DESIGN, NOT DENSITY, OF URBAN FORM AS THE PATH TO SUSTAINABILITY

An Examination of Examples Urban Green Space Provision in Relation to Density

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INTRODUCTION

Although there are a few dissenting voices, the trend in planning policy for Australian cities is the pursuit of a progressive increase in residential densities in new outer suburbs, infill in existing suburbs and within city centres. Higher density targets are be found within regional policies for new suburbs. Recent construction within existing urban areas is generally at significantly higher densities than older development surrounding it. However, it should also be noted that, although there is a comparative increase over what went before, these density levels are still significantly lower than those to be found in European and Asian cities. Rather than reviewing what has been said previously concerning this policy trend, the purpose of this paper will be to attempt to point to a further contribution to the debate.

Quantitative analysis of examples of residential urban form reveals that there can be a wide variation of spatial patterns at any given density level. One of the major components that vary within the spatial arrangement is the quantity and distribution of green space. There is a significant body of literature on the environmental role of urban green space which, when brought to bear on the variation in its incidence in residential form, can reveal very significant variations in the sustainability of these areas. This can, in turn, have important implications for planning policy. This paper examines this argument by analysing and comparing examples of Australian and British residential form. The evidence suggests that, if more sustainable outcomes are being sought, then the design of urban form can be more significant than its density. It is suggested that there could be significant public benefit from pursuing this line of enquiry further.

METHOD

Selected examples of suburban form within distinct typologies from Australia, and subsequently from Britain, are presented. Data on the parameters of residential density and provision of green space are obtained from measurements made by the author. This empirical base is interpreted in the light of findings from the literature on the environmental quality of the green space and the policy context of the development. Conclusions, including policy implications, are sought by making comparisons between the Australian and British examples.

Before embarking on a discussion of residential density, it is necessary to consider the ways in which it can be measured as this can affect the argument. A large-scale measure is number of people per unit area. The data are easy to obtain at a macro level, although less easily locally, and they relate well to social issues. Another measure is to count dwellings per unit area. The physical form of cities, especially dwellings, can last a very long time, even centuries, while dwelling occupancy can vary markedly over this time period. The two measures will therefore diverge over time. When considering the planning of cities it is the construction of dwellings that is controlled, not where people live, and so it is dwellings per hectare (dph) that will be used here. There is also the matter of the use of gross density, where the denominator includes land for all uses, or net density where only dwellings, access roads and integral open space are included. Both can have significance but net density will be assumed here unless otherwise stated. In Australia there is a particular issue arising from the use in planning regulations of proxies for net density, such as lot size, lot coverage and building height. Whatever the usefulness in their own right, they are inadequate as density measures as they neglect the role of roads and integral open space. They could not properly describe the layouts discussed in this paper.

TRANSPORT ENERGY AND DENSITY

In Australia, one of the most influential arguments for increased residential densities has come from the work of Newman and Kenworthy (1989, 1991, 1999) that relates expenditure of energy on transport to overall population (and job) density for a large selection of cities around the world, illustrated by their, by now, well-known graph. It shows that cities with low gross populations densities, as in USA and Australia, have high transport energy use and those with higher densities, in Europe and East Asia, have much lower
consumption. As impressive as the statistics are, the method and argument have not been without their critics (Gomez-Ibanez, 1991; Kirwan, 1992; Mindali et al, 2004). The statistics relate to population and employment densities, and also to quantity of public transport, at a macro level rather than the design of cities. Notwithstanding this, the authors have explicitly called for a substantial increase in residential density at a local level within the physical design of cities (Newman and Kenworthy, 1991). Is, however, the argued link causal, and will its converse apply? If new construction is at a higher density will it automatically be characterised by lower car use?

