Eco-cities, a sustainable solution to urbanisation ?

1. Introduction and overview

In the past two decades many governments have pursued policies of urban intensification, promoting mixed-use and housing development on used and unused commercial land and in the back gardens of suburban properties in the belief that intensification will promote sustainability, primarily in terms of the economics of public transport use. In many instances, that policy has now reached its limit, both physically and politically, with local communities re-acting adversely to what is perceived as (and in a number of circumstances actually is) a decline in urban amenity. There has also been a growth and intensification in unplanned settlements on the periphery of primate cities in particular and with the world rapidly urbanising and global trade being promoted it is not difficult to predict that urban growth pressures will be most severe along the primary trade routes most able to accommodate the growth in trade, principally at port cities on the trade routes. The opportunity therefore exists to divert migrants from large overcrowded cities, which may not have the capacity to absorb further population increases without a serious deterioration of living standards and the local environment. Additionally, by encouraging some residents in already overcrowded settlements to move to new settlements the opportunity becomes available to create much needed parkland, greenbelts and environmental improvements within existing settlements and substantially raise the living standards of remaining citizens as well. With global warming, housing shortages and urban poverty as driving motives the concept of the new planned settlement is once again gaining prominence as a solution to rapid urbanisation. However, the greatest potential for new planned settlements, or the organised expansion of existing settlements in sustainable locations, is as an opportunity to localize rural-urban migration and stem mass long distance migration in a manner that minimizes the environmental impacts of the march of humanity to urban living. There are political and humanitarian issues to consider, and there always have been, as this involves the movement of people from one place to another, the potential imposition of a new large urban population on a much smaller local population and the need to acquire and manage land to achieve the most desirable form of development, that is, well designed settlements that allow people to attain high living standards without compromising (indeed improving) the environment they live in.

The design principles promoted for some of the most recent proposals for new settlements are focussed on achieving sustainable living patterns and zero carbon standards and those proposals are being promoted as eco-cities, eco-towns and eco-villages. Yet these ideas are not new at all, with the concept of the self sustaining settlement being promoted in Ebenezer Howard's garden city theory, developed at the turn of the twentieth century and which spawned the creation of the Town and Country Planning Association, an organisation devoted to the realisation of Howard's vision. Indeed, before the advent of mass private transport, many settlements were highly self sustaining as a matter of necessity and this was often reflected in the design of the settlement, and the settlements which grew most were often located along primary trade routes. And whilst settlement design is an important factor in facilitating sustainable living patterns, urban and rural management policies, citizen work and living patterns and recognition of the interdependence of settlements with their rural hinterland will still be significant determinants as to whether a settlement has a truly sustainable character with a positive impact on the local environment. Simply achieving zero carbon standards or using carbon and ecological footprint measurement methodology will not make a settlement an ecologically successful entity and a contradiction may develop whereby settlements (new or existing) promoted as 'eco' are in fact less ecologically sound than settlements which are not. For this reason, more detailed and internationally recognised minimum standards need to be established that will more effectively influence the planning and design of new settlements and the evolution of existing settlements into ecologically sound entities. As settlement structure and

design is the primary remit of the planning profession, developing new design concepts to best meet the requirements of changing paradigms is fundamental and necessary if the profession is to retain primacy as a mover for positive change and the task of achieving sustainable settlements in an age of global trade and communications, mass consumption and high expectations of personal and independent mobility will not be an easy one. This paper postulates location, management and design themes that may provide guidance for the design and management of an eco-city.

2. Establishing a locational criteria for sustainable settlements

Clearly for any settlement, new or existing, to have the least possible impact on the environment it must be situated where it causes least damage to the surrounding environment and has a very high potential for movement into and out of the settlement to be by the least polluting means. A process of site elimination therefore needs to be established in order to identify the most suitable locations for settlements. The first such step needs to identify what type of land should not be developed for (and indeed must be protected from) urban purposes. The most ecologically sensitive land and environs (such as national parks, important habitat sites and land above sensitive groundwater aquifers), water stress areas, flood prone areas, geologically unstable land and climatically dangerous locations are clearly the least suitable sites for urban development. Preventing development on high quality agricultural land is often promoted; however such control works against the tendency for such land to sustain intensive farming and high population densities (and consequently more intensive development) and discounts the potential for food production within urban areas. The ability of the surrounding rural environment to absorb the by products of a settlement and more intensive use must also be considered.

Additionally, if walking, cycling and public transport use are to be encouraged to the maximum extent then a settlement will need to be located on relatively flat land with a relatively benign climate is. Similarly, suitable sites would need to be adjacent to regional and nationwide transport corridors in order to promote public transport use between settlements, to ensure the most efficient and sustainable movement patterns for the transport of goods and materials[1] and to minimise the level of infrastructure development required to connect any new settlement into the national and international transport network. This would indicate that a location adjacent to a national railway line and highway route would be the most sustainable location for an eco-city. This locational concept of establishing new settlements along national and international transport corridors and trade routes is not simply a sustainable and desirable outcome, it is a natural and historical urban phenomenon (for example the Zahringer settlements of Switzerland and Germany and many port settlements of Asia, Africa, the Americas and Australasia). It is also a necessary requirement because a failure to recognise this phenomenon would likely result in a planned new settlement, located away from the corridor, requiring higher traffic levels to and from the settlement whilst private investment continues to seek to move to its most logical location along the transport corridor but does so in an unplanned manner.

