

Canterbury

District Health Board

Te Pōari Hauora o Waitaha

**THIS DOCUMENT HAS BEEN PREPARED BY
THE PUBLIC HEALTH INFORMATION TEAM
COMMUNITY AND PUBLIC HEALTH**

**Housing, home heating
and air quality:
a public health perspective**

**A briefing paper for the
Canterbury District Health Board
April 2012**

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Executive Summary

- The housing environment is a key setting with impacts on human health. Housing factors which contribute significantly to health outcomes include temperature, humidity and ventilation, overcrowding, affordability and fuel poverty.
- Direct effects of cold homes on health include excess mortality from cardiovascular and respiratory disease amongst the elderly, increased respiratory problems in children, increased illnesses such as colds and flu, mental health problems and the exacerbation of conditions such as arthritis.
- Retrofitting New Zealand homes with insulation and clean heat options has been shown to increase indoor temperatures, decrease relative humidity, reduce energy use and has also been associated with an improvement in the self-reported health of occupants and reduced mortality among older persons.
- Overcrowding is associated with a range of infectious diseases including meningococcal disease, hepatitis B, tuberculosis, acute rheumatic fever and respiratory and skin infections.
- When housing becomes unaffordable compromises may be made regarding living arrangements and a household's ability to acquire basic necessities such as food, clothing and health care may be limited.
- Fuel poverty arises from a combination of three factors: household income, fuel or energy costs and the energy efficiency of the house.
- There is considerable international evidence that air pollution causes excess morbidity and mortality particularly through increases in the incidence of respiratory and cardiovascular disease.
- The majority of air pollution (80%) in Christchurch is caused by PM₁₀ emissions from domestic solid fuel heating. The WHO advises there are no safe levels of PM₁₀ below which adverse effects are not observed.
- The Christchurch Air Plan is designed to manage the move towards improved air quality (2016 and 2020 targets) as demanded by the National Environmental Standards for Air Quality (based on WHO air quality guidelines).
- The information about housing, home heating and air quality is presented in the context of what is currently known post-earthquakes. The central concern is the potential for any of the issues considered in each arena to impact upon the most vulnerable of our citizens and on the health system itself, particularly over the upcoming winter period.

1.0 Background

This paper has been prepared for the Canterbury District Health Board in support of the Board's intention to provide leadership in the area of housing and health in post-earthquake Christchurch. The Board acknowledges that housing is a significant determinant of health and in light of the increased health risks associated with post-earthquake Christchurch seeks to advocate for repairs and rebuilds that create healthier homes.

Board members have also expressed interest in housing and associated issues particularly Environment Canterbury's (ECan) position regarding replacement homes (full rebuilds post-earthquake) and the Christchurch Air Plan. The Board seeks to ensure that they operate from a sound evidence base to inform decision-making and highlight opportunities for advocacy.

ECan's position, in line with the Christchurch Air Plan is as follows:

- If homes have been damaged but can be repaired and they currently have a woodburner installed that has been damaged, it may be replaced with a compliant woodburner, if homeowners choose to do so (other options are also available).
- It is only when a home has been demolished and a new build is required that the Clean Air rules for a new home apply – i.e.
 - **Heating options include installing a heat pump, nightstore heater or a fixed-flued gas or liquid fuel heater.**
 - **Resource consent is necessary for any pellet fire.**
 - **Residents cannot install an open fire or any new woodburner.**

In response to earthquake issues ECan have extended their relaxation on the use of non-compliant woodburners (i.e. older than 15 years old) to the winter period of 2012. Introduced in 2011, post-earthquakes, non-compliant burners may be used in quake-damaged homes if the home has no other heating source. Non-compliant woodburners cannot normally be used between 1 April and 30 September each year (introduced 1 April, 2010 under the Christchurch Air Plan).

The paper continues with the presentation of a draft position statement concerned with home heating and air quality together with recommendations based on the paper for the Board's consideration. The full paper follows.

