NW Bicester

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

Drainage Strategy

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NW Bicester Eco Development

Drainage Strategy - Exemplar Site

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1 INTRODUCTION

1.1 Terms of Reference

Hyder Consulting (UK) Ltd. (Hyder) has been instructed by A2Dominion Group (A2Dominion) and P3Eco (Bicester) Ltd. (P3Eco) to provide engineering and infrastructure design in support of the masterplanning and planning for the proposed new eco development on the north-western periphery of the town of Bicester, Oxfordshire. The proposed eco development site will comprise approximately 5,000 homes with supporting employment and education infrastructure. The Exemplar Site is the first phase of the development, located at the north eastern end.

The NW Bicester development is identified in the Planning Policy Statement PPS 1 supplement as one of four eco-towns which have received support from central government. The scheme is also supported locally by Cherwell District Council and Oxfordshire County Council, and is identified as a strategic allocation within CDC draft Core Strategy. The NW Bicester development is proposed to comprise some 5000 homes, a secondary school, a number of primary schools, retail and commercial space along with health care and other community facilities. 40% of the overall site will be green open space, including sports playing fields, semi private and public open space. The development will meet the requirements of the PPS 1 supplement on Eco Towns; which sets out the key sustainability principles.

The first phase of the NW Bicester eco development will be an exemplar for future 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 drainage strategy proposed to manage surface water runoff and foul water generated by the Exemplar Site development only. The remainder of the NW Bicester eco development will be covered within a separate drainage strategy.

1.2 Location

The town of Bicester lies approximately 24km to the north east of Oxford and 28km to the south east of Banbury. The M40 motorway lies 2km to the south west, with established access to the town from Junction 9.

The eco development will be situated on the north-western periphery of Bicester, beyond the A4095 (which forms part of the Bicester Ring Road), approximately 1.5km from the town centre.

The Exemplar Site is situated at the northeast end of the development and covers an area of approximately 21.1ha of Grade 3 agricultural land. To the west of the Exemplar Site is the village of Bucknell, with Caversfield located on the north-eastern Exemplar Site boundary, beyond the B4100 highway.

The locations of the eco development and Exemplar Site are presented on drawing 7006 within Appendix A.

2 EXISTING SITE

2.1 Topography

A topographical survey has been completed for the Exemplar Site. Ordnance Survey DTM (Digital Terrain Model) data and Mastermap have been used to provide ground profile and mapping information respectively for the remainder of the surrounding area.

Drawing 7013 (Appendix A) shows contours and topological details of the Exemplar Site produced from the topographical survey.

The existing topography of the Exemplar Site falls by approximately 4m from the north-western boundary to the south-eastern boundary (from ~92m AOD to ~87m AOD), with watercourses lying in central depressions reaching a depth of 82.5m AOD.

2.2 Ground Conditions

Ground conditions have been assessed within a desk study (Phase 1 Desk Study, document 2501-UA001881-01) and a factual report summarising the findings of onsite ground investigation (Exemplar Site Factual Report, document 2504-UA001881-01).

In summary, the investigations indicate that the site comprises stratum of sand and gravel overlying clay bands and limestone.

No significant contamination issues or risks have been identified within the reports and it is considered that ground contamination will not impact on the potential for drainage and ground infiltration.

2.3 Local Hydraulic Conditions

Drainage and Water Features

Within the eco development there are several water features: the Bure and its associated tributaries, field drains, ponds and springs. The Bure (a main river) flows in a southerly direction from Caversfield House to a culvert beneath the A4095. Downstream from this it flows in an open channel between Lucerine Avenue and Purslane Drive. There is a tributary flowing in an easterly direction from Bucknell which converges with the Bure downstream of Home Farm. The Langford Brook (an ordinary watercourse) flows in an easterly direction from Crowmarsh Farm, which converges with the Bure at the A4095 culvert. There is a field drain south of Gowell Farm flowing in a southerly direction to a culvert under the A4095 and the downstream urban area. There are several ponds within the boundary of the eco development, most notably at Crowmarsh Farm and south of Himley Farm and a spring is shown to present east of Himley Farm.

In addition to these prominent water features, it is likely that a number of ditches and other smaller features drain individual fields and feed in to the network. The existing water features are identified on Drawing 7019 within Appendix A.

