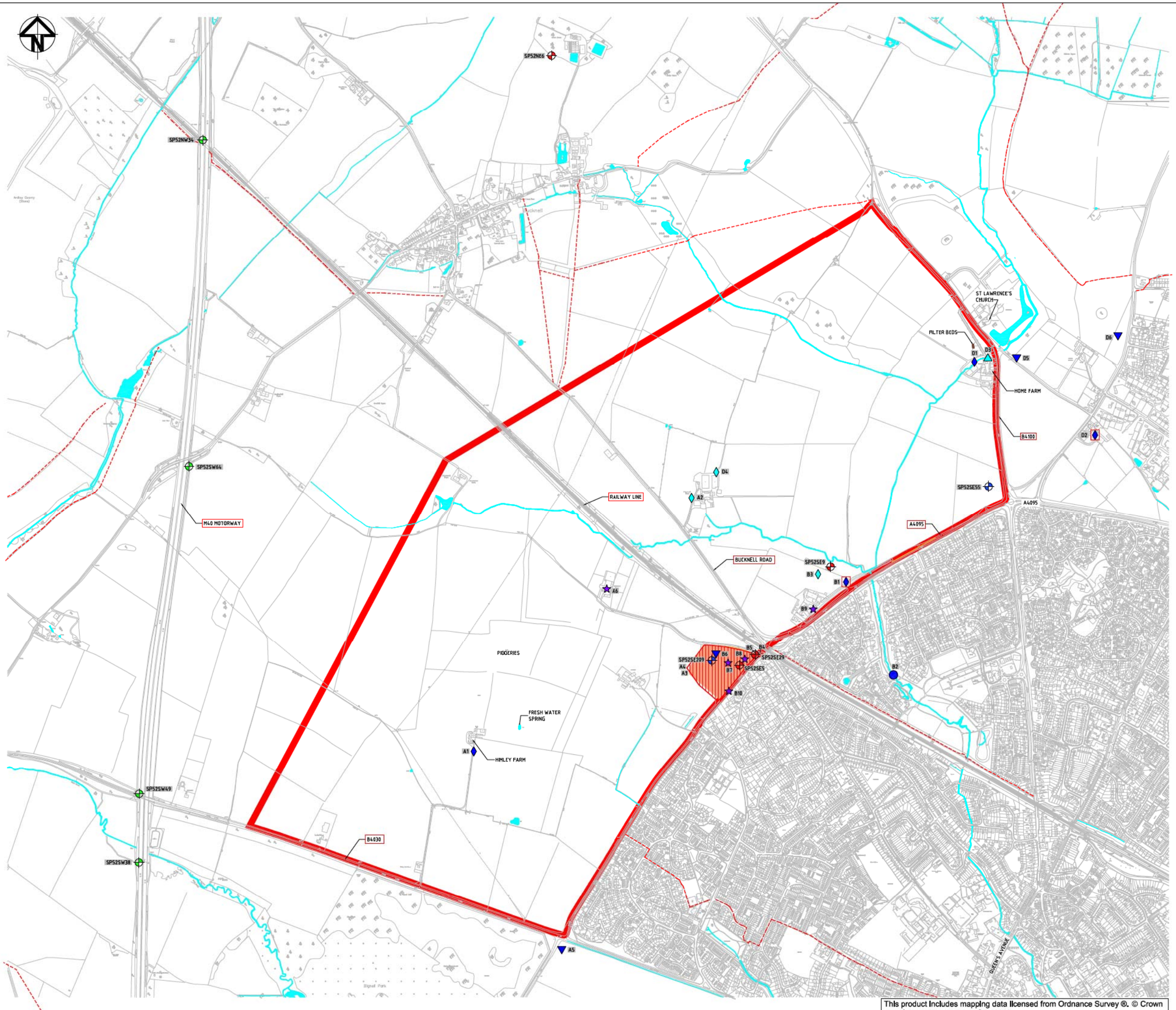

KEY

- OVERALL SITE BOUNDARY
- PUBLIC BRIDLEWAY
- PUBLIC FOOTPATH
- HEDGEROW
- WOODLAND
- WATER COURSE
- B8 — MAP ID:- B=SLICE B, 8= ITEM No.
- DISCHARGE CONSENT
- POLLUTION INCIDENT TO CONTROLLED WATERS
- WATER ABSTRACTION
- TRADE DIRECTORY ENTRY
- BGS RECORDED MINERAL SITE
- LOCAL AUTHORITY POLLUTION PREVENTION AND CONTROL
- MORE THAN ONE OF TYPE AT LOCATION
- LOCAL AUTHORITY RECORDED LANDFILL SITE
- EA HISTORIC LANDFILL (POLYGON)
- BGS BOREHOLE DEPTH 0-10m
- BGS BOREHOLE DEPTH 10-30m
- BGS BOREHOLE DEPTH 30m +
- A4095 — POTENTIAL NOISE SOURCES - LOCAL ROAD NETWORK (INC. M40/ A4095/ B4100/ B4030/ BUCKNELL ROAD) AND RAILWAY LINE.

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Project: BICESTER ECO TOWN

Title: ENVIROCHECK INFORMATION

Drawing No.	Project No.	Issue
7015	UA001881	01

APPENDIX 12.5
NW BICESTER ECO DEVELOPMENT: GROUNDWATER SUPPLY FEASIBILITY STUDY

P3 Eco (Bicester) Ltd & A2 Dominion Group Ltd

NW Bicester Eco Development

Geotechnical Interpretative Report - Masterplan Site

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NW Bicester Eco Development

Geotechnical Interpretative Report - Masterplan Site

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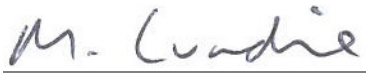
Checker	M Lundie	
Approver	C Plumb	

Report No	2507-UA001881-UP33R-01
Date	February 2011

CONTENTS

Figures

Appendices

1 INTRODUCTION

Hyder Consulting (UK) Limited (HCL) has been instructed by P3Eco (Bicester) Ltd. (P3Eco) and A2Dominion Group Ltd. (A2Dominion) to undertake a Geotechnical and Geo-Environmental intrusive investigation with subsequent factual and interpretative reports for a proposed new Eco development on the north-western periphery of the town of Bicester, Oxfordshire.

This geotechnical interpretative report presents a summary of data collected during an initial preliminary ground investigation undertaken at the proposed Masterplan site from August to September 2010 and provides advice relating to the physical and chemical nature of the ground based on interpretation of this data. Prior to undertaking the ground investigation, a desk study report (Ref. 1) and following completion of the investigation a factual report (ref. 2) were produced by HCL, which should be read in conjunction with this document.

1.1 Background to the Proposed Development

Land at NW Bicester is identified in the Supplement to Planning Policy Statement 1 (PPS1) entitled 'Eco Towns' (July 2009) as a potential location for an Eco-town. PPS1 sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system. The Supplement to PPS1 sets out a range of criteria against which Eco-town proposals should be assessed.

The development of land at NW Bicester as an Eco-town has been promoted by P3Eco. P3Eco have selected A2Dominion as its affordable housing partner and development partner for the promotion and implementation of the Masterplan scheme (see Figure 1 – site location plan for land proposed for the Masterplan scheme).

The proposed development is still in the preliminary design stage and as such, the ground investigation was designed based on the information provided within the desk study to provide the assessment of general ground conditions and parameters from a geotechnical, hydrogeological and geo-environmental perspective.

The purpose of this report therefore is to identify the geotechnical, environmental, geological, hydrogeological and hydrological conditions and constraints to the proposed Eco development present at the Masterplan site. Plus additionally to use the information gathered during the investigation and desk study phases, including the historic land use knowledge, to develop an understanding of any potential contamination risks that might arise from current or potential future use of the site.

1.2 Objectives of the Report

The principal objective of the report is to provide an assessment of the current geotechnical and geo-environmental conditions of the proposed Masterplan site. To this end, this report aims to:

- Establish ground and groundwater conditions beneath the site;
- Identify the presence of contaminants within the soil;
- Identify health and safety issues arising as a result of the ground conditions; and
- Discuss materials management and waste disposal issues.

In order to meet these objectives, a preliminary site-specific intrusive ground investigation was undertaken by HCL's in –house SI contracting division, using CJ Associates Ltd. (CJA) as the specialist drilling subcontractor, with all technical direction and supervised provided by HCL.

2 THE MASTERPLAN SITE SETTING

2.1 Site Location

The town of Bicester lies approximately 24km to the north east of Oxford and 28km to the south east of Banbury. The M40 motorway lies 2km to the south west, with ready access to the town from Junction 9. The proposed Eco-town site will comprise approximately 5,000 homes with supporting employment and education infrastructure, and will be situated on the north-western periphery of Bicester, beyond the A4095 (which forms part of the Bicester Ring Road), approximately 1.5km from the town centre.

The whole of the development site covers an area of approximately 345ha and at present, comprises Grade 3 agricultural land with a number of farmhouses and other buildings, as well as a small commercial area on the western side of Howes Lane (A4095). Immediately beyond the Site to the north-west is the village of Bucknell, with Caversfield located on the north-eastern Site boundary, beyond the B4100 highway and this geotechnical interpretative report covers the whole of the Masterplan site.

There are some 15 landowners associated with the Masterplan development and the location of the landowners boundaries and exploratory hole locations are presented in Figure 1 with the proposed site development plan included in Figure 3; and comprises of predominantly two storey houses, although this is subject to change and was current at the time of writing.

2.2 Site Description

The Masterplan site is predominantly flat, arable farmland and the agricultural land value is Grade 3 (good to moderate quality). As characterised by Grade 3 land, the principal land uses on Site are for arable cropping and rotational grassland, e.g. cereals or as grass leys for dairy cows, beef and sheep. Fields are bounded either by post and wire fences or by dense hedges with some large trees. Many fields were surrounded by drainage ditches approximately 0.5m to 0.75m deep, though all were dry at the time of the Site walkover and Ground Investigation.

Existing buildings within the Site boundary include those at Himley Farm, Aldershot Farm and Gowell Farm, located to the south of the railway line, and Hawkwell Farm, Lord's Farm and Home Farm located to the north. Home Farm and Himley Farm contain Grade II Listed Buildings.

The Site is dissected through its centre by the north-west to south-east trending Birmingham Snow Hill to London Marylebone railway, with the Bucknell/Bicester Road running roughly parallel to its east. In the north-west of the Site, the railway lies in a cutting, which rises to an embankment of around 5 metres height in the south-east.

The employment land on the western side of Howes Lane comprises a Thames Valley Police Traffic Base and the Avonbury Business Park, with a range of small business units.

2.3 Public Register and Historical Information

Public register information relating to the Site and the surrounding area has been obtained mainly from the Landmark Information Group Ltd. A full review of public register and historical information can be seen in the desk study report (Ref. 1).

2.4 Geology and Hydrology

The following section contains extracts from the accompanying desk study report (Ref. 1) and supplemented by information gained from the ground investigation.

2.4.1 Superficial Deposits

Late Quaternary age superficial deposits of Alluvium flank the streams in narrow tracts, typically some 20m wide (locally up to 80m wide) and some 1m to 3m in thickness. The Alluvium typically comprises sandy, calcareous clay overlying gravelly clay with limestone clasts and may locally include highly compressible, organic-rich (peaty) layers.

Head deposits may be present near the streams where the erosive action of the water has carved small valleys. These deposits are formed by soil creep or hill wash and their composition reflects that of the local materials from which they were derived, either the bedrock or other types of superficial deposits (or both). They are typically poorly stratified and poorly sorted and are not expected to be present in thicknesses much greater than 1m.

Beneath the topsoil, the remainder of the Site has only a thin cover (approximately 1m) of superficial deposits, mainly derived from the partial to complete weathering of the underlying solid geology.

2.4.2 Solid Geology

The landscape of the Site follows the underlying geology, which dips in a south-easterly direction at a very gentle ~0.7°. The Site area is underlain at rock head by various formations and members of the Great Oolite Group, of Mid-Jurassic age, which are dominated by limestone's with subordinate mudstone beds.

There are no geological faults shown on Site; however some minor faults have been mapped to the north-east of Bucknell village, with ground displacements of up to 5m. Faults are planes of movement, along which, adjacent blocks of rock strata have moved relative to each other. They commonly consist of zones, perhaps up to several tens of metres wide, containing several to many fractures. The portrayal of such faults as a single line on the geological map is therefore a generalisation. The geological faults in the Bicester area are ancient in origin and are today mainly inactive, therefore are not thought to present a threat to the proposed development, though they may result in unexpected changes in geological strata.

Sequence of Strata

The Cornbrash Formation (CB) is the youngest bedrock unit represented and dominates the outcrop within the Site area. It comprises approximately 5m of thick grey to brown, bioclastic, rubbly-bedded limestone with thin subordinate beds of grey mudstone.

The older, underlying Forest Marble Formation (FMB) is exposed as a narrow outcrop on the flanks of the three stream valleys in the area where the Cornbrash Formation has been eroded. The FMB comprises approximately 5m to 10m of grey calcareous mudstone with lenticular beds of bioclastic, ooidal limestone (particularly common at the base).

Although not represented in outcrop on Site, the FMB is underlain at an erosive contact by the White Limestone Formation (WHL), which crops approximately 2km to the north-west. The WHL comprises up to 25m of white to yellow, bedded, peloidal and bioclastic limestone (see Additional Geological Considerations below).

The White Limestone Formation is underlain by four further formations of the Great Oolite Group: in ascending order the Horsehay Sand, the mudstone-dominated Sharp's Hill, the Taynton Limestone and the mudstone-dominated Rutland formations, totalling approximately 20m in thickness. These are then underlain by 2m to 6m of the ferruginous sandstones of the Northampton Sand Formation before the 100m+ of the mudstone-dominated Lias Group is encountered.

2.5 Hydrogeology

With the exception of the Forest Marble Formation cropping out in the floors and sides of the valleys, the whole of the Site area is underlain by the Cornbrash Formation. This is a local aquifer and water strikes have been recorded in shallow boreholes drilled within the Site area. The standing water levels are generally between 0.5m and 4.0m below the ground surface.

The Forest Marble Formation may hold small quantities of water in any limestone bands present, but the upper part generally acts as an aquiclude, i.e. an essentially impermeable barrier between the Cornbrash Formation and the underlying White Limestone Formation. None of the boreholes drilled at the Masterplan Site reached the Forest Marble Formation.

The White Limestone Formation constitutes a major aquifer in the area, which provides some sources of public supply. There are several boreholes in the wider area, some within the Site area, that penetrate this formation:

- A 34m deep borehole at Gowell Farm (SP52/19 at SP 5709 2384), drilled pre-1909 to supply Bicester with water. This penetrated the complete 25m thickness of the White Limestone Formation, underlying about 7.2m of Forest Marble Formation and terminating in the underlying Rutland Formation. Water was struck at 28m and 32m below the ground level in the White Limestone Formation. The rest water level rose to the surface after the first strike, and was artesian, with a rest water level about 1m above ground level (about 88m AOD) after the second strike. The yield was over 7 l/s.

- An 80 m deep borehole at Lords Farm (SP52/18 at SP 5746 2424), drilled in 1941, was drilled through a similar sequence and terminated in the Lias. It struck water in the Cornbrash Formation, which was cased out, and at two levels below the White Limestone Formation. The rest water level was at 11m below ground level (about 68m AOD) and it yielded 1.7 l/s.

Other records of water levels at Lords Farm (SP52/17A, B and C at about SP 569 245) show that the water level was at approximately 3.6m below ground level (about 76m AOD).

In addition to the available geological information, the Environment Agency (EA) Groundwater Vulnerability Map on the EA website has been reviewed to determine the vulnerability of the groundwater underlying the Site with the following conclusions:

- The superficial deposits are not classified as an aquifer. The underlying Cornbrash Formation is classified as a Secondary 'A' Aquifer, which comprises "permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers."

This designation corresponds with the geological interpretation given above.

There is insufficient data to determine a groundwater flow direction, but locally it will probably be towards the nearest stream and regionally, down-dip towards the south-east.

2.5.1 Groundwater Source Protection Zones

The Environment Agency (EA) has defined Source Protection Zones (SPZs) for groundwater sources such as wells, boreholes and springs used for public drinking water supply. The SPZs show the risk of contamination from any activities that might cause pollution in the area.

Source protection zones are defined as follows:

A Source Protection Zone III is the total area needed to support removal of water from a borehole, and to support any discharge from the protected borehole/well/spring used for public drinking water supply.

A Source Protection Zone II (outer protection zone) covers pollution that takes up to 400 days to travel to the abstraction point, or 25% of the total catchment area – whichever area is the biggest.

A Source Protection Zone I (inner protection zone) defines an area where pollution can travel from the source to the extraction point within 50 days. A Source Protection Zone I also has a minimum 50m protection radius around a public supply borehole.

According to the EA website, the Site does not lie within a SPZ.

2.6 Flooding

Information contained within the desk study report (Ref. 1) indicates that the site does not generally lie within the zone susceptible to flooding from fluvial watercourses. According to the Environment Agency Flood Maps included within the Envirocheck Report, the Site does not generally lie within a zone susceptible to flooding; however, the River Bure that flows to the south east of the site in a roughly north-easterly to south-westerly direction is shown to present a risk of flooding from Rivers or Sea without Defences (Zone 3)" to an area confined to the stream's valley (i.e. its natural floodplain).

Note that EA flood maps are based upon coarse DTM and JFLOW modelling and are not considered suitable to delineate the flood plain to support a planning application. The stream that flows across the site in a west to east direction has not been modelled by the EA, as it is too small. As such, a separate, Site-specific hydraulic model should be developed in order to confirm the flood plain extents across the Site.

2.7 Drainage Soakaways

As part of the development, the suitability of the ground for accepting soakaways for surface water drainage will need to be considered. Based on the available documented evidence on the geology and visual evidence from the Site walkover (where the superficial deposits were typically loamy and all field drainage ditches and the stream that feeds the River Bure were dry), it is considered at this stage that the ground will likely be suitable for some form of soakaway, although this is discussed in more detail within the Hyder Masterplan Site Drainage Strategy Report (Ref.3).

3 GROUND INVESTIGATION

The preliminary ground investigation for the whole site was carried out on 2nd August to 7th September 2010 and the investigation was undertaken and supervised by HCL on behalf of A2Dominion and P3Eco.

The site specific ground investigation at the Masterplan site was designed to address the objectives identified within Section 1.2 of this report. The findings of the ground investigation, GI are summarised below and are detailed in the HCL Factual Report (Ref. 2).

3.1 Site Works

The completed scope of the ground investigation at the Masterplan site is as follows:

- 5 no. rotary boreholes (BH3, BH4, BH4a, BH10, BH11) to maximum depth of 9m below ground level (bgl) with Standard Penetration test (SPTs) at 1m interval to 5m and at 1.5m intervals thereafter. Gas and groundwater monitoring standpipes were installed within BH3, BH10 and BH11;
- in-situ permeability tests were carried out within boreholes BH10, BH11 and BH4a;
- 11 no. machine excavated trial pits (TP7 to TP14, TP12A, TP16, TP18, TP20) to depths of up to 2.85m bgl; and
- 5 no. in-situ soakaway tests within selected machine-excavated trial pits (TP7, TP11, TP12, TP12A, TP20).

The depth, thickness and descriptions of the strata (including depths of sampling points) are given on the relevant exploratory logs, presented within the HCL Factual Report (Ref. 2).

Upon their completion, the trial pits were safely backfilled and compacted and the ground re-instated, as far as practicable. Selected rotary boreholes (BH3, BH10 and BH11) were completed with gas and groundwater monitoring installations for monitoring purposes with raised locking covers.

3.2 Sampling

A Geotechnical Engineer from HCL logged the boreholes and trial pits in accordance with the recommended procedures provided by document BS5930:1999 “Code of Practice for Site Investigations” (Ref. 4). Disturbed, and environmental samples were collected from the exploratory holes, which were subsequently sent for geotechnical, chemical and contamination analysis with the testing scheduled by HCL.

Water was added to all boreholes to assist drilling so groundwater inflows were not apparent. Furthermore boreholes BH1, BH3, BH5, BH10 and BH11 have been installed with groundwater and gas monitoring standpipes and an ongoing programme of monitoring over a three month period was undertaken to allow the groundwater and gas levels to stabilise and to be recorded over a range of (short-term) climatic variations.

The full results of the gas and groundwater monitoring are shown in Appendix B.

3.3 Laboratory Testing

Geotechnical and chemical laboratory testing was undertaken on selected samples taken from the boreholes and trial pits and are summarised in Table 3.1 below. Testing of all samples was scheduled by HCL and undertaken by an HCL appointed laboratory. The test results are discussed within Sections 5 to 8 of this report and are presented in full within the HCL Factual Report (Ref. 2). Asbestos presence was analysed as a precautionary health and safety measure due to the desk study identifying possible ACMs (Asbestos Containing Materials) as being present on site, and possibly residing in the ground following demolition of former buildings.

Table 3.1: Summary of Analysis Undertaken on Scheduled Samples

Type of Test	Standard	Number of Samples
Geotechnical Testing on Soil Samples		
Soil Moisture Content	BS1377:1990 Part 2:3	16
Atterberg tests	BS1377:1990 Part 2:4 & 5	12
Particle Size Distribution tests (PSDs)	BS1377:1990 Part 2:9	9
Consolidation Tests	BS1377:1990 Part 5	3
Point Load Tests	International Journal of Rock Mechanics, Science and Geomechanics, Abstract volume 22, No.2 pp 51 to 60, 1985	2
Unconfined Compressive Strength	ISRM Suggested Methods pp 111 to 116 1981	1
Compaction testing, 2.5kg rammer	BS1377:1990 Part 4	6
BRE Sulphate Suite	BRE Special Digest 1:2005	10
Consolidated undrained triaxial compression	BS 1377 : Part 8 : 1990	1
Uniaxial compressive strength	ISRM Suggested Methods Vol 16 no.2, pp 135-140 1979	2
Type of Test	**Standard**	**Number of Samples**
Contamination Tests		
Soil		
arsenic, barium, beryllium, cadmium, chromium, nickel, lead, copper, zinc, mercury, lithium, magnesium, phosphorous, potassium, selenium, sodium, strontium, zinc	MCERTS Accredited	23
Total, complex and free cyanide, total phenols, sulphide and pH.	MCERTS Accredited	23
Speciated PAH (USEPA 16)	MCERTS Accredited	19
TPH GRO/DRO/MRO	MCERTS Accredited	16
TPH (Total Petroleum Hydrocarbons) 6 banded	MCERTS Accredited	16

Total phenols	MCERTS Accredited	16
PAH	MCERTS Accredited	16
Asbestos screen	MCERTS Accredited	2

4 GROUND CONDITIONS ENCOUNTERED

4.1 Summary of Strata Sequence

The typical strata sequence encountered across the proposed Masterplan Site has been summarised in Table 4.1, with the full exploratory hole logs presented within the HCL Factual Report (Ref 2). The material properties and engineering considerations of the strata encountered are discussed respectively in Section 5 of this report and the contamination testing is discussed in Section 6.

The strata sequence generally comprises of Topsoil overlying an orange-brown, superficial head deposit comprising gravelly, sandy Clay with many cobbles and / or orange-brown, sandy, clayey Gravel and Cobbles. Below this superficial layer, yellow-grey, sandy Gravel, and in places yellow grey Clay was encountered. This layer is thought to be a completely weathered layer derived from the underlying limestone as it grades into a limestone rock with depth. Below this level, the stratum alternates between generally a moderately strong to strong limestone, interbedded with stiff Clay and Mudstone layers. The weathered and strong limestone rock with interbedded clay and mudstone layers combine to form part of the cornbrash formation.

The strata descriptions used in the factual report (Ref. 2) are in accordance with BS 5930:1999 (Ref. 4).

