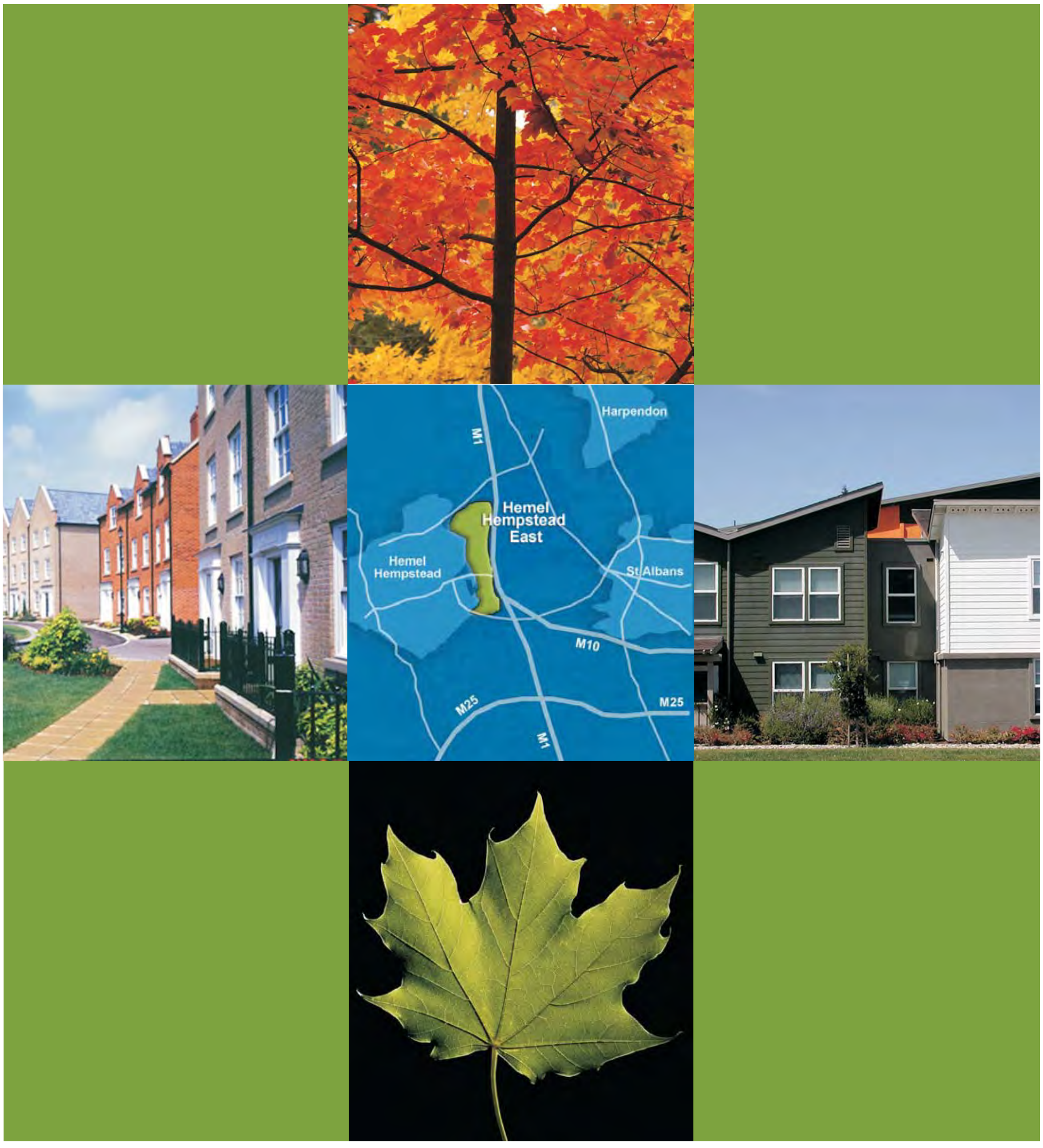
Entec

Part C
Climate Change and Sustainability



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1. Introduction

The purpose of this Part C of the document is to specifically explore how the proposed mixed use development at Hemel Hempstead East can push the boundaries of sustainability, creating a highly sustainable mixed use extension to the town which assists in the overall regeneration of the town.

It explores the need for highly sustainable development which responds to climate change and considers key issues such as reducing carbon dioxide emissions, reducing waste arisings and water use. The Crown Estate is committed to the principles of sustainability and stewardship and having the advantage of single ownership of this area of land believes that there is a real opportunity to ensure growth of the town through development of an exemplar development which pushes the boundaries of sustainability whilst being well integrated with the town.

This section explores different options and does not specify which measures would be incorporated into the proposed development at this stage. This is a decision that will need to be made as the development progresses through the LDF process and once there is more certainty about the amount and specific direction of development.

Chapter 2 of this Part C considers options relating to the energy/carbon strategy for the proposed development at Gorhambury. This looks at the background of evolving energy/carbon policy which is critical to the strategy. If the development is constructed in a phased manner between say 2012 and 2032 and the government's proposed timetable to zero carbon is adhered to, much of the development will be built to comply with building regulations that require zero carbon housing. The proposals for the development will therefore need to consider how to achieve this. Some of the proposed development is intended to be built before the likely requirement for zero carbon comes into force. This part of the development will most likely have to meet tighter building regulations than are currently in force but it should also consider whether zero carbon can or should be achieved voluntarily.

The energy use of the proposed development is estimated and the possible options to provide the required energy for the proposed development are then considered. The technical options available for the various approaches are considered along with some basic cost estimates for the different approaches. This chapter should be read alongside chapter 8 Part B on infrastructure and utilities which looks at the likely infrastructure requirements of the site and capacity issues. This chapter in Part B does not take into account any of the measures put forward as options in this Part C. Once these are taken into account, the infrastructure requirements are likely to be reduced as will the demands for gas and electricity from the main network.

Chapter 3 considers the issues surrounding water supply, wastewater, and drainage for the proposed development to the east of Hemel Hempstead. In particular it focuses on the sustainable use of water resources and considers how water demand can be minimised and how measures could be incorporated to work towards water neutrality. Water conservation will be particularly important at Gorhambury as there are water supply issues in the whole region, and therefore if measures can be introduced to reduce water use at source and encourage water conservation, the demand for water from the development will be reduced. This chapter should be read alongside chapter 8 Part B on infrastructure and utilities which looks at the likely infrastructure requirements of the site and

capacity issues. The baseline situation and likely requirements set out in Part B do not take into account the measures put forward as possible options in this Part C. If any of or a combination of these measures were introduced then the water requirements for the site would be reduced.

Chapter 4 considers two main sources of waste associated with the development at Gorhambury, construction waste and municipal waste. In particular it focuses on the key areas in which waste management can increase the sustainability of the overall development and it proposes measures to assist in achieving this.

2. Energy/Achieving Zero Carbon

2.1 Introduction

The purpose of this chapter is to consider the options for achieving zero carbon for the residential element of the proposed development. It firstly considers the policy background and what standards are currently and what will be required in future, including details of the Code for Sustainable Homes. The chapter goes on to assess the predicted energy use of the development and to identify different options for meeting this demand from renewable resources, including consideration of wind energy and biomass energy. The measures suggested in this chapter are set out as options, and it should be noted that these options are not taken into account in chapter 8 Part B on infrastructure and utilities which sets out the likely demand for energy from the development assuming traditional energy requirements without the measures proposed in this chapter being incorporated.

2.2 Policy Background for Energy in the Built Environment

2.2.1 Current Building Regulations

In England and Wales, energy use in new buildings is regulated by Part L of the building regulations which deals with the conservation of fuel and power.

Part L was last updated in April 2006 and a number of important changes were introduced to the regulations. The most important change was a shift from regulations defined in terms of energy to a definition based on carbon dioxide emissions. To comply with building regulations it is now necessary to enter details of the building into an approved energy calculation model that predicts likely emissions from the building. Buildings must be designed so that their emissions are below certain limits in order to gain the building control approval which is necessary before construction. The precise limit varies slightly from building to building depending on the use of the building, the size and shape of the building, the heating fuel and whether or not a building is air conditioned.

Table C2.1 gives an indication of the carbon emissions limits for different building types.

Part L sets a limit on carbon emissions associated with the energy use of building services. The emissions limits have been set at a level that ensures all new buildings have building services of a good standard of energy efficiency which is substantially better than typical existing buildings. The limits have generally been set at the threshold of cost-effectiveness so that while it is possible to improve the energy efficiency, there is no clear economic benefit in doing so.

Nevertheless, carbon emissions of buildings can be reduced relative to the building regulations limits in a number of ways such as either 1) passive design to reduce energy consumption, 2) improving energy efficiency to reduce energy consumption or 3) providing energy from low or zero carbon sources (renewable energy). Currently

building regulations do not require renewable energy and because renewable energy is often more expensive than energy efficiency options it is not standard practice to include renewable energy.

Building regulations are seen as an important part of the government's climate change policies and so Part L will be reviewed regularly (the maximum period between reviews is set at five years). The government has already given several indications of the future direction of building regulations and the next review of Part L is set to start in 2008 with an updated set of regulations expected in 2010. The future of building regulations is discussed further in the Timetable to Zero Carbon section.

'Regulated' and 'Unregulated' energy

Not all energy that is used in buildings is currently regulated by the building regulations. Generally speaking, only building services that use substantial amounts of energy such as space heating, hot water, cooling/humidification, ventilation and lighting are covered. Other building services such as lifts, escalators, emergency lighting, IT/communications and water pressurisation are not regulated. Energy consumption associated with activities undertaken in the building such as use of domestic appliances and cooking, office equipment, machinery and catering are not covered by building regulations and are also unregulated.

Table C2.1 gives an indication of the likely regulated and unregulated carbon dioxide emissions per square meter for different building types.

Because energy used by machinery, computers, catering equipment etc. is not regulated, the equipment used is often not as good as it could be. It is likely that future building regulations will be expanded in scope to include some or all of the 'unregulated' energy uses in an attempt to control emissions associated with such equipment.

Table C2.1 Typical Carbon Dioxide Emissions from Buildings

Building Type	'Regulated' Emissions($kgCO_2/m^2$)	'Unregulated' Emissions ($kgCO_2/m^2$)
Existing buildings		
Average existing household	60	15
Typical existing air-conditioned office	130	95
New buildings		
Terraced house/flat gas heated	19	15
Terraced house/flat electrically heated	28	15
Detached house gas heated	24	13
Detached house electrically heated	30	13

Building Type	'Regulated' Emissions($kgCO_2/m^2$)	'Unregulated' Emissions ($kgCO_2/m^2$)
Office without cooling	35	95
Office with cooling	65	95
Industrial building	25	0-1,000

2.2.2 Code for Sustainable Homes

The Code for Sustainable Homes (CSH) was introduced in April 2007 following a manifesto pledge by Labour in the 2005 general election to introduce a Code for Sustainable Buildings. It is anticipated that a more general Code that can also be applied to non-domestic projects will be launched sometime in 2008.

The CSH has a wider remit than energy/climate change and considers a number of other social and environmental issues such as waste and recycling, water conservation, noise, crime, accessibility and adaptability. A variety of credits can be achieved by including certain sustainability measures (such as measures to reduce carbon dioxide emissions or water consumption) into a building project. Depending on the amount of credits achieved, a certain sustainability rating is awarded. The CSH has six different levels of sustainability with Level 1 being the lowest and Level 6 being the highest.

In addition to minimum number of credits, each increasing level of the CSH has an increasingly demanding minimum energy/carbon performance and there are also mandatory aspects of the code relating to potable water consumption, site waste management, domestic recycling facilities, surface water and materials. The gradual improvement in energy/carbon performance required with each increasing level of the code is shown in Figure C2.1.

The CSH is (almost) entirely voluntary at present (some exceptions are that homes funded by the Housing Corporation, Defence Estates or built on English Partnerships' land must achieve Level 3 of the CSH). Central government has indicated that it may become mandatory for new homes to go through the CSH rating process in the future but there will not be a requirement to meet a specific level of the CSH, rather, the CSH will be used as a tool that will allow consumers to differentiate between new homes and so drive a shift to more sustainable homes if that is what the market desires. Some local authorities may incorporate minimum CSH standards into their planning legislation.

The Crown Estate will seek to achieve a minimum of Level 3 of the Code for Sustainable Homes on development on its land at present.

Figure C2.1 Extract from the CSH

Achieving a sustainability rating

	Minimum Standards				
	Energy		Water		
Code Level	Standard (Percentage better than Part L[1] 2006)	Points Awarded	Standard (litres per person per day)	Points Awarded	Other Points[4] Required
1(★)	10	1.2	120	1.5	33.3
2(★★)	18	3.5	120	1.5	43.0
3(★★★)	25	5.8	105	4.5	46.7
4(★★★★)	44	9.4	105	4.5	54.1
5(★★★★★)	100[2]	16.4	80	7.5	60.1
6(★★★★★★)	A zero carbon home[3]	17.6	80	7.5	64.9

Notes

1. Building Regulations: Approved Document L (2006) – 'Conservation of Fuel and Power.'
2. Zero emissions in relation to Building Regulations issues (i.e. zero emissions from heating, hot water, ventilation and lighting).
3. A completely zero carbon home (i.e. zero net emissions of carbon dioxide (CO_2) from all energy use in the home).
4. All points in this document are rounded to one decimal place.

NB While the table refers to a percentage improvement in energy performance relative to Part L, this is actually meant to be improvement in carbon performance.

The government has stated that the CSH will be used to signpost future changes to Part L which means the energy/carbon aspects are of particular interest. To achieve Level 6 of the CSH it is necessary for homes to be zero carbon and the code sets out what is expected to meet this criteria. Firstly this requires that homes are super-insulated to minimise heat demand. It also requires that the calculations required for Part L predict zero emissions and that additional electricity generation is installed to power 'unregulated' energy use for domestic appliances and cooking (a simple formula is provided to predict this energy use, typically around 30-40% increase compared to 'regulated' emissions). If domestic air conditioning is installed, additional renewable energy generation capacity will also be required.

Accredited External Renewables

The CSH introduces the concept of 'Accredited External Renewables' for the first time. Previously, to have any impact on reducing a building's calculated carbon dioxide emissions, renewable energy systems would have had to have had a direct connection to the building (effectively meaning energy systems had to be located on or very close to the site). The CSH recognises that in some cases, it will not be possible to achieve zero carbon with systems

located on or close to the site and that, to ensure substantial generation of renewable electricity, it may be necessary to locate systems such as wind turbines a substantial distance away. The CSH provides a number of rules for remote systems and these are:

i) systems must be renewables as defined by the Energy Act 2004 (i.e. defines rules around energy from waste and nuclear power);

ii) systems must be new generation designed to meet the needs of the development; and

iii) systems must be additional to capacity already required under the Renewables Obligation (i.e. it will not be possible to sell Renewable Obligation Certificates for energy generated in order to make homes zero carbon).

