Sustainable Development, Subdivision, Surveyors and Sun Angles II

Grant Calvin
Team Leader, Design & Investigation, Greater Taree City Council
solidearth@bigpond.com

ABSTRACT

This paper reviews the principles of the comfort zone for human habitation, passive solar house design theory with a view to provide more sustainable development, sun angles as they change daily and seasonally by location, and annual temperature variation. It provides a summary of observations based on years of surveying in private practice, related to the traditions of construction and orientation of dwellings erected on modern subdivisions, and how these traditions are often at odds with passive solar house design. If these principles are put together with the preferred orientation of the subdivision road and lot layout, the overall energy usage of the housing estates can be optimised or minimised by the layout of various development types. Modelling has shown potential energy savings of 30% through adoption of the ideas behind this paper. A case study of a recently zoned area of land under the NSW Local Environmental Planning template is also presented along with predictions of high and low energy requirements as a result of the design of subdivision layout which is apparently fixed by the 'planning system'. This paper is a follow-up to a presentation given at the APAS2002 conference over a decade ago.

KEYWORDS: *Sustainable development, subdivision, surveyors, sun angles.*

1 INTRODUCTION

The theme of this conference is 'Capitalising on our Position'. How can we benefit from where we are? Our Position as surveyors, particularly registered surveyors, is that we must be involved, by virtue of legislation, in any subdivision of land parcels into two or more lots. Surveyors lay out the basis for living spaces of human habitation, the lots, roads and byways. When we do this, we create the building footprints for the end user, the households.

This paper combines the observations of 35 years of experience as a surveyor and family man with an interest in the principles of comfortable living and passive solar house design to provide an insight into superior low energy input subdivision orientation. Incorporating these insights into future subdivision design using the models demonstrated in this paper along with the surveyor's own local knowledge can lead to significant reduction in energy usage and more sustainable, comfortable housing estates.

Why do a follow-up paper to one given at the APAS2002 conference (Calvin, 2002) over a decade ago? Design ideas tend to follow three Fs: functional, fashionable and forgotten. Following up on forgotten ideas can bring back useable design and function based on reliable logical concepts. The 'pelmet' for example was originally functional. Pelmets reduce heat loss and gain by cutting off air circulation around curtains where exchange of heat through the glass occurs. Pelmets then became fashionable. Interior designers hid the lights behind the pelmet and removed the top so that reflected light bounced off the ceiling and provided lighting ambiance. The original function of the pelmet was lost. Today, pelmets are forgotten even as a lighting treatment and are seldom seen in any modern construction.

Similarly, Australia's wide eaves and verandas seem to have lost their appeal. In the quest for larger floor space in modern small-lot developments, verandas and eaves that perform the function of shading the walls of houses appear to have been forgotten and have been replaced with costly, energy-consuming reverse-cycle air conditioners.

This paper makes the connection between the subdivision lots and the housing built thereon. It provides preferred orientations of road and lots for use by surveyors and planners in development. This paper chronologically reviews Australian housing and climate research that forms the basis for low energy housing and how it links to road and lot orientations. The objective is to provide surveyors with information and logical argument that can assist surveyors and planners in creating better, more effective and efficient living spaces.

2 SUSTAINABLE DEVELOPMENT

Sustainable development became fashionable in the 1990s – that is doing something that you can keep on doing, ad-infinitum. Yet the idea for providing a sustainable framework for today and future generations has been around for much longer. Bill Mollison, a forward thinker, put the ideal of sustainable living and permanent culture into his design theories into his book *Permaculture 1* (1978) which is still used as a model for sustainable low-energy input, high-yielding agriculture today. Permanent culture has been shown throughout history to be very difficult to achieve. Many past civilisations have proved to be unsustainable for a variety of reasons. The legacies of old cities remain in the road layout and basis for land parcels conceived by their surveyors.

An Australian surveyor may have to work with road layout created anytime since 1788. In Europe, surveyors may work with the framework created by ancient Romans. Thus, it must be recognised that the work designed today provides the framework and living spaces for many generations to come. A small change in design orientation could create a notable advantage for future society.

2.1 Are We Doing It Right?

Traditional views are probably the greatest things to overcome in promotion of energy efficient housing to the public. These views have come about due to convention, building industry trends and people's increasing removal from the natural environment:

- Most houses are designed to 'face the road'. This often means that the largest area of glass will commonly face the street. This was traditionally designed to show your wealth and is a pattern especially hard to break.
- The front wall of houses is generally fixed at the front by the 'building line', an imaginary offset from the street boundary set by the local Council, in front of which the house cannot be built. This is often solely to save costs by minimising the length of the driveway.
- The building will often be placed at the minimum side boundary offset for either the main wall or the eave and gutter, depending on the width of the eave. This is done to maximise the available building footprint. Side boundary setbacks of 675 mm to the eave and 900 mm to the wall were, and remain, common.

- When the lot is not square, the building is usually aligned parallel to a side boundary rather than the road boundary.
- Many houses seem to be built where the garages have become a feature of the northern wall.

With these conventions, it can be seen that the orientation of the street can and will directly affect the layout of the building on the allotment. The trick is to orientate the roads to provide building spaces where the warming winter sun can be included and incorporated into the living spaces of the house and the hot blast of the summer sun can be excluded.

3 OPTIMUM ROAD AND LOT LAYOUTS

3.1 East-West Road Alignment

East-west is the optimum orientation for roads designed for single detached housing. Houses on east-west roads tend to naturally provide warmth in winter and cool in summer. They have uninterrupted solar access to their northern wall and are often protected from the summer sun by their neighbouring buildings. In preparing layout plans, one must consider yield and building concepts like utilising the maximum footprint available. In addition, it should be considered making the allotments shallower and wider to allow optimum solar access on the northern wall (Figure 1).

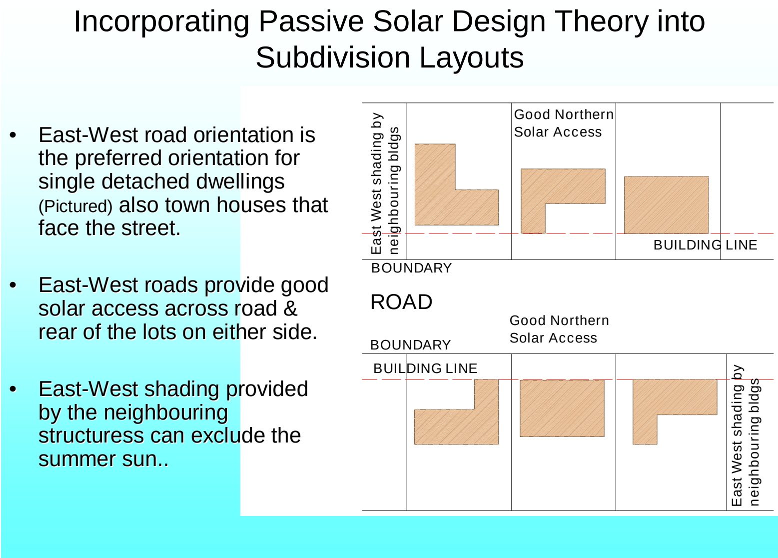

Figure 1: Preferred orientation along east-west roads.

