

**Mirvac Fini: Burswood Lakes**  
**Healthy Housing**



**SARKISSIAN ASSOCIATES PLANNERS PTY LTD**  
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*Healthy Housing*

**Mirvac Fini**  
**Burswood Lakes**

by Dr Wendy Sarkissian, James Bryant  
and Beauford Stenberg with  
Karl Langheinrich, Andrew Kerr and Bianca Moscato

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Sarkissian Associates Planners Pty Ltd  
207 Boundary Street West End Queensland 4101  
Phone (07) 3844 9818 Fax (07) 3846 2719  
Email: [sarkissian@pacific.net.au](mailto:sarkissian@pacific.net.au)  
Website: <http://www.sarkissian.com.au>

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## ***1.0 Introduction***

The organisation of this *Working Paper* is as follows. The paper begins with a brief introduction of the healthy housing concept and an outline of what healthy housing is. The reader is then informed about the implications for interior design, materials in use and their alternatives, as well as various ways to deal with the implications for interior fit-outs.

This report outlines the issues associated with healthy housing for consideration in the design of the Burswood Lakes development in the Town of Victoria Park. Human health within the home is an increasing concern, with the upsurge in illnesses that correlate with the use of long-chain molecule plastics, glues and laminates, and certain types of electrical equipment. The healthy home concept stems from issues relating to Sick Building Syndrome (SBS), Environmental Illness (EI), Serotonin Irritation Syndrome (SIS), General Adaption Syndrome (GAS) and Chronic Fatigue Syndrome (CFS) or Myalgic Encephalomyelitis (ME) (Baggs, 1996:8). Further, a range of other allergic symptoms less likely to be diagnosed are migraines, stomach cramps, asthma, eczema, joint and muscle pain, which can lead to Multiple Chemical Sensitivity (MCS). Indoor air quality, and physical exposure to toxic chemicals and the addition of harmful Volatile Organic Compounds (VOC's) are the factors contributing to these illnesses.

The material for this report was sourced from previous work done by this company, from literature reviews, including a wide range of books and journals, as well as web searches for relevant material

This report aims to influence the building practices of architects, engineers and builders who specify and install materials, products and systems that only recently have been suspected, and in some cases proven, to be detrimental to the people that use these buildings.

*Healthy homes* are living spaces that are sensitive to the needs of human health, physically and psychologically. The healthy home responds to these human needs to reduce and avoid the use of harmful materials, in addition to identifying benefits with materials sustainability.

Environmental sustainable practices are becoming more influential in large-scale developments in terms of marketability and industry responsibility. The Healthy Homes concept creates marketing opportunities for Mirvac Fini, displaying their commitment to their Ecologically Sustainable Development (ESD) principles and promoting occupant health advantages. The possible design and planning responses outlined in this *Working Paper* aim to increase awareness about potential health hazards associated with dwelling construction and increasing the marketability of the housing.

## 2.0 What is healthy housing?

Human health within the home is an increasing concern for architects, planners and households. This healthy home concept stems from issues relating to Sick Building Syndrome (SBS) and the addition of harmful VOCs to indoor air quality during construction. Healthy homes are defined as living spaces that are sensitive to the needs of human health and comfort and psychological perceptions (Hunter, 2003). A healthy home responds to these human needs to reduce and avoid the use of harmful materials in addition to identifying benefits with materials sustainability.

The following table shows some of the air pollutants present in homes and the amount of harmful material released over specific time periods.

HAZARD	MEASURE	TEMPORAL DURATION	ADVISOR
Carbon monoxide	9 ppm	8-hr average	NHMRC
Nitrogen dioxide <sup>1</sup>	25 ppm	1-hr average	WHO
	0.30 ppm <sup>1</sup>	not specified	NHMRC
	0.16 ppm (ambient goal)	1-hour average	NHMRC
Formaldehyde <sup>2</sup>	0.11 ppm	1-hour average	WHO
	0.1 ppm	not specified	NHMRC
Lead <sup>3</sup>	1.5 µg/m <sup>3</sup>	3-month average	NHMRC
Ozone	0.1 ppm	1-hour average	NHMRC
	0.08 ppm	4-hour average	NHMRC
Radon <sup>2</sup>	200 becquerels/m <sup>3</sup>	annual mean	NHMRC
Particles <sup>3</sup>	90 µg/m <sup>3</sup> (TSP)	annual mean	NHMRC
	50 µg/m <sup>3</sup> (PM <sub>10</sub> )	annual mean	US EPA
	150 µg/m <sup>3</sup> (PM <sub>10</sub> )	24-hour average	US EPA
VOCs (total) <sup>2,3</sup>	500 µg/m <sup>3</sup>	1-hour average	NHMRC
VOCs (individual) <sup>2,3</sup>	250 µg/m <sup>3</sup>	1-hour average	NHMRC

**Table 1: Harmful materials commonly found in dwellings**

Source: Indoor Air Quality guidelines (New South Wales EPA)

## 3.0 Interior Design

It is the intention of this report to draw attention to implications the implications of design, describing the concept of environmental and architectural determinism as a direct relationship between built form and its psychological effects. Good design considers the psychological ramifications of built form. A healthy house also needs to have a healthy psychological effect on residents and be a harmonious living environment.

The design of a healthy house's design is sensitive and accountable to human health by the arrangement of form, colour, texture, light and weight. Interior colour is a topic is explored in *Working Paper 10*, as well as in Section 6.2 below.

## *Feng Shui*

The increasing influence of Chinese design principles and Chinese philosophy, as well as a growing number of Chinese-born residents and architects, have brought the ancient concept of *feng shui* to the attention of designers of healthy housing in Australia. This is sure definitely requires further consideration.

*Feng shui* is an ancient system, the Taoist science of auspicious siting and layout. Literally meaning "wind and water," it posits that these forces help to determine health, prosperity and good luck. Harmonious places have good *Ch'i* (*Qi*); harmonious places are sought by avoiding negative forces (Pearson, 1992: 33). This form of geomancy concentrates on the relationships between people, their buildings and tombs and the life force or *Ch'i*, which flows through all environments (Skinner, 1980: xiii).

While some of the subtleties of *feng shui* have doubtless been lost in translation, it can be described as the Chinese science of divining the presence of subtle currents in the earth and their effect on humans. It has been called geomancy for want of a better English term. Also called *P'ungsui*, the concept can be seen to have "many parallels with new paradigm thinking in science, which emphasises a holistic and systemic approach to scientific understanding," according to a recent Australian book. Kim argues that "not only can understanding and applying the principles of *P'ungsui* help to improve environmental understanding and decision-making; *P'ungsui* could also be influential in changing the value systems of the general public and particular interest groups" (1994: 73). He compares the planning implications of both *P'ungsui* theory and current anthropocentric approaches to planning.

Tracing the origins of the concept of *feng shui*, Clare Marcus explains that it originated with the absolute nothing, which evolved out of the great absolute, the primordial cause of all existence. "When it first moved, its breath or vital energy, the *ch'i*, animated the male and female principles" that produced all of life, animate and inanimate. At its origin, *feng shui* was "principally a way of ensuring good fortune emanating from the spirits of ancestors by locating their tombs propitiously." It is now widely used in building siting and design in Hong Kong, Taiwan and Singapore and is growing in acceptance in mainland China, experiencing a revival in rural areas, following its suppression during the Cultural Revolution. In rural areas, the *feng shui* master is often approached to advise on personal health matters, as there is a critical shortage of doctors in Chinese villages. Younger men are now being trained in this profession (C. Marcus, 1987: 7 and *pers. comm.*, 1995 and 1996).