Table 4.1: General Sequence of Strata across Site

Stratum	General description of Stratum	Typical Depth Range (m bgl)
Topsoil	Topsoil	GL to 0.2m (Max. 0.3m)
Superficial/Head deposits	Red brown, clayey sandy gravel and cobbles, or in places gravelly sandy Clay with cobbles	Generally to 0.9m (max 1.8m)
Completely Weathered Limestone	Recovered as yellow-grey, sandy Gravel or places yellow grey Clay	Generally To 1.5m, maximum 2.6m
Interbedded Limestone and Clays	Interbedded moderately strong to strong Limestone and stiff or hard Clay and mudstone	>9m

4.2 Groundwater and Ground Gas

During the ground investigation at the Masterplan site, water was added to the boreholes to assist the rotary drilling process within the limestone rock to keep the drill bit cool and limit the rock dust generated. It was therefore not possible to carry out groundwater monitoring of the boreholes during the investigation.

Within the trial pits, ground water was encountered at depths of 2.6m, 0.6m, 2.6m, 1.7m, 0.75m, and 2.4m in trial pits TP7, TP8, TP9 TP10, TP13 and TP18 respectively. The remaining trial pits were dry. Trial pits TP7 to TP10 and TP13 were carried out after a period of heavy rain.

Gas and groundwater monitoring results following completion of the ground investigation at the Masterplan site have been carried out; see section 6.3 of this report and Appendix B.

The results suggest that excavations for shallow foundations may encounter some groundwater flow in some areas, particularly after heavy rain so that provision for pumping should be allowed for. The groundwater strikes within the trial pits generally coincide with the top of the limestone.

During the ground water monitoring visit, gas measurements were taken from the boreholes, with the results showing that no methane was present and only a small concentration of carbon dioxide was present.

5 GEOTECHNICAL PROPERTIES

5.1 Introduction

A testing programme for soil samples recovered from the exploratory hole locations was scheduled by HCL and carried out by a designated laboratory, as specified by document BS1377:1990 “Methods of Tests for Soils for Civil Engineering Purposes” (Ref. 5). The results are summarised in this Section and included in full in the factual report (Ref. 2).

5.2 Superficial Deposits/Head

The superficial deposits/Head are generally consistent across the Masterplan site with a typical depth of 0.9m, although up to 1.8m in places. The deposits predominantly comprise of a reddish/orange, brown clayey Gravel with cobbles, or in places a gravelly Clay with cobbles. Based on inspection of the trial and archaeological pits carried out on the Exemplar site, the material composition varies with depth. When the ground level drops towards the streams or water courses, the granular content of the subsoil decreases and vice versa. Therefore at a higher elevation there is a much higher content of granular material, with increasing cobble content.

5.2.1 Laboratory Testing on Superficial Deposits/Head

Three atterberg limits test and three moisture content (mc) tests were carried out on cohesive samples of the superficial deposits in borehole BH3, BH11 and TP9. The material was found to be of intermediate plasticity with plasticity index (PI) values of between 22% and 24%. The moisture content testing for the same material indicates an mc of between 18% and 25%. Moisture content testing on a more granular sample from TP8 indicates an mc value of 22.

Three particle size distribution tests were carried out on the subsoil and indicate this material to comprise mainly gravel and some cobbles; although in places the cobble fraction is more dominant. Three compaction tests at 0.5m depth were carried out in the superficial deposits and the maximum dry density ranged from 1.68 mg/m^3 to 1.73mg/m^3 and optimum moisture content of between 11% and 14%.

In accordance with BRE Special Digest SD1 (Ref. 9), sulphate content and pH value testing was carried out on selected soil samples from the Head deposits and the test results lie within the limit of Sulphate Design Class DS-1, as defined within the BRE guidelines. The minimum pH value is 7.67 and the sulphate values are generally below detection limits of 10mg/l, with one result at 20mg/l. The groundwater regime is considered as mobile, therefore an Aggressive Chemical Environment for Concrete (ACEC) classification of AC-1d is considered appropriate.

5.2.2 In Situ Testing in the Superficial Deposits

Three standard penetration tests, SPT’s were carried out within the superficial deposits giving SPT values of 50, 50 and 8, suggesting that the superficial deposits can be variable in density.

5.3 Completely Weathered Limestone

The completely weathered Limestone was generally recovered as a yellow-grey, sandy Gravel and yellow grey Clay. This material grades to a moderately weathered limestone with depth. In

borehole BH11, the clay is described as soft to firm. This is anomalous with all other areas however, and it is considered likely that this is drilling induced.

5.3.1 Laboratory testing on the completely weathered Limestone

Three atterberg Limit tests were carried out on the completely weathered limestone in trial pit TP7 at 1.8m and in TP12 at 2.1m and TP18 at 1.9m. All three test results indicate an intermediate plasticity, of between 18% and 24%, although test results for the Exemplar sites indicate higher plasticities of 31%. Moisture content testing was carried out on 4 samples and indicates mc values of between 16% and 30%.

Four particle size distribution tests were carried out on the weathered limestone in BH4a, BH11, TP18 and TP20 and indicate variable composition of either clayey Silt or silty clayey gravel and cobbles. In situ testing in the completely weathered Limestone

Three SPT tests were carried out within the completely weathered Limestone giving SPT results of 15, 31 and greater than 50 suggesting a degree of variability with regards to density.

5.4 Interbedded Limestone

The Limestone was encountered in all exploratory holes, however due to the high strength of the material, excavation of the Limestone was not possible with the JCB 3CX. Rotary coring was used to investigate the limestone strata to depths of up to 9m.

The Limestone was generally moderately strong to strong, oolitic and frequently fossiliferous and grey, interbedded at medium spaced intervals with a stiff to very stiff or hard grey, silty Clay and in places mudstone.

5.4.1 Laboratory testing on the interbedded Limestone

Three atterberg limit tests were carried out on the Clays that are interbedded within the limestone. The tests indicate that the material is of intermediate to high plasticity, with PI values of between 23% and 27% recorded.

Moisture content testing was carried out on all of the samples tested for Atterberg Limits and give mc values of between 21% and 26%.

One dimensional consolidation testing was carried out on three clay samples from the interbedded Limestone. Test results indicate a coefficient of volume compressibility (Mv) values ranging from 0.026 m^2/MN to 0.518 m^2/MN and coefficient of consolidation (Cv) values ranging from 2.008 m^2/yr to 22.288 m^2/yr.

The minimum pH value in the interbedded Limestone is 6.97. and the maximum sulphate value is 240mg/l. The design sulphate class for the site is DS-1 and the groundwater regime is considered as mobile, therefore an Aggressive Chemical Environment for Concrete (ACEC) classification of AC-1d is considered appropriate.

Point load tests indicate Point Load Indices ($I_{s(50)}$) of between 0.19MPa and 3.94MPa in a diametral direction and 0.14MPa and 5.76MPa in an axial direction.

Testing to determine the Unconfined Compressive Strength (UCS) of the limestone was carried out on one sample and indicates a UCS 50MPa.

Testing carried out to determine the Uniaxial Compressive Strength was carried out and recorded values of between 19.5N/mm^2 and 19.5N/mm^2.

Consolidated undrained triaxial compression testing was carried out on one sample from BH3 and recorded a shearing resistance angle of 31°.

5.4.2 In situ testing in the interbedded Limestone

Fourteen SPT tests have been carried out within the Limestone bands, thirteen of these giving results in excess of 50 blows. Two results of 49 and 44 were recorded within the Clay bands encountered within the Limestone strata indicating that this material is very Stiff.

5.5 General

Geotechnical Parameters for each principal stratum type encountered within the boreholes are summarized in Table 5.1. These are based on available test results or published data. It is important that the accompanying notes and previous reports are read in detail when using this data for design and the construction process.

Table 5.1 – Summary of geotechnical properties

	Plasticity Indices			Natural Moisture Content	Undrained Cohesion	Effective angle of Shearing Resistance	Unconfined Compressive Strength	Standard Penetration Test	Concrete Class	Coefficient of volume compressibility /Coefficient of Consolidation/ Point load test results
Strata	LL (%)	PL (%)	PI (%)	%	Cu (kPa)	Phi' (degrees)	UCS (MPa)	('N') value	DC/ACEC	(m^2/MN)/(m^2/year/MPa)
Superficial deposits cohesive	43-48	20-24	22-24	19-25	150 based on description	27 based on PI value	-	>50 (1 result of 8)	DS1/AC-1	N/A
Superficial deposits Granular	-	-	-	-	-	40 (based on description SPT and BS 8002)	-	>50	DS1/AC-1	N/A
Weathered Limestone Granular	-	-	-	-	-	40 (based on description, SPT and BS 8002)	-	>50	DS1/AC-1	N/A
Weathered Limestone Cohesive	16-30	42-47	19-29	18-23	>150 based on description and SPT result	25	-	>50 one result of 15, one result of 30	DS1/AC-1	N/A
Interbedded Limestone Rock						40 (based on values published by Hoek and Bray)	20-50	>50	DS1/AC-1	N/A / N/A 0.19 to13.94 diametral, 0.14 and 5.76 axial
Interbedded Limestone Clay	21	43	20	23	>150 based on description and SPT result	28	-	>50, 44 and 49	DS1/AC-1	0.026 to 0.518,/ 2.008 to 22.288

5.6 Foundations

The exploratory hole logs indicate that shallow strip or pad foundations will be suitable for a residential two storey site development.

Based on Atterberg testing, the cohesive strata on the Masterplan site are generally of between low and medium volume change potential. Foundation design should be carried out in conjunction with landscaping design and in accordance with the guidance provided in NHBC chapter 4.2 (Ref. 7) to ensure that no damage to foundations results from shrinkage/swelling of clays.

Due to the potential presence of medium volume change potential Clay beneath the Superficial Deposits, it is recommended based on NHBC chapter 4.2 that foundations are located at a minimum of 0.9m below ground level (where roots are noted / present then foundations should be extended below the level of the roots – see section5.8.1), unless limestone is encountered at shallower depth.

There is some variability in the depth to the interbedded limestone across the site, so that when considering foundation types and loadings, consideration of differential settlement should be taken between those areas where limestone might lie directly beneath the foundation and where foundations are underlain by cohesive weathered limestone or Clays. Based on this variability in likely founding strata, strip foundations are not recommended for long rows of terraced houses without the inclusion of flexible movement joints and/or frequent gaps.

No Made Ground was recorded in any of the exploratory holes. Soft to firm however if Made Ground or soft material is encountered in any of the excavations for foundations then this material should be excavated and replaced with suitably compacted, granular fill. All shallow foundation excavations should be inspected by a suitably qualified Geotechnical Engineer, to confirm that a suitable founding stratum is available.

5.7 Excavations

Prior to excavation, any utilities services are to be disconnected and removed under the footprints of the proposed areas of works. Excavations for foundations although slow in the dense gravel, should prove straightforward with a standard backhoe machine excavator, as proven by the trial pitting during the ground investigation.

All pits were stable during the ground investigation. However water ingress occurred in a number of exploratory holes, and should be anticipated at depths shallower than the proposed depth of foundation, particularly after heavy rainfall, when it may be encountered at the top of the weathered limestone bedrock. Some form of dewatering during temporary works may be required.

If any excavations for other infrastructure are required to greater depth, there is an increased possibility of encountering groundwater.

5.8 General Construction Issues

Should significant changes in ground level be required as part of the proposed development of the Masterplan site, the excavatability of the limestone must be considered, as the ground investigation proved that this material is extremely difficult to dig. The overlying superficial and weathered deposits also present difficult/slow digging conditions. Excavations for drains, services and infrastructure may also prove difficult and time consuming, particularly where the limestone is at a shallower depth.

In areas where ground slopes more steeply, for example towards water courses, consideration of slope stability is required to ensure that no instability of the superficial deposits is induced through foundation loading, and/or cuttings for roads and other infrastructure. It is recommended that the foundations to proposed properties in steeply sloping areas are deepened to found below any potential zone of influence to the slope.

The development must follow current guidelines, and the recommendations of the appointed ecologist when constructing in the vicinity of any protected habitats that may be encountered on site. Any soft material encountered should not be re-used as backfill beneath any planned structures, road pavements, hard standing areas or other areas that may be sensitive to future settlement.

5.8.1 Building Near Trees

Where the development is proposed adjacent to existing or proposed planting, foundations should comply with the requirements of NHBC Guidelines Chapter 4.2 (Ref. 7). In which case, it may be necessary to extend the foundation depths quoted in Section 5.5.

5.8.2 Solution Cavities/Swallow Holes

Although no evidence of solution cavities or swallow holes were recorded during the preliminary ground investigation, these features may be present within the site, particularly in the limestone deposits. Any evidence of such features discovered during excavations should be investigated further by an experienced Geotechnical Engineer, and an appropriate remediation scheme adopted if deemed necessary.

5.9 Roads

The roads on site should be constructed in accordance with Design Manual for Roads and Bridges (DMRB) Volume 4, Section 1, Part 1 (HA44/91), (Ref 8) and Volume 7, Section 2, Part 2 (HD25/94). Further ground investigation should include CBR testing, once founding levels and layouts for the roads are known, in order to assist in the design of roads and bridges.

Particular care should be taken to avoid excessive trafficking in areas of proposed roads, and pavements should be constructed soon after excavation in order to limit deterioration and softening of the formation.

5.10 Radon Protection

As part of the Desk Study Report (Ref. 1), a detailed BR 211 Radon Report was obtained from the British Geological Survey (BGS), which states that basic radon protection measures are required for the site area as the estimated probability of a property being above the Action Level for radon is 3-5%.

Details on the technical specifications for basic radon protection measures are given in document BRE Report BR211 (Ref. 9).

5.11 Protection of Buried Concrete

The pH values tested on site are greater than 6.97 and the groundwater regime is considered as ‘mobile’ water. The laboratory testing for sulphate and pH has recorded results indicative of ACEC Class AC-1 as described in BRE Special Digest 1 3rd Edition, (2005) and Design Sulphate Class DS-1.

5.12 Permeability Testing

Three falling head tests were undertaken within boreholes BH4, BH10 and BH11 at the Masterplan site. The results are included in the HCL Factual Report (Ref 2)

Soakaway testing was undertaken in TP7, TP11 and TP12 and TP12A within the limestone rock and indicates limited or no soakage.

The full permeability test results are shown in the Hyder factual report (Ref. 2).

6 CONTAMINATED LAND

6.1 Introduction

This Section of the report relates to the potential risks to human health and controlled waters that development of the site may represent. This Section also describes:

- The current baseline conditions at the Masterplan site;
- Any potential impacts and the mitigation measures required to prevent, reduce or offset any potentially significant adverse effects; and
- The likely residual effects after these measures have been implemented.

To assist the understanding of the principles of this subject and their particular application within the context of the proposed development, it is recommended that the reader refers to the associated Hyder Consulting (UK) Ltd. (HCL) Phase 1 Desk Study Report (Ref. 1).

Establishment of Baseline Conditions

The baseline conditions for the Masterplan site have been determined based on the Phase 1 Desk Study Report and from laboratory testing results obtained from the follow-up preliminary intrusive ground investigation undertaken on site in August to September 2010.

Assessment of Effects

The potential effects on the identified receptors from contaminants at baseline conditions at the Masterplan site have been assessed under the headings 'Human Health Risk Assessment', 'Ground Gas Risk Assessment' and 'Controlled Waters Risk Assessment'.

6.2 Human Health Risk Assessment

The Statutory Guidance on Part IIA of the Environmental Protection Act 1990, as set out in DEFRA Circular 01/2006, and Contaminated Land Report 11 (CLR 11) form the basis on which this contaminated land assessment has been undertaken.

Current legislation and guidance on the assessment of potentially contaminated sites acknowledges the need for a tiered risk based approach comprising:

- Tier 1 Assessment: Comparison of site contaminant levels against generic standards and compliance criteria including an assessment of risk using a source-pathway-receptor model.
- Tier 2 Assessment: Derivation of site-specific risk assessment criteria and calculation of site-specific clean-up goals.

The assessment has therefore been undertaken in a phased approach, focussing initially on the Tier 1 Assessment. The Tier 1 assessment includes the following stages, which were completed where applicable:

- Zoning of data/site averaging areas;
- Maximum Concentration Assessment - comparison of maximum detected concentrations against relevant Generic Assessment Criteria (GAC);
- Mean and Maximum Value Statistical Analysis – consideration of statistical outliers and 95% Upper Confidence Levels (UCLs) against relevant GAC;

- Risk Evaluation/Assessment of Significant Results; and
- Identification of the need for Tier 2 Assessment and derivation of Site Specific Assessment Criteria (SSAC).

The current philosophy in the assessment and remediation of contaminated land in the UK is to adopt an 'end use' approach whereby the significance of contamination at a site is evaluated according to either the existing use or to a proposed development end use.

For the Tier 1 Assessment, Environment Agency published generic Soil Guideline Values (SGVs) derived using the Agency's CLEA model, was used. Where these are not available, GAC published by LQM/CIEH were utilised (Ref 11).

The assessment criteria relevant to the standard sensitive receptor setting within the CLEA model has been used i.e. a female receptor aged 1 to 6 years, a residential building (small terraced house) and a sandy loam soil with a pH7 and SOM 1%. Given the proposed site end use, the stringent "residential with plant uptake" land use scenario has been adopted.

Zoning of Data/Site Averaging Areas

The development is expected to comprise predominantly residential properties, therefore the site has been considered to comprise one zone and averaging area for the purposes of this assessment.

Tier 1 Assessment

In order to focus on contaminants of potential concern (COPC), the laboratory testing results have been compared with the respective SGVs/GAC. The results and respective screening criteria are presented in Tables 6.1 to 6.4.

Any contaminants that exceed the SGVs/GAC are considered to be COPC. Those that do not exceed the respective SGVs/GAC are not considered to be COPC and do not require further assessment in relation to the proposed development of the site.

Table 6.1 Summary of Analytical Chemical Testing Results (Inorganic)

Determinand	Number of Samples Tested	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	SGV/GAC (mg/kg) Res. with Plant Uptake	No. of Exceedances
Arsenic	23	5.4	36.2	32[(1)]	1
Barium	23	17	221	1300[(2)]*	0
Beryllium	23	0.2	3.7	51[(2)]	0
Cadmium	23	<0.2	0.42	10[(1)]	0
Chromium	23	7	31	3000[(2)]	0
Copper	23	4.5	19.4	2330[(2)]	0
Lead	23	7	68.8	450[(3)]	0
Mercury	23	<0.5	<0.5	1[(1)]	0
Nickel	23	9.7	28.9	130[(1)]	0
Selenium	23	<0.5	0.6	350[(1)]	0
Zinc	23	17	84.6	3750[(2)]	0

Cyanide (free)	13	<0.5	<0.6	53[2]	0
Cyanide (complex)	12	<0.5	<0.6	266[2]	0
Asbestos	2	Not detected	N/A	N/A	N/A

1 EA published SGV
2 LQM/CIEH published GAC (2nd Edition)
3 Previous EA published SGV (currently withdrawn)
*Residential without plant uptake scenario

Table 6.2 Summary of Analytical Chemical Testing Results (PAH)

Determinand	Number of Samples Tested	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	GAC (mg/kg) Res. with Plant Uptake	No. of Exceedances
Naphthalene	14	<0.09	<0.1	1.5[1]	0
Acenaphthylene	14	<0.1	<0.1	170[1]	0
Phenanthrene	14	<0.09	1.6	92[1]	0
Benzo(a)anthracene	14	<0.1	2.3	3.1[1]	0
Benzo(b)fluoranthene	14	<0.1	1.9	5.6[1]	0
Benzo(k)fluoranthene	14	<0.1	1.1	8.5[1]	0
Benzo(ghi)perylene	14	<0.1	2.0	44[1]	0
Pyrene	14	<0.1	4.5	560[1]	0
Benzo(a)pyrene	14	<0.1	<0.1	0.83[1]	0
Fluorene	14	<0.1	0.2	160[1]	0
Fluoranthene	14	<0.1	4.9	260[1]	0
Acenaphthene	14	<0.1	<0.1	210[1]	0
Anthracene	14	<0.1	0.6	2300[1]	0
Chrysene	14	<0.1	2.4	6[1]	0
Dibenzo(ah)anthracene	14	<0.1	0.3	0.76[1]	0
Indeno(123cd)pyrene	14	<0.1	1.6	3.2[1]	0
Total PAH (USEPA 16)	14	<1.40	<1.53	No value	N/A

1 LQM/CIEH published GAC (2nd Edition)

Table 6.3 Summary of Analytical Chemical Testing Results (TPH)

Determinand	Number of Samples Tested	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	GAC (mg/kg) Res. with Plant Uptake	No. of Exceedances
Gasoline Range Organics (GRO)					
C5-6	16	<0.2	<0.2	30[(1)]	0
C6-7	16	<0.2	<0.2	73[(1)]	0
C7-8	16	<0.2	<0.2	73[(1)]	0
C8-10	16	<0.2	<0.2	19[(1)]	0
Aliphatic Fractions					
C8-10	16	<4	<5.25	19[(1)]	0
C10-12	16	<4	<5.25	93 (48) [(1)]	0
C12-16	16	<4	5.03	740 (24) [(1)]	0
C16-21	16	<4	<5	45000 (8.48) [(1)]	0
C21-35	16	<9.61	<34.7	45000 (8.48) [(1)]	0
Aromatic Fractions					
C8-10	16	<4	<5	27[(1)]	0
C10-12	16	<4	<5	69[(1)]	0
C12-16	16	<4	<5	140[(1)]	0
C16-21	16	<4	<5	250[(1)]	0
C21-35	16	<9.61	<10.43	890[(1)]	0

Table 6.4 Summary of Analytical Chemical Testing Results for Soils (BTEX)

Determinand	Number of Samples Tested	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	GAC (mg/kg) Res. with Plant Uptake	No. of Exceedances
BTEX					
Benzene	16	<0.01	<0.01	0.33[(1)]	0
Toluene	16	<0.01	<0.01	610[(1)]	0
Ethyl Benzene	16	<0.01	<0.01	350[(1)]	0
m/p-Xylene	16	<0.01	<0.01	230[(1)]	0
o-Xylene	16	<0.01	<0.01	250[(1)]	0

1 LQM/CIEH published GAC (2nd Edition)

Values in blue are solubility saturation limits. Values in green are vapour saturation limits.

Contaminants of Potential Concern

Only one soil sample of potential contaminant concern was identified in trial pit, TP13 at 0.6m depth. The sample exceeded the respective SGVs/GAC for Arsenic with a concentration of 36.2mg/kg which is marginally above the SGV of 32 mg/kg. On review of the log for TP13, this slightly elevated result was encountered within natural soils (very clayey sandy GRAVEL) and therefore it is possible that the Arsenic is from natural sources. Due to the depth that it has been encountered, residents are unlikely to come into day to day contract with this material, as long as site levels remain the same.

All of the other samples tested contained contaminants which were below the SGVs/GAC for residential with plant uptake soil screening values for human health purposes. As such, the risks posed to human health are considered to be low and no further consideration is required.

Human Health Risk Assessment Conclusions

As only one sample of the 23 samples tested returned contaminant values greater that the respective SGVs/GAC, the soil that has been tested is deemed suitable for use in gardens (including growing edible plants) without the need for treatment or other remedial action. It should however be noted that samples have been taken from depths ranging from 0.2m to 1.2m bgl. There has therefore been limited testing of shallow soils and very limited testing (if any) of topsoil across the site.

During site construction works, site workers should remain vigilant to the possible risk of encountering isolated areas of contaminated material. Should potentially contaminated material be encountered, further testing will be required to assess the risks to the health and safety of site workers and the environment. All persons engaged in site construction works should be made aware of the findings of the intrusive investigation and the hazards associated with handling potentially contaminated materials. It is recommended that all works are conducted in accordance with the Health and Safety Executive publication entitled “Protection of Workers and the General Public during the Development of Contaminated Land” (Ref. 13).

6.3 Ground Gas Risk Assessment

It should be noted that, in accordance with current best practice and guidance, the number and frequency of ground gas monitoring rounds is dependent on the sensitivity of the development and the generation potential of any ground gas source. In this case, the ground gas monitoring programme has been devised in order to establish a preliminary indication of the ground gas regime at the site.

Monitoring of the ground gas regime was undertaken between September and November 2010 with the full results included in Appendix B.

The results of monitoring have and will be assessed using the current guidance document: CIRIA C665 “Assessing Risks Posed by Hazardous Ground Gases to Buildings” and BS8485:2007 “Code of Practice for the Characterization and Remediation from Ground Gas in Affected Developments”.