3.2 North-South Road Alignment

Obviously, some north-south roads will be needed. However, much consideration of the solar access on these north-south roads is required. Detached housing on north-south road alignments tend to be hot in summer and cold in winter. This is because the important northern wall is often overshadowed in winter by the neighbouring buildings and the eastern and western walls are generally un-protected from the summer sun. Thus, external energy for heating and cooling may be required for comfort.

On north-south road alignments, the lots need to be significantly wider than normal in order to account for the winter overshadowing. This is particularly difficult in areas where the popular

2-storey McMansions are prevalent. They cast a long shadow in winter, almost twice as long as the building is high and detrimentally affect the solar access of the southern neighbour as shown on the western side of Figure 2. Recent modelling of energy usage and road orientation indicates that houses on north-south roads may require up to 30% more energy than houses on east-west roads to stay comfortable (A. Gentle, 2011 – email communication).

North-south road orientation is the best for multi-unit developments where the units tend to be arrayed behind each other along the block as shown on the eastern side of Figure 2. Surveyors should consider shaping allotments designed for multi-unit developments where a north-south road orientation is required.

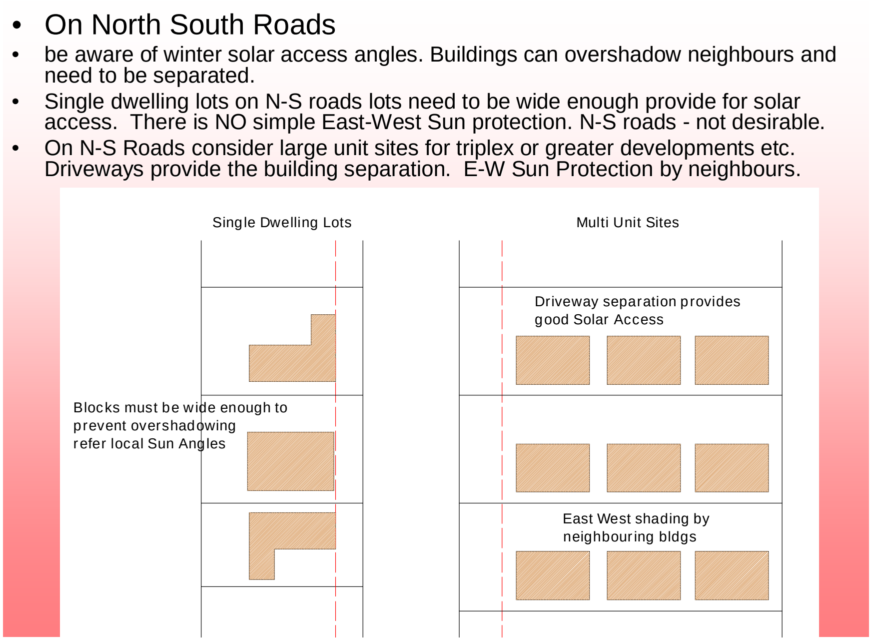

Figure 2: Considerations for houses along north-south roads.

3.3 Skew Lots

Lots skewed to the cardinal directions are probably the most difficult to consider. No walls can effectively control the input or exclusion of the sun's energy. All walls are open to the summer sun and can only effectively receive 70% of the northern sun's energy in winter. Some suburbs like Cundletown, near Taree, are seemingly entirely oriented on the 45° axis due to being aligned with the adjacent river (Figure 3).

Figure 3: Cundletown aligned parallel to the Manning River.

To promote effective solar orientation of the dwellings, it should be considered aligning the side boundaries north-south to create well-oriented building envelopes (Figure 4). This method also sets up an interesting streetscape with buildings being stepped along the street, which can also provide cross-ventilation. This methodology departs from the traditional survey that seeks to provide symmetrically square allotments and is a very difficult tradition to break. The arguments that follow provide the basis for making the change.

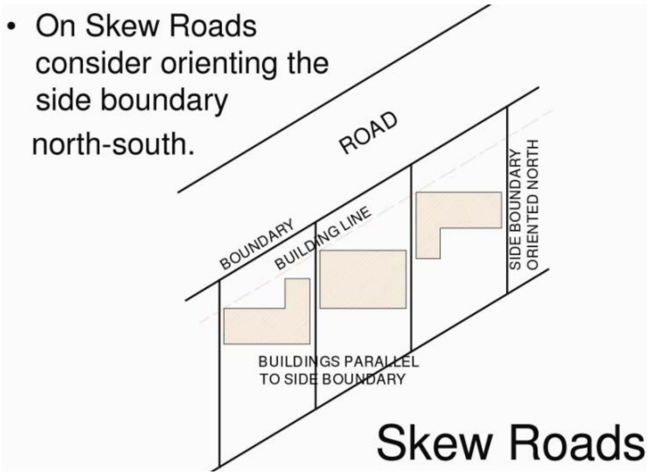

Figure 4: Orientation of lot boundaries on skew roads.

3.4 Road, Lot and Building Orientation

The tradition and compunction to comply with standard building and lot orientation (i.e. how the building aligns with the boundaries and addresses the street) appears to be too great for most people to vary. Changing the building orientation on lots of varying alignments has been promoted and documented numerous times by many individuals, architects and authorities.

One example is shown in Figure 5, taken from a brochure *Housing Western Australia* (June 1989), which provides an architectural solution to solar orienting houses on lots of varying street alignments. The same figure has been copied into any number of energy-smart Development Control Plans (DCPs), including Newcastle City Council's and Wagga Wagga's DCP 13. The reality is that building designers unerringly resort to the standard orientation of building on lots (as noted above) regardless of the alignment of the street, and the ideals depicted in this diagram seldom occur.

The ideal suggested by this paper is for the surveying and planning professions to provide lots with orientation and shapes that result in the traditional building and lot layout providing optimum solar alignment.

Occasionally, people do align their house on the block to attain optimum passive solar orientation. One case recently occurred in Wallabi Point near Taree, where the developer noted how other home/lot owners in the estate had pilloried the crazy lady who built her house crooked on the block, raising concerns that in doing so she had ruined the look of the subdivision and potentially had a negative effect on the value of the properties (A. Hook, developer – personal communication).

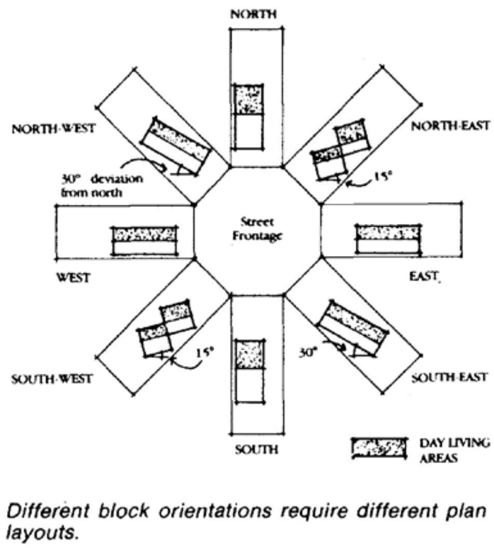

Figure 5: Architectural ideal for lots of varying orientation (Housing Western Australia brochure, June 1989).

An astute person may see this situation quite differently. Only one of the hundred odd houses in the estate actually got it right! The 1% of the houses in this development oriented to the sun rather than controlled by the lot layout are probably well above the norm. The percentage of non-conformists who actually overcome the lot orientation in development of their houses is in all probability much, much less. This can be seen in almost every urban development across Australia and can be confirmed with a quick 'google map' of any urban area.