2.2.3 Planning Policy

Planning policy is also being used to address climate change in a number of ways. Primarily, planning policy is expected to develop spatial strategies which identify sites for development that will create minimal environmental impact and consider future impacts of climate change (e.g. flooding). Planning policy increasingly has an element of energy policy with Local Authorities expected to require a proportion of energy used in new developments to be generated from renewable sources on site and to promote district heating schemes and the benefits these can offer.

The government set out their thinking on the relationship between planning, the CSH and building regulations in a recent consultation document 'Building a Greener Future: Towards Zero Carbon Development'. This makes it clear that government expects to address emissions from new buildings primarily through building regulations and indeed, the consultation proposed a timetable to make new housing zero carbon. This was partially intended to give clarity to local authorities and so avoid the need for local planning policy to seek to develop independent rules covering emissions from buildings.

Nevertheless, local planning authorities are continuing to set more demanding requirements for a greater proportion of energy use to be met by renewable energy systems. Some planning authorities are also setting a requirement for all new homers to meet minimum standards in the (ostensibly voluntary) CSH.

2.2.4 Timetable to Zero Carbon

As well as the 'Building a Greener Future: Towards Zero Carbon Development' consultation, initiatives such as English Partnerships' Carbon Challenge and the HMRC stamp duty exemption for zero carbon homes demonstrate the government's commitment to requiring new housing to be zero carbon.

Government has now put forward their proposed timetable to zero carbon housing which suggested an incremental decrease in carbon emissions allowed from new housing and this is shown in Figure C2.2.

Figure C2.2 Extract from 'Building A Greener Future'

Date	2010	2013	2016
Energy/carbon improvement as compared to Part L (Building Regulations 2006)	25%	44%	zero carbon
Equivalent energy/carbon standard in the Code	Code level 3	Code level 4	Code level 6

It can be seen that the future standards in 2010, 2013 and 2016 have been related to the CSH (which is expected given that government has said that the CSH will signpost future building regulations). This means that building regulations in 2016 are likely to be similar to the requirements for meeting Level 6 of the CSH (i.e. super-insulation, zero carbon for items covered by Part L and additional electricity generation capacity for any 'unregulated' energy use).

Domestic and Non-Domestic Environments

The timetable for zero carbon is very much focussed on housing and there are a number of reasons for this. From an environmental point of view, the UK intends to build large numbers of additional homes over the next 20 years and it is seen as important to minimise the impacts of this construction.

It is also worth noting that the practicalities of setting regulation to make non-domestic buildings zero carbon are more challenging. This is because the energy use in non-domestic buildings is far more diverse than that found in housing and it is practically impossible to predict the likely energy use of a speculative industrial development until an occupant and likely use of the building has been identified. For this reason, it is thought unlikely that a blanket requirement for non-domestic buildings to be zero carbon will be enacted in the near future.

Recent exchanges with the government department responsible for building regulations and developing the Code for Sustainable Buildings suggest that it is intended to set challenging carbon targets for non-domestic buildings which will be zero carbon if a practical approach can be found for achieving this. Thus construction of some types of building where the unregulated energy use is well understood (generally commercial or service sector buildings such as offices rather than industrial sites) may well require a substantial amount of renewable energy.

2.3 Energy/Carbon Strategy

The energy/carbon strategy for residential development at Gorhambury needs to be considered against the background of evolving energy/carbon policy described in the previous section.

If the development is constructed in a phased manner between 2012 and 2032 and the government's proposed timetable to zero carbon is adhered to, much of the development will be built to comply with building regulations that require zero carbon housing. The proposals for the development will therefore need to consider how to achieve this.

Some of the proposed development is intended to be built before the likely requirement for zero carbon comes into force. This part of the development will most likely have to meet tighter building regulations than are currently in force but it should also consider whether zero carbon can or should be achieved voluntarily.

2.3.1 Predicted Energy Use for the Development

It is important to understand that while zero carbon homes will be designed to have very low heat demand, they will still use some energy for hot water, cooking, appliances, heating and lighting. What makes these homes zero carbon is the fact that all of their energy needs will be provided from renewable sources. The same goes for non-domestic zero/low carbon buildings.

In order to develop a strategy for supplying the development with renewable energy, it is necessary to assess the energy demand and to break the demand down into certain forms of energy that can be provided by different systems:

1. heat energy - some energy is used in the form of heat and this can be provided by solar energy, geothermal energy, combustion of fuel or electricity;

2. cooling - some cooling is likely to be required but this can be provided from a number of sources such as ground water (or other ambient sources), absorption cooling (which can be powered by heat) or electricity; and

3. electricity - there will ultimately be a demand for electricity in the development.

The energy use has been estimated with a number of assumptions including volume (7,000) and mix of housing types and amount (~220,000m^2 - a floor area equivalent to around 44 football pitches) and types of non-domestic buildings.

It has been assumed that buildings will include a high degree of energy efficiency and will be designed to take advantage of passive techniques (good use of daylight, solar gains, thermal mass etc.).

Table C2.2 Estimated Energy Demand for Gorhambury

Energy Type	Energy demand (GWh pa)		
	Housing	**Non-domestic**	**TOTAL**
Electricity	19.6	6.5	26.1
Heat	32.8	9.8	42.6
Cooling energy	0	0.8	0.8
TOTAL	52.4	17.1	69.5

This is equivalent to around 3MW of continually running electricity generation, 5MW of continually running heat generation and around 0.3MW of installed cooling capacity.

Impact of Phasing

The figures in Table C3.1 represent the estimated total energy consumption of buildings in the completed development. Energy consumption will be lower than this whilst the development is being constructed with the annual increase in energy consumption dependent on the build rate that is achieved.

Predicted Requirement for Renewable Energy

It is anticipated that housing will have to be zero carbon in the near future but it is not thought likely that non-domestic buildings will have to be completely zero carbon. As a minimum, the energy use of non-domestic buildings associated with building services (cooling, heating, hot water, ventilation, lighting, etc.) is likely to have to be met from renewables. Table C2.3 gives an estimate of the amount of different forms of energy to be provided from renewable sources.

Table C2.3 Percentage of Energy from Renewable Sources

Energy Type	Energy demand (GWh pa)	
	Housing	**Non-domestic**
Electricity	100	33-100*
Heat	100	100
Cooling energy	n/a	100

* It is not expected that building regulations will require 'unregulated' energy use in non-domestic buildings to be supplied from renewable sources but this is subject to change. Additional capacity could be provided voluntarily.

2.3.2 Meeting the Demand from Renewable Resources

There are a number of options available to provide the required energy for the proposed development at Gorhambury. For example, zero carbon heat could be provided from individual boilers in homes burning renewable biomass fuels (e.g. wood) or from larger communal heat producing facilities such as biomass fuelled CHP. Solar thermal systems could also be used although these would not be able to provide 100% of the heat demand. Even electric space and water heating could be used provided that sufficient renewable electricity generation capacity was installed to meet the annual demand.

The implications of choice of system for space heating (and to a lesser degree cooling) are significant. If the development uses communal biomass CHP to both generate electricity and provide heat via district heating, around 3.75MWe of biomass CHP and a further 3MW of wind turbine would make the development zero carbon. However, if electric heating was used to provide all space and water heating, around 32MW of wind turbine would be required.

The section below reviews the technical options available and considers the pros and cons of several different approaches. This considers standalone systems that could be used for a single home and communal systems that would serve multiple homes. The pros and cons often boil down to a trade-off between reduced system costs on site and an increased need for accredited external renewables off site (which will have a cost implication).

Standalone Systems

OPTION ONE:
Heat from conventional electrical space heating and hot water from combination of solar thermal/immersion heating *Electricity from accredited external renewables (likely to be large wind turbines)*
Pros
Lowest capital cost (considering site only)
Good control
Can be applied at small scale
Simplest to implement
Cons
Most carbon intensive way of heating dwellings so largest demand for accredited external renewables (i.e. largest off-site cost)

OPTION TWO:
Heat from air source heat pump (ASHP), low carbon electrical heating in combination with solar thermal panels *Electricity from accredited external renewables (likely to be large wind turbines)*
Pros
Can be applied at small scale
Cons
Still a large demand for accredited external renewables
Considerable capital cost (considering site only)
OPTION THREE:
Heat from biomass stove with back boiler in winter *Heat from solar thermal with immersion heater in summer*
Pros
Can be applied at small scale
Cons
Still a demand for considerable amounts of accredited external renewables
Space heating less controllable
Maintenance requirement of biomass stove
OPTION FOUR:
Heat and electricity from hydrogen fuel cell micro-CHP
Pros
All heat and electricity generated on site
Can be applied at small scale
Cons
Still at prototype R&D stage in 2007 - available in 2012?
Requires development of renewable hydrogen supply chain - unlikely by 2012
Cost implications unknown

Note: Further options could consider onsite generation from micro-renewables (e.g. photovoltaic (solar electric) panels and small wind turbines). These technologies have not been considered in detail as a source of electricity generation as they are considered cost-ineffective (when compared to large scale wind turbines). For example, a typical home would require ~£20k of PV but only ~£2k of large scale wind to meet the annual electricity demand.

Community Scale Systems

OPTION ONE:
Large biomass CHP plants distributing renewable heat through district heating and generating ~75% of the required renewable electricity *Remaining electricity from accredited external renewables (likely to be large wind turbines)*
Pros
Considerable reduction in accredited external renewable requirement (i.e. least investment required off-site from currently available technologies)
Cons
Most expensive (considering site only)
Requires ESCO/community scale management
Requires 500-1,000 homes before becomes viable
Cost/practicality of district heating reduces as density of dwellings falls (<50 per hectare)
OPTION TWO:
Biomass heat only district heating provides all heat requirements *All electricity from accredited external renewables*
Pros
Large reduction in accredited external renewable requirement compared to standalone systems
Cons
Almost as expensive as biomass CHP (considering site only) but fewer benefits
Requires ESCO/community scale management
Requires 100+ homes before becomes viable
Cost/practicality of district heating reduces as density of dwellings falls (<50 per hectare)

Note: Further options could consider onsite generation from micro-renewables (e.g. photovoltaic (solar electric) panels and small wind turbines). These technologies have not been considered in detail as a source of electricity generation as they are considered cost-ineffective when compared to large scale wind turbines.

Implications at Gorhambury

As suggested previously, the choice of system is largely down to balancing investment in on-site carbon saving technologies versus the saving generated by avoiding the need for accredited external renewables.

Table C2.4 shows the difference in requirement for additional accredited external renewables from the technology that will require the most (conventional electric heating/solar thermal panels) and the (currently available) technology that will require the least (biomass CHP). Additional accredited external renewables are most likely to be large (2MW+) wind turbines.

Table C2.4 Biomass and Wind Turbines - Required Capacity and Costs

Type of development	Estimate of required biomass CHP capacity	Estimate of required capacity of wind turbines	Cost of renewable technologies on site	Cost of accredited external renewables
Single development with biomass CHP	3.75MWe	3MW	£25-45M	£2-3M
Single development with electric heating + solar thermal	0MW	20MW	£8-15M	£15-25M

This shows the reduction in required wind capacity afforded by biomass CHP (which can generate renewable electricity continuously) compared to wind turbines (which only generate intermittently). Including biomass CHP reduces the number of large wind turbines by around 85%.

The cost estimates are not decisive. The net cost of achieving zero carbon with biomass CHP is £27-48M and with conventional electric heating is £23-40M.

At Gorhambury there are other issues to consider as well as cost including:

- desire to locate any wind turbines close to the settlement to promote sense of connectivity;
- large new urban extension presents excellent opportunity for district heating; and
- potential use of land east of M1 for either turbines or biomass fuel.

It is clear that whatever strategy is used, large wind turbines are likely to feature in some way or form and so the following section (section 4) looks at the potential for large scale wind to be incorporated into the proposed development.

From a practical perspective, a strategy based on biomass CHP is considered the neatest and most sensible solution to achieving a zero carbon development as it may be possible to utilise currently unused forestry residues and waste garden material as fuel. Thus a biomass CHP scheme could provide additional environmental benefit by helping to provide a solution to recycling of garden materials from nearby towns and cities. Biomass CHP also minimises the requirement for wind turbines which minimises exposure to risk associated with gaining planning permission for wind turbines/planning delays etc. Biomass CHP is discussed further in section 5.

2.4 Wind Energy at East Hemel Hempstead

This section investigates the potential for wind energy development at the proposed Gorhambury Urban Extension. Two areas of land have initially been proposed for the purposes of providing a wind energy park. This will study these two areas for their suitability and will also provide commentary on other likely wind energy options for the development.

It has been estimated that the development of 7,000 homes will require an average electricity demand of around 3MW. If wind is to be considered for generation around 12MW of generation would be required to meet this demand based on a capacity factor of 25%. This would equate to around five to six 2MW to 2.5MW machines. If heat or cooling is also supplied from non-renewable sources, a greater amount of wind generation would be required to make the development zero carbon.

2.4.1 Wind Energy Potential

The estimated wind speed from the UK NOABL wind speed database in the Gorhambury area is moderate at 6.2m/s to 6.4m/s at 45m above ground level. The main constraints to wind energy development at the site will be from infrastructure constraints and the acceptability to the nearby residents from noise and visual impact issues.

The original sites suggested for wind development lie to the North and East of the Buncefield Oil Storage Depot and have been highlighted in green on Figure C2.3.

Large Scale Wind (500kW to 2.5MW)

To meet the required load at the site and assist with creating a zero carbon development it would be preferred to use the largest turbines suitable for the site to maximise the benefits. This assessment has focused on the technical barriers to development and it is likely that planning and environmental constraints will limit the types and number of turbine that will be suitable for the site.

A summary sheet has been completed which identifies the key constraints to development of large commercial wind turbines at the site. Assuming that residential areas are not within approximately 450m of the proposed turbine location the key constraints identified during this high level study are likely to be:

- proximity to Buncefield Infrastructure (storage tanks, pipelines etc.);
- impact to National Air Traffic Service (NATS) Infrastructure;
- proximity to Luton Airport (13km) and other nearby aerodromes, and;
- landscape and visual effects.

The Summary Sheet is included below.