An issue arising from their data that is often not given sufficient attention is the significant variation in transport energy between cities at approximately the same density level. For US cities this can vary significantly. Why should Houston have substantially higher energy use than New York when their overall gross densities are very similar? One answer, and one that the authors discuss, is that, although having low-density suburbs, New York contains substantial older areas at high density, together with significant public transport provision, in a way that Houston does not. They also attribute certain qualities of “European-ness” to those North American cities which have lower transport energy expenditure than others. An additional conclusion that can be drawn is that this shows that, because of their evolution over different time periods, it is the design of the urban form, and its relationship to transport infrastructure, that is different. This is even more the case when asking why all European and Asian cities have lower transport energy expenditure than all American and Australasian ones and also why the cities from different continents cluster together on the graph without overlap. It can be argued that this arises from the fact that different economic and social forces over different time periods have caused their physical form, and its relationship to its infrastructure, to be designed in different ways. The outcome is that the form of European and Asian cities is characterised by higher densities than in North America and Australasia but the converse does not necessarily follow.

If the design of urban form is studied at the neighbourhood level, there is no particular evidence to suggest that an increase in density within new construction will automatically result in lower energy expenditure irrespective of its design and the way its form relates to the transport infrastructure. Clearly, a walkable neighbourhood centred on a station on a rapid transport line would be expected to facilitate sustainable transport usage. However, examples can easily be found from Australian cities from the early 20th century where this occurs with low-density suburban form. They were laid out around rail-based transport before the age of high car ownership. Examples can also be found, such as the area adjacent Bond University on the Gold Coast, of schemes of recent construction which are medium density but with very poor accessibility by public transport and active modes. A recent British study (Barton et al, 2011) of 12 contrasting localities across four cities examined transport use with a particular focus on the health and social effect of active travel and in the context of their differing urban forms. Spatial characteristics, especially location and viability of facilities, were found to be strongly connected with modal choice. Although there was no single dominant factor, residential density was very poorly correlated. The point, in all these cases, is that the issue of transport usage cannot be divorced from the design of the urban form of localities.

ENVIRONMENTAL QUALITIES OF URBAN FORM

It is not the transport aspects of sustainability that will be the principal concern of this paper but ecological and environmental ones. The comparative form of cities becomes even more significant when addressing the wider goals of sustainability. It must be noted first that transport energy is not the only energy that should be conserved. There is also the energy used to heat or cool buildings and the energy embodied in their construction. Furthermore, conservation of energy is only one component of sustainability. There is also the reduction of pollutants, particularly carbon emissions, conservation of water and biodiversity, social and recreation activities and their contribution to human health. Some of these factors may be inversely related to residential density: all of them will be affect by the design of urban form.

All of these elements come together in the “greening” of the urban environment, in particular the degree of vegetative cover. (Interestingly, in terms of the discussion in the previous section, its significance has been acknowledged by Kenworthy (2006).) This is not just a matter of the provision of public parks, as important as they are, but the degree of tree cover, both in the streets and around the buildings, and in the contiguous planted areas created by backyards. In particular, the interaction of trees, plants and water in these environments is important for the maintenance of a beneficent microclimate (Oke, 1989; Gilbert, 1991). This is especially important in the hot and dry circumstances of Australia. The shade provided by tree cover, the evaporation of retained rainwater and the transpiration of plants can all combine to cool surface temperatures significantly (Plant, 2006).

The interconnecting area of soft landscaping created by adjoining backyards in the older suburbs also hosts a high degree of biodiversity. The density and variety of the planting in a domestic garden is something that
is not found elsewhere. The minimisation, and even elimination, of planted areas has, therefore, serious consequences for biodiversity in general (Moroney and Jones, 2006; Daniels & Kirkpatrick, 2006). Once lost, species may take many decades to re-establish themselves or may disappear form the area forever. Another major advantage of the planted areas created by contiguous backyards and other planted areas is the sequestration of carbon dioxide, and various other pollutants, from the atmosphere (Nowak & Crane, 2002; Plant, 2006; Coutts et al, 2007). In addition to these benefits to the community as a whole, the backyard provides important benefits to the individual household. The most important ones, those relating to outlook and ventilation, apply even if the occupants never venture out into their back garden. One of the most important roles of private open space around the home is to provide a pleasant outlook from inside the dwelling. This is an important quality of life issue (Ulrich, 1981, 1984).