Achieving such a location selection criteria requires the existence or development of regional, national, continental and international GIS databases that can map all of these geographical, ecological, climatic and transport values, including capacity constraints or under-utilisation of transport infrastructure. With this knowledge transparent land-development and land protection zoning plans can be developed that fully justify promoting what development should occur where and where development should not occur at all. And if we recognise the fact that a massive level of sustained migration and urbanisation is already occurring, and is going to continue over the coming decades then we need to identify the land that is going to need to be developed in order to accommodate people in the best possible manner and set about designing settlements where people can live a prosperous and dignified life in harmony with their environment. This will require surveying, designating and subdividing land (including for infra-structure, streets and parks), and establishing development regulations to ensure that

development proceeds in an organised and well thought out manner that does not compromise the need to minimise environmental impacts. Notably, this also allows potential for the gradual development of settlements through a combination of civic investment and local people and migrants investing their own resources developing land plots, if such luxuries exist.

3. Establishing criteria for the design and layout of an eco-city.

The stimulus for this paper originated from an attempt by the author to work up a coherent and comprehensive form of development based on the real standards and physical measurements set by government and professional publications and also on advice received by experts in a wide range of fields. The concepts which are described are based primarily on my own professional experiences, observations and calculations and I am indebted to my colleagues in the Planning, Ecology, Landscape, Engineering, Highways, Conservation and Building Control departments of Winchester City Council and Hampshire County Council for the specialist knowledge they have imparted to me. The concepts are not intended as design templates but as an effective means of demonstrating how urban areas can accommodate movement, high population densities and ecological habitats in the most sustainable and benign manner.

In order to create an effectively integrated settlement (including integration into the local ecosystem) with high amenities, societal adaptability, a stable economy and minimal impact on the environment the design of an eco-city would need to specifically achieve a number of objectives, notably:

1. Maximising bio-diversity and local wildlife habitat, including the ability for wildlife to move between places within the settlement and beyond;

2. Energy efficient buildings;

3. Maximum self-sufficiency in local energy supply by sustainable methods.

4. A frequent, comfortable and desirable public transport system (including between settlements) with maximum accessibility that people would want to use as a matter of choice and which is able to transport people to as many locations as possible as fast and directly as possible;

5. Conveniently located local facilities such as schools, sports fields, shops, local parks and medical centres which are safe and comfortable for all residents to walk and cycle to;

6. A full complement of civic, leisure and educational facilities which are conveniently accessible to all residents by walking, cycling or public transport and which is also convenient for commuters and visitors from outside the settlement;

7. A population size and density that allows the economic provision of such services and facilities.

8. A safe and comfortable pedestrian environment generally;

9. Space for mature trees to grow unrestricted;

10. Rainwater retention systems, including balancing ponds and lakes and swales along some streets;

11. Commercial activity readily accessible to all residents and commuters from other settlements by walking, cycling or public transport;

12. Provision for bad neighbour uses[2] and associated traffic that does not affect residential areas and which is able to maximise potential use of railways;

13. Conveniently located countryside recreation facilities (such as horse riding, golf course, countryside parks with walkways, cycleways, bridleways and fishing ponds)[3];

14. Local food production for sale to the entire settlement[4];

15. Modern telecommunication facilities available to all residents which are able to allow people not to travel for many activities[5];

16. Equitable outcomes and opportunities for all residents.

Achieving these objectives necessitates establishing a basic regulatory framework capable of shaping the form and size of a settlement and its rural periphery and requires a level of restriction on how land can be used and developed in different locations in order to promote effective investment choices. It will also require co-ordinated civic investment, stewardship and land acquisition programmes[3].

4. Basic form for a sustainable settlement.

In order to achieve these objectives it becomes evident that the basic form of the most sustainable form of settlement needs to be linear with a central spine road (or several broadly parallel streets) traversing the whole settlement and connecting neighbourhoods to a town centre and larger employment and commercial sites beyond. This linear form permits all urban uses to be situated within convenient walking distance of the spine road, in order to make public transport along the spine road as convenient, economical and accessible as possible. It also requires well connected streets (the permeable grid) at reliable intervals as this is the form of development which maximises opportunities for walking and cycling to all places in a settlement over the shortest distances possible. If people are to have choices as to where they live and work and are to be able to maintain a settled life whilst being able to adapt to changes in their work and movement patterns[6] then an eco-city must be designed and managed to allow this to occur without people being dependent on private cars for travel as their travel patterns change. To achieve this local public transport routes will need to connect with the national (public) transport network, with the connection point being proximate to those activities most likely to generate the highest number of trips within and between settlements. This form of development reflects the natural trend towards the development of a city centre at the most intensive transport node. Additionally, commercial activity that generates a great deal of noise and commercial traffic needs to be concentrated in a location that does not require large commercial vehicles to travel through residential streets and which has maximum potential to economically utilise the railway system for freight transport[2].