Isolated properties across the eco development are likely to discharge runoff from roofs and paved areas to ditches or piped networks discharging to the watercourses. Highways crossing and adjacent to the site shed surface water to their grassed verges, from where it infiltrates the ground.

Mapping obtained from Thames Water Utilities indicates that urban areas surrounding the eco development are drained by a positive drainage network of surface water pipes and manholes which discharge to nearby watercourses, and a network of foul sewers discharging by both gravity and pump to Bicester Treatment Works.

Existing Drainage Mechanism

Rainfall on the Site discharges predominantly through the following mechanisms:

- Ground Infiltration - water seeps into the ground
- Surface Water Runoff – water discharges along the surface of the ground forming surface water features such as streams, rivers and ponds
- Evaporation and Transpiration – water evaporates from the surface of the ground or is taken up by plants

During large rainfall events, surface water runoff from the Site will contribute to flow in the watercourses, both on Site and further downstream, directly via surface water runoff and indirectly via ground infiltration, by flowing along impermeable stratum and seeping into watercourses.

Assessment of the hydrological conditions provides information regarding the proportion of water discharging by these mechanisms.

Greenfield Runoff Rates

The proportion of rainfall discharging as surface water runoff across the surface of the pre-development site to watercourses has been estimated. These results are expressed as greenfield runoff rates and have been agreed with the Environment Agency. The results are shown within Table 2.1 below.

The IoH124 method has been used to derive these figures, as recommended by the Environment Agency and set out within the SuDS Manual for sites up to 200ha. Further details of their derivation are provided within the Flood Risk Assessment (document 3501-UA001881-01).

Return Period	(l/s/ha)
Mean Annual Flood	2.29
1 in 30 year	5.12
1 in 100 year	7.29

Table 2.1 Calculated Greenfield runoff rates for the predevelopment site

Ground Infiltration Rates

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 Site. Table 2.2 sets out the ground infiltration rates derived which are of relevance to the Exemplar Site. Appendix B contains the soakaway test results and test locations.

The results indicate moderate ground infiltration rates and that discharge of surface water runoff via ground infiltration is feasible at the site. The ground investigation also identifies other shallow impermeable stratum into which it would not be feasible to discharge. Therefore, the ground investigation findings have been interpreted to define areas where ground infiltration is likely to be feasible and those where relatively impermeable stratum more likely to prevent effective ground infiltration.

Trial Pit	Infiltration Rate (mm/hr)	Stratum Tested
SP1	180	Slightly clayey sandy limestone GRAVEL
SP2	56	Slightly clayey gravelly SAND
SP3	64	Gravelly CLAY

Table 2.2 Soakage test results

To achieve ground infiltration rates that reflect the likely depth of soakaway features, the soakaway tests were conducted at depths of approximately 1m below ground level. The results indicate that ground infiltration is feasible within the superficial deposits and that soakage will be feasible between depths of 1-2m below ground level where there is sufficient depth to impermeable strata, soakaways would be feasible.

2.4 Planning Context

2.4.1 Cherwell District Draft Core Strategy

The vision for the Core Strategy is to achieve a sustainable balance between water supplies 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 – CDC will seek to allocate development beyond the floodplain. Flood risk assessments will be required for appropriate sites and management sought.

2.4.2 PPS 1

The supplement to Planning Policy Statement 1 states that Eco-towns should:

a Incorporate measures for improving water quality and managing surface water, groundwater and local watercourses to prevent surface water flooding from those sources;

b incorporate sustainable drainage systems (SuDS) and, except where this is not feasible, as identified within a relevant Surface Water Management Plan, avoid connection of surface water run-off into sewers;

c include a strategy at planning stage for the long term maintenance, management and adoption of the SuDS; and

d reduce and avoid flood risk wherever practicable through consideration of the location, layout and construction, whilst not increasing the risk of flooding elsewhere and using opportunities to address and reduce existing flooding problems.

3 SURFACE WATER DRAINAGE STRATEGY

3.1 Principles

The aim of the drainage strategy is to demonstrate that it would be feasible to develop detailed drainage proposals for the development that meet the flood risk requirements of the Environment Agency and the requirements for Eco-towns as set out within PPS1, and requirements to achieve level 5 of the Code for Sustainable Homes (CSH).

The drainage strategy is based on the masterplan submission and site investigation, and sets out proposals for key drainage features and the principles in line with which detailed design should be carried out, based on currently available information. At detailed design stage further site investigations would be conducted providing additional detail of ground conditions and the findings used in conjunction with the drainage strategy to develop a detailed design.