4 STAYING COMFORTABLE

4.1 Temperature Range

Humans naturally desire a safe and comfortable habitat. We depend on several variables including air temperature, humidity and air movement. The temperature range or comfort zone has been variously described as being between 15C° and 25°C, between 20ºC and 25ºC and 18ºC and 28ºC, with relative humidity between 30% and 70% based on various documents. The other variables include:

- Air movement: 0 to 1.5 m/s
- Radiant temperature: within 3°C of air temperature
- Maximum temperature variation: 1.5ºC per hour
- Clothing: light

Maintaining our living spaces within the comfort zone commonly needs intervention in most Australian climates. Essentially, we need to be warmed in winter and cooled in summer. However, rather than thinking about designing our houses to minimise potential energy consumption, we seem to be more and more reliant on costly energy-consuming reverse-cycle air conditioners.

The average temperature of Campbelltown (Figure 6) fluctuates with the seasons. In order to stay comfortable, this requires heating in April to October and cooling (or exclusion of energy) may be required in November to March. This temperature chart is typical of much of temperate NSW. The record maximum and minimum temperature (also shown in Figure 6) indicate that the average temperatures can spike significantly.

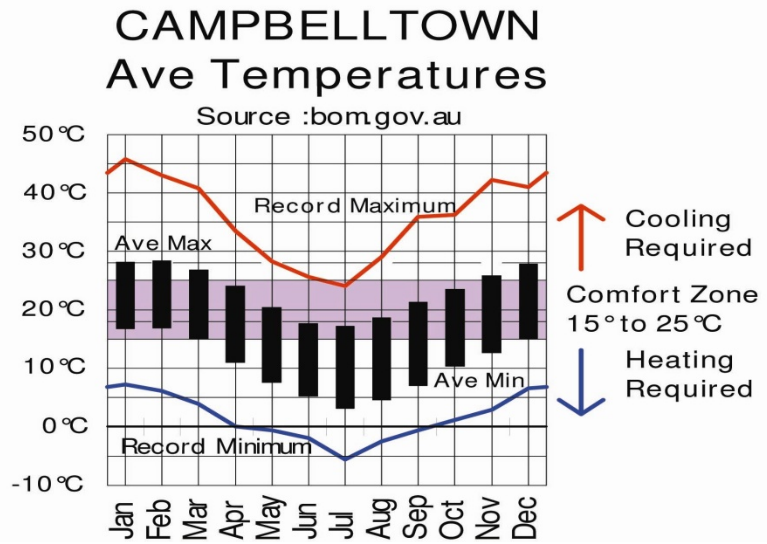

Figure 6: Campbelltown temperature chart.

4.2 Domestic Energy Use

Table 1 shows the typical energy use for households in 1992 and 2012. The major difference between the two is in the energy used for cooling, which appears to have significantly increased. A similar increase from 1.2% to 8% is believed to be occurring in Australia due to the increase in the number and use of reverse-cycle air conditioners over the last 20 years.

Table 1: Typical household energy usage comparison between Australia (1992) and the U.S. (2005) (Ballinger et al., 1992; US Energy Information Administration, 2011).

Domestic Energy Use in AUS	1992
Heating	41.5%
Water heating	26.6%
Cooking	9.8%
Appliances	8.8%
Refrigeration	8.7%
Lighting	3.4%
Cooling	1.2%

Domestic Energy Use in USA	2005
Space heating	41%
Electronics lighting & appliances	26%
Water heating	20%
Air conditioning	8%
Refrigeration	5%

The energy requirement for heating and cooling our living and working environments can be significantly lowered by effectively utilising the sun's energy in winter and by excluding the sun's energy from our living space in summer.

5 SUN ANGLES

According to the University of Technology Sydney's Earth Building website, the Australian Commonwealth Experimental Building Station (EBS) was formed in 1944 in order to produce standards for more efficient buildings with improved thermal comfort. Most of the basic principles of passive solar design date back to the work of these scientists (UTS, 2007).

The EBS produced and disseminated information from their research. Technical Study No. 23 (1948) became *Sunshine and Shade in Australasia* (EBS Bulletin 8, 1963) and described the apparent motion of the sun in our region. EBS 8 published sun charts for a variety of latitudes and described how energy from the sun may be may be controlled through orientation and shading devices (Phillips, 1977). Sun charts reduce the sun's location at any season and time to simple azimuth angle (bearing) and altitude angle (Figure 7).

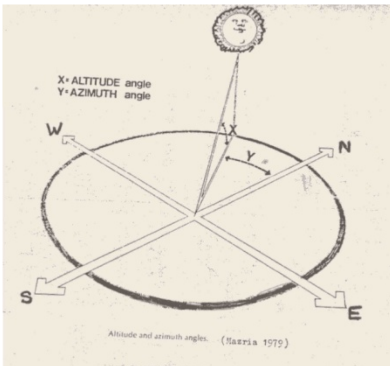

Figure 7: Altitude and azimuth angles (Mazria, 1979).

Figure 8 shows the seasonal sun paths, which are labelled with dates:

- Time lines (sun time) curve through these sun paths labelled 5 am through 7 pm.
- The azimuth angle of the sun is read off the protractor as a bearing.
- The altitude angle of the sun is read off the concentric rings.

Diagrams from EBS 8 are useful and understood by surveyors in a format they are used to. Displayed as sun time, these charts are correct for all points along any given latitude.

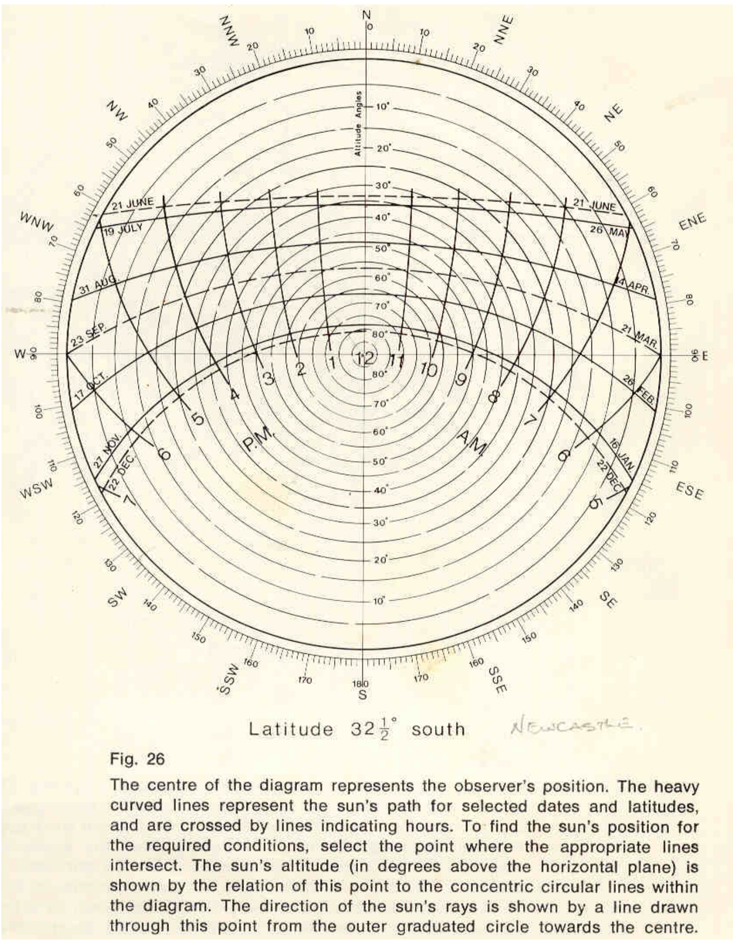

Figure 8: Solar chart for 32° latitude, approximating Newcastle (EBS 8).