Site Name	Gorhambury Urban Extension		
Site Location	Gorhambury East Hemel Hempstead St. Albans		
Site Type	Large wind development	OS Grid Reference	E 508900, N 208300
Planning Consent Considerations			
Planning Authority	St. Albans District Council		
Environmental Designations (Up to 20.0km)	**SSSI** Roughdown Common 5km Little Heath Pit 7km Ashridge Commons & Woods 8km Bricket Wood Common 8km Moor Mill Quarry West 8km Alpine Meadow 9km Westwood Quarry 10km Whippendell Wood 11km Sarratt Bottom 11km Kensworth Chalk Pit 11km Frogmore Meadows 12km Dunstable & Whipsnade Downs 12km Ivinghoe Hills 13km Blow's Down 13km Aldbury Nowers 13km Croxley Common Moor 14km Redwell Wood 14km Pitstone Hill 14km Sherrardspark Wood 15km Oddy Hill & Tring Park 15km Water End Swallow Holes 15km Pitstone Quarry 15km Castle Lime Works Quarry 16km Houghton Regis Marl Lakes 16km Totternhoe Knolls 16km Galley & Warden Hills 16km Tring Woodlands 16km Totternhoe Chalk Quarry 16km		

	Tring Reservoirs 16km Totternhoe Stone Pit 17km Harrow Weald 17km Bentley Priory 17km Dancersend Waterworks 17km Old Park Wood 18km Dancersend 18km Sundon Chalk Quarry 18km Knebworth Woods 18km Froghall Brickworks 18km Tewinbury 18km Ruislip Woods 18km Mid Colne Valley 18km Hodgemoor Wood 18km Wain Wood 19km Fancott Woods & Meadows 19km Harefield Pit 19km Northaw Great Wood 19km Aston Clinton Ragpits 19km Smithcombe, Sharpenhoe & Sundo 20km **AONB** Chilterns 4km	
Landscape Type	Currently used as mostly farm land. Area is proposed to be redeveloped as a mixed use urban extension	
Archaeology	No known issues	
MoD	No known issues	
CAA	Within 13km of Luton Airport, 14km of Elstree Aerodrome and 18km of Pansanger Aerodrome. Consultation will be required	
NATS En-Route Radar	At a tip height of 60m the development is in an area likely to interfere with NERL safeguarding infrastructure. Consultation will be required.	
Technical Considerations		
Wind Resource	NOABL Wind Speed @ 45m Height	Approx 6.4m/s
	NOABL Wind Speed @ 25m Height	Approx 5.9m/s
Potential Noise Constraints	At present only 2 residential areas have been identified close to the proposed site. As new residential areas are planned these should be located 450m from any potential turbine to avoid noise problems. The presence of the M1 adjacent to the site may create high levels of background noise which should minimise noise constraints.	

Electrical Connection Potential	Electrical connection should be available close to the site. As the site is being redeveloped the grid connection options should be studied to determine the potential for onsite generation and potential demand.
Radio and Communications	Several microwave links cross the sites. Turbines should be located over 100m from these links. Further links may be identified by consulting with relevant telecoms operators.
Construction Issues	Development close to Buncefield will be restricted. As a minimum, topple distance (around 100m) should be observed from oil pipelines and critical infrastructure.
Access Issues	Access is not expected to be a problem due to the close proximity to the M1 motorway.
Wind Farm Development Notes	
	Early consultation will be required to ensure that the development does not conflict with safeguarding of the Buncefield Oil Depot. It will also be important to consult with aviation interests to determine the effects on nearby airports and radar systems. There are likely to be landscape and visual issues due to the low topography and high population density around the site.
Recommendation	Large Turbines may be suitable for the site at the East of the Buncefield depot. The space available for turbines will depend on the intended land use around the site. If large scale turbines are to be considered as an option a full feasibility study is recommended.

Depending on space available, the maximum number of turbines that are likely to be available for the site is two 2MW to 2.5MW type machines. This would require a redesign of the site buildings and layout and location away from any safeguarded pipelines. It is likely that competing land use will restrict development. This on-site development is shown in Figure C2.3.

Offsite Development

If development is not suitable on the proposed site then there may be the possibility of locating turbines off-site. The Crown Estate owns farmland to the east and this may be suitable for the development of a larger wind farm, although this is Green Belt. Figure C2.4 shows a constraints plan of the area with the maximum number of turbines (five) that could be located here.

The third option for large scale wind development would be to locate turbines at a suitable site well away from the Gorhambury area. This has not been considered further but could be an option for achieving zero carbon.

Small Scale Wind (<250kW)

If large scale wind is deemed to be unsuitable or visually obtrusive then another option is to use smaller scale machines. These devices may be more acceptable to the development but will reduce the energy available due to lower tower height and smaller capacity of the generator.

There are fewer turbines available at the sub 250kW range as it is often a small step to install a much larger machine. A 100kW machine would have a rotor of 21m and a total tip height of 46m while a 250kW machine will have a rotor of 29.5m and a tip height of 57m. To generate a level of electricity that would contribute to creating a carbon neutral development it is likely that the turbines would require a large area of land.

Micro Scale Wind (<10kW)

There could be potential for micro scale wind development at the site depending on the final development plan and site layout. These devices are likely to be located close to the users of electricity and would be positioned on shorter towers (10 to 20m). Small turbines will operate with much less efficiently than their larger and taller counterparts. The development would require a very large number of these turbines to make any substantial impact on meeting the site's electrical demand.

The position of the development close to an urban area may reduce the wind resource available for turbines at low heights due to the energy lost by the wind as it passes over buildings and infrastructure. These devices are likely to provide a small amount of energy at a high cost and would not be the preferred method of electricity generation.

2.5 Biomass Energy Potential

2.5.1 Introduction

This section of the report discusses the potential for the use of biomass material as fuel for the supply of zero carbon energy to contribute significantly to the zero carbon goal of the proposed development at Gorhambury.

The section defines the types of biomass material that might be considered, briefly considers the electricity and heating demands of the proposed development, discusses supply chain issues for possible fuels and briefly discusses the various energy technologies that might be considered suitable for the site.

2.5.2 What is Biomass Energy?

The UK Biomass Energy Centre which is owned and managed by the Forestry Commission defines biomass as "any fuel type derived from recently living tissue". Energy produced from biomass is considered to be carbon neutral because the amount of carbon (primarily in the form of carbon dioxide) that is released during the

combustion of a biomass fuel is equivalent to the amount of carbon that has been absorbed and retained in the biogenic material (or living tissue) during its lifetime.

For the purposes of this report biomass is considered to be solid materials of recent biogenic origin that are suitable for use as a fuel feedstock for an energy raising process. Some examples of biomass materials that may be suitable fuels for this type of development include:

- woody biomass which could be derived from a number of sources including forestry residues, arboricultural arisings (tree surgery etc.), short rotation coppice (e.g. willow, poplar or miscanthus grown specifically for the purposes of use as a biomass fuel);
- fibrous biomass which could include paper material, or material derived from crop residues (e.g. straw or husks); or
- waste derived biomass which could include waste wood (used pallets and construction and demolition derived wood), green waste from municipal sources such as gardens and parks, the biogenic components of municipal solid waste, sewage sludge and animal waste.

Liquid fuels such as bioethanol and biodiesel are typically known as biofuels rather than biomass. These types of fuels are derived from a biomass material (e.g. sugar beet or oil seed rape) that has undergone considerable processing to extract and refine the organic liquid component that becomes the biofuel. The primary use of these fuels at present is within the transport sector where they are used as low carbon substitutes to vehicle petrol and diesel fuels. It is possible to use these fuels for the purposes of heat and/or electricity generation but in the present market they can attract a considerably higher market value when used for transport purposes. Use of biofuels to provide energy to the proposed housing development is not considered here as it would be expected to be a considerably more expensive (up to five times) option than the above mentioned biomass fuel types on a fuel cost per MWh of energy provision basis.

2.5.3 Development Energy Demand Considerations

The energy demand of the proposed 7,000 zero carbon homes has been projected and discussed in more detail in section 2.2. However for the purposes of considering the suitability of biomass to contribute to this projected energy demand, it has been assumed that the housing, once completely constructed and occupied, will have an approximate average electricity demand of 3MW and an average base load thermal heating demand of 5MW. A CHP plant of around 3.75MWe is likely to be suitable to match this load as it will not operate at all times. It is also understood that the rate of building of the zero carbon homes could be as slow as 350 homes per year over a 20 year period, resulting in a proportionally slow increase in the total energy demand for the development.

The zero carbon homes would be expected to have a high level of energy efficiency inherent to their design and construction and this is expected to result in a relatively small demand for space heating provision from any biomass heating system. The most significant base load heating demand throughout the year is likely to be the homes' hot water demand.

In addition to the zero carbon housing that would be included in the development, it may also be worth considering the suitability of inclusion in any biomass energy scheme of any other types of (new or existing) buildings or businesses that might be within the development or adjacent to but outside the development, particularly those buildings or businesses that may have a significant and reasonably constant energy demand. This may be beneficial to the economic attractiveness of the development of a biomass energy system.

Any sales of electricity outside of the housing development should be eligible for Renewable Obligation Certificates (ROCs) which considerably increase the value of any eligible renewable energy sold. The current ROC legislation is under reform but the likely outcome of this reform is that for each Megawatt hour of electricity sold could receive two ROCs (under the current legislation only one would be awarded), depending on whether or not the installation could achieve good quality CHP status. The current market value of a ROC is around £45/MWh. Electricity sold would also be exempt from payment of the Climate Change Levy (currently worth approximately £4/MWh). Electricity sold to zero carbon housing would not be eligible for ROCs as part of the requirements for accredited external renewables (see section 2.2.1).

Energy sold outside the housing development in the form of heat is not currently eligible for renewable energy credits although some system of this type may be introduced in the future. The UK policy for renewable heat is currently under review. The heat energy would however be considered renewable energy and be exempt from payment of the Climate Change Levy and could provide further economic benefit associated with emissions trading schemes such as the Carbon Reduction Commitment.

2.5.4 Biomass Supply Chain

When considering investment in any type of biomass energy system there are a number of reasons why it is essential to establish that there will be a viable supply of biomass fuel over the life of the project. Confidence is required before investing in biomass energy capital equipment that there will be sufficient material available within economic transport distance and that supply of this material can be secured on an ongoing basis over the entire life of the development. Before any investment is made, it is recommended that a detailed supply chain study be carried out to examine surety of such supply. Some fuel options that could be included in this study include short rotation coppice, arboricultural and forestry management arisings, agricultural residues, municipally derived green waste and wood waste. Each of these potential biomass fuels is discussed briefly below.

Further waste derived types of biomass could also be considered but would be likely to subject to more stringent emissions control legislation, in particular the Waste Incineration Directive (WID). Compliance with WID would require significant additional capital investment in flue gas cleaning equipment which could increase the investment cost of energy plant by as much as 25% as well as resulting in additional ongoing operational costs associated with chemical reagent for flue gas cleaning and the disposal costs of air pollution control residues to hazardous landfills. Use of a fuel that is seen to be a waste could also present some potential difficulties in gaining planning approval for the energy plant installation.

Short Rotation Coppice (SRC)

This type of material is generally specifically tree or woody grass material that is specifically planted for use as a biomass fuel. Normally following the initial establishment of a plantation, SRC yields a high rate of biomass production to the order of 10 dry tonnes per hectare per year, and a crop is harvested after a short number of years (e.g. once every three years). Typical examples of short rotation coppice in the UK include miscanthus, willow and poplar. The crop yields will depend on their specific preferences for climate and soil type.

Most of the willow SRC crops within the UK use willow varieties from Scandinavian countries and although they perform well in the milder climates of the UK, most of the established UK plantations are located in cooler, damper climates than would be expected in Hertfordshire.

Miscanthus is a fast growing cane like grass that originates from tropical and subtropical Asia. There have been a number of trial plantations within the southern areas of England including in Cambridgeshire where a site in low lying peaty loam soil was able to achieve average yields in excess of 15 dry tonnes per hectare per year. A preliminary check of the soil type of the agricultural land across the M1 from the proposed development suggests that it may be suitable for miscanthus. It is understood that this land is currently managed by The Crown Estate's tenants. The majority of the land appears to be Grades 2 and 3 (of the Agricultural Land Classification) arable and grassland with loamy soil, ranging from moderate to high fertility. A detailed assessment of the land type would be recommended in order to better establish the suitability of miscanthus in this area.

Following harvest, maturing of SRC over a period of months will reduce the moisture content, thereby improving the fuel quality. This type of material can be readily chipped to achieve a uniform desired size to suit the energy plant's requirements. Some undesirable contaminants such as stone and grit are usually present.

Arboricultural and Forestry Management Arisings

Although Hemel Hempstead is not located close to any large managed forest areas or significant sawmills, there are still a number of potential virgin wood biomass sources that could be considered within economic transport distance. Any municipal or rural area will have a number of activities ranging from gardening, tree surgery and private woodland management that generate woody material that is suitable for use as a biomass fuel. This type of material often has competing use markets including for compost, garden and park bedding material and for equestrian surfaces. In some areas, however, the demand for the alternative uses of this type of material is not as great as supply and marketing the material as an energy fuel can be an economically attractive option. Aging this type of fuel will also dry and improve its fuel properties. Chipping to a uniform desired particle size is also possible. Some undesirable contaminants such as stone and grit are usually present.

Urban Area Derived Green Waste

Within urban areas there is a considerable amount of biomass material arising from gardening (domestic or council sources) activities and in some council areas this material is source segregated from other municipal waste. The

main end use for this type of material is for compost, however, there are now a large number of composting organisations within the Greater London area producing large quantities of this material and not all of the compost products attract a large monetary value. Oversize biomass material can be less suitable for compost production, particularly the woody components and in some processes is removed in order to be shredded to a smaller size.

There is one major composting operation located very close to Hemel Hempstead. This is a potential source of green waste material that could be used as a biomass fuel. There are also other composting sites located in the other Greater London areas within reasonable transport distance of Hemel Hempstead. This type of fuel tends to have a higher level of contamination of stones and grit and may need a pre-processing step such as air classification to remove such contaminants. Size reduction of this type of material would normally be carried out with a shredding machine such as a hammer mill and the resulting shredded product is slightly more difficult from a materials handling point of view than a chipped product. If the material is source segregated from other waste streams and it is ensured that no potentially hazardous contaminants are contained in the material, it should be possible to avoid the requirement for WID compliance to use such green waste as a fuel.

Agricultural Residues

Hertfordshire and Cambridgeshire have significant areas of crop and straw production. For example, following crushing of oil seed rape fibre to extract oil, the residual husk material could be used as a biomass fuel. There are already two large straw fired biomass power stations located at Ely in Cambridgeshire and Thetford in Norfolk which could place some constraint on straw availability for a new project. Further investigation may uncover further sources of crop residue materials. These types of material will tend to require different types of handling equipment than woody biomass due to the differences in fuel particle size.