The concept of *feng shui* is still widely accepted in Hong Kong for new buildings and adaptations (Pearson, 1992: 33). It is also growing in acceptance in mainstream Western culture. In Vancouver, Canada, destination for wealthy Hong Kong residents reluctant to continue living under the Chinese administration, *feng shui* masters are now regularly employed in design and siting of new dwellings for Chinese residents. In Vancouver, a highly successful local chain of organic food shops and restaurants has used this

expertise for building design and siting. Real estate agents have used the method to improve a property's chances of a quick sale in San Francisco. Reflecting cultural change, even an Australian women's magazine now has a regular *feng shui* feature.

For a selection of *feng shui* approaches, see: C. Marcus, 1987; Kim, 1994; Pennick, 1979; Skinner, 1980; Walters, 1988; Lip, 1985; Rossbach, 1987; and Pearson, 1992.

*Feng Shui* aims at creating a psychological effect of tranquillity and harmony. The psychological effect of *Feng Shui* has been well documented and embraced in western design, as can be seen in both the public and private sectors of the built environment, from hospitals to residential (Lip, 1985; Marcus, 1987; Rossbach, 1987; Walters, 1988). The principle of *Feng Shui* is to combine sound interior design sense with ancient mysticism. These principles apply equally to terraces and apartment blocks as it does to separate family homes. However, extra factors must be considered when you apply those principles (Harrison, 2003).

## ***4.0 Natural lighting and ambient temperature***

The following section discusses natural lighting and ambient temperature. Effective design of windows and ambient temperature mechanisms will result in reduced service costs as well as health benefits.

### **4.1 Natural ventilation and window orientation**

Natural ventilation supplies air for respiration, dilutes contaminants, reduces stuffiness and increases air movement. Although natural ventilation is highly uncommon in many office buildings and increasingly in homes, many people prefer natural ventilation for personal comfort reasons. Natural ventilation also provides the choice to alter the incoming air according to comfort requirements.

Inadequate ventilation is the cause of many health problems. According to the World Health Organisation, the cause of Sick Building Syndrome is for the most part unknown; however, air-conditioning and other forms of mechanical ventilation are primary contributors to health problems. Natural ventilation is simple to achieve with appropriate consideration to aspect and orientation of windows and door openings relative to local meteorological conditions.

Passive ventilation and wind turbines are also possible alternatives to air-conditioning. They are more energy-efficient, cheaper to run and maintain, as well, the filtered fresh air generated is healthier for occupants when compared to recycled air.

### **4.2 Natural lighting**

Natural lighting is strongly dependent on dwelling orientation. Rooms which are used most during the day, for example lounge rooms, dining rooms and kitchens, should be oriented in order to gain sunlight from mid-morning to late afternoon. As discussed in Section 6.2, paint selection has considerable influence on the amount of natural lighting

available. Lighter/brighter colours should be used in living areas of the dwelling, as they promoted light reflection and increase the vibrancy of the room.

### **4.3 Heating**

The room mostly used during the daylight hours should be oriented to allow early morning sun to warm up areas of the dwelling such as the kitchen and dining room while allowing the afternoon sun to warm up bedroom walls, etc.

Indoor heating is directly related to the construction. For example, timber floors are warmer than tiles. They also have a lower thermal capacity, meaning timber can lose its warmth faster than concrete. Therefore, combinations of various materials may be required. Material selection, together with dwelling orientation, can alter the materials used and energy efficiency of the dwelling, increasing the liveability and marketing potential of the development.

#### **Nitrogen dioxide (NO<sub>2</sub>) from heating.**

Nitrogen Dioxide (NO<sub>2</sub>) can be found in homes that use natural gas for cooking and some types of gas heating. In relatively high concentrations, it is known to cause lung damage. Australian investigations show that its major sources in indoor air are un-flued gas heaters and gas cooking appliances. If gas appliances are correctly installed, maintained and have good ventilation, then concentrations are well below dangerous levels.

### **4.4 Insulation**

Insulations outgas small amounts of chemicals such as formaldehyde and retardants. While many chemicals used in insulation are harmful to health, the primary concern is not exposure to occupants but to the installers and manufacturers. Additional insulation material such as foam, cellulose and fibreglass exist. However, because of the nature of the development, it is not expected that insulation will be required in large volumes.

## ***5.0 Materials selection***

This section discusses internal building materials that have significant health implications on households. Each material discussed provides possible design and planning responses that can lead to creating a non-toxic home (Pearson, 1989: 130). Cost factors and external building materials are also discussed.

### **5.1 General issues**

As stated in the Ecological Sustainable Development Strategy for the Burswood Lakes development, a Life Cycle Analysis (LCA) of all materials shall determine the material selection for the development. The LCA shall not only incorporate recycled materials but will also address the manufacture, use and end-life disposal methods for construction materials.



While natural materials are normally more expensive because of transport and processing costs, local materials will reduce costs significantly. Buying materials locally may not always be convenient and may involve contacting manufacturers rather than suppliers (Woolley, 1997: 198). Where the cost of materials may be more expensive than commonly used materials, the increased cost up-front will result in an overall reduction in the cost of replacing toxic materials in the future.

Toxin release from building materials is the primary concern associated with unhealthy buildings. These toxins are released in the form of gases and vapours, particles and radiation (Pearson, 1989: 46). Healthy building materials are becoming more common. However, careful attention and shopping around are required.

Modern synthetic or chemically treated building materials outgas VOCs or create dust that pollutes internal air in buildings. They include treated timber and timber products such as chipboard, creosotes, adhesives, glues, paints, varnishes, anti-fungal agents, and treated fabrics. Out-gassing can be minimised by not installing materials immediately after manufacture. This allows them to off-gas first.<sup>1</sup> This requires a source management program.

Generally, use natural materials in preference to artificial and treated ones and select low-emission products. Where the latter are used, advise residents of their dangers and measures to minimise risks.

To take an example of a LCA, we consider a product, namely Hebel Blocks (aerated cement blocks). First, one has to consider the production of this product. Issues of civic health and environment must be considered in the mining and processing. Beyond environmental implications of mining of the raw materials, Hebel Blocks are a high-dioxin containment source in manufacturing due to the cement kiln processing. The greatest health hazard is in construction phase, where these blocks have chronic health implications due to the presence of respirable quartz (crystalline silica) dust typically produced from cutting the blocks. This product has no known health hazards in its final state in the built environment. Hebel Blocks can also be recycled by reprocessing at the end of their life cycle.

## **6.0 Walls**

### **6.1 Introduction**

Walls are an important structural element of a house or apartment. They are commonly painted or wallpapered, and often decorated with pictures. Walls in apartments serve not merely as structural supports and room dividers they also provide sound regulation functions and ensure a degree of acoustic privacy. Walls are also the largest treated

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<sup>1</sup> The ethical problem with this approach is that the toxins are simply sent elsewhere: into the atmosphere. A more prudent approach, consistent with ESD principles, is to select non-toxic materials in the first place.

surfaces in a dwelling, and consequently the potential for undesirable health effects is obvious. Those effects have been widely reported and cases of lead and other chemical exposure issues in relation to children's health problems are also well documented. How walls are constructed and what additives are used in cement and concrete, what timber treatment was employed and what insulation was used- if any? Those questions and questions about the surface treatment of walls are therefore of great interest in achieving healthy housing.