Some people, unfamiliar with working with bearings, found this style difficult to understand. To overcome this, sun charts have been modified, updated and now come in a variety of shapes (Figures 9 & 10). The time lines have been elaborated to be correct for specific locations (longitudes) with variation from the central meridian and the equation of time. This is shown in the more complex Figure 10. Not surprisingly, the charts shown in Figures 8-10 all show the same results.

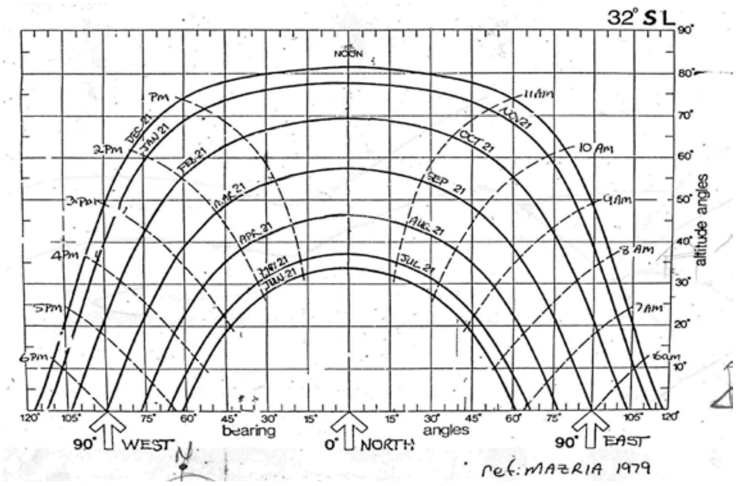

Figure 9: Sun chart (Mazria, 1979).

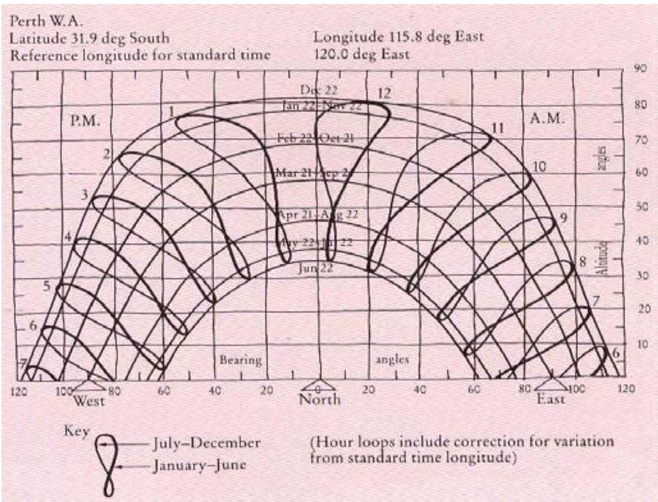

Figure 10: Sun chart (Ballinger et al., 1992).

Most people are surprised that the sun only rises east and sets west twice a year at the equinox (21 March and 21 September). During the rest of the year, it rises and sets off the cardinals up to 27° at the solstice (21 June and 21 December).

Major positions on the sun angle calendar are the noon altitude angles for:

- Equinox noon altitude = 90° – latitude 58°
- Summer solstice noon altitude = 90° – (latitude – 23.5°) 81.5°
- Winter solstice noon altitude = 90° – (latitude + 23.5°) 34.5°

These seasonal changes can be effectively utilised in providing passive solar house design for dwellings that will be built on properties subdivided by the surveyor.

5.1 Understanding and Utilising Sun Angles

Surveyors should be aware of the sun angles and climate factors in the locality of their developments. This includes the prevailing breezes that may be positive or negative depending on the season. All of the sun charts shown above are appropriate for 32°S latitude (Taree, NSW), though the time lines in Figure 9 may vary due to the longitude and variance from the central meridian of the time zone.

Combining the temperature chart (Figure 6) and the sun angle charts (Figures 8-10) one can see that the sun angles can be used to effectively control the sun's energy input and exclusion on the northern wall by simply utilising the correct eave width.

5.2 Sunshine on East-West Walls

Phillips (1977) describes how difficult it was to shade the eastern and western walls. Figure 11 shows how the rising and setting sun affects these walls. Protecting the east and west walls from the sun is difficult even with a wide eave. When a building is positioned skew to the cardinal bearings, impact of the rising and setting sun occurs partially on all sides of the building.

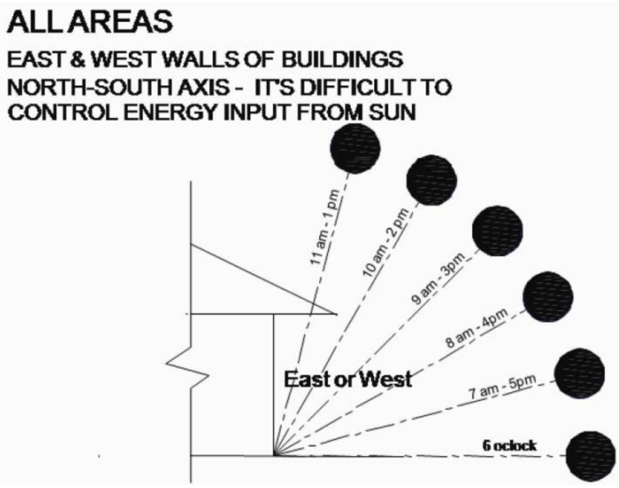

Figure 11: Sun angles for eastern and western walls.

The azimuth angle of the sun at sunrise and 9am on the eastern end of buildings skew and square to the cardinal bearings is shown in plan in Figure 12. The effect on the western wall is similar and it should be recognised that the eastern sun provides the same radiant energy as the western sun. The fact that the air has heated by the afternoon gives the impression that the afternoon sun is hotter.

The azimuth angles show the angle of incidence with the wall, which controls the impact the sun's energy has on the walls and windows of a building. When set square to the cardinal bearing, the important northern wall is virtually shaded solely by its orientation for a significant part of the day in summer while receiving significant solar benefit in winter. These benefits are not available to the walls of a building set skew to the cardinal bearings.