Wood Waste

Within the Greater London area and surrounds, there are a number of wood recycling organisations that specialise in taking wood waste from various sources including used pallets and construction and demolition waste and processing it into a relatively clean and uniform shredded fibre suitable for use either as a feedstock to biomass energy or for fibre board or pulp use. Based within North London are two or three of these organisations who have experience in preparing a high quality energy fuel product. The WID makes an explicit exclusion of wood waste from additional emissions control requirements, but not if the wood waste has the potential to contain wood that has been treated with potentially harmful chemicals such as Copper Chromium Arsenic (CCA) and halogenated hydrocarbon treatments. In practice, proving that these types of treatments are not present in a wood waste source to the Environmental Agency can be difficult so the relevance of WID to a specific fuel source needs to be carefully considered at the outset of a project.

2.5.5 Energy Technologies

Two main categories of Biomass Energy technologies are considered here, biomass heating only and Biomass Combined Heat and Power (CHP).

Biomass Heating

Biomass heating using combustion boiler systems has been widely recognised as being a very efficient and cost effective method of heat production from a renewable energy source. The biomass heating industry in the UK is currently undergoing a fast rate of growth with boiler suppliers having trouble keeping up with customer demand.

Biomass heating systems could be provided to the estate from a micro generation scale (individual wood pellet boilers in each home) through to a centralised biomass fired district heating scheme that provides energy to the entire housing development in the form of steam or hot water through an integrated system of district heating pipes installed throughout the development.

The micro generation approach in this case however would be expected to be a much more costly and fairly impractical approach to providing biomass heating. The capital cost of installing individual boilers in each home is likely to significantly outweigh the costs of a centralised system with a distributed heat pipe network or district heating scheme. The micro generation option also places significant restriction on the types of biomass fuels that could be used, such systems typically use wood pellets which are considerably more expensive on an energy content per tonne basis than other biomass types such as wood chips etc.

A reasonably large scale heating boiler plant would allow the bespoke design of fuel handling and combustion system in order to have greater scope for the plant to accept a variety of biomass fuel types. This opens up the potential for lower ongoing fuel costs and greater security of feedstock supply due to the equipment's fuel flexibility. In addition the delivery of fuel would be required to only one centralised location where the biomass energy plant would be located. A modular concept could be explored to allow for the steady growth of demand as more houses within the development are occupied. The size of a single boiler module could be optimised as the rate of occupancy growth is better established. For example, 10 by 500kW heating boilers could be installed to match the anticipated growth rate i.e. one additional boiler required every two to three years.

Location of a site for such a centralised boiler plant facility should give careful consideration to the need for the boiler chimney stack or stacks and to allow for easy access to lorries bringing in the fuel. To supply 42GWh of heating energy to the development it is anticipated that approximately 20,000 tonnes per annum of biomass material would be required (assuming that the average moisture content of the material is 45%). Approximately 900 lorry deliveries per annum would be required to supply this amount of material (assuming an average 22 tonne payload).

Housing densities are an important factor in the economics of district heating schemes and higher density development (>50 dwellings/ha) is preferred.

Biomass Combined Heat and Power (CHP)

Biomass CHP technologies would be a mechanism for delivering a significant proportion of the development's heat and power demand. Delivery of the heat to the housing development would be similar to the system as described for a centralised biomass district heating system. Connection to the grid of the electrical generation plant would be necessary to allow for import from the grid during periods when supply is greater than demand and export when more electricity is being produced than is required by the development. The financial attractiveness of biomass CHP is generally enhanced by the eligibility for external electricity sales for ROCs, offsetting the additional capital outlay required over and above a fossil fuelled plant (e.g. gas). It is understood however that electricity for internal use within the zero carbon development would not be eligible for ROCs (see section 2.2.1). Consideration of energy sales to adjacent business users outside the housing development may be a way to gain additional financial benefit.

The electricity to heat demand ratio for the housing development is projected to be around 1:2 (3MW electricity: 5MW heat once fully occupied). Selection of a technology type and design of a CHP system should be optimised to suit this demand ratio. Again a modular concept to accommodate demand growth could be used with biomass CHP as described for biomass heating systems however there are minimum scale constraints on CHP technologies that would result in fewer, larger modules than would be possible for heating only boiler systems.

The most established and proven type of technology for the CHP energy raising plant would be a combustion process where the biomass fuel is burnt and energy is recovered from the combustion gases to generate steam or hot oil. Steam turbine systems become less attractive for CHP modules below 2MW of electrical output and for systems between 0.5 and 2MW in electrical output Organic Rankine Cycle (ORC) systems (with a combustion process heating thermal oil with heat exchanged to an organic fluid turbine system) are generally considered more thermally efficient and better suited to achieve the 1:2 power to heat demand ratio. Other options that could be considered include indirect fired gas turbine systems and biomass gasification systems, systems that may allow a smaller module size enabling the energy supply to better match the anticipated demand growth rate. However, these technologies are considered to be more technically challenging than more traditional combustion technologies and currently have limited demonstrable reference experience.

Assuming a modular ORC plant design is used with four by 1MW electrical CHP modules, the build rate based on an anticipated demand of 350 homes/year would be one module every five years. Depending on the plant design specifics, it would require approximately 75,000 tonnes per annum of biomass fuel to achieve the total development electricity demand of 3.75MW (3,400 deliveries per annum). Such a system would be capable of a power to heat ratio of 1:3 or greater, meaning that it could supply surplus heat (3.75MW or more available for external use) to domestic or business consumers if such a demand existed within reasonable economic heat transport distance of the CHP plant (e.g. in existing parts of Hemel Hempstead). If no such external heat demand existed an air cooler or cooling tower could reject this heat, however with no carbon or economic benefit.

An alternative would be to scale down the CHP so that it was designed to match the thermal load. This would mean that the electrical load would not quite be met by the CHP and would require additional renewable electricity generation most likely in the form of large wind turbines.

A 4MW electrical biomass CHP plant may require a main building area of approximately 50 metres by 50 metres (0.25ha) and a building height between 15 to 20 metres. In addition further space would be required outside for various auxiliary services including access roads, weighbridge, cooling system etc., depending on site shape and road access this may require a further 0.25ha. The chimney height required would need to be determined by site specific air dispersion modelling, although similar sized plants located elsewhere in the UK require a minimum stack height of 40 metres.

2.5.6 Ownership and Management of District Heating

Most developers will not want to be involved in a development after handover and operation of any biomass district heating scheme is likely to be by an Energy Services Company (ESCO). There are several large companies that provide ESCO services and some local authorities have also set up ESCOs in order to catalyse district heating schemes. The Crown Estate may also be interested in taking on such a role. An alternative business model could see ownership staying in the hands of the community (although this may be more suitable for smaller schemes).

Early involvement of an ESCO would be expected and they would take on design, installation, commissioning, (part-) financing and operating responsibilities. Part financing by the developer is expected as provision of district heating and biomass CHP will be essential to securing approval for building.

2.6 Conclusions

The majority of the proposed development at Gorhambury is likely to be built to regulations that require zero carbon housing and low or zero carbon non-domestic buildings.

Some of the earliest development may not be built to such demanding environmental standards but even this is likely to be built to standards considerably in excess of current building regulations.

The likely energy demands of the proposed development have been assessed and a range of potential approaches to achieving zero carbon have been put forward. Even though these strategies are focussed on achieving zero carbon, they are generally relevant to low carbon development too and so could be scaled down to achieve this for the earlier phases of development if required.

A strategy that utilises biomass CHP, possibly supported by one or two large wind turbines, is seen as most favourable and realistic for the site. The issues associated with including biomass CHP and large wind turbines into the development have been discussed in some detail in earlier sections.

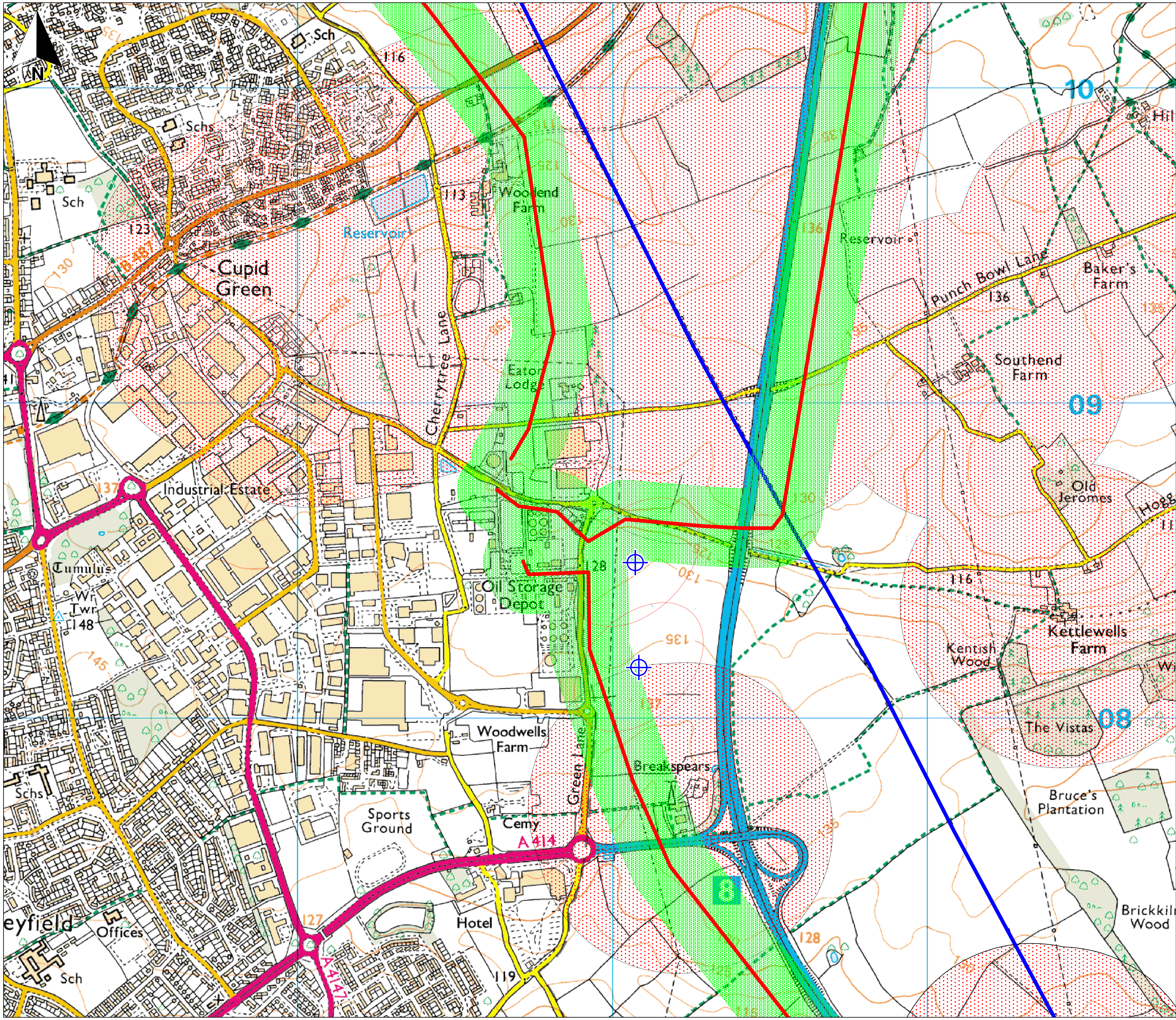
A particular advantage of district heating is that there is scope for existing development to be connected into the network which could provide large carbon saving potential in Hemel Hempstead. In addition, development subsequent to that at Gorhambury would also be able to connect into the network which will facilitate future low carbon development.

The only feasible alternative to biomass CHP with district heating is large scale wind (five to six 2 to 2.5MW turbines) located either on site, to the east of the M1 or at a remote site.

The likely cost of a scheme based on biomass CHP and wind is estimated at £27-48M and with wind only at £23-40M (i.e. £3-7k of central renewable energy systems). Alternative strategies using various combinations of micro-renewables installed in individual homes (e.g. biomass stoves, small wind turbines, solar thermal panels, etc.) are expected to be far less economic (up to £140M or £20k per home).

It is recommended that a more detailed study into the capacity for wind in and around the site be undertaken as the proposals progress. Similarly, a review of the potential availability of various biomass feedstocks should also be undertaken and a review of the potential existing heat loads (e.g. nearby industrial sites, schools, housing estates, hospitals, sports centres, etc.) in Hemel Hempstead should be undertaken at the appropriate stage.