Gas Screening Values (GSV)/hazardous gas flow rates for methane and carbon dioxide have been calculated and are summarised in Table 6.5. The corresponding Characteristic Gas Situation (CGS) is also presented in this table. It is understood that the proposed development is to comprise mainly residential houses and therefore the CGS for ‘Situation A’, defined in the guidance as ‘*all development types except those in Situation B*’ has been considered (Situation B is defined as ‘*low rise housing with a ventilated underfloor void*’).

Table 6.5 Maximum Gas Concentrations and GSVs

Borehole No.	Max. CH_4 (v/v %)	Max. CO_2 (v/v %)	Max. Flow Rate (l/h)	Max. CH_4 GSV (l/h)	Max. CO_2 GSV (l/h)	Characteristic Gas Situation A
BH1	0	2.5	0.2	0	0.005	1
BH3	0	1.0	0.0	0	0.00	1
BH5	0	3.7	0.3	0	0.011	1
BH10	0	0.9	0.1	0	0.001	1
BH11	0	1.1	0.4	0	0.004	1

Radon Gas

The above gas situation does not account for radon. As such, as part of the Desk Study Report, a detailed BR 211 Radon Report was obtained from the British Geological Survey (BGS), which states that basic radon protection measures are required for the site area. This is because the estimated probability of a property being above the Action Level for radon is 3 to 5%.

Details on the technical specifications for basic radon protection measures are given in document BRE Report BR211: Radon – Guidance on Protective Measures for New Buildings (Ref. 9).

Ground Gas Risk Assessment Conclusions

The results of the gas monitoring indicate a very low risk classification for the proposed development from methane and carbon dioxide. However, basic radon protection measures will be necessary in the construction of all new dwellings or extensions on site.

6.4 Controlled Waters Risk Assessment

The Controlled Waters Risk Assessment (CWRA) has been undertaken in accordance with the guidance suggested in the Model Procedures for the Management of Land Contamination (Contaminated Land Report 11, CLR 11) and comprised a staged approach (referred to as 'Levels'). A Level 2 Assessment has been undertaken for the purposes of this CWRA. For information, all Levels (1 to 4) are summarised in Table 6.6.

Table 6.6 – Quantitative Risk Assessment Levels

Level	Soil	Groundwater
1	Pore water contamination compared directly to receptor target concentration	Not applicable
2	Attenuation in unsaturated zone and dilution at the water table	Groundwater below source - groundwater data is compared directly to target concentrations
3	Attenuation in the aquifer	Attenuation and down gradient receptor or compliance point – groundwater concentration at the receptor/compliance point is predicted using numerical modelling

4	Dilution in the receptor	Dilution in the receptor - dilution in a receiving watercourse or pumping abstraction borehole (only with approval of EA)

The basis for the screening criteria is to ensure that the selected screening values are protective of the identified receptor. For groundwater, the general approach is to use an environmental standard as experience shows that remediation of contaminated groundwater to background quality is not achievable (Environment Agency 2006a). The standard should be relevant to the current and future receptors and the standards compliance criteria should be considered.

Standards that are applicable to this study are:

- UK Environmental Quality Standards (EQS) for the protection of aquatic life (in both freshwater and saline environments);
- UK Water Supply (Water Quality) Regulations, 2000 and 1989.

The groundwater beneath the site is considered to be the receptor in the first instance and therefore the UK Drinking Water Standards (UKDWS) have been selected as the appropriate screening criteria for the Level 2 Assessment.

UK drinking water must be 'wholesome' and this is defined in law by standards for a wide range of substances, organisms and properties of water in regulations. The standards are extensive and are set to be protective of public health and the definition of wholesome reflects the importance of ensuring that water quality is acceptable to consumers.

The legal standards in the UK are those which are set in Europe in the Drinking Water Directive 1998 together with national standards set to maintain the high quality of water already achieved. The standards are strict and include wide safety margins. They cover:

- micro-organisms
- chemicals such as nitrate and pesticides
- metals such as lead and copper
- the way water looks and how it tastes

However, the water analysis carried out on the four samples at the Bicester Masterplan site were predominantly analysed against the metals suite. Therefore the water samples obtained were tested against some of the requirements for UK Drinking Water Standards; the results are shown in Table 6.7.

Table 6.7 Summary of Water Analytical Metal Suite Testing Results

Determinand	Number of Samples Tested	Minimum Concentration (mg/l)	Maximum Concentration (mg/l)	UK Drinking Water Standards (mg/l)	No. of Exceedances
Arsenic	4	<0.001	0.007	0.01[(1)]	0
Barium	4	0.01	0.15	0.7[(1)]	0
Beryllium	4	<0.01	<0.01	N/A	N/A
Cadmium	4	<0.0001	0.0002	0.005[(1)]	0
Chromium	4	<0.001	0.006	0.05[(1)]	0
Copper	4	<0.001	0.013	2[(1)]	0
Lead	4	<0.001	0.013	0.025[(1)]	0

Mercury	4	<0.0001	<0.0001	0.001[(1)]	0
Nickel	4	<0.001	0.018	0.02[(1)]	0
Selenium	4	<0.001	<0.001	0.01[(1)]	0
Zinc	4	0.029	0.005	3[(1)]	0
Cyanide (free)	4	<0.02	<0.02	0.05[(1)]	0
Cyanide (total)	4	<0.02	<0.02	0.05[(1)]	0
Sodium	4	7	56	200[(1)]	0
Magnesium	4	3	10	50[(1)]	0
Strontium	4	0.2	2.18	N/A	N/A
Potassium	4	<1	5	12[(1)]	0
Lithium	4	<0.01	0.05	N/A	N/A
Phosphorous	4	<0.1	0.5	2.2[(1)]	0
Phenol	4	<0.05	<0.05	0.05[(1)]	0
PAH	4				

1 UK Human Health / Drinking Water Standards

2 N/A – Not available.

The results show that the there are no exceedances of the metals tested for UK drinking water quality, however further tests are required to assess the extent of any micro-organisms, chemical and taste to confirm the full UK drinking water requirements.

Level 2 Assessment

The Level 2 Assessment has been undertaken assuming that there is one hydrogeological unit (at a depth affected by the development) underlying the site (groundwater within the Cornbrash Formation Secondary 'A' Aquifer).

There are no contaminants that exceed their respective UKDWS.

Controlled Waters Risk Assessment Conclusions

As noted none of the contaminants tested returned values greater that the respective UKDWS, therefore the waters that has been tested indicate that no remedial action with regards to ground water is required.

7 Description of Existing Baseline Conditions

The Phase 1 Desk Study Report (Ref. 1) was undertaken for the entire NW Bicester Eco Town site to determine likely soil, groundwater and contamination conditions.

A summary of the findings from the Desk Study Report and ground investigation, as relevant to the Masterplan site, is as follows:

- Since the earliest available historical map of 1881 to the present day, the site has been dominated by agricultural activity.
- There are two streams on site; one minor, unnamed stream (flowing in a NW to SE direction), which feeds the N to S flowing River Bure in the southern part of the site.
- Geologically, the site is summarised as follows:
    - 0-0.2m thickness of Topsoil;
    - 0.2-0.6m (up to 0.8m deep in places) of Subsoil, comprising an orange/brown gravelly/sandy Clay or sandy clayey Gravel;
    - 0.6m to 1.9m (up to 2.9m deep in places) of yellow sandy Gravel and in places yellow/grey Clay, grading to completely weathered Limestone (Cornbrash Formation);
    - From 1.9 to 7m depth, alternating Limestone and Clay bands of the Cornbrash Formation are represented.
- No water strikes were recorded within the Cornbrash formation or superficial deposits during drilling. Follow-up groundwater monitoring recorded groundwater standing at in excess of 3m depth on average.
- There are no historic or current sources of industrial activity; farming being the only use of the land. If contamination is present on site, it is not expected to be widespread or significant. However, naturally occurring radon is present and basic radon protection measures will be required for the construction of new dwellings and extensions.

The intrusive ground investigation undertaken on site confirms that there are no contaminants present above the relevant human health and controlled waters assessment criteria, therefore the baseline conditions on site are such that remedial action in terms of contamination is not necessary prior to redevelopment.

7.1 Design and Mitigation

In the following section, the criteria used to define the significance of the effects, both adverse and beneficial, are:

- Major impact – where the development would cause a large change to the existing environment;
- Moderate impact – where the development would cause a noticeable change to the existing environment;
- Minor impact – where the development would cause a small change to the existing environment; and
- Neutral – where no impact will occur on the environment.

7.1.1 Construction

Effects likely to arise on-site through construction activities are outlined below. All construction works have the potential to generate the following potential effects relevant to this assessment:

- Creation of areas of contamination e.g. through spillage;
- Waste generation;
- Dust generation;
- Risk to contamination of workers; and
- Mobilisation of contamination and migration into controlled waters.

As the contamination testing has not identified any COPC, it is not considered that construction work will lead to exposure of construction workers and members of the public to any existing contamination present within soils, nor is it expected that the work will mobilise existing contaminants into ground or controlled water (surface water and groundwater). However, the scale of the site is such that complete coverage of all land area during the ground investigation was uneconomical and impractical, and as such, there is always a possibility that contaminants may be present in previously unexplored areas. These possibilities are discussed below in the context of existing site conditions, i.e. pre-remediation:

7.1.2 Dust

Whilst likely not contaminated, dust and silt can result from ground disturbance during construction, which can lead to accidental ingestion, dermal contact or inhalation of particles by site workers and possibly the general public. In some cases, generation of dust and silt may also lead to deposition on nearby surface waters. These risks would be most severe in the event that construction works were to take place on contaminated land, however, as previously stated it is considered unlikely that the site is contaminated.

As no significant contamination sources have been identified, **the impact is assessed to be neutral to minor adverse**. Nevertheless, mitigation measures such as damping down, covering of stockpiles, use of wheel washes and covering of lorries during transportation will be implemented as part of a general, good site management plan to ensure that the potential effects associated with airborne dust are minimised.

7.1.3 Water

Construction activities can result in the mobilisation of contaminants within the soil and the creation of a pathway for contaminants to migrate to underlying groundwater. Pathways can also be created for the transport of contaminants to surface water via airborne dust and through overland flow from poorly managed stockpiles. However, as previously stated, negligible contaminant concentrations in the soil and groundwater have been measured in the explored areas of the site, therefore it is considered unlikely that the construction works will introduce new contamination from the shallow soil to the underlying Secondary ‘A’ Aquifer (Cornbrash Formation) and the two on-site streams. **The impact is assessed to be neutral**.

7.1.4 Work in Previously Unexplored Areas

In the event that construction activities are undertaken in areas where previously unknown contamination is encountered during construction, a management strategy would be devised to ensure that any risks associated with its mobilisation are minimised. If required, suitable arrangements for stockpiling will be implemented to minimise the potential for the leaching of contaminated liquids and run-off of sediment through loading and exposure to rainwater. Mitigation measures will include stockpiling in bunded areas underlain by impermeable material away from watercourses. Stockpiles will be covered to prevent leaching of the material.

If excavation works are undertaken in areas where locally contamination water is identified, water may enter the excavations and lead to contaminants migrating vertically and horizontally. Abstraction of potentially contaminated water from excavations will need to be controlled to prevent cross contamination of soils and potential impact upon the Secondary 'A' Aquifer. Mitigation could include the abstraction and disposal of water to a foul sewer or to surface water following appropriate treatment (and with the appropriate consent in place).

It is prudent in unexplored areas for a suitably qualified Geo-environmental Engineer to be present during the construction works tasked with a watching brief, in order to ensure that correct measures are taken if unexpected contamination is encountered.

7.1.5 Waste

In general, material removed from an excavation will not normally be regarded as waste if:

- It is intended to be reused on site and meets risk based values;
- It is suitable for use as backfill and meets risk based values; and
- It does not need to be processed before it can be reused.

In such cases, the material is unlikely to be subject, at that point in time, to the duty of care for waste and environmental permitting. This should be agreed with the Environment Agency Waste Officer prior to works commencing. The document published by CL:AIRE The Definition of Waste: Development Industry Code of Practice provides further details about the criteria which should be meet for re-use of soils on site.

If it is not possible to reuse excavated material on site, then off-site disposal to an appropriately licensed landfill may be required. In this case, due consideration should be given to the UK Landfill Directive. Furthermore, any materials without a defined use on site can be considered as waste.

As of July 2009, the final phase of the landfill regulations from 2002 came into force and developers should be aware of the impact that it could have on their developments.

With measures already in place, the final phase of the regulations means that specified wastes can no longer be disposed off site to landfill and all wastes intended for landfill must receive prior treatment. Options for treatment (which include chemical, biological, mechanical separation and sorting) exist for most wastes and exemptions to this requirement are only limited to: inert wastes where treatment is not technically possible and wastes where viable treatment would not reduce the quality or the hazard(s) posed to human health or the environment.

The basic Government policy applies in the management of waste, and sites should adhere to the following protocol:

I. Reduction of the waste generated by managing the development to keep the amount of 'waste soil' to a minimum;

II. Re-use or re-distribution of soil on site (this will require the necessary authorisation);

III. Recovery or recycling by way of treatment on site (this will require the necessary authorisation); and finally

IV. Disposal, following pre-treatment (with necessary authorisation) to landfill.

If, having followed the above hierarchy, off-site disposal of soil is necessary; there is a requirement to determine whether the waste soil is "hazardous" or "non-hazardous". This is undertaken by means of CATWASTE^{SOIL}, as described below.

CATWASTESOIL

The results of the investigation have been input into CATWASTE^{SOIL} (Ref. 14), which has determined from the total contaminant concentrations that the soil is non-hazardous.

Disposal

The geology identified at the site indicates that shallow spread foundations may be suitable for all anticipated low-load structures; therefore, the generation of spoil is expected to be minimal.

It is anticipated that any spoil generated may be reused on site for landscaping or other purposes, therefore it is expected that only minimal volumes of material may require disposal off-site.

In general, for offsite disposal, Waste Acceptance Criteria (WAC) testing is necessary once a waste has been characterised as hazardous or if a non-hazardous waste is to be disposed at an "inert" landfill site. Non-hazardous waste does not require WAC testing unless disposal to an "inert" landfill is being considered.

In the event that large volumes of material will require off-site disposal, WAC testing is recommended to confirm whether the material is inert and can therefore be disposed at an "inert" landfill (thereby attracting less landfill tax).

7.1.6 Accidental Spillage of Construction Related Material

During any construction work, there always some potential for accidental spillage of contaminated materials. The main source of spillages is considered to be from construction plant and materials stored on site, particularly fuel and lubricating hydrocarbons. **The impact is assessed as neutral to minor adverse** depending on the nature, frequency and volume of the spillage. Mitigation measures will include the storage of chemicals and contaminative material in accordance with the Environment Agency guidance; regular servicing and inspection of vehicles used on-site; restriction of refuelling of vehicles to bunded areas underlain by hard standing, or other impermeable materials and the restriction of vehicle movements within close proximity of the surface watercourses.

Overall, it is considered that the effect during construction will be neutral to minor adverse.

7.1.7 Operation

For the proposed primarily housing end use, it is expected that receptors will come into regular contact with the soil, therefore potential for accidental ingestion, dermal contact or inhalation of dust particles exists. However, as no contaminant sources have been identified from the historical or current use of the site (confirmed by laboratory testing of the soil and groundwater) **the impact is assessed as neutral**. If contaminated material were discovered in previously unexplored areas of the site, remedial measures would be implemented where a complete pollution linkage would be possible, e.g. if contaminated soil were discovered in an area earmarked for residential gardens, then appropriate remedial action would occur, such as excavating the soil and replacement by clean material. Alternatively, a cover system could be employed.

It is anticipated that a small proportion of the site may contain retail/leisure facilities. During operation, there may be limited potential for accidental spillage of potentially contaminating materials from delivery locations and plant operational locations. Due to the expected hard standing in these areas with appropriate drainage infrastructure and the adoption of standard materials handling and storage procedures, **the impact is assessed as neutral**.

Overall, it is considered that the effect during operation would be neutral.

7.2 Assessment of Residual Effects

7.2.1 Construction and Operation

In those areas of the site covered by the intrusive ground investigation, no contaminated soil or groundwater was discovered. In those unexplored areas of the site, it cannot be conclusively stated that there are no contaminants present. However, should localised contaminated areas be encountered, the degree of contamination is not expected to be significant, and it is considered that the previously described mitigation measures would significantly reduced or completely mitigated any potential impacts. No residual effects are identified.

7.3 Summary

The intrusive ground investigation has demonstrated that no elevated concentrations of contaminants are present in the soil or groundwater in explored areas of the site. In unexplored areas of the site, the Desk Study Report indicates that it is unlikely that contaminants will be present in significant concentrations.

Construction impacts are considered to be neutral to minor adverse and will be mitigated thorough the use of appropriate PPE and good site management practices.

Operational impacts are considered to be neutral and therefore require no mitigation measures.

Overall, the contamination risks associated with the Masterplan site are considered to be very low, though the risks from naturally occurring radon gas require basic radon protection measures to be incorporated in the construction of new dwellings and extensions.

8 CONCLUSIONS

8.1 Ground and Groundwater Conditions

The ground investigation generally confirms the expected geology, the site being underlain by Topsoil overlying granular and in places cohesive superficial/head deposits to a depth of 0.9m, with weathered limestone (Possibly the Cornbrash formation) to depths of up to 2.6m and interbedded Limestone and Clay below the weathered layer. Laboratory and in situ testing of the soils has been carried out and are discussed in section 5.

Groundwater was encountered in exploratory holes at depths of between 0.6m and 2.6m. Following heavy rain, groundwater was encountered as perched water table above the limestone.

8.2 Engineering Considerations

Shallow foundations are expected to be a suitable option for residential and low rise structures proposed at the site, however suitable precautions should be taken in line with NHBC Foundation guidance with respect to the presence of medium volume change potential cohesive strata. In areas of low grade sloping ground, slope stability must be considered when assessing structural loadings and any road cuttings.

Excavations for foundations and infrastructure should prove straightforward, though if deeper excavations are required, extremely difficult digging conditions are likely to be encountered below the top of the interbedded Limestone/Clay strata. Excavation sides are expected to remain stable, except following heavy rain ground water maybe encountered, particularly after heavy rain, and pumping equipment should be provided.

Excavations should be inspected by a suitably qualified geotechnical engineer to confirm that no solution features are present and to confirm that a suitable formation is present. Any soft or Made Ground materials should be removed to prevent differential settlement. Due to the variable depth to the interbedded Limestone and Clays, it is recommended that strip foundations be designed to prevent differential settlement, with movement joints incorporated. Test results for concrete classification to BRE standards for sulphate and pH testing has recorded results indicative of ACEC Class AC-1.

8.3 Contamination

None of the soil or water samples analysed contained contaminant concentrations above the relevant, corresponding screening values and no noteworthy elevated ground gas concentrations were observed. As such, the risks posed to human health and the environment is considered to be very low and no remedial action is required.

The risks posed to humans including site and maintenance workers are considered to be very low from pre-construction contamination. However, contamination from materials brought on to site during the construction phase must also be considered as harmful to human health and the environment.

Should the developer wish to re-use topsoil during development then further testing is required.

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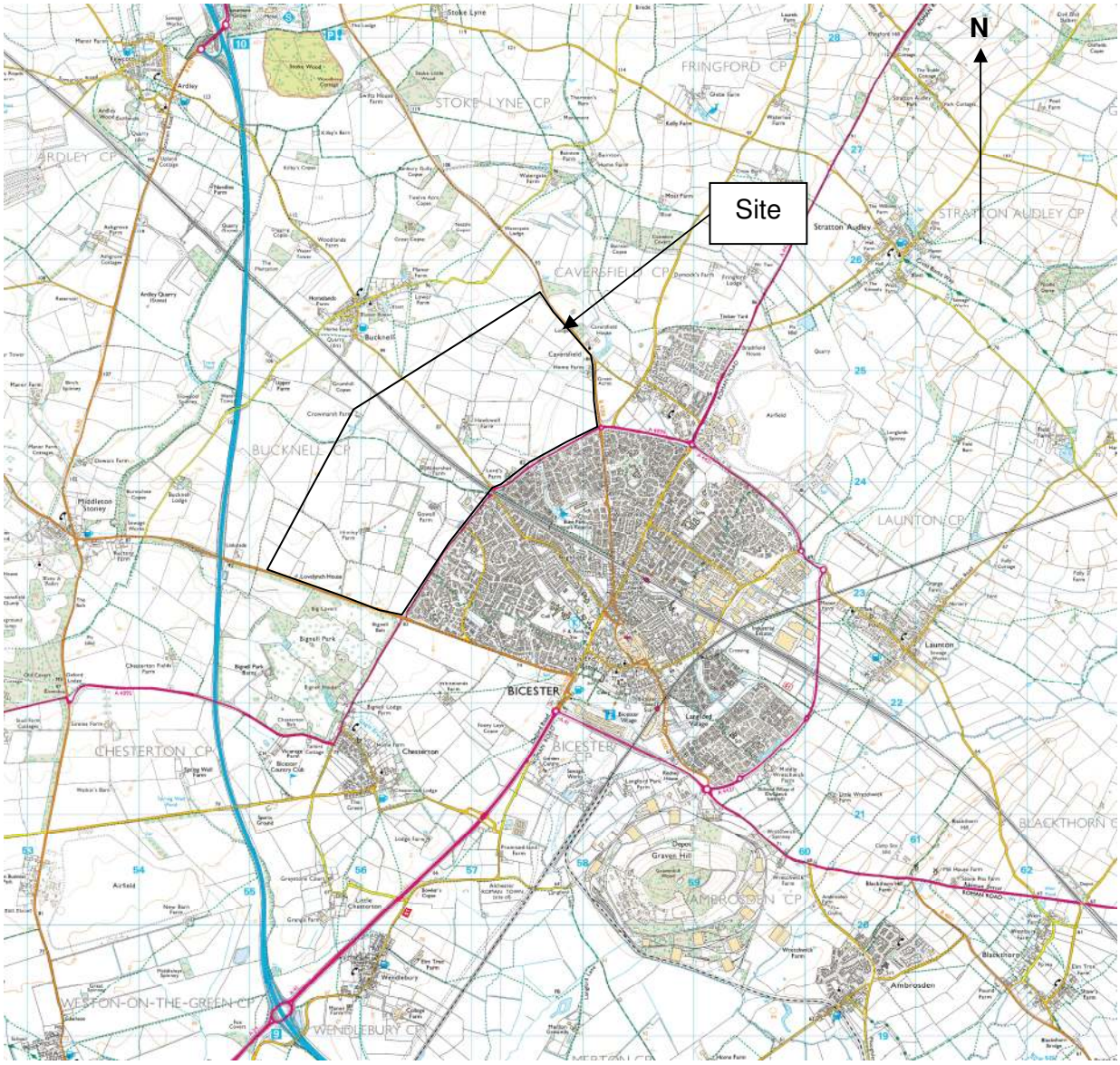
Figures



Client a2dominion P3Eco Ltd	Project Bicester Eco Town Master plan	Hyder Consulting Hyder Consulting Ltd 5th Floor, The Pithay, All Saints St Bristol BS1 2NL Tel: 0870 000 3003 Fax: 0870 000 3903
	Title Site Location Plan	
Scale N/A Datum N/A		Project Code UA001881 Drawing Number 001 Issue A

KEY

- DEREK HEDGES & CATHERINE MURYELL
- UNKOWN
- MR PHIPPS
- MESSERS WILLIAM & TIMOTHY MALINS
- GALLAGHER ESTATES LTD
- MR & MRS BARNES
- OXFORDSHIRE COUNTY COUNCIL
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- MR & MRS RICKETTS
- AVONBURY BUSINESS PARK
- TVPA
- MR BONNER
- MR & MRS MURFITT
- MRS MARIA INES ASTORGA DE PAIN
- MS HENSON
- HON MICHAEL RICHARDS