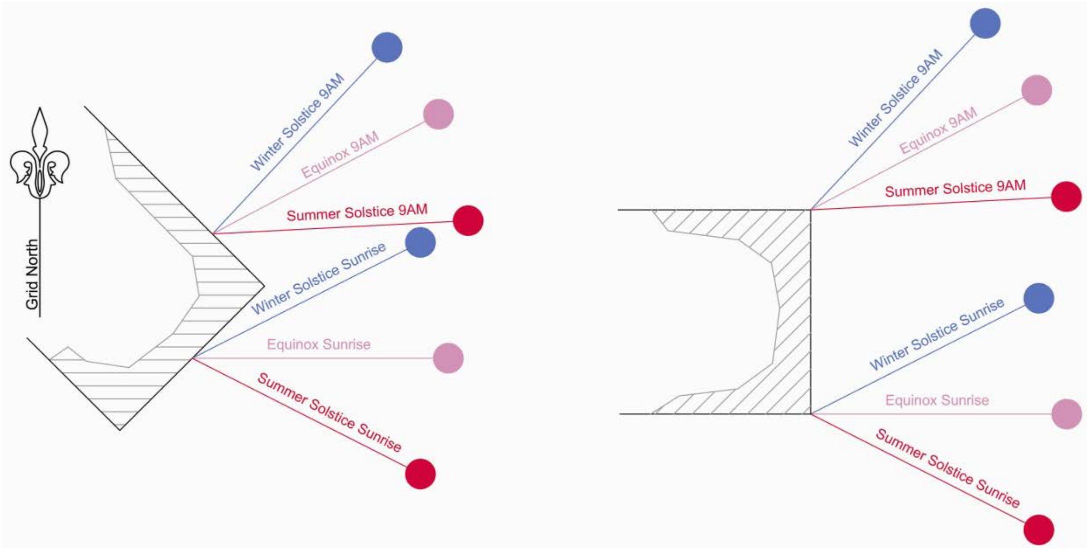

Figure 12: Changing seasonal angle of incidence sun on eastern walls.

Phillips (1977) also describes how seasonal movement of the sun provides the means to effectively control the sun's energy on the northern wall through variation in the eave width. In this way, one can choose which months the sun's energy is to be excluded from the northern wall. Around Taree at 32° S latitude, we have satisfactorily used the equinox sun angle of 57° to define eave lengths on northern walls. Eave widths set to about half the drop to the windowsill will gain sun penetration through northern wall windows starting around equinox in March. Sun penetration increases until the winter solstice and then reduces until exclusion after the spring equinox in September – really quite simple. At higher elevations or latitudes, where it is cooler, earlier sun penetration may be warranted.

6 PASSIVE SOLAR HOUSE DESIGN

6.1 Recent History of Knowledge

Sunshine and Shade in Australasia (1948) was followed up with further research and the publication of *Designing Houses for Australian Climates* (EBS Bulletin No. 6) in 1952 (Drysdale, 1977). This gave a scientific insight into design and construction practices in Australia. The original ideas in this publication were often simple but effective. It seems that each point of the original text has been studied and expanded upon in the ensuing years:

- *Sunshine and Shade in Australasia* (EBS 8) (1948) is a booklet of only 38 pages.
- *Designing Houses for Australian Climates* (EBS 6) (1952) a booklet of 50 pages.
- *Energy Efficient Australian Housing* (1992) is a book of 280 pages.
- *Your Home* (2010) is a manual of 353 pages (Commonwealth of Australia, 2010).
- A Google search of 'passive solar design' brings up 3,820,000 results.

The implications and ideas contained in the original 50-year-old-documents are still being expanded and incorporated into government policies today. For example, many of the underlying principles of the BASIX system used in NSW have a direct input lineage from these documents. There is a mass of information available but perhaps so much that the basics have been forgotten. For those in the market for a new home, or wishing to renovate their existing home, seeking and gathering this information to assist with the design or purchase decision is strongly advised. Surveyors who understand this information stand a better chance of creating better and more sustainable developments.

The caption to Figure 19 on page 34 of EBS 8 succinctly summarises some passive housing principles: "*Orient to admit cooling breezes, exclude cold winds, admit sunshine in winter, exclude sunshine in summer. Buildings sited with their long axis east-west simplify the shading problem.*" Aligning the long axis east-west promotes the important northern wall, which can seasonally control and exclude energy input from the sun. Eastern and western walls cannot control the sun's energy and need to be protected.

In relation to breezes, EBS 8 provides wind roses that depict the breezes you might expect in most climatic regions of Australia. For example, on the Mid North Coast of NSW, the most prevalent cooling summer breeze is the nor-easter. Less prevalent but also cooling in summer is the southerly-buster, and less prevalent again but scorching in summer is the westerly wind. In the cooler months, the westerly can be quite cold as it comes down off the mountains, the southerly is also cold but the common nor-easter is milder as it comes off the warm ocean. From these few observations, it can be seen that the nor-easter is the breeze to be admitted and the westerlies are to be excluded. Southerly winds remain an each-way bet. Surveyors are often local and will therefore intuitively know this information in regards to their area. When working remotely, the local breezes should be recognised and incorporated into any designs if possible.

6.2 Energy Free from the Sun

At NSW latitudes, the sun's radiation at the earth's surface is equivalent to about 1,100-1,200 watts/m^2 in summer and about 800-1,000 watts/m^2 in winter. These measurements are taken square to the path of radiation and the actual energy received on the wall of a building related to the angle of incidence of the sun's rays.

The original graph from EBS 6 provides the basis for Figure 13 and shows the energy in kW that passes through a 2 m^2 window. Kilowatts, a measure of energy, are foreign to most people. A one-bar radiator, however, is more familiar – it is equivalent to about 1 kW and has been depicted as an energy unit. Similarly, many people have trouble visualising a 2 m^2 window but most are familiar with a double-glass sliding door with an area of about 4 m^2.

Imagine every day in summer turning on two one-bar radiators and running them for four hours in your kitchen (or whatever room has an unprotected double-glass door facing east or west). You would not do it, but that is exactly what the design and window placement of many houses does. Eastern and western windows collect solar radiation and heat (8 kWhr) in summer when it is desired to keep it out, and in winter the same window provides very little energy input (about 3 kWhr). The same double-glass sliding door on the northern wall receives significant energy, equivalent to two one-bar radiators running for over six hours (>13 kWhr) in winter when it is needed. On the other hand, it receives very little energy in summer.

As noted earlier, skew walls cannot be simply protected through the seasonal change in sun angles. One should be wary of real estate agents who espouse the fantastic attributes of the 'north-east aspect of a building'.