The strategy includes proposals for a surface water drainage system based on Sustainable Drainage System (SuDS) principles, ensuring that following large rainfall events the developed site presents no greater flood risk to the surrounding area than the predevelopment site.

Residential property would be designed in accordance with the requirements of the CSH, whilst 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). BREEAM sets targets for flood risk depending on type of property and awards credits against the level achieved for other drainage criteria. For example, for educational establishments, credits can be achieved for the following:

- Rainwater and greywater recycling
- Use of SUDS to minimise flood risk

The non-residential property would be expected to meet very similar criteria to residential property and therefore, for the purposes of the drainage strategy, a common set of criteria based on CSH has been used.

Mandatory requirements are set out within CSH for the management of peak runoff rates and the volume of runoff, which can be met by ensuring that:

1 the peak rate of runoff into watercourses is no greater for the developed site than it was for the pre-development site for rainfall events having return periods ranging between 1 and 100 years.

2 the additional predicted volume of rainwater discharge caused by the new development, for a 1 in 100 year event of 6 hour duration, including an allowance for climate change, is entirely reduced using infiltration or rainwater harvesting/recycling. Where conditions make these two options infeasible, the peak discharge rate to watercourses from the entire site should be substantially reduced to a defined minimal level.

Two credits are available under CSH for the management of surface water run-off by ensuring that:

1 no discharge to the watercourse occurs for rainfall depths up to 5mm.

OR

2 agreements are established for the ownership, long term operation and maintenance of all sustainable drainage elements used.

CSH supports the drainage hierarchy which is also encouraged within other guidance documents such as the SuDS Manual and the Building Regulations, through which infiltration is to be used as far as is practicably feasible. Where it is not feasible, surface water is to be discharged in a controlled manner to nearby watercourses.

PPS25 states that an allowance for climate change should be incorporated within SuDS proposals, applied by increasing rainfall intensity within calculations. The rate recommended depends on the anticipated lifespan of the proposals in question. A value of 30% is recommended by PPS25 for the period 2085-2115, reflecting building lifespans of 75years and over. This would be appropriate for the majority of development being considered as residential property typically has a lifespan of 100years and commercial property of 75 years. Therefore, across the site an allowance for climate change of 30% has been made within calculations.

The drainage strategy has been designed to meet the requirements set out above and to prove that such a scheme is feasible, based on the currently available information.

3.2 SuDS Strategy

The development has been 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 is based on discharge via ground infiltration alone, wherever possible, in accordance with the drainage hierarchy, minimising surface water discharges to nearby watercourses and the risk of flooding due to surface water. Ground infiltration testing has been conducted and the findings outlined in Section 2.3.

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 have therefore been proposed across the site where appropriate and 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 are proposed and described within Sections 3.2.3 and 3.2.4. Each treatment train has been assessed hydraulically using WinDES to model their control of water quantity, with further details provided within Section 3.2.9. The treatment trains have been assessed in terms of water quality using a matrix to ensure that the best water quality is achieved through feasible and practical proposals, as set out within Section 3.2.6.

The strategic layout for surface water drainage infrastructure is shown on Drawings 7060 and 7061 within Appendix A. Key elements of the strategy are outlined further in this section.

3.2.1 Soakaways

During large rainfall events, hard paved areas would discharge surface water to soakaways at a greater rate than it is possible to discharge to the ground. Storage volumes are therefore required to store accumulating surface water whilst it steadily discharges to ground.

Storage is generally provided integral with the soakaway but it can take a number of forms, including surface features, such as basins, ponds or swales, or subsurface features, such as tanks, cellular units and permeable pavements, with incoming water filling the soakaway and gradually discharging to the ground through the base and sides. It is likely that a range of forms would be constructed at the site depending on factors local to the soakaway, including the depth of incoming drainage, water treatment requirements, land use and adoption requirements.

As key elements of the strategy set out, each indicative soakaway has been designed and modelled to support the feasibility of the proposal principles, specifically the use of ground infiltration on site. Further details of each type of soakaway proposed are set out in Section 3.2.3.