ACCESS ROUTES TO LOCATIONS

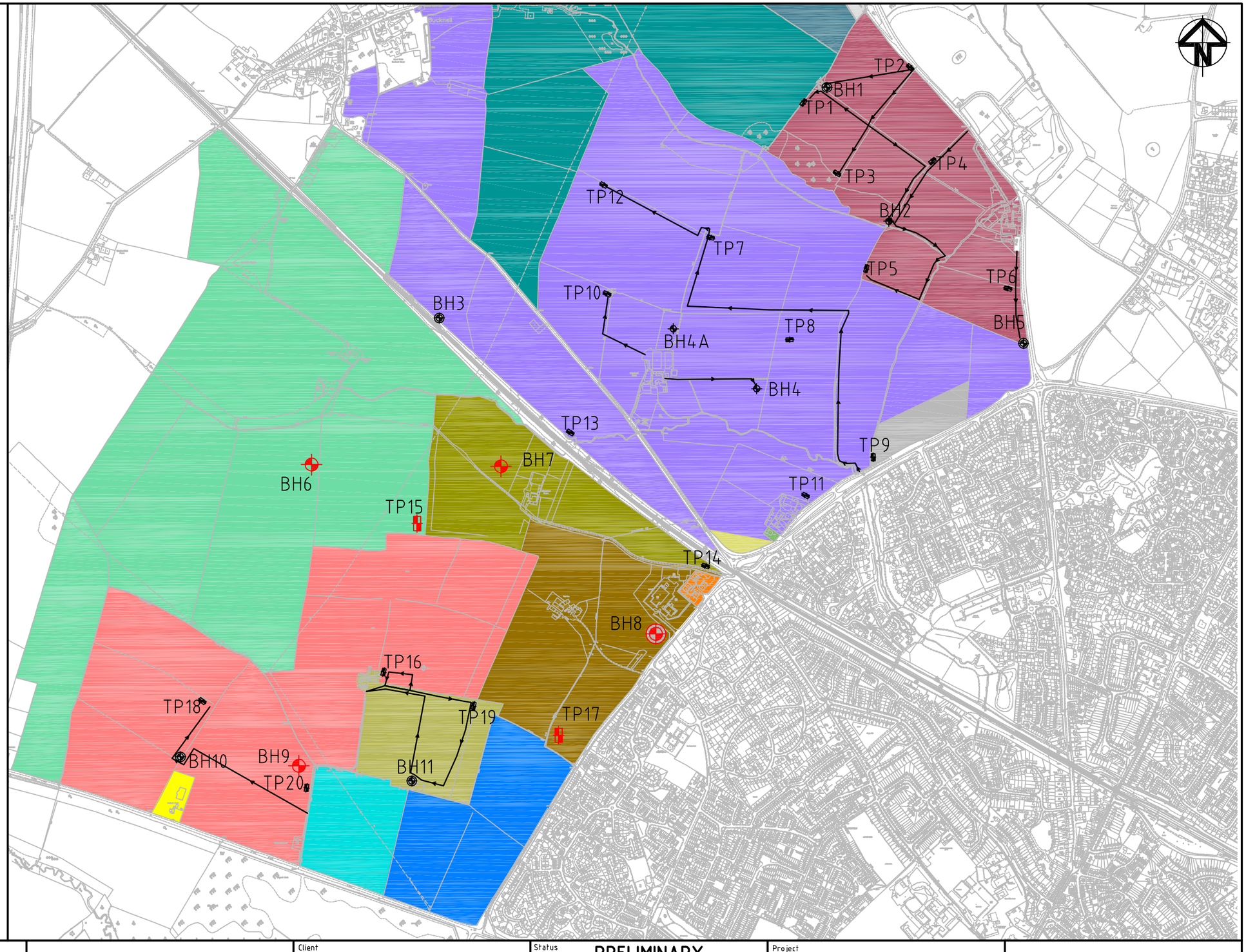
PROPOSED EXPLORATORY HOLES NOT COMPLETED DUE TO ACCESS RESTRICTIONS

BH4 ROTARY BOREHOLE - ALL CORED TO 7.0m

TP1 TRIAL PIT

BH1 MONITORING BOREHOLE

TP8, BH4A AND BH4 ARE APPROXIMATE LOCATIONS ONLY ALL OTHER LOCATIONS RECORDED USING GPS.



01	FIRST ISSUE	15/09/10
Issue	Description	Date

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Client

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Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

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Height Datum	-	Checker D.THOMAS
Grid	GRID	Approver C.PLUMB
Filename: 2004-UA001881-UP33D-01.DWG		© Copyright reserved

Project: BICESTER ECO TOWN

Title: LANDOWNER BOUNDARIES WITH EXPLORATORY HOLE LOCATIONS

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Drawing No.	Project No.	Issue
2004	— UA001881 —	03

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Appendix A: Risk Assessment Definitions

Risk assessment considers the identified sources, the potential receptors and the pathways linking them together.

In the pollutant linkage table of this report, the column designated as 'Hazard (severity)' gives an indication of the sensitivity of a given receptor to a particular source being considered. It is a worst case classification and is based on full exposure via the particular linkage being examined. The derivation of the classes used to rank this particular aspect are given in the table below

Classification of Potential Consequence (Severity)

Classification	Human Health	Controlled Water	Built Environment	Ecosystems
Severe	Irreversible damage to human health. Short term (acute) risk to human health likely to result in "significant harm" as defined by Part 2a.	Substantial pollution of sensitive water resources	Catastrophic damage to buildings, structures or the environment	A short-term risk to a particular ecosystem or organism forming part of such ecosystem.
Medium	Chronic damage to human health. Non-permanent health effects to humans	Pollution of sensitive water resources or small scale pollution of sensitive water resources	Damage to buildings, structures or the environment	A significant change in a particular ecosystem or forming part of such ecosystem
Mild	Slight short term health effects to humans	Pollution to non-sensitive water resources	Damage to sensitive buildings, structures services or the environment.	Significant damage to crops
Minor	Non permanent health effects to human health (easily prevented by means such as personal protective clothing etc)	Insubstantial pollution to non-sensitive water resources	Easily repairable effects of damage to buildings or structures	Harm (although not necessarily significant harm which may result in financial loss or expenditure to resolve. e.g. loss of plants in a landscape scheme.

Subsequently, in the column entitled 'Likelihood of Occurrence", in the Pollutant Linkage table, an assessment is made of the probability of the selected source and receptor being linked by the identified pathway. This assessment is ranked based on site specific conditions as detailed in the table that follows

Classification of probability

High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that there us a probable that an even will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an even could occur. However it is by no means certain that even over a longer period such event would take place and in less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

In the Pollutant Linkage table of this report, the 'Potential Risk' column is an overall assessment of the actual risk, which considers the likely consequence of a given risk being realised and the likelihood of that risk being realised. The risk classifications are assigned using the following consequence/likelihood matrix:

Potential Consequence				
Severe	Moderate/Low	Moderate	High	**Very High**
Medium	Low	Moderate/Low	Moderate	High
Mild	Very Low	Low	Moderate/Low	Moderate
Minor	Very Low	Very Low	Low	Moderate/Low
Likelihood	**Unlikely**	**Low**	**Likely**	**High**

Table below describes the risk classifications

Risk Term	**Description**
Very High Risk	There is a high probability that significant harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
Moderate Risk	It is possible that without appropriate remedial action harm could arise to a designated receptor from an identified hazard. However it is either relatively unlikely that any such harm would be severe or if any harm were to occur it is more likely that such harm would be relatively mild.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard but it is likely that this harm if realised would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Appendix B: Gas & Groundwater Monitoring

Gas monitoring Bicester Masterplan
13/09/2010

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.3	18.5	-0.2	
		BH3	1011	30	0	1	14.9	-0.3	GW at 3.05
				60	0	1	14.7	-0.1	
				75	0	1	14.6	-0.2	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.9	18.8	-0.1	
		BH10	1011	30	0	0.9	18.4	0.1	GW at 2.38
				60	0	0.9	18.4	0.1	
				75	0	0.9	18.5	0	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.9	18.8	0.3	
		BH11	1012	30	0	0.9	18.4	0.3	GW at 1.1
				60	0	0.9	18.4	0.4	
				75	0	0.9	18.5	0.4	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
		Hole No.	Atmos (mb)	10					
				30					
				60					
				75					

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
		Hole No.	Atmos (mb)	10					
				30					
				60					
				75					

05/10/2010

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.2	15.2	-	
0	0	BH1	1008	30	0	0.3	15.6	-	Groundwater @ 3.10m
0	0			60	0	0.4	15.2	-	
0	0			75	0	0.2	16.4	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	3.2	18.2	-	
0	0	BH5	1009	30	0	3.4	18.2	-	Groundwater @ 6.50m
0	0			60	0	2.8	17.9	-	
0	0			75	0	2.1	18.4	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.6	19.8	-	
0	0	BH11	1008	30	0	1.1	19.6	-	Groundwater @ 1.42m
0	0			60	0	0.5	19.2	-	
0	0			75	0	0.3	19.4	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.5	20.8	-	
0	0	BH10	1008	30	0	0.6	20.5	-	Groundwater @ 2.17m
0	0			60	0	0.6	20.5	-	
0	0			75	0	0.8	20.6	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.7	20.9	-	
0	0	BH3	1009	30	0	1.4	18.2	-	Groundwater @ 2.95m
0	0			60	0	1.8	15.9	-	
0	0			75	0	1.5	15.7	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
		Hole No.	Atmos (mb)	10					
				30					
				60					
				75					

Gas monitoring Bicester Masterplan
10/11/2010

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.4	20.5	-	
0	0	BH1	988	30	0	1.7	15.8	-	Groundwater @ 3.22m
0	0			60	0	2.2	12.2	-	
0	0			75	0	2.2	12.2	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	2.7	17.5	-	
0	0	BH5	988	30	0	3.4	16.8	-	Groundwater @ 6.34m
0	0			60	0	3.7	16.4	-	
0	0			75	0	3.7	16.4	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.2	20.9	-	
0	0	BH11	989	30	0	0.3	20.9	-	Groundwater @ 1.21m
0	0			60	0	0.3	20.9	-	
0	0			75	0	0.2	20.9	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.4	21	-	
0	0	BH10	989	30	0	0.8	20.5	-	Groundwater @ 2.08m
0	0			60	0	0.8	20.5	-	
0	0			75	0	0.8	20.5	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
0	0	Hole No.	Atmos (mb)	10	0	0.4	20.8	-	
0	0	BH3	989	30	0	1.4	17.6	-	Groundwater @ 2.72m
0	0			60	0	2	15.5	-	
0	0			75	0	2	15.2	-	

H2S	CO			Time of Reading (sec)	CH4 %	CO2 %	O2 %	Flow Rate (l/h)	Comments
		Hole No.	Atmos (mb)	10					
				30					
				60					
				75					

APPENDIX 12.6
NW BICESTER ECO DEVELOPMENT:
GEOTECHNICAL INTERPRETIVE REPORT – MASTERPLAN SITE

A2Dominion South

NW Bicester Eco Development

Groundwater Supply: Feasibility Study

Technical Briefing Note

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A2Dominion South

NW Bicester Eco Development

Groundwater Supply: Feasibility Study

Technical Briefing Note

Author	Carol Davies	
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Approver	Ric Horobin	

Report No 5040-UA005241-UP31R-01

Date October 2013

CONTENTS

1 INTRODUCTION

1.1 Brief

Hyder Consulting (UK) Ltd (Hyder) were instructed by A2Dominion (Gerry Walker e-mail of 24 July 2013) to conduct a desk study based feasibility study for a groundwater supply for Bicester Eco Town (referred to as the" Site" in this report).

1.2 Scope

The agreed scope of work is:

a) Review existing desk study information;

b) Review Catchment Abstraction Management Strategy;

c) Discussions with Environment Agency to identify early any issues with abstraction licensing;

d) Identification and assessment of water interests;

e) Review of (known) water quality and any issues;

f) Develop a hydrogeological conceptual model;

g) Analytical appraisal of anticipated well volumes, radius of influence and potential effects on neighbouring water interests; and

h) Produce a Technical Briefing Note (this report) – identifying initial feasibility of a groundwater supply scheme.

1.3 Bicester Eco Town Water Needs

Details of the water strategy for Bicester Eco Town is presented in the Hyder (April 2011) NW Bicester Eco Development, Water Cycle Study Outline Stage. This discusses the average consumption for an average household, which was estimated as 159 litres per person per day (L/person/day). The Bicester Eco Town water strategy includes the need for use of water efficient devices and for water re-use for some non-potable water uses. The proposed residential property water use will be at least 110 L/person/day; meeting level 4 of the Code for Sustainable Homes as a minimum. Preliminary calculations in this report are based on a worst case 150 litres/person/day (as advised, P. Harker e-mail 28 August 2013).

The total Bicester Eco Town population is expected to be in the region of 13,000 residents on completion of the development. In addition there are proposed new primary schools, a secondary school and various businesses and community buildings. The preliminary annual water demand has been calculated by Hyder (P Harker e-mail 28 August 2013) as below:

Table 1.1 – Preliminary Water Demand Estimate

Type	Annual Water Demand (Litres)	Demand (Equivalent cubic metres per day)	Demand (Equivalent Litres Per Second
Residential Units (5000)	**716,881,443**	1964	22.7
Primary School	**71,200,000**	195	2.3
Secondary School	**20,160,000**	55	0.6
Business/ Employment	**86,237,288**	236	2.7
Retail/ leisure	**21,152,542**	58	0.7
Community	**5,536,000**	15	0.2
Total	**921,167,274**	2524	29.2

1.4 Information Sources

Table 1.2 – Summary of Information sources

Subject	Main Source Of Information
Geology	BGS sheet 219, Buckingham, S&D (2002), 1:50,000). BGS (2002) Sheet 219, sheet explanation of the geology. BGS borehole/well records (BGS website)
Hydrogeology	BGS UK Hydrogeology Viewer (1:625 000 scale) covers Bicester. BGS well borehole/well records (BGS website)
Groundwater resources	CAMS (EA website) Existing abstraction licences and discharge permits (EA data request and Envirocheck, 2010) Existing private water supplies (LA)
Water Quality	Pollution incidents (Envirocheck, 2010) Regional (EA website and data request) Local from private water supplies (LA)

BGS is British Geological Survey;
EA is Environment Agency
LA is local authority (Cherwell District Council)

2 SITE DESCRIPTION AND SURROUNDINGS

Figure 2.1 shows the extent (green hatch) of the Site, which is located immediately north east of Bicester town. The Ordnance Survey (OS) grid reference of the Site centre is SP 566 243.

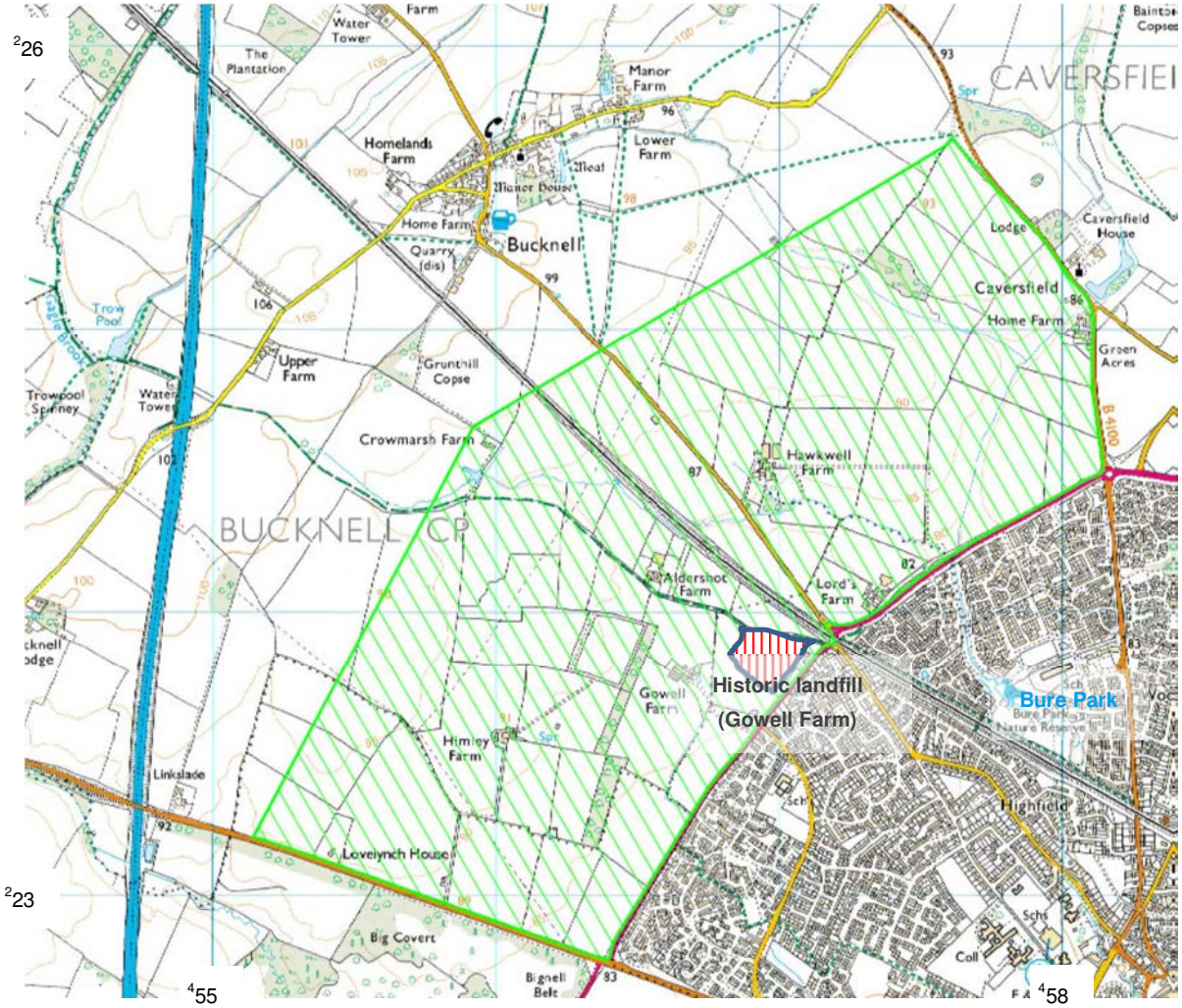


Figure 2.1 – Site location of Bicester Eco Town

The Site currently comprises mostly farm land including several farm houses. Bucknell Road and the railway line run through the centre of the Site. “B” roads border the Site to the east and south-south-west. The A4095 road and Bicester town border the Site to the south-east. Streams run through the Site as marked by the thin blue lines in Figure 2.1. These generally flow towards the SE to SSE and join the River Ray 7 km away, south of Bicester.

Bure Park Nature Reserve is located approximately 500 metres from the southern site boundary (Figure 2.1). See Appendix 1.

Ardley Cutting & Quarry Site of Special Scientific Interest (SSSI) is located west of the Site (Envirocheck 2010, see Appendix 1).

An historic landfill is recoded as present on the Site at Gowell Farm. Records suggest that this location may have been previously quarried for limestone. Also a local authority recorded landfill site is recorded at approximately the same location (Envirocheck 2010, see Appendix 1).

Several other historic landfills are recorded off Site on the EA website (approximate O.S. grid references of landfill site centres are shown):

- Ardley Fields Farm 2 (4542 2255);
- Ardley Inert Area (ditto);
- Disused Tip at Elm Farm Quarry, Stratton Audley (waste 1948 to 1975) (4599 2253).

Authorised landfills within 2 km of the Site boundary are also shown on the EA website:

- Ardely Quarry (southern extension) (4542 2263) (edge of 2 km radius)
- Glebe Farm, Fringford. (4591 2274)

3 GEOLOGY AND HYDROGEOLOGY

3.1 Regional Geology

The regional geology comprises a patchy outcrop of generally thin superficial deposits such as alluvium and head deposits over bedrock comprising mostly limestone and mudstone of the Jurassic. The regional stratigraphy, in order of increasing depth, is summarised in Table 3.1. Figure 3.1 and Figure 3.2 shows an extract of BGS Sheet 219 and legend.

BGS Sheet 219 (1:50,000) shows “Bicester 1 Borehole”, located at grid reference 5878 2081, as being a deep borehole of c. 400 m depth. This has been used in the sheet cross section 2.

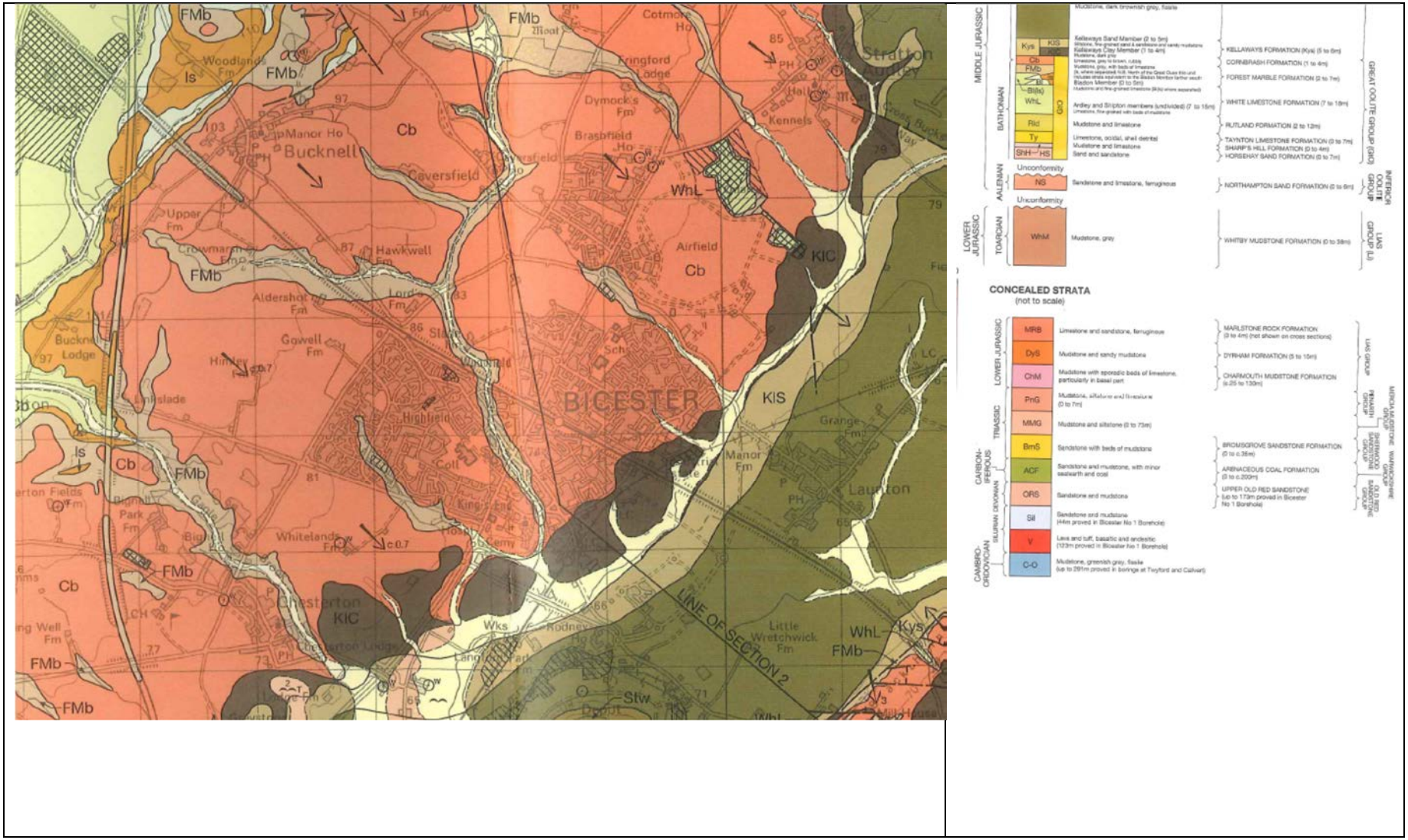


Figure 3.1 – Regional Geology Map (BGS copyright: [C09/013-CCSL] British Geological Survey @ NERC. All rights reserved)