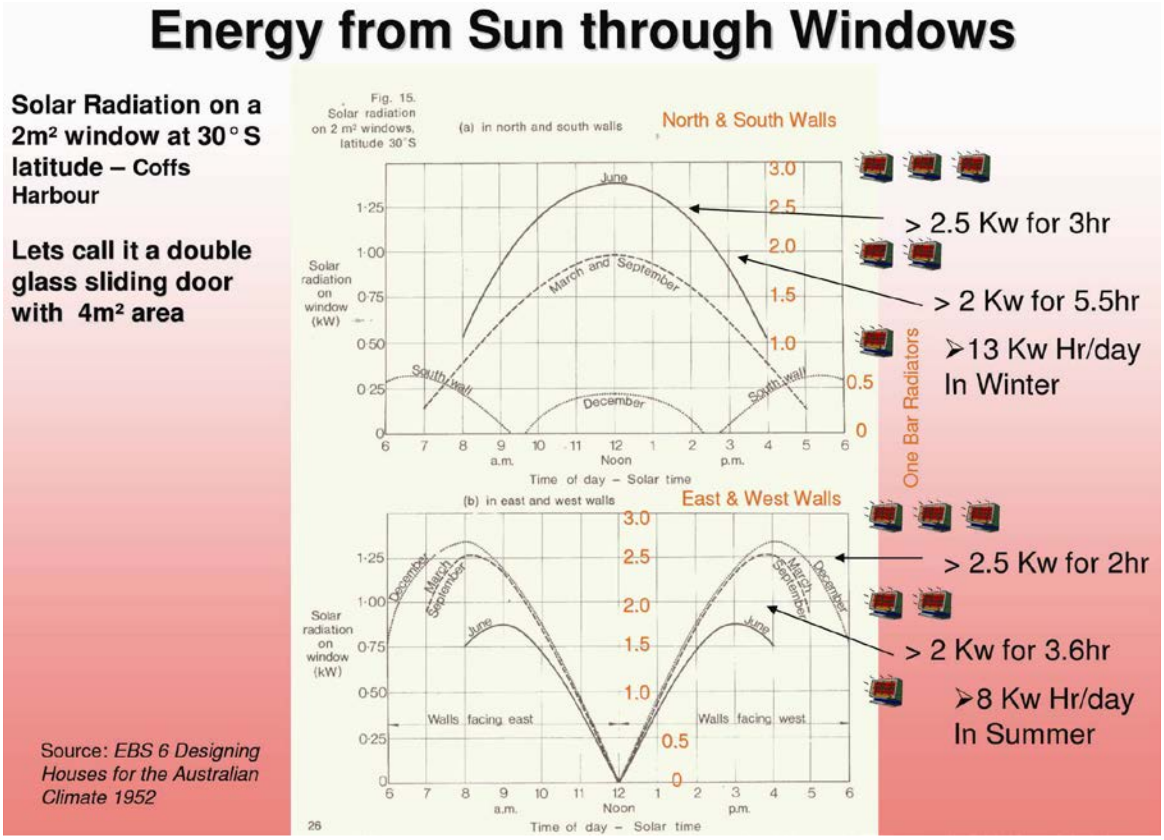

Figure 13: Energy through windows on various walls.

A plethora of information describes what and how to build an energy efficient house. For example, refer to Chapter 4 in Ballinger et al. (1992): "*Thermodynamics and heat flow; density, specific heat and time lag; black body radiation and surface properties; thermal conductance; thermal resistance; thermal transmittance; transparent materials; opaque materials*". However, this is beyond the scope of this paper.

It is sufficient to say that a well-oriented building can be designed to be thermally efficient if well researched and documented. The importance of solar access for the northern wall and protection from solar gain on the eastern and western walls is well documented. This, in turn, relates to energy savings in winter where heating of the dwelling is simply by effectively utilising the sun's radiation and in summer when the energy from the sun is excluded as much as possible.

The majority of the passive solar house design information is aimed at individual houses. The layout of the roads and subdivision of the lots is what combines the individual houses and promotes the requisite solar access to be able to effectively utilise the sun's energy. In NSW, the BASIX system is designed to promote energy efficient buildings. However, it does not effectively consider the surrounding environment.

As surveyors, we must consider holistically the developments we are involved in. This goes well beyond servicing the lots with roads, water sewer and phone. When the subdivision orientation promotes good solar access, energy efficient housing can eventuate and be designed to a certain degree. When the subdivision orientation promotes shading of the neighbour's northern wall, then the passive energy provided by the sun is denied and additional external energy inputs are required. Recent modelling of energy usage and street orientation indicate that up to 30% more energy may be required on north-south street alignment (A. Gentle, 2011 – email communication).

6.3 Sunshine by Lot Orientation: East-West Road Alignment

Ideally, the houses to be built on all allotments will be able to be constructed with passive solar design principles providing a comfortable, low-energy lifestyle. A shadow diagram of a typical single and double storey house set on an east-west road at the latitude of Canberra is shown in Figure 14.

Figure 14: Shadow diagram for east-west road alignment at the latitude of Canberra.

Clearly, the solar access for the northern walls on the neighbouring allotments is preserved. On the southern side of the road, it is preserved by the road and the building line. On the northern side of the road, it is preserved by rear yards and rear boundary setbacks (which often include sewer and drainage easements). Neighbouring buildings are also protected from the morning and afternoon sun by virtue of the adjoining structures. Only the houses at either end of the street need to cater for the eastern and western sun angles as described in section 5.1. Lots on east-west road alignments have the capacity to build energy efficient buildings with the potential to live a low-energy lifestyle. Solar access is available to all without the need for easements and other restrictions being imposed upon the lots.

6.4 Shading by Lot Orientation: North-South Road Alignment

On north-south road alignments, standard suburban lots are typically not wide enough to provide unfettered solar access for the majority of lots. This is exacerbated when a 2-storey dwelling is erected on the north side. The shadow diagram (Figure 15) shows how a typical single and double storey house in Canberra overshadows the adjoining lots on a north-south road. Clearly, where 2-storey dwellings are prevalent a standard subdivision layout on a north-south road would block solar access on all but the northern most property of the street.

As noted in section 4.2, the greatest energy consumption is for heating of homes. The loss of solar access in this way has a multiplier effect. Because natural heating is not available, the building is cooler and more additional external energy input is required for comfort. A home designed under the BASIX system that is purported to ensure energy-efficient housing in NSW will be cold in winter when subject to the shadowing seen in Figure 15. In addition, it will more than likely be hot in summer as it addresses the street in the traditional manner. Buildings on north-south roads often need higher external energy inputs for comfort.

Figure 15: Shadow diagram for north-south road alignment at the latitude of Canberra.

If a north-south road alignment is unavoidable then consideration should be given to the separation available to the buildings that will eventually be constructed on the properties. The separation required to maintain solar access increases at high latitudes. The two examples shown in Figure 16 are for Campbelltown, a western suburb of Sydney (34°S), and Christchurch, New Zealand (43.5°S). While a building separation of over 5 m is required around Sydney (4.7 m from wall to eave shown), further south in Christchurch a separation of well over 7 m is required to maintain solar access for a neighbouring building on the south side.

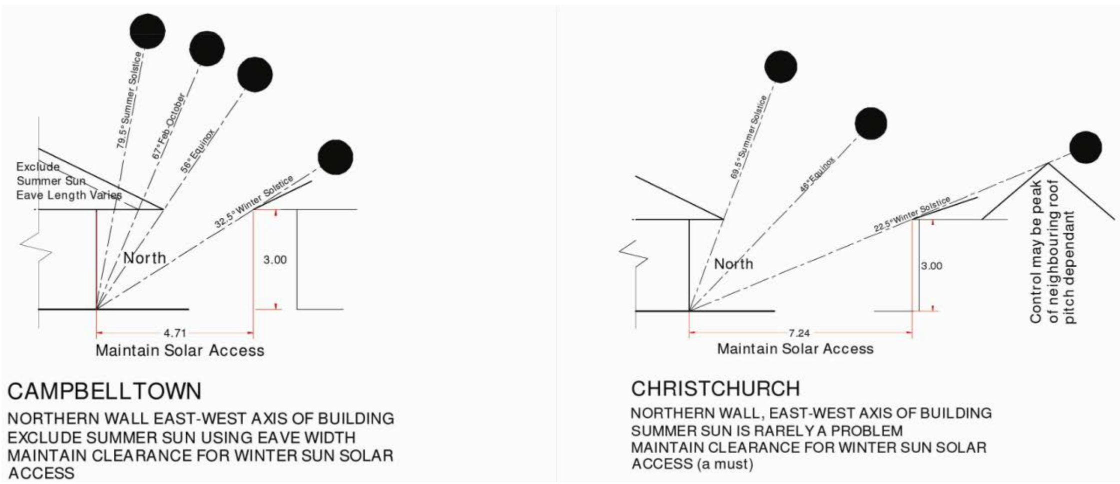

Figure 16: Separation of buildings on north-south aligned roads.