3.2.2 Controlled Discharge to Watercourse

The controlled discharge of surface water to watercourses is required where ground infiltration and soakaways are not likely to be feasible. Discharge control would be provided by a flow control device restricting discharges to the mean annual greenfield runoff for the site for all rainfall events up to the 100 year event. During large rainfall events, surface water would enter the drainage system at a greater rate than can be discharged, requiring storage to accommodate the resulting volume of water.

The mean annual greenfield runoff rate has been derived using IH124 method, as outlined in Section 2.3. Approximately 3.5ha of the proposed development would remain relatively unaffected by the proposals, comprising perimeter areas of landscaping and flood zone, and would continue to drain as per the natural mechanisms. This area has therefore been excluded from the calculation of the total site greenfield runoff rates, which have been calculated by applying the residual site area of 17.5ha to the greenfield runoff rates, as shown in Table 3.1.

Total discharges from the development to watercourses would be limited to the mean annual greenfield runoff rate of 40.1l/s, to significantly reduce flood risk as outlined in Section 3.2.7.

Areas containing storage structures such as basins would be landscaped and designed to achieve an integrated layout suitable to the spatial requirements of both uses, meeting the functional requirements of the soakaways and the aesthetic and amenity requirements of landscaping.

Return Period	Greenfield Runoff	
	(l/s/ha)	(l/s)
Mean Annual Flood	2.29	40.1
1 in 30 year	5.12	89.6
1 in 100 year	7.29	127.6

Table 3.1 Calculated Greenfield runoff rates for the predevelopment site

3.2.3 Roads, Paved and Parking Areas

Adopted roads within the site would drain via a mixture of permeable paving, swales and channel features, discharging to the ground or to ponds or subsurface storage to a watercourse. Private roads, parking, driveways and other areas of paving would drain surface water via permeable block paving.

Permeable Block-Paving

Permeable block paving are designed systems comprising block paviors underlain by a permeable sub-base. The block paving is spaced with permeable joining medium such as sand which allows rainfall to infiltrate and enter the sub-base, in which it is stored as it slowly infiltrates the ground beneath. A typical detail of permeable block paving is provided on drawing 7163 within Appendix A.

During normal rainfall events, areas of permeable paving would discharge via ground infiltration alone, as described above. During exceptionally large rainfall events and in the event of blockages and other such failures, water would overflow to adjacent areas of permeable paving or flow overland, directed away from property, to basins and ponds and from there to a watercourse.

Permeable paving provides a high level of treatment of runoff, with filtration trapping and biologically breaking-down particles and pollutants such as suspended solids and hydrocarbons.

Infiltration SuDS Feature

Infiltration trenches are proposed to be located adjacent the primary roads within the site and comprise an excavation with permeable base, backfilled with granular filter and plant bedding material. A typical detail is provided on drawing 7163 within Appendix A.

By incorporating a flat vegetated verge between the road and infiltration trench, particles can be trapped and removed by filtration as the water passes through the vegetation and then percolates down through the bedding medium or granular filter material. Surface water would discharge directly to ground, infiltrating the base and sides of the trench, with infiltration trapping and biologically break-down particles and pollutants such as suspended solids and hydrocarbons.

Village Street SuDS Feature

The commercial hub of the Exemplar site is the village High Street. A SuDS feature incorporating attractive planting would serve this area. A narrow, relatively deep and vertically faced channel would be formed within the paved area, backfilled with planting and filter medium. A grill near the surface would provide a resilient surface through which would protrude vegetation, such as reeds planted in the base. A typical detail is provided on drawing 7163 within Appendix A.

Surface water would run off the surrounding paved area over the edge of the channel from where it would be filtered by the vegetation and planting medium, stored and treated, whilst slowly being released to a nearby basin or pond by a flow control device. Particles would be trapped by the vegetation or drawn into the plants thus improving the water quality, whilst filtration in the planting medium would trap and biologically break-down particles and pollutants such as suspended solids and hydrocarbons.

Ponds

Ponds would be incorporated as permanent water features in some areas. Ponds would be supplied with water by channels from the nearby road network and would incorporate an element of attenuation storage before overflowing to adjacent basins and storage structures, further defined in section 3.2.4.

3.2.4 Property

Surface water runoff from the roofs and paved areas of residential and commercial property would be discharged via soakaways wherever reasonably practicable. Where soakage is not practicable, rainwater would be discharged to a network of pipes and basins for controlled discharge to watercourses.