Creating the environment for business



Key

- Potental Turbine Locations
- Turbine Spacing Buffer (3Dx2D)
- 450m Noise Buffer (Acceptable Distance from Residences)
- 400kV Power Line
- Standard Pressure Pipeline
- Pipeline Exclusion Area for Turbine Development (125m)

0 km 600m

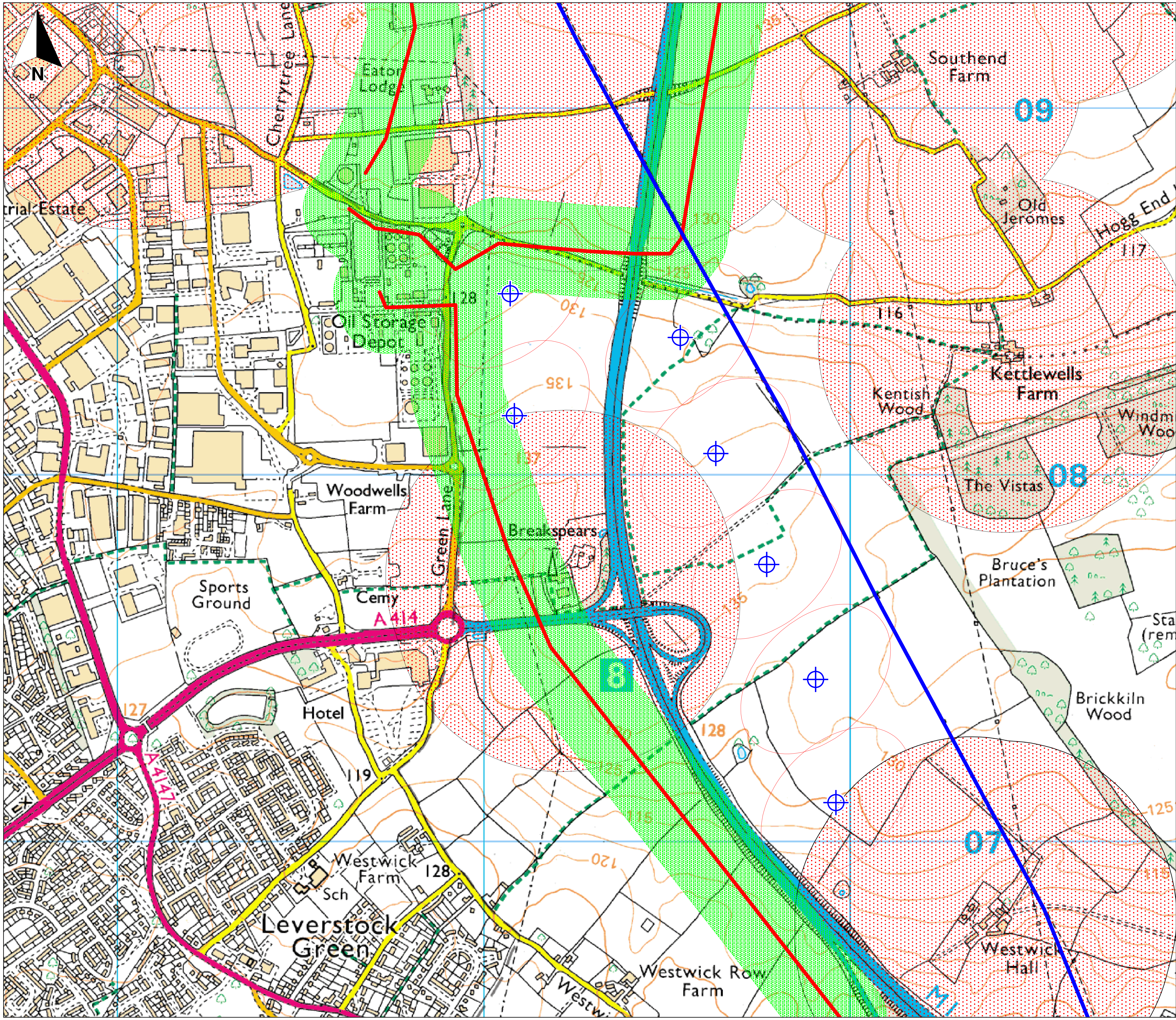
Scale 1:10,000 @ A3

The Crown Estate
Gorhambury LDF Submission

Figure C2.3
Potential Turbine Locations On Site

November 2007
05907-07-E001.WOR wattc01

Entec



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- 400kV Power Line
- Standard Pressure Pipeline
- Pipeline Exclusion Area for Turbine Development (125m)

0 m 600 m

Scale 1:10,000 @ A3

The Crown Estate
Gorhambury LDF Submission

Figure C2.4
Potential Turbine Locations
Off Site

November 2007
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3. Water Neutrality/Conservation

3.1 Introduction

This chapter considers the issues surrounding water supply, wastewater, and drainage for the proposed development at Gorhambury to the east of Hemel Hempstead. Up to 7,000 residential units are planned, with construction likely to start in 2010/2011 at the very earliest and potentially taking up to 20 years to complete. The contents of chapter 8 on Utilities and Infrastructure in Part B are also relevant and should be read alongside this chapter. It should be noted that the water conservation measures that are put forward as options in this chapter have the potential to reduce the water supply requirements that are set out in chapter 8.

3.2 Sustainable Water Use and Water Neutrality

Sustainable use of water resource within the new development will be important. Water availability is scarce in the east/southeast of the country generally and within the Gorhambury area in particular. Therefore in order to plan a sustainable development, water demand will need to be minimised.

This chapter looks at how that might be achieved through the following:

- minimising water use through water efficient appliances and metering;
- reuse of water where appropriate, through rainwater and grey water recycling and possibly black water recycling; and
- sourcing water close to the development, and treating wastewater on site where possible.

Although there are a range of measures available that could be used to minimise water use, it is generally considered impossible and also undesirable to reduce net water consumption to zero at a household or even development scale. Water treated to potable standards is required for drinking, personal washing, cooking and other kitchen uses (e.g. dishwashing).

At present, the most appropriate means of providing this ‘essential’ potable water is considered to be via traditional water treatment and supply systems. This is principally for health reasons and this is reflected in very stringent drinking water quality standards, as regulated by the Drinking Water Inspectorate in England and Wales. Recycling of water (e.g. at a development scale) also presents significant challenges in terms of public perception and is likely to be difficult to implement from an economic perspective as well.

Whilst the relevance of these issues may change over the 20 year development period at Gorhambury, it is unlikely that the development will take place without generating an additional demand for potable water, at least in the foreseeable future. However, the net effect of the development can be managed by seeking to offset this new demand by reducing consumption in surrounding areas. This is a particularly useful approach when existing demand can be reduced in areas that are supplied from the same sources of water as the new development. This offsetting approach is currently the most likely way of achieving water neutrality.

3.3 Site Description

The development site is located on unconfined chalk which forms part of the regionally important aquifer of the southeast of England. The River Gade flows south through Hemel Hempstead which is immediately to the west of Gorhambury, and the River Ver flows in a southerly direction approximately 4km to the east of the site. These rivers are classic chalk streams, fed predominantly from groundwater. They form tributaries to the River Colne further south, and the Colne flows into the Thames upstream of Teddington Lock, approximately 35km south of Gorhambury. The Grand Union Canal follows a course adjacent to the River Gade and then the River Colne from south of Watford.

There are no water courses flowing through the development site itself and the only water features evident from the 1:25000 scale OS map are a small reservoir on the northern boundary of the site, at NGR 508400 209700, and a small pond towards the south of the site at NGR 509000 207600. However, The Crown Estate owned land extends east of the M1 motorway and the A5183. The River Ver flows south through the northeast part of The Crown Estate land, and there are other water channels indicated which drain to the river in this area.

3.4 Water Efficiency

3.4.1 The Code for Sustainable Homes and Water Use

The Government published a Code for Sustainable Homes in December 2006. This sets out voluntary targets for sustainable water use, and other sustainable measures, for new homes. The targets for internal potable water demand are as follows.

Table C3.1 Water use targets from the Code of Practice for Sustainable Homes

Sustainability star rating	Per capita consumption (l/head/day)*
1 and 2	120
3 and 4	105
5 and 6	80

Table C3.2 shows how water use can be reduced to 80l per person per day, using currently available efficient and low volume water appliances and an integrated rainwater recycling unit, as well as a conventional rainwater butt for

outdoor use. Volumes and frequencies of use are taken from Assessing the Cost of Compliance with the Code for Sustainable Homes.

For a development of 7,000 properties this “current good practice for new homes” scenario implies a household water demand of 1.35Ml/day.

Table C3.2 Household Water Consumption - Current Good Practice for New Homes Scenario

	Component of water use	Comment	Water use/property/day (l)
Demand	WC	low volume dual flush (4.5/3.0 l)	43.2
	Basin	low volume, aerated taps (1.7 l/min)	20.4
	Kitchen sink	low volume, aerated taps (1.7 l/min)	20.3
	Electric power shower		36.1
	Low volume bath	64 l per use	61.4
	Washing machine	water efficient (45 l/use)	36.5
	Dishwasher	water efficient (13 l/use)	9.2
	Outdoor use		16
Recycling	Rainwater butt	Saving	-16
	Rainwater harvesting system	Saving	-34.5
	Net water demand (litres per property per day)		192.7
	Net per capita consumption (litres per head per day)		80.3
	Net water demand for development of 7,000 properties		1.35 Ml/day

Assumed occupancy rate = 2.4

3.4.2 Rainwater Harvesting

Rainwater harvesting systems (which collect rain from roofs and often from other impermeable areas such as driveways) can be installed for individual dwelling units, or more economically at a larger scale to provide for several properties. In a domestic setting they are generally used for toilet flushing and external water use, and may reduce domestic demand by 25 to 30%. They have also been installed successfully in community buildings such as schools, where studies indicate a saving in water use of around 50%. These systems depend on sufficient rainfall throughout the year, and so cannot be relied upon in long dry summer and drought events.

It will be possible to reduce water demand further by considering the technologies summarised in the following sections.

3.4.3 Greywater and Blackwater Recycling

It may be possible to achieve economies of scale by collecting greywater or blackwater at the community level and recycling it for use in toilet flushing and other non-potable uses. The main advantage that these systems have over rainwater harvesting is that they generate a relatively steady stream of recycled water, and do not rely on seasonally varying rainfall. Information in the public domain suggests that the two greatest barriers to the uptake of such technology on a communal/development level are likely to be public concern about the risk to health, and system maintenance requirements. To ensure that there is no risk to public health; community level greywater systems would require treatment to a high standard and would in essence be development-level sewage treatment plants. For this reason, examples of greywater and blackwater systems are considered together below.

Living Machines™

Living Machines have a ‘green’ image but are in effect traditional aeration treatment plants in greenhouses. UK examples include systems at BedZed, The National Botanic Garden Wales, Findhorn Foundation and the Earth Centre. Grant and Morgan (1999) provides analysis of the performance and energy requirements of Living Machines™ showing that the technology is unlikely to be sufficiently reliable on its own to provide blackwater recycling for demand management purposes. The energy requirements for operating the system and maintaining sufficient temperature to sustain the plants mean that the system would have a high carbon footprint relative to other options (if operated using grid electricity).

Membrane Bioreactors

Membrane Bioreactors (MBRs) are a rapidly developing technology that can produce a very high quality effluent suitable for non-potable reuse including WCs, washing machines and irrigation. These systems are best suited to treating combined grey and blackwater rather than greywater alone and that the economics start to improve with systems treating about 300m^3/day (2,000 people). Capital cost for a project of this size would be about £1M.

Adding Reverse Osmosis (RO) followed by re-hardening to an MBR would allow the production of potable water thus achieving water neutrality on site. A small volume of rainwater would make up for any losses.

Whilst possible with current technology, such a solution is unlikely to be acceptable and would be high risk and uneconomic for a single development because of the need for very high levels of monitoring and backup. A slightly less controversial variant is aquifer recharge, possibly with local abstraction. This would provide some extra treatment, dilution and re-mineralisation.

As sludge would need to be disposed of or treated, another option is sewer mining with an MBR. Waste is then returned to the same sewer. Perhaps a better option would be to add ultra filtration to the outlet of a local sewage treatment works. The energy requirement would be pumping plus 1Bar membrane pressure drop.

These technologies make most sense for large industrial demands especially where low hardness (e.g. using RO) is a benefit.

Rotating Biological Contactors

Rotating Biological Contactors, ‘Biodiscs’ or RBCs are a wastewater treatment technology that has been used for greywater recycling, as well as ‘normal’ wastewater treatment. RBCs tend to be robust and reliable and have a low energy consumption compared with many other package treatment systems. RBC effluent could be further treated to a standard suitable for WC flushing and even washing machines.

Sand Filters and Reedbeds

Fixed film processes such as intermittent sand filters or vertical flow reed beds work by gravity and so have a very low energy consumption. On a site without the required metre or so of fall, pumping requires minimal energy. The main energy input would be pumping the treated effluent back to the buildings.

Sand filters are capable of achieving very high effluent quality suitable for WC flushing and subsurface irrigation. Disinfection might allow use in washing machines and garden but would typically require the use of chlorine or ultraviolet. This could lead to operational and maintenance issues and increased life cycle impacts.

Required area is around $2m^2$/100 litres of effluent or 2-$3m^2$/population equivalent, but filters can be buried or designed into the soft and hard landscape or planted as with reed beds.

Summary and Recommendations

This section has outlined some of key issues associated with development scale harvesting and recycling demand management measures. It is clear that development scale measures offer certain advantages over household level installations, mainly around economies of scale for infrastructure costs and the maintenance (and therefore, reliability) of systems. These advantages are particularly relevant to greywater or blackwater recycling, such that these technologies would only be considered at a development scale.

Given the state of these technologies (based on evidence from existing installations) as well as public perception issues, it is likely that rainwater harvesting would be the most likely development scale measure to be implemented at Gorhambury in the near future. However, it is clear that technologies do exist for recycling greywater and blackwater, and it is considered that these measures could be part of a water neutral solution in the later stages of the Gorhambury development, once technology has advanced and been proven further. Public perception is also likely to be a key issue for the recycling options. Of these, it is considered more likely that greywater systems will be developed, given the lower risks associated with pathogens, odour and public perception.

3.4.4 Sustainable Drainage Systems (SUDs) and Flood Risk

Sustainable drainage systems should be included in the Gorhambury development to manage rainfall and to help minimise the risk of flooding within the site. Government planning policy (PPS25) which sets out how flood risk should be assessed and managed, also requires that surface runoff from the site to adjacent land is minimised, with peak flow rates no greater than those from the pre existing greenfield site. A flood risk assessment will be required at the early planning stage to demonstrate how runoff will be managed, and the drainage solutions to be implemented.

SUDs design at Gorhambury is likely to incorporate a mix of:

- Filter strips and swales - areas of vegetation where rainwater can be intercepted and drain away slowly, mimicking natural drainage patterns.

- Filter drains and porous pavements to allow rainwater and run-off to infiltrate into permeable material below ground. This water may be collected in underground storage tanks for recycling if required.

- Storage and attenuation ponds or lakes - wetlands. These storage areas would need to be lined, given the chalk geology.

Water collected in ponds and attenuation tanks can be treated and then recycled for non-potable water use if required, or discharged to groundwater at controlled rates. Alternatively treated water could be piped to, and discharged into the River Ver on the eastern edge of The Crown Estate's land, although this would imply additional infrastructure and maintenance costs.

The development site is not within an area at risk of fluvial or tidal flooding (as defined by the Environment Agency's flood risk maps). Therefore the flood risk assessment will only need to consider localised flooding from surface water, drainage and sewerage, and groundwater levels.

On The Crown Estate's land to the east of the M1 motorway, the River Ver and adjacent watercourses is liable to flood. However, this is a considerable distance from the proposed development at Gorhambury.

Groundwater Source Protection

The development land is within a groundwater protection zone (designated as a 'whole catchment' zone), requiring potentially less protection than 'inner' or 'outer' zones. These areas as the name implies, are within recharge areas for public groundwater sources, and any potential source of pollution will be regulated by the Environment Agency. Therefore the design of the integrated drainage system will need particular care in order to ensure good quality of treated water discharged to ground. The main focus of this design is likely to be on the separation and removal of oil and petrol from discharges or seepages to ground.

3.5 Offsetting for Water Neutrality

In order to achieve a water neutral development i.e. with no net impact on water resources locally, it will be necessary to offset the net demand for water. This can be affected by retro fitting water saving appliances to existing homes within the Colne river catchment.

Water efficiency devices which may be considered for this purpose are presented in Table C3.3. Data is from several sources including Water Efficiency in the South East of England.

