NW Bicester

An application for the exemplar phase of the
NW Bicester Eco Development proposals submitted by
P3Eco (Bicester) Limited **and the** A2Dominion Group

Water Cycle Strategy – Outline Stage

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NW Bicester Eco Development

Water Cycle Study – Exemplar Site

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1 INTRODUCTION

1.1 Overview

North West Bicester has been identified as the site for a 5,000 home eco development.

NW Bicester is identified as an Eco-town location within the Planning Policy Statement PPS 1 supplement, which has received support from central government. The eco development would meet the requirements of the PPS supplement on Eco-towns, which sets out key sustainability principles.

Guidance from the Department of Communities and Local Government (CLG) states that eco-towns should be new settlements of between 5,000 and 15,000 low-carbon homes, designed to meet strict environmental standards. Eco-towns should be carbon neutral, with 30-50% affordable housing allocations, and should be well linked to the services and amenities of neighbouring urban areas. In essence, the eco development should aim to be an exemplar of environmental sustainability.

The CLG are responsible for managing local government and consequently the planning process. The Local Development Framework (LDF) forms the basis for the spatial planning strategy of an area[1]. The new eco-town will lie within Cherwell District Council, and North West Bicester is a strategic allocation in the LDF's draft Core Strategy.

It is anticipated that 3,000 of the total 5,000 homes at NW Bicester would be built by 2026, which is the timescale that the LDF is covering.

The eco development proposals would:

- Deliver an additional 5,000 homes; designed to achieve a zero carbon development and more sustainable living using the best new design and architecture;
- Deliver a high quality eco development, which complements local character and which is sustainably constructed, climate change resilient and energy efficient;
- Deliver a development with exemplar sustainable water management.

The first phase of the NW Bicester eco development, the Exemplar Site, will comprise 394 homes, a primary school, nursery and local retail centre, and areas of commercial offices.

This report contains details of the water cycle strategy for the Exemplar Site development and refers to the wider development strategy.

1.2 Scope

A2Dominion Group (A2Dominion) and P3Eco (Bicester) Ltd. (P3Eco) jointly appointed Hyder Consulting (UK) in July 2010 to complete a combined scoping and outline Water Cycle Study (WCS) for the proposed eco development.

The overall aim of the WCS is to make sure that there is a strategic and sustainable approach to the management and use of water by all stakeholders throughout the catchment. The water

[1] Introduced in England and Wales by the Planning and Compulsory Purchase Act 2004. Refer to Planning Policy Statement (PPS) 12 for further details.

infrastructure (supply, wastewater collection and wastewater treatment) required to support the housing and employment growth planned for the eco development and surrounding area consequently needs to be identified, along with any development constraints to be the subject of further investigation at the Detailed WCS stage.

Key objectives of this WCS will be to:

- Identify any water infrastructure services provision and usage constraints based on natural or anthropogenic changes, whilst testing the potential impact of the eco development on the water environment
- Develop a sustainable framework that enables the phased delivery of the key infrastructure needs and adaptation of future developments, in line with the aspirations and environmental demands of the local area. New infrastructure should, where possible benefit the local water environment;
- Inform the planning process to mitigate for any negative effects whilst maximising environmental gains through positive planning approaches;
- Promote a reduction in the risk of flooding from all sources, including fluvial, surface water and groundwater. Development would be located in Flood Zone 1, with areas of Flood Zone 2 and 3 used to create open amenity and wildlife spaces;
- Promote and incorporate Sustainable Drainage Systems (SUDS) and water harvesting to provide storm water management and create a sustainable resource from rainfall. SUDS should include green roofs, swales, ponds, bioretention areas, permeable surfaces and rainwater harvesting;
- Promote good water quality standards, enhancing the local environmental water quality where possible. SUDS would be used to remove any polluted runoff from diffuse sources proving at source treatment prior to discharge into watercourses;
- Provide an evidence base for infrastructure requirements to inform the business plans of the water companies;
- Provide a basis to implement effective solutions to reduce the water demand within the area, helping to reduce the environmental impact of over-abstraction and ease the stress on the infrastructure demands. The development should aim for water neutrality to minimise the reliance on the existing water resources, promoting the reduction in water use through water efficiency measures, and water reuse, including greywater recycling. Water use should not exceed 80 L/person/day, equivalent to meet levels 5 or 6 of the Code for Sustainable Homes; and
- Consider any biodiversity issues and how the water cycle impacts upon designated sites, both now and into the future, including the capacity of watercourses and ecosystems to absorb additional discharge from new developments.

1.3 Stakeholders

The development of this WCS has involved consultation with the following stakeholders:

- Thames Water Utilities (TWU);
- Environment Agency (EA);
- Natural England (NE);
- Cherwell District Council; and
- Oxford County Council.

In addition, Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust (BBOWT) have contributed information.

1.4 Stages

A water cycle study is normally broken down into three stages:

1 Initial Scoping study – this involves the Local Planning Authority (LPA) and key consultees such as the Environment Agency, and looks to identify baseline information and constraints

2 Outline Strategy – this involves the LPA, Environment Agency, Local Water Companies (in this case Thames Water Utilities), and local delivery vehicles. This builds on the baseline data and develops strategies to manage the water cycle. The outline strategy would typically be used to inform the LDF and Core Strategy.

3 Full strategy – this involves all initial stakeholders, and the developer. From this stage, development plans are made.

If a WCS is undertaken early enough in the Core Strategy and site allocation process, its findings can influence the location of development and make best use of the available environmental and infrastructure capacity.

In the case of the eco development, the draft Core Strategy has already been produced, and this study will look at the water cycle at a local level to support the eco development.

This report combines the initial site-specific scoping and outline stages of the WCS.

1.5 The Water Cycle

The natural water cycle commences with precipitation (i.e. rain, snow, sleet or hail). This is intercepted by the ground or ground cover and either travels overland through the process of surface runoff to rivers or lakes, or percolates through the surface and into underground aquifers where it may be stored or fed into rivers as base flow.

A portion of precipitation is lost directly back to the atmosphere through evaporation, or transpiration and evapo-transpiration from vegetation.

In the simplest form of the water cycle, the terrestrial water then travels through the catchment, where it sustains life, and is in turn evaporated or continues onwards to the sea. Here it would be evaporated from the surface and returned to the atmosphere or retained in the sea. Evaporated water vapour would form into clouds and fall as precipitation to complete the cycle. Figure 1-1 shows this process diagrammatically.

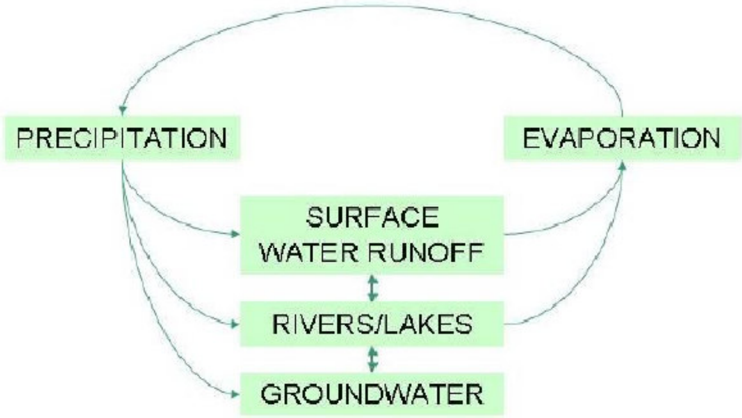

Figure 1-1 - Natural Water Cycle

Urbanisation creates a number of interactions with the natural water cycle. Water is abstracted, stored and transported for agriculture, industry and domestic purposes and then returned to the natural system, sometimes polluted or discharged into a geographically different catchment from where it fell. Pipes, pumps, dams and other technologies have facilitated these changes, and the natural water cycle is often controlled and managed. Urbanisation also creates a barrier for water infiltrating the ground, increasing the direct runoff to watercourses and reducing the supply of water to aquifers.

Water Cycle in this context includes both the natural water related environment and the built environment, where the control and distribution of water is driven by human demand, and includes storage facilities, treatment works and distribution networks.

With the manipulation of the water cycle to facilitate growth and development, there is a requirement for:

- additional impoundment and storage of water to maintain the water supply over dry spells, reducing the available water downstream in the catchment and the natural cycles of flood and drought.
- clean water supply which is taken from natural sources, including groundwater stores and watercourses. Excessive abstractions can deplete or degrade the natural environment. Following treatment at a water treatment works (WTW) this water, now potable, is transported via trunk mains and distribution pipes to the dwellings in the area. The potable water is then used by the population for a number of different purposes, creating large volumes of wastewater.
- the treatment of wastewater and disposal or reuse of treated effluent. The wastewater from the developments is transported via the sewerage network to a wastewater treatment works (WwTW), where the water is screened, treated, and then discharged back into rivers or groundwater. This can affect water quality and degrade the natural environment dependent on the watercourses.
- improved drainage to manage the increase of storm water runoff due to increases in impermeable area. The traditional approach of discharging water to watercourses as quickly as possible has lead to increased flood risk downstream and alterations to natural flow regimes.

Increased urbanisation in a catchment increases the demand for water and the volume of wastewater and wastewater treatment. In addition, flood risk may increase if development is not identified and planned for in a strategic manner. WCS's identify approaches to minimise the impacts of urbanisation on the natural cycle.

A diagrammatic representation of a typical urbanised water cycle, is shown in Figure 1-2 and Figure 1-3.

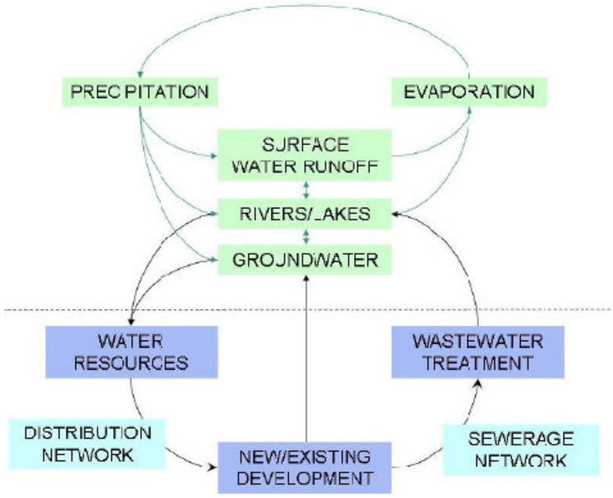

Figure 1-2 – The Wider Water Cycle

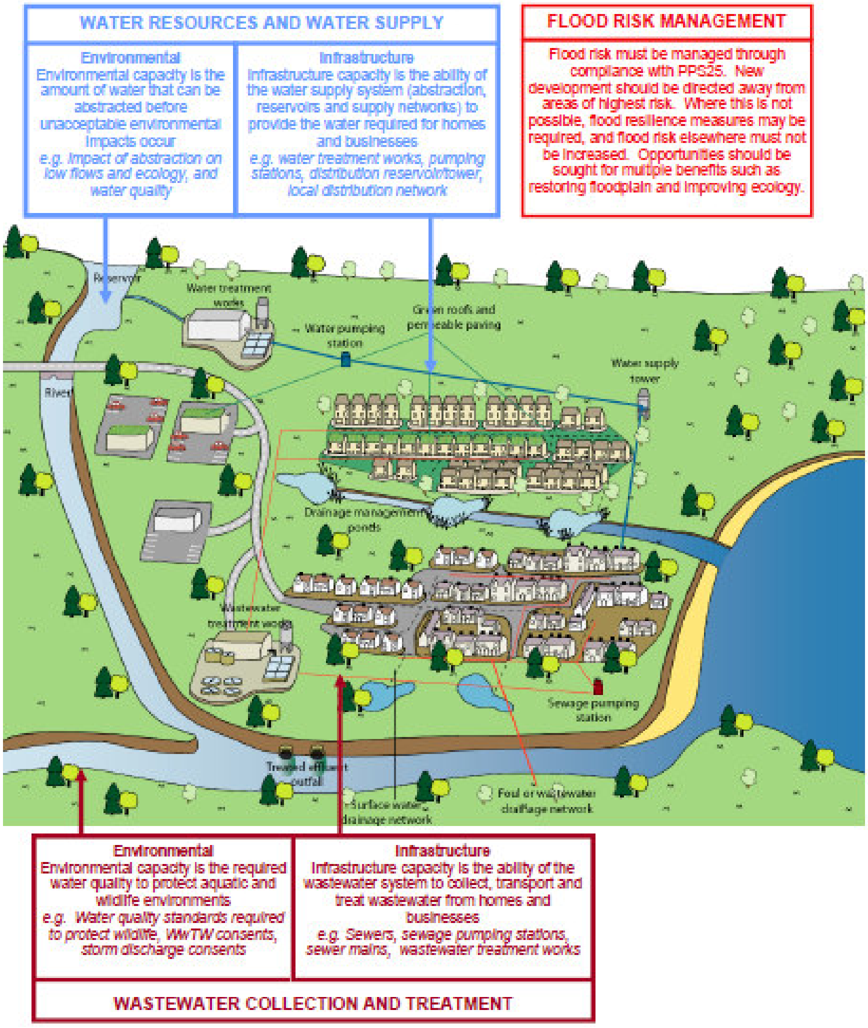

Figure 1-3 – The Wider Water Cycle schematic[2]

1.6 Current Funding

Asset Management Periods (AMP) are five yearly cycles that look at the improvement and upgrade works required for water company assets. The current AMP is AMP 5 (2010-2015).

[2] http://publications.environment-agency.gov.uk/pdf/GEHO0109BPFF-e-e.pdf , Environment Agency

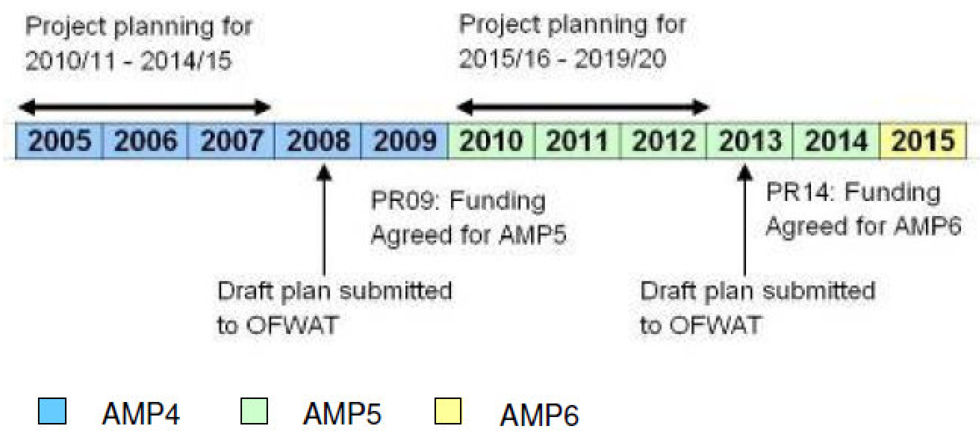

Figure 1-4 - AMP cycle[3]

Figure 1-4 illustrates the AMP5 process to 2015. This may dictate the constraints on capital project planning and funding that could influence the phasing of the planned development. Therefore, it is essential that the future infrastructure requirements are accurately factored into the water companies' AMP proposals to accommodate the proposed growth in the District.

Water companies have a duty to supply potable water to customers under Section 52 of the Water Industry Act 1991, and are hence obliged to connect developments to the network once planning permission has been received.

Under Section 106 of the Water Industry Act 1991, developers have the right to connect to a nearby sewer once planning permission has been received; subject to the provision that surface and foul water systems are not combined where a separate sewerage system exists. Currently, this law makes no allowance for the existing capacity of the sewerage network.

Where there is no existing local infrastructure in the locality of a development, or the route of such infrastructure would be required to cross land owned by a third party, the provision of water and wastewater services to new homes is subject to the requisitioning process described in sections 90 to 99 of the Water Act 2003. The difference between the costs of infrastructure upgrades (including reinforcement to the existing network to ensure adequate capacity) and the predicted revenue from the new customers can be passed onto developers from water companies using Requisitioning Agreements. The amount charged is referred to as the "relevant deficit", and can be paid over a 12-year period, or immediately following the work as one lump sum discounted to a net present value.

The process ensures that water companies do not make a loss when connecting new developments into their networks. However, the majority of the capital funding required for major strategic infrastructure would be sourced from the expenditure approved by Ofwat.

[3] Adapted from Rye Meads Water Cycle Strategy Scoping Report; EA, August 2007

2 SITE DESCRIPTION

2.1 Site Location and Description

The proposed eco development would cover 345 ha of primarily agricultural land. The site is located approximately 2 km to the north west of the existing town of Bicester, as shown in Figure 2-1. The site is located north of the A4095, which forms the current boundary of the town, west of the B4100 and east of the B4030. The village of Bucknell lies to the north.

The Exemplar Site is situated at the northeast end of the development and covers an area of approximately 21.1ha.

Although the site is largely greenfield, it includes some existing development, including: Lovelynch House, Himley Farm, Gowell Farm, Aldershot Farm , the police depot, Lord's Farm, Hawkwell Farm, Crowmarsh Farm and Home Farm. The site is bisected by both Bucknell Road and the railway line to Bicester.