In order to make public transport and places as accessible as possible to all residents, land extensive activities such as schools, sports fields and parkland would need to be located at the edge of the urban area rather than within it. Additionally, viable public transport and local facilities that are within convenient walking distance of all residents requires a residential density that would most likely prevent the provision of houses with large private gardens. So the provision of sports fields, schools, grouped garden allotments and even community farms at the settlement edge would allow for the provision of additional private and communal space for urban residents and would assist in defining the urban form of the settlement. The linear form of settlement would also ensure that these activities are able to be located within walking distance of local neighbourhood and would direct public and private educational and recreational investment to ownership of land on the periphery of the urban area, providing direct public control of the rural/urban edge[3].

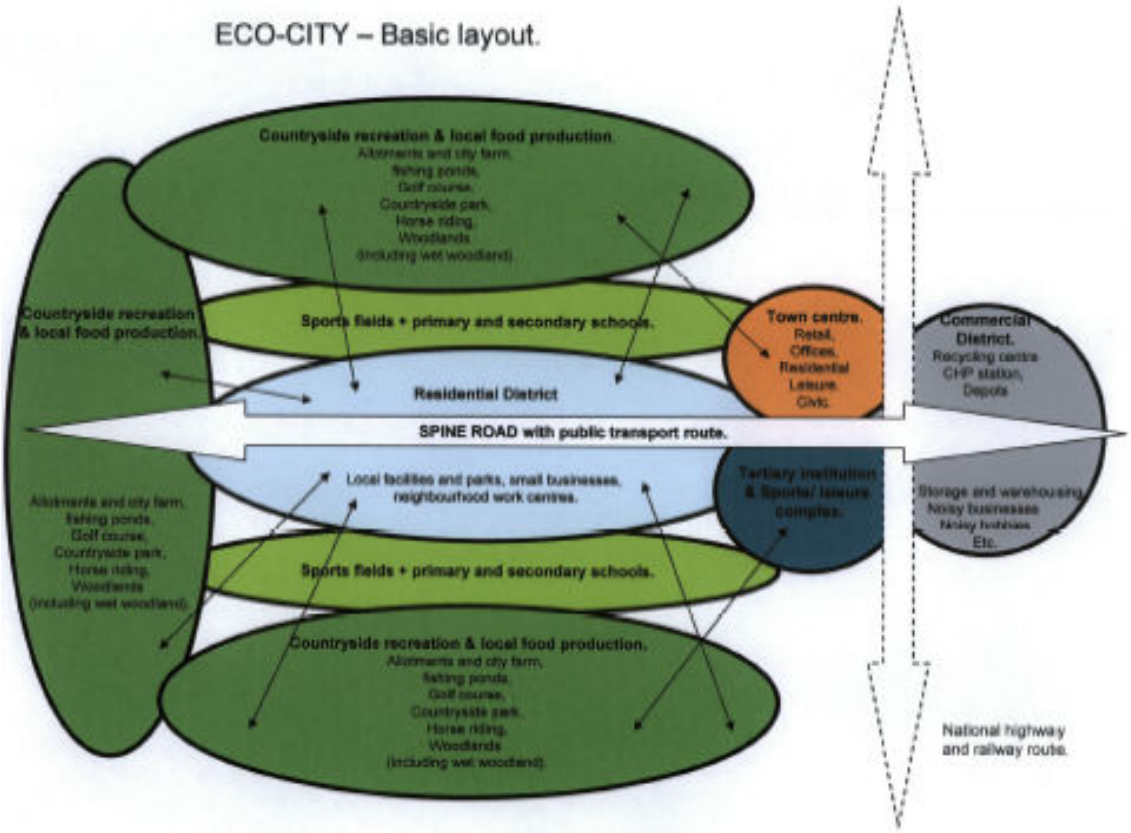

Diagram 1. Diagram by J. Jenkison.

5. Detailed layout for a sustainable settlement.

The detailed layout for an eco-city is likely to necessitate a compromise between three potentially conflicting requirements, and keeping this conflict to a minimum is perhaps one of the greatest challenges in achieving a sustainable settlement. On the one hand people require a legible and understandable settlement, that is, one where things, activities and places are where you expect them to be and are easy to find and get too. Secondly, people also like their places to be distinctive and an important aspect of sustainable development is the use of local resources and materials in construction. Thirdly, if a settlement is to have a substantial and integrated eco-system capable of sustaining a high level of mature trees and plant and wild life rather than simply a collection of landscape features then the layout of the settlement and the amount, size and location of parkland and green corridors requires careful consideration. Yet in order to achieve the most energy efficient buildings and to maximise the potential of renewable energy resource use such as solar gain there is a pressure too design and locate buildings according to a set format which is not compatible with general and professional views of what a settlement should look like and how it should function. For example, achieving the most solar efficient buildings in high latitude countries has often resulted in the establishment of long rows of evenly spaced buildings of the same or similar design, which are designed so as not to overshadow one another and which are often set perpendicular to a street (The Bedzed scheme in Croydon, London being a notable example). This results in much of the space between the buildings (or on the side of the building which does not face the sun) being cast in deep shadow for long periods of the year, inhibiting vegetation growth and creating an unpleasant environment for pedestrian movement and circulation. Additionally, maximising solar efficiency for such buildings requires that they are not unduly overshadowed by mature trees. Thus, achieving the most solar efficient buildings necessitates sacrificing plant life and pedestrian comfort. Streets are also compromised as they may lack building enclosure and continuous and