Table C3.3 Potential Water Saving by Retro-Fitting to Existing Households

Device	Assumed saving (l/prop/day)
Variable flush retro fit device for WC	24.7
Ultra low flush WC replacement	53.1
Low flow showerhead and taps	15.6
Water efficient white goods - Washing machine - Dishwasher	 12.2 3.5
Rainwater butt for garden	Already commonly in use therefore no saving assumed
Rainwater harvesting system	Expensive as retro fit therefore not considered
Water efficiency promotion and publicity	No estimate of saving available due to lack of data

Although no saving can be assumed from promotion and publicity on its own, campaigns of this sort will be important to ensure that retro fitted devices are effective, because influencing consumer behaviour will be important in this respect.

Entec is currently undertaking a study for the Environment Agency into the feasibility of achieving water neutrality in the Thames Gateway, where 165,000 new homes are planned between 2005-06 and 2015-16. This study has estimated that between 3.1 and 5.4 existing homes would have to be retrofitted with the demand management measures highlighted in Table C3.3, in order to offset the demand from one new home built to CSH Level 5/6, to deliver a consumption rate of 80l/h/d.

This suggests that between 21,700 and 37,800 existing homes would have to be retrofitted with the devices summarised in Table 3, to offset the additional household demand from the Gorhambury development. This assumes that:

- 7,000 new homes are built;
- their actual consumption is equivalent to 80l/h/d; and

- the retrofitted demand management measures deliver the estimated savings.

It must be noted that these estimates are approximate and subject to significant uncertainty.

Additional reductions in household demand could be achieved by implementing a compulsory metering programme that would force the large proportion of existing un-metered households onto a metered supply. However the benefits of this in the Three Valleys Water supply area may be limited, as the Company is already committed to metering properties when there is a change of occupancy. Further reductions in household demand could be achieved by introducing a variable tariffs structure, such as rising-block tariffs, where customers pay more per unit of water above a certain threshold volume.

Implementing compulsory metering or variable tariffs is likely to reduce the numbers of existing households that would need to be retrofitted with demand management measures to offset demand from the new development.

This note does not consider commercial and other non household water use, but similar water efficiencies can be used to minimise these components of demand and this could also be used to offset demand from the Gorhambury development.

3.6 Water Resource Situation and Supply Options

Efficient water use and reuse of water will minimise the requirement for potable water supply at Gorhambury. There will however be a need for a water supply to the development, as described.

The site is within the Colne catchment, and the consultation document for the Colne Abstraction Management Strategy was published by the Environment Agency in April this year. This document states that all water resource management units are classified as currently over-licensed and over-abstracted. As a result the Environment Agency proposes that they will not issue new licences for consumptive abstraction. This would mean that a licence for new water for the Gorhambury development from this catchment would not be likely unless the water was returned locally to the abstraction point (i.e. a non consumptive licence).

However, this note proposes that some runoff and wastewater could be treated and discharged to groundwater on, or close to the development. In this case, there may be an option of a private water supply - an abstraction might be from the chalk groundwater, or direct from the River Ver at the northeast part of The Crown Estate's land (east of the M1 motorway), subject to the outcome of the abstraction licensing application process with the Environment Agency. On the other hand the cost of water treatment to potable standards at this relatively small scale may mean that public water supply is a more economic option.

For the Colne catchment as a whole, the total volume of current licensed abstractions is 700Ml/day with 60% of this for public water supply, 14% for agriculture, and 17% for industry including energy production. 70% of licensed abstraction is from groundwater, and 30% from surface water sources. In terms of the Three Valleys supply area, which covers parts of Bedfordshire, Berkshire, Buckinghamshire, Essex, Hertfordshire, Surrey and several London Boroughs, the company supplies 900Ml/d, of which 60% is groundwater abstracted, with the remainder from surface water including imports from outside the water company area.

Three Valleys Water PLC provides public water supply to the area - Gorhambury is in their Central Water Resource Zone. In discussion with their Water Resources Manager, it was confirmed that water resources are scarce in the Gorhambury area, and exacerbated by the Buncefield Oil Depot close by and the recent contamination from it; a contamination plume from this site has meant that one groundwater source has already been put out of supply for the foreseeable future. The current Water Resource Plan published by the company in 2004, and covering the period to 2030, identified no significant potential for resource development within the Central Zone, or indeed the whole of the company area. Effort will be focused instead on demand management measures and a small aquifer storage and recovery scheme scheduled for 2018. The Plan includes for up to 10Ml/d to be available to meet peak demands from the proposed Thames Water Oxfordshire Reservoir Scheme, from 2021.

The 2009 Water Resource Plan is currently being prepared by the water company, but this will not include the demand for water from the proposed Gorhambury development as this is not an allocated site in the Local Development Framework.

Early discussions with the Environment Agency and/or the water company will be necessary to identify how the additional water demand will be met. The Water Act makes provision for water companies to require a contribution from the developer towards the cost of infrastructure for new water they supply.

3.7 Water Environment

There are two small water features identified on the site (a reservoir and a pond) as noted in section 3. In addition, the River Ver flows through the northeast part of The Crown Estate’s land to the east of the M1 motorway. It will be necessary to create additional wetlands and storage areas, and perhaps reed beds, as part of the strategy for drainage, wastewater treatment and water recycling. With good design and management these can be incorporated as features of a ‘natural’ wetland habitat and contribute amenity value to the development. Ideally all elements of the integrated drainage and recycling system would be located within or close to the development, though there may be scope for some of the wetland areas to be located to the east of the motorway. The potential to link this rural area and the river with footpaths from the development under the motorway has been considered, so there may be potential to develop nature walks and other recreational activities (cycling, swimming) which might incorporate other built water features.

3.8 Conclusions

Water availability is scarce in the eastern region and therefore sustainable use of water resources within the proposed development will be very important. The scale of the development provides advantages if household level installations relating to greywater or blackwater recycling are to be introduced as there are clear economies of scale. However as some of these technologies are still being developed, rainwater harvesting is likely to be most appropriate in the earlier stages of development. At the later stages, technologies may have developed further. There is an opportunity to retro fit water saving appliances to existing homes within the Colne River catchment as a way of achieving water neutrality. This would significantly reduce the water supply requirements of the development which is a significant advantage given the issues associated with water supply in the region.

The proposed development is not in an area at risk of fluvial or tidal flooding and therefore a Flood Risk Assessment will be required to consider surface water runoff from the site. SUDs would be incorporated to manage rainfall and minimise the risk of flooding within the site.

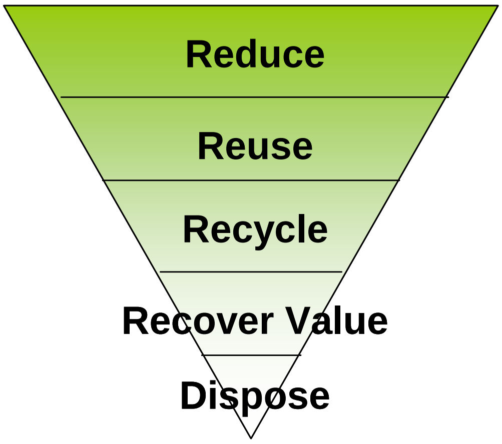
Efficient use of water resources will minimise the requirements for water. There is still however a need for water supply to the development, and once more detail on the scale of development is known then discussions can take place with Three Valleys Water and the Environment Agency regarding water supply.

4. Resource Efficiency/Waste Reduction

4.1 Introduction

The proposed development of the area of land between the eastern boundary of Hemel Hempstead and the M1 motorway has the potential to generate large amounts of waste, during its construction, when the development is occupied and at the end of its useful life. A considered approach to the management of waste from the early planning stages of the project can reduce the overall impact of waste on the local, regional and global scale.

This chapter will consider the two main sources of waste associated with the Gorhambury development; construction waste and municipal waste, and will outline the key areas in which waste management can increase the sustainability of the overall development. Modern waste management is generally based on the concept of the waste management hierarchy. This hierarchy dictates that the most effective method of managing waste is to eliminate it, then to minimise the waste that is produced. The hierarchy then states that waste items should be reused and recycled before having energy recovered from them (e.g. through incineration). Only materials that can no longer be reused or recycled or have energy recovered from them should be disposed of to landfill. The hierarchy is presented graphically below.



In managing the waste generated by the Gorhambury development the aim is to move waste up this hierarchy. Achieving this requires a change in the way both developers and residents view waste. Waste materials should be considered valuable resources rather than useless and worthless rubbish. If this ‘waste as a resource’ approach is incorporated into the Gorhambury project from the outset there are great opportunities to set new benchmarks for waste reduction, reuse and recycling.

4.2 Construction and Demolition Waste

The waste hierarchy states that avoidance of waste is the most environmentally sustainable management method. The use of thoughtful design can mean that there is less material to be handled, segregated, transported and disposed of at later stages in the process. The design phase also offers a wealth of opportunities for incorporation of materials made from recycled materials or with recycled content.

4.2.1 Use of Recycled or Reused Materials in Design

Designers often avoid including reused or recycled materials within their plans because of concerns regarding the performance of the material. Recent years have seen significant investment in research into recycled and recycled content materials and some are now subject to British Standards. The Waste and Resources Action Programme (WRAP) is a not-for-profit government funded company set up in 2000 to create new markets for waste materials collected across the UK. One of the work streams operated by WRAP focuses on the construction industry and seeks to cut construction costs and increase efficiency through a better use of materials.

Specification of recycled or recycled content products into the design of new properties has the benefit of reducing the amount of material sent for disposal whilst enhancing the market for recycled products which, in turn, drives a demand for further recycling in the UK. The case study below shows how the recycled content of a new four bedroom semi-detached house can be increased at minimal cost and effort. The home in the case study has masonry external walls and ground floor and timber framed internal walls, upper floors and roof.

Using standard practice materials, the house has a recycled content of accounting for 12% of the materials value of the structure. This recycled content avoids four tonnes of landfill. Substituting products with best available recycled content in four elements of the house - external walls, internal walls, ground floor and foundations - increases the overall recycled input from 12% to 33% by value. By building this way it would be possible to avoid a further 53 tonnes of landfill.

The levels of recycled content in this case study are stretching but advances in material processing and continuing demand for recycled content products are likely to make 33% a realistic recycled content by value target. However, the benefits of using recycled materials in construction should be balanced by the overall environmental impact of the product. The processes used to create a product with a high recycled content may have an excessive energy of water demand, for example.

In order to maximise the recycled content of properties built at Gorhambury it would be relatively simple and cheap to specify materials with the best available recycled content for all materials. It may be possible to provide home owners with a personalised recycled content figure for their newly built home. A demanding target would ensure that recycled content levels are kept high.

4.2.2 Standard Dimensions and Prefabricated Units

The standardising of dimensions within buildings or building types is another relatively passive measure that can reduce off-cut waste during construction phases. This requires the designer to specify dimensions that relate to standard industry dimensions. For example, dry lining materials are produced in standard sizes but this rarely coincides with the dimensions of a building resulting in large numbers of off-cuts.

Additionally there is a growing acknowledgment that off-site prefabrication of certain elements of buildings can make financial as well as environmental sense. Prefabrication of sections of buildings typically moves some of the building work to a factory based rather than site based process. This substitutes the often imprecise site construction process where off-cuts and mistakes cause waste, with the efficiency of production line fabrication. This allows the production and micro-assembly process to be subject to closer scrutiny and management, reducing wastage.

The scale of off site fabrication can vary. In some cases whole houses are pre-fabricated off site, transported to a desired location and constructed in situ. On a smaller scale it is not unusual to have standard kitchens and bathrooms, such as those in apartment buildings constructed off site, simply ‘slotted’ into the building shell and connected to the various utilities. On a still smaller scale it is often possible for ducting, pipe-work, internal wall panels and roof trusses to be assembled in a factory before being installed with minimal waste, within a building.

4.2.3 Bonded and Composite Materials

It is important to consider the whole life cycle the development, particularly at the early design stage. In some cases, such as steel reinforced concrete, the composites can be relatively easily separated. However other materials commonly used in new buildings such as bonded resin/fibre insulation material and fire resistant coatings for structural steel are less easily (or economically) separated.

It would therefore be recommended that bonded and mixed composite materials would be avoided where possible within the Gorhambury development. This would allow simpler resource separation for recycling when building elements are required to be replaced either during refurbishment or at the end of its life. As new materials are developed which reduce the need for bonded or composite materials, these should be used in preference.

4.2.4 Construction Practices

The typical approach to house building places pressure on contractors and sub-contractors to complete work in the shortest time possible to maximise profit. There are often late completion penalties associated with overdue sign-offs. However thought should be given to the potential reduction in waste if the construction programme was lengthened slightly to allow for more careful execution of tasks. Very tight timescales and large penalties may also encourage the habit of materials over-ordering to avoid delivery delays. Material over-ordering is a significant source of waste material on construction sites.

4.2.5 Design Life of Works

Ensuring that all buildings planned for the development are durable is an excellent way of reducing the potential waste burden of the overall project. The ‘built to last’ concept should apply not only to buildings, but also to highways, public spaces and other infrastructure elements. This has the potential to greatly increase the satisfaction of those living and working in the area, as well as maximising the potential of the resources used in construction.

4.2.6 Contractural Arrangements

Appointment of Designers and Contractors

In order to make a clear and defined statement of intent, the environmental credentials of designers and contractors should feature highly in the evaluation of tenders for work. Engendering the sustainability ideals for a project within the many members of the project team will provide a common purpose and bring an enthusiasm for its aims. Organisations with particular experience or expertise in sustainable construction should be utilised where possible. It may be possible to appoint the contractor prior to the design stage to enable them to provide advice and expertise to the design team from and early stage.

Main contractors should be required to provide site waste management plans as part of their contact and the effectiveness of the plan should be regularly monitored through independent site audits.

It may be possible to incorporate a series of environmentally based ‘bonuses’ into contracts. This could reward demonstrated waste avoidance, reuse and recycling and would offer incentive in addition to the financial savings often realised through avoiding landfilling of waste.

Waste Treatment and Disposal Contracts

The terms of waste treatment and disposal contracts agreed are key to the environmental impact of waste arisings from the development. There are a number of landfill sites within Hertfordshire, however as landfill is the lowest ranked option within the waste hierarchy there are significant opportunities for contracts to be agreed with material reprocessors and recyclers. Preliminary research shows that there are a number of businesses close to Hemel Hempstead that specialise in the treatment, reclamation and recycling of a range of waste streams; including oil, inert building materials, metals, paper and cardboard. The chief aim will be to make landfill a last resort. Landfill void space in the UK is decreasing rapidly and this is likely to lead to significant investment in alternative disposal technologies in the near future in all areas of the UK.