Within the site there are several watercourses, including the River Bure and its associated tributaries, field drains, ponds and springs. The River Bure flows in a southerly direction from Caversfield House to a culvert beneath the A4095 and into Bicester. A tributary, flowing in an easterly direction from Bucknell, converges with the River Bure downstream of Home Farm. A further tributary flows in an easterly direction from Crowmarsh Farm and converges with the River Bure a short way upstream of the A4095 culvert.

There is a field drain south of Gowell Farm flowing in a southerly direction to a culvert under the A4095. There are several ponds within the site boundary, most notably at Crowmarsh Farm and south of Himley Farm. A spring is shown to occur east of Himley Farm.

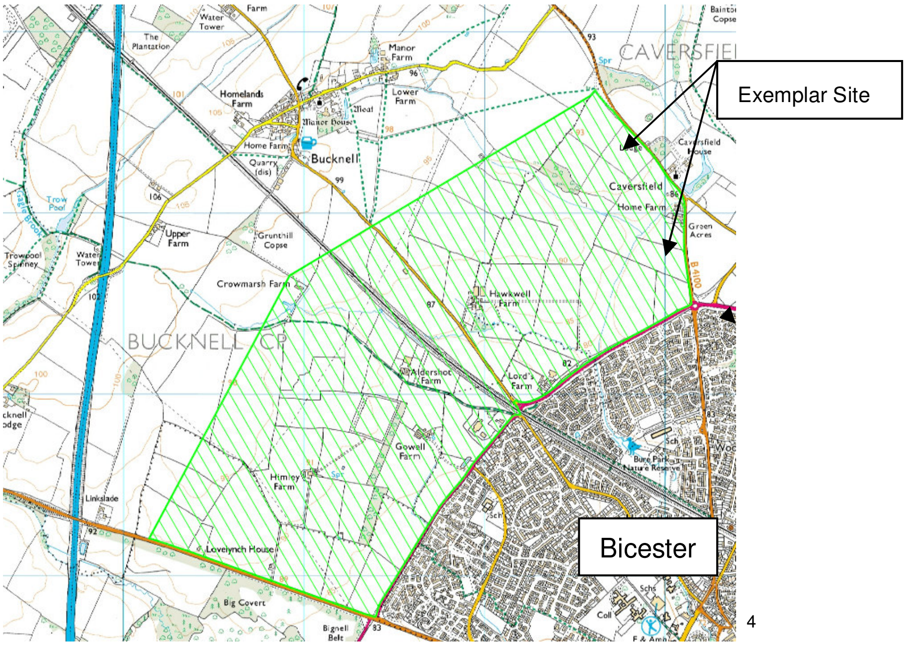

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Figure 2-1 - Site location

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[4] Crown Copyright – all rights reserved.

2.2 Study Area

This study focuses on the eco development and the first phase, exemplar site. However, to understand the context of the site, it needs to be assessed in relation to its position within the wider catchment area.

The site lies within Cherwell District in the northeast of the County of Oxfordshire. The District is predominantly rural in nature with a large number of smaller villages and lies within an area referred to as Cherwell Villages South.

The villages include Ambrosden, Ardley, Arncott, Blackthorn, Bucknell, Caversfield, Chesterton, Cottisford, Duns Tew, Finmere, Fringford, Fritwell, Godington, Hardwick with Tusmore, Hethe, Launton, Lower Heyford, Middle Aston, Middleton Stoney, Mixbury, Newton Purcell with Shelswell, North Aston, Piddington, Somerton, Souldern, Steeple Aston, Stoke Lyne, Stratton Audley, Upper Heyford and Wendlebury.

Bicester is centrally located to the larger urban areas of Oxford, Banbury, Milton Keynes and Aylesbury.

The Oxford-Bicester-Milton Keynes area has a high demand for housing and is experiencing large-scale urban expansion. The District is consequently under continuous development pressure due to its location in this growth area, and its proximity to London and the M4 corridor.

Figure 2-2 has been taken from the NW Bicester Eco-town concept study undertaken by Halcrow[5] and shows the context of the site in relation to Bicester.

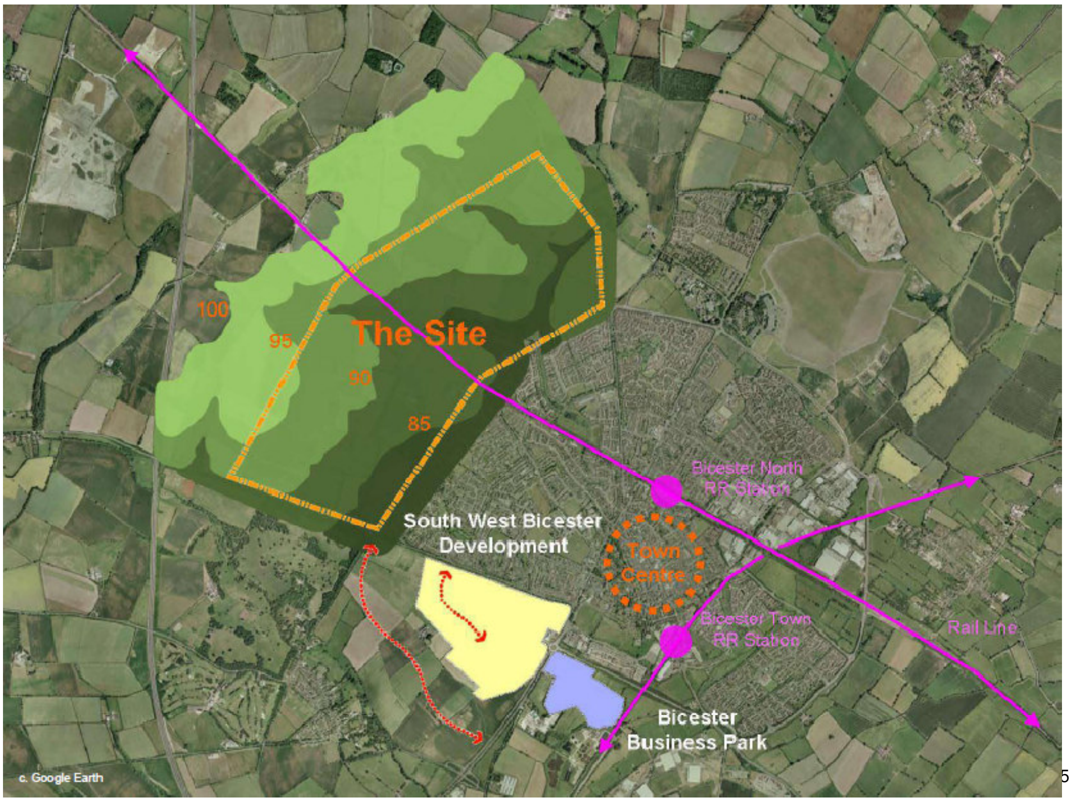

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Figure 2-2 – Site Context

[5] NW Bicester Eco-town Concept Study prepared for Cherwell District Council, Halcrow, February 2009

Ardley Trackways Site of Special Scientific Interest (SSSI) consists of a series of working quarries near the village of Ardley, about 4 km northwest of Bicester and to the west of the site. The SSSI lies near the Gagle Brook but upstream of the eco development. The quarries have been designated for geological reasons, and contain fossilised dinosaur tracks.

Stratton Audley Quarries are noted on the Nature England online as having been destroyed. They lie to the north east of the site, beyond Caversfield.

Downstream of Bicester, the Wendlebury Meads and Mansmoor Closes SSSI bound the River Bure near to the confluence with the River Ray, and influences in the upstream catchment could have an influence on these SSSI's.

Between 2006 and 2031 Cherwell's total population is expected to increase by 24%, as indicated within Table 2-1, with the population group aged 75 and over expected to grow by 110% over the same period[6].

Table 2-1 - Cherwell Demographics

Population by Age and Gender						
	2006		2016		2031	
	000's	%	000's	%	000's	%
0-4	8.7	6	9.8	7	10.1	6
5-14	17.3	13	17.7	12	19.7	12
15-24	15.9	12	16.2	11	17.9	11
25-59	69.4	51	73.3	49	75.5	44
60-74	16.9	12	21.8	14	24.7	16
75 and over	9.2	7	11.8	8	19.3	11
Total (All ages)	**137.4**	**100**	**150.6**	**100**	**169.9**	**100**

Population by Settlement		
	2006	
	000's	%
Banbury	43.0	31
Bicester	30.0	22
Kidlington	15.5	11
Rural Wards	48.9	36
Total	**137.4**	**100**

Water resources in Cherwell are already limited and demand from new housing development in the district may have to be met from outside the Cherwell catchment area[7]. The population expansion in this District combined with the influences of climate change would exacerbate water supply and drainage issues, highlighting the need for water neutral development.

Cherwell's rivers have consistently been assessed as poorer in chemical quality than rivers in other districts in Oxfordshire[7]. The eco development proposals would ensure that water quality would not be adversely affected, and would aim to improve water quality where possible.

[6] Source: ONS population estimates and projections. The standard date selected for population data is 2006 as this is the base date for the ONS population. Tables taken from Living in Cherwell, Executive Summary, Cherwell District Council, July 2009.

[7] Living in Cherwell, Executive Summary, Cherwell District Council, July 2009

The site lies near to the watershed between the Gagle Brook and the River Bure, which runs in a northwest-southeast direction. The following watercourses are relevant to the site:

- **Gagle Brook** – The Gagle Brook runs in a southwesterly direction from the Ardley Trackways SSSI, before flowing southeast, past the southern boundary of the site, and continuing towards Chesterton. The Gagle Brook is an ordinary watercourse.
- **River Bure** – The River Bure and its tributaries cross directly through the site before their confluence into a single channel at the A4095 Lord's Lane. The River Bure then flows into Bicester in a southeasterly direction, where it is split into the urbanised Back Brook and Town Brook. The River Bure is a tributary of the Ray, Cherwell and ultimately the Thames.
- **Pingle Brook** – The Pingle Brook flows eastwards through the south of Bicester. It is an Environment Agency main river and confluences with the River Bure before its confluence with the Langford Brook.
- **Langford Brook –** The Langford Brook flows in a southwesterly direction through the eastern edge of Bicester and confluences with the River Bure south of Bicester. The Wastewater Treatment Works for Bicester is located a short way downstream of the confluence.

The local tributaries of the River Bure on the site and included within the study area are:

- The stream flowing in an easterly direction from its source at the north western boundary of the site to its confluence with the River Bure at the A4095
- The channel that collects surface water runoff from Bucknell and flows in a southerly direction to meet the River Bure south of Home Farm.

The drainage strategy for the Eco Development recognises that the northern part of the development would drain to groundwater and directly into the River Bure and its on-site tributaries while the southern part of the site would discharge to groundwater with a sewer network which outfalls to the Pringle Brook, or into the Gagle Brook. The Exemplar site is located in the northern part of the development.

The catchment study area for the eco development consequently includes the River Bure and the Gagle Brook, which are shown in Figure 2-3 overleaf.

Figure 2-3 has been taken from the Flood Estimation Handbook CD ROM and shows the locations of the main watercourses within the Bicester area in relation to the larger urban centres.

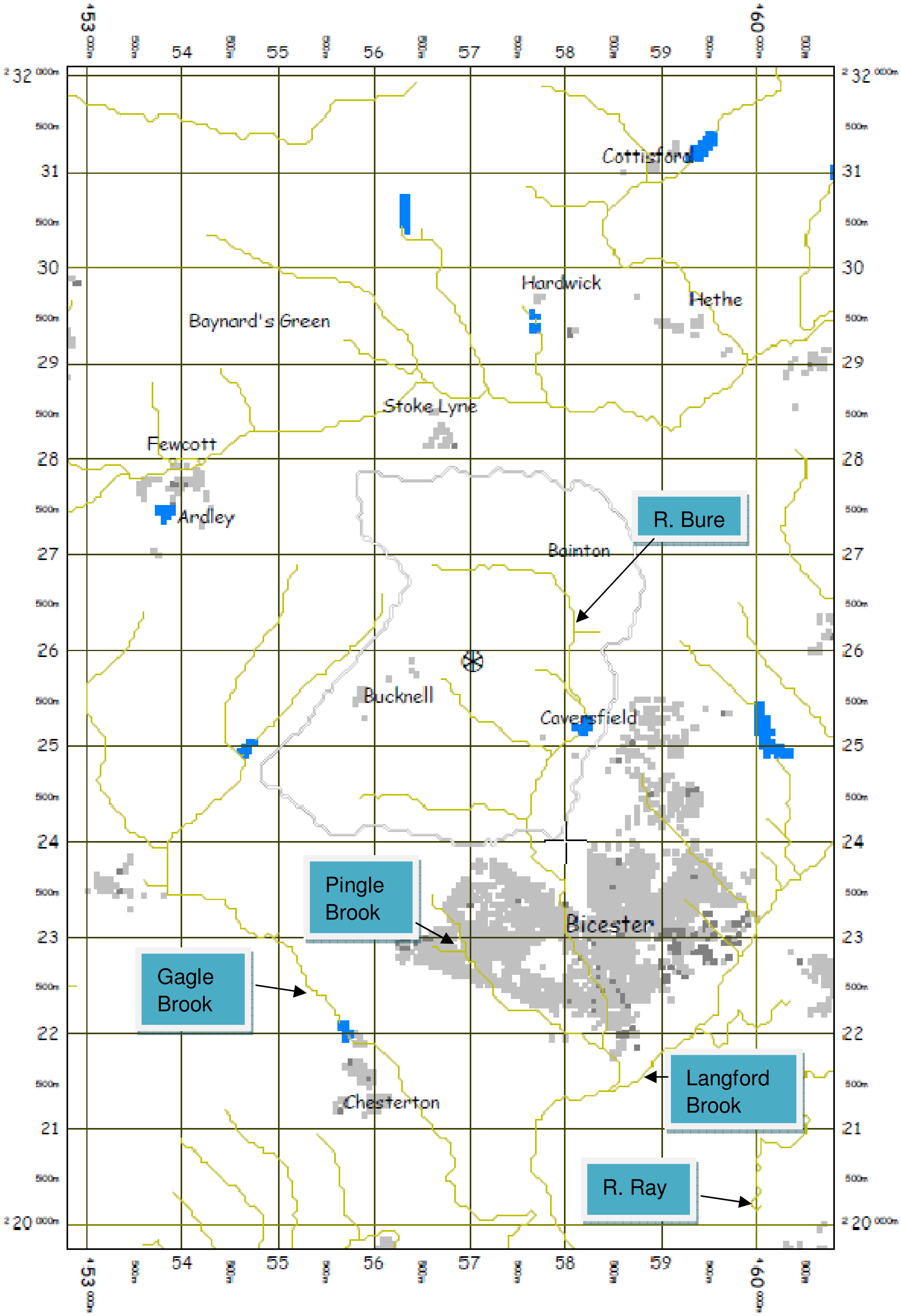

Figure 2-3 – FEH catchments

3 PLANNING POLICY

3.1 Planning Context

The following sections introduce a number of national, regional and local policies that must be considered by the Planning Authority, water companies and developers within the District. Key extracts from these policies relating to water consumption targets and mitigating the impacts on the water environment from new development are summarised below.

3.2 National Planning Policy

3.2.1 Planning Policy Statements

Planning Policy Statements (PPS) and some Planning Policy Guidance Notes (PPG), which have not yet been superseded by PPS, are national planning documents that are intended to guide Local Authorities on planning policy. Local Authorities should ensure that planning documents consider these policies, and may be able to use some of the policies contained within PPS to make decisions on individual planning applications.

The most relevant PPS to this WCS are:

- PPS1: Delivering Sustainable Development (and the 2007 Supplement entitled Planning and Climate Change);
- PPS: Eco-towns – A supplement to PPS1;
- PPS3: Housing;
- PPS9: Biodiversity and Geological Conservation;
- PPS12: Local spatial Planning;
- PPS23: Planning and Pollution Control; and
- PPS25: Development and Flood Risk.

Relevant topics that consistently occur within the above-mentioned PPS are:

- Resilience to climate change;
- Conservation / biodiversity;
- Sustainable use of resources;
- Mitigation of flood risk and the use of SUDS;
- Suitable infrastructure capacity; and
- Protection of groundwater and freshwater.

Key extracts from the above PPS are included in Appendix A.

3.2.2 The Code for Sustainable Homes

The Code for Sustainable Homes (CSH) was introduced in England in April 2007. The code sets a framework and acts as a tool for developers to create homes to higher environmental standards than previously. All new residential property would be required to meet minimum levels of sustainable performance with the required minimum level rising until 2016.

The CSH Levels require different levels of performance regarding water use, particularly per capita consumption (PCC). These are:

- Levels 1/2 – 120 l/p/d;
- Levels 3/4 – 105 l/p/d; and
- Levels 5/6 – 80 l/p/d.

The timetable for the implementation of the CSH requires that new homes be built to Level 3 from 2010 onwards and Level 6 from 2016[8].

The proposed target for the eco development is 80 l/p/d.

3.2.3 BREEAM

Non-residential property such as schools and commercial premises are likely to be specified in accordance with and assessed using BREEAM (BRE Environmental Assessment Method), and to be designed to the highest standards recommended within. BREEAM sets targets for water use and flood risk depending on type of property and awards credits against the level achieved.