The separation of buildings shown in Figure 16 is based on buildings with heights of 3 m on flat ground; 2-storey buildings will require twice this distance. Sloping ground also has its problems. South-sloping ground requires a greater separation than a north-sloping block. Clearly, the old standard side boundary offsets of 675 mm to the eave and 900 mm to the wall will not protect the neighbouring building from poor orientation and maintain solar access. Easements for solar access are therefore desirable, but may be a complex and limiting burden to place on developers and buyers.

Terrace houses on north-south roads are surely the epitome of this situation. The only solar access comes from the east and west. This often translates to the inhabitants being hot in summer and cold in winter. People in the market for a 'cute little terrace' to live in should be thoroughly aware of the street orientation. The ongoing energy costs just to maintain comfort may end up being formidable.

7 OLD BAR: A CASE STUDY IN ORIENTATION

Old Bar is a coastal village on the NSW Mid North Coast within the Greater Taree City Council LGA. It is typical of many coastal villages built behind the dunal system adjacent to a river entrance. The road layout of this village has been elongated north-south and contains a number of long north-south oriented roads. The older areas are typified by grid-pattern streets. Later development of the 1970s and 1980s are curvilinear in pattern.

Figure 17 shows a few of the dwellings that can be found in Sheppard Street, one of the typical north-south street alignments in Old Bar. While Old Bar typically receives a cooling nor-easterly sea breeze in summer, certainly some of the residents feel the heat of the afternoon sun. On the north-south streets, a large number of owners have endeavoured to protect the western wall of their houses with external screens, shutters and the like, presenting an unusual streetscape.

Figure 17: Typical western aspect window treatments.

7.1 Case Study: Old Bar North (Precinct 2B)

A rezoning application (RA) for Old Bar North was lodged with the Greater Taree City Council in October 1998. It included a plan endorsed by the 67 landowners and described, in part, with the following statement: "*With a glance at the proposed road layout you can see that the roads are arranged generally along the north/south and east/west cardinal directions where the higher proportion of roads are aligned east/west. As a result, a majority of lots are provided with the optimum solar alignment. In turn, orienting the houses to take advantage of the winter sun reduces the necessity to provide excessive power to maintain comfort in those dwellings, lowers the consumption of fossil fuels and minimises the ongoing effects on global warming and climate change.*"

Greater Taree City Council planning staff took over the rezoning process and, through the major developer Mirvac Pty Ltd, who had taken up purchase options, hired Mirvac's fully owned subsidiary HPA Planners to prepare the 'master plan' (Figure 18). This plan is now part of Greater Taree City Councils Development Control Plan (DCP) 2010.

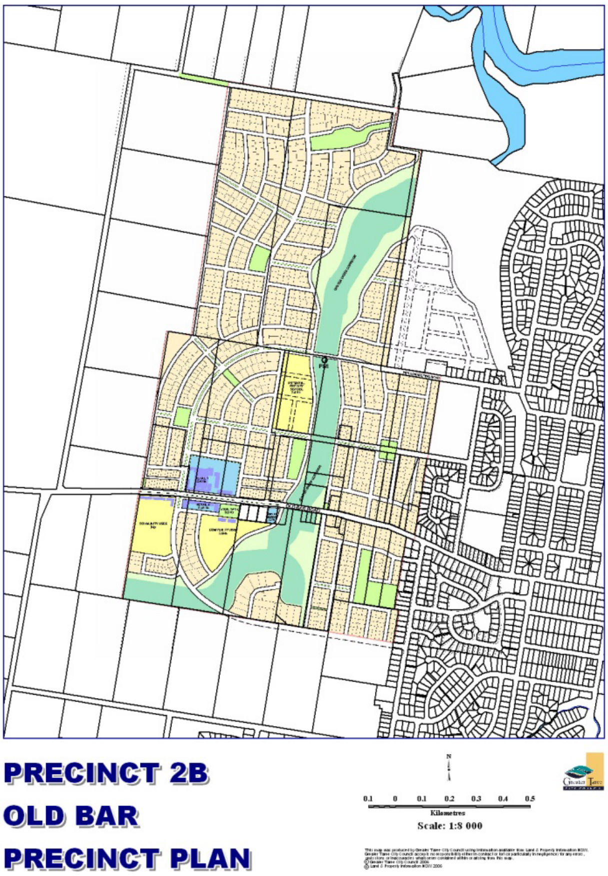

Figure 18: Master plan for Old Bar North (Precinct 2B).

The grid pattern of the plan reflects the typically rectilinear pattern of the older sections of the village to the east. The predominance of east-west roads of the rezoning application plan has been replaced with a predominance of north-south roads. Public submissions raising concerns about the poor orientation were answered by Council stating that the HPA planner had noted "how the north-south roads though unorthodox, allow for sufficient solar access to dwellings."

As shown in this paper, the north-south roads in reality have the opposite effect. The photographs of dwellings in the existing village clearly indicate that these orientations are not optimum at Old Bar and the stated aim of the DCP providing sites where "homes can easily achieve effective solar access" has not been achieved. The resultant is a village expansion that will contain a high percentage of high-energy consuming allotments. As noted earlier, modelling suggests as much as 30% more energy will be required by houses on north-south roads than comparable lots on east-west road alignments.

In order to gauge the effect, allotments on north-south roads have been highlighted on Council's DCP 2010 master plan (Figure 17). It shows that a significant percentage of proposed lots are likely to be high-energy consuming lots. In this age of increasing energy costs, awareness of 'greenhouse gases', concerns about 'anthropogenic climate change' and 'global warming', this is not a good result. This precinct plan is a long way from the best practice outcome claims in the text of Council's DCP 2010.

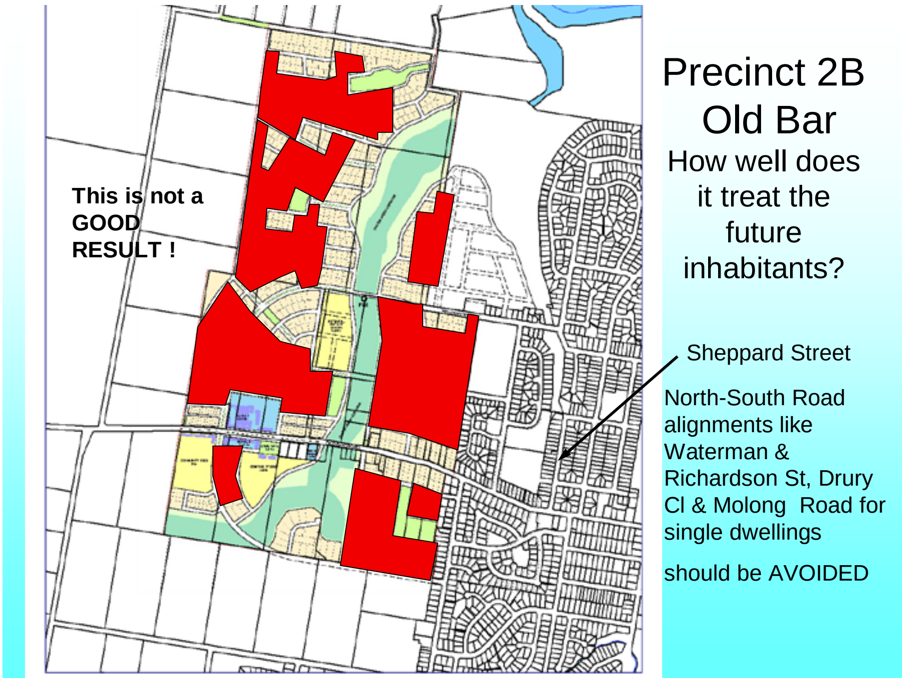

Figure 19: Master plan for Old Bar North (Precinct 2B), highlighting allotments on north-south roads.