active street frontages. Moreover, the facades of facing buildings will be different in height and shape and when looking between different rows of buildings each row will present the same or similar character and appearance (creating visual monotony and spatial confusion for the pedestrian) and will lack the distinctiveness required to maintain a discernable differentiation in the character of every street. Conversely, the completely enclosed perimeter block compromises solar efficiency potential along two sides of the block, inhibits the connection of street spaces to the interior of the block (and in doing so restricts the connection of landscape areas, thereby reducing ecological diversity and wildlife potential) and can reduce residents perceptions of space and openness to an undesirable extent.

Diagram 2

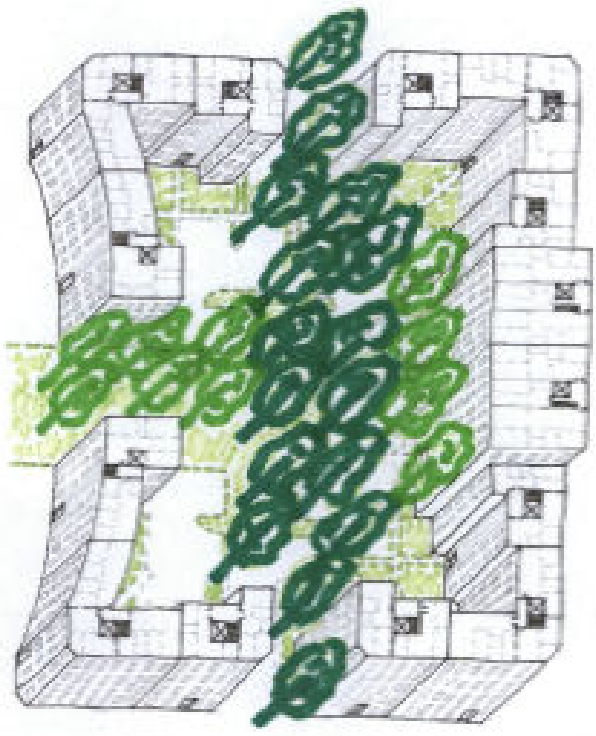

Diagram 3

Diagrams by J. Jenkison.

Diagram 2 demonstrates a dense suburban style perimeter block (achieving forty three 2-5 bedroom dwellings to the hectare, each able to incorporate thermally massive walls) with a 'mews' type alley in the centre of the block that provides carparking spaces for the mews houses and houses on three sides of the street block. The building designs are intended to maximise the level of sunlight into each building, ensure double aspects and perceptions of spaciousness, expose as much roofspace as possible to the sun and to minimise garden overshadowing. The diagram demonstrates how each side of the street block is able to have its own distinctive character and how landscape features such as hedgerows are able to extend into the block from the street. Trees have not been drawn, however trees with a branch spread of 6 metres are able to be evenly distributed throughout the interior of the block in a manner that ensures that they do not create branch over hang of buildings or the garden space immediately adjacent to them. Two street corners are used to allow the provision of two very large houses, which may assist in promoting income diversity within a neighbourhood and throughout the settlement and mitigate against the evolution of neighbourhoods with large income disparities.

Diagram 3 demonstrates how an 'open' perimeter block of apartment/mixed use buildings is able to ensure that streets are well defined but which also allows landscape areas within the block can be connected with the surrounding street network. Higher levels of sunlight penetration into the interior of the street block are achieved and outlook from building windows

becomes more spacious. These diagrams also demonstrate the potential adaptability of the use of surrounding streets, with 50% of street space surrounding the blocks having the potential to be closed off to vehicle traffic whilst still allowing vehicle movement into the street block. Land area freed from vehicle movement and parking in the streets provide the potential for continuous and significant amounts of landscaping, thereby making streets more conducive for wildlife movement and providing wildlife with a much greater habitat. Diagram 3 has also been drawn to demonstrate how the effective use of different tree species, apart from promoting bio-diversity, can assist in giving visual definition to travel paths. In both diagrams, the height of the buildings graduates from one side of the block to the other, allowing a height transition from the lowest density blocks to the highest density blocks whilst at the same time ensuring that streets have buildings of similar height facing one another. The dimension of the street block is the same in both diagrams.