For example, for educational establishments, credits can be achieved for the following:

- Potable water consumption of less than 1.5m^3 per person per year;
- Low flow fittings for taps, urinals and showers;
- Installation of water meters and a major leak detection system;
- Motion detectors and sensors in washrooms;
- Rainwater and greywater recycling;
- Efficient exterior irrigation systems; and
- Use of SUDS to minimise flood risk.

3.2.4 Building Regulations

The Building Regulations prescribe the required performance of new dwellings (and alterations to existing dwellings) in England and Wales. Revisions to Part G of the Building Regulations (sanitation, hot water and water efficiency) came into effect on 6 April 2010. This requires new buildings to achieve a minimum calculated whole building performance (PCC of potable water) of 125 l/p/d[9]. This is equivalent to CSH Levels 1 and 2, with an additional allowance of 5 l/p/d for outside use.

This would be reinforced with amendments to the Water Supply (Fittings) Regulations 1999, which set performance levels for individual fittings.

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[8] Greener homes for the future, CLG, 2008

[9] The Buildings Regulations 2000 – Approved Document G, HM Government, 2010

3.2.5 Future Water

The UK Government's strategy for water in England is described in Defra's Future Water[10] document. This strategy sets out an aspirational target for average PCC, across all dwellings, of 130 l/p/d. Defra predict this target can be achieved by 2030 through a combination of water efficiency and demand management measures, such as installation of low consumption appliances and fittings within new and existing homes, and changes in metering and tariffs to encourage water-economy. Defra suggest that 120 l/p/d may also be achievable dependant on new technological developments and innovation.

3.2.6 Water for People and the Environment

In 2009 the Environment Agency published its strategy for managing water resources in England and Wales to 2050 and beyond, entitled Water for People and the Environment[11]. This strategy supports Defra's 130 l/p/d PCC target and shows that the average PCC for England and Wales could be reduced from around 150 l/p/d to close to 120 l/p/d by 2030. To achieve this, by 2020 the PCC for new dwellings would have to meet CSH Level 3 (105 l/p/d plus 5 l/p/d for outside use) and near universal metering of properties would be required in water-stressed areas.

The Environment Agency strategy concludes that the above demand management approach has the potential to be cost effective when compared to the development of new resources or desalination plants. The EA also suggest that, as metering becomes more widespread and incentives to use water efficiently increase, rainwater harvesting and grey water recycling systems would become more cost-effective and could play an increasingly important part in managing water resources in the future.

In addition, the EA strategy suggests that all planning applications for significant new housing developments should be accompanied by a water cycle strategy.

3.2.7 Flood and Water Management Act 2010

The Government's Flood and Water Management Bill (hereafter referred to as "the Bill") received Royal Ascent in April 2010.

One of the key inclusions within the Bill is legislation on Sustainable Drainage Systems. The Bill proposes:

- the production of National Standards for the design, construction, operation and maintenance of SUDS. The National Standards for SUDS would cover the need to mitigate flood damage, improve water quality, protect and improve the environment, protect health and safety, ensure the stability and durability of drainage systems; and address the cost-effectiveness of such solutions in different situations;
- the establishment of SUDS Approving Bodies (SAB) which would take the role of approving SUDS prior to their construction (bodies would be the relevant Unitary or County Council);

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[10] Future Water, Defra, 2008

[11] Water for People and the Environment, Environment Agency, 2009

- that Unitary/Country Councils would be responsible for adopting and maintaining SUDS for new properties which affect the drainage of other properties or for all SUDS in the public realm (although it appears maintenance function might be divested to the Local Authority);
- that approval for construction of SUDS would specify a “non-performance bond” which would be payable by the developer and withheld if it is later identified that the SUDS has not been constructed in accordance with approvals; and
- a requirement on developers to demonstrate that they have met national standards for the application of SUDS techniques before they can connect any residual surface water drainage to a public sewer.

3.3 Regional Planning Policy

3.3.1 Regional Spatial Strategy

Regional Spatial Strategies provided a regional level framework for the regions of England to inform spatial planning. They were introduced in 2004, but have since been revoked and consequently no longer apply.

3.3.2 Regional Economic Strategy

The South East of England Development Agency (SEEDA) produced the third Regional Economic Strategy (RES) for South East England covering the period 2006-2016[12].

One objective of the strategy is to promote Sustainable Prosperity Targets. Those relevant to this study include:

- Sustainable Consumption and Production - reduce per capita water consumption in the South East by 20% from 169 litres per day in 2003/04 to 135 litres per day by 2016; and
- Natural Resources and the Environment - achieve measurable improvements in the quality, biodiversity and accessibility of green and open space.

The RES states that new development must be supported by adequate and timely provision of environmental infrastructure, designed to meet the highest standards of design and sustainability. This includes water supply, water resource management, wastewater treatment, sewerage and surface water drainage capacity, and flood risk management. Importantly, this infrastructure must be provided in sufficient time for the phasing of major new developments.

In the RES, key drivers in achieving the reduced per capita consumption targets include behavioural changes, improved water efficiency standards in new development such as the eco development (including greywater systems), and innovation in technologies to improve water efficiency.

[12] The Regional Economic Strategy 2006-2016, A Framework for Sustainable Prosperity, SEEDA, 2006

3.4 Local Planning Policy

3.4.1 Cherwell District Draft Core Strategy

The vision for the Core Strategy is to achieve a sustainable balance between water supply and demand. Policies are being developed through the draft Core Strategy to make sure development:

- Addresses issues of water supply and sewage disposal;
- Reduces the consumption of energy and water, minimizes the production of pollution and waste and incorporates facilities for recycling water and waste; and
- Reduces flood risk – Cherwell District Council would seek to allocate development beyond the floodplain. Flood risk assessments would be required for appropriate sites and management sought.

Development would be directed to areas of lowest flood risk in accordance with the sequential approach in PPS25. It should be noted that the Sequential Test has not yet been completed. However, based on existing and proposed development locations available at the time of writing, the following comments can be made regarding potential Level 2 SFRAs.

Within the Cherwell District, Level 2 SFRAs may be required for Bicester and Kidlington as outlined below:

- At Lords Lane Bicester, there are two watercourses flowing through areas of potential development. Flood risk is defined for the Northern watercourse through EA broad-scale mapping, but there are no Flood Zones defined for the western watercourse. The Level 2 SFRA would address this data gap.

4 FLOOD RISK AND DRAINAGE

4.1 On-site Space Constraints

The constraints relating to the water environment are shown on Drawings 7007 and 7019 within Appendix B. This includes flood plains, river maintenance strips, ponds, springs and surface water attenuation features.

For the watercourses on the site, the Environment Agency requires a buffer strip of 8m from the top of each bank to facilitate channel maintenance and to provide a buffer strip.

Sufficient space should be allowed for surface water balancing ponds and other SUDS features.

Development should only take place in Flood Zone 1, and hydraulic modelling of the local watercourses should be undertaken to better define the areas prone to flooding.

Any ground raising within the floodplain would need to be compensated for on a level for level basis.

4.2 Hydrogeology

There are several springs within the site. Development around these areas should preferably be avoided and enhanced public open space should be designed with these incorporated.

4.2.1 Source Protection Zones

Source protection zones identify areas of abstraction from groundwater and the catchment for these abstraction points, and as such the areas where influences on groundwater could affect water supply.

The Environment Agency Source Protection Maps have been consulted, and no source protection zones are shown either on or within the vicinity of the eco development.

4.2.2 Aquifers

To protect groundwater, different types of aquifer have been defined by the Environment Agency, including underground layers of water-bearing permeable rock or drift deposits, which would typically have the potential for water abstraction.

The Environment Agency has updated the aquifer designations in line with the Water Framework Directive, based on British Geological Survey geological mapping. Aquifer designations include:

- Superficial (Drift) - permeable unconsolidated (loose) deposits e.g. sands and gravels; and
- Bedrock -solid permeable formations e.g. sandstone, chalk and limestone.

Figure 4-1 and Figure 4-2 show that secondary aquifer designations are present on the site, both in superficial deposits associated with the watercourses (which broadly mirror their courses), and in the bedrock. Secondary aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale.

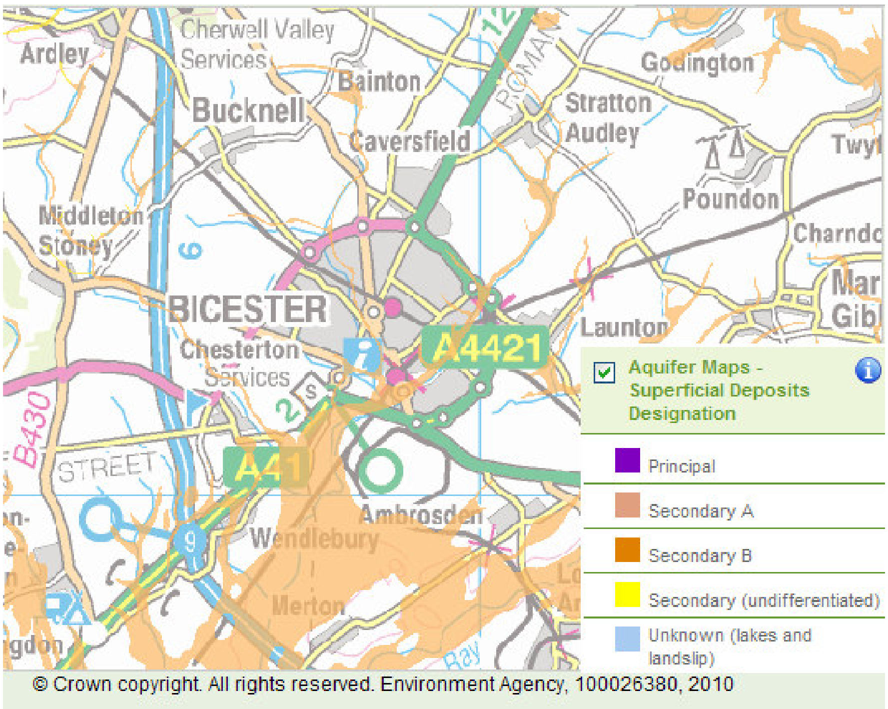

Figure 4-1 – Superficial Deposits Designation

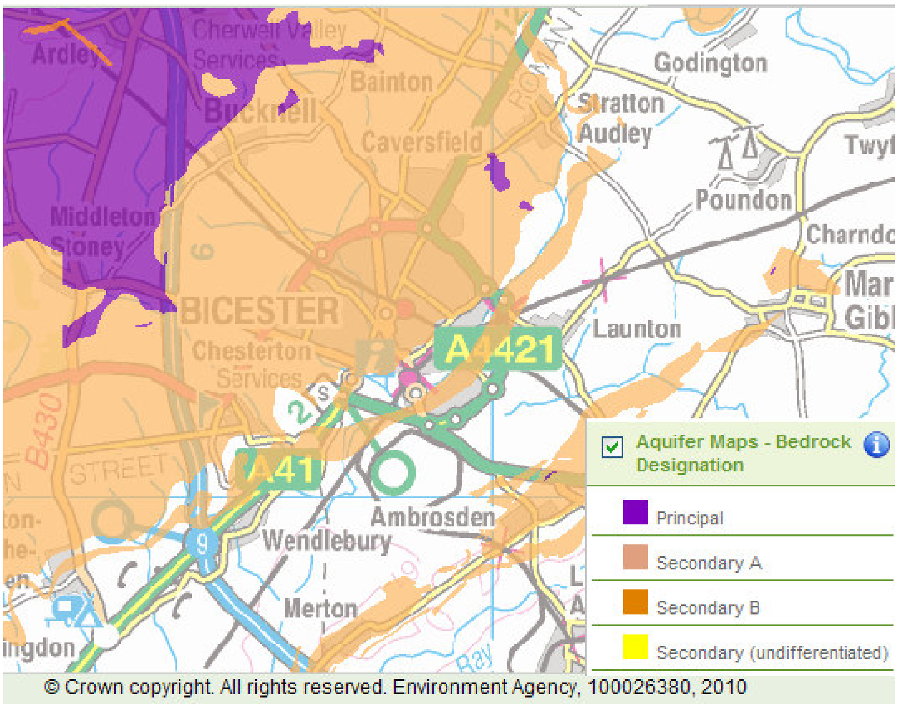

Figure 4-2 - Bedrock Designation

To the north west of the site, the watershed of the River Bure and Gagle Brook and follow the transition between the principal and secondary aquifers in the underlying limestone bedrock. The principal aquifer within the Gagle Brook catchment has the designation of being able to provide a high level of water storage and may support water supply on a strategic scale.

The viability of discharging surface water from the development via ground infiltration has been tested as part of the site investigation. Tests were completed in accordance with the requirements of BRE365 (Soakaway Design, March 2007, Building Research Establishment) and used to derive ground infiltration rates across the development.

Trial pits on the site confirm the presence of the limestone bedrock on the site, with weathered limestone and limestone bedrock being encountered between 0.6 to 1.9 m below ground level.

Soakage tests undertaken during the ground investigation returned soakage rates of between 56 and 180mm/hr, which would be sufficient to allow infiltration drainage, subject to suitable protection of the groundwater from contaminants through appropriate treatment. All trial pits encountered the limestone bedrock or weathered limestone, and no ground water was recorded[13].

4.3 Exemplar Fluvial Flood Risk

The fluvial flood risk to the site has been assessed by creating a site specific hydraulic model for both the Baseline conditions and the Post Development conditions.

4.3.1 Baseline Conditions

The EA flood maps that cover the site are based upon coarse DTM and JFLOW modelling and as such do not take account of the impacts of climate change. The flood maps are therefore not suitable for use within a Flood Risk Assessment to determine the extents of flood zones in relation to building locations and associated finished floor levels. Detailed hydraulic modelling has therefore been undertaken.

The hydraulic model predicts that floodwater would generally be confined to the localised valleys in which the watercourses flow, with ponding occurring at confluences and upstream of constricting structures. The model has not predicted any occurrences of overland flow.

Figure 4-3 shows the modelled flood extent for the exemplar site for the 100-year and 1000-year events (i.e. Flood Zones 3 and 2 respectively). Flooding occurs predominantly on the flatter land around the confluence between the River Bure and the northernmost of the two tributaries. Away from the confluence, flooding is confined to the relatively narrow valley of the watercourse.

[13] Soakage tests undertaken in August 2010

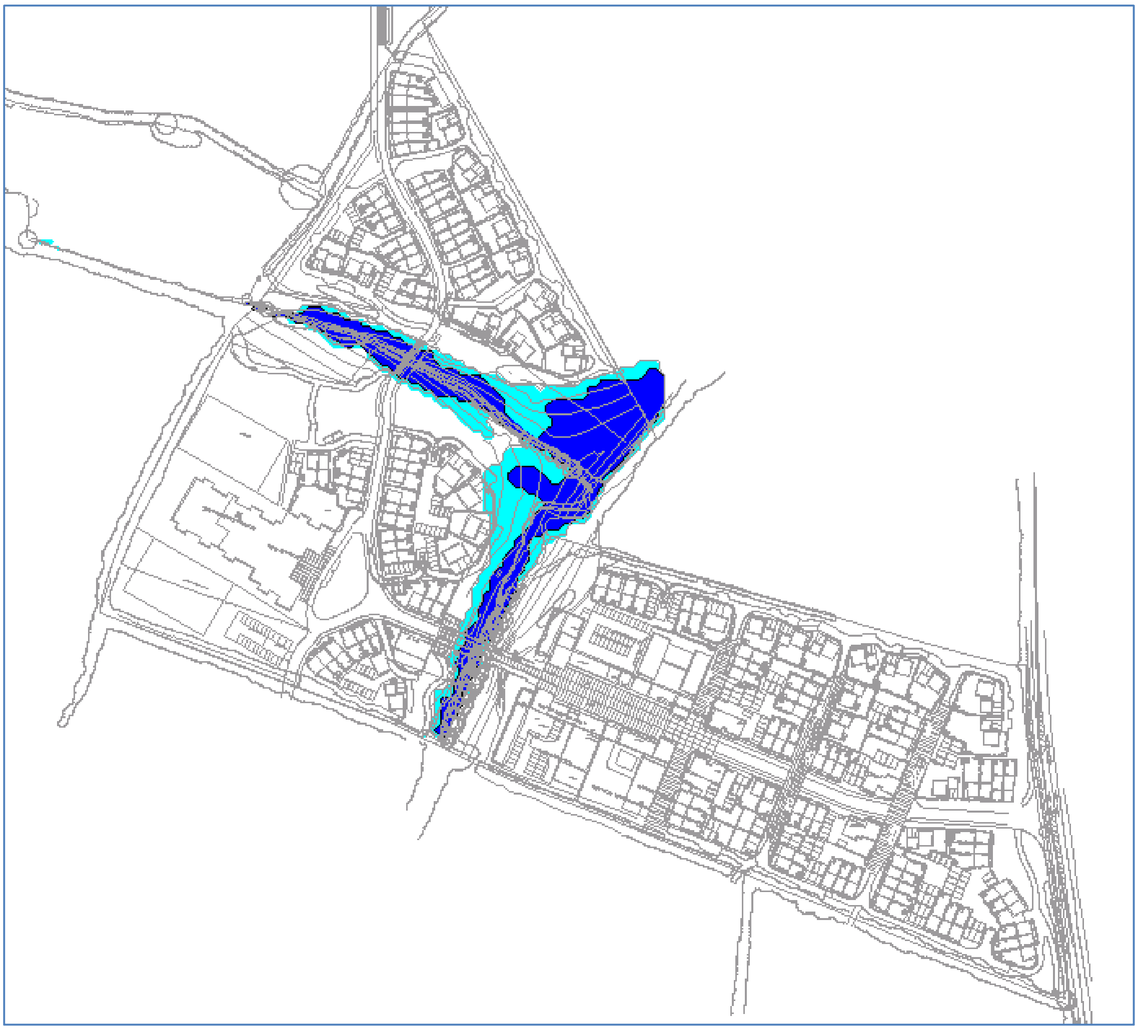

Figure 4-3 – Modelled flood extents for Exemplar Site

Figure 4-3 shows that the flooding only impacts on green space within the development, and no buildings are affected by flood water. Without the proposed modification to topography (proposed as the Post Development condition) a small section of residential gardens and roads to the west of the River Bure confluence would be impacted by the 1000-year event and therefore be within Flood Zone 2. However, the proposed modification to topography shown in Figure 4-5 will remove this small risk, as discussed in section 4.3.2 below.