## **6.2 Internal wall finishes**

Internal finishes such as paints, plaster, wallpaper, and tiles are detrimental to health. Toxic fumes and odours exist not only during application but continue to linger after application. People become exposed to these materials as they appear on the surface of many materials used within the home. Therefore, they cause greater risk to the health of residents. This section concentrates on additional finishes, including paints, wallpaper, plaster, plasterboard and drywall.

## **6.3 Paints**

Paints outgas VOCs, biocides (preservatives) and anti-freeze ingredients. However, length of exposure after paint dries determines the negative impacts on humans. It is suggested, however, that all dwellings be sufficiently ventilated post painting, as this will lower the concentration of out-gassed chemicals. The three primary paints for consideration are oil-based, water-based and natural paints. However, all three pose health risks, including severe brain tissue damage. The primary concern when using paints is to identify the hazardous ingredients, which exist in different types of paints. Specifically:

- Avoid using oil-based paints that contain synthetic alkyd, epoxy resins and white spirit.
- Consider using microporous synthetic paints that allow underlying materials to breathe, reducing moisture and rot problems.
- Consider using low-out-gassing paints that may still contain synthetics but are low in odours.
- Utilise natural paints made from plant oils, natural resins, citrus solvents and mineral pigments eg: milk paint.
- For paint application on timber surfaces, linseed oil paint has traditionally been considered as it makes the timber water resistant. However, linseed oil has recently been suspected of having cancerous properties.
- Avoid water-based paints which contain mercury based chemicals known to cause brain and tissue damage over long periods.
- Consider applying water-based paints such as lime wash in areas associated with food. Lime wash is a natural antiseptic, which deters insects.
- Besides general information, look for: VOC Content: Usually listed in grams per litre, this can range from 5 to 200. Using a product with the lowest VOC content will yield the lowest overall health risk.

- Solids content: Solids, or pigments, can range in concentration from 25% to 45% by volume. The higher the percentage of solids, the lower the level of volatiles in the paint.
- Re-use turpentine and paint thinners. Simply allow used thinner or turpentine to stand in a closed, labelled container until paint or dirt particles settle to the bottom. Pour off the clear liquid and reuse.
- Circulate. To reduce the impact of indoor air pollutants, circulate fresh air through the dwelling as often as possible. Avoid the use of spray paints altogether. When painting ceilings, be sure to provide cross-ventilation to remove paint fumes. Fumes rise as paint dries, and so with ceilings the fumes dissipate more slowly since there's no air above the paint.

### **Alternative paint products**

EXTRAPAINTE by OIKOS is one of the many paint alternatives available on the market at present that endorses the healthy housing concept. EXTRAPAINTE is a highly washable acrylic paint with a pleasant surface to the touch and a smooth matt finish. Because of its technical peculiarities, this product can be applied to both new and old civil plasters, on gypsum plasters and on walls painted in dark colours. It is odourless, non-toxic and non-flammable.

Another popular paint available is Watty Clean Air 3 Low Sheen. This paint has a 100% acrylic finish with a subdued sheen level suitable for interior applications. The latest technology raw materials have been used to create broad wall paint with low VOC and a low odour without compromising performance or application properties. Watty Clean Air 3 Low Sheen is recommended for use on all suitably prepared interior surfaces. It is particularly suited for walls and ceilings in bedrooms, dining and family rooms, kitchens and any high usage living areas. Watty also have a Clean Air 3 Ceiling White which also has low VOC and odour out-gassing. These paints by Watty are available only in white. However, matches for competitor colours are available through the Watty tinting system.

**Bio Products Australia Pty Ltd.** produces natural paints (interior and exterior), primers, pigments, lacquers, lazure paints, wood primer, varnishes, seedlac, oils, waxes, adhesives, thinner, paint strippers, wood grain fillers, cleaners and furniture polish. These products are free of dangerous solvents. Bio Paints are importers and local manufacturer of Biofa natural paint products. Many of their products are totally solvent-free. The solvent that they do use does not contain toluene, xylene, glycol and other dangerous substances found in common thinners.

Livos product is natural paints for interior and exterior, wood finishes, wood protection, priming oils, natural oil paints, floor and furniture finishes, cleaners and waxes. A wall and ceiling paint product is their 'Dubron-Dispersion No. 414' which is solvent-free and has no VOCs. It contains water, chalk, talcum, natural resins, zinc oxide, bentonite, methyl cellulose, beeswax, beeswax soap, hemp oil, linseed oil, safflower oil, silver chloride, isaliphate, orange peel oil.

### Colour schemes

The effect of colour psychologically is unquestioned and must be considered in any application in housing. Apart from its impacts on emotion, colour impacts differently on men and women, as one sex may find a particular colour appealing and the other not. Colour can have dramatic effect on the marketability of housing. To avoid gender-exclusive colours, consider selecting a uni-sex colour, yellow being a good example. A tone of colour may have dramatic effect on lighting, changing a space from dark and claustrophobic to bright and spacious without the assistance of artificial lighting. Functionally, colour can also be used to dramatize or subdue different built forms.

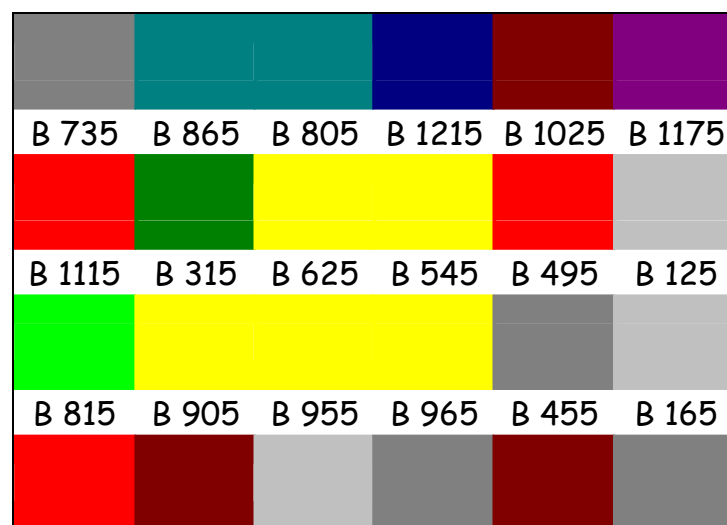


Figure 1: Colour schemes available in the EXTRAPAIN range by OIKOS

### 6.4 Plywood and particleboard

Use whole woods wherever possible. Formaldehyde emissions from plywood and particleboard are major contributors to airborne toxins in homes, although this off-gassing does diminish with time. Where possible, these materials may be sealed to reduce emissions.

### 6.5 Plaster, plasterboard and drywall

Plaster and plasterboard are suitable alternatives for wall finishing, as once completed, a plaster wall is inert. Out-gassing is prevented by the hard and dense surface created by the plaster once cured.

Therefore:

- ♦ For board finishes, use plasterboard that does not outgas chemicals (hard dry) and may be left unpainted.
- ♦ Avoid using drywall in sensitive households because the paper facing releases ink odours.
- ♦ Because drywall requires painted finishes, choose low-out-gassing natural paint
- ♦ Consider the advantages of using plaster over a plasterboard background or masonry wall.

## **6.6 Wallpaper**

Wallpaper made from plain paper, coated paper or plastic, which contain fungicides. Therefore, out-gassing, is common. Glues used in wallpapers also contain fungicides to prevent mould. The main concern associated with the use of wallpapers is the toxic treatments and chemical additives. Therefore:

- ♦ Place new wallpaper rolls outside to outgas for a few days before application.
- ♦ Consider using 100 per cent cotton fabric wall coverings instead of conventional wallpapers, which are made from natural resources.