VARIATIONS IN THE DESIGN OF URBAN FORM AT GIVEN DENSITY LEVELS

This argument will be examined firstly by comparing examples of urban tissues at the same density level, but with different physical form, and then repeating this exercise for different density levels. The data for the examples are summarised in Table 1.

Variations in form at low density, 10-15 dph

![Figure 1: Aerial view of part of Camp Hill QLD](image)

The first Australian examples to be discussed will be those with densities in the range 10-13 dph and/or with 600m$^2$ lots. Figure 1 shows an aerial view of part of the suburb of Camp Hill QLD. It was originally a scheme for housing returning servicemen and was subdivided between 1945 and 1947. The layout is characterised by houses and gardens set out in a rather formal grid pattern at a density of 11 dph. The houses are generally of the “Queenslander” type, the vernacular architecture of the State. The locality is notable for the number of trees both in front and behind the houses. The lots are a standard 625m$^2$, generally around 15m wide and 40m deep, with a small degree of variation. 78% of the house footprints are under 200m$^2$, leaving a significant backyard area of 150-300m$^2$ containing many mature trees and other planting. 70% of the properties have a lot coverage of under 30%. The frontages also provide a home for large trees but they struggle to overcome the dominance of the excessive 9m carriageway. As this road serves only the houses fronting it, it is difficult to see the rationale for its width and it demonstrates that low densities do not arise solely from the size of backyards. The area does well when measured against many of the objectives of sustainability. Well located, it lies 6 km southeast of the centre of Brisbane and enjoys a frequent and reasonably fast bus service to the city centre. Local shops and a primary school are within a short walk. The house types are well adapted to the warm climate and hilly terrain and the layout permits a high degree of biodiversity.
Figure 2: Aerial view of part of Hebersham NSW

Figure 2 shows an aerial view of part of Hebersham, near Mount Druitt NSW, subdivided in the 1980s. It is some 38 km west of the centre of Sydney which is reached by local bus then a long train journey. Lot areas are 550-600m², similar to Camp Hill, giving a density of 13 dph. Back-to-rear boundary distances range from 8-15m, depending on lot size. The house footprints occupy, on average, 23% of the lot area. Although a few of the dwellings have fairly small, or poorly shaped, back gardens, the majority have significant areas and a square shape. There are comparatively fewer trees than Camp Hill but more swimming pools.

Table 1: Urban form data for the Australian examples

<table>
<thead>
<tr>
<th></th>
<th>Camp Hill QLD</th>
<th>Hebersham NSW</th>
<th>Carina QLD</th>
<th>Spearwood WA</th>
</tr>
</thead>
<tbody>
<tr>
<td>distance from city centre</td>
<td>km</td>
<td>6</td>
<td>38</td>
<td>8.5</td>
</tr>
<tr>
<td>net density</td>
<td>dph</td>
<td>11</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>typical front-to-front distance</td>
<td>m</td>
<td>30</td>
<td>34</td>
<td>21</td>
</tr>
<tr>
<td>average lot area</td>
<td>m²</td>
<td>628</td>
<td>579</td>
<td>260</td>
</tr>
<tr>
<td>net average dwelling footprint</td>
<td>m²</td>
<td>165</td>
<td>132</td>
<td>144</td>
</tr>
<tr>
<td>average net lot coverage</td>
<td>%</td>
<td>27</td>
<td>23</td>
<td>56</td>
</tr>
<tr>
<td>gross average dwelling footprint</td>
<td>m²</td>
<td>181</td>
<td>201</td>
<td>147</td>
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<td>average gross lot coverage</td>
<td>%</td>
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<td>57</td>
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<tr>
<td>average backyard area</td>
<td>m²</td>
<td>268</td>
<td>169</td>
<td>51</td>
</tr>
<tr>
<td>average rear setback</td>
<td>m</td>
<td>29</td>
<td>12</td>
<td>4</td>
</tr>
</tbody>
</table>

Note: gross and net dwelling footprint refers to with or without lightweight extensions respectively