4.3.2 Post Development Conditions

The proposed development for the Exemplar Site includes changes to riparian corridor which consists of the removal of an existing bridge structure, the addition of two large bridge structures where new roads cross the watercourse, and reshaping of the riparian corridor. These alterations have been done to improve the multi-functionality of the riparian corridor to meet wildlife, landscape and conveyance objectives. Figure 4-5 below highlights the key changes for modelling. Post-development modelling was undertaken to determine the impact of the riparian corridor on flooding in the area and ensure that any development continued to be out of the flood zones.

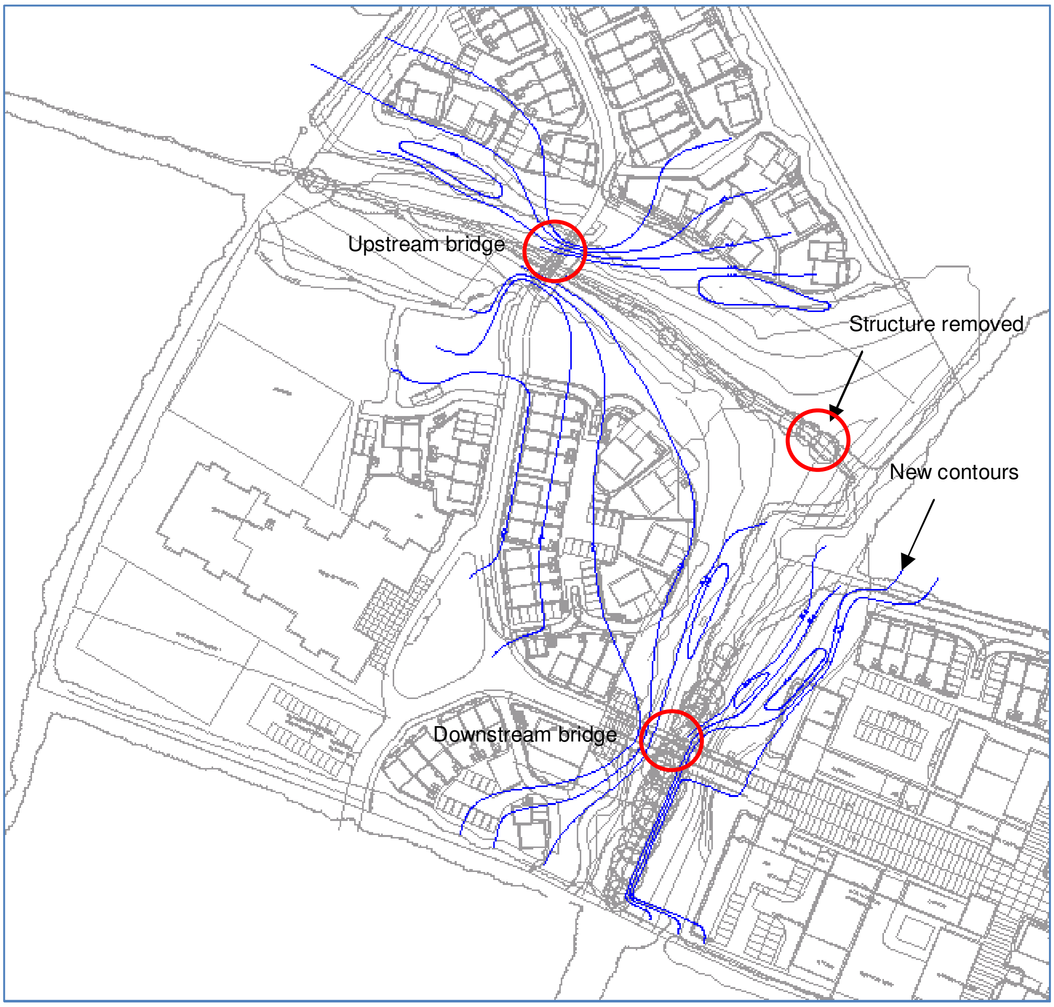

Figure 4-5 Post Development condition – changes to the riparian corridor changes

Figure 4-6 overleaf shows the change in flood extent caused by the proposed development for the 1000-year flood event, where the revised baseline is shown in blue and the post-development extent in black.

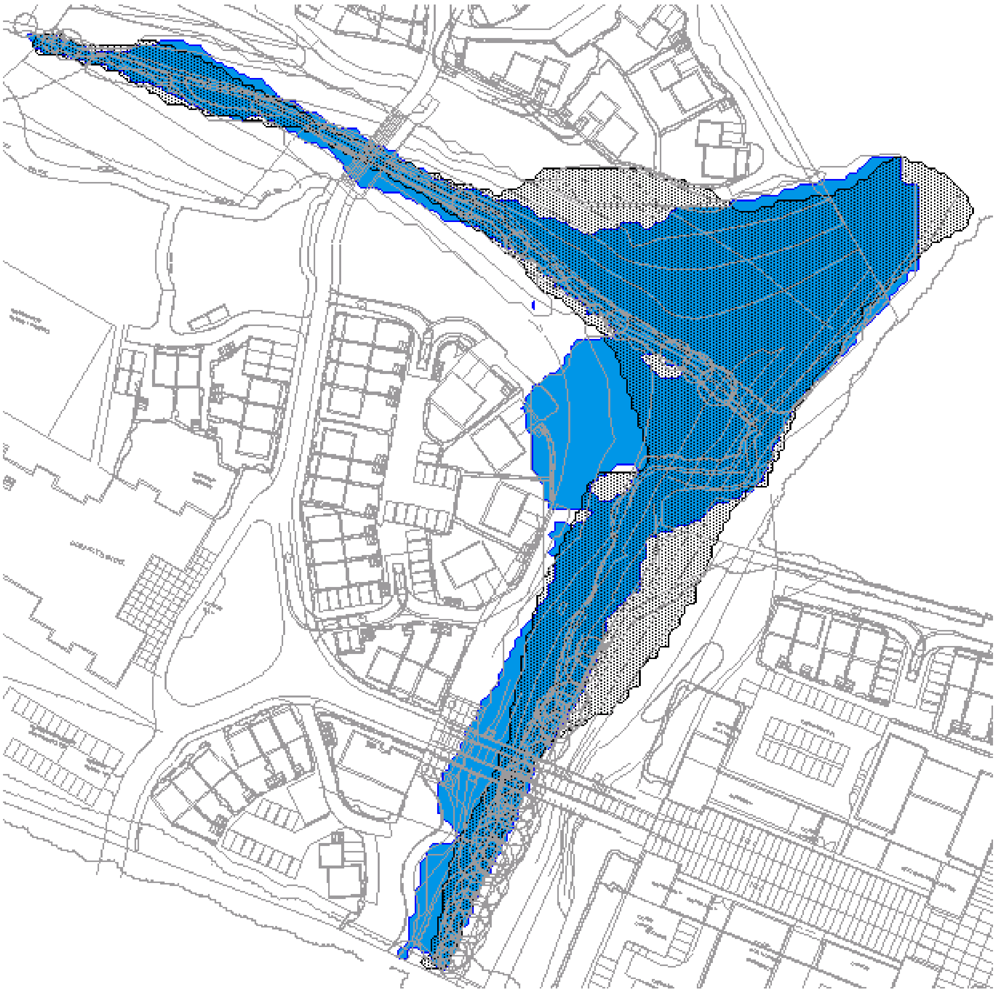

Figure 4-6 Post-development extent comparison

This shows that around the proposed bridge on the tributary, the contouring and bridge structure have little impact on the modelled flood extents. Downstream of this area, the re-contouring causes additional flooding on the open space on the left bank, but this does not threaten the proposed development. At the confluence with the River Bure, the re-contouring has significantly reduced the flood extent on the western side of the confluence, removing the area of flooding that had impacted on gardens and roads in the proposed development. Downstream of this area, the landscaping associated with the second bridge has decreased the flood extent at the bridge location and downstream, but increased the flood extent upstream of the bridge on the left bank of the River Bure. This also does not threaten the proposed development.

The model results have confirmed that the proposed development site is predominantly located within the Low Flood Risk Zone, with small areas of Medium and High risk around the watercourses. All proposed development has been located within the areas of Low risk, and therefore the development is considered to be at **low** risk of flooding from fluvial sources.

4.3.3 Proposed Fluvial Flood Risk Management

Flood Protection

Due to PPS1 restrictions on the siting of development in an Eco-Town, all of the buildings in the proposed development would be sited in Flood Zone 1. Therefore, no flood protection or mitigation measures would be necessary on the site.

A comparison of modelled velocities through the development reach has shown increases in velocities in the reaches around both proposed bridges. Figure 4-7 shows the areas of increased velocity on the proposed development plan.

Figure 4-7 Reaches showing increased velocity

Some of the increases in velocity shown are potentially significant, with velocities at the downstream bridge increasing by approximately 40 - 60%. This has the potential to cause scour in the areas around the bridges, therefore scour protection has been incorporated into the design of the riparian corridor.

Third Party Flood Risk

The proposed development causes no significant change in flood extents, levels or velocities downstream of the development site.

All development would be sited within Flood Zone 1 and any roads crossing watercourses would have culverts adequately sized to cause no restriction on flow. Therefore, no loss of floodplain storage would be caused by the proposed development. Any increased surface water runoff caused by the development would be attenuated to Greenfield rates (see Section 4.4). Therefore, there would be **no change** in third part flood risk as a result of the development.

Site Access and Egress

As stated earlier, all development would be sited within Flood Zone 1 and any roads crossing watercourses would be raised above flood levels and have culverts adequately sized to cause no restriction on flow. Therefore, emergency access routes would not be affected by flooding.

4.4 Surface Water

4.4.1 Baseline Conditions

The site discharges predominantly through the following mechanisms:

- Ground Infiltration - water seeps into the ground and contributes to aquifers and ground water reserves;
- Surface Water Runoff – water that does not infiltrate runs along the surface, combining to form surface water features such as streams, rivers and ponds; and
- Evaporation and Transpiration – water evaporates from surfaces or is taken up by plants and released back to the atmosphere through transpiration.

Surface water runoff across the site flows largely at greenfield rates to the local watercourses, with the potential for localised ponding to occur in small low-lying areas. When antecedent moisture contents in the soil are lower, more rainfall is expected to infiltrate, and in wetter months a greater proportion of rainfall would translate into surface water runoff. The percentage runoff would also increase in longer and more intense storms.

Increasing the impermeable areas of the site would influence this natural process, with less water being able to infiltrate and more surface water runoff being generated.

4.4.2 Drainage Areas

The site can be divided into three drainage areas for discharging surface water runoff:

1. The north of the site can be divided into three smaller sub-catchments, all discharging to the River Bure and on-site tributaries;
2. The area south of the railway line falls to the southeast and drains towards the urban edge of Bicester. This area is expected to ultimately drain into the Pringle Brook;
3. The most southerly area of the site falls to the southeast and drains towards the urban edge of Bicester and the Gagle Brook to the south of the town. This area is expected to drain into either the Pingle Brook or the Gagle Brook. Both watercourses ultimately discharge into the Bure downstream of Bicester.

The Exemplar site is located in Area 1.

4.4.3 Proposed Surface Water Drainage Systems

There are several surface water features within the site; these consist of ponds, open channels and ditches. The ponds should ideally become a focus of the area and enhanced.

The development would be designed to mitigate flood risk from surface water through use of SuDS, comprising a system of devices designed to manage both the quality and quantity of surface water runoff. The system would be used in conjunction with effective site management to prevent flooding and pollution.

The SuDS strategy would be primarily based on discharge via ground infiltration alone, in accordance with the drainage hierarchy, minimising surface water discharges to nearby watercourses and the risk of flooding due to surface water. The SuDS strategy takes a conservative approach to infiltration and appropriate spaces have been set aside for open attenuation features within the site layout.

Discharge by ground infiltration alone has been proposed wherever possible. Testing indicates that some areas are likely to be suitable for a wide variety of infiltration structures and others suitable for shallow structures only. Therefore, where drainage is too deep to permit ground investigation, the area would be required to discharge to a nearby watercourse.

PPS25 advises that a key component of SuDS is that drainage infrastructure should be spread across a site and discharge close to the source of runoff, mimicking the natural diffuse nature of greenfield site drainage (source control). A variety of forms of soakaway would therefore be proposed across the site where appropriate to suit the particular location requirements. Each of these would collect and discharge surface water from nearby buildings and paved areas.

Soakaways have not been considered as feasible in areas of shallow impermeable stratum such as rock or clay, where soakage cannot be achieved. At such locations, surface water runoff would be stored in suitable attenuation structures, such as basins, and discharged to local watercourses at controlled rates.

SuDS can be formed from many potential components, each having a variety of attributes and strengths which make them suitable or unsuitable for use in differing situations. SuDS systems often comprise chains of linked SuDS components which complement one another and can be combined to form the optimal solution for each situation, often referred to as treatment trains.

The critical requirements of the SuDS system are to control water quantity and improve water quality. A number of treatment trains that meet the criteria would be proposed that each meet the required hydraulic and water quality requirements.

Attenuation measures would be located both amongst the built up areas at source, and within the public open spaces adjacent to the development areas. Building layouts and road geometry should also be minded to the natural topography to allow surface flow to be routed away from sensitive receptors.

The SUDS within the drainage network would be responsible for reductions in the total volume of run-off discharging from the development, albeit that their performance would depend on the time of year, prevailing climatic conditions and the underlying ground conditions. If ground conditions do not allow for infiltration of any increased volume of surface water runoff generated by the site, extended attenuation storage is considered appropriate for the development. This requires that the maximum discharge rate is reduced to QBAR (mean annual return period) for all events.

To limit the potential for sewer flooding within the development, run off from developed areas would be initially attenuated at source where possible using SUDS measures such as rain gardens, online swales, permeable paving with storage in the aggregate base and ponds.

Any locations where the use of SUDS systems are unable to prevent sewer flooding in events in excess of the 1 in 30 year event, flood flows would be routed overland (using the roads where possible) and conveyed into the structural landscape away from vulnerable development where for attenuation. The complete drainage system would be tested to ensure that no flooding of properties occurs in the 1 in 100 year storm event, including an allowance for climate change.

Surface water drainage systems would be designed in accordance with 'Sewers for Adoption'. These would cater for the design event (either the 1 in 2 or the 1 in 5 year events) with no surcharge and the 30 year event with no on surface flooding. Any underground storage required within the system to attenuate the 1 in 30 year event to prevent flooding should be sited within the system being offered for adoption.

4.4.4 Storage Structures

A variety of storage structures could be used at the site to provide attenuation storage, including ponds, basins and cellular storage.

Attenuation ponds and basins would incorporate shallow planted benches, about 0.3 m deep, around the perimeter for safety reasons and to provide a ledge for aquatic planting. Ponds could also incorporate a shallow wetland fringe with depths varying between 0 - 0.3 m. The wetland fringe areas would be inundated relatively frequently during a normal rainfall year. This would be achieved by appropriate design of the pond outfall structure.

The design of ponds should aim to both maintain a minimum water level and accommodate a maximum water level required for attenuation storage. Where possible the embankments surrounding the pond should be relatively gentle (no steeper than 1 in 3 batters).

The Environment Agency advises that they usually allow approximately 25 mm/week for evaporation loss in the summer. Consequently, during prolonged dry periods the water level in the ponds would be expected to fall. This is expected to encourage the development of marginal vegetation around the fringes of the ponds, and is not expected to be of concern unless fish are proposed.

Ground investigations would need to be carried out in the proposed pond locations, with each pond being assessed on an individual basis given the variability in local ground conditions. These investigations would confirm the need for liners in all ponds with permanent water.

As well as attenuating flows, the ponds can improve the quality of surface water discharges. Vehicle access should be provided to the ponds and the inlets/outlets so that maintenance can be carried out and sediment can be removed. Appropriate barrier planting should then be incorporated in other areas to discourage access.

The landscape corridors should also be aligned with the natural overland flow path and directed towards the ponds, basins and other storage structures.

4.4.5 Use of Open Green Space for SUDS

The form of upstream sustainable drainage measures would include swales, open channels, sewers, wet and dry pond storage, and bio-retention areas. It would be possible for these natural areas to be landscaped to Accessible Natural Greenspace Standards (ANGSt) such that they represent usable open amenity spaces. It is envisaged that requirements of the drainage / flood strategy would result in the areas generally lying within 400m distance from all dwellings.