Diagram 4

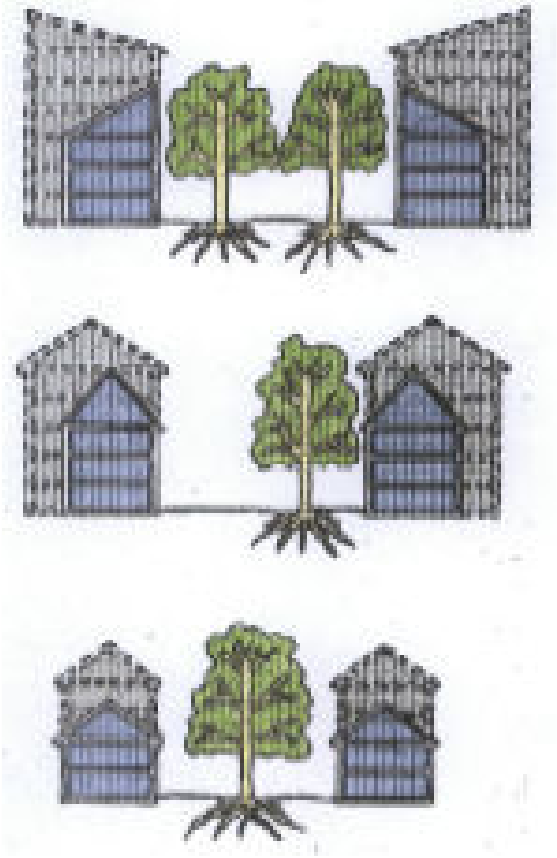

Diagram 5

Diagrams by J. Jenkison.

Diagram 4 demonstrates how an effective local park and street network is able to perform the additional function of maintaining integrated green corridors that are capable of extending through the settlement and into the countryside. Diagrams 2, 3 and 4 demonstrate how the layout of building blocks in a street grid network are able to be adapted to ensure that every second street is capable of being adapted to prohibit or restrict vehicle traffic within the green corridors and thereby limit the need for pavement surfaces. With the prohibition or restriction of vehicle traffic along these streets the corridors are also able to incorporate children's play spaces in home zone type arrangements and will allow uninterrupted pedestrian and cyclist movement over long distances. Local parks are capable of being designed in different shapes, providing each park with its own distinctive character, and which also assists in defining a neighbourhood and which may include small streams and swales, which promote amphibian and fish life, can accommodate rainwater run-off and are capable of being designed for both amenity and recreational purposes.

The even distribution of local parks throughout a settlement also ensures an equitable level of access for all residents to local parks and Diagram 4 demonstrates the extent to which high levels of aquatic and plant life can be established within a densely populated urban area through this methodology. Importantly, the location of gaps in street blocks ensures that landscape connections are able to be established between the interior of blocks and the street and parkland network (diagrams 2, 3, 4).

Photograph by J. Jenkison.

River passing through a local street.
Itchen River, Water Lane, Winchester.

Photograph by J. Jenkison.

The same river passing through a local park.
Itchen River, Abbey Gardens, Winchester.

Diagrams 4 and 5 demonstrate how street trees are able to be used to inform the function, orientation and locations of streets within a network. Diagram 5 demonstrates how as streets become wider the streets are able to accommodate more rows of street trees in different locations, which further assists in providing different streets with different functions with a distinctive character. Varying street widths and building sizes according to the function of a street (local pedestrian dominated streets, multi-functional all purpose streets, avenues and spine roads) assists to ensure that people can readily associate the nature of a street with where it leads too, and trees are able to assist in the visual definition of a streets function. By concentrating different tree species along different streets the distinctive bark, leaf colour and texture of each tree species will contribute to the distinctiveness and individuality of a street and the position of a row of trees in a street further adds to its distinctive visual definition (for example, a street with one row of trees planted along only one side of the street is readily discernable from a street with a single row of trees planted along the centre of the street, and a street with two rows of trees is readily discernable from a street with one or three rows of trees planted along it). This usually co-relates well with the functions of a street and the widths required too maintain adequate levels of visual privacy between buildings facing one another across a street. So a local multi-purpose street with a width of 20-25 metres between building faces is usually adequate for the provision of two rows of mature street trees, small front gardens, 1.5-2 metre wide footpaths on either side of the street, landscaped road verges and a central road surface which can comfortably accommodate carparking spaces and the movement of cyclists and vehicles. Separating footpaths and vehicle traffic movement spaces with carparking and verges is essential to maintain a safe and comfortable pedestrian environment (for example, pedestrians are safe from splashing by passing vehicle traffic during periods of rain).

Local streets, where vehicle traffic can be restricted or prohibited, still require a minimum width of at least 15 metres between building faces, which is sufficient to ensure adequate levels of privacy between buildings, is capable of accommodating a central row of mature street trees and is also sufficient for the provision of children's play spaces centrally within the street in a home zone style environment. It is these local streets, which have less need for pavement, that are able to connect local parks and the countryside with a continuous landscape corridor.