Where soakaways are feasible, each residential property would incorporate a combined rainwater harvesting and soakaway system within the back garden. Rainfall would be retained within the rainwater harvesting tank, ready for future reuse within the property. Excess rainwater would discharge to a soakaway structure within the garden should the tank capacity be exceeded.

Commercial property, the school and other areas would be served by separate private drainage systems incorporating basins, ponds and other soakaways within open areas of the property boundary. Many forms of soakaway could be used and the selection would be made to suit each property, varying in form to suit land availability and the quality of the runoff water. Rainwater harvesting would also be incorporated.

At locations where shallow impermeable strata prevent the use of a soakaway, excess rainwater within the rainwater harvesting tank would discharge by pipe to a basin or pond nearby via a local pipe network. Basins and ponds would discharge via pipework to a nearby watercourse at a controlled rate to ensure site discharges remain at greenfield rates.

Social housing and flats may benefit by allowing a number of properties to discharge to shared soakaway and rainwater harvesting features, allowing substantial volumes of water to be stored for reuse.

Rainwater Harvesting

The development is in an area subject to water stress. Rainwater harvesting allows reuse of collected rainwater within the home to supply toilets and washing machines, and for use in gardens and landscaped areas, reducing demand on water supply infrastructure.

Rainwater would run off a roof into guttering, protected by a leaf guard, and discharge via downpipes to a subsurface rainwater harvesting tank. The water would be filtered on entry to remove sediments and stored within the body of the tank. A small submersible pump would supply water to the property as required. When the tank is at capacity, additional rainwater would be discharged via a pipe to a soakaway wherever feasible, and where not feasible via pipework to a basin or wetland area.

When the rainwater harvesting tank is empty, the water supply would revert to the potable (Water Authority) network. The Water Cycle Study considers the demand for potable water in further detail (document 5003-UA001881-01, Hyder, November 2010). A typical detail is provided on drawing 7163 within Appendix A.

Overflow Soakaways

Should a rainwater harvesting tank exceed capacity during periods of consistent heavy rainfall, an overflow pipe would discharge excess water to a percolation tunnel, lined soakaway or similar structure within the property curtilage, where ground infiltration methods are feasible. A typical detail is provided on drawing 7163 within Appendix A.

Overflow Structures, Basins and Wetlands

Overflow water from rainwater harvesting systems would be directed to nearby storage structures located around the site, including basins, subsurface storage structures and wetlands, in areas not suitable for ground infiltration methods and soakaways.

Following rainfall events, basins located around the site would receive and store surface water runoff, slowly discharging to the nearest watercourse at greenfield rates via a flow control device within an adjacent chamber. The basins would be designed to incorporate small areas for relatively frequent inundation allowing the creation of wetlands, and larger and less frequently inundated areas which would provide additional storage volume during less frequent, very large rainfall events. It is anticipated that during such events the basins would typically discharge all water within a maximum of 12 hours. The basins would be modelled in detail at detailed design stages, but it may be possible to achieve a frequency of inundation of 12 hours once every two years for the area less frequently inundated, allowing use of the area for amenity.

Surface water would pass over and through vegetation within the wetland area, filtering some particles and retaining others. Detained water would allow particles to settle, improving the quality of the water discharged. Prior to discharge to a storage structure, additional treatment could be provided to runoff from paved areas through use of bypass separators (petrol interceptors) and from all areas through use of a vortex treatment system, through preference would be given to passive treatment using vegetation.

Basins would be designed to form a part of the landscaping, shaped to allow overflow to adjacent roads preventing the build up of unsafe volumes and depths of water and incorporating shallow areas at the periphery. Typical details are provided on drawing 7164 within Appendix A.

Subsurface Storage

Some locations are likely to be highly constrained and the provision of surface storage structures such as basins, ponds and wetlands may not be feasible to accommodate the entire storage volume required. In such locations subsurface storage would be used to supplement the preferred surface storage structures. A variety of methods are available, including oversized pipes and cellular storage.

3.2.5 Adoption and Maintenance

Soakaways on site would be adopted and maintained by a variety of parties. It is likely that soakaways serving residential and commercial properties would become the responsibility of property owners or the private maintenance company proposed to manage other shared facilities on the site, with residents and occupiers paying a maintenance fee.

Where soakaways cannot be provided close to the source of runoff, carrier drains would convey runoff to infiltration channels, basins and ponds. These carrier drains would be offered for adoption by the Water Authority.