Appropriate SUDS should be integrated within landscape corridors to capture, detain and filter stormwater runoff from hard surfaces during minor storms. These landscape corridors would also function as overland flow paths in major storms to direct stormwater away from buildings into attenuation and conveyance systems. General principles for SUDS within the landscape corridors include:

- sitting planted buffers and rain gardens perpendicular to the flow direction;
- bio-retention trenches and swales should be parallel to the flow direction; and
- Permeable paving to be used in areas of flat grades (subject to appropriate soil and groundwater conditions).

Public open space such as village greens and informal games areas provide opportunities for infiltration and attenuation. These areas could incorporate both infiltration and attenuation through the use of bio-retention systems. These can be in the form of trenches, infiltration blankets or rain gardens depending on the landscape function. Overland flows should be directed to these areas via landscape corridors and detained within the village green through appropriate site grading.

4.4.6 Green/Brown Roofs

Green and brown roofs (otherwise known as "living roofs" and "stony grassland" roofs respectively) offer ecological and environmental benefits. It may be possible to design these roofs for 40% or greater proportion of roof areas. The voids within the roof substrate can provide additional storage of rainfall runoff, making a significant contribution to the attenuation of surface water runoff and complimenting other ground level SUDS drainage facilities.

The use of green and brown roofs would need to be carefully considered when used with rainwater harvesting systems. Green roofs by their nature reduce the runoff from the roof which would contradict the likely requirement of rainwater harvesting to maximise runoff. Additionally, runoff from green and brown roofs tends to have colour, leading to staining of appliances when reused in the home, concerns over water quality for users and renders the water unsuitable for use in washing machines.

4.4.7 Rainwater Harvesting

The South East of England typically experiences below average annual rainfall when compared to the UK average, and water reuse provides an opportunity to conserve water and minimise the demand on mains water. Rainwater could potentially be harvested across the site and make a significant contribution to the water supply system.

60% of the total household water use in the UK is typically used for flushing toilets, washing machines and watering gardens. Rainwater harvesting would therefore be important to meet the target of water neutrality, and would form part of the SUDS provision for the site.

Larger facilities within the eco development, such as schools and offices, provide opportunities to harvest rainwater on a large scale for reuse within the buildings for toilet flushing. Rainwater harvesting may also be implemented for irrigation of the local landscaped areas.

Rainwater tanks for individual dwellings are also recommended for small scale harvesting in private gardens, and could provide water for toilet flushing, washing machines and garden uses.

Similarly, rainwater could be collected centrally from a number of properties, such as a block of flats, and distributed back to the building. The system would be maintained by a specialist company or trust on behalf of the residents to ensure the system continues to function as intended.

Rainwater harvesting systems are discussed further in Section 4.6.

4.4.8 Baseline Watercourse Flows

Proposals incorporate extensive use of rainwater harvesting and deliberate control of discharges to watercourses across the eco development. To mitigate the potential risk that reductions in discharges to watercourses would lead to deterioration of the watercourse quality through a less frequent flow regime, some impermeable areas of the development could be designed to direct discharge surface water to watercourses, providing a regular baseline flow.

The revised flow regime could even achieve significant betterment in terms of water quality by increasing the regularity of flow. The optimum discharge would be agreed with the Environment

Agency in advance in order to maximise the enhancement provided and to ensure that deliberate discharges are designed in a suitable manner that doesn't increase flood risk.

4.4.9 Phasing

Surface water drainage systems would be constructed to meet the requirements of the phased development of the site.

4.4.10 Exemplar Site

Proposals for the Exemplar Site incorporate ground infiltration wherever feasible to discharge surface water runoff, with discharges to watercourses for the remainder of runoff. The proposals have been developed to meet the requirements of the Code for Sustainable Homes.

The SUDS network would be designed to ensure that discharges to watercourses would be restricted to the mean annual greenfield runoff rate, for rainfall events up to the event expected to occur on average once every 100 years, reducing flood risk downstream of the site during large rainfall events.

Rooftop runoff from residential property would be collected within a rainwater harvesting system in back gardens for reuse to supply toilets, washing machines and gardens with water. Rainwater harvesting would overflow when full to a nearby soakaway structure, or where ground infiltration is not feasible to the watercourse via an attenuation storage structure and a piped network. Rooftop runoff from flats and other buildings with shared open areas or parking, such as flats, would use a similar mechanism, but would utilise shared rainwater harvesting systems and soakaways. Rooftop runoff from non-residential property would discharge via similar mechanisms.

Runoff from the core vehicular routes would run over the edge of the carriageway into linear features incorporating vegetation, filtration and bioremediation. Wherever feasible these would discharge by ground infiltration. In other cases runoff would be directed to attenuation storage structures and discharged to the water courses.

Runoff from other vehicular routes and paved areas would either percolate into permeable paving, discharge by ground infiltration, or be conveyed by shallow channels to supply ponds and other permanent water features. Permanent water features would incorporate attenuation storage and would discharge via pipes to watercourses or via ground infiltration in wetland areas at their fringes.

The SUDS network proposed utilises treatment trains comprising a number of individual components to collectively provide appropriate treatment, conveyance and storage of surface water runoff. A variety of methods are proposed to be employed for different sources of runoff to remove hydrocarbons, metals, sediments and other impairments on water quality. Pre-treatment would be utilised to supplement filtration, bioremediation, detention and vegetative uptake processes through use of bypass separators (petrol interceptors), catchpits, vortex separators and other similar water treatment processes.

Further details of surface water proposals are provided within the Exemplar Site Drainage Strategy (7501-UA001881, Hyder Consulting, March 2011).

4.5 Foul Water

4.5.1 Baseline Conditions

The nearest sewage treatment works is at Bicester and is operated by Thames Water. An extensive foul water network serves Bicester utilising a series of pumping stations to reach the treatment works.

The capacity of the environment, most notably the capability of the receiving watercourses to receive greater discharges from WwTW, would be assessed through a review of the Environment Agency River Basin Management Plans (RBMP), which describes the current water quality of the watercourses, and proposed remedial actions for the future.

Additional environmental and biodiversity constraints have been assessed through the review of both UK wide and local Biodiversity Action Plans, and additional data on important sites collected from Natural England, with further details provided within Section 2.2.

Early indications are that it is likely that there is insufficient capacity within the Thames Water existing infrastructure to service a large development; however, further consultation are being made to establish any infrastructure issues for a development of this size.

4.5.2 Proposed Foul Water Drainage Systems

Previous work on the scheme has indicated that the Thames Water Waste Water Treatment Works, which would serve the development, does not have sufficient capacity to serve the whole eco development, based on conventional discharge rates.

Thames Water has advised that modifications to or extension of their network may be required to allow connection of parts or the whole of the eco development and that further investigation by them would be necessary to identify the exact works required.

To treat foul water the following options exists:

- Upgrades to the existing treatment works, if required, to accommodate the increase foul flows and volumes, with wastewater treated to the required standard and discharged to the existing point of discharge;
- Construct a smaller sewage treatment works on the site to deal with the flows generated, with treated effluent discharged directly to the River Bure or local tributary;
- Construct a smaller sewage treatment works on the site to deal with the flows generated, with treated effluent discharged into local balancing ponds. Water could then be used to maintain water features, for irrigation over drier months, or be drawn off into a polishing unit for reuse within the development or discharge to watercourse. This has the advantage of being able to use rainfall and recycled effluent in a single system;
- Separate sewage from greywater at source (i.e. toilet waste would discharge to the sewage treatment works, and grey water from showers, washing machines etc would discharge to a separate grey water treatment facility for recycling within the development). Sewage is then piped to either the offsite of on-site sewage treatment works. This requires dual plumbing systems i.e. for both outgoing sewage and greywater, and incoming recycled and potable water;
- Incorporate local greywater recycling systems within properties, either comprising exterior tanks to collect and disseminate greywater, or, comprising ‘in-room’ units where water

from a sink is filtered in a unit beneath the sink and supplied to the adjacent toilet cistern; and

- In order to determine which option should be selected; a working group comprising the developer, TWL and the EA should be established to appraise and agree the most sustainable long term wastewater treatment option.

4.5.3 Exemplar Site

The Exemplar Site would be served by a network of gravity sewers collecting foul water from individual properties. A pumping station would collect these flows and discharge them to a suitable point of treatment. Thames Water has advised that modifications to or extension of their network may be required to allow connection of the Exemplar Site and that further investigation by them would be necessary to identify the exact works required. Further to this, Thames Water have agreed that the foul water connection could be conditioned on the understanding that discharge to the existing network would be feasible, subject to agreement of a set of works to be defined at detailed design stage.

The Exemplar Site is subject to a separate planning application to the remainder of the eco development and therefore has had to be considered as an independent site with allowance for appropriate connections and interfaces with the wider eco development, which may incorporate foul water treatment to serve the discharges from the Exemplar Site. Therefore, for the Exemplar Site foul water would be pumped offsite to a connection on the existing Thames Water foul water network for treatment at Bicester Treatment Works. However, with the subsequent development of the wider eco development and any treatment facility, it would be likely to be feasible to redirect discharges from the pumping station to the treatment facility.

4.6 Water Resources and Supply

4.6.1 Baseline Assessment

Precipitation

The South East of England is one of the driest regions in the country. The average annual rainfall for the United Kingdom is 1080 mm, reducing to 823 mm for England, and 688 mm for the Thames Region. Only the Anglian region receives less rainfall[14].

The Standard Annual Average Rainfall (SAAR) for the River Bure catchment measured at the site is 647 mm[15], which is below the average for the Thames Region. As such, the site is considered to lie within a water scarce area.

Droughts also form part of the natural cycle, where water scarcity increases. The four major droughts in the last 90 years occurred between 1920-21; 1933-34; 1943-44 and 1975-76.

The recent 2005-06 drought in February 2006 was assessed as having a drought severity of 1 in 17 years, being the fifth ranked event in 86 years of reliable record[16].

[14] Based on 1961-1990 Long Term Average data, DEFRA, 2008. These figures were compiled by the Centre for Ecology and Hydrology, Wallingford using data supplied by the National Climate Information Centre, Met Office.

[15] from catchment descriptors provided on the Flood Estimation Handbook CD Rom

[16] Revised Draft Water Resources Management Plan, Volume 2, TWU, Sept 2009

Following the 2005-2006 drought, the Thames region was identified by the Environment Agency as being in an area with serious water stress. This was based on the high proportion of the current effective rainfall which was required to meet domestic requirements, and anticipated increases in demand.

Water Resource Management Plans

Water companies in England and Wales are required to produce Water Resources Management Plans on a 5-year cycle outlining how each company aims to meet predicted water demands over a 25 year period.

In September 2009 Thames Water published their revised draft plan for the period 2010 to 2035[16].

The plan consists of several elements, including:

- A 25-year demand forecast, considering factors such as climate change and population growth;
- A 25-year supply forecast, considering current and future water availability given the impacts of climate change and potential sustainability reductions;
- An assessment of the options to manage demand, including installation of water meters to encourage water-efficiency and leakage reduction; and
- An assessment of the options to increase the available water supply, including groundwater and surface water schemes.

The eco development lies within Water Resource Zone (WRZ) reference SWOX WRZ. The definition of a WRZ is an area in which all water resources, including external transfers, can be shared and in which all customers experience the same risk of supply failure from a water resource shortfall.

In the case of the SWOX WRZ, comparing supply and demand (including Target Headroom) predicts deficits at the present time during the Peak Week (usually in July or August) in a dry year of up to 50 Ml/d and that, although reducing slightly, the deficits will continue for the foreseeable future (until 2025 under this plan). The predicted situation under Average conditions is slightly better, with surpluses of around 20 Ml/d at the present time, but with deficits occurring beyond 2014.

The main resources scheme that Thames Water are promoting is the Upper Thames Major Resource Development. The development is likely to comprise a reservoir to be constructed in the Upper Thames catchment during AMP7 (2020-25), with the preferred site being near Abingdon. Before then, a number of smaller groundwater resource schemes will be implemented between 2010 and 2020. In addition, Thames Water will also be implementing a 10 year targeted programme of compulsory metering.

Catchment Abstraction Management Strategy

Catchment Abstraction Management Strategies (CAMS) detail how water resources will be managed within a catchment, and cover a 6-year timeframe. The site lies within the Cherwell CAMS, which covers the whole length of the River Cherwell and its tributaries, such as the River Ray and on site watercourses, from its source in Northamptonshire to the confluence with the River Thames at Oxford.

Banbury and Bicester are located within the Cherwell catchment and are both expected to be urban growth points with the potential to generate a significant increase in water demand.

The status of water resources in and around the District can be assessed through a review of the CAMS to give an indication of the likelihood of any new abstraction licences for public water supply. Bicester lies in Water Resources Management Unit 2 (WRMU 2). WRMU2 includes the Lower River Cherwell, River Ray, Middle River Cherwell and Sor Brook, which have been classified as having 'No water available at low flows.'

The status of 'No Water Available' means that abstraction licenses are available but that they are restricted in their use at times of low flows. Water abstraction could form part of the water supply for the eco development, although due to the implication of water stress on the resource, they are unlikely to present the solution for the majority of the site.

As such, no new abstraction licences from surface waters is expected to be consented in order to meet the demands of the eco development, unless an existing licence could be upgraded above current abstraction limits.

The groundwater within the Cherwell catchment was not assessed as part of the CAMS due to the lack of large abstractions and the fragmented nature of the formations due to faulting. No assessment has therefore been carried out on the groundwater resources of this catchment.

Local Abstractions

Information obtained from the Envirocheck on abstraction licences within a 1km radius of the site are shown in Table 4-1. It is anticipated that other local abstractions exist but are unlicensed.

Table 4-1 - Local Abstractions

Holder	Licence Number	National Grid Reference	Source type	Use	Max Daily (m^3)	Max Annual (m^3)	Period of Use
CF Hilsdon, Manor Fm	28/39/14/ 102	452700 225200	Ground water	General farming and domestic	20	7,319	All year
W V Malins Hawkwell Farm	28/39/14/ 348	457400 224200	Ground water	General farming and domestic	48	17,520	All year
J Hunter, Watergate Fm	28/39/14/ 0048	457700 226700	Ground water	General farming and domestic	24	8,901	All year

Potable Water Demand

The average consumption for an average household for 2004-05 was estimated by Thames Water to be 159 litres/head/day (OFWAT, 2006[17]).

Figure 4-4 provides a breakdown of water use within a typical new build property[18]. As can be seen, toilet flushing accounts for a significant proportion of the overall water usage within a

[17] http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/AttachmentsByTitle/leakage04-05.pdf/$FILE/leakage_04-05.pdf

[18] Harvesting rainwater for domestic uses: an information guide, Environment Agency Jan 2008

household. The non-potable uses for greywater and rainwater include toilet use, washing machines and for watering gardens. In community facilities, the primary use of rainwater harvesting would be for toilet flushing.

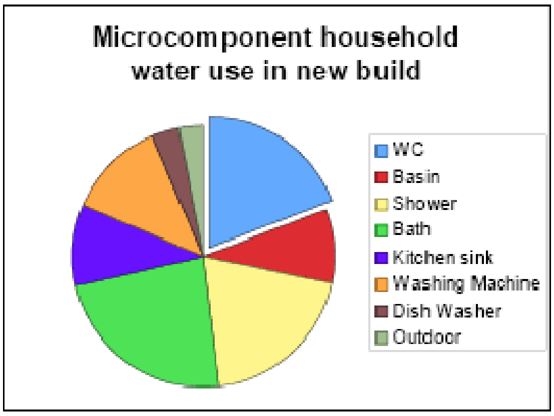

Figure 4-4 – Water consumption in new build housing (based on WRc modelling)*
* Note: This figure should only be used as a guide and actual usage may vary. Non-potable water uses in community facilities vary and would need to be calculated on an individual basis. The values presented would consequently not apply in such instances.

This report considers options for providing recycled water the non-potable fraction of household or community facilities water use.

4.6.2 Proposed Water Supply

Water Neutrality

To help achieve the aim of water neutrality consideration should be given to the incorporation of treatment of the wastewater produced on site to a high standard so that preferentially it can be re-circulated within the water supply infrastructure. Alternatively, if public perception is likely to limit such an approach, then wastewater could be cleaned to a standard that it can then be used for non drinking water uses and be termed a 'green water' reuse scheme or returned to watercourses. These options have the added benefit of being able to adapt to potential longer term water stress caused by future climate change by increasing treatment and reuse.

As part of any system, rainwater harvesting and grey water (water reuse) systems should be investigated for incorporation as part of a site wide network.

Furthermore, opportunities to provide water saving/reduction methods to properties within the site as well as across the wider resource zone area should be instigated as one of several methods to achieving water neutrality.

The potential of providing an onsite water supply for the development from groundwater sources should be considered and / or consideration that through making on-site groundwater abstractions redundant then that presents a positive saving to the resource zone and may regarded as an off-set.

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http://www.environment-agency.gov.uk/commondata/acrobat/geho0108bnpnee_809069.pdf

The Environment Agency Water Neutrality Advice Note sets out potential methodologies for offsetting additional demand, considering retrofitting homes and non-domestic buildings, and metering and variable tariffs to be viable options.

Water Efficiency

Although not currently specified, water-recycling targets are likely to be introduced for major developments.