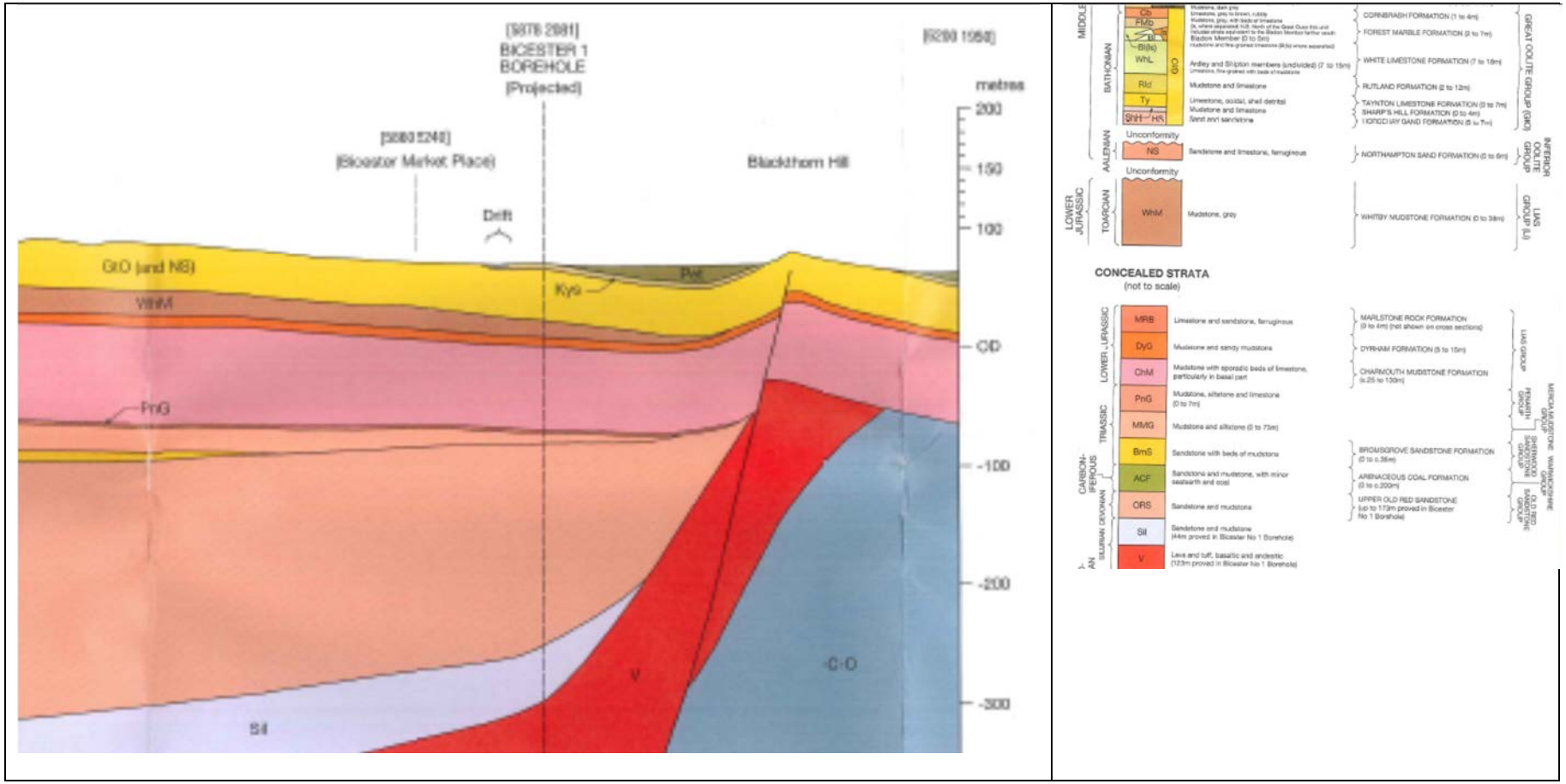


Figure 3.2 – Regional Geological Section (Line of Section 2)

Table 3.1 - Summary of Bedrock Stratigraphy

Geological Group (Age)	Formation	Description	Thickness range (metres)
Great Oolite Group (Middle Jurassic)	Cornbrash Formation	Rubbly Limestone	1 – 4
	Forest Marble Formation	Pale grey mudstone with beds of flaggy limestone	2 - 7
	White Limestone Formation	Mainly fine grained limestone (mudstone may be present)	7 - 15
	Rutland Formation	Mudstone, calcareous mudstone and limestone	2 – 12
	Taynton Limestone Formation	Shell fragment and ooidal limestone	0 – 7
	Sharps Hill Formation	Mudstone. calcareous mudstone and limestone	0 – 4
	Horsehay Sand formation	Sand and sandstone (previous name, "White Sands")	0 – 7
Inferior Oolite Group (Middle Jurassic)	Undifferentiated but includes Northampton Sand Formation (NS)	Sandstone and limestone, ferruginous.	0 - 6
Lias Group (Lower Jurassic)	Whitby Mudstone Formation	Medium and dark grey fossiliferous mudstone and siltstone	0 - 38
	Marlstone Rock Fm. (MRB), Dyrham Fm.(DyS)	MRB: limestone, sandstone ; DyS: mudstone and sandy mudstone	MRB 0– 4; DyS 5- 15
	Charmouth Mudstone Formation	Mudstone with sporadic beds of limestone	25 - 130
Penarth Group and **Mercia Mudstone Group** (PnG) (MMG) (Triassic)	(undifferentiated)	PnG: mudstone, siltstone, limestone.	PnG: 0-7; MMG:10-20
Sherwood Sandstone Group (Triassic)	Bromsgrove Sandstone Formation	Sandstone with beds of mudstone	0 – 15 [2]
Old Red Sandstone Grp. (Devonian)	Upper Old Red Sandstone	Sandstone and mudstone.	Up to 173 m proved[3]
(Silurian)	(undifferentiated)	Sandstone and mudstone	44 m proved[3]
(Silurian)	(undifferentiated)	Lava and tuff, basaltic and andesitic	123 m proved[3]

Notes: 1.Stratigraphy and thicknesses based on BGS sheet 219 and explanation booklet interpretations unless otherwise stated; 2 Thickness based on BGS sheet 219 cross-section 2;

3. Thickness proved in Bicester No. 1 Borehole (according to BGS sheet 219).

3.2 Geology of the Site

Ground investigations have been conducted at the Site and comprise window sample drilled holes, rotary boreholes, trial pits and soak away tests in pits (various reports including Hyder September 2010 to Hyder September 2012 listed in section 8). The ground investigations have been for geotechnical purposes and the maximum depth of investigation is 8 metres below ground level (bgl).

Superficial deposits were either thin or absent with bedrock strata encountered close to ground level.

The whole of the Site area is underlain by the Cornbrash Formation, with the exception of the Forest Marble Formation cropping out in the floors and sides of the stream valley features.

3.3 Regional Hydrogeology

Overview

The main hydrogeological units identified from the geological sequence are summarised in Table 3.2 in order of increasing depth.

Table 3.2 – Regional Aquifers and Aquicludes

Unit	Type	Permeability, m/d	Transmissivity of aquifers, m^2/d	Storage of aquifers	Depth to top, mbgl (thickness, m)
Great Oolite [1]	Aquifer (Secondary) (fracture flow; semi-unconfined) (fracture flow, confined)	Inter quartile range of 2.5 E^{-4} to 3.0 E^{-3} m/day and a geometric mean of 9.8E^{-5} m/d (core data)	Inter quartile Range: 37 to 825. Geometric Mean: 212	Specific yield : 3%. Storage coefficient interquartile Range: 1.0 E^{-4} to 6.8 $E^{-4.}$	c. Ground surface (c. 40)
Lias mudstones	Aquiclude (locally aquitards)		-	-	c. 40 mbgl; (c. 130 m)
Old Red Sandstone [2]	Aquifer (Secondary)		Inter quartile Range:49 Geometric mean:11	Minimum, maximum storage coefficient 1.9 E^{-4} to 5.0 E^{-2}	c.160 m (c. 200 m)

1. Values of transmissivity and storage from the Major Aquifers Manual (BGS, EA 1997);
2. Values of transmissivity and storage from the Minor Aquifers Manual (BGS, EA 2000)

Great Oolite Aquifer

Bicester lies towards the eastern edge of the Great Oolite aquifer, classed as a moderately productive aquifer capable of supporting local supplies. Further towards the Cotswolds the Great Oolite and the Inferior Oolite form a principal aquifer which overlies the Lias Group. Beneath Bicester the Inferior Oolite appears to be absent.

The Great Oolite limestone aquifer comprises an alternating sequence of limestones and clays; the limestone beds are thinly bedded and typically not laterally persistent. The aquifer is characterised by low storativity and high transmissivity; this is demonstrated by a highly responsive aquifer with large seasonal variations. Spring lines are well-developed at the boundary of geological contacts and provide significant base flow to rivers (BGS website).

The yield of individual wells varies and is particularly dependent on the number of fissures encountered and their degree of interconnection. Large scale structure (e.g. zones of geological faults) may also account for regional variations in permeability (BGS, EA 1997).

The Table 3.2 Great Oolite permeability and transmissivity values are based on Cotswold examples, where the aquifer is thicker and is of a higher transmissivity (only available reliable data). Therefore the values of permeability may be higher than for Bicester.

Old Red Sandstone Aquifer

The Old Red Sandstone (ORS) is deep below the whole region and little data are currently available. Published data relate to other UK regions. Data from the Minor Aquifers Manual (BGS, EA 2000) have been summarised in Table 3.2; it is likely that the Bicester example is from deeper strata which may have consequently lower transmissivity and storage values.

The Minor Aquifers manual (BGS, EA 2000) comments that “in spite of the great thickness attained by the Old Red Sandstone, the permeability (and hence the transmissivity) is limited.” This is in part due to the presence of mudstone, siltstones and marls. In the actual sandstone the primary porosity can also be low. In general the predominant flow mechanism is via fractures, with much of the storage likely to occur in joint- and fault-related fracture systems (BGS, EA 2000).

The ORS may be overlain by 0 to 15 m thick Bromsgrove Sandstone Formation (Sherwood Sandstone Group). This formation would be expected to be in hydraulic continuity with the ORS aquifer and would increase the thickness and transmissivity of the ORS aquifer.

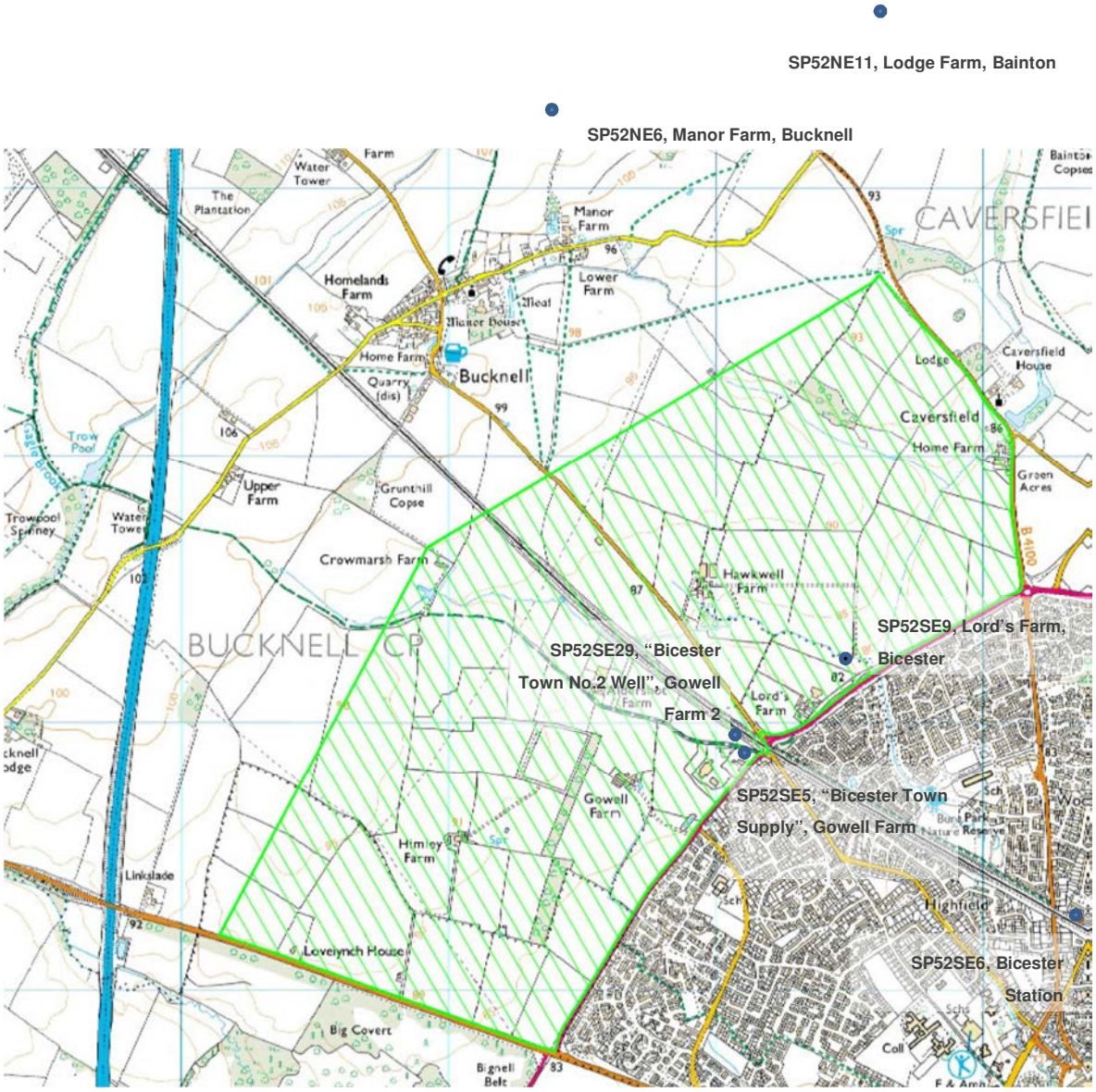
The ORS is expected to be underlain by Silurian sandstones and mudstones. There is limited information available for these strata and it is likely that deeper drilling could make anything more that marginal gains with respect to water supply.

Historic Wells

Historic well and borehole records have been obtained. These are generally of old wells drilled in the Great Oolite Group and underlying Northampton Sandstone Formation (latter where present). The records show that the Great Oolite was used for water supply including for Bicester town in the 1930’s. Associated pumping test data for these locations are generally limited to a stated yield and absent or brief drawdown information. Yields stated in these records for the Great Oolite in this area are typically between 0.5 to 11 litres per second. Further discussion is presented in section 6.2. Historic well and borehole records are summarised in Table 3.3 below and locations are approximated on Figure 3.3.

Table 3.3 – Summary of Historic Wells

Name	Location; O.S. grid reference	Recorded Yield, (calculated) cubic metres per day	Recorded Yield, (calculated) litres/second	Ground level (mAOD); Depth (mbgl)	Interpreted Strata within well screen or open bore	Notes
BGS SP52NE6	Manor Farm, Bucknell; 456350,226250	39	0.5	97.5 mAOD 77 mbgl	Uncertain (Great Oolite, Inferior Oolite and top of Lias mudstone?)	Year of 1924; Drawdown of 60 m.
BGS SP52NE11	LODGE FARM BAINTON; 457670,226770	196	2.4 (yield during 8 hours of pumping)	? mAOD 41 mbgl	Uncertain (Great Oolite, Inferior Oolite and top of Lias mudstone?)	Year 1949; Drawdown of c. 1 m. Recovered to rest level within 3 minutes
BGS SP52SE5	"Bicester Town Supply", Gowell Farm, nr. Bicester; 457090,223840	715	8.8 to 0.6 (9 hours pumping per day in 1934)	84.4 mAOD 34 mbgl (BGS scan title says 43)	Great Oolite Group	Test in 1934. Artesian flow of 7.6 L/s. Artesian head c. 1 m (1934). "Bulk of water" from 32 mbgl in 3 m thick (Taynton?) rock. Handwritten note on BGS record says, "bore caved in; pump removed".
BGS SP52SE6	Bicester Station; 458510,223190	872	10.8 (artesian flow of 4 L/s)	77.7 mAOD 37 mbgl	Great Oolite Group	Year? Artesian flow. Main water strike at 30.5 mbgl in <5 m thick sands (Serford Beds facies, sands of the Chipping Norton Limestone Fm.?)
BGS SP52SE9	Lord's Farm, Bicester 457450,224230	147	1.8	79.2 mAOD 80 mbgl	Great Oolite Group (base at c. 37 mbgl)` with Lias clays logged below)	Year 1941. Water struck at 4, 27 and 75 mbgl (inferred as coincident with White Limestone Fm., Horsehay Fm. and possible Lias limestone band
BGS SP52SE29	"Bicester Town No.2 Well"	770	9.5	85.5 mAOD 43 mbgl	Great Oolite Group	Year drilled 1936. 14 days pumping test. Rest water level 69 mAOD (16 mbgl). Pumped drawdown at 57 mAOD. Well base in top of Lias Clay with only 0.9 m of Northampton Sand (Inferior Oolite) above the Lias Clay.



Key: ● Historical well location (approximate)

Figure 3.3 – Historic Well Locations

Aquifer Vulnerability

The EA Groundwater Vulnerability Map shows that the Great Oolite aquifer has high vulnerability to surface pollution. This is due to the thin or absent cover of superficial deposits.

3.4 Site Hydrogeology

The Hyder (February 2011) Geotechnical Interpretative Report - Masterplan Site, states that within the trial pits, groundwater was encountered between 0.6 to 2.6 m in trial pits TP7, TP8, TP9 TP10, TP13 and TP18 respectively (location plan in Hyder, February 2011) . The remaining trial pits were dry. Trial pits TP7 to TP10 and TP13 were carried out after a period of heavy rain. Groundwater monitoring, following completion of the ground investigation at the Masterplan site, was carried out. The results suggest that excavations for shallow foundations may encounter some groundwater flow in some areas, particularly after heavy rain. The groundwater strikes within the trial pits generally coincide with the top of the limestone (Cornbrash Limestone). It is

not known whether these recorded water levels are indicative of the Great Oolite aquifer as a whole. The above report indicates they may have been caused (at least in part) by perched water after a rainfall event.

There is insufficient data to determine a groundwater flow direction, but locally it will probably be towards the nearest stream and regionally, down-dip towards the south-east.

Water courses sometimes follow lines of geological faults in the Great Oolite (BGS, EA 1997) which are also locations of higher permeability and greater flow. Therefore the location of the un-named streams on Site (Figure 2.1) may be influenced by the structural geology (i.e. main fissure orientations); indeed there is an apparent orthogonal shape to the stream pattern on Site. The Forest Marble Formation (mudstones with flaggy limestones) crops out at the sides and bottom of the small streams (Figure 3.1). Therefore the hydraulic connection of the streams with formations beneath the Forest Marble Formation may be limited depending on the thickness and permeability of the formation.

3.5 Lord's Farm Well

The Lord's Farm well is located within the Eco Town Site. The EA have sent a pumping test summary report (2 pages) for the well (Appendix 1) (EA, 2013b). The report summarises a test conducted on 3 June 2003. The test pumping rate was 3 m^3/hour (equivalent to 0.83 L/s) giving a drawdown of 0.91 m. A semi-artesian aquifer was noted based on the reported overflowing of the well during winter periods. The EA reported no visible impact on the local stream during the pumping test. The report also states a licence application for 60 m^3/day (0.7 L/s) although this may have been unsuccessful as the reported licence amount is currently 48 m^3/day (Table 4.1).

4 WATER RESOURCES, QUALITY AND INTERESTS

4.1 Water Resources

Abstraction Licences

There are no groundwater source protection zones that cross the Site (EA, August 2013) and hence no major potable water supplies (such as public water supply wells) appear to within 5 km of the Site centre.

The Environment Agency has confirmed, in response to a data record request (EA, 2012) that there is one licensed groundwater abstraction within the Site. Two other licensed abstractions are situated within 3.5 km of the Site centre; details are shown in Table 4.1. No details of depth, aquifer or pumped water levels are available. Locations are shown on Figure 4.1.

Table 4.1 – Licensed Groundwater Abstractions (within 3.5 km of Site)

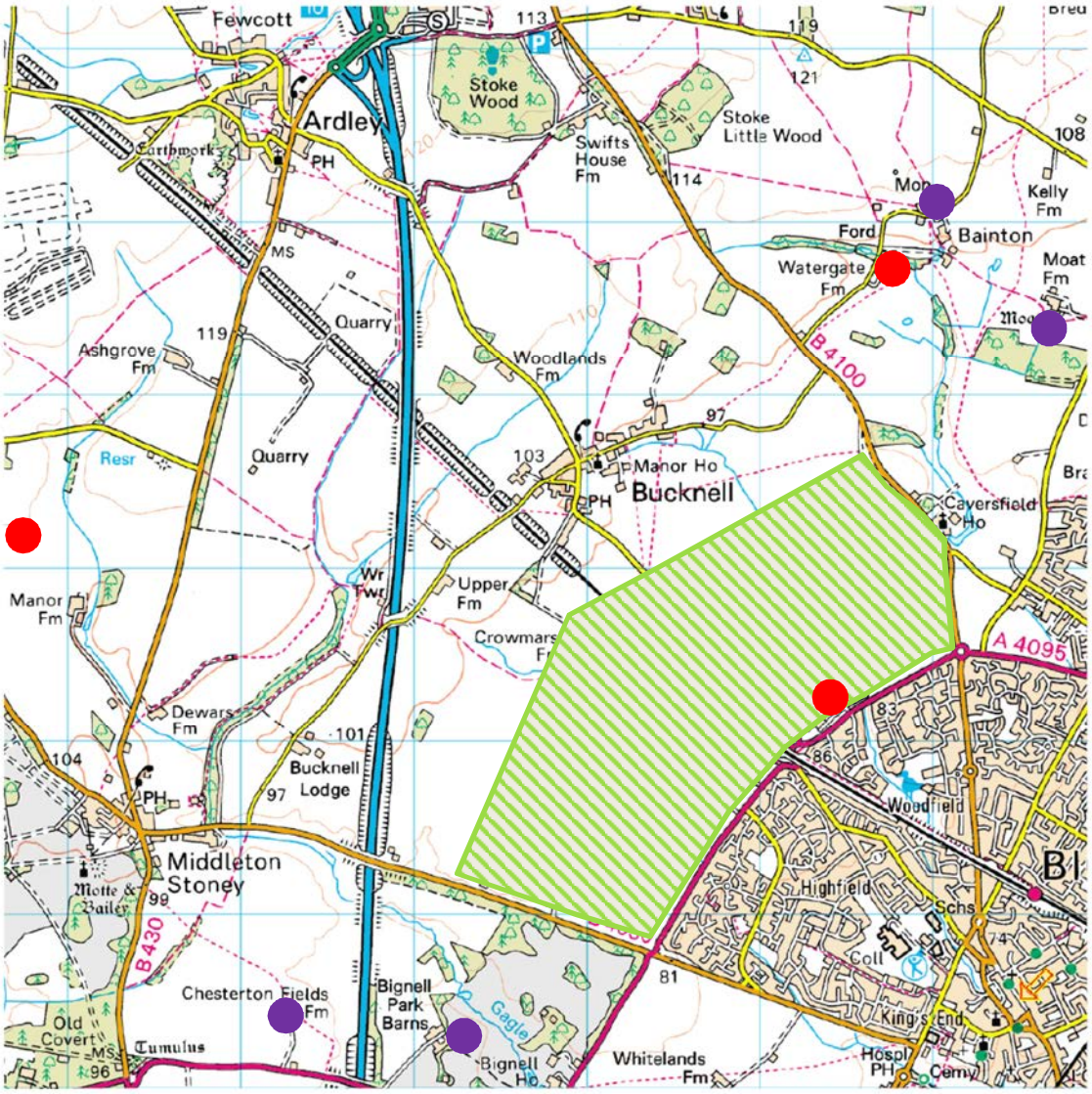
Licence Holder	Licence No. and type	Location	Distance from Site, km approx.	Quantity (cubic metres per day)	Equi-valent L/s	Quantity (cubic metres, annual)	Use and Status
W V MALINS & SON	28/39/14/0348 (Full licence) LORDS FARM - BOREHOLE	457400, 224200	On site	48	0.6	17,520	General Farming & Domestic (Current)
CF Hilsdon, Manor Fm.	28/39/14/ 102	452700 225200	1 km from site boundary (to NE)	20	0.2	7,319	General Farming & Domestic
J Hunter, Watergate Fm.	28/39/14/ 0048	457700 226700	3 km from site boundary (to WNW)	24	0.3	8,901	General Farming & Domestic

Private Water Supplies

Cherwell District Council has provided private water supply data. Such abstractions are small, i.e. less than 20 m^3/day. Details are shown below although none are located actually on Site. Locations are shown on Figure 4.1. It is possible that other private water supplies exist but the data are not held by the LA. Water quality data is discussed in section 4.2.