Soakaways serving private commercial and community premises would be privately owned and maintained and would become the responsibility of the property owner. Community facilities such as schools would also be responsible for the drainage features within the property.

Soakaways and drainage features conveying and discharging runoff from adopted highways would be offered for adoption by the Highway Authority, such as the Infiltration SuDS Feature.

All adopted features would be developed in consideration of the requirements of the adopting authority. For example, ponds and basins would incorporate banks not steeper than 1 in 3 and maintenance strips between the structure and adjacent property to facilitate maintenance and any easement required.

3.2.6 Water Quality and Treatment Trains

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 treatment trains have been assessed and the findings presented within Appendix C.

3.2.7 Flood Volume

The proposed drainage strategy results in the discharge of a significant proportion of surface water by ground infiltration, however discharges to watercourses are also required.

The additional predicted volume of rainwater discharge to watercourses caused by the new development, for a 1 in 100 year event of 6 hour duration, including an allowance for climate change, is likely not to be entirely reduced for the Exemplar Site. Any flood risk due to the increased volume of water discharged from the site is mitigated by the applied restriction of outflow to the mean annual greenfield run off rate.

Therefore, the peak discharge rate to watercourses from the Exemplar site would be substantially reduced, in line with the requirements of the Code for Sustainable Homes.

Flow control devices would restrict the rate of discharge to watercourses, but overall volume of discharge would be greater than pre-development. Therefore, to provide the required betterment in terms of flood risk, discharges from the site would be restricted to the mean annual greenfield runoff rate for events up to the 100 year event, thereby reducing the flood risk downstream through significantly reduced discharge rates from the site.

3.2.8 Overland Flowpaths

The Code for Sustainable Homes requires that the site should be designed to accommodate all runoff for events up to the 100 year rainfall event, with an appropriate allowance for climate change. The ponds, basins and other structures discharging directly to the watercourse would be designed to ensure this criterion is met and to ensure that surface water in excess of this event is discharged safely away from property to a watercourse via overland flowpaths. Such flow paths would include the local road network in some locations and direct overflow to watercourses in others.

Individual drainage features would be designed to accommodate a variety of specific maximum rainfall events depending on the requirements of legislation, the adopting party and constraints local to the feature, typically the 10 year, 30 year or 100 year rainfall events. Therefore, where not feasible, practical or permitted to deliberately accommodate 100 year events, surface water in excess of the design event could result in overland flows. Overland flows would be directed to areas where storage can be provided, such as within basins and ponds designed to accommodate such flows, and permeable paving which would be likely to contain significant surplus storage within its substructure. This is shown in calculation 7010-UA001881 in Appendix D. Anticipated overland flowpaths have been shown on Drawings 7160 and 7161 in Appendix A.

3.2.9 Hydraulic Modelling

Key elements of the drainage strategy set out above have been modelled to demonstrate the feasibility of the proposals, specifically the ability of the site to discharge by ground infiltration and to accommodate suitable basins and other storage structures. Typical elements have been modelled as the final designs would be determined at detailed design stage in consideration of the final site layout and additional information.

Modelling of the drainage network has been undertaken using industry standard software, MicroDrainage WinDES. WinDES uses the Modified Rational Method to analyse pipe networks, soakaways and other drainage features, running a suite of design storms through the system to comprehensively test a network or SuDS feature.

Each element has been designed to meet a variety of requirements including flood risk, adoption and health and safety, with amenity and habitat features incorporated where feasible. Each element has been tested for the appropriate protection (e.g. 10 years) using a range of rainfall events with storm durations varying between 15 minutes and 10 days. Typical details are shown on Drawings 7163 and 7164 within Appendix A, and calculations provided within Appendix D.

Rainwater harvesting would provide significant storage within the system. However, this storage has not been included within calculations as a worst-case scenario has been assumed in which the rainwater harvesting tanks are already at capacity when rainfall events begin.

The surface water drainage strategy on Drawings 7060 and 7061 in Appendix A shows a pipe network that indicates the maximum potential lengths to verify the extent of the site that would drain if directly connected to a basin or pond.

Each pond catchment has been defined and, based on the ground investigation to date, a proportion of properties are assumed as being feasible to discharge via soakaways. Those that would not drain by soakaway would discharge to basins/ponds. Areas which are drained by soakaway would not need the pipe network indicated and therefore the constructed network would be significantly smaller, subject to the findings of the site investigation at detailed design stage.