For the NW Bicester eco development it is suggested that the following targets are considered at this stage for discussion purposes:

- A minimum of 50% of water requirements to be supplied through on site reclamation;
- Demand for potable water should be limited to 80 litres per person per day for residential property;
- Water use in new commercial, community and other non-residential property on site should meet the highest aspirations of the targets set out within the appropriate BREEAM documentation;
- Fittings and appliances should be specified to reduce water through increased efficiency of domestic water use;
- 100% non-potable water use to be supplied by grey water or rainwater recycling; and
- Metering of all new properties.

To achieve the reduction in water use to meet the aspirations for water neutrality, all new housing and facilities would need to install water efficient devices (i.e. toilets, taps, showers, washing machines and dish washers), use rainwater harvesting and/or greywater recycling for non potable uses, and should be metered.

The phasing plans of the development indicate that 3000 of the proposed units would be completed by 2026.

Table 4-2 gives the current phasing proposals.

Table 4-2 - Phasing

Phase (Hub)	No of Units	Av Build out per yr	Start yr	End yr
1a Exemplar	394	100	2011	2014/15
1b	267	150	2014	2015/16
1c	702	200	2016	2020/21
2a	700	150	2012	2017/18
2b	732	200	2018	2022/23
3	437	200	2017	2020
4	625	200	2022	2025/26
5	1092	200	2026	2031/32

Water use targets are expected to be revised during the construction period. Water use limits should therefore be reviewed under future planning applications for future phases.

4.6.3 Exemplar Site

To meet the water-use target of 80 litres per person per day, the Exemplar Site proposals utilise rainwater harvesting. The Water Efficiency Calculator for New Dwellings has been used to evaluate the proposed residential property, as required by the Code for Sustainable Homes. To achieve the required water-use target, evaluations utilising the method show that water efficient appliances and rainwater recycling could reduce demand within properties to between 67 and 79 litres per person per day. The range of rates allow for the range of residential properties anticipated and indicate that rainwater harvesting and water efficient appliances and fittings are likely to allow all residential property to meet the level 5 requirement of the Code for Sustainable Homes for water-use of less than 80 l/hd/day/. Calculations are provided within Appendix C

In the process of evaluating potable water demand, capacities and flow rates have been obtained for currently available fittings and appliances. Unproven technology that may provide low-performance (and which would therefore be likely to be replaced by residents) has deliberately been excluded.

Rainwater harvesting systems have been proposed for each residential property or for groups of properties, typically collected in a subsurface tank within each back garden or communal or open area. The Water Efficiency Calculator for New Dwellings allows for a contribution to the water-use from rainwater harvesting by evaluating the potential rainwater yield against the potential demand within the property. The method used complies with BS 8515-2009 (Rainwater Harvesting Systems) and estimated that a typical system would offer a contribution of between 15 and 28 litres per person per day depending, on the type of residential property (these values have already been incorporated within the evaluations above).

The evaluations made comply with all requirements of the methods required by the Code for Sustainable Homes. However, the rainwater harvesting has been further considered in the context of the regularity of rainwater supply, specifically regarding droughts. Analysis of rainfall data shows that the average monthly rainfall for every month throughout the year exceeds the demand within properties for rainwater for use in toilets, washing machines and exterior uses. Therefore, only irregularly dry months would potentially impact on the supply from the rainwater harvesting system.

Investigation of rainfall for the driest month within the last ten years (2000 to 2010) indicates that a typical $2m^3$ rainwater harvesting tank would have continued to supply the property throughout the month, finally depleting after 32 days assuming demand to have stayed constant and that the tank was subject to normal rainfall and thereby full at the start of the month. During a dry period of three months having half their typical rainfall rates, the rainwater harvesting tank would continue to supply the property for seventy out of ninety days. Calculations are provided within Appendix C. Both scenarios indicate that rainwater harvesting systems would be resilient to periods of low rainfall, assisting with minimisation of depletion of catchment water supplies such as reservoirs.

To further progress towards water neutrality, it is proposed that a suitable contribution is made to enhance the existing water efficiency campaign run by Thames Water Utilities Ltd. This would be additional to any existing and/or planned programme and create further water efficiency savings within the resource zone; and would likely include:

- Retrofitting existing homes with more efficient fittings and appliances
- Expanding metering to existing homes

- Introducing innovative tariffs that reward efficient use of water
- Leakage reduction

It is estimated that, following the implementation of water efficiency and reuse, the remaining water neutrality gap for the Exemplar site will be in the order of 82m^3 per day; which would roughly equate to improving water efficiency in approximately 2000 existing homes. This would be off set in the context of the wider site development through future connection to the on site treatment facility and waste water reuse.

5 WATER QUALITY

5.1 River Basin Management Plans

The Water Framework Directive (WFD) sets standards for water quality in rivers, estuaries, coastal waters and aquifers. River Basin Management Plans aim to protect and improve the water environment by identifying the main issues within a catchment and outlining the means of achieving the targets set by the WFD.

The River Basin Management Plans have been approved by the Secretary of State for the Department for Environment, Food and Rural Affairs (DEFRA).

Two waterbodies would be potentially impacted by the proposed eco development:

1. GB106039030150 is the River Bure through the eco development and Bicester; and
2. GB106039030140 is the Langford Brook downstream of the eco development.

Both waterbodies are considered “at risk” of failing WFD standards principally because of high phosphate and nitrate concentrations. These are nutrients which can feed algal growth (leading to de-oxygenation and smothering of aquatic plants) and come from both sewage effluent and agricultural runoff.

The eco development would lead to a reduction in agricultural runoff to the watercourses, reducing the phosphate and nitrate concentrations, whilst presenting opportunities to increase the regularity and quantity of flows within the watercourses on site, and therefore offers the potential to improve the status of these waterbodies by reducing nutrient release and increasing dilution.

The existing sewage treatment works in Bicester are not likely to support the whole eco development without significant upgrade. An upgrade to the sewage treatment works could improve the water quality issues. An alternative would be on site treatment with polishing to remove nutrients using reed beds or more advanced treatment systems (which could also be used to recycle water)..

5.2 Proposed Drainage Systems

The foul water and surface water systems of the eco development would be designed to maintain the quality of water within the catchment.

The surface water network would discharge by infiltration wherever possible, with SUDS utilised throughout the site to ensure discharges are sufficiently high in quality and would not impact on ground water quality. Watercourses would receive discharges from the site where ground infiltration is not feasible. The range of SUDS techniques used would ensure that the water quality within the receiving watercourses would not be reduced through the introduction of additional pollutants whilst allowing improvement in water quality by removal of phosphates and nitrates. Discharges would be designed to improve the flow regime within the watercourses on site and thus further improve water quality, as outlined in Section 5.2. The proposed SUDS network is outlined further in Section 4.4.

A range of options for the remediation of foul water arising from within the eco development are feasible, as outlined in Section 4.5. Should onsite treatment of foul water be proposed, discharges to the local watercourse network would need to be of sufficiently high quality to avoid adverse effects on both the watercourse and groundwater and could improve flow regime within the receiving watercourse through improvement in flow regime.

Water quality monitoring is recommended to ensure that the water quality is maintained following development.

5.3 Exemplar Site

The proposed SuDS system has been formed using a broad range of components, each having a variety of attributes and strengths which make them suitable or unsuitable for use in differing situations. The SuDS system proposed comprises chains of linked SuDS components which complement one another and have been combined to form a treatment train.

The SuDS Manual provides advice on the relative merits of different components using ratings of Low, Medium and High. The treatment trains described within Sections 3.2.3 and 3.2.4 have been assessed in terms of water quality using the ratings of the SuDS Manual to ensure that the best water quality is achieved through feasible and practical proposals.

Where the major SuDS features would be unlikely to provide the required level of water quality treatment, pre-treatment methods would be used to supplement the treatment trains. Pre-treatment are components not subject to water treatment ratings within the SuDS Manual and include systems for water treatment such as bypass separators (petrol interceptors) to remove hydrocarbons, catchpits to remove sediments and vortex separators for sediment and pollutant removal.

It is important to consider the quality of runoff to be discharged when considering the treatment required. For example, relatively clean runoff from a roof would be likely to require less rigorous treatment than runoff from a road. Therefore, where it may be acceptable to treat roof runoff with SuDS features having low to moderate water quality treatment characteristics, it would be more desirable for road runoff to be treated by a SuDS feature having medium or high treatment characteristics for the appropriate contaminants.

Runoff from parking areas and roads would require some form of pollutant removal due to the presence of to remove hydrocarbons and other similar pollutants associated with motor vehicles. Treatment would be by filtration within SuDS features as it runs through vegetation and percolates through the surface stratum and via percolation through layers of filtration material such as sand within permeable paving. Bypass separators (petrol interceptors) or vortex separators could be used for discharges where space is insufficient for a suitable SuDS feature. Catchpits would be used within any piped networks to capture sediments.

The naturally high quality and unpolluted nature of runoff from roofs and paved areas is likely to require minimal treatment. Filtration and settlement of any solids and pollutants would naturally occur within soakaways, further improving the water quality.

It is important to also consider the treatment trains in the context of their function. Where structure perform vital SuDS functions but have low water treatment characteristics, such as detention basins providing storage, such features have been combined with complimentary features to provide suitable water treatment.

The range of SUDS techniques used would ensure that the water quality within the receiving watercourses would not be reduced through the introduction of additional pollutants whilst allowing improvement in water quality by removal of phosphates and nitrates. Discharges would be designed to improve the flow regime within the watercourses on site and thus further improve water quality.

The watercourses crossing the site are generally dry or have minimal flow. The Langford Brook and River Bure are considered “at risk” of failing WFD standards principally because of high phosphate and nitrate concentrations. These are nutrients which can feed algal growth (leading to de-oxygenation and smothering of aquatic plants) and come from both sewage effluent and agricultural runoff. The eco development would lead to a reduction in agricultural runoff to the watercourses, reducing the phosphate and nitrate concentrations, whilst presenting opportunities to increase the regularity and quantity of flows within the watercourses on site, and therefore offers the potential to improve the status of these waterbodies by reducing nutrient release and increasing dilution. These measures should be developed further at detailed design stage in line with Environment Agency requirements.

Direct discharges would be required to the watercourses at controlled rates for the purpose of enhancing the flow regime of watercourses crossing the site and would also be used as a contingency for areas not being feasible for use of ground infiltration methods.

Foul water would be discharged off site to the TWU sewer network for treatment at the Bicester Treatment Works and would not impair the water quality of the area. A pumping station would be located on site to pump foul flows via a rising main up to the level of the connection point Future phases of the eco development would allow discharges from the Exemplar Site pumping station to be redirected to an on site treatment works.

A significant reduction in discharges would be achieved through the implementation of water efficient measures, when compared to regular developments. Due to the phased nature of the development, key elements of the foul drainage strategy, such as the pumping station, would need to be constructed at an early stage together with any necessary off site improvements.

Further details for the Exemplar Site are available within the Exemplar Site Drainage Strategy (ref 7501-UA001881).

6 CONCLUSION

A strategic and sustainable approach has been set out for the management and use of water by all stakeholders throughout the Bicester eco development. The water infrastructure (supply, wastewater collection and wastewater treatment) required to support the housing and employment growth planned for the eco development and surrounding area has been identified, along with any constraints that may prevent this, to allow further investigation within the Detailed Water Cycle Strategy.

Potable water supply infrastructure is under considerable strain as the area is considered to be water-stressed. Foul water infrastructure is also potentially under capacity and may require improvement. The minimised water demand proposed for the eco development through extensive water reuse and the water efficiency of the properties, together with off-site improvements to the wider catchment in the form of installation of water efficient devices, offers the opportunity to achieve water neutrality, equalising both demand for potable water within the Water Resource Zone and demand of capacity for foul water treatment within the catchment of Bicester Treatment Works.

The widespread use of Sustainable Drainage Systems (SUDS) and water harvesting would provide sustainable storm water management and create a sustainable resource from rainfall, whilst ensuring that flood risk is reduced for areas downstream and benefitting the local area. The rate of discharge to watercourses would be greatly reduced during large rainfall events when compared to the natural state of the site, offsetting historical development within Bicester which would have increased surface water discharge rates to the local watercourses and consequently increased flood risk.

The use of SUDS would allow the creation of new wildlife spaces incorporating wetlands, ponds and a variety of vegetation, creating valuable open amenity areas whilst enhancing the local water environment.

The eco development would promote good water quality standards, enhancing the local environmental water quality where possible. SUDS would be used to remove any polluted runoff from diffuse sources proving at source treatment prior to discharge into watercourses.

7 TECHNICAL GLOSSARY

7.1 Acronyms

Acronym	Full Description
Amm. N	Ammoniacal Nitrogen (re Discharge Consent)
AMP	Asset Management Period
AMR	Annual Monitoring Report
BAP/ (L)BAP	(Local) Biodiversity Action Plan
BAT	Best Available Technology
BATNEEC	Best Available Technology Not Entailing Excessive Cost
BOD	Biochemical Oxygen Demand
CAMS	Catchment Abstraction Management Strategies
CFMP	Catchment Flood Management Plans
CSH	Code for Sustainable Homes
CSO	Combined Sewer Overflow
DEFRA	Department for Environment, Food and Rural Affairs
DPD	Development Plan Documents
DWF	Dry Weather Flow
DYCP	Dry Year Critical Period
EA	Environment Agency
GEP	Good Ecological Potential
GWV	Groundwater Vulnerability
HMWB	Heavily Modified Water Body
HOF	Hands Off Flow
LDD	Local Development Documents
LDF	Local Development Framework
LDS	Local Development Scheme
NE	Natural England
OFWAT	The Water Services Regulation Authority
ONS	The Office for National Statistics
P	Phosphorous (re Discharge Consent)
PCC	Per Capita Consumption
PE	Population Equivalent
PPS	Planning Policy Statement
PR09/ 14	Price Review 2009/ 2014

RBMP	River Basement Management Plan
RSS	Regional Spatial Strategy
SFRA	Strategic Flood Risk Assessment
SPD	Supplementary Planning Document
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Drainage Systems
TWU	Thames Water Utilities
UKTAG	United Kingdom Technical Advisory Group
UWWTD	Urban Waste Water Treatment Directive
WAFU	Water Available for Use
WFD	Water Framework Directive
WRZ	Water Resource Zone
WwTW	Wastewater Treatment Works

7.2 Definitions

Asset Management Period (AMP) - A period of five years in which water companies implement planned upgrades and improvements to their asset base. For example, AMP4 is 2005-2010 and AMP5 is 2010-2015.

Aquifer – a layer of permeable rock, which acts as a store of groundwater. Water is stored within fissures, or within the rock matrix itself. Aquifers are defined as follows:

Principal Aquifers - These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

Secondary Aquifers - These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:

- Secondary A - 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. These are generally aquifers formerly classified as minor aquifers;
- Secondary B - lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.
- Secondary Undifferentiated – this designation is used where it has not been possible to attribute either category A or B to a rock type. Typically, these strata would have been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

- Unproductive Strata - These are rock layers or drift deposits with low permeability with negligible significance for water supply or river base flow (taken from the Environment Agency website[19]).

Best Available Technology (BAT) – in this context refers to the most advanced methods (that have been proven in the industry) that a water company can utilise to obtain the best result from a process.

Best Available Technology Not Entailing Excessive Cost (BATNEEC) – similar to the above, but taking account of the whole life cycle costs. BATNEEC is often applied by water companies because they pass on costs to customers through the Price Review process, and this funding regime requires that the optimum balance between benefits and costs is therefore achieved.

Biochemical Oxygen Demand – a measure of the oxygen demand that results from bacteria breaking down organic carbon compounds in water. High levels of BOD can use up oxygen in a watercourse to the detriment of the ecology.

Catchment Abstraction Management Strategies (CAMS) - the production of a strategy by the EA to assess and improve the amount of water that is available on a catchment scale. The first cycle of CAMS have recently been produced and are currently being reviewed. An interim update of the CAMS process can be viewed at http://publications.environment-agency.gov.uk/pdf/GEH00508BOAH-ee.pdf?lang=_e.

Code for Sustainable Homes (CSH) - released in 2007 and aims to make newly built homes more efficient in the future. The code gives a star rating (between 1 and 6) for a home based on nine different categories including water, waste and energy. In May 2008 the government announced a timetable to ensure the implementation of the CSH through the tightening up of building regulations. At present, all new homes are required to be assessed for a CSH star rating. Details and technical guidance for the CSH can be found at; http://www.communities.gov.uk/planningandbuilding/buildingregulations/legislation/englandwales/codesustainable/.

Combined Sewer Overflow (CSO) – a point on the sewerage network where untreated wastewater is discharged during storm events to relieve pressure on the network and prevent sewer flooding. Sewerage systems that are not influenced by storm water should not require a CSO.

Deployable Output – the amount of water that can be abstracted from a source (or bulk supply) as constrained by environment, license, pumping plant and well/aquifer properties, raw water mains, transfer, treatment and water quality.

Discharge Consent – a consent issued and reviewed by the EA which permits an organisation or individual to discharge sewage or trade effluent into surface water, groundwater or the sea. Volume and quality levels are set to protect water quality, the environment and human health. Regarding water quality, the detriments controlled under a discharge consent are:

- Suspended Solids;
- Biochemical Oxygen Demand; and
- Ammoniacal Nitrogen (Amm. N) and Phosphorous (P), where the UWWTD conditions apply.