2.0 Draft Position Statement

CANTERBURY DHB DRAFT POSITION STATEMENT Home Heating and Air Quality

1. The Canterbury District Health Board (CDHB) acknowledges that a warm home is vital for comfort and good health whilst also recognizing that many New Zealand homes tend to be cold with temperatures regularly falling below the World Health Organization's recommendations.¹
2. The CDHB acknowledges that the direct effects of cold homes on health include excess mortality from cardiovascular and respiratory disease amongst the elderly, increased respiratory problems in children, increased illnesses such as colds, influenza and mental health problems, and the exacerbation of existing conditions such as arthritis.
3. The CDHB recognises that home heating (temperature, humidity and ventilation), energy costs and fuel poverty are key housing issues with implications for health outcomes.
4. The CDHB wishes to emphasize the importance of home heating and energy efficiency, as a health protection measure, due to the significant public health impacts that result when dwellings do not provide a healthy environment for occupants.
5. The CDHB considers the human right to housing to be much more than simply a right to shelter but also the right to have somewhere to live that supports good health outcomes. The CDHB therefore acknowledges the inextricable link between the right to housing and the need for warm and dry, affordable, culturally appropriate and accessible housing that is part of a wider community with easy access to essential services within a healthy environment.
6. The CDHB understands that retrofitting New Zealand homes with insulation and clean heat options has been shown to increase indoor temperatures, decrease relative humidity, reduce energy use and improve the self-reported health of occupants, and consequently encourages actions to retrofit insulation and clean heat options for households.

¹ The World Health Organization has recommended a minimum indoor temperature of 18°C and a 2-3°C warmer minimal temperature for the very young and the very old. World Health Organization. 1987. *Health impact of low indoor temperatures: Report on a WHO meeting, Copenhagen, 11-14 November 1985*. Copenhagen: WHO.

7. The CDHB recognises that clean air is a requirement for health and wellbeing and that urban outdoor air pollution is the eighth most common risk factor for death in high income countries.²
8. The CDHB acknowledges the considerable international evidence that air pollution causes excess morbidity and mortality particularly through increases in the incidence of respiratory and cardiovascular illness.
9. The CDHB acknowledges that whilst air quality has improved in recent years the most recent best estimate (2005) indicates that air pollution in Christchurch results in 158 premature deaths annually in those aged 30 years and over. The proportion of these deaths associated with smoke, caused by woodburners, was calculated as 78% or 124 of these deaths.
10. The CDHB remains committed to its support of the Christchurch Air Plan, recognising the long term health benefits to Christchurch citizens, whilst acknowledging the ongoing challenge of improving air quality in order to meet the National Environmental Standards for Air Quality by 2016 and 2020.
11. The CDHB recognises the impact of the recent earthquakes on those who have lost their favoured primary heating source, due to the loss of their home, particularly when that appliance cannot be replaced under the Christchurch Air Plan.
12. The CDHB wishes to highlight the risks of unflued gas heaters to human health, due to the high levels of moisture and harmful combustion products which are produced by these appliances and the associated significant reduction in the quality of the indoor environment.
13. The CDHB acknowledges the risks that the affordability and fragility of our electricity system pose to the health of the most vulnerable community members and seeks to work with partner agencies to develop mitigation strategies.

² World Health Organization. 2009. *Global Health Risks: Mortality and burden of disease attributed to selected major risks*. Geneva: WHO.

3.0 Recommendations

1. That the CDHB continues to fully support the Christchurch Air Plan in acknowledgement of the health benefits for Christchurch citizens.
2. That the CDHB highlights the risks that the affordability and fragility of our electricity system pose to the health of the most vulnerable community members and works with partner agencies to develop mitigation strategies.
3. That the CDHB develops an action plan, including the development of a communications strategy, to address the following matters and explore opportunities for advocacy at a national, local and community level:
 - Providing active leadership in the wider housing arena, informed by understandings of the health implications of housing quality, home heating options and air quality.
 - Pursuing partnerships with CERA, the Christchurch City Council and others to focus both attention and resources towards healthy housing and the associated positive health outcomes.
 - Advocating for healthy housing and seeking to make the links between housing and health explicit in the public arena, recognising the significant social and health costs associated with substandard housing.
 - Advocating for the best possible repair alternatives that maximise warmth and minimise damp, through retrofitting insulation and utilising clean heat options.
 - Advocating for the application of sustainable building principles in all new builds (or rebuilds) for both temporary and long-term housing solutions, for the protection of human health.
 - Advocating for healthy rental housing and seeking to establish opportunities to protect the health of those living in rental accommodation.