Significant storage structures such as ponds and basins have been associated with a catchment, comprising property and road areas. A large proportion of the site would discharge via ground infiltration, and therefore an allowance has been made within each catchment for the proportion of properties which are likely to infiltrate and would not require storage within structures. The proportion has been estimated based on the depths of impermeable stratum recorded within the site investigation. The catchments are shown on Drawings 7160 and 7161 within Appendix A and modelling results within Appendix D. A summary of the results is shown in Table 3.2.

Reference	Storage Volume (m^3)	Discharge (l/s)
1	105	6.1
2	80	2.5
3	215	12.7
4	95	8.7
5	65	5
6	90	5
Total	645	40

Table 3.2 SuDS Storage Structure Design Summary

4 FOUL WATER DRAINAGE STRATEGY

4.1 Principles

Foul water at the Exemplar Site would discharge to a manhole on the existing nearby Thames Water network for treatment within Bicester Sewage Treatment Works. A pumping station would be located on site to pump effluent via a rising main up to the level of the connection point.

A significant reduction in discharges would be achieved through the implementation of water efficient measures, when compared to regular developments.

During future stages of the wider NW Bicester eco development, it may be possible and desirable to treat foul water on site. Foul water from the Exemplar site could be disconnected from the Thames Water network and redirected via the pumping station to a centrally located treatment plant, if this is found to be the most suitable option.

The foul water drainage strategy is shown on drawing 7162 within Appendix A.

4.2 Foul Loading

A breakdown of the types of property within the masterplan has been used to assess foul water discharges. Accommodation and non-residential building schedules have been provided within Appendix E. These figures were used to calculate the preliminary flow estimate based on the number of occupants for each dwelling, the number of end-users/floor plan area for non-residential property and typical usage rates provided by Thames Water (Thames Water Guidelines for Undertaking Sewerage Modelling (November 2005)). The peak foul water loading has been assessed based on the Thames Water rates as being 49l/s.

The Thames Water rates are conservative and actual discharges from site will be reduced by use of water efficient appliances, and potentially greywater recycling. The rates have been assessed and reduce the peak discharge to 28l/s.

4.3 Liaison with Thames Water

An extensive foul water network serves Bicester. 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.

Thames Water have agreed (see correspondence in Appendix F) 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.

5 CONCLUSION

A drainage strategy is set out that provides a framework for development of both foul and surface water management systems for the Exemplar Site and ensures that the requirements of level 5 of the Code for Sustainable Homes are achieved.

Foul water at the site would discharge offsite and connect to the local sewer network, with a significant reduction in discharges to be achieved through the implementation of water efficient measures. The wider eco development offers the potential to redirect foul water arising from the Exemplar Site to a treatment area within the eco development, further reducing foul water discharges to the local sewer network and Bicester Treatment Works, if this is found to be the most sustainable option.

The widespread use of Sustainable Drainage Systems (SuDS) and rainwater 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. Ground infiltration would be used extensively throughout the Exemplar Site to ensure that discharge volumes to watercourses are kept to a minimum and that ground water resources continue to be recharged by the site, whilst attenuation features will ensure that discharge rates to watercourses are reduced during large rainfall events to far below existing rates, 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 excellent 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.

Appendix A

DRAWINGS

7001-UA001881- Site Location & Boundary

7013-UA001881 – Exemplar Area

7160–UA001881 - Surface Water Drainage Layout 1 of 2

7161–UA001881 - Surface Water Drainage Layout 2 of 2

7162–UA001881 - Foul Water Drainage Layout

7163-UA001881 – Drainage Details 1 of 2

7164-UA001881 – Drainage Details 2 of 2

Appendix B

GROUND INFILTRATION RATES

2004-UA001881- Exploratory Hole Locations

Soil Infiltration Rate Test Data

Appendix C

TREATMENT TRAIN ASSESSMENT

Appendix D

HYDRAULIC CALCULATIONS

7009-UA001881- Domestic Soakaway

7010-UA001881 – Permeable Block Paving

7011-UA001881 – SUDS Storage

7012-UA001881 – SUDS Roadside Feature

Appendix E

FOUL WATER LOADINGS

7006-UA001881- Site Sewage Generation

Appendix F

CORRESPONDENCE

TW email 23 Nov 2010