4.2.7 Construction

The construction phase of a typical housing development will generate large amounts of waste materials. Waste is typically placed, unsorted, in large skips on the construction site before being hauled away. In some cases the material will be sorted at a reclamation yard where metals and inert material such as blocks and mortar will be extracted for reuse or recycling. Reliable markets exist for such materials and separated construction and demolition waste is an established industry. Materials with lower market values or that are unsuitable for reclamation due to the nature of a single skip collection (e.g. physical damage, contamination) tend to be landfilled. The proposed development at Gorhambury presents an opportunity to incorporate waste reduction through both sustainable design and diligent management of site wastes. Waste production will be minimised and reuse and recycling of all materials possible will be routine.

Ordering of Materials

Most construction projects order materials to be delivered in large quantities at the commencement of the construction phase or when site preparation has been completed. This simplifies the ordering process and reduces the risk of a shortage of a particular material or product when needed. However, this practice leads to materials being stored on site for long periods of time, increasing the likelihood of wastage through accidental damage to products. This could be avoided if materials are delivered just prior to the phase in which they are required. This may require some additional monitoring and management but has the potential to deliver financial and environmental benefits to the Gorhambury development.

Inaccurate estimation of materials required and deliberate over-ordering of materials are commonplace on many developments. Over-ordering assumes that materials will be wasted during construction and this should be avoided through more accurate quantity surveys. The close liaison with contractors during early phases of the project should seek to reduce over ordering and improve material requirement estimates.

Packaging waste from materials forms can form 18-20% of the volume of material generated on a typical housing construction project. Sub-contractors can be required to procure materials from suppliers who either use minimal packaging or provide reusable and/or returnable packaging. This has the added benefit of encouraging a wider network of suppliers to consider their own environmental practices and the potential business benefits of reducing the volume of packaging supplied with materials.

Worker Training

The contracts and procedures agreed at contract sign-off are worth little if the front-line workers completing the project are not adequately trained to fulfil them. Time dedicated to training staff to incorporate environmental procedures into their standard working practice is imperative if the planning put in at earlier stages is not to be wasted. It is also important to ensure that training is ongoing and relevant, particularly on a large, long running project such as the Gorhambury development. Regular training on correct materials handling, waste segregation procedures and reuse opportunities for off-cuts can all lead to a reduction in the tonnage of material sent to landfill.

The scale of the proposed development will require large amounts of manual labour and may see significant staff turnover during the course of the project. In addition, best practice and construction methods may change as the project progresses. Consequently it is vital that a commitment to ongoing training is maintained, reviewed and improved throughout the duration of the project.

Materials Handling and Storage

Inadequate storage and poor handling of materials can lead to damage and waste of a significant tonnage of resources. Thought should be given during design phases to the provision of suitable storage areas for materials, particularly on such a large site. Ideally all materials should be neatly stored on level solid ground, with bulk materials in purpose built bays. All materials should be secure and hazardous materials should be stored in the conditions determined by risk assessments. There should be adequate space for vehicles to collected pallets, bags or other items from storage areas without causing damage to surrounding materials.

Training should be provided to ensure that those responsible for handling materials are able to do so safely and without generating waste through damage.

Waste Segregation

Segregation is perhaps the most visible method of diverting site waste from landfill and as such forms a vital element of the site waste management plan that will be implemented by the contractor.

It is accepted that waste material will be generated on the site of the Gorhambury development. However low waste to landfill targets can only be achieved if there is a robust and reliable system of waste segregation on the site. This must be supported by awareness raising and training for all site staff to ensure that waste streams are separated before leaving the site. Waste segregation can be achieved through the provision of a range of well labelled skips designed to contain a single waste stream such as plasterboard, inert waste, timber or metals. The cost of contracting multiple skips is easily offset by the avoided cost of landfill, cheaper disposal prices and the potential income from the sale of materials.

Waste Auditing

The auditing of waste materials generated on the construction site during the whole project is important as it enables the identification of areas where large amounts of waste are being generated, enables evaluation of contractor performance in relation to targets and provides useful management information for future phases of the project and, indeed, future projects. Detailed waste auditing is not routinely incorporated into most construction projects however, software packages such as the BRE SmartAudit tool are available which provide a structured approach to auditing. It is suggested that such a tool is used on the Gorhambury development.

The audit process should be designed to capture information about materials being delivered to the site as well as the contents, volumes and weights of skips leaving the site or materials reused within the development site. Occasions where materials leave the site for reprocessing before being delivered back for use within the development should also be captured by the audit. This information will provide the evidence base from which the waste management performance of the development can be judged.

4.3 Household Waste

Whilst the construction phases of the Gorhambury development have the potential to generate large amounts of waste it is also important to consider the waste management requirements of residents once each property is occupied. Waste management behaviours such as reducing waste and participating in recycling schemes are personal choices. However, it is possible to positively influence the habits of individuals by ensuring that waste reduction, reuse and recycling is made as easy as possible within the community. Many new build developments have been designed with little thought given to providing recycling facilities. The Gorhambury development offers an opportunity to incorporate features which may help residents to manage their waste in a more sustainable manner.

Waste Reductions and Minimisation

The waste hierarchy applies not only to construction waste but also to household waste, and reducing the total amount of waste generated reduces the environmental impacts of waste handling and disposal. Waste reduction in the domestic situation requires an integrated approach. There is a need for awareness raising and education to ensure that residents give thought to the items that the purchase which are likely to be wasted (such as product packaging). On a more national and local scale pressure must be placed on large waste producers (such as supermarkets) by consumers. Supermarkets have become more environmentally and socially aware in recent years and it may be that there is scope for trialling waste minimisation initiatives in conjunction with supermarkets and shops within the development. This could include not issuing carrier bags, packaging take-back schemes, issuing refillable containers for some products or adapting loyalty and reward schemes to incentivise waste minimisation, reuse and recycling.

Waste Reuse

It may be possible to establish a ‘waste club’ whereby unwanted but useable items are exchanged or traded to prolong their life. Examples might include furniture reuse schemes or scrap stores (where materials are reused by schools and groups for craft and similar activities). This could be conducted through a physical building within the development, perhaps operated by a local charity or community group. Alternatively a community website could incorporate a listings section for unwanted items or materials.

Recycling

Gorhambury is located within the St. Albans District Council (SADC) who currently provide a weekly collection of refuse using refuse sacks and a fortnightly kerbside recycling collection of (newspaper and magazines, cans and plastic bottles). Approximately 15,000 residents also receive a fortnightly cardboard collection in a reusable bag and a further 15,000 receive a fortnightly collection of glass bottles. 43,500 homes also receive a garden waste collection, with the material sent for composting. The collection is made using either reusable bags or wheeled bins. The services offered may depend on the space available for storing the recyclable material, it is therefore important to ensure that homes within the development are designed to enable all recycling services to be offered.

In addition the authority also operates 20 recycling 'bring' sites, with banks located at supermarkets, village halls, public houses and schools. These banks provide facilities for the recycling of newspapers and magazines, glass, plastic bottles and cans; some sites also have cardboard, textile and shoe banks. It is assumed that, as a minimum, SADC will provide the fullest available kerbside recycling services to the proposed development and will provide/service bring sites where appropriate.

Typical bring sites consist of large wheeled bins or 'igloo' type banks, however there are alternative bank types which could be incorporated into the site design. An example would be the underground banks which are produced by several manufacturers such as Otto, Taylor and Mulok. These hide the bank in an engineered underground hole with a top plate and litter bin style aperture above ground. Recyclable materials are easily dropped into the banks which have the advantage of being more discrete than traditional banks.

Whilst the local authority can provide comprehensive recycling services to the community, there is, at present, little which can be done to compel residents to recycle their waste. However, it is generally accepted that making recycling easy increases the amounts of waste obtained. Therefore, there is scope for incorporating design features within the development that could facilitate increased recycling from properties in Gorhambury. Any increase in the level of recycling would assist the local authority in achieving its recycling targets and would also contribute to diverting waste from landfill in line with statutory requirements. Perhaps the simplest improvements would be to ensure that residents have adequate storage space for recyclable waste both inside and outside their properties. The Code for Sustainable Homes provides minimum standards which incorporate measurement criteria and a points system which determine an overall sustainability of a dwelling. The development should seek to achieve the maximum points for waste management provision as a minimum.

It may also be possible to move away from the conventional methods of waste and recyclables collections and examine the possibility of incorporating more innovative methods into the Gorhambury development plans. The principle behind conventional waste and recycling collections is that a vehicle embarks on a journey, passing every property on its round and stopping regularly to allow waste material to be deposited into the body of the vehicle. A novel yet effective alternative to this has been to convey waste using vacuums and suction within a network of underground pipes. Systems such as those manufactured by Envac and Precision AirConvey are employed in numerous residential schemes in central and northern Europe, the Far East and the USA. These systems can be used for the deposition of waste material either within the home or using on-street containers, this material is then sucked through a network of pipes to a collection station. The collection station can be used for the bulking and hauling of waste. Additional waste inlets allow the system to sort recyclable materials separately.

Once the material has been delivered to the collection station it can be directed into conventional waste disposal routes or onward for further resource extraction at a materials recycling facility.

Composting

Many residents within St. Albans District Council already have opportunities to recycle biodegradable garden waste using the kerbside collection scheme or using home composting bins for food and garden waste. These bins are currently discounted for residents of Hertfordshire by the County Council. In addition there may be scope for the introduction of community composting sites which would accept biodegradable waste from properties within the development, compost it at a central site or sites and return the finished compost to residents, allotment holders or to the local authority for use in gardens and parks. This closed system would be a highly visible method of demonstrating the benefits of recycling waste.

4.4 Potential Waste Targets

It is possible to calculate indicative targets which may be attainable by implementing a range of the waste reduction, reuse and recycling measures described above. The charts and explanatory notes below show the waste reductions which may be possible using both current benchmarks and best estimates of future performance.

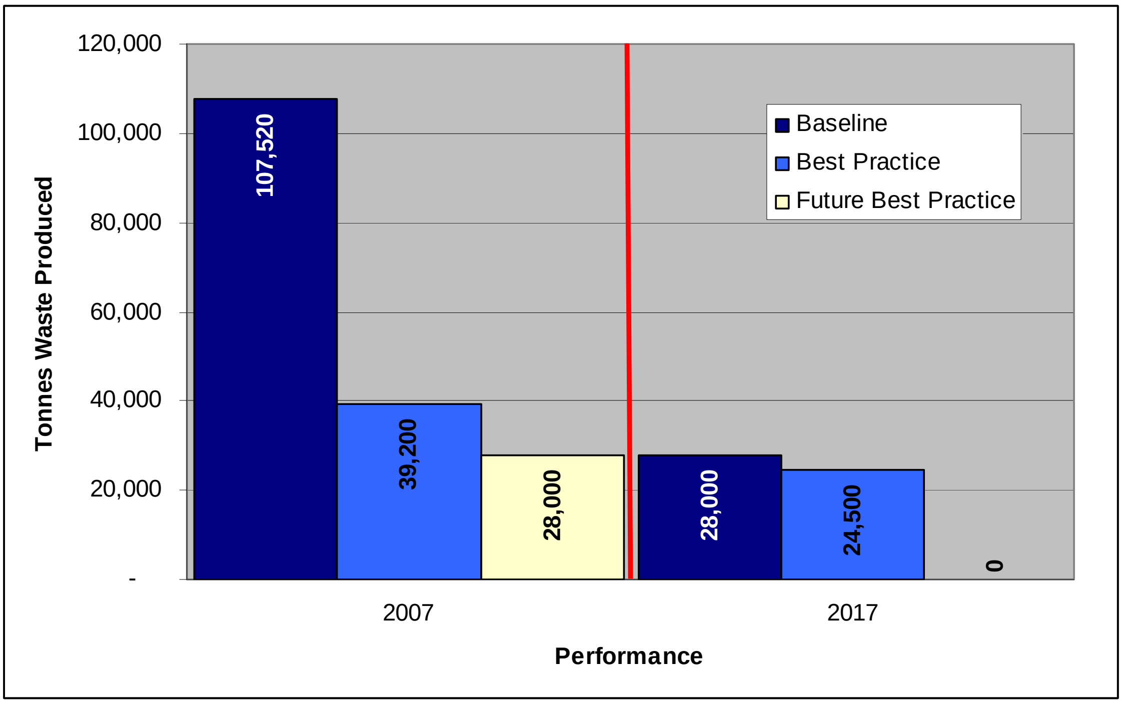
Construction Waste

- If the proposed 7,000 dwellings were built today, to current standards, the development would produce around 107,000 cubic metres of construction waste. This assumes that typical construction practices produce around 15.36 cubic metres construction waste per 80 square metres of housing. The cost of this construction waste, including material, labour and disposal costs, is estimated at around £48.5 million.

- If built to best practice a significant reduction in construction waste of around 68,300 cubic metres could be achieved. This would result in around 39,200 cubic metres of waste being produced with an estimated cost of £17.7 million.

- Achieving a further reduction to 28,000 cubic metres of construction waste may be possible but would be likely to depend on significant changes in design, procurement and construction practices. It may not be possible at the commencement of the Gorhambury development but is expected to be best practice by, perhaps, 2017. This will require the construction waste produced per 80 metre square house to be reduced to just four cubic metres. Zero construction waste is unlikely to be achievable with the next 10 years although environmentally ambitious developments such as that at Gorhambury may achieve 'zero waste to landfill' targets.