## ***7.0 Internal flooring materials***

### **7.1 Introduction**

Flooring is the chief contact surface for humans in housing. It is also a major pollutant source. An example is wall-to-wall or fitted carpeting. Carpets pose not only specific health concerns but also require constant cleaning. Vacuuming carpets picks up only large dust particles, while expelling finer particles into the air to be subsequently inhaled by the home occupants. Possible alternatives for consideration of floor covering are discussed below.

Floor coverings have significant negative impacts on the environment due to the manufacturing of synthetic sheets, fibres, rubbers and foams. They emit VOCs, which have links to SBS and consist of vapours and gases such as formaldehyde, benzene and toluene, which are extremely harmful to human health (Warde, 1997: 152).

### **7.2 Tiles**

Tiles are made from combinations of clay, shale, gypsum, talc, vermiculite and sand, and by firing tiles in a kiln they become inert materials which have no associated chemical substances. Therefore, tiles are safe for households as they do not release toxic chemicals. Cleaning of tiles is also easy therefore removing fine inhaleable particles unlike the resistance associated with carpet.

- ♦ Purchase tiles that have had long firing times to increase their inertness
- ♦ Consider using glazed tiles that prevent staining and are harmless to human health
- ♦ Ensure ceramic tiles are used in all wet spaces (such as bathrooms, kitchens and laundries) to prevent mould and bacteria growth and for easy cleaning.

### **7.3 Linoleum**

Linoleum has the advantages of vinyl/PVC with little human health effects. The only concern when utilising linoleum from a health perspective is the type of adhesive used during laying. Commonly used adhesives consist of petrochemicals that are toxic. An alternative is wood lignin paste.

- ♦ Avoid the use of petrochemical adhesives containing toxic gases

- ♦ Use wood lignin paste or other alternative healthy adhesives to lay linoleum tiles or sheets
- ♦ Ensure linoleum is laid on firm, damp-proof surfaces to prevent rotting occurring in backing.

#### **7.4 Timber**

Timber is essentially a green product because it is natural, renewable, durable and biodegradable. Timber naturally regulates the indoor environment because it has the ability to "breathe", assist with ventilation, stabilise humidity, filter, and purify air

Primary concerns surrounding timber flooring consist of the use of non-sustainable tropical hardwoods and solvent-based adhesives and varnishes. From a health perspective, timber products use toxic preservative treatments, chemical retardants and harmful pesticides preventing pest outbreaks in exotic species, termite attack, increase fire resistance and maintain mould and water resistance. Arsenic has been widely used in the past as a termite preventive however under new Australian Standards, arsenic is no longer used due to its associated health risks. Timber products also utilise toxic glues and adhesives.

Some suggested responses include:

- ♦ Ensure timber products are certified to specific standards;
- ♦ Avoid parquetry (hardwood) flooring because of its non-renewable qualities and the quantity of glue content required. However there are some plantation woods appropriate for indoor flooring;
- ♦ Avoid softwoods that contain toxic pesticide treatments, although they are considered to be less harmful on the environment;
- ♦ Be aware that natural terpene compounds are released from softwoods containing offensive odours;
- ♦ Ensure fine wood and tropical wood dust is controlled during and after installation as inhaled dust particles can have negative respiratory effects on occupants;
- ♦ Avoid the use of oak products which can irritate sensitive households due to its natural odours;
- ♦ Consider using benign woods such as maple, beech, birch and tulip, which are ideal for sensitive people;
- ♦ Ensure timber is chemically treated to prevent termite and mould attack;
- ♦ Ensure chemical treatments are low out-gassing and non-toxic to humans; and
- ♦ Avoid toxic polyurethane finishes.

#### **Timber products available for flooring**

There is a wide variety of timber flooring products on the market that are healthy to humans and are ecologically sound. The following is a sample of the products available on the market and bar far not a complete representation. These products are:

- ♦ Factory 'UV cured' hard woods have no odours from petroleum based solvents and other volatile organic compounds;
- ♦ Water-borne finishes are non-toxic and fume free;

- ♦ For wide-boards or rare timbers, recycled timber merchants offer the best and often only resource;
- ♦ Radiata Pine (*Pinus radiata*) has similar properties to popular Baltic Pine, is also available in a 'clear' knot free grade, and has long been used in the United Kingdom, New Zealand and Europe as a timber floor of choice;
- ♦ Ecoply plywood;
- ♦ Hardipanel Compressed is a strong cement fibreboard suited for internal flooring;
- ♦ Hardwood flooring timbers from certified plantations in Europe, as well as Australia, an example being Swedish hardwoods are available in 'Oak', 'Oak Rustic', 'Mahogany Beech', 'Jarrah', 'Ash', 'Beech', and 'Nordic White' and a good Australian example being 'Blue Gum';
- ♦ Hoop Pine (*Araucaria cunninghamii*) is suitable for flooring; and
- ♦ Plyboo is a newly developed product made from strips of bamboo and laminated into a type of parquet floor<sup>2</sup>.

### 7.5 Carpeting

Despite being the most popular flooring material, carpet is the unhealthiest floor covering option. Carpets create comfort and warmth due their influence on ambient air temperature. This influence is due to its ability to hold pockets of air, giving its temperature stabilising nature. As a new material, carpet contains a 'new carpet smell' that is a combination of highly hazardous toxins such as formaldehyde, ethyl benzene, toluene, amines and styrene. However, the chemicals used to repel insects and stains and the glues and backings all outgas. Carpets harbour dust and the house dust mite, and give off fabric particles as they wear as discussed. Health effects of newly installed carpet and existing carpets include: nausea, headaches, unquenchable thirst and burning eyes, noses, and sinuses initially. Long-term exposure displayed symptoms increased to depression, skin rashes, insomnia and may even lead to Multiple Chemical Sensitivity (MCS) and Environmental Illness (EI) (Baggs, 1996: 9). Carpet padding is also of concern as an underlay also outgases. Unfortunately, there is not much difference between synthetic or natural fibre pads because all contain toxic adhesives.

The best alternative is a timber floor secured with real nails not glue. Wool and sisal carpet with jute underlay are available. Slate and tile is acceptable, and linoleum (cork flour) is preferable to vinyl (a petrochemical product).

The three main types of particles found in many homes are environmental tobacco smoke, house dust mites and wood smoke. Tobacco smoke is not an issue for this *Working Paper* as this is a risk created by the occupant however dust mites and wood smoke are resultants of materials used in dwelling construction. Dust mites live mainly in mattresses and carpets where they feed off human skin flakes and other products. These mites are a major source of the allergy-causing substances (allergens) commonly found in house dust.

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<sup>2</sup> For any further information on this product or any other product in this section, the 'one stop timber shop' is a good start ([www.timbershop.wilderness.org.au](http://www.timbershop.wilderness.org.au)).

The common myth that carpets are clean once vacuumed is misguided as vacuuming only removes the large particles within carpet. The smaller particles still remain present and as acknowledged by scientists, the smaller the particle, the more dangerous it is to human health. Vacuuming (using machines without effective filters) and renovation activities such as sand papering, sawing and grinding produce high levels of particles.

It is suggested that if carpeting is to be used for the Burswood development then additional design should be considered to mitigate the health effects of internal carpeting. One possible suggestion is that a communal vacuum system be installed into the development. This would require a vacuum outlet in each dwelling which would supply dwellings with a continuous facility with a higher than normal vacuum to remove smaller/deeper particles in the carpet.