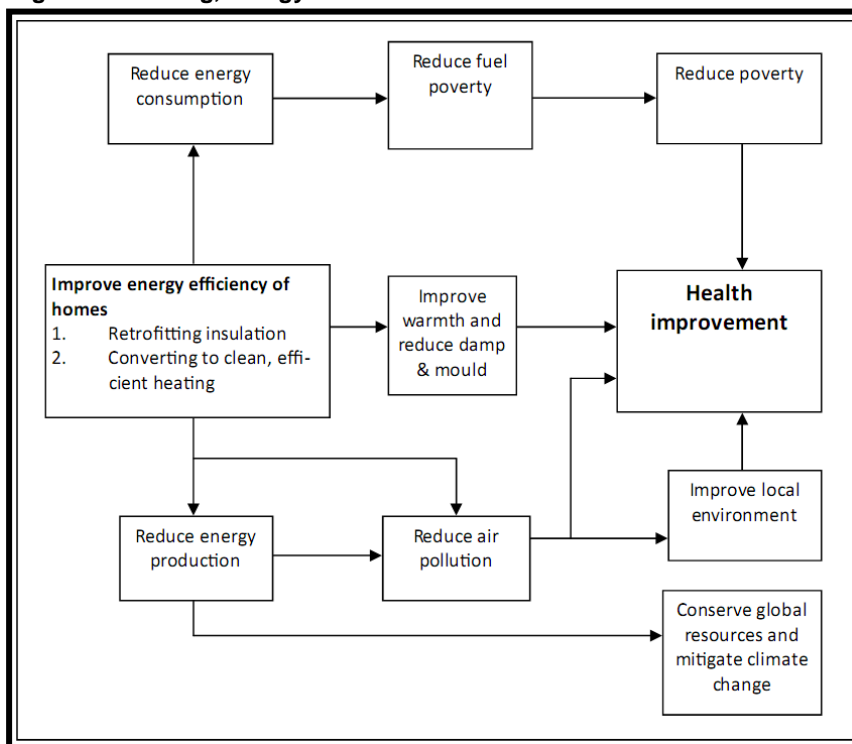
4.0 Introduction

The housing environment has long been recognised as one of the key settings with impacts on human health.³ As a determinant of health, housing has also been identified as an important component of the relationship between poverty and health.⁴ The links between housing and health are multifaceted and as a consequence housing can affect health in multidimensional ways.

This paper provides a rapid review focusing on the interrelationships between housing, home heating and air quality with a particular emphasis on the current situation associated with each factor following the earthquakes of 2010 and 2011 in the Christchurch and Canterbury region. Information regarding the current local situation has been provided wherever possible.

The interrelationship of housing*, energy (home heating), air quality and health improvement can be illustrated diagrammatically (see Figure 1 below).

Figure 1: Housing, energy and health



Source: adapted from Green⁵

*This diagram with its focus on improving current housing stock does not capture the potential for new sustainably designed housing to be highly energy efficient. This is particularly pertinent to rebuilds in post-earthquake Christchurch and environs as such homes require significantly less energy to provide and maintain a healthy environment.

³ Thomson, H., Peticrew, M. 2007. Housing and health. *British Medical Journal*, 334(7591):434-5.