Figure 3 shows an aerial view of an extension of the Perth suburb of Spearwood from the early 2000s. It is just over 17 km south of the city centre, which can be reached by a local bus service. At 14 dph, the density is near to that in older suburbs but this does not result in the same amount of green space. The distribution of lot sizes is similar to that at the two previous examples, being based on a 600m² lot pattern. While the lot dimensions are large, so are the house footprints which are approximately 200-350 m². Consequently, the backyards are, at 45-80 m², very small, especially in comparison to the house and lot size. Some of the houses are almost entirely surrounded by others. A street scene is dominated by large paved areas and by wide garage doors. There are few windows and little sense of enclosure or surveillance. The rear and side elevations of the houses also have a meagre provision of windows (Hall, 2010).
Spearwood is just one example of the substantial change in the nature Australian suburban form that began in the early 1990s (Hall, 2010). Whereas the older suburbs are characterised by tree cover, in the newer ones, large roof areas predominate and dwellings can be nearly roof-to-roof. Why should this lack of green space around buildings be a problem? The salient reason is that domestic backyards, and communal green space for apartments, have an ecological function, as referred to in the previous section, and its importance goes way beyond the interests of the individual household. The reduction in planting means a significant reduction in biodiversity and carbon sequestration.

Aside from the front lawns, only a small proportion of the total land area is permeable and planted. This reduction in permeable surface area increases storm water run-off, a matter that has serious implications. The most immediate consequence is the increase in cost arising from expenditure on concrete storm drains, not just for the development itself but also for other communities “downstream” of it. It also represents a loss of water that could have been used to support local planting and so encourage biodiversity. This is an issue that is particularly important for the Australian climate where long dry spells can be punctuated with episodes of heavy rainfall.

The reduction in width between dwellings not only means less shade from trees but also makes natural ventilation very difficult (Lee, Hussain and Soliman, 1980). The narrowness of the gaps between the houses prevents airflow around them, creating a “heat island effect” (Lee Su San, 1998). The problem is exacerbated by the exhaust from the air conditioners and use of dark coloured roofs which absorbed, rather than reflected, the heat. The consequence is an unpleasant milieu around the house and increased electricity consumption for the residents.

Where the backyard has been reduced in size, or even eliminated altogether, the degree of enjoyment of the house by its occupants is, in consequence, reduced. The space around the new outer-suburban house is now rarely able to accommodate an in-ground swimming pool. Barbecues may be possible but the space is limited and large social gatherings would be very restricted, as would other outdoor dining events. Home food production is not a realistic option and accommodating large external rainwater tanks and home composters is made more difficult. For many, there is no room for a Hill’s Hoist and the ability to dry laundry in the open air is very limited. Children have little space for them to run around make a noise without disturbing others while, at the same time, remaining in a secure environment with a responsible adult keeping watch from inside the house. This is especially important for very young children (Spurrier, Magarey, Golley, Curnow and Sawyer, 2008).

To review these low-density examples, Camp Hill is well located in terms of public transport and amenities and has a very green form. Had it been laid out with narrower road reservations it would have had a much higher density. Hebersham maintains a fairly green layout but is not well placed for sustainable access. Spearwood, however, appears to lose out on all counts. Although a long, slow bus ride from the city, it is low-density, high-energy with negligible “urban green”. Why this is significant is that this example is not only recent but that is its lack of vegetative cover around the dwelling is now characteristic of all new Australian outer suburban development (Hall, 2010).

**Variations in form at 20-25 dph**
Two examples in a comparatively more “urban” density range, as typical of suburban infill, will now be examined. Figure 4 shows an aerial view of Charlotte and Prudence Streets in Carina, a suburb of Brisbane lying 8.5 km south east of the city centre. The development was completed in 2002. It contains 80 dwellings, including both single and 1½ storeys, at a density of 23 dph. It has the appearance of being built all at one time. There is a limited range of house types, with just two sizes, apparently by one builder. What is striking about the design is that useful private amenity space to rear and sides of the dwellings is almost absent. More than half of the backyards are under 50 m$^2$. There is a space of under 1m at the sides and 1-5m at the back. All the lots are under 450 m$^2$ with 44% under 350 m$^2$. The dwellings are all deep-plan in form. For 85% of the lots the coverage by the dwelling footprint is over 60%. Although the carriageway is 5m wide with traffic calming features, much as might be found in parts of Europe, it is set within a front-to-front distance of 21 m. The front aspect is open-plan, laid to grass and hard standings. There are some small trees, which make little impact on the street scene. The forward position of the garages, combined with the use of small, tinted windows, creates a blank townscape with a lack of transparency and surveillance. The problem of the lack of vegetative cover is even more marked in this example than at Spearwood (Hall, 2010).