Table 4.2 – Private Water Supplies (within 3 km of Site centre)

Name	Location	Notes
Moats Farm	458725, 226489	Borehole. Water sample last taken in 2006
Chesterton Fields Farm	454322, 222393	Borehole. Water sample last taken in 2005
Bainton Manor	4580, 2270	Source not recorded. Water sample last taken in 2003
Bignell Park Farm	455167, 222335	Borehole. Water sample last taken in 2005



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KEY: Licensed abstraction; Private Water Supply

Bicester Eco Town area

Figure 4.1 – Groundwater Abstraction Locations (approximate)

Catchment Abstraction Management Strategy

A Catchment Abstraction Management Strategy (CAMS) details how water resources will be managed within a catchment and cover a 6-year timeframe. The Site lies within the Cherwell CAMS (EA, December 2012). The CAMS is sub-divided into areas following surface water catchments and the Bicester area is discussed as part of the Ray catchment. The CAMS document discusses water resources mostly in terms of surface water. In this region the most important factor is ensuring that sufficient flow flows towards the River Thames. The summary of the status of The Ray resources as assessed at assessment point number 4 ("AP4") is presented in Table 4.3.

Table 4.3 – CAMS Summary of Bicester Area (part of The Ray)

Item	Surface Water	Groundwater
CAMS Local Resource Status	Water available for licensing' at low flows. This status is overridden by the flow requirements of the Thames. Status changed to 'Water not available for licensing' at low flows	Not directly stated
Implication for New Licences	No new consumptive licences will be granted at low flows	All new consumptive groundwater licences in direct hydraulic continuity with surface water will be subject to a determined flow at Kingston gauging station. Consumptive groundwater licences, which do not have a direct impact and immediate impact on river flow, may be permitted all year. Restrictions will be determined case-by-case based on the nature and scale of the abstraction. All licences will be time limited to the CAMS common end date
	Licences for non-consumptive purposes or with a net benefit to the environment may be granted irrespective of the resource availability status	
Renewals and Management of Existing Licences	There will be a presumption of renewal, subject to the other renewal criteria and local considerations. Time-limited licences may be renewed with more restrictive terms and conditions. For example, the licensed quantity may be reduced to reflect actual abstraction	
Trading of Licences	EA likely to allow trades of recent actual abstraction and licensed abstraction, but little demand for trading is expected within the water body since water is available for new abstractions.	

Notes:
Information based on the Ray area as detailed in the CAMS (EA December 2012)

4.2 Water Quality

4.2.1 Regional Water Quality

River Basin Management Plans – Groundwater

The EA website (EA, 2013) shows that area around Bicester is of:

- poor "chemical quality" both currently and projected for 2015;
- good "quantitative quality" both currently and projected for 2015.

The waterbody name, that underlies the Site, is Bicester-Otmoor Cornbrash. This is assumed to indicate that the mapping refers to the thin, shallow Cornbrash Formation, stratigraphically near the top of the Great Oolite Group (see Table 3.1).

The Tackley Jurassic waterbody, located north of Bucknell, tentatively assessed as up hydraulic gradient of the Site, is shown as good chemical and quantitative quality. The BGS sheet 219 (BGS, 2002) (Figure 3.1) shows this area as comprising White Limestone Formation. It is not clear why the Tackley Jurassic waterbody is of better groundwater quality than the Bicester-Otmoor Cornbrash waterbody since both have no superficial deposits and both are agricultural areas. Possibly the Cornbrash, being thin as well as cropping out at ground surface, means that it is more susceptible to pollution.

Published Groundwater Vulnerability to Pollution

The EA website (EA, 2013) shows that area around Bicester is designated as a:

- Minor Aquifer of High Vulnerability to pollution from surface.

Nitrate Vulnerable Zones (NVZ)

The EA website (EA, 2013) shows that:

- The area around Bicester is designated within a surface water NVZ;
- A more limited area, but including most of the Site, is within a groundwater NVZ.

The EA (September 2013) state that most principal and secondary aquifers across the South East are classed as NVZs (EA, 2013b).

EA Water Quality Data

A brief assessment of received EA water quality data (EA, 2013b) has been conducted; the data comprises results from two monitoring boreholes (Figure 4.2). The geology at the Kirklington monitoring location is the Cornbrash Formation (BGS, 2013a) which is the same as at the Eco Town Site. The geology at the Wendlebury location is shown as the Kellaways Clay Member of the Great Oolite Group (BGS, 2013a); younger than found at the Site. Both monitoring locations appear to be down hydraulic gradient compared to the Eco Town site and both within the Great Oolite aquifer. The Wendlebury location may be influenced by an unnamed River Ray tributary although the outcrop of Kellaway Clay may limit its influence.

Table 4.4 summarises the recorded major ion chemistry. The major ion chemistry shows strong influence from the natural carbonate dominated strata of the Great Oolite; bicarbonate and alkalinity concentrations are high relative to other non-carbonate aquifers.

Table 4.4 – EA Water Quality, Major Ions

Parameter	UKDWS	Minimum	Maximum	Number of Tests
Calcium	-	80	113	40
Magnesium	-	12	18	45
Sodium	200	71	93	45
Potassium	-	5	8	45
Chloride	250	18	22	40
Sulphate	250	115	155	40
Alkalinity ($HCO_{3)}$	-	336	399	40
Nitrate (NO_3/l)	50	Less than 0.9	7.2	40

All results are mg/l

The presented results indicate similarity with confined groundwaters of the Great Oolite aquifer when compared against the same strata from the Cotswolds (BGS, EA 2003). However sodium and sulphate concentrations recorded in Table 4.4 are greater that the Cotswolds example and may indicate more ionic exchange related to longer residence times or other external unknown influences.

The nitrate concentrations shown in Table 4.4 are all less than the drinking water standard. The results are relatively low for an agricultural area and are typical of a confined aquifer where diffuse anthropogenic influences (e.g. application of fertilisers) have less influence. The EA said that there are unable to comment on nitrate concentrations below the Eco Town Site (EA, 2013b).

Virtually all hydrocarbon compounds are recorded as below detection level and therfore contamination from hydrocarbons appears to be low. Detection was recorded for three results (bentazone, m-p xylene and ethyl benzene at Wendlebury Chicken Farm); these are shown in the below table. The results are less than the UK drinking water standard. In addition three gas chromatography-mass spectrometry (GCMS) scans detected target compounds; the recorded concentrations were low (generally less than 1 µ/l).

Table 4.5 – EA Water Quality, Selected Data

Parameter	UKDWS	Minimum	Maximum	Number of Tests
Nitrate (mg NO_3/l)	11.3	Less than 0.9	7.2	40
Bentazone (µ/l)	500	Less than detected	0.00754	9
m-p xylene (µ/l)	500	Less than 0.2	0.59	10
ethyl benzene (µ/l)	300	Less than 0.1	0.12	10

Note: Bentozone water quality standard available is for surface water quality only and relates to the WFD; xylene and ethylbenzene drinking water quality standards shown are for WHO as no specific UK drinking water standard are available. Results are from Wendlebury Chicken Farm and Kirklington Park Farm, located 2 km S of the Site boundary and 4.5 km W of the Site respectively. These are EA monitoring boreholes installed within the Great Oolite aquifer.

KEY: EA Groundwater Quality Monitoring Location

Figure 4.2 – EA Water Quality Monitoring Locations (approximate)

Private Water Supply Water Quality Data

Cherwell District Council has provided private water supply data (section 4.1) within 3 km of the Site centre. Data are from single sampling events, between 2003 and 2006. Water analyses of the borehole supplies are expected to be from the Great Oolite aquifer and are summarised below.

Table 4.5 – Water Quality Data (Private Water supplies)

Parameter	UKDWS	Minimum	Maximum	Number of Tests
pH (pH units)	6.5 to 10	7.4	7.6	2
Electrical Conductivity (µ S/cm at 20 °C)	2500	706	728	2
Total Coliforms (cfu/100 ml)	0	1	9	2
Nitrate ($mgNO_3/l$)	50	57.1	58.4	2

Note: Results are from Chesterton Fields Farm and Bignell Park Farm.

The results indicate that, based on the limited data, nitrate concentrations of the Great Oolite aquifer, at these locations, exceed the UK drinking water standards (UK DWS)..

Local bacteriological contamination is also evidenced. A larger testing suite would be needed to assess the groundwater quality suitability with respect to other contaminants.

Old Red Sandstone Aquifer Water Quality

There are no water quality data currently available. The aquifer is deep and unlikely to receive direct rainfall recharge. Therefore high residence times of groundwater may mean a high mineral content (e.g. high iron, manganese and other trace metals). Water quality could tend towards brackish rather than fresh.

Pollution Records

The Envirocheck records (2010) shows one pollution incident to controlled waters:

- stream 200m south of southern site boundary just upstream of Bure Nature Reserve (Envirocheck, 2010, item B2) located at approx. 4576 2239) (Appendix 1)

The Bure Nature Reserve could be a receptor from upstream contamination, if it occurred, including from the Site. The above pollution incident is unlikely to represent a Site groundwater quality problem; the source is more likely to be related to the urban location of the reserve.

Landfills

Landfills can be a potential source of groundwater pollution. Locations of historic and authorised landfills are summarised in section 2. The Gowell Farm historic landfill, on Site, may be a potential source of contamination (Great Oolite aquifer) although may be generally down hydraulic gradient of most of the Site.

Historic and authorised landfills at Ardley are approximately 2 km north-west of the Site and therefore are likely to be up-hydraulic gradient of the Site and a potential source of contamination of the Great Oolite aquifer

Discharges

Discharges to ground, and to a lesser extent, discharges to surface water can be a potential source of contamination to groundwater. Envirocheck (2010) (Appendix 1) shows that there are:

- 3 existing discharge consents on the Site

Two of the consents are located at Himley Farm and Lord's Farm (Figure 2.1); they are not adjacent to a water course and therefore may be discharges to ground. No further information is available but they could relate to domestic septic tanks and hence could be a local source of contamination to the Great Oolite aquifer. Further checks would be needed to confirm if necessary. The third discharge is located on a stream beside filter beds at Caversfield and therefore appears to be a discharge to surface water.

4.2.2 Site Water Quality

Water analyses were carried out as part of Hyder ground investigations using the shallow standpipes. Therefore these are not directly related to the water quality of the whole Great Oolite aquifer or deeper strata. Emphasis was checking for heavy metal contamination and to a lesser extent, hydrocarbon contamination. The results indicated uncontaminated water based on the testing of the selected samples which were below UK drinking water standards (Hyder 2010 to 2012). A larger testing suite would be needed to assess the groundwater quality suitability for drinking water.

The offsite water quality testing does not give a clear indication of whether the Eco Town site groundwater has high nitrate as there is apparently conflicting evidence when comparing the

results of the EA monitoring locations and the private water supplies. The EA website shows poor “chemical quality” which may indicate high nitrates, but is possibly related to the Cornbrash Formation only (section 4.2.1). Deeper formations within the Great Oolite Group may be of better quality as at the Eco Town site the White Limestone Formation is overlain by thin Forest Marble Formation mudstones (Table 3.1).

4.3 Water Interests and Features Summary

A preliminary summary of water interests and water features is presented in Table 4.5. The search radius is between 3 km to 6 km depending on feature.

Private water supplies, other than those locations provided by the LA, may exist. Private water supplies are likely to be from the Great Oolite aquifer, if a borehole source.

Springs are characteristic of Great Oolite caused by water colleting on layered geology and also rising through fissured rock. The occurrence of the springs should be checked if necessary (walkover, historical maps). Springs may be an important contributor to stream flow and any private water supplies.

All the listed water features or interests relate the Great Oolite aquifer. The deep Old Red Sandstone aquifer is not in hydraulic connection with these given the c. 130 m thick aquiclude or aquitard strata above the Old Red Sandstone aquifer.

Table 4.5– Preliminary Summary of Water Features and Interests

Water Feature/Interest	Location	Distance from Site	Notes
Groundwater Abstractions			
Public Water Supply Sources	None	None < 5 km	None
Lord's Farm Borehole (licence))	475400, 224200	On Site	Licensed groundwater abstraction (Great Oolite aquifer). See Table 4.1.
Manor Farm Well (licence)	452700, 225200	1 km (NE)	Licensed groundwater abstraction (Great Oolite aquifer). See Table 4.1.
Water Farm Well (licence)	457700, 226700	3 km (WNW)	Licensed groundwater abstraction (Great Oolite aquifer). See Table 4.1.
Private Water Well Abstractions (unlicensed)	4 or more locations	Off site	Rural, isolated properties may utilise small groundwater supplies of which EA would protect. Wells likely to be in Great Oolite aquifer. See Table 4.2.
Springs			
Spring at Himley Green	TBC	On Site	Noted on Envirocheck (2010)
Other springs	Not known	Not known	Springs are characteristic of Great Oolite
Water Courses			
Un-named streams on Site	See Figure 2.1	On Site and within 3 km	Great Oolite may be an important contributor to base flow of local streams.
River Ray	e.g. SP 600 182	6 km (S)	R. Ray fed by numerous streams including those from Site. R. Ray flows to Thames.
SSSI's and Nature Reserves			
Ardley Cutting & Quarry Site SSSI		TBC (W)	Envirocheck 2010 information source
Bure Park Nature Reserve	SP 577 238	0.5 km (S)	Wildfowl reserve; wetland. Downstream from Site.
Upper Ray Meadows Nature Reserve	TBC (beside A41)		Grassland and wetland beside River Ray.

5 HYDROGEOLOGICAL CONCEPTUAL MODEL

The hydrogeological conceptual model, inferred from the preceding geological and hydrogeological information, is summarised in Figure 5.1. In summary:

- The Great Oolite aquifer (a fracture flow aquifer) underlies the whole site and is in probable hydraulic connection/partial connection to surface water streams. Springs typically occur due to local shallow low permeability beds or intersection of highly fissured ground;
- The Great Oolite aquifer is 30 – 40 metres thick extending from ground surface. It comprises a sequence of limestones, mudstones and sandstones including the Cornbrash Formation (rubbly limestone) at ground surface at White Limestone Formation beneath the interlaying mudstones of the Forest Marble Formation;
- The thin or absent cover of superficial deposits means that the Great Oolite it is vulnerable to pollution from the surface (e.g. spillages, landfill or diffuse pollution). The shallow, thin Cornbrash Limestone which crops out at ground surface at the Site is vulnerable. The presence of the Forest Marble Formation mudstones may give protection locally to deeper formations, depending on the thickness and permeability of the mudstones;
- A high nitrate concentration may be present in the Great Oolite aquifer but there is conflicting information from offsite EA monitoring locations (low nitrate) and offsite private water supply wells (high nitrates). Published information tentatively indicates that high nitrates may be present in the shallow Cornbrash Formation but may be better in the deeper formations within the Great Oolite Group. ;
- Licensed groundwater abstractions at and in the vicinity of the site appear to be from boreholes constructed in the Great Oolite aquifer, with well screen intakes across most of the formations ;
- The Great Oolite typically has highest permeability where fissuring is greatest and streams sometimes occur at these locations due to geological structural influence of their location. Storage is typically low and therefore shows large seasonal variation of levels;
- Historical wells completed in the Great Oolite aquifer had relatively low yields (c. 2 to 11 L/s). There appears to have been a decline of the use of these wells to redundancy or lower licenced or unlicensed abstraction rates. This may indicate that the sustainability of higher yields is problematic;
- The Old Red Sandstone aquifer is approximately 160 m deep and extends to around 400 m deep;
- The Old Red Sandstone aquifer is overlain by thick mudstones and is therefore not in hydraulic continuity with the shallower aquifer;
- The Old Red Sandstone aquifer is predominantly a fracture flow aquifer and may behave as a complex multi-layered aquifer but with the potential for fracture closure with increasing depth. Published transmissivity values are low;
- The Bromsgrove Sandstone Formation (0 – 15 m thick) may be present and if so would slightly increase the thickness and transmissivity of the Old Red Sandstone aquifer, being in hydraulic continuity with it;
- The Old Red Sandstone does not receive direct rainfall recharge in the region and therefore long residence times of groundwater mean the potential for leaching out of minerals. The water could tend to be more brackish than at shallow depths and there could be elevated mineral content of say iron, manganese and trace metals;

- Geological faults (e.g. BGS sheet 219 mapped fault located 1 km to the north or other smaller unmapped faults) are likely to give locally more fissured and therefore higher permeability zones in the bedrock.

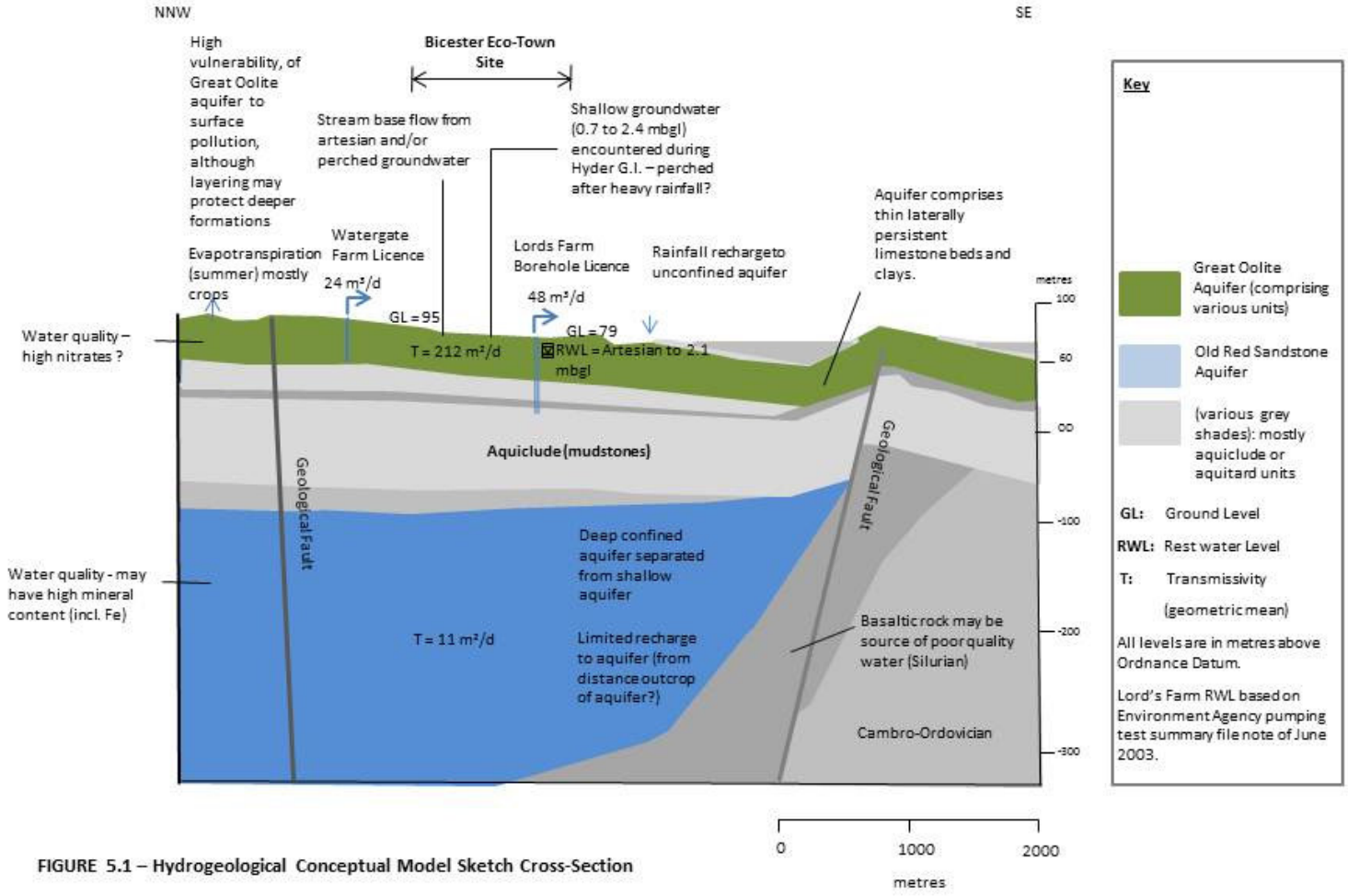

FIGURE 5.1 – Hydrogeological Conceptual Model Sketch Cross-Section

6 APPRAISAL OF A NEW SUPPLY

6.1 Feasibility

The feasibility of a new groundwater supply is largely determined by several key factors and is summarised in Table 6.1:

- Yield – can it be demonstrated that the required yield can be given from the proposed well?
- Sustainability of yield – evidence needed to demonstrate likely longevity of yield;
- Water quality needs to be suitable for potable water (or economic treatment is available);
- Environmental impacts should be low.

Table 6. 1 – Feasibility Summary of Aquifers for New Supply

Factor	Great Oolite Aquifer	ORS Aquifer
Yield	Marginal. More than one well would be needed. Spacing and location may be problematic.	Marginal. More than one well likely would be needed.
Sustainability	Probably low due to low storage. Susceptible to dry periods as water levels tend to fall quickly.	Marginal due to slow recharge and aquifer typically has low transmissivity.
Water Quality	High vulnerability to any surface pollution in shallow formations. Possibly greater protection for deeper formations. Current water quality shown as “poor”, probably relating to the shallowest formation. Further water quality information required to assess whether treatment would be required.	More information required. High mineral content possible due to likely long residence times.
Environmental Impact	Lord’s Farm Borehole (licensed) may be impacted. Stream flows on Site may be impacted.	Negligible as separated by thick aquiclude.

6.2 Analytical Appraisal

An analytical appraisal of anticipated well volumes, radius of influence and potential distance-drawdown effects (relevance to on neighbouring water interests) has been conducted. The analysis is tentative as it is based on the very limited pumping test data from the historical wells and published aquifer parameters for the same aquifers found outside the region.

The rest groundwater level in the Great Oolite is assumed to be shallow (e.g. approximately 0 to 2 mbgl); a saturated thickness of 37 m has been assumed and has been estimated from the local borehole logs. The rest piezometric pressure in the Old Red Sandstone is assumed to be at ground level. Reliable data for the whole of the aquifers are not available. These need to be confirmed and caution is required because the below calculations may not be sufficiently conservative if the rest water level is lower.

Great Oolite Aquifer

Historical wells data analysis (Cooper and Jacob 1946 in Krusemann and De Ridder) indicates a median permeability of $1.7E^{-5}$ m/s (transmissivity of c. 52 m^2/day). The maximum calculated permeability is 8.0 E^{-5} m/s (data thought unreliable as only 8 hour test). The results are less than the Major Aquifers (EA, BGS 1997) interquartile range (Table 3.2) but the latter is probably representative of the aquifer in the Cotswolds rather than in the Bicester area.

The On-Site Lord's Farm licensed abstraction is relatively small (48 m^3/day or 0.5 L/s) and calculated drawdown (Dupuit-Forcheimer in CIRIA C515) at the well, using the above permeability, is less than 2 metres. This concurs with the 2003 pumping test summary report (section 3.5). Therefore the radius of influence form Lord's Farm is calculated as being minimal (less than 50 m).

A new well in the Great Oolite aquifer would not be able to achieve the 29 L/s in a single well when calculated using the Dupuit-Forcheimer method (in CIRIA C515). This is based on the median permeability. The yield is theoretically possible for the above maximum permeability but with a theoretical drawdown in the well of over half the aquifer thickness. This is not considered sustainable when considering seasonal water level variation.

New multiple wells in the Great Oolite would only be feasible if more than approximately seven wells were used (each of 4 L/s) based on the Dupuit-Forcheimer calculation method. The assumed permeability, being relatively low, would mean that the radius of influence of these would be relatively small (c. 100 m). This distance would be a first approximation for well spacing and the required distance from sensitive water features or interests.