An important aspect of any ecological settlement is the amount and different species of mature trees that are able to be accommodated within it. Accordingly, individual street identity and transitions between neighbourhoods throughout an entire settlement is able to be achieved through an effective street tree planting strategy. Importantly, the use of locally indigenous tree, shrub and grass species assists to make every settlement distinctive from one another and maintaining variety not only promotes bio-diversity and effective wildlife habitats and food chains but also protects the local ecology from mass blight that may occur from reliance on too few plant species.

Photograph by J. Jenkison.

Spine Road with tram line,
Freiburg, Germany.

Photograph by J. Jenkison.

All purpose street,
Hampshire, Britain.

Photograph courtesy TCPA.

Local street with landscape corridor.
Ludlow, Britain.

Thus it can be seen that even settlements with high population densities and intensive building development can be designed to maintain high levels of plant, aquatic and wild life without compromising important urban planning and design principles. Significantly, these factors are mutually re-inforcing as significant tree planting within an urban area will often create a benign micro-climate that is more comfortable for pedestrians and cyclists as mature trees provide a level of shelter from sun and rain, act to slow and disperse wind, keep air and pavement surfaces cool in hot weather, absorb pollution, help to reduce noise and also promote a visually and sensually attractive environment that is pleasant to walk and cycle through.

Local Energy Production.

Localised energy production is also essentially about transport and minimising the movement of energy over long distances, but is also about reducing pollution and its potential is closely associated with technological development. However, the potential still exists for high levels of local energy production systems to be developed which minimise a settlements dependence on imported energy and this potential is significantly greater for settlements which are able to exploit geothermal[7] and water resources for energy production, particularly as hydro-electric generation systems are now available which do not require the damming or diversion of rivers. Ground and air source heat pump technology is also able to contribute to local energy production, however, ground source heat pumps in particular may be impractical in densely developed cities with high amounts of tree planting.

Effective wind power requires high wind environments, yet these environments are uncomfortable for pedestrian movement and mature trees and buildings act to slow and disperse wind currents. However, wind speed tends to increase with altitude and whilst low and inconsistent wind conditions may not provide the most economical situation for wind turbines their utilisation is still able to provide a noticeable contribution to local energy needs and the alternative is more polluting forms of energy production, with the pollution being externalised from the cost of production. Wind turbines can also be noisy and the widespread installation of the same type and design of wind turbine can create a sameness that detracts from a settlement's distinctiveness and which makes it less legible. Locally distinctive designs (including vertical axis wind turbines, which may have more desirable design qualities than rotor blade turbines) therefore need to be encouraged and tall pole mounted wind turbines (which will need to be set at heights greater than the branch crown of mature trees) need to be located and arranged in a manner that reinforces the place of their location (such as being concentrated in a commercial district and along particular streets within a settlement). Importantly, the pole mountings of wind turbines located along streets need to perform multi-functional purposes (such as acting as street lamp mountings and incorporating street utilities) in order to minimise the land footprint of poles and utilities and to ensure there is extensive street space for intensive tree planting and other activities.

Solar gain potential is also dependent on local conditions and is most effective in locations which receive high levels of sunlight consistently throughout the year. As demonstrated in diagram 2, traditional urban

forms and building designs do not need to significantly compromise the solar energy potential of buildings. For some locations a combination of solar and wind energy generation devices may allow for a consistent level of energy production throughout the year.

High concentrations of mature trees and other plant life within a settlement ensure that a continuous supply of bio-mass (such as branch and vegetation cuttings) is available for energy production and which will create CO_2 emissions. The suitability of wood and bio-mass as fuel needs to be balanced against whether this is more carbon efficient that using other forms of polluting energy sources. The use of wood and bio-mass as a fuel also needs to be balanced against the alternative uses of these products such as soil replenishment and as a local building material. Additionally, local climate conditions will influence whether or not wood is a suitable source of local energy supply, as still air conditions could result in significant levels of localised air pollution. It is the author's view that efficient home wood burners (incorporating water heating systems) should have priority over the large scale collection of bio-mass and its use in power stations as this keeps the energy source local and equitably distributed and minimises transport requirements.

Viable unit sizes for Combined Heat and Power (CHP) stations needs to be considered as isolated examples can have difficulties with maintenance, parts and repairs. A networked system of wind, solar and CHP systems and other technologies rather than singular examples ensures that an effective maintenance, parts and repairs infrastructure is able to be developed to ensure the economic and continuous operation of an integrated local network.

Photograph by J. Jenkison.
Southampton geothermal and CHP Station.

Photograph by J. Jenkison.
Wharf Mill direct flow hydro proposal.
Itchen River, Winchester.