Issues to be considered when carpeting dwellings:

- ♦ Avoid synthetic carpets where possible;
- ♦ If carpet is to be used, roll carpet out in a large space to allow out-gassing before installation;
- ♦ Use cotton, wool and other natural fibres which are renewable materials and longer lasting than synthetic materials;
- ♦ Avoid natural carpets that contain strong and irritating synthetic smells;
- ♦ Avoid polyester carpets that can cause eye and respiratory tract irritation and skin rashes;
- ♦ Use fibrous carpet padding which allows easier cleaning and has more effective dust and dirt collection;
- ♦ Use Hessian and polyethylene underlays that are toxic free;
- ♦ Use cotton rugs that can be cleaned easily in washing machines;
- ♦ Use natural fibre rugs that are less harmful to health and use renewable materials;
- ♦ Use non-pile woven mats or rugs that are manufactured with organic cotton preventing large amounts of built-up dust; and
- ♦ Use Persian carpets and Indian rugs, which are not treated with harmful substances.

### **Alternative carpeting products**

There are pure wool carpets on the market that contain no dyes, pesticides or stain protection chemicals. Pure wool carpet, together with cotton and hemp backing and a natural adhesive from the rubber tree with jute, provides a safe alternative to the Styrene and 4-PC adhesives used in traditional carpeting methods. Adhesives 4-PC and Styrene are known toxins, while Styrene is suspected of being carcinogenic.

These wool carpets are non-toxic, non-allergenic and deters bacterial growth. Purification of indoor air contaminants such as formaldehyde, nitrogen dioxide and sulphur dioxide by wool carpet also occurs by locking the contaminant deep in the core of the carpet fibre. Natural Wool fibre carpet is also cleaned more efficiently than normal synthetic fibre carpets. Wool carpets have can have a life span in the order of 30 years. However, as pure wool carpet is biodegradable once it is replaced, it can be reused in landscaping, decreasing waste production.



In addition, "Tip and Tack" is a tradesperson's term for a traditional technique of laying carpet on concrete floors, where nailing the carpet is not an option and adhesives are not used. This involves a wooden batten framed out around the floor edges. Then carpet is then laid on the floor, flush with the wall of the room and is pulled tight over the batons. This results in clean and flush carpeting while mitigating the use of toxic adhesives. The current contemporary practice is called 'smooth edging' and uses a "heat tape" to fix the carpet to the skirting board, introducing another pollutant source.

## **7.6 Cork**

Cork is not only a healthy flooring material; it requires little energy to produce. The only associated cost with cork is transportation, which is still considerably less than transporting stone or wood. However, it is important to distinguish between composite cork materials using synthetic materials, which result in an unhealthy material. While cork is lightweight, extremely durable, non-flammable, resistant to water, decay and moisture and is much warmer than tiles, it can be sensitive to abrasions.

- ♦ Use "ready-to-seal" cork rolls or tiles
- ♦ Avoid vinyl-cork composite tiles with vinyl/PVC backing that increase abrasion resistance and chemical content.

## **7.7 Vinyl/PVC**

Vinyl floor tiles have the advantage of being easy to clean. They have the disadvantage of emitting plasticizers such as dibutyl phthalate or similar compounds. Though there is little scientific proof that such compounds are harmful on inhalation exposure. Some early studies suggest that they may produce inflammatory responses in the respiratory airways that may predispose an exposed individual to asthma. (Godish, Thad PhD. 2001)

Vinyl floor tiles are also believed to release asbestos, a mineral fibre, which has been shown to cause lung and stomach cancer. Not all asbestos products are hazardous however, only those which release fibres small enough to be inhaled and become lodged in lung tissue (Dadd, 1992: 147). From a health perspective, asbestos products are harmful if they are disturbed or come into direct contact with occupants. Natural flooring materials should be preferable over synthetics. Although natural materials are more expensive due to transport and processing costs, they have fewer negative effects on the environment and are of higher quality.

Vinyl/PVC is one of the most common thermoplastics manufactured from vinyl chloride monomer and ethylene dichloride. Both are carcinogens and irritants. Vinyl also contains large amounts of additives such as fungicides, pigments, plasticisers, heavy metals and high levels of dioxins surround PVC manufacturing plants. Although plasticiser additives increase vinyl flexibility, they release high quantities of emissions due to high heat levels. From a health perspective, vinyl/PVC is the most harmful type of plastic as it is the cause of birth defects, cancer, chronic bronchitis and skin diseases. Therefore

vinyl/PVC should be avoided in the use of flooring materials and other products due to its serious health hazards.

### **Alternative for PVC's**

Flooring materials include Linoleum, Rubber, Wood and Cork. Linoleum once dominated the flooring market and is starting to make a revival as PVC/vinyl flooring is being overlooked because of its high toxicity. Cork is hard wearing, sound absorbent and is becoming more popular for its reflection of warmth and natural resilience. (Greenpeace International: Building the Future)

### **Non-PVC pipes and ducts**

Alternatives for PVC piping and ducts are becoming more popular as some PVC piping used for services such as sewage become very brittle over time. This means that the replacement of PVC piping would be more frequent than vitrified clay pipes which in most cases can stand the test of time up to 100 years. PVC has health effects during installation if cutting is required however if PVC piping requires replacement once broken and damaged, the attributed health effects replacing the piping are doubled.

PVC ducts are also used to carry electrical cables within buildings. Alternative plastics include high-density polyethylene (HDPE) and polypropylene (PP). PVC also requires the use of toxic adhesives when joining pipes and, as PVC is a rigid material and can only be supplied in specific lengths, the number of joins required for a project can have significant health effects at the installation phase. HDPE can be laid straight from rollers, which is less labour-intensive and hazardous.

Some local companies which are producing underground and supply pipes as alternatives to PVC include:

- Rib loc - HDPE;
- James Hardie Pipelines - PE;
- Warvin Hall - HDPE/PE;
- Geberit/Starion - HDPE;
- Tersia - PP; and
- Industrial Pipe Systems - MDPE/HDPE.

## **7.8 Laminates**

Advantages are that laminates do not trap dust or pollens, and so is excellent for people suffering from allergies.

Flooring laminates such as Pergo-type wood laminates are widely used as specialty floor covering in North America. They consist of a hard simulated wood Formica-like top layer, a central core of a wood composite material and relatively thin Formica-like layer on the bottom. Most of the laminate thickness is associated with a composite wood core. This core appears to be medium-density fibreboard (MDF) or a product somewhat similar to it. Medium-density fibreboard historically has been a potent source of

formaldehyde. However, there is some indication that emissions from MDF are significantly less than they once were (Godish).

Pergo-type laminates have not been tested or if tested, test results are not publicly available. As such, it is hard to make a positive recommendation about the use of such products (Godish, Thad, 2001).

## ***8.0 Electrical cables, wiring and power points***

Cabling is used to either conduct information or electricity. This is the most dangerous usage of PVC in Australia. Nearly 95% of all electrical cabling insulation in Australia is made from PVC. However, there are alternatives (chlorine-free) for PVC insulation available. The concern arising from PVC insulation in electrical cabling has arisen from the behaviour of PVC cables in fires and the toxic fumes associated with burning PVC.

Power points should be placed so that appliances with high EMF are not close to people for long periods, eg. a television set or microwave oven should not be near a bed even if on the other side of a wall. Power outlets should not be located near the head position in bedrooms and electrical ducting in large buildings should not be placed near work stations, bedrooms and other areas of dwellings where residents spend long periods of time (Baggs, 1996: 167; Pearson, 1989: 194). Notably, special attention should also be placed on dimmer switches positioning for interior lighting, as they have a very high EMF (Baggs, 1996: 167).