Old Red Sandstone Aquifer

Calculation of achievable yield (using Thiem equation in CIRIA C515) indicates only moderate yields (c. 15 L/s) are available if the published transmissivity geometric mean (11 m^2/day) is used and a large theoretical drawdown (150 m) to near the top of the aquifer. Full penetration of the aquifer is assumed.

At least two wells in the Old Red Sandstone aquifer (each of 15 L/s) would be required to achieve the required yield of 29 L/s (based on calculations using the Thiem equation in CIRIA C515). The calculated radius of influence is c.400 m. calculation method. This distance would be a first approximation for well spacing. Additional well(s) should be considered for contingency purposes.

6.3 Effect on Water Features and Interests

Potential effects on neighbouring water interests are presented in the below table. Anticipated well volumes and drawdowns are estimated in this section and are based on published aquifer properties.

Table 6.2 – Qualitative Assessment of Effects on Neighbouring Water Interests

Feature Type	Detail	New Great Oolite Well	New ORS Well	Possible Mitigation
Public Water Supply Wells	No wells within 5 km	No effect	No effect	Not needed
Licensed Wells (domestic and farming)	Lord's Farm, Watergate Farm	Potential to deepen pumped water level and reduce yields.	No effect	Locate any new Great Oolite well at c. 100 m distance from existing well
Local Springs	One at Himley Farm on Site. Others?	Potential to reduce or stop spring flow	No effect	Locate any new Great Oolite well at 100 m distance from spring features
Local Streams	On Site streams	Potential to reduce flow. Potential to reduce flow downstream incl. R. Ray (see CAMS section 4)	No effect	Locate any new Great Oolite well at 100 m distance from streams
Stream Water Quality	-	Turbidity if temporarily released to stream	pH, Eh and mineral content	Locate any new well away from streams or identify mitigation
Groundwater Quality		No effect	Potentially high mineral content in ORS.	Normal best practice techniques for well casing
SSSI's and Nature Reserves	e.g. Bure Park	Could reduce stream inflow to wetland	No effect	Locate any new Great Oolite well at 100 m distance from streams

6.4 Preliminary Well Design and Investigation

The preliminary design of new wells and investigation and licensing considerations is briefly summarised below. This is based on the desk study information presented earlier in this report and should be considered as a first approximation in relation to yield and well spacing estimates (due to scarcity of data).

Well Locations Options:

Great Oolite	Supply not recommended (unless reduced supply). If so then restrictions required for potential spillage of pollutants (e.g. fuel tanks)
Old Red Sandstone	No restrictions other than suitable spacing if multiple wells (400 m). Best yields may be achieved near geological faults.

Investigation Strategy:

Great Oolite	Supply not recommended (unless reduced supply). Water quality assessment.
Old Red Sandstone	Exploratory hole drilling to 400 metres deep. Pumping test. Water quality assessment.

Licensing Requirements:

Great Oolite	Supply not recommended (unless reduced supply). If so, then: Investigation consent for drilling and pumping test then Full Licence application. Likely need to prove negligible derogation of Lord's Farm borehole (or private negotiation) plus negligible reduction of stream flow.
Old Red Sandstone	Exploratory hole drilling to 400 metres deep. Ditto above. Need to prove sustainability of yield and appropriate water quality. Pumping test.

Borehole Construction:

	Depth, m	No. of Wells	Casing, Liner
Great Oolite	40	Supply not recommended (unless reduced supply). If so, then multiple wells may be required.	Casing: to c. 10 m depth; Liner: 30 m length screen
Old Red Sandstone	400	Two plus contingency	Casing: to c. 160 m depth; Open hole to c. 400 m (or well screen of 240 m length).

Notes:
Well spacing for Great Oolite aquifer assumes low yielding (c. 4 L/s) multiple wells (see section 6.2). For a large yield well (probably not possible) the distance drawdown effects would need to be reassessed.

7 CONCLUSIONS

The Great Oolite aquifer underlies the whole site and is approximately 30 to 40 m thick extending from ground surface; it comprises beds of limestone, mudstones and sandstones. The aquifer is assessed as being marginal as a potential source of groundwater for the Eco-Town. This is due to the relatively low yields of historical wells (c. 2 to 10 l/s) and the assessed relatively low transmissivity. There may or may not be a partial hydraulic connection to surface water streams. Any new abstraction would need to demonstrate negligible impact on stream flows due to CAMS restrictions. The absence of superficial deposits means that the aquifer may be vulnerable to surface spillages although layering may protect deeper formations. Published information tentatively indicates that high nitrates may be present in the shallow Cornbrash Formation but may be better in the deeper formations within the Great Oolite Group.

There is a potential second aquifer unit comprising the Brosmsgrove Sandstone (0 - 15 m thick) and the Old Red Sandstone Group (ORS) (c. 170 m thick). This has been termed the ORS aquifer in this report and it underlies the whole site. Utilisation of this aquifer would mean deep drilling to around 400 m depth.

The ORS, whilst thick, can have relatively low permeability for sandstone and the presence of an open fracture network would be important. The ORS does not receive direct rainfall recharge in the region and therefore likely long residence times of groundwater mean the potential for leaching out of minerals. The water could tend to be more brackish than at shallow depths and there could be elevated iron, manganese and trace metals. No water quality data for this aquifer in this region are currently available.

Water demand for the Eco-Town has been estimated (by others) and is equivalent to 29 litres per second (L/s). Further work will be needed to assess whether peak demand management and water treatment requirements will require a different peak abstraction rate.

There is one existing groundwater abstraction licence (Lord's Farm) within the Eco Town site area. The licensed abstraction rate is 48 m3/day (0.6 L/s) and the well utilises the Great Oolite aquifer. The Environment Agency would seek quantification that any new abstraction would not derogate this supply. Alternatively negotiations could be instigated on a private basis to discuss the provision of an alternative supply. At this stage, given the above listed problems of a new Great Oolite water supply, then this is not proposed.

The Great Oolite aquifer as a potential source for a new water supply for the Eco-Town seems unlikely based on the desk study presented in this report. Alternatively the Great Oolite could be considered as a potential water supply for only part of the Eco-Town water requirement, subject to further assessment of water quality (e.g. for nitrate) and assessment of the likely long term water quality with respect to vulnerability to surface spillages.

Whilst the ORS might represent a better potential source for a new water supply for the Eco-Town; the available information suggests that it has relatively limited permeability meaning that two or more wells (15 L/s each would be needed (based on initial calculations). Spacing of c. 400 m would be required between wells. However, there is very limited data available for this aquifer and, whilst the calculations are moderately conservative, it is possible that yields are lower due to the depth of the aquifer (causing closure of fractures) or lower than assumed rest piezometric level. Water quality, as stated above is unknown but it is likely that some treatment will be required before potable use.

8 REFERENCES

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Appendix 1 – Envirocheck Information (extracts from the 2010 report)

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
1	**Local Nature Reserves** Name: Bure Park Multiple Area: N Area (m2): 83957.83 Source: Natural England Designation Date: 5th December 2005	(SE)	53	3	457592 224148
2	**Nitrate Vulnerable Zones** Name: Not Supplied Description: Surface Water - Designated 2006 Source: Department for Environment, Food and Rural Affairs (DEFRA - formerly FRCA)	(N)	0	4	455900 227700
3	**Sites of Special Scientific Interest** Name: Ardley Cutting & Quarry Multiple Areas: N Total Area (m2): 401251.72 Source: Natural England Reference: 1000903 Designation Details: Geological Conservation Review Designation Date: 12th May 1988 Date Type: Notified Designation Details: Local Wildlife Trust Reserve Designation Date: 12th May 1988 Date Type: Notified	C3NE (W)	407	3	455933 224998

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
1	**Discharge Consents** Operator: A G Phipps, Esq. Property Type: Domestic Property (Multiple) Location: Home Farm Complex Home Farm Banbury Road Caversfield, Bicester Oxfordshire Ox27 0tg Authority: Environment Agency, Thames Region Catchment Area: Not Supplied Reference: Cawm.0566 Permit Version: 1 Effective Date: 19th November 2002 Issued Date: 16th January 2003 Revocation Date: Not Supplied Discharge Type: Sewage Discharges - Final/Treated Effluent - Not Water Company Discharge Environment: Freshwater Stream/River Receiving Water: The Town Brook **Status: New Consent (Water Resources Act 1991, Section 88 & Schedule 10 as amended by Environment Act 1995)** Positional Accuracy: Located by supplier to within 10m	D2NE (SE)	0	1	458020 225040
2	**Discharge Consents** Operator: Mr. M.S. Purewal Property Type: Domestic Property (Single) Location: The Old Vicarage, Caversfield, Near Bicester, Oxon Authority: Environment Agency, Thames Region Catchment Area: Not Supplied Reference: Ctwc.1546 Permit Version: 2 Effective Date: 30th January 2007 Issued Date: 30th January 2007 Revocation Date: 31st March 2019 Discharge Type: Sewage Discharges - Final/Treated Effluent - Not Water Company Discharge Environment: Irrigation Area Receiving Water: Cornbrash **Status: Modified (Water Resources Act 1991, Schedule 10 as amended by Environment Act 1995)** Positional Accuracy: Located by supplier to within 10m	D3SW (SE)	389	1	458500 224750
2	**Discharge Consents** Operator: Mr. M.S. Purewal Property Type: Domestic Property (Single) Location: The Old Vicarage, Caversfield, Near Bicester, Oxon Authority: Environment Agency, Thames Region Catchment Area: Not Given Reference: CTWC.1546 Permit Version: 1 Effective Date: 27th March 1987 Issued Date: 27th March 1987 Revocation Date: 30th January 2007 Discharge Type: Sewage Discharges - Final/Treated Effluent - Not Water Company Discharge Environment: Irrigation Area Receiving Water: Cornbrash **Status: Transferred from COPA 1974** Positional Accuracy: Located by supplier to within 100m	D3SW (SE)	389	1	458500 224750
3	**Local Authority Pollution Prevention and Controls** Name: Teslayne Engineering Location: Unit 4 The Courtyard, Caversfield, Bicester, Ox27 8tg Authority: Cherwell District Council, Environmental Health Department Permit Reference: CDC P/WOB/011 Dated: Not Supplied Process Type: Local Authority Air Pollution Control Description: PG1/1Waste oil burners, less than 0.4MW net rated thermal input **Status: Application Not Yet Authorised** Positional Accuracy: Manually positioned to the address or location	D2NE (SE)	0	2	458065 225047
	Nearest Surface Water Feature	D1NE (W)	0	-	457282 225207

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
3	**Historical Landfill Sites** Licence Holder: Not Supplied Location: Bicester, Oxfordshire Name: Gowell Farm Operator Location: Not Supplied Boundary Accuracy: As Supplied Provider Reference: EAHLD13573 First Input Date: Not Supplied Last Input Date: Not Supplied Specified Waste Type: Deposited Waste included Inert, Industrial, Commercial and Household Waste EA Waste Ref: -9999 Regis Ref: Not Supplied WRC Ref: 3100/0027 BGS Ref: Not Supplied Other Ref: 13.6.5723, TP0230	A12NE (E)	0	1	456880 223813
	Local Authority Landfill Coverage Name: Cherwell District Council - Has supplied landfill data		0	2	462471 222097
	Local Authority Landfill Coverage Name: Oxfordshire County Council - Has supplied landfill data		0	6	462471 222097
4	**Local Authority Recorded Landfill Sites** Location: Gowell Farm, Bicester Reference: 14 Authority: Cherwell District Council, Environmental Health Department **Last Reported Status: Unknown** Types of Waste: Ash, Glass, Brick, Pottery Date of Closure: Not Supplied Positional Accuracy: Positioned by the supplier Boundary Quality: Good	A12NE (E)	0	2	456879 223829

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
1	**Discharge Consents** Operator: Catharine Murfitt Property Type: Domestic Property (Single) Location: Himley Barns Middleton Stoney Road Chesterton Bicester Oxfordshire Ox26 1rt Authority: Environment Agency, Thames Region Catchment Area: Cherwell and Ray (Oxon) Reference: Npswqd005893 Permit Version: 1 Effective Date: 16th December 2008 Issued Date: 15th December 2008 Revocation Date: Not Supplied Discharge Type: Sewage Discharges - Final/Treated Effluent - Not Water Company Discharge Environment: Freshwater Stream/River Receiving Water: Tributary Of Pingle Stream **Status: New Consent (Water Resources Act 1991, Section 88 & Schedule 10 as amended by Environment Act 1995)** Positional Accuracy: Located by supplier to within 10m	A11SE (E)	0	1	456035 223498
	Nearest Surface Water Feature	A12NE (E)	0	-	456908 223635
2	**Water Abstractions** Operator: W & W Malins Licence Number: 28/39/14/0214 Permit Version: 100 Location: Lords Farm, Bicester (A) Authority: Environment Agency, Thames Region Abstraction: General Farming And Domestic Abstraction Type: Water may be abstracted from a single point Source: Groundwater Daily Rate (m3): 10 Yearly Rate (m3): 1763 Details: Great Oolite Authorised Start: 01 January Authorised End: 31 December Permit Start Date: 8th May 1967 Permit End Date: Not Supplied Positional Accuracy: Located by supplier to within 100m	A16NE (NE)	0	1	456900 224500
	Water Abstractions Operator: A D Woodley Ltd Licence Number: 28/39/14/0123 Permit Version: 100 Location: Whitelands, Bicester (A) Authority: Environment Agency, Thames Region Abstraction: General Farming And Domestic Abstraction Type: Water may be abstracted from a single point Source: Groundwater Daily Rate (m3): 20 Yearly Rate (m3): 1818 Details: Great & Inferior Oolite Authorised Start: 01 January Authorised End: 31 December Permit Start Date: 9th January 1967 Permit End Date: Not Supplied Positional Accuracy: Located by supplier to within 100m	A4SE (SE)	754	1	456700 222100
	Groundwater Vulnerability Geological Classification: Minor Aquifer (Variably permeable) - These can be fractured or potentially fractured rocks, which do not have a high primary permeability, or other formations of variable permeability including unconsolidated deposits. Although not producing large quantities of water for abstraction, they are important for local supplies and in supplying base flow to rivers Soil Classification: Soils of High Leaching Potential (H3)- Coarse textured or moderately shallow soils which readily transmit non-absorbed pollutants and liquid discharges but which have some ability to attenuate absorbed pollutants because of their large clay or organic matter contents Map Sheet: Sheet 30 Northern Cotswolds Scale: 1:100,000	A12SE (E)	0	1	456817 223520
	Groundwater Vulnerability Geological Classification: Minor Aquifer (Variably permeable) - These can be fractured or potentially fractured rocks, which do not have a high primary permeability, or other formations of variable permeability including unconsolidated deposits. Although not producing large quantities of water for abstraction, they are important for local supplies and in supplying base flow to rivers Soil Classification: Soils of High Leaching Potential (U) - Soil information for restored mineral workings and urban areas is based on fewer observations than elsewhere. A worst case vulnerability classification (H) assumed, until proved otherwise Map Sheet: Sheet 30 Northern Cotswolds Scale: 1:100,000	A12SE (E)	0	1	456817 223520

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
6	**BGS Recorded Mineral Sites** Site Name: Gowell Farm Location: Bicester, Oxford, Oxfordshire Source: British Geological Survey, National Geoscience Information Service Reference: 57413 Type: Opencast **Status: Ceased** Operator: Unknown Operator Operator Location: Not Supplied Periodic Type: Jurassic Geology: Cornbrash Formation Commodity: Limestone Positional Accuracy: Located by supplier to within 10m	B9NW (W)	0	3	456996 223880
	BGS 1:625,000 Solid Geology Description: Cornbrash	(NW)	0	3	456217 225693
	Coal Mining Affected Areas In an area which may not be affected by coal mining				
	Potential for Collapsible Ground Stability Hazards No Hazard				
	Potential for Compressible Ground Stability Hazards Hazard Potential: No Hazard Source: British Geological Survey, National Geoscience Information Service	B14SW (E)	0	3	457625 224012
	Potential for Compressible Ground Stability Hazards Hazard Potential: Moderate Source: British Geological Survey, National Geoscience Information Service	B14NW (N)	0	3	457650 224425
	Potential for Compressible Ground Stability Hazards Hazard Potential: Moderate Source: British Geological Survey, National Geoscience Information Service	B13NW (NW)	0	3	457275 224350
	Potential for Compressible Ground Stability Hazards Hazard Potential: Moderate Source: British Geological Survey, National Geoscience Information Service	B13NE (NW)	0	3	457325 224325
	Potential for Compressible Ground Stability Hazards Hazard Potential: Moderate Source: British Geological Survey, National Geoscience Information Service	B14SW (E)	0	3	457625 224012
	Potential for Compressible Ground Stability Hazards Hazard Potential: Moderate Source: British Geological Survey, National Geoscience Information Service	B14NW (N)	0	3	457675 224550
	Potential for Ground Dissolution Stability Hazards Hazard Potential: Very Low Source: British Geological Survey, National Geoscience Information Service	B13SE (N)	0	3	457575 224025
	Potential for Ground Dissolution Stability Hazards Hazard Potential: No Hazard Source: British Geological Survey, National Geoscience Information Service	B13SE (N)	0	3	457575 224025
	Potential for Ground Dissolution Stability Hazards Hazard Potential: Very Low Source: British Geological Survey, National Geoscience Information Service	B14SW (E)	0	3	457700 224012
	Potential for Ground Dissolution Stability Hazards Hazard Potential: No Hazard Source: British Geological Survey, National Geoscience Information Service	(SW)	193	3	456900 223175
	Potential for Landslide Ground Stability Hazards Hazard Potential: Very Low Source: British Geological Survey, National Geoscience Information Service	(W)	0	3	456700 224300
	Potential for Running Sand Ground Stability Hazards Hazard Potential: No Hazard Source: British Geological Survey, National Geoscience Information Service	B14SW (E)	0	3	457625 224012
	Potential for Running Sand Ground Stability Hazards Hazard Potential: Low Source: British Geological Survey, National Geoscience Information Service	B14NW (N)	0	3	457675 224550
	Potential for Running Sand Ground Stability Hazards Hazard Potential: Low Source: British Geological Survey, National Geoscience Information Service	B14NW (N)	0	3	457650 224425
	Potential for Running Sand Ground Stability Hazards Hazard Potential: Low Source: British Geological Survey, National Geoscience Information Service	B13NW (NW)	0	3	457275 224350

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
4	**Historical Landfill Sites** Licence Holder: Not Supplied Location: Bicester, Oxfordshire Name: Gowell Farm Operator Location: Not Supplied Boundary Accuracy: As Supplied Provider Reference: EAHLD13573 First Input Date: Not Supplied Last Input Date: Not Supplied Specified Waste Type: Deposited Waste included Inert, Industrial, Commercial and Household Waste EA Waste Ref: -9999 Regis Ref: Not Supplied WRC Ref: 3100/0027 BGS Ref: Not Supplied Other Ref: 13.6.5723, TP0230	B9NW (W)	0	1	457155 223885
	Local Authority Landfill Coverage Name: Cherwell District Council - Has supplied landfill data		0	2	462510 222289
	Local Authority Landfill Coverage Name: Oxfordshire County Council - Has supplied landfill data		0	6	462510 222289
5	**Local Authority Recorded Landfill Sites** Location: Gowell Farm, Bicester Reference: 14 Authority: Cherwell District Council, Environmental Health Department **Last Reported Status: Unknown** Types of Waste: Ash, Glass, Brick, Pottery Date of Closure: Not Supplied Positional Accuracy: Positioned by the supplier Boundary Quality: Good	B9NW (W)	0	2	457154 223881

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
1	**Discharge Consents** Operator: Messrs Wej & Tmf Malins Property Type: Domestic Property (Single) Location: Lords Farm Lords Lane Bicester Oxfordshire Ox27 7hl Authority: Environment Agency, Thames Region Catchment Area: Not Supplied Reference: Cawm.0876 Permit Version: 1 Effective Date: 16th September 2004 Issued Date: 16th November 2004 Revocation Date: Not Supplied Discharge Type: Trade Effluent Discharge-Site Drainage Discharge Environment: Freshwater Stream/River Receiving Water: Trib Of The Town Brook **Status: New Consent (Water Resources Act 1991, Section 88 & Schedule 10 as amended by Environment Act 1995)** Positional Accuracy: Located by supplier to within 10m	B13SE (N)	0	1	457510 224170
1	**Discharge Consents** Operator: Messrs Wej & Tmf Malins Property Type: Domestic Property (Single) Location: Lords Farm Lords Lane Bicester Oxfordshire Ox27 7hl Authority: Environment Agency, Thames Region Catchment Area: Not Supplied Reference: Cawm.0877 Permit Version: 1 Effective Date: 16th September 2004 Issued Date: 16th November 2004 Revocation Date: Not Supplied Discharge Type: Sewage Discharges - Final/Treated Effluent - Not Water Company Discharge Environment: Freshwater Stream/River Receiving Water: Trib Of The Town Brook **Status: New Consent (Water Resources Act 1991, Section 88 & Schedule 10 as amended by Environment Act 1995)** Positional Accuracy: Located by supplier to within 10m	B13SE (N)	0	1	457520 224180
	Nearest Surface Water Feature	B13SE (N)	0	-	457583 224208
2	**Pollution Incidents to Controlled Waters** Property Type: Not Given Location: BICESTER Authority: Environment Agency, Thames Region Pollutant: General Note: Not Supplied Incident Date: 16th December 1997 Incident Reference: 37374 Catchment Area: Not Given Receiving Water: Not Given Cause of Incident: Not Given Incident Severity: Category 3 - Minor Incident Positional Accuracy: Located by supplier to within 100m	B10NW (SE)	405	1	457700 223800
3	**Water Abstractions** Operator: W V Malins & Son Licence Number: 28/39/14/0348 Permit Version: 1 Location: Lords Farm - Borehole Authority: Environment Agency, Thames Region Abstraction: General Farming And Domestic Abstraction Type: Water may be abstracted from a single point Source: Groundwater Daily Rate (m3): Not Supplied Yearly Rate (m3): Not Supplied Details: Underground Strata At Lords Farm, Bicester. Authorised Start: 01 January Authorised End: 31 December Permit Start Date: 1st April 2008 Permit End Date: Not Supplied Positional Accuracy: Located by supplier to within 100m	B13SE (NW)	0	1	457400 224200

Appendix 2- Lord's Farm Well 2003 Pumping Test

PUMPING TEST SUMMARY (Thames Region EA)

APPLICATION		**Consent No:**	TP 02/W/16
Applicant:	Tim Mallins of Lords Farm	**File Ref:**	WRW/A/1105
Site:	Lords Farm, Bicester	**Well Index No:**	
NGR:	SP 5742 2424		
Quantities:	60 m^3/d and 21900 m^3 per year		
Purpose:	For supplying dairy cattle (300 in the summer and 500 in the winter)		

GEOLOGY

Strata:	Cornbrash and Forest Marble on Great Oolite.
Aquifer:	Great Oolite

BOREHOLE CONSTRUCTIONS

Borehole Depth:	79.3 m
Diameter:	457 mm
Linings:	No info – presumably slotted through the Great Oolite.
New/Existing:	New
Drilling Company:	Not known

TEST CONDITIONS

Quantities:	3 m^3/h for around an hour or so.
Radius of Search:	Decided a radial survey would not be necessary as the borehole is semi-artesian.

TEST RESULTS

Test Date : 3rd June 2003

Pumping Rate: 3 m^3/h – abstracts 500 litres in 5 minutes around 6 times an hour.
ABH RWL: 1.22 m **PWL:** 2.13 m **Drawdown:** 0.91 m

OTHER OBSERVATIONS:

None

REPORT:

The borehole is an old borehole originally drilled by the Ministry of Defence in 1941 (borehole card SP 52/18). According to Mr Mallins the borehole is artesian in the winter and during the summer water levels are only 5 to 7 feet below ground level. This was confirmed during the site visit when the rest water level was only around 4 feet below ground level (or 1.22m).