Council's DCP for this precinct requires that future developers 'justify' any changes proposed to be made to the layout of the adopted plan. The most likely outcome is that developers will simply avoid confrontation and additional costs, adopt the plan and provide a large proportion of high-energy consuming lots as depicted in Figures 18 & 19.

7.2 Case Study: Old Bar South (Precinct 3)

Rezoning in the adjacent Old Bar South precinct was undertaken at the same time. The rezoning was gazetted without the requirement for a pre-prepared 'master plan'. Figure 20 shows part of the draft layout plan proposed as the development blueprint. The plan was prepared by a local survey firm, Lidbury Summers & Whiteman of Forster.

It can be seen that:

- There is a pre-dominance of east-west roadways for single lots, and larger wider lots are proposed on north-south roadways to promote/accommodate unit sites.

- The existing land parcels have been recognised, and the plan is prepared to allow for potential discrete development on the separate parcels.
- The existing dwellings have been located and recognised as part of the existing infrastructure, and the lots have been designed to cater for them.

This is a most pleasing result from one of our local surveyors. Consequently, the Old Bar South precinct is likely to have a much lower energy requirement than the corresponding Old Bar North precinct. This is considered to be a far better, more sustainable result.

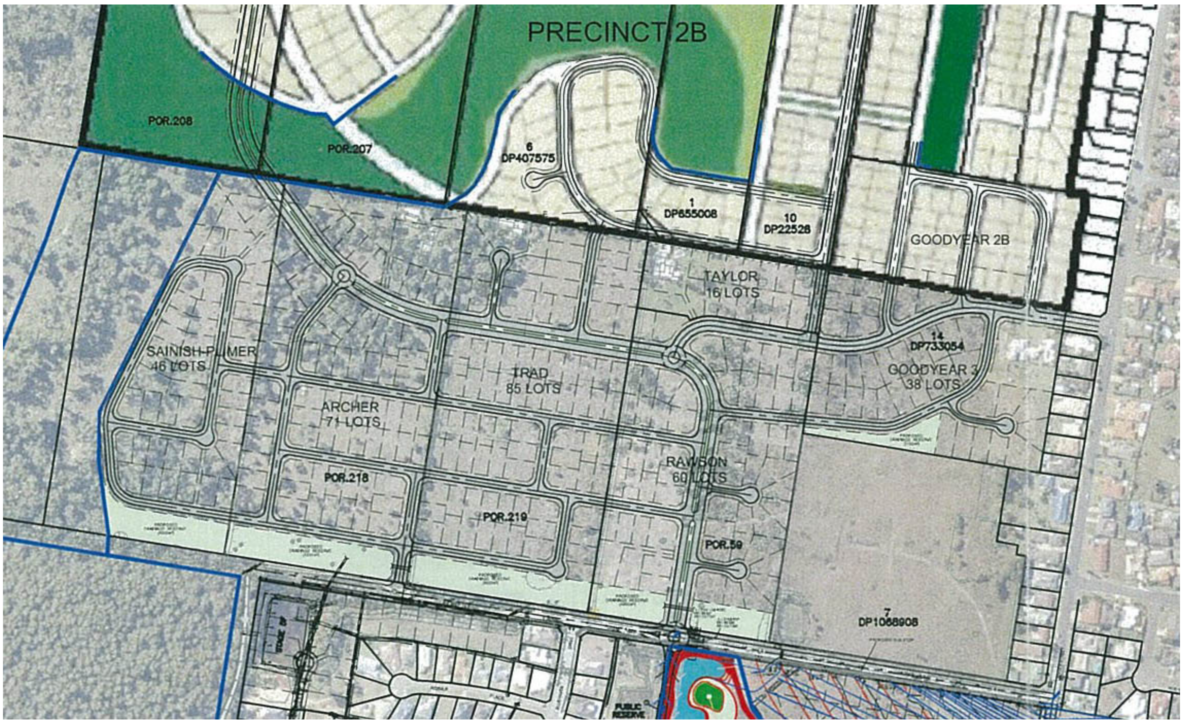

Figure 20: Part of the master plan for Old Bar South (Precinct 3).

8 CONCLUDING REMARKS

This paper has provided a nexus between the orientation of subdivision roads and the principles of passive solar house design. It has provided surveyors with detailed knowledge in order to discuss with land developers the preferred orientation of road layout. The aim is to minimise the energy footprint of future housing estates and provide a practical way in which the surveying profession can contribute towards a sustainable future, both in Australia and well beyond. Examples of development principle plans have been analysed to ascertain how energy consumption may vary as a result of the layout design and orientation.

ACKNOWLEDGEMENTS

The following individuals are gratefully acknowledged for assisting with the preparation of this paper:

- Dr Angus Gentle, University of Technology Sydney (Angus.Gentle@uts.edu.au) for his comments, research and modelling of energy consumption on various street alignments.
- Cindy Schlipzand, Cinz 3D Drafting and Graphics (cinz3ddrafting@live.com) for preparing and providing the shadow diagrams.

- Surveyor Brian Lidbury (http://www.lswsurveyors.com.au/) for giving permission to publish the Old Bar South draft layout.
- Sam and Neil Ryan, building designers and BASIX certifiers of Taree (http://www.neilryan.com.au/) for comments on BASIX and design constraints.

REFERENCES

Ballinger J.A., Prasad D.K. and Rudder D. (1992) *Energy efficient Australian housing* (2nd edition), Australian Government Publishing Service, Canberra.

Calvin G. (2002) Sustainable development, subdivision, surveyors and sun angles, *Proceedings of Association of Public Authority Surveyors Conference (APAS2002)*, Sutton, Australia, 5-8 March, 81-91.

Commonwealth of Australia (2010) Your home technical manual: Australia's guide to environmentally sustainable homes (4th edition), http://www.yourhome.gov.au/technical/index.html (accessed Jan 2013).

Drysdale J.W. (1977) *Designing houses for Australian climates* (4th edition), Experimental Building Station (EBS) No. 6, Australian Government Publishing Service, Canberra.

Mazria E. (1979) *The passive solar energy book*, Rodale Press, Emmaus, Pennsylvania.

Phillips R.O. (1977) *Sunshine and shade in Australasia* (4th edition), Experimental Building Station (EBS) No. 8, Australian Government Publishing Service, Canberra.

US Energy Information Administration (2011) Use of energy in the United States explained, http://www.eia.gov/energyexplained/index.cfm?page=us_energy_homes (accessed Jan 2013).

UTS (2007) University of Technology Sydney – Earth Building Research Forum, http://www.dab.uts.edu.au/ebrf/research/index.html (accessed Jan 2013).