## ***9.0 Kitchen materials***

Bench top and cupboard materials are extremely hazardous and one of the most polluting materials used within the home. Due to out-gassing, these materials can have hazardous effects especially when located near food prepared. These materials consist of plastic laminates and timber products. However, the main concern are the adhesives and the finishes used.

- ♦ Ensure all bench top edges are covered with laminate to reduce formaldehyde exposure;
- ♦ Consider covering exposed bench top undersides with aluminium foil to reduce formaldehyde exposure; and
- ♦ Ceramic tiles, stainless steel, marble and granite provide an inert bench top material due to baked-on finishes that reduces out-gassing levels.

## ***10.0 Composite boards***

The primary concern with composite board is the content of formaldehyde produced from fresh timber grown in already affected hard-pressed forests. These boards contain VOC's such as formaldehyde and phenol, which are added during manufacturing. Chemicals out gassed from composite boards cause dermatitis, rashes and other skin diseases. However, composite boards made from timber and vegetable matter are relatively healthy and natural products utilising non-toxic contents and low-out-gassing agents are suitable alternatives to traditional composite boards. Therefore, consider the following:

- ♦ Utilise composite boards containing no formaldehyde content;
- ♦ Utilise plywoods with low glue usage that have lower content levels of formaldehyde;
- ♦ Consider using fibreboards that are made from compressed and dried wood and vegetable fibres while avoiding the use of adhesives;
- ♦ Avoid using MDF (medium-density fibreboard), OSB (oriented strand board) or chipboard because they are usually treated with formaldehyde-based preservatives;
- ♦ Consider using tectan, a chipboard-like material made from drinking cartons;
- ♦ Consider alternative boards such as soft, medium or hardboard or cement-bonded boards, which are considered healthy alternatives; and
- ♦ Where healthy boards are unsuitable, consider using particleboards bonded with diisocyanate resins (a form of VOC) that do not outgas.

## ***11.0 Adhesives and glues***

Adhesives and glues contain similar ingredients as PVC and exist in many building materials. Adhesives give off unpleasant smells that can irritate eyes, throats and noses. Water-based latex products contain non-toxic fumes and mineral solvents. These are non-flammable, have low VOC's and contain no chlorine, toluene, ammonia, ethylene and glycol. Additional alternatives using dry methods of fixing include nails, pegs and tacks. Choosing materials that do not require the use of adhesives or glues is the most beneficial way of reducing the possibility of occupants being subject to health hazards.

As with the concerns surrounding paints, adhesives outgas when they are wet and although out-gassing may reduce over time, the rate of decrease is unknown and depends on a combination of several aspects. Adhesives within the home are evident in furniture, tiling, flooring and cupboards. This section focuses on adhesives, glues, mastic's and joinery techniques used in the home and concentrates on health concerns related to the out-gassing of adhesives, glues and sealants.

- ♦ Determine whether adhesives or glues are the only suitable solution for materials being used;

- ♦ Avoid products from cork manufacturers that continue to use formaldehyde-based glues as a corking adhesive;
- ♦ Use water-based sealants made from sodium silicate and water rather than sealants containing toxic chemical vapours;
- ♦ Consider using alternatives to adhesives and glues such as pegs, screws, bolts, tacks or nails;
- ♦ When using timber flooring panels, nail to cross battens rather than gluing to concrete foundations;
- ♦ Use board, sheet or slab finishes as an alternative to tile finishes using toxic glues;
- ♦ Use polyvinyl acetate glue, a synthetic glue with low toxic levels, which is also water soluble;
- ♦ Avoid PVA wood glues that are claimed to be non-toxic after an initial out-gassing occurs. These glues are water-resistant but cannot be exposed to water continuously;
- ♦ Shop around for new low-toxic, water-based adhesive products rather than using common commercial glue;
- ♦ Shop around for sealants that are said to reduce carpet emissions;
- ♦ Use water-based adhesives that are less toxic than solvent-based adhesives to install carpet;
- ♦ Where possible, avoid adhesives and use tack strips to install carpet;
- ♦ Avoid using laminate materials such as particle board and plywood, which contain glues that emit formaldehyde; and
- ♦ When using laminate boards, consider using water-based adhesives.

### ***13.0 Varnishes, polishes and stains***

Varnishes, polishes and stains used on floors, timber products and furniture products have small health risks to occupants but still contain harmful VOC's. Varnishes give materials a finished, protective layer and provide an aesthetic finish. They are different from adhesives as they seal rather than join a material, however should they come into direct contact with occupants, can be extremely hazardous, in addition to the possible contamination of food during preparation.

Varnishes contain synthetic additive, insecticides and fungicides. To prevent health risks from these harmful ingredients, natural varnishes should be utilised where possible. Natural varnishes have several advantages, including a natural smell, use natural plant extracts, allow surfaces to breathe and are therefore generally less harmful to health. Therefore:

- ♦ Avoid urethane varnishes that contain synthetic rubber, acrylics and other additives such as insecticides and fungicides;
- ♦ Avoid polishes containing phenol chemicals that may cause skin rashes;
- ♦ Use natural varnishes and polishes that have natural, harmless scents and use natural plant extracts;

- ♦ Use linseed oil for wood products as it impregnates deeply and makes the wood water-resistant;
- ♦ Avoid using linseed oil that has been boiled and implanted with drying agents to speed up the drying process; and
- ♦ For timber products, utilise pure beeswax which is antistatic and natural scented.

## ***14.0 Rubbish, recycling and compost***

The design should acknowledge the need to deal with rubbish, its storage, transfer disposal and recycling, both in construction and domestic use. Design should be specific to site conditions. This may include the incorporation of in sink organics disposal and recycling and waste disposal chutes. Where rubbish chutes are provided, ensure that they are carefully designed and located. Locate chutes so that they do not pass by bedrooms of dwellings, causing disturbance with night use. A communal compost heap for organics would provide assistance in landscape management while reducing waste management cost associated with the development. In addition, the waste reduction and possible environmental awareness of the utilities provided by the developer could serve as a marketing aspect (Green Thumb).

### **Composting and worm farms**

Composting and worm-farms are a sustainable means of recycling green waste and reducing landfill materials. While often thought of only as a solution for detached dwellings, both composting and kitchen-waste recycling through worm-farms can also be applied in multi story housing and high rise living situations.

Green waste recycling together with other recycling of plastics and other material are an accepted necessity for most consumers, and by providing this service to apartment owners in high-rise dwellings, the apartment blocks or complexes are fostering and supporting good social citizenship behaviour, while supporting the total wellbeing of their occupants. The following is an example from the City of Yarra<sup>3</sup> where both a green waste and worm-farms project for high rise buildings are in use.

Worm farms are a sustainable and efficient way of dealing with kitchen waste. Units can operate their own or share a larger farm. The plastic containers are stacked sieve-like on top of each other. The top container holds the waste which when processed, eaten and chewed by earthworms, degenerates into small fragments that fall into the next lower container. The lowest containers contain the useable fertiliser that is rich in micro organisms and trace minerals. Both worm farms and composted green waste save on landscaping maintenance costs as well as generating positive community support for such ecologically sound planning.

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<sup>3</sup> More information can be obtained from Meryl Triggs, Waste Management Project Officer, City of Yarra, Yarra NSW 2580.