⁴ Commission on Social Determinants of Health. 2008. *Closing the gap in a generation: health equity through action on the social determinants of health*. Geneva: World Health Organization

⁵ Green, G. 1996. Housing, energy, health and poverty. In: Price, C., Tsouros, A., Editors. *Our Cities, Our Future*. Copenhagen: WHO Healthy Cities Project Office

5.0 Housing

5.1 Healthy Housing a Human Rights Issue

The Universal Declaration of Human Rights Article 25(i) recognises the right to housing as part of the right to an adequate standard of living:

Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.⁶

In common with other social determinants of health, such as access to education and conditions of work, healthy housing is not distributed equitably through society. It has previously been identified, for example, that Māori and Pacific peoples are more likely than non-Māori to live in rental or temporary accommodation and to experience crowded living conditions.^{7,8} In addition, natural disasters, such as the recent earthquakes, are known to exacerbate inequalities. Those with greater available resources recover more quickly.^{9,10}

5.2 Defining Healthy Housing

'Healthy Housing' is a complex construct which encompasses much more than the physical structure of the home. The World Health Organization has conceptualised housing as a four-dimensional model,¹¹ encompassing the physical structure of the dwelling, the meaning of home to individuals and families, the community and the immediate external housing environment (see Figure 2).

Figure 2: The four dimensions of housing



⁶ <http://www.un.org/en/documents/udhr/index.shtml#a25> accessed March 2012

⁷ Robson, B., Cormack, D. 2007. Social and economic indicators. In: Robson, B., Harris, R. Editors. *Hauora: Māori standards of Health IV A study of the years 2000-2005*. Wellington: Te Ropu Rangahau Hauora a Eru Pomare

⁸ Butler, S., Williams, M., Tukuitonga, C., Paterson, J. 2003. Problems with damp and cold housing among Pacific families in New Zealand. *The New Zealand Medical Journal*, 116(1177)

⁹ Hutton, D. 2001. *Psychosocial aspects of disaster recovery: integrating communities into disaster planning and policy making*. Montreal: Institute for Catastrophic Loss Reduction

¹⁰ Morrow, B.H. 1999. Identifying and mapping community vulnerability. *Disasters*, 23(1):1-18.

¹¹ Bonnefoy, X. 2007. Inadequate housing and health: an overview. *International Journal of Environment and Pollution*, 30(3/4):411-28.

The four dimensions of housing incorporate:

- The home – the social and psychological aspects of the house, including safety and privacy.
- The dwelling – includes the physical structure and condition of the dwelling, its design and characteristics; the level of occupancy for size, indoor air quality, indoor temperature and humidity, affordability and tenure.
- The community – the social characteristics of the community, for example the level of social cohesion, trust and collective efficacy promoted by public places and social facilities.
- The immediate environment – includes the quality of urban design, such as access to green space and public services as well as general environmental conditions within neighbourhoods.

Aspects of these four elements can affect health through physical, psychological and social mechanisms and each element can interact with others, reflecting the complex relationship between housing and health.

5.3 Housing and legislation in New Zealand

A definition of acceptable housing is not made explicit in the Health Act 1956, the Building Act 2004 or the Residential Tenancies Act 1986.¹² However, both the Health Act 1956 and the Building Act 2004 seek to minimise the potential for immediate illness and injury risks in relation to existing dwellings.

Under the Building Act 2004 Territorial Authorities (TAs) are required to adopt policies on insanitary, dangerous and earthquake prone buildings. If satisfied that a building is likely to cause injury to human health or cause death the TA can prevent access to the building and give written notice to have remedial work carried out.

A TA can also issue a cleansing order or require repairs, and issue a closing order under the Health Act 1956 where it is satisfied that a home is likely to cause injury to the health of a resident. A TA can be directed by the Medical Officer of Health to issue a cleansing or closing order and the Medical Officer of Health may issue a closing order if the TA fails to act. In practice such orders are used sparingly.

¹² Bierre S, Howden-Chapman P, Signal L, Cunningham C. 2007. Institutional challenges in addressing healthy low-cost housing for all: learning from past policy. *Social Policy Journal of New Zealand*, 30:42-64.