Table C4.1 Construction Waste Estimated Performance 2007 and 2017 (7,000 properties)



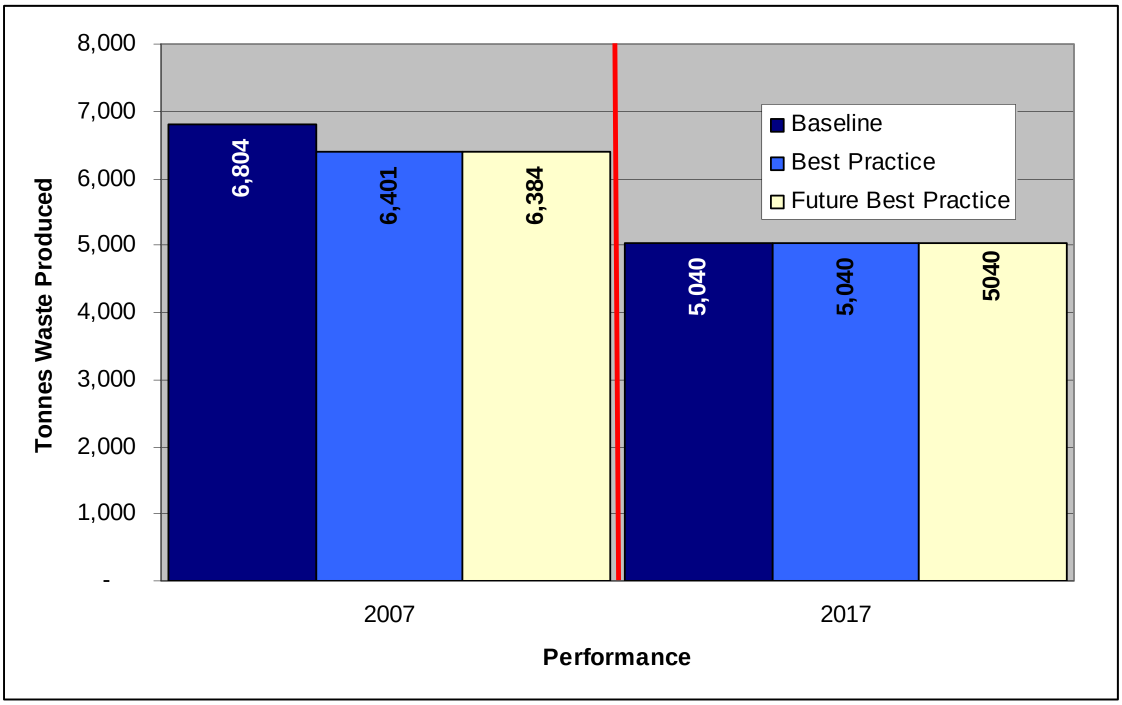
Potential Targets - Household Waste

- Current national average for municipal waste produced by an individual is 405 kilograms of waste per year. Assuming 100 per cent occupancy and 2.4 people per household this would equate to a total waste output of 6,804 tonnes.

- By reducing individual waste outputs to 381 kilograms per person (best UK practice) this could reduce total waste arisings to 6,401 tonnes.

Pushing this further it may be possible to reduce per capita waste arisings to 380 kilograms per person per year. This would reduce household waste arisings from the development to 6,384 tonnes. It is not possible at this stage to envisage how this could be reduced further.

Table C4.2 Household Waste Estimated Performance 2007 and 2017 (7,000 properties)



4.5 Conclusions

It is possible to greatly reduce the resources used by, and waste produced from, the development. The principles that should be adopted are:

- Minimise resource use through design, off site construction and materials specification.
- Use on site, sustainable remediation methods and maintain a cut and fill balance on development plots to reduce site preparation waste. Topsoil requirements could be supplemented from composted material.
- Maximise the use of materials with a high recycled content and those from renewable and sustainable sources, preferably from local sources.
- Minimise the production of waste and maximise recycling during the construction process.
- Minimise the production of waste and maximise recycling during the occupation phase.
- Ensure, through design, materials specification and construction, that the buildings are easy to dismantle and recyclable after demolition, at the end of their life.

A multidisciplinary approach to design, construction and procurement will need to be adopted in order to achieve the resource objectives for the development, which should be built into the design and developer briefs.

Local authority recycling schemes are becoming more widespread. Over the next decade we expect these to become more efficient and so increase the recycling rate substantially. It is likely that direct, possibly weight or volume based, charging for domestic waste will be introduced in the next decade. This should help to further reduce domestic waste production.

Options exist for collecting waste and recyclables including:

- Segregated collections of recyclables (dry and biodegradable) and residual waste by vehicles (the existing approach).

- An automated collection system. There are examples of these systems being adopted in some other European countries and in developments in Brent and Barking Riverside for example.

Both of these will require good storage facilities within the houses and buildings. It may also be possible to incorporate more contemporary bring site facilities which are less visually intrusive, can make the streetscape more attractive and reduce noise impacts on nearby homes.

Several waste management options have been discussed for reusing, recycling and composting household waste. Adoption of these will depend on the specific waste management options employed by the local authority. Reducing biodegradable waste is a particular focus of current European and UK legislation. This can be reduced through the use of home/community composting for garden waste and through other methods such as the use of in-sink waste disposal units for food waste.

The incorporation of allotments in the development for small scale, local food production could also help to reduce waste. Compost from biodegradable domestic waste could be used to fertilise and condition the plots and locally produced food could help to reduce the transport associated with food delivery and packaging. Health, social and economic benefits could be derived from allotments by giving people access to good quality, affordable food, regular exercise and community interaction.

The promotion of local delivery schemes such as milk and groceries could present another local economic opportunity. Local, cotton nappy delivery and laundry services are an alternative to disposable nappies. Services currently operating across the UK tend to be fairly small, locally run enterprises and so could present another local economic opportunity.

5. Conclusions

There are a number of opportunities to reduce energy use (and therefore carbon dioxide emissions), water use and production of waste by implementing the measures considered in this Part C of the document. By fully implementing these measures development to the east of Hemel Hempstead can be a truly sustainable development with considerably less impact on the environment than if the development was a standard development. The fact that the site is owned by a single land owner, The Crown Estate means that there is true commitment to the principles of sustainable development and consideration of impacts on climate change. These should be key considerations for the local authorities in making decisions on preferred options for growth. The proposals offer the opportunity to create a high profile exemplar development as a sustainable mixed use urban extension to Hemel Hempstead.

The key conclusions/recommendations relating to sustainability and climate change are as follows.

5.1 Energy Use/Achieving Zero Carbon

With regard to energy use and achieving zero carbon, the technical work undertaken demonstrates that the residential element of the proposed development can be zero carbon. This could be achieved assuming that all buildings will include a high degree of energy efficiency and will be designed to take full advantage of passive techniques such as good use of daylight, solar gains and thermal mass.

There are a number of options available to provide the required energy for the proposed development at Gorhambury. For example, zero carbon heat could be provided from individual boilers in homes burning renewable biomass fuels (e.g. wood) or from larger communal heat producing facilities such as biomass fuelled CHP (which would be connected to a district heating network). Solar thermal systems could also be used although these would not be able to provide 100% of the heat demand. Even electric space and water heating could be used provided that sufficient renewable electricity generation capacity was installed to meet the annual demand.

Large wind turbines are likely to feature in some way or form and the report looks at the potential for large scale wind to be incorporated into the proposed development.

The implications of choice of system for space heating (and to a lesser degree cooling) are significant. If the development uses communal biomass CHP to both generate electricity and provide heat via district heating, around 3.75MWe of biomass CHP and a further 3MW of wind turbine would make the development zero carbon. However, if electric heating was used to provide all space and water heating, around 32MW of wind turbine would be required.

From a practical perspective, a strategy based on large wind and biomass CHP is considered the neatest solution to achieving a zero carbon development as it may be possible to utilise currently unused forestry residues and waste

garden material as fuel. The potential for incorporating micro and small/medium scale wind is not thought to be promising. Wind speeds in the area are moderate. However, various options could be considered.

In addition to the new zero carbon housing, it may be beneficial to the economic attractiveness of the development of a biomass energy system to include existing homes adjacent to the site.

Most developers will not want to be involved in a development after handover. Operation of any biomass district heating scheme is likely to be by an Energy Services Company (ESCO). There are several large companies that provide ESCO services and some local authorities have also set up ESCOs in order to catalyse district heating schemes. An alternative business model could see ownership staying in the hands of the community (although this may be more suitable for smaller schemes).

Early involvement of an ESCO would be expected and they would take on design, installation, commissioning, (part-) financing and operating responsibilities. Part financing by the developer is expected as provision of district heating and biomass CHP will be essential to securing approval for building.

The above options are clearly all dependent on the scale of the development and could not necessarily be applied successfully to a much smaller development given the need for economies of scale.

5.2 Water Neutrality/Conservation

The work undertaken demonstrates a number of ways in which water demand associated with the development to the east of Hemel Hempstead can be minimised. Even with improved technology and changing attitudes towards recycling of water over the development period, it is unlikely that the development can take place without generating an additional demand for potable water, at least in the foreseeable future. However, the net effect of the development can be managed by seeking to offset this new demand by reducing consumption in surrounding areas. It is particularly useful to be able to reduce demand in the areas that are supplied from the same source as the new development. This offsetting approach is currently the most likely way of achieving water neutrality.

Rainwater harvesting systems (which collect rain from roofs and often from other impermeable areas such as driveways) can be installed for individual dwellings or more economically at a larger scale. There are clear advantages to developing these measures at the larger development scale and this is likely to be the most appropriate measure to be implemented in the near future. There are a number of developing technologies for recycling greywater and blackwater. Given the state of these technologies and public perception issues, it is only likely that such measures would be part of a water neutral solution in the later stages of the proposed development once the technology has advanced and has been proven further.

SUDs design at Gorhambury is likely to include a mix of filter strips and swales, filter drains and porous pavements to allow rainwater and run-off to infiltrate into permeable material below ground and storage and attenuation lakes and ponds.

In order to ensure that the development is water neutral, i.e. with no net impact on water resources locally, it is necessary to offset the net demand for water. This can be affected by retro fitting water saving appliances to existing homes within the Colne river catchment. Between 21,700 and 37,800 homes would have to be retrofitted with the devices identified in the report in order to offset the additional household demand from the Gorhambury development. Implementing compulsory metering or variable tariffs is likely to reduce the numbers of existing households that would need to be retrofitted with demand management measures to offset the demand from the new development.

5.3 Resource Efficiency/Waste Reduction

The resource use associated with the proposed development can be significantly reduced by adopting the following principles:

- Minimise resource use through design, off site construction and materials specification.
- Use on site, sustainable remediation methods and maintain a cut and fill balance on development plots to reduce site preparation waste. Topsoil requirements could be supplemented from composted material.
- Maximise the use of materials with a high recycled content and those from renewable and sustainable sources, preferably from local sources.
- Minimise the production of waste and maximise recycling during the construction process.
- Minimise the production of waste and maximise recycling during the occupation phase.
- Ensure, through design, materials specification and construction, that the buildings are easy to dismantle and recyclable after demolition, at the end of their life.

Options to assist in further reducing domestic waste production include the following:

- Segregated collections of recyclables (dry and biodegradable) and residual waste by vehicles (the existing approach).
- An automated collection system. There are examples of these systems being adopted in some other European countries and in developments in Brent and Barking Riverside for example.

Such measures will require good storage facilities within the houses and buildings. It may also be possible to incorporate more contemporary bring site facilities which are less visually intrusive, can make streetscape more attractive and reduce noise impacts on nearby homes.

A number of waste management options have also been discussed for reusing, recycling and composting household waste.

5.4 Planning for a 'Climate Proofed' Development

The proposed development at Gorhambury will need to be resilient to future climate change impacts. The UK Climate Impacts Programme Scenario produced for the East of England Region in 2002 indicates that the impacts are hotter drier summers and wetter milder winters with increased risk of storms. There is scope to modify existing developments to ensure that they are resilient to climate change impacts (retrofitting adaptation measures, flood defences etc.) but there is significant potential to ensure the buildings that are constructed now and in the future are responsive and resilient to these potential impacts.

Buildings in the eastern extension to Hemel Hempstead will need to be resilient to future climate change impacts and this will need to be incorporated into the design process at the outset to 'climate proof' them against expected temperature rises, increased risk of flooding and more extreme weather. Increased potential for overheating is particularly important from an energy point of view, and so the design to avoid air conditioning should be robust enough to deal with future rises in temperature.

It will be important to incorporate Passive design techniques to achieve energy savings. One notable standard is *PassivHaus* which has resulted in designs that achieve up to 90% energy savings. A passive building will heat and cool itself to maintain a comfortable interior without heating and cooling systems. Reducing the energy requirement will be a key aim for the proposed development at Gorhambury and so passive design techniques can play a key part in this.

Climate change 'checklists' are to be increasingly used in the future to assess the performance of a development. There are a number of these checklists currently available including for example, *Adapting to climate change: a checklist for development* (South East Climate Change Partnership 2005) covering aspects such as the location, layout and built form of the development. Appropriate checklists should be used prior to the development stage to ensure that the development is working towards incorporating measures to adapt to climate change.

5.5 Development Principles

There are key development principles that can be taken on board as part of the proposed development at Gorhambury, including the neighbourhood concept and enhancement of the natural, historical and recreational environment, all of which ensure that the proposed development is as sustainable as possible. These are discussed in greater detail in Parts B and D of this report, in particular the sections on Design Principles and Concept, Historic Environment, Ecology and Recreation.

Community involvement in formulation of the proposals through to development is a key part of ensuring that the development is sustainable. Chapter 5 in Part D of this document on Community and Stewardship sets out the basis for community involvement at Gorhambury and sets out possible options of models for stewardship of community assets.

Self-build is an option that could be considered at Gorhambury. At the appropriate scale this could be beneficial in working towards meeting key sustainability principles and could also be beneficial in terms of affordability for the local community. Affordable housing shortages in Dacorum and St. Albans mean that there is severe pressure on housing in the districts. Self-build is increasingly popular throughout the country and in many areas it is being promoted by local authorities. For instance in Shropshire, South Shropshire District Council is encouraging self-builders in their community with an innovative scheme to allow planning permission in areas where applications are sometimes declined. It also allows local people, who cannot afford to buy homes in the communities where they grew up, to become involved and remain in their local community. There are also restrictions on the size of the properties built to ensure that it is not solely about profit. As a New Town, Milton Keynes promoted self build at the outset of its planning and plots are still selling today.

Self build can range from people physically building much of a house themselves, to handing over responsibility for the entire construction process to other parties. It can also be undertaken collectively, usually with groups of the community pooling their expertise, skills and resources. An option would be for parts of the proposed development area to be put aside specifically to be sold as plots for self build. Design guidance and coding would need to be applied to these areas. Criteria could be introduced for self-build applicants, for instance people could have to demonstrate that they are from the local area, or have a genuine housing need.

5.6 Supporting Policies

The Secretary of State’s Proposed Changes to the emerging RSS, RSS14 for the East of England propose a number of policies which are supportive of some of the options explored in this part of the document. These include Policy ENG1 on Carbon Dioxide Emissions and Energy Performance which encourages the supply of energy from on site renewable and/or decentralised renewable or low carbon energy sources. It goes on to advise that as a minimum 10% of the energy consumed in new development should come from such sources, and local authorities are advised to encourage energy service companies (ESCOs) and similar energy saving initiatives. With regard to water efficiency, Policy WAT1 sets out the need to ensure that development provided for in the Spatial Strategy is matched by improvements in water efficiency. Policy WM1 sets out waste management options, which include minimising the impact of new development on regional waste management requirements. It also includes seeking community support and participation in promoting responsible waste behaviour and approaches to management, viewing waste as a resource and maximising re-use, recycling and composting, while responding positively to the need to manage the remainder. The supplement to PPS1: Planning Policy and Climate Change, is also supportive of the types of measures set out as options in this document.

Creating the environment for business