Is such a design a necessary consequence of a move to a marginally higher density compared to the older surrounding houses, which are more typical of the Camp Hill example? This question can be answered by examining an iconic British example, Letchworth Garden City in Hertfordshire. Built 100 years ago, it was the world’s first planned “garden city” and its landscape-dominated form and neo-vernacular architecture became a model that was influential and widely copied. Both its plan, and its neo-vernacular architecture by Parker and Unwin, became an archetype not only for British public housing but also for “garden city” schemes in many disparate parts of the world. What is particularly interesting is that the actual density is much higher than visitors usually imagine when they first encounter its landscape-dominated townscape. The Garden City ideal was 12 houses to the acre which is nearly 30 dph. Figure 5 shows part of the Pixmore Hill estate, designed by Parker and Unwin and built 1906-1911, one of the most representative residential areas of the Garden City. Data relating to its urban form are listed in Table 2. The gross density is approximately 20 dph while the net residential density is generally around 22 dph rising to a maximum of 35 dph. The front-to-front distances of 20-35 m are not too dissimilar from those in Australia but are devoted predominantly to front gardens and roadside verges with street trees, rather than to road space. The back-to-back distances range from 40-70m, way in excess of even the older Australian suburbs. Lots range from 200m$^2$ to 480m$^2$, small by Australian standards. However, the really dramatic difference from Australia is the size of the dwelling footprint, 7m x 8m. Even allowing for the fact that the dwellings are all two-storey, this is still very small in comparison. In consequence, the house footprint occupies less than 30% of the lot area, and often this figure is as low as 12%. This allows backyards which are generally just under 100m$^2$ although some can be as much as 168m$^2$. 

Figure 4: Aerial view of development at Carina QLD
What is notable about Letchworth, and its descendents, is that at urban densities substantially higher than in the Australian suburb, the design devotes most of the land area to “green” uses and all in a planned, walkable environment with local amenities and good public transport. In contrast, the example of recent Australian infill at Carina has almost no vegetative cover and suggests a lifestyle that is internalised within the dwelling. Moreover, the evidence (Hall, 2010) is that this combination of house design and lack of green space in suburban infill is not untypical within Australia.

**Variations in form at 30-55 dph**

The second British example to be considered can be seen as representative recent best practice in the UK for new suburban housing. The scheme is that known as Bishops Mead, by Reeves Bailey Architects, within at Chelmsford in Essex (Hall, 2007). It was constructed in 1999 and won a British Housing Design Award in 2002. It is a faithful implementation of the principles of the revised Essex Design Guide (Essex CC, 2005) and in line with the design policies now favoured by the British government and its advisory bodies. Figure 6 shows the layout of the Bishop’s Mead scheme. Data relating to its urban form are listed in Table 2. Back-to-back distances are a minimum of 23 m providing back gardens of 100-134 m$^2$, equal to that found only in the oldest and lowest-density Australian suburbs (Hall, 2010). The net density here is 33 dph and this has been achieved by reducing the front-to-front distance to 8-9m. House footprints are small, all shallow-plan, and two to three storeys in height. The areas of the lots are, at 210-270m$^2$, marginally smaller in area than the “cottage lots” in newer Australian suburbs. However, the house footprints occupy, in general, approximately one third of the lot area.
Other examples of recent residential development in the same town show the same pattern (Hall, 2007). For one, shown by Figure 7, the net density is 55 dph but, nevertheless, it contains three-storey town houses possessing back gardens in the general range of 70-100m². Some are as much 130-160m². The apartment blocks that turn the corners of the blocks all have communal private space at the rear.