While the Health Act, the Building Act and the Residential Tenancies Act attempt to ensure that houses do not pose immediate health and safety risks, the wider determinants of health in terms of housing are not addressed through current legislation.

The Building Code provides a set of performance-based standards that all new building work in New Zealand must comply with. The Building Code is a performance-based code consisting of objectives, functional requirements and performance criteria (rather than descriptions of how a building must be designed and constructed) and includes a number of standards important for health and wellbeing, such as indoor moisture, ventilation and energy efficiency. However, these standards apply largely to new housing and renovations.

The Residential Tenancy Act 1986 requires that a rental property be 'reasonable' but there is no clear definition of 'reasonable' and the onus of complaint is on the tenant. There is a perception that rental properties are generally in worse condition than owner-occupied dwellings but there is little data available and no rental accommodation standards. The 2010 BRANZ housing condition survey, a survey of over 500 randomly selected homes revealed a decline in the average quality of properties compared to previous surveys.¹³ Rental properties were included in the BRANZ survey for the first time in 2010.

5.4 Housing conditions and health

Surveys indicate that New Zealanders spend about 70 percent of their lives in the indoor home environment.¹⁴ This has significant public health implications particularly when a dwelling is not providing a healthy environment for occupants. A number of associations between housing conditions and health have been identified in a variety of epidemiological studies.¹⁵ Housing factors that have been identified as contributing significantly to poor health outcomes include:

- Temperature, humidity and ventilation
- Overcrowding

¹³ BRANZ media release 11 May 2011, available at: <http://www.scoop.co.nz/stories/AK1105/S00300/branz-uncover-drop-in-new-zealand-housing-conditions.htm> accessed March 2012

¹⁴ Baker, M., Keall, M., Au, E., Howden-Chapman, P. 2007. Home is where the heart is - most of the time. *The New Zealand Medical Journal*, 120(1264).

¹⁵ Ibid.

- Affordability
- Fuel poverty

Barnard found that hospitalisation in New Zealand was higher in winter, was higher in the very young and older people, among Māori and Pacific peoples, and increased with increasing levels of deprivation. Winter hospitalisation was higher amongst those living in villas and pre-war bungalows than in post-war bungalows and quality bungalows.¹⁶ Winter mortality rates in New Zealand between 1980 and 2000 were 18 percent higher than expected from non-winter rates, similar to rates in the United Kingdom and above those seen in Scandinavia.¹⁷ Excess winter mortality is not directly related to climatic conditions, with higher rates often found in countries with milder winters. For example cold countries with more energy efficient housing and high building standards, such as Finland and Germany, have lower excess winter mortality compared with Spain, Ireland and Portugal.¹⁸

A study investigating the trends and determinants of excess winter mortality in New Zealand established, in common with international findings, that excess winter mortality is a particular problem for those in older age groups. In addition the study identified that New Zealand infants and children are also at high risk, particularly from respiratory-related causes. Children under 5 years of age were estimated to have a mortality associated with respiratory disease almost 2.5 times higher in winter than expected.¹⁵

5.4.1 WHAT WE KNOW – Pre-quake housing situation in Christchurch

- An analysis of existing housing stock in New Zealand has confirmed the prevalence of indoor environmental factors that can negatively impact upon occupants. New Zealand homes tend to be highly energy-consuming and are also recognised as having cold, damp interiors.¹⁹
- Fifty-two percent of Christchurch housing stock was built before 1970 and prior to the implementation of insulation standards in 1977.²⁰

¹⁶ Barnard, L. 2009. Home truths and cool admissions: New Zealand housing attributes and excess winter hospitalisation. Dunedin: University of Otago.

¹⁷ Davie, G., Baker, M., Hales, S., Carlin, J. 2007. Trends and determinants of excess winter mortality in New Zealand: 1980 to 2000. *BMC Public Health*, 7(1):263.

¹⁸ Marmot Review Team. 2011. *The Health Impacts of Cold Homes and Fuel Poverty*. London: Friends of the Earth & the Marmot Review Team.