Conclusion

Recent prestige new town projects have been described as 'eco' for being designed in a manner that is intended to afford a potential pattern of sustainable modern living and zero carbon standards (which includes using carbon off-set projects). However, the methodologies used for calculating carbon and ecological footprint ratings are inappropriate for judging whether a city is an effective ecological entity or not. In attempting to develop an eco-city from the drawing board the planning professional is forced to consider and be conversant with all of the factors that contribute to establishing a sustainable settlement with the smallest possible ecological impact and the concepts set out in this paper have been strongly influenced by the successful strategies and policies pursued by Winchester City Council. These factors are more complex than footprint calculations and will inevitably be accorded different weightings by different communities as the very design and operation of an eco-city must be adapted to its local environment and circumstances. Furthermore, different communities and cultures facing different circumstances need to be able to adopt the most appropriate mix of regulations, incentives and investment and development strategies to suit their own particular circumstances (adopting a strict standard, for example, is meaningless if the community is unable to develop the infrastructure necessary to achieve the standard). Indeed, necessity requires many city governments too actively promote innovative and cost effective schemes and concepts to reduce pollution, ranging from redevelopment,

appropriate urban intensification, land and aquatic rehabilitation projects and waste recovery and recycling schemes to innovative transport schemes and traffic management systems.

International standards for improving the ecological character of cities are able be developed whereby the term eco-city moves away from being utopian concepts and advertising slogans and towards being a governance requirement and strategic and physical planning tool for the future development and evolution of all settlements. A toolkit of such standards would be able to be used to guide regulatory, incentive, development and investment programmes and act as a reference point for developing short, medium and long term strategies and objectives for the evolution of settlements in accordance with their own local circumstances. Such standards would need to include.

1. Per capita energy consumption.
2. Percentage of local energy consumption produced by local renewable energy production systems.
3. Land, air and water quality (including that of receiving environments outside the settlement).
4. Ratio, of green space, local and countryside parks and trees per person.
5. Equity in the distribution and accessibility of local and countryside parks, green spaces, trees and allotments and equity in the quality of provision (ie. No under provision in any neighbourhood).
6. Percentage of food consumption produced locally.
7. Quantity, age and variety of locally indigenous tree species per hectare and per street kilometre.
8. Number and variety of fruit trees per hectare and their productivity.
9. Wildlife quantity and diversity.
10. Amount and proportion of 'waste' reused and recycled.
11. Water use efficiency and sustainability (including non-depletion and non-pollution of local water supply, flood minimisation and water recycling).
12. Quality and distribution of housing stock (ie. Dispersal of large and small dwellings throughout a settlement rather than concentrations in specific neighbourhoods).
13. Percentage of housing with clean water supply.
14. Percentage of population exposed to air, water and noise pollution.

With a robust set of standards communities can more accurately measure where improvements need to be made, how development pressures can be accommodated and how maximum benefits can be achieved for the least cost according to local circumstances. Utilising such standards also ensures that the performance of settlements is able to be scrutinised and compared at a regional, national and international level in order to identify where successes and failures are occurring. Most importantly, however, communities and decision makers are more likely to view their settlements as integral aspects of local eco-systems rather than as parasitic and destructive impositions on their surroundings.

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Endnotes:

1. International and bilateral trade, finance and travel agreements between countries promote increased movements of goods and people between and within countries as economies adapts to the new trade and travel patterns. This adaptation process will also influence the spatial arrangement of settlements and travel patterns within settlements.

2. Poorly located industrial sites, industry dispersal into the countryside and residential sprawl around industrial areas is particularly undesirable not simply for the pollution and loss of amenity that occurs, but also because traffic congestion is a cost to business (in terms of competitiveness) and dispersed industry cannot benefit from the economies that are able to be obtained from shared infrastructure, is less accessible to the potential workforce because public transport becomes unviable, comprises costly and time consuming travel (both for workers and for the transport of goods) and because businesses cannot gain the advantages that can accrue from clustering together. The potential result is that businesses become much more marginal and uncompetitive, particularly as

the additional costs of an isolated or congested location results in higher prices of goods and services for sale. Industrial estates therefore need to be carefully established and located so as to ensure heavy goods traffic does not have to negotiate residential or other streets, but which are also highly accessible by means of public transport. Notably, increases in residential populations necessitates the need for more commercial land for such activities as noisy hobbies, vehicle service stations, builders and contractors yards, vehicle depots, transport an distribution centres and a wide range of other businesses and activities that are frequently under provided for and even displaced by residential and other development, primarily because they require large sites with low land values. Strong regulations and even city government land acquisition and ownership are required to provide for and protect such activities because it is the least profitable use of urban land and businesses of this nature have the most difficulty finding sites and securing tenure (indeed residential sprawl around industrial areas ensures that the highest vale for the land is for residential and high rent commercial redevelopment). Focusing economic development on 'knowledge' industries will not reduce the land requirement for these activities, as the relocation of manufacturing industries that continue to produce the goods that people consume necessitates an increase in the import trade of a settlement and the transport infrastructure and logistics to achieve this, including the need for local storage and distribution centres and ancillary activities, such as goods vehicles parking lots and railway goods yards.