Draft Water Resource Management Plan (WRMP) - Currently in their draft stages awaiting approval by OFWAT later this year, the Water Resource Management Plans are studies undertaken by every water company in England to determine the availability of water resources for the next 25 years. WRMPs can be found on most water company websites.

Drainage Impact Assessment – a study that sets out the principles of how a development site will be drained, and predicts the impact on the existing drainage system and associated flood risk.

Dry Weather Flow (DWF) – an estimation of the flow of wastewater to a WwTW during a period of dry weather. This is based on the 20th percentile of daily flow through the works over a rolling three year period.

Dry Year Critical Period (DYCP) – the period of time during which the customer experiences the greatest risk of loss of potable water supply during a year of rainfall below long-term average (characterised with high summer temperatures and high demand).

Eutrophication – higher than natural levels of nutrients in a watercourse, which may lead to the excessive build up of plant life (especially algae). Excessive algal blooms remove valuable oxygen from the watercourse, block filters at water treatment works, affect the taste and smell of water, and can be toxic to other wildlife.

Fluvial – term referring to rivers or streams.

Hands Off Flow (HOF) – the minimum river flow that must be achieved at a monitoring point to allow abstraction to take place at any associated abstraction points.

Local Development Framework (LDF) – A folder of development documents outlining the spatial planning strategy for each local authority. The LDF will contain a number of statutory Local Development Documents (LDDs), such as a Statement of Community Involvement, Annual Monitoring Reports, Core Strategy, Local Development Scheme as well as a number of optional Supplementary Planning Documents. More information can be found at: http://www.planningportal.gov.uk/uploads/ldf/ldfguide.html.

National Nature Reserve (NNR) – are areas of national importance, protected because they are amongst the best examples of a particular habitat in the country. Details of NNR can be found at http://www.natureonthemap.org.uk/.

Per Capita Consumption (PCC) – the volume of water used by one person over a day, expressed in units of litres per person per day (l/p/d).

Planning Policy Statement (PPS) - set out the Government's national policies on different aspect of planning. The policies in these statements apply throughout England and focus on procedural policy and the process of preparing local development documents. One of the Statements, PPS 25, deals with the impacts of Flood Risk on development. More information can be found at:
http://www.planningportal.gov.uk/england/professionals/en/1020432881271.html.

Population Equivalent – a method of measuring the loading on a WwTW, and is based on a notional population comprising; resident population, a percentage of transient population, cessed liquor input expressed in population, and trade effluent expressed in population.

Potable Water – water that is fit for drinking, being free of harmful chemicals and pathogens. Raw water can be potable in some instances, although it usually requires treatment of some kind to bring it up to this level.

Price Review – the process with which Ofwat reviews water company business plans and subsequently sets limits on the prices the companies can charge their customers for the following AMP. The business plan submissions are often referred to as the Price Review submission, e.g. business plan submitted in 2009 for AMP5 (2010–2015) is referred to as the PR09 submission.

Raw Water - water taken from the environment, which is subsequently treated or purified to produce potable water.

Regional Spatial Strategy (RSS) - a broad development strategy for a region for a 15 to 20 year period prepared by the Regional Planning Body. It establishes the broad development strategy for the region, and provide a framework within which local development documents and local transport plans.

Riparian Landowner – the owner of land adjacent to a watercourse.

River Basin Management Plans (RBMP) – documents being produced for consultation by each of the EA regions to catalogue the water quality of all watercourses and set out actions to ensure they achieve the ecological targets stipulated in the WFD.

Site of Special Scientific Interest (SSSI) - an area of special interest by reason of any of its flora, fauna, geological or physiographical features (basically, plants, animals, and natural features relating to the Earth's structure). A map showing all SSSI sites can be found at

http://www.natureonthemap.org.uk/**.**

Source Protection Zones (SPZ) - zones designated around public drinking water abstractions and sensitive receptors which detail risk to the groundwater zone they protect:

> **SPZ1** – Inner Protection Zone: This zone represents the area within which a pollutant would take up to 50 days to travel to the abstraction point, plus a 50 m exclusion zone around abstraction point;
>
> **SPZ2** – Outer Protection Zone: This zone represents the area within which a pollutant would take up to 400 days to arrive at the abstraction point. The previous methodology gave an option to define SPZ2 as the minimum recharge area required to support 25 per cent of the protected yield. This option is no longer available in defining new SPZs and instead this zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction.
>
> **SPZ3** – Total Catchment: Source catchment protection zone, defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. There is still the need to define individual source protection areas to assist operators in catchment management.

Former zone of special interest - A fourth zone SPZ4 or 'Zone of Special Interest' was previously defined for some sources. SPZ4 usually represented a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream). In the future, this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone (taken from the Environment Agency website[19]).

Strategic Flood Risk Assessment (SFRA) – document required by PPS25 that informs the planning process of flood risk and provides information on future risk over a wide spatial area. It is also used as a planning tool to examine the sustainability of the proposed development allocations.

Surface Water Management Plans (SWMP) –assist in the assessment of flood risk to ensure that increased levels of development and climate change do not have an adverse impact on flooding from surface water sources within the catchment. SWMP were introduced following the severe flooding in 2007 as means for Local Authorities to take the lead in reducing flood risk.

Sustainable Drainage Systems (SUDS) – a combination of physical structures and management techniques designed to drain, attenuate and in some cases treat runoff from urban (and in some cases rural) areas.

Target Headroom - the threshold of minimum acceptable headroom, which would trigger the need for water management options to increase water available for use or decrease demand.

UK Biodiversity Action Plan (BAP) – is the Government's response to the Convention on Biological Diversity 1992. It describes the UK's biological resources, both species and habitats, and details a plan to protect them. UK BAP habitats are often encompassed within the other sites listed above, however smaller pockets of UK BAP habitat may also exist outside these sites. More information can be found at http://www.ukbap.org.uk/.

Water Available for Use (WAFU) – the amount of water remaining after allowable outages and planning allowances are deducted from deployable output in a WRZ.

Water Framework Directive (WFD) 2000 - A European Union directive (2000/60/EC) which commits member states to make all water bodies of good qualitative and quantitative status by 2015. The WFD could have significant implications on water quality and abstraction. Important dates for the WFD are:

- 2008 Draft River Basin Management Plans for each river basin district completed;
- 2009 Final River Basin Management Plans completed;
- 2012 Programs of measures for improvements to be fully operational; and
- 2015 Achieve the first set of water body objectives.

Water Neutrality – the concept of offsetting demand from new developments by making existing homes and buildings more water efficient.

Water Resource Zone (WRZ) – are areas based on the existing potable water supply network and represent the largest area in which water resources can be shared.

Wastewater - is any water that has been adversely affected in quality by anthropogenic influence. It comprises liquid waste discharged by domestic residences, commercial properties, industry, and/or agriculture.

Water Treatment Works (WTW) – facility which treats abstracted raw water to bring it up to potable standards.

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[19] http://www.environment-agency.gov.uk/homeandleisure/37793.aspx

Wastewater Treatment Works (WwTW) – facility which treats wastewater through a combination of physical, biological and chemical processes.

Winterbourne – describes a river or stream which only flows during the winter season, when groundwater levels are high enough.

Appendix A

Planning Policy Context

Planning Policy Context

National Policy

National policy for development and planning is set by the Government. The planning system has changed significantly in recent years due to the Governments planning reform. This reform has included the introduction of the 'Planning for a Sustainable Future: White Paper' and the 'Planning and Compulsory Purchase Act' which has lead to the need for Local Authorities to develop unified Local Development Frameworks. The planning reform has also lead to the revision of a number of planning policy documents. Extracts from the most relevant Planning Policy Statement (PPS) documents is set out below. This is not an exhaustive list but include the key areas where Local Authorities are required to contribute to the protection of the water environment.

Planning Policy Statement (PPS)

PPS 1: Delivering Sustainable Development [20]

PPS1 sets out the overarching planning policies on the delivery of sustainable development through the planning system. Regional planning authorities and Local Authorities should promote:

...the sustainable use of water resources; and the use of sustainable drainage systems in the management of run-off.

Development plan policies should take account of environmental issues such as:

- the protection of groundwater from contamination;
- the conservation and enhancement of wildlife species and habitats and the promotion of biodiversity; and
- the potential impact of the environment on proposed developments.

The Government is committed to promoting a strong, stable and productive economy that aims to bring jobs and prosperity for all. Planning authorities should ensure that infrastructure and services are provided to support new and existing economic development and housing.

In preparing development plans, planning authorities should seek to:

...address, on the basis of sound science, the causes and impacts of climate change, the management of pollution and natural hazards, the safeguarding of natural resources, and the minimisation of impacts from the management and use of resources.

[20] Planning Policy Statement 1: Delivering Sustainable Development, Office of the Deputy Prime Minister. 2005

PPS Planning and Climate Change: Supplement to PPS1[21]

This PPS on climate change supplements PPS1 by setting out how planning should contribute to reducing emissions and stabilising climate change and take into account the unavoidable consequences. In deciding which areas and sites are suitable, and the appropriate type and intensity of development, planning authorities should assess their consistency with the policies in this PPS. In doing so, planning authorities should take into account:

- the capacity of existing and potential infrastructure (including for water supply, sewage and sewerage, waste management and community infrastructure such as schools and hospitals) to service the site or area in ways consistent with cutting carbon dioxide emissions and successfully adapting to likely changes in the local climate;
- the effect of development on biodiversity and its capacity to adapt to likely changes in the climate;
- the contribution to be made from existing and new opportunities for open space and green infrastructure to urban cooling, sustainable drainage systems, and conserving and enhancing biodiversity; and
- known physical and environmental constraints on the development of land such as sea level rises, flood risk and stability, and take a precautionary approach to increases in risk that could arise as a result of likely changes to the climate.

In their consideration of the environmental performance of proposed development, taking particular account of the climate the development is likely to experience over its expected lifetime, planning authorities should expect new development to:

...give priority to the use of sustainable drainage systems, paying attention to the potential contribution to be gained from water harvesting from impermeable surfaces, and encourage layouts that accommodate waste water recycling.

PPS Eco-towns: Supplement to PPS1[22]

This PPS on eco-towns supplements PPS1 by setting guidelines and targets that eco-towns should achieve. Section ET 17 of this document covers water and requires:

- eco-towns to be ...ambitious in terms of water efficiency across the whole development, particularly in areas of serious water stress , and should contribute, where existing water quality leaves scope for further improvement, towards improving water quality in their localities.
- eco-towns to ...incorporate measures in the water cycle strategy for improving water quality and managing surface water, groundwater and local watercourses to prevent surface water flooding from those sources;
- eco-towns to ...incorporate sustainable drainage systems (SUDS) and, except where this is not feasible ... avoid connection of surface water run-off into sewers.

Water cycle studies for eco-town planning applications should be undertaken to:

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[21] Planning Policy Statement: Planning and Climate Change. Supplement to Planning Policy Statement 1, Office of the Deputy Prime Minister. December 2007

[22] Planning Policy Statement: Eco-towns. Supplement to Planning Policy Statement 1, Office of the Deputy Prime Minister. July 2009

- assess the impact that the proposed development will have on water demand within the framework of the water companies' water resource management plans and set out the proposed measures which will limit additional water demand from both new housing and new non-domestic buildings
- demonstrate that the development will not result in a deterioration in the status of any surface waters or ground-waters affected by the eco-town; and
- set out proposed measures for improving water quality and avoiding surface water flooding from surface water, groundwater and local watercourses.

Planning applications for all eco-towns should include a strategy for the long-term maintenance, management and adoption of the SUDS.

Eco-towns in areas of serious water stress should aspire to water neutrality, and new homes should meet the water consumption requirement of Level 5 of the Code for Sustainable Homes. In addition, new non-domestic buildings should be equipped to meet similar high standards of water efficiency with respect to domestic water use.

Flood risk management is also a key focus and:

...the location, layout and construction of eco-towns should reduce and avoid flood risk wherever practicable. Eco-towns should not increase the risk of flooding elsewhere and should use opportunities to address and reduce existing flooding problems.

Development should, where possible, be located within Flood Zone 1, with Flood Zone 2 being used for open spaces and informal recreational areas that can serve as multi-functional spaces (i.e. flood storage). There should be no built-up development in Flood Zone 3, with the exception of water-compatible development.

PPS 3: Housing[23]

PPS3 sets out the national planning policy framework for delivering the Government's housing objectives. Local Planning Authorities should encourage applicants to bring forward sustainable and environmentally friendly new housing developments, including affordable housing developments, and in doing so should reflect the approach set out in the forthcoming PPS on climate change, including on the Code for Sustainable Homes.

PPS 9: Biodiversity and Geological Conservation[24]

PPS9 sets out planning policies on protection of biodiversity and geological conservation through the planning system. Regional planning bodies and local planning authorities should adhere to the following key principles to ensure that the potential impacts of planning decisions on biodiversity and geological conservation are fully considered.

Development plan policies and planning decisions should be based upon up-to-date information about the environmental characteristics of their areas. These characteristics should include the relevant biodiversity and geological resources of the area. In reviewing environmental

[23] Planning Policy Statement 3: Housing, Office of the Deputy Prime Minister. November 2006

[24] Planning Policy Statement 9: Biodiversity and Geological Conservation, Office of the Deputy Prime Minister. August 2005

characteristics, Local Authorities should assess the potential to sustain and enhance those resources.

Plan policies and planning decisions should aim to maintain, and enhance, restore or add to biodiversity and geological conservation interests. In taking decisions, local planning authorities should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; and to biodiversity and geological interests within the wider environment.

Plan policies on the form and location of development should take a strategic approach to the conservation, enhancement and restoration of biodiversity and geology, and recognise the contributions that sites, areas and features, both individually and in combination, make to conserve these resources.

Plan policies should promote opportunities for the incorporation of beneficial biodiversity and geological features within the design of development.

Development proposals where the principal objective is to conserve or enhance biodiversity and geological conservation interests should be permitted.

The aim of planning decisions should be to prevent harm to biodiversity and geological conservation interests. Where granting planning permission would result in significant harm to those interests, local planning authorities will need to be satisfied that the development cannot reasonably be located on any alternative sites that would result in less or no harm. In the absence of any such alternatives, local planning authorities should ensure that, before planning permission is granted, adequate mitigation measures are put in place. Where a planning decision would result in significant harm to biodiversity and geological interests, which cannot be prevented or adequately mitigated against, appropriate compensation measures should be sought. If significant harm cannot be prevented, adequately mitigated against, or compensated for, then planning permission should be refused.

Local development frameworks should indicate the location of designated sites of importance for biodiversity and geodiversity, making clear distinctions between the hierarchy of international, national, regional and locally designated sites. They should also identify any areas or sites for the restoration or creation of new priority habitats, which contribute to regional targets, and support this restoration or creation through appropriate policies.

PPS 12: Local Spatial Planning[25]

PPS 12 sets out government policy on local development frameworks. The core strategy should be supported by evidence of what physical, social and green infrastructure is needed to enable the amount of development proposed for the area, taking account of its type and distribution.

This evidence should cover who will provide the infrastructure and when it will be provided. The core strategy should draw on and in parallel influence any strategies and investment plans of the local authority and other organisations.

Good infrastructure planning considers the infrastructure required to support development, costs, sources of funding, timescales for delivery and gaps in funding. This allows the identified infrastructure to be prioritised in discussions with key local partners. This has been a major

[25] Planning Policy Statement 12: Local Spatial Planning, Office of the Deputy Prime Minister. 2008

theme highlighted and considered via HM Treasury's CSR07 Policy Review on Supporting Housing Growth. The infrastructure planning process should identify, as far as possible:

- infrastructure needs and costs;
- phasing of development;
- funding sources; and
- responsibilities for delivery.

The need for infrastructure to support housing growth and the associated need for an infrastructure delivery planning process has been highlighted further in the Government's recent Housing Green Paper. The outcome of the infrastructure planning process should inform the core strategy and should be part of a robust evidence base. It will greatly assist the overall planning process for all participants if the agencies responsible for infrastructure delivery and the local authority producing the core strategy were to align their planning processes. Local Authorities should undertake timely, effective and conclusive discussion with key infrastructure providers when preparing a core strategy. Key infrastructure stakeholders are encouraged to engage in such discussions and to reflect the core strategy within their own future planning.

However the Government recognises that the budgeting processes of different agencies may mean that less information may be available when the core strategy is being prepared than would be ideal. It is important therefore that the core strategy makes proper provision for such uncertainty and does not place undue reliance on critical elements of infrastructure whose funding is unknown. The test should be whether there is a reasonable prospect of provision.

Contingency planning – showing how the objectives will be achieved under different scenarios – may be necessary in circumstances where provision is uncertain.

PPS 23: Planning and Pollution Control[26]

The following matters (not in any order of importance) should be considered in the preparation of development plan documents and may be material in the consideration of individual planning applications where pollution considerations arise:

- the potential sensitivity of the area to adverse effects from pollution, in particular reflected in landscape, the quality of soil, air, and ground and surface waters, nature conservation (including Sites of Special Scientific Interest (SSSIs), National Parks, Areas of Outstanding Natural Beauty (AONBs), Special Areas of Conservation (SACs), Special Protection Areas (SPAs),Wetland of International Importance (RAMSAR sites), agricultural land quality, water supply (Source Protection Zones), archaeological designations and the need to protect natural resources;
- the possible adverse impacts on water quality and the impact of any possible discharge of effluent or leachates which may pose a threat to surface or underground water resources directly or indirectly through surrounding soils;
- the need to make suitable provision for the drainage of surface water; and
- the provision of sewerage and sewage treatment and the availability of existing sewage infrastructure.