**Green waste**

Green wastes collected from the garden maintenance activities, mowing, pruning and weeding, are corralled in an unobtrusive part of the yard and when stored and occasionally turned, this waste turns into mulch. When applied around landscape features and trees, it reduces the loss of moisture through evaporation, retards the growth of weeds, and provides soil stabilising fibre to the earth and in the process feeds micro organisms that help keep the soil healthy and fertile.

## References

### *BOOKS*

Collie Planning and Development Services Pty Ltd. (n.d.) *New Choices in Housing: Guidelines for Cost-Effective Residential Land Development*. Dickson, ACT: Collie Planning and Development Services Pty Ltd.

Ku-ring-gai Municipal Council (1998). *The Good Design Manual*. Sydney: Ku-ring-gai Municipal Council.

Greenpeace Australia (1997) *Alternatives to PVC: Suppliers Guide*. Sydney: Greenpeace Australia.

NSW Department of Urban Affairs and Planning (1997) *NSW Model Code: A Model for Performance-Based Multi-Unit Housing Codes*. Sydney: NSW Department of Urban Affairs and Planning.

Greenpeace (1996) *Building the Future: A Guide to Building Without PVC*. London: Greenpeace.

Leichhardt Municipal Council (1994). *Towards a Sustainable Future*. Sydney: Leichhardt Municipal Council.

Leichhardt Municipal Council (1994). *Energy Efficient Housing*. Sydney: Leichhardt Municipal Council.

Baechler, M.C, Hadley D.L., Marseille T.J. & Stenner, R.D. (1992). *Sick Building Syndrome. Sources, Health Effects, Mitigation*. Park Ridge: Noyes Data Corporation.

Baggs, Sydney & Joan (1996). *The Healthy House: Creating a safe, healthy and environmentally friendly home*. Sydney: Harper Collins Publishers.

Baird, John C. (1991). *Indoor Air Quality for People and Plants*. Stockholm: Swedish Council for Building Research.

Bentham, Peggy (1991). *Terminal Sickness. Computer Health Risks and How To Protect Yourself*. London: Green Print.

Bower, John (1993). *Healthy House Building: A Design and Construction Guide*. Unionville: Healthy Housing Institute.

Bower, John and Lynn Marie Bower (1997). *The Healthy House Answer Book*. Bloomington, Indiana: The Healthy House Institute.



- Clayton, S. (1993). *The Reverse Garbage Garden*. Melbourne: Hyland House.
- Corn, Morton ed. (1993). *Handbook of Hazardous Materials*. San Diego: Academic Press.
- Cullen, M. and Johnson, L. (1992). *Backyard and Balcony Composting*. Melbourne: Bookman Press.
- Cundall, P. (1993). *Organic Gardening, Gardening Australia Collector's series No. 1*. Alexandria NSW: Federal Publishing Company.
- Curwell, Steve, Chris March and Roger Venables (1990). *Buildings and Health: The Rosehaugh Guide to the Design, Construction, Use and Management of Buildings*. London: RIBA Publications.
- Dadd, Debra Lynn (1997). *Home Safe Home: Protecting Yourself and Your Family from Everyday Toxics and Harmful Household Products*. Los Angeles: Jeremy P Tarcher.
- Dadd, Debra Lynn (1990). *Nontoxic, Natural and Earthwise: How to Protect Yourself and Your Family from Harmful Products and Live in Harmony with the Earth*. Los Angeles: Jeremy P Tarcher.
- Dadd, Debra Lynn (1992). *The Non Toxic Home and Office: Protecting Yourself and Your Family from Everyday Toxics and Health Hazards*. Los Angeles: Jeremy P. Tarcher Inc.
- Deville, Adrian and Harding, Ronnie (1997). *Applying the Precautionary Principle*. Sydney: Federation Press.
- Harrison, Athol (2003). "Multiple Unit Buildings: Simple steps to in applying basic Feng Shui to homes in high-density housing scenarios," *Easy Feng Shui* (1): 49.
- Harte, J, Holdren, C, Schneider, R. & Shirley, C. (1991). *Toxics A-Z. A Guide to Everyday Pollution Hazards*. Berkeley: University of California Press.
- Holdsworth, W.J. and Antony Sealey, Antony (1992). *Healthy Buildings: A Design Primer for a Living Environment*. England: Longman.
- Johnson, Stuart (1993). *Greener Buildings: Environmental impact of property*. Basingstoke, Hampshire: Macmillan.
- Larry Hodgson and Charles C. Powell 1992. *Ortho's complete guide to successful houseplants*. San Ramon, California: Chevron Chemical Co.

Levitt, Blake B. (1995). *Electromagnetic Fields. A consumer's guide to the issues and how to protect ourselves*. San Diego: Harcourt Brace.

Mahler, Margaret S. (1968). *On human symbiosis and the vicissitudes of individuation in collaboration with Manuel Furer*. New York: International University Press.

Marcus, Clare Cooper (1995). *Design Guidelines: A bridge between research and decision-making*. Berkeley: Institute of Urban and Regional Development, University of California.

Marcus, Clare Cooper (1987). "Alternative Landscapes: Ley-Lines, Feng-Shui and the Gaia Hypothesis," *Landscape* 29(3):1-10.

Marcus, Clare Cooper & Wendy Sarkissian (1986). *Housing As if People Mattered: Site Design Guidelines for Medium-Density Family Housing*. Berkeley: University of California Press.

Moscato, Bianca (1998). *Homes in Health Harmony: Home design and Planning Responses for Human Health and Comfort*. B.Sc. (Arch.) thesis, Department of Architecture, Planning and Applied Arts, University of Sydney.

Nunes, K. (1998). *The Good Compost Guide: A directory of compost bins and wormeries*. Melbourne: Gould League and EcoRecycle Victoria.

Pearson, David (1989). *The Natural House Book: Creating a healthy, harmonious, and ecologically-sound home environment*. New York: Gaia Books.

Pearson, David (1992). *The Natural House Book*. Sydney: Angus and Robertson.

Pearson, David. (1996). *The Natural House Catalogue: Everything you need to create an environmentally friendly home*. New York: Simon and Schuster.

Pennick, Nigel (1979). *The Ancient Science of Geomancy: Living in Harmony with the Earth*. Sebastopol, California: CRC Publications.

Ranson, Ray (1991). *Healthy Housing: A practical guide*. London: E & F N Spon.

Raw, G.J. (1992). *Sick Building Syndrome: a review of the evidence on causes and solutions*. HSE Contract Research Report No. 42/1992. Watford: Building Research Establishment.

Rostron, Jack (1997). *Sick Building Syndrome. Concepts, Issues and Practice*. London: E & F Spon.