![Figure 7: Plan of the Writtle Road development, Chelmsford UK](image1)

In contrast, Figure 8 shows an aerial view a housing scheme within the Brisbane suburb of Hendra, a gated estate of two-storey houses constructed in 2002. The net density is 35 dph. This is, indeed, a high value for suburban Australia generally and is achieved by providing very little in the way of both private and communal open space within the development. Some of the dwellings are duplexes. Although they gain more light and air than the Spearwood and Carina examples, because of their upper storey, they do not enjoy significant backyards. The distance at the back of the house ranges from 3-5 m. For 70% of the properties, the coverage of the lot by the dwelling footprint is over 50%.

![Figure 8: Aerial view of a scheme at Hendra QLD](image2)

<table>
<thead>
<tr>
<th></th>
<th>Letchworth Garden City UK</th>
<th>Chelmsford UK</th>
<th>Hendra QLD</th>
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<tr>
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</tr>
<tr>
<td>net density</td>
<td>dph</td>
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<td>34</td>
</tr>
<tr>
<td>typical front-to-front distance</td>
<td>m</td>
<td>20-35</td>
<td>10</td>
</tr>
<tr>
<td>average lot area</td>
<td>m²</td>
<td>200-480</td>
<td>240</td>
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<tr>
<td>average dwelling footprint</td>
<td>m²</td>
<td>63-96</td>
<td>56</td>
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<tr>
<td>average lot coverage</td>
<td>%</td>
<td>12-28</td>
<td>33</td>
</tr>
</tbody>
</table>
What the British examples demonstrate is that it is perfectly possible to have urban form in an accessible location with ample vegetative cover including significant private open space at densities up to 55 dph. Unfortunately, it is difficult to find examples of it occurring in Australia. There is, however, no evidence to suggest that this is inevitable and that such designs could be built here.

**Origins of current British practice**

How then did current British practice come about? It certainly does not stem from a world in which everything is perfect and everyone is enlightened but, rather, from particular political and economic circumstances and the reactions to them. The way that the development industry and planning process works in the UK is different from that in Australia and this fact has to be fully acknowledged. Nevertheless, the physical outcomes can still have applicability here. In Britain, land supply is constrained by the planning process. Development is not normally permitted outside of areas allocated in development plans. There is also intense local grass-roots opposition to development. The commercial market is in land rather than dwellings, which always sell because demand exceeds supply, and is dominated by a small number of large players. Having purchased land, these large development companies build the dwellings themselves and sell direct to the public. Central government policy requires all large developments to pay for their own infrastructure, public amenities and affordable housing.

The perceived problem during the mid-late 20th century was a preponderance of low quality house types, mass produced across the country and laid out on roads of standard widths. The first substantial move for change was the *Essex Design Guide* of 1973 (Essex CC, 1973). It argued that, to be successful in townscape terms, urban spaces should be contained by trees at low densities and by buildings at high ones. House design should reflect the locality and provide a sense of place. The Guide’s authors’ most significant achievement was to persuade local highway engineers to adopt more flexible road standards relating carriageway width to the minimum required for the traffic flow and bringing in the first shared surfaces for small groups of houses.

During the 1980s, government policy discouraged design intervention by planning authorities in favour of reliance on market forces. However, a financial crisis in the property market towards the end of the 1980s forced a total rethink culminating in a reversal of policy. Space does not permit a full account of what happened to be related here but the essential point is that government policy swung decisively in favour of planning intervention in the development process with an emphasis on quality in design. Design guidance began to be published in considerable quantities at all levels of government, a process that continues to the present day. In addition, in the mid 1990s, came a minimum net density requirement of 30 dph across the board (recently made non-compulsory by the current government). It is also useful to note that residential densities in the UK are always measured in dph, not in terms of other parameters or proxies such as height or lot coverage.