The borehole uses an automated pumping system which fills a bowser based on water demand. The bowser has a capacity of 500 litres and is filled using a 100 litre pump operating for around 5 minutes. According to Mr Mallins this operates around 6 times an hour and operates all day. This means that the total daily abstraction is around 70,000 litres or 70 cubic metres which is

slightly above our previous estimate.

On operation of the pump the water level declines from a rest water level of around 4 feet (1.22 m)to a pumping water level around 7 feet (2.13 m) below ground level. Recovery is relatively rapid to the rest water level of 4 feet. Thus the abstraction is causing a minimal decline in water levels.

After some time spent viewing the pumping system the stream 50m to the north of the borehole was examined. This was found to contain some flowing water. In addition the stream to the east near the road was examined and also contained some water. Neither of these streams will be affected by this abstraction as the borehole abstracts from the Great Oolite aquifer and the stream flows on the Forest Marble.

RECOMMENDATION:

As the borehole is semi-artesian and drawdowns are relatively low there are no issues licensing this borehole. However Mr Mallins needs to be contacted to confirm the required daily licence limit for the borehole. The borehole can thus be licensed for a limit of **60 m^3/d and 21900 m^3 per year.**

M. Leeson
11th July 2003

APPENDIX 13.1
AGRICULTURAL LAND CLASSIFICATION

Technical Appendix 13.1: Agricultural Land Classification: Himley Village, Bicester

An Agricultural Land Classification (ALC) survey of the proposed Himley Village development site at Bicester was undertaken on 14, 17 and 26 November 2014. The survey work was carried out by a specialist ALC consultant, Daniel Baird Soil. The purpose of the survey was to provide baseline data on agricultural land quality for the Himley Village proposal Environmental Impact Assessment.

Field work was undertaken at a semi detailed level, one survey point per two hectares. The semi detailed assessment was chosen in preference to a detailed survey (one point per hectare) as existing ALC survey cover on adjacent land to the east, with the same topography and parent material, found uniform Grade 3b agricultural land.

The ALC assessment followed the Ministry of Agriculture Fisheries and Food Agricultural Land Classification for England and Wales revised guidelines and criteria for grading the quality of agricultural land, published October 1988.

Auger boring data from the survey is given on the attached data sheet. In addition pits were dug by spade at sample points 19 and A to confirm that the subsoil was not slowly permeable.

ALC Methodology

The MAFF ALC system of grading land quality for use in land use planning purposes divides farmland into five grades according to the degree of limitation imposed upon land use by the inherent physical characteristics of climate, site and soils. Grade 1 land is of an excellent quality, whilst Grade 5 land has very severe limitations for agricultural use.

The MAFF revised guidelines and criteria for ALC of October 1988 require that the following factors be investigated:

- Climate: Average Annual Rainfall (AAR) and Accumulated Temperature above 0°C ` between January and June (AT0);
- Site: Gradient, Micro Relief and Flooding;
- Soils: Texture, Structure, Depth, Stoniness, and Chemical Toxicity;
- Interactive Factors: Soil Wetness, Soil Droughtiness and Liability to Erosion

Agricultural Land Classification Assessment

Climate

Climatological data for ALC are provided for 5km intersections of the National Grid by the Meteorological Office, in collaboration with the National Soil Resources Institute. The data from these points can be interpolated providing climate data for specific sites. Interpolated data for the Himley Court site is given in Table 1 below:

Table 1

Reference Point:	SP 560 235
Altitude (m)	91
Average Annual Rainfall AAR (mm)	681
Accumulated Temperature AT0 (day degrees)	1401
Moisture Deficit for wheat (mm)	102
Moisture Deficit for potatoes (mm)	93
Field Capacity Duration (days)	147

The main parameters used in the assessment of an overall climatic limitation are AAR as a measure of overall wetness, and AT0 as a measure of the warmth of the site in the growing season.

Climate does not impose an overall limitation on ALC grade at this site. Climate does however have an important influence on the interactive limitations, soil wetness and soil droughtiness.

The Site

The extent of the site is shown on Plan 13.1 from the Himley Village ES. Land within the site is level to gently sloping. There are no gradient or micro topography limits to ALC grade within the site.

The site is not crossed by any surface water courses, shallow dry ditches are present on some field boundaries. The land does not lie below any features that could generate significant overland flow. ALC grade is not limited by flood risk at this site.

Soils and Parent Materials

The British Geological Survey Geology of Britain Viewer[i] shows the site within an extensive area of Cornbrash limestone. Field survey of the site found soils consistent with this parent materials. Soils are typically shallow with the fractured limestone found from as little as 25cm below the surface. Soil depth is a limiting factor to overall ALC grade for the shallowest soils. In places the topsoil content of large stones (greater than 2cm) is sufficiently high to also limit overall ALC Grade.

Interactive Factors

Soils within the site are typically well drained (Wetness Class I) medium textured soils overlaying the permeable parent material of fractured limestone.

The soil's capacity to retain plant available water is limited by the shallow depth and stone content. All soils are limited to grade by soil droughtiness, the deeper soils being limited to Grade 3a and the shallower soils being limited to Grade 3b.

Agricultural Land Classification of the Himley Village Site.

The agricultural land within the site has been classed as ALC Grade 3a and 3b. Plan 13.1 from the ES shows the distribution of the ALC grades within the site. Table 2 below gives the area estimates for each grade.

Table 2 – ALC Grade Distribution

ALC Grade	Area (ha)	%
3a	11.73	13.02
3b	74.5	82.75
Non Agricultural	3.8	4.32
Total	90.03	100

Survey Data Table

The attached data table provides the field data collected by the semi detailed ALC survey. ALC grades are given for each individual point on the basis of the soil physical characteristics at that point. However the grade distribution mapped for the site identifies consistent areas of ALC grade, not just unrelated zones around each sample points.

The data table headings are:

Grid Reference	Location by Ordnance Survey National Grid, with 100km grid square, easting and northing to 100m
Horizon	distinct soil layers numbered sequentially from the uppermost topsoil
depth	lower depth of the horizon
Colour	soil colour using Munsel colour notation
texture	clay, silt and sand composition as per ALC Guidelines Appendix 2
Subsoil Structure	Structural condition of subsoil as per ALC Guidelines Appendix 4
Total Stone	percentage volume of stone greater than 2mm
>2cm	percentage volume of stone greater than 2cm - topsoil only
>6cm	percentage volume of stone greater than 6cm - topsoil only
Stone type	As per ALC Guidelines Appendix 4
Mottles	colour variation, Munsel notation
Gley	Presence of gleying as per ALC Guidelines Appendix 3
SP	Slowly Permeable horizon as per ALC Guidelines Appendix 3
MB Wheat	Moisture Balance (mm) for Wheat as per ALC Guidelines section 3.4
MB Potato	Moisture Balance (mm) for Potato as per ALC Guidelines section 3.4
Wetness Class	As per ALC Guidelines Appendix 3
Calculation	Calcareous, greater than 1% calcium carbonate - topsoil only
ALC grade	ALC grade by most severe limitation at the sample point
Limitation	principal limitation(s) of ALC Grade at the sample point
Notes	Other pertinent information

[1] British Geological Survey Geology of Britain viewer.
http://www.bgs.ac.uk/data/mapViewers/home.html?src=topNav

Agricultural Land Classification (ALC) Survey – Himley Village, Bicester

Survey by Daniel Baird

14, 17, and 26 Noveber 2014

Fair to overcast after rain for all three days

Level to gently sloping. Predominantly arable with some temporary paddocks.

Number	Grid Ref	E	N	Horizon	Depth	Colour	Texture	Subsoil structure	Total Stone %	>2cm	>6cm	Stone Type	Mottles	Gley	Slowly Permeable	MB Wheat	MB Potato	Wetness Class	Calc	ALC Grade	Limitation	Note
1	sp	562	240	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	drought	
				2	45	7.5yr5/4	mcl		5			hard limestone		n	n							stop for stone
2	SP	559	239	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
3	SP	561	239	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
4	SP	563	239	1	25	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
5	SP	565	239	1	25	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
6	sp	560	238	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	drought	
				2	45	7.5yr5/4	mcl		5			hard limestone		n	n							stop for stone
7	SP	562	238	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
8	SP	564	238	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
9	SP	555	237	1	25	7.5yr4/3	mcl		2			hard limestone		n	n	28	2	III	y	2	wetness and droughtiness	
				2	45	7.5yr5/4	mcl	m	2			hard limestone		n	n							
				3	60	7.5yr5/4	mcl	m	2			hard limestone	faint 5/2	n	n							
				4	100	7.5yr6/1	c	p	0				5/8	y	y							
10	SP	559	237	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
11	SP	561	237	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
12	SP	563	237	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
13	SP	554	236	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth	stop for stone at 25
14	SP	556	236	1	25	7.5yr4/3	mcl		10			hard limestone						I	y	3b	depth	stop for stone at 25
15	SP	560	236	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
16	SP	562	236	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
17	sp	564	236																	non ag		tree belt
18	SP	553	235	1	25	7.5yr4/3	mcl		12			hard lmestone				-1	3	I	y	3a	drought	
				2	60	7.5yr5/4	hcl	m	10			hard lmestone		n	n							stop at 60
19	SP	555	235	1	25	7.5yr4/3	mcl		5			hard limestone						I / II	y	3a	drought	
				2	60	7.5yr5/4	hcl	m	5			hard limestone		n	n							
				3	75	7.5yr5/1	hcl	m	5			hard limestone	5/6	y faint	n							
20	sp	557	235	1	30	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth	stop for stone at 30
21	SP	559	235	1	22	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth	stop for stone
22	SP	561	235	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
23	SP	563	235	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth drought	stop for stone
24	SP	554	234	1	25	7.5yr4/3	mcl		12			hard limestone						I	y	3a	drought	
				2	65	7.5yr5/4	hcl	m	10			hard limestone		n	n							stop at 60
25	SP	556	234	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	drought	
				2	30	7.5yr5/4	hcl	m	5			hardlimestone		n	n							
				3	40	7.5yr5/1	c	p	10			hard limestone	5/6	y	n							too shallow for SP. Stop at 40
26	SP	558	234	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth, drought	
				2	30	7.5yr5/4	mcl		5			hard limestone		n	n							stop for stone
27	SP	560	234	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth, drought	
				2	30	7.5yr5/4	mcl		5			hard limestone		n	n							stop for stone
28	SP	562	234	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth drought	stop for stone
29	SP	564	234																	non ag		tree belt
30	SP	553	233	1	25	7.5yr4/3	mcl		20			hard limestone						I	y	3b	depth	stop for stone at 25
31	SP	555	233	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	drought	
				2	40	7.5yr5/4	mcl		5			hard limestone		n	n							stop for stone
32	SP	557	233	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth, drought	
				2	30	7.5yr5/4	mcl		5			hard limestone		n	n							stop for stone
33	sp	559	233	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	drought	
				2	45	7.5yr5/4	mcl		5			hard limestone		n	n							stop for stone
34	SP	561	233	1	30	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth drought	stop for stone
35	SP	563	233	1	30	7.5yr4/3	mcl		8			hard limestone						I	y	3b	depth drought	stop for stone
36	SP	552	232	1	25	7.5yr4/3	mcl		20			hard limestone						I	y	3b	depth	stop for stone at 25
37	SP	554	232																	non ag		residential
38	SP	556	232	1	25	7.5yr4/3	mcll		5			hard limestone						I	y	3b	depth drought	stop for stone
39	SP	558	232	1	25	7.5yr4/3	mcl		10	8		hard limestone						I	y	3b	depth, drought	
				2	30	7.5yr5/4	mcl		10			hard limestone		n	n							stop for stone
40	SP	555	231	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth, drought	
				2	30	7.5yr5/4	mcl		5			hard limestone		n	n							stop for stone
41	SP	557	231	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3b	depth, drought	
				2	30	7.5yr5/4	mcl		5			hard limestone		n	n							stop for stone
42	SP	558	230																	non ag	residential	
43	SP	560	232	1	25	7.5yr4/3	mcl		20	15		hard limestone		n	n			I		3b	depth and stone content	stop for stone at 25
44	SP	559	231	1	25	7.5yr4/3	mcl		20	15		hard limestone		n	n			I		3b	depth and stone content	stop for stone at 25
45	SP	561	231	1	25	7.5yr4/3	mcl		20	15		hard limestone		n	n			I		3b	depth and stone content	stop for stone at 25
46	SP	560	230	1	25	7.5yr4/3	mcl		5			hard limestone		n	n			I				
				2	40	7.5yr5/6	mcl	m	5			hard limestone		n	n							stop for stone at 40
A	SP	553	237	1	25	7.5yr4/3	mcl		10			hard limestone						I	y	3a	drought	
				2	60	7.5yr5/4	hcl	m	10			hard limestone		n	n							stop at 60
B	SP	552	236	1	25	7.5yr4/3	mcl		5			hard limestone				-17	-18	I	y	3a	drought	
				2	45	7.5yr5/4	mcl	m	5			hard limestone		n	n							
C	SP	552	234	1	25	7.5yr4/3	mcl		20			hard limestone						I	y	3b	depth	stop for stone at 25
D	SP	551	233	1	25	7.5yr4/3	mcl		5			hard limestone						I	y	3a	drought	
				2	50	7.5yr5/4	hcl	m	5			hard limestone		n	n							
				3	95	10yr5.1	mcl	m	40			hard gravel		n	n							
E	SP	560	231	1	25	7.5yr4/3	mcl		20	15		hard limestone		n	n			I		3b	depth and stone content	stop for stone at 25

APPENDIX 14.1
HIMLEY VILLAGE HERITAGE STATEMENT

Himley Village Development Heritage Statement

Prepared for
P3Eco
December 2014

Alan Baxter

Himley Village Development Heritage Statement

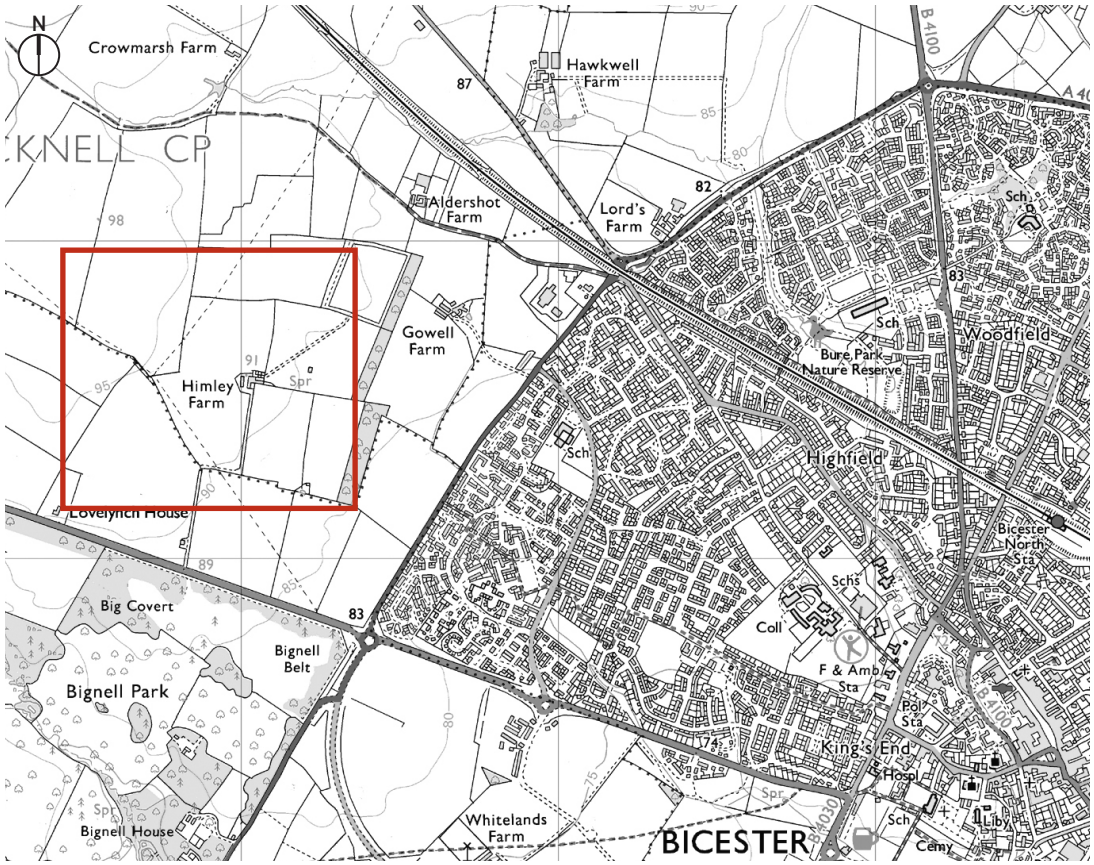
Prepared for

P3Eco

December 2014

Contents

Alan Baxter



OS map showing the Site relative to the town of Bicester

Aerial photograph of Site

1.0
Introduction

1.1 Purpose of this report

This report was commissioned by P3Eco, and produced by Alan Baxter & Associates LLP (ABA). The report functions as a Heritage Statement, to support the Proposed Development at Himley Village. The Heritage Statement also forms the Technical Appendix to the Built Heritage chapter of the Environmental Statement. The Himley Village Development is a key part of the NW Bicester Masterplan.

This report has assessed all the heritage assets within the red line boundary, which amounts to the two listed barns at Himley Farm. It describes their history and significance, assesses the impact of the proposals on their significance, and provides a reasoned assessment of the proposals in the light of polices for the protection of the historic environment.

This report covers the built heritage of the site and does not examine the potential for below ground archaeology. However, in accordance with the National Planning Policy Framework, a search of the Historic Environment Record has been carried out (see appendix 1).

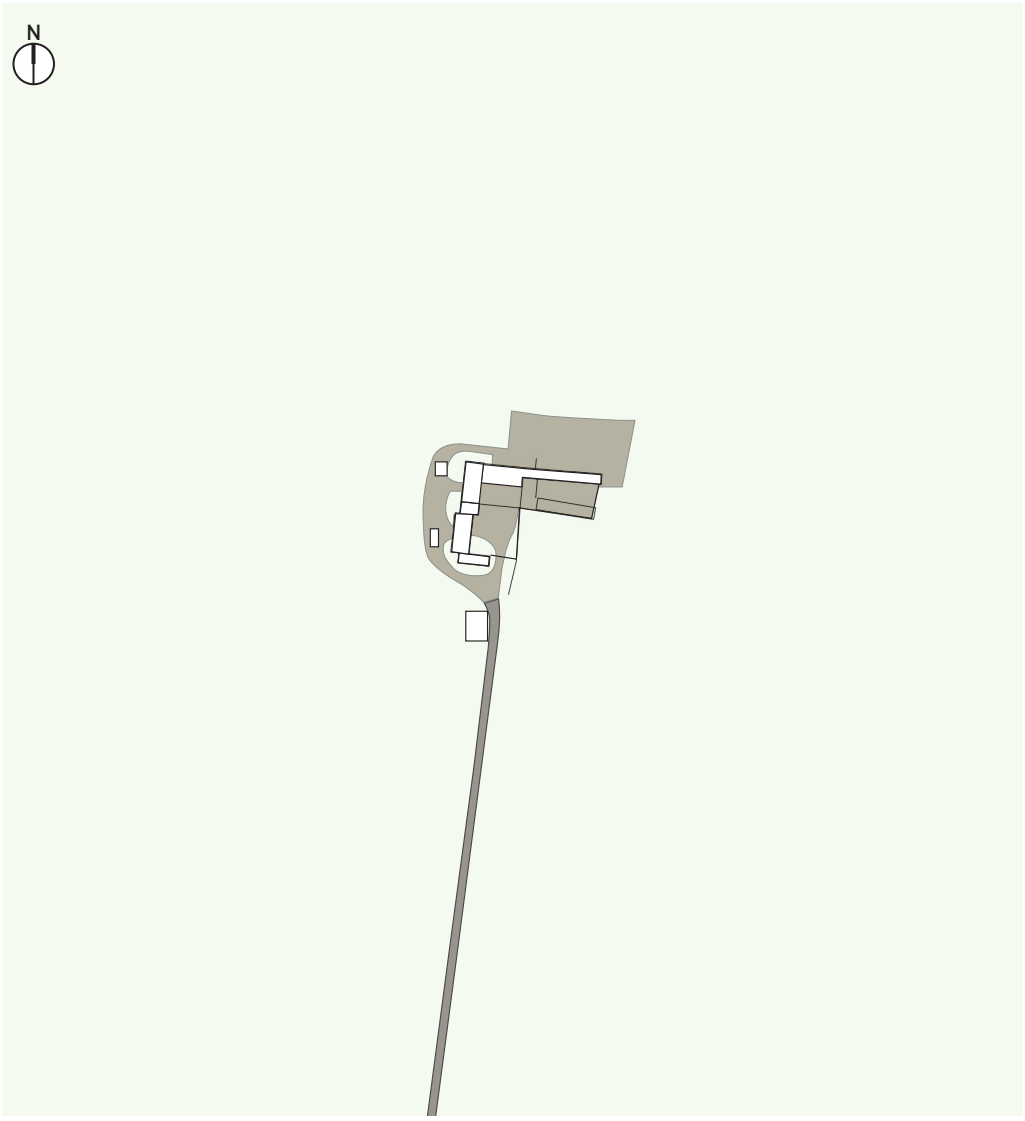
1.2 The site and project

In 2009, the Government named North West Bicester as one of four eco town locations, in accordance with the Planning Policy Statement 1: Eco-towns. The development will provide 6000 homes in a zero carbon development.

In May 2014, the NW Bicester Masterplan was produced by the Masterplan team, including Farrells, Barton Wilmore, Hyder, Bioregional, SQW and Remarkable for A2Dominion. The project aims to establish a pioneering community providing up to 6000 future-proof homes.

The site in question here - the Himley Village Development- is a key part of this overall masterplan. The site at present (see aerial photograph opposite) is principally agricultural, and contains a small complex of barns located at Himley Farm. Himley Farm is located in the centre of the Himley Village Development site. Two of the barns on the farm are listed at Grade II with a single list entry. No part of the site lies within a Conservation Area.

The stone-built barns are located in the territory of Bicester, in the parish of Bucknell. The barns are located at the end of a farm track leading north from Middleton Stoney Road, in the centre of the farm-owned open fields. Historically, there was no farmhouse or dwelling on the site until 2004, when one of the barns was converted for residential use. The barns are built with rough coursed stone and retain the original wooden truss roof structure concealed by modern roofing materials. The barns, both north-east oriented, are connected by a lower structure built with similar building materials and in a similar form. The barns are adjoined by a low building, probably a stable for small animals, which projects from the north-east corner of the north barn and extends along the whole length of the yard.



Map of Site, showing the access road and the buildings in the complex. The two store buildings

The two barns from the south looking north

The more northerly barn was refurbished in 2004 and converted into a domestic dwelling for the current owner.

1.3 Structure

This Heritage Statement sets out the history and the significance of the Himley Farm barns, and analyses the proposals and their impact on the heritage significance of the buildings. The history and current design of the building is described in Section 2.0. Section 3.0 assesses the historical and architectural significance of the barns, Section 4.0 outlines the development proposals, and Section 5.0 summarises the relevant national, regional and local legislation. Section 6.0 discusses the impact of different elements of the proposal on the asset and its settings, with a conclusion in Section 7.0. Sources are provided in Section 8.0 with the Appendices containing the list description and HER.

1.4 Methodology

The assessments made in this report are based on desktop research, including a review of existing sources and archival research. A full list of sources can be found at Section 8.0 and the Appendices. A site survey was undertaken on 18 September 2014; this covered the Site, and included a visual inspection (internal and external) of the listed buildings on the Site. Environmental Statement methodology is outlined in Chapter 14 of the Environmental Statement.

The study area of this report has been defined principally by the red line boundary of the Himley Village Development Site, but also takes into account the larger quadrant of land bounded by the B4030 Middleton Stoney road, the B4095 Howes Lane, the M40 and the railway track to the north, because of its relationship with the historic field boundaries.

The following assessments of significance are proportionate both to the importance of the receptor and to the nature and extent of the proposals. There are no direct works to the barns. Therefore, what follows is sufficient to understand the potential impact of the proposed Development on the significance of the barns and their setting.