- Rossbach, Sarah (1987). *Interior Design with Feng Shui*. London: Rider.
- Samways, Louise (1991). *The Non-toxic House. Making Your Home and Work Environment Pollutant Free*. North Carlton, Victoria: McCulloch Publishing/Green Press.
- Sarkissian, Wendy and Ann Forsyth (1986). *Meeting the Challenge: Better Public Housing for Older People in NSW*. Sydney: Sarkissian Associates Planners.
- Sarkissian, Wendy, Ann Forsyth and Kristin Stewart (1992). *Background Research Report. Non-Traditional Household Design Requirements*. Canberra: Australian Model Code (AMCORD) and Sarkissian Associates Planners.
- Sarantakos, Sotirios (1993). *Social Research*. South Melbourne, Victoria: Macmillan Education Australia.
- Skinner, Stephen (1980). *Terrestrial Astrology: Divination by Geomancy*. London: Routledge and Kegan Paul.
- US Environmental Protection Agency, US Department of Health and Human Service. (1992). *Building Air Quality*. Baltimore, Maryland: Government Institutes Inc.
- Venolia, Carol (1988). *Healing Environments: Your Guide to Indoor Well-Being*. Berkeley: Celestial Arts.
- Walters, Derek (1988). *Feng Shui: the Chinese Art of Designing a Harmonious Environment*. London: Simon and Schuster.
- Warde, John (1997). *The Healthy Home Handbook: All You Need to Know to Rid Your Home of Health and Safety Hazards*. New York: Random House.
- Wolverton, B.C. (1996). *Eco Friendly House Plants: 50 Indoor Plants that Purify the Air in Homes and Offices*. London: Weinfeld and Nicolson.
- Woolley, T., Kimmins, S., Harrison, P. and Harrison, R. (1997). *Green Building Handbook: A Guide to Building Products and Their Impact on the Environment*. London: E & F N Spon.

## ***JOURNAL ARTICLES***

- Aldous, Tony (1997). "Canada's Commitment to Hypo-Allergenic Housing," *Architects Journal* 205 (10) 13 March: 22.
- Best, Simon (1995). "Wired For Cancer," *Control Your Health*, November: 8.
- Catalfo, Phil (1994). "Home, Sweet Office". *New Age Journal*, September/October: 113-114,

Chapin, David and Clare Cooper Marcus (1993). "Design Guidelines: Reflections of Experiences Passed," *Architecture and Comportement*, 9: 99-120.

Chevin, Denise (1990). "Buildings and Health," *Building* (book review), 255 (43), 2 November 2: 55-59.

Cone, James. E., ed. (1989). "Problem Buildings: Building-Associated Illness and the Sick Building Syndrome," *Occupational Medicine: State of the Art Reviews* 4 (4) October-December: 688-692.

Evans, Barrie (1995). "Timber—Not Green Enough"? *The Architects Journal* 201 (18), 4 May: 43.

Fackelmann, K. A (1994). "Do EMF's Pose Breast Cancer Risk"? *Science News* 145 (25), 18 June 18: 388.

Lorch, (1989). "Curing Sick Buildings," *RIBA Journal*. V96 (12), December: 89.

Martin, Ian (1991). "Healthy Housing: Passing the Buck," *Architects Journal* 194 (13), 25 September: 14.

Owens, Ruth (1993). "The Effects of Poor Housing on Health," *Architects Journal* 198 (2), 14 July: 52.

Robinson, Terry (1994). "Interior Wall Finishes 1: Healthier Paints," *Canadian Architect* 39 (10), October: 33.

Rodrigues, Gail (1997). "Hazards around the House," *Wellbeing Magazine* 69 (35).

Russell, James S. (1990). "Indoor Air Quality: the Architects Role," *Architectural Record* 178 (12), November: 105-106.

Ryd, Harriet (1991). "My Home is My Castle: Psychological perspectives on sick buildings," *Building and Environment* 26 (2): 87-93.

Stavid, Ruth (1996). "Building for Health," *The Architects Journal* 204 (13), October: 46.

Swedish National Team (1996). "Swedish Crusade against Sick Buildings," *Caddet Energy Efficient Newsletter* 1: 12-13.

Yeung, Y.N *et al.* (1991). "Sick Building Syndrome - A Case Study," *Building and Environment* 26 (4): 319-330.

## **PAMPHLETS AND MONOGRAPHS**

State Electricity Commission of Victoria (n.d.). *The Facts: Electric and Magnetic Fields*. Melbourne, Victoria: State Electricity Commission (SEC).

Triggs, Meryl (1999). *Organic waste recycling at highrise estate community gardens*. Melbourne: City of Yarra.

Total Environment Centre, Sydney, NSW. (1994). *A Consumer's Guide to Formaldehyde*. Sydney: Total Environment Centre, December.

## **NEWSPAPER ARTICLES**

"Always be on the Lead Paint Alert," *Northern District Times*. June 16, P24, 1998

"Household Power Linked to Cancer." *Control Your Health*. November, V6, N8, P5, 1995

Dale, David (1998). "Greens' Purple Patch is Fading," *Sydney Morning Herald*, 19 June: 5.

Glaskin, Max (1996). "Breathing House Stays Warm," *The Sunday Times*. 28 January 28.

Hellaby, David (1997). "Working From a Living Room," *The Daily Telegraph* 8 April: 31.

Jenson, Rodney (1998). "Home, Green Home," *The Weekend Australian*, 6-7 June: 1.

Leonard, Susanne (1996). "Indoor Airheads," *The Sunday Age*, 29 December: 2.

"Mould May Plague 'Sick' Buildings" (1996), *Financial Times*, 1 January.

Vine-Hall, Margaret. "Indoor Illness". *The Mercury*. June 9, P32, 1998

## **INTERNET SITES**

Affordable Comfort

[www.AffordableComfort.org](http://www.AffordableComfort.org)

Accessed: 10/4/03

Australian Grown Plantation Timber Species

[http://www.rainforestinfo.org.au/good\\_wood/oz\\_pln.htm](http://www.rainforestinfo.org.au/good_wood/oz_pln.htm)

Accessed: 7/4/03

Australia and New Zealand - Natural Paint Manufacturers

[http://www.ecobusinesslinks.com/natural\\_paint\\_manufacturers.htm](http://www.ecobusinesslinks.com/natural_paint_manufacturers.htm)

Accessed: 8/4/03

Bio Paints

<http://www.biopaints.com/>

Accessed: 9/4/03

Bio Products Australia Pty Ltd.

<http://www.bioproducts.com.au/>

Accessed: 9/4/03

CSR Material Safety Data Sheet

[www2.csr.com.au/msds/csrprod.nsf/3e93695b5180a481ca2569e3002458fc/ecd540b8062fb18f4a2564b800449483?OpenDocument](http://www2.csr.com.au/msds/csrprod.nsf/3e93695b5180a481ca2569e3002458fc/ecd540b8062fb18f4a2564b800449483?OpenDocument)

Accessed: 9//

Earth Easy, Non toxic paint

[http://eartheasy.com/live\\_nontoxic\\_paints.htm](http://eartheasy.com/live_nontoxic_paints.htm)

Accessed: 10/4/03

Eco-design

[www.ecodesign.bc.ca/](http://www.ecodesign.bc.ca/)

Accessed: 10/4/03

Eco-House

[www.eco-house.com](http://www.eco-house.com)

Accessed: 8/4/03

Godish, Thad (2001) "Indoor Environment Notebook"

<http://www.bsu.edu/web/IEN/archives/2001/032201.htm>

Ball State University, Department of Natural Resources

Accessed: 28/3/03

Hunting, Eric "Shelter Documenting a personal quest for non-toxic housing".

<http://radio.weblogs.com/0119080/stories/2003/01/30/whatIsNontoxicHousing.html>

Accessed on 9/4/03

Plantation Timber Association of Australia

<http://www.ptaa.com.au/pubs/qc.pdf>

PVC Alternatives Database, Product Name: AAC Thick Bed Mortars, AAC Thin Bed Adhesive

<http://archive.greenpeace.org/~toxics/pvcdatabase/bad.html>

Accessed: 10/4/03

Oikos - Green Building Source

[www.oikos.com](http://www.oikos.com)

Accessed: 10/4/03

The one stop timber shop, The Wilderness Society  
[www.timbershop.wilderness.org.au](http://www.timbershop.wilderness.org.au).  
Accessed: 9/4/03