**Issues at high density, 75-100+ dph**

Although the thrust of this paper is suburban form, for completeness some mention must be made of issues relating to high-density living, especially in tall apartment buildings at densities of, say, over 100 dph. Providing such housing within and near to city centres certainly reduces the need to travel and the need for a private car. Whether residents take advantage of this is another matter. It is not reflected in the parking provision within the buildings which remains high. This is, however, the only aspect that is potentially, if not actually, sustainable. Multiple lift shafts and units that cannot take advantage of natural ventilation in summer, or solar gain in winter, require a heavy daily usage of electrical power. Moreover, the buildings also have high embodied energy (and high embodied carbon emissions) from the steel and concrete from which they are constructed.

Although there is a trend in high-density schemes towards the provision of more swimming pools, fitness centres and barbeque areas, in ironic contrast to the outer suburbs, such developments tend to lack communal green space. The trend is towards having little in the way of provision of communal gardens nor is the opportunity taken for the enhancement of the quality of the public realm. In summary, contemporary Australian residential development suffers from high-energy use, lack of vegetative cover and poor townscape at both high densities, just as it now does at low densities.
Even at high densities this is not inevitable. It is possible to produce alternative designs that may provide for higher degrees of sustainability in this type of development. As has already been implied, it is possible to require communal green space around apartment blocks as used to be the case in many Australian cities is a routine matter northwest Europe. The British Urban Task Force report, *Towards an Urban Renaissance* (1999) argued strongly that it is design rather density that is important and illustrated this with the diagram reproduced as Figure 9. Is shows the three alternative ways of providing a density of 75 dph, only one of which is a tower. The others are low-rise, with private or communal green space and not requiring energy for lifts.

**CONCLUSIONS AND IMPLICATIONS**

The first point to note in conclusion is the scientific evidence from the literature that points to the essential role of green space within urban form in the achievement of sustainable goals. This vegetative cover has a direct and decisive effect on storm drainage, beneficent microclimate the sequestration of pollutants and promotion of biodiversity. It should not only have a place alongside other goals of sustainability, such as conservation of energy and social sustainability, but actively contributes to their achievement. The problem in Australia, as illustrated by the examples examined, is that current trend is for green space to be reduced, or even eliminated, within the detailed design of residential form. Examination of Australian urban form shows that this is not necessarily connected with moves to higher density. It occurs at all density levels, low as well as medium and high.

In contrast, the British examples illustrate that it is possible to have housing at a densities of 25-60 dph in which the greater part of the land area has vegetative cover. These examples can contain house designs that are shallow plan, low energy and utilise sustainable methods of construction. Their layouts are not car dominant. This produces quality townscape and housing which, in the British context, is both commercially viable and affordable. Despite differences in circumstances between Australia and Britain, it would seem difficult to argue constraints would prevent such a design philosophy being replicable, or at least tried out, here. For example, Figure 10 shows a drawing produced as part of an undergraduate study (Gibbs, 2008) that that shows ideas for combining the principles of the *Essex Design Guide* (Essex CC, 2005) with the best aspects of Queensland vernacular. There is a range of dwelling types with single houses, larger corner types and different combinations of upper and lower units. Back-to-back distances are generally 20m and front-to-front distances 15m. Typical footprints for the single houses are 10m x 10m with backyards of 100m². The net density is 34 dwellings per hectare. This is just one possible example, but it does show that higher-density residential form could be achieved in a manner which is both sustainable and eco-friendly and also appropriate to the Australian climate and cultural context.
Figure 10: An exploration of combining aspects of British practice with the best aspects of Queensland vernacular.

It must be stressed that this paper is not arguing for against moves to higher residential densities. On the contrary, it is almost inevitable that a sustainable Australian city would have a higher overall residential density than that which pertains at present. However, what the examples discussed in this paper point to is that a different approach to the way that higher density residential form is designed is required. Higher densities should be seen outcomes rather than inputs and something to be achieved but over a wide area, not within individual lots. When designing urban form, all aspects of sustainability should be considered together. Such an approach would require a focus on goals of sustainability and quality of life and a focus on achieving these through particular design outcomes.

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