[26] Planning Policy Statement 23: Pollution Control, Office of the Deputy Prime Minister. 2004

PPS 25: Development and Flood Risk[27]

RPBs and LPAs should adhere to the following principles in preparing planning strategies:

- LPAs should prepare Local Development Documents (LDDs) that set out policies for the allocation of sites and the control of development which avoid flood risk to people and property where possible and manage it elsewhere, reflecting the approach to managing flood risk in this PPS and in the RSS for their region;
- where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, LPAs should consider whether there are opportunities in the preparation of LDDs to facilitate the relocation of development, including housing to more sustainable locations at less risk from flooding;

In addition, LPAs should in determining planning applications:

- give priority to the use of SUDS; and
- ensure that all new development in flood risk areas is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed.

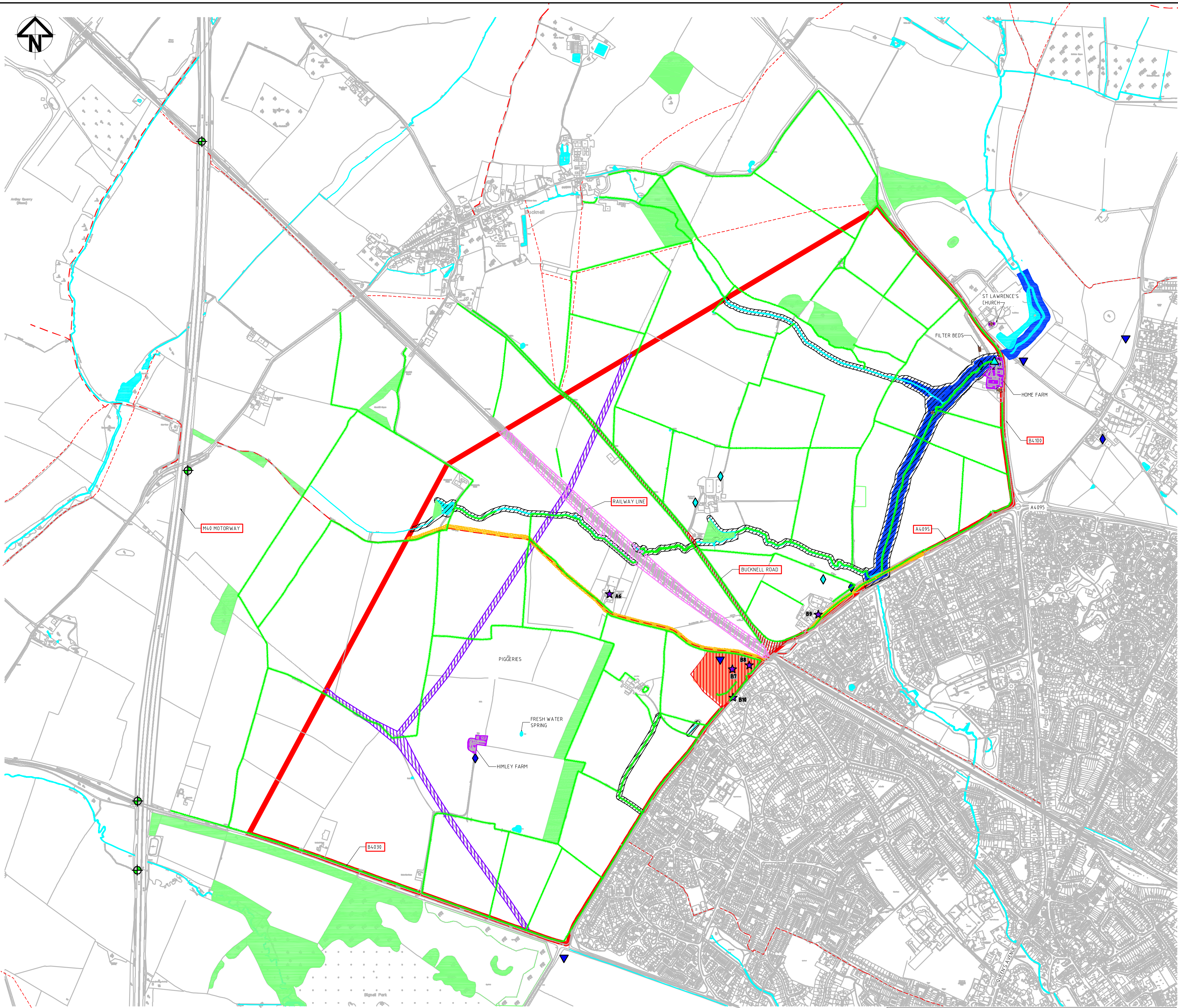
[27] Planning Policy Statement 25: Development and Flood Risk, CLG, 2006

Appendix B

Drawings

7007-UA001881 : Site Sensitivity Features

7019-UA001881 : Existing Water Features



NOTES:

ENVIRONMENTAL CONSTRAINTS
a. POTENTIAL LOCALISED CONTAMINATION ALONG RAILWAY LINE.
b. DRAINAGE DITCHES/ SITE ACCESS CROSSING POINTS.
c. FARM EQUIPMENT FUEL SPILLS.
d. PIGGERIES AND FARM LAND SPILL/ EFFLUENT/ PESTICIDES/ HERBICIDES.
e. FILTER BED NEAR HOME FARM.
f. POTENTIAL FUTURE 'AIR QUALITY MANAGEMENT AREA' (QUEEN'S AVENUE, BICESTER).
g. SEVERAL BRITISH GEOLOGICAL SOCIETY (BGS) RECORDED MINERAL SITES (E.G. FORMER QUARRIES) POTENTIALLY INFILLED WITH MADE GROUND.

LANDSCAPE RECEPTORS
PUBLIC FOOTPATH TO THE NORTH OF THE SITE, PROPERTIES / FARMSTEADS AT CAVERSFIELD AND RESIDENTIAL PROPERTIES AT THE NORTHERN EDGE OF BICESTER.

AIR QUALITY AND NOISE RECEPTORS
RESIDENTIAL AREAS AFFECTED BY INCREASED TRAFFIC ON LOCAL ROADS.
NEW HOUSES TO INCLUDE A BUFFER ZONE TO LOCAL ROADS AND RAILWAY TRACK

ARCHAEOLOGICAL CONSTRAINTS
NO CONSTRAINTS HAVE BEEN IDENTIFIED WITHIN THE EXEMPLAR SITE BOUNDARY HOWEVER A COUNTY ARCHAEOLOGIST FIELD SURVEY IS REQUIRED PRIOR TO APPLICATION.

FLOOD RISK CONSTRAINTS
WATERCOURSES TO INCLUDE A 10m BUFFER ZONE FOR ENVIRONMENT AGENCY MAINTENANCE ACCESS.

KEY

- OVERALL SITE BOUNDARY
- PUBLIC BRIDLEWAY
- PUBLIC FOOTPATH
- HEDGEROW
- WOODLAND
- WATER COURSE
- APPROX. RISK OF FLOODING AREA
- EA 10m BUFFER ZONE (TAKEN FROM EDGE OF WATER) - SEE NOTE6.
- SERVICE CORRIDOR 33kV OVERHEAD POWER CABLES
- SERVICE CORRIDOR TRUNK WATERMAIN
- RAILWAY LINE
- BUCKNELL ROAD
- LISTED BUILDING (GRADE II)
- 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)
- A4095 POTENTAIL NOISE SOURCES - LOCAL ROAD NETWORK (INC. M40/ A4095/ B4100/ B4030/ BUCKNELL ROAD) AND RAILWAY LINE.

MAP ID	TRADE DIRECTORY ENTRY DETAIL
A6	D RICKETTS - COMMERCIAL VEHICLE DEALERS (INACTIVE)
B7	RATIONEL WINDOWS (UK) LTD. - WINDOW FRAME MANUFACTURERS
B8	RAVENSBURGER LTD. -TOYS, GAMES & SPORTING GOODS MANUFACTURER
B9	TURNEY-AGRIFORCE -AGRICULTURAL ENGINEERS
B10	MICROM UK LTD. -MEDICAL INSTRUMENTS - MANUFACTURERS

Issue	Description	Date
03	FLOODING RISK AREA UPDATED FROM EA DATA	05/10/10
02	MINOR AMENDMENTS	
01	FIRST ISSUE	11/06/10

Status

		Current Issue Signatures	
Scales	1:5000	Author P. WILLIAMS	
Original Size	A0	Checker SA. DAVIES	
Height Datum	NEWLYN	Approver SA. DAVIES	
Grid	O.S.	© Copyright reserved	

Filename 7007-UA001881-UP21D-03-SITE SENSITIVITY FEATURES.DWG

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Project

BICESTER
ECO DEVELOPMENT

Title

SITE SENSITIVITY FEATURES

Drawing No.	Project No.	Issue
7007	UA001881	03

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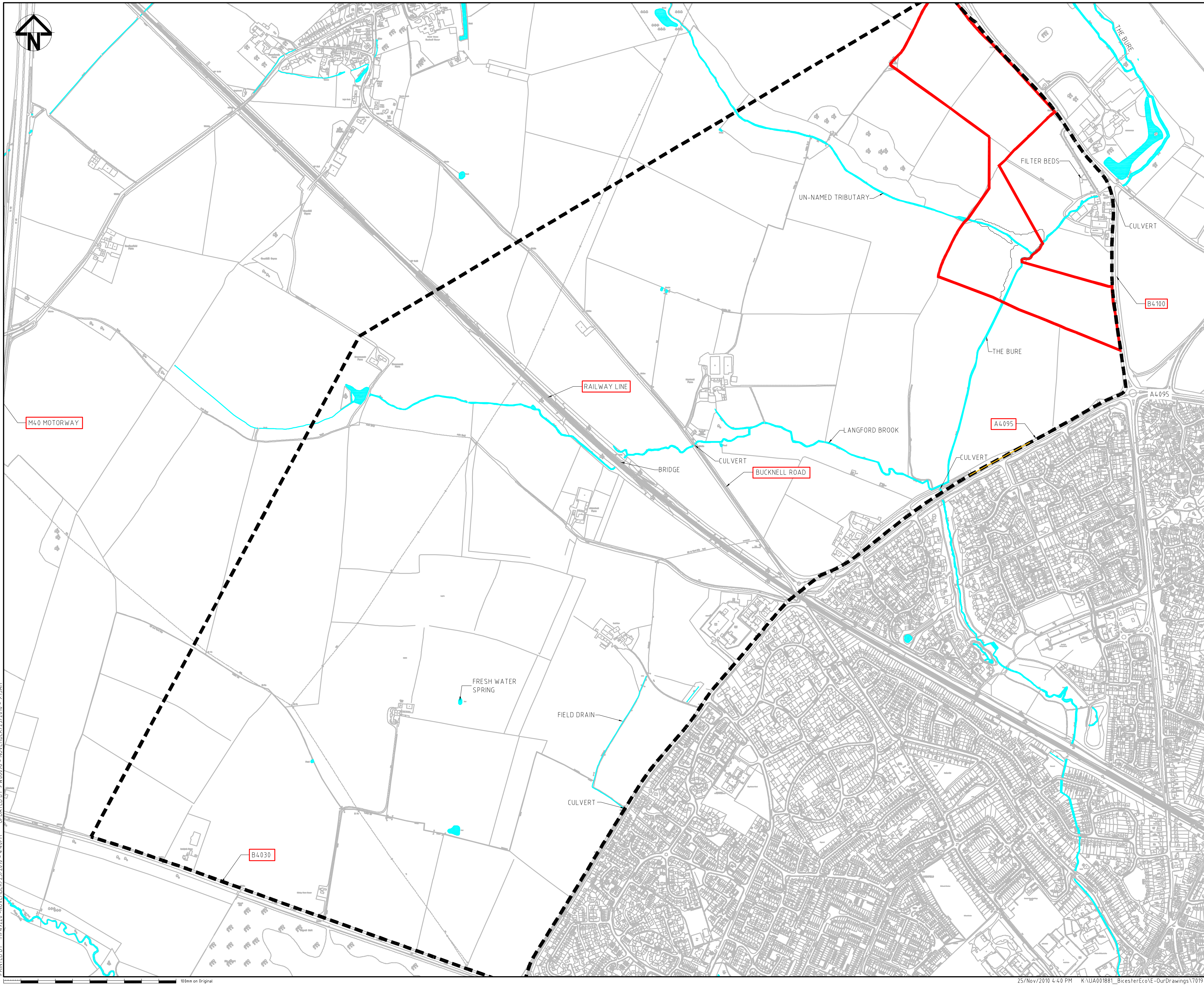

KEY

ECO DEVELOPMENT BOUNDARY

EXEMPLAR SITE BOUNDARY

Issue	Description	Date
02	MINOR REVISIONS	24/11/10

Status

Scales	1:5000	Author M.LLEWELLIN
Original Size	A1	Checker M.PEARSON
Height Datum	-	Approver S.A. DAVIES
Grid	O.S.	© Copyright reserved

Filename 7019-UA001881-UP21D-02-EXISTING WATER FEATURES.DWG

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Project

BICESTER
ECO DEVELOPMENT

Title

EXISTING WATER FEATURES

Drawing No.	Project No.	Issue
7019	UA001881	02

Appendix C

Water Efficiency

Table 1: The water calculator for new dwellings

Installation Type	Unit of Measure	Capacity/Flow rate (1)	Use Factor (2)	Fixed use (litres/person/day) (3)	Litres/person/day = [(1)x(2)] + (4)
WC (single flush)	Flush Volume	0	4.42	0	0
WC (dual flush)	Full flush Volume	4	1.46	0	5.84
	Part flush Volume	2.6	2.96	0	7.696
WC (multiple fittings)	Average effective flushing Volume (litres)	0	4.42	0	0
Taps (excluding kitchen/utility room taps)	Flow rate (litres/min)	7	1.58	1.58	12.64
Bath (where shower also present)	Capacity to overflow (litres)	140	0.11	0	15.4
Shower (where bath also present)	Flow Rate (litres / minute)	4.7	4.37	0	20.539
Bath Only	Capacity to overflow(litres)	0	0.5	0	0
Shower Only	Flow Rate (litres/minute)	0	5.6	0	0
Kitchen/Utility room sink taps	Flow rate (litres/minute)	13.2	0.44	10.36	16.168
Washing Machine	(Litres/kg dry load)	7	2.1	0	14.7
Dishwasher	(Litres/place setting)	0.95	3.6	0	3.42
Waste disposal unit	(Litres/use)	Not-present 0	3.08	0	0
Water Softener	(Litres/person/day)	0	1	0	0

	Property Type	Private House	Affordable House	Flats (5 per block)
(5)	Total Calculated use (litres/person/day) =SUM(column 4)	96.40	96.40	96.40
(6)	Contribution from greywater (litres/person/day)			
(7)	Contribution from rainwater (litres/person/day)	28.24	19.14	15.40
(8)	Normalisation factor	0.91	0.91	0.91
(9)	Total water consumption (Code for Sustainable Homes) = [(5)-(6)-(7)]x(8) (litres/person/day)	62.03	70.31	73.71
(10)	External water use	5.00	5.00	5.00
(11)	Total water consumption (Building Regulation 17.K) =(9)+(10)(litres/person/day)	67.03	75.31	78.71

Table 5.1: The rainwater collection calcultion for new dwellings - BS8515
Intermediate approach

Property Type			Private House	Affordable House	Flats (5 per block)
Collection area (m2) - Including garage roofs		(a)	70	70	160
Yield co-efficient and hydraulic filter efficiency e.g. 0.7		(b)	0.72	0.72	0.72
Rainfall (average mm/year)		(c)	610	610	610
Daily rainwater collection (litres)	[(a)x(b)x(c)]/365 =	(d)	84.23	84.23	192.53
Number of occupants		(e)	2.26	4.40	12.50
Daily rainwater per person (litres)	**(d) / (e) =**	**(f)**	37.27	19.14	15.40

Table 5.5: Rainwater saving calculation for new dwellings

	Litres per person per day		
Property Type	Private House	Affordable House	Flats (5 per block)
Rainwater collected (a)	37.27	19.14	15.40
Rainwater demand (b)	28.24	28.24	28.24
Rainwater savings* (c) = (a)/(b)*(b)	28.24	19.14	15.40

*where the amount collected (a) is greater than the demand (b), the rainwater savings (c) are equal to the demand (b)

Month	Total Half Average Rainfall for Month (mm)	Collected Rainwater Volume (l/day)	Rainwater Demand (l/day)	Rainwater Surplus / Deficit (l/day)	Volume Remaining at Month End (2000 l Tank - Full at Start)	No. Days Supplied via Rainwater Harvesting
Feb	20.25	36.45	63.82	-27.37	1233.57	Full month
Mar	18.44	29.97	63.82	-33.85	184.25	Full month
Apr	25.17	42.29	63.82	-21.54	0.00	Approx 10 days

Appendix C
Rainwater Harvesting Calculation for Private Dwellings