CASE STUDY 1 - WINCHESTER INDUSTRIAL LAND DEVELOPMENT POLICY: Winchester City Council has focused primarily on the regulatory process, directing industrial development to land at the edge of only one side of the City (the side adjacent the national motorway) and this has ensured that heavy goods vehicles do not pass through residential areas or the town centre and do not have to negotiate congested streets. The Council also denies permission for the re-use of land and buildings on this industrial estate for higher value commercial activities (this has not entirely prevented unauthorised changes, and enforcement has been difficult). This has ensured that the buildings are always available for re-use on good tenures, as land owners and prospective purchasers and tenants are aware that higher value uses will always be denied permission. The industrial estate is located at the end of a tree lined spine road connecting the City and the motorway. The motorway is used as a definitive urban edge to the City and development is strictly controlled within the rural hinterland to prevent all forms of urbanisation sprawling around and beyond the industrial estate. When identifying extensions to the urban area for housing the land identified has always been at another city edge accessible along a different spine road. The increase in the residential population has also increased demand for unneighbourly industrial activities, and because there is no space for the industrial estate to expand industrial development is directed to redundant farmyards along major roads in the surrounding countryside and the expansion of the farmyards have been restricted. Because of this there is potential for these rural sites to be served by public transport routes between settlements, though this potential is limited. Furthermore, the rural sites where farmyard conversions have been favoured are on the side of the city where the industrial estate is located, ensuring that traffic between these sites and the industrial estate (which may be the result of an expanding business locating some of its activity to a converted/replacement building in the farmyard) and the motorway does not have to pass through the rest of the city. Away from these areas, farmyard conversions to commercial activity have tended to be denied permission. The unauthorised occupation of farm buildings by low profit commercial activities has persisted nevertheless and this once again demonstrates the influence of land value economics on the location of activities, as these low profit commercial uses still achieve a higher yield than the use of the buildings for rural activities. The increase in land and buildings required for industrial purposes has occurred despite the fact that Winchester City has no factory line manufacturing industry (apart from a small chocolate factory, Bendicks). The majority of industry growth has been in areas directly related to local population growth including storage and warehousing, bespoke manufacturing and finishing for the construction and home furnishing industry, machine tool hire businesses, contractors yards, depots and businesses involved in vehicle sales, maintenance and repair.

CASE STUDY 2 - WINCHESTER GREENBELT POLICY: Winchester's original expansion outside the historic roman settlement was constricted to the land along the main spine roads as a result of a private school (Winchester College) utilising the adjoining rural land for sports fields and agriculture. Linear development along the spine roads was also restricted by religious institutions which also owned surrounding fields. In the modern era, several more schools (King's, St. Peter's, St. Swithun's, Oliver's Battery) have been established at the city edge and Winchester City Council has acquired rural land on the boundaries of the settlement and established sport fields and a nature reserve there. The Council has also permitted the development of 3 golf courses at other locations along the urban boundary and also uses some urban edge land for sewage works. The biggest sports field complexes include sports/leisure centre buildings at the urban edge, with the sports playing fields extending into the countryside. Hampshire County Council has also acquired ownership or control of farmland immediately adjacent to the urban boundary of Winchester City and continues to farm the land as well as owning/managing nature reserves and nature parks nearby. Other nature parks and reserves have been acquired through funds raised jointly by the Councils and national nature and wildlife agencies and stewardship is often undertaken by the Hampshire Wildlife Trust. St. Catherine's Hill, an important archeological site of an ancient Iron Age hill fort and a natural landmark for the City, is owned by Winchester College and managed by the Hampshire Wildlife Trust. In combination, these nature reserves are spread around the settlement, ensuring close proximity of at least one

reserve to every resident and all reserves are within 0.5- 5 kilometres walking distance of the City centre. Through a process of strategic purchase, structured ownership, stewardship, regulations and incentives Hampshire County and Winchester City Council have been able to maintain a compact city form with an effective green belt that provides for a high level of countryside recreational pursuits within walking distance of the city centre.

CASE STUDY 3 – HAMPSHIRE FARMERS MARKET: Hampshire County and Winchester City Council established a working group in 1998 to promote a local farmers market in Winchester which is now the largest in England. Hampshire Farmers Markets Ltd. was then established as a company to expand and manage farmers markets throughout the County. The markets are required to source all products sold from within 10 miles of the County boundary, with local consumers and producers also connected through the company's website.

3. The caveat here is internet shopping for material goods, as this still requires the movement of goods. There is potential for this to work effectively where the purchase of local produce is concerned or where large numbers of ordered goods are singularly delivered to a local store.

4. Changing workplaces is now both a necessity and desire of life, particularly as businesses open and close and expand and contract. Additionally, people prefer to have choices in terms of education, recreational and leisure interests and the most desirable preference may not be the most proximate one. If people, households and communities cannot access new opportunities (such as finding a new place of work as a result of redundancy, or a shift from one family member working to another family member working, or having a variety in choice of educational and training attainment at different stages of life) and if they do not have the potential to secure a diversity of income sources to maintain overall income stability as employment situations and requirements change then they become much more vulnerable to hardship and poverty. This vulnerability becomes particularly acute during economic recessions and people who lack travel opportunities and the finances to travel to different work places are the hardest affected. For this reason, economic and employment diversity and the location of employment activities are an essential factor in sustainable settlement patterns and requires consideration of the most sustainable linkages between settlements.

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