¹⁹ Leardini, P., & Raamsdonk, T. 2009. *Design for Airtightness and Moisture Control in New Zealand Housing*. School of Architecture & Planning, University of Auckland. Available from <http://www.cmsl.co.nz/assets/sm/5934/61/11.PN035Leardini.pdf>

²⁰ <http://resources.ccc.govt.nz/files/MakingSenseOfOurCityTodayLiveable-christchurchourcity.pdf>

- Home ownership has been declining in the city. The 2006 census indicated that 54.7% of all private dwellings were privately owned down from 65% in 2001 and 74% in 1991. ^{21,22,23}
- As private home ownership has been declining the level of renting has increased. In 2001 private rentals were at 31% compared with 24% in 1991.
- Of those in Christchurch rental accommodation in 2006 more than three-quarters were renting from private owners, trusts or businesses. The remainder were renting from Housing New Zealand (approx 12%) and the City Council (approx 5%).²⁴

5.4.2 WHAT WE KNOW & WHAT IS LIKELY – Earthquake-related housing issues

- 770 households are currently getting the temporary accommodation assistance package offered by CETAS (as at early march, 2012) – Canterbury Earthquake Accommodation Service. Insurance council funding is being provided to some 6,500 households. Most policies allowed for a maximum of 1 year paid accommodation so it is likely that a large number of households may transfer to TAS in the near future.
- CETAS are receiving about 300 monthly referrals.
- It has been estimated that approximately 15,000 new homes and 140,000 home repairs are required in Christchurch. Of these approximately 25,000 fall into the EQC severe damage category (over \$100,000 worth of damage).
- CCC social housing has been impacted badly as have areas with low cost private rentals.
- The 20 December 2011 report to Council’s Housing and Community Facilities Committee stated that 199 units were vacant due to structural damage and 149 were vacant due to infrastructure damage (repairable).
- The two temporary accommodation villages (Kaiapoi and Linwood) are averaging 95% occupancy. Some 70% are long term tenants i.e. staying for more than 4 months.
- Housing New Zealand figures indicate that 634 of nearly 6000 state homes in Canterbury are now uninhabitable, with many boarded-up for eventual demolition. The vacated homes are mostly in the worst-hit suburbs in Christchurch east and Kaiapoi with 210 houses empty in the residential red zones. ²⁵

²¹ Statistics New Zealand, 2006 Census of Population and Dwellings.

²² Statistics New Zealand, 1991 Census of Population and Dwellings.

²³ Statistics New Zealand, 2001 Census of Population and Dwellings.

²⁴ Ibid.

²⁵ HNZN Canterbury Regional Manager in Christchurch Press 14/01/12 Available from <http://www.stuff.co.nz/national/christchurch-earthquake/6256108/Empty-Housing-NZ-homes-invite-trouble>

- Overcrowding of remaining homes is currently exacerbated and maintained by both real and perceived employment insecurity and a low wage economy.
- A shortage of available rental housing has resulted in both challenges for those seeking a rental property and a rent price hike.
- Significant numbers of rental properties are likely to be demolished and not replaced in the short term; the economics of new rental housing do not stack up; it is not certain how many of the rebuilds in the red and green zones were rental properties.
- Ongoing uncertainty about property equity and resale potential is probable. Property ownership may decrease.
- It is estimated that 7,000 to 10,000 red-zoned households need to be relocated; uncertainty remains about the final red zone numbers especially in South Shore and the Port Hills.
- Financial and insurance concerns are ongoing and significant – e.g. many households are paying bridging finance, or two mortgages and rent; subsidies are time limited; insurance payouts uncertain, delayed etc.
- EQC have a stated policy not to insulate when repairing homes (except where demanded by the building code standard)²⁶ – despite the CCC waiving consent requirements. When damage is over the \$100,000 cap repairs are being carried out by insurers and insulation is being installed.²⁷
- Unsanitary housing continues to pose risks for residents.
- Dangerous housing – some residents are living in or spending time in dangerous properties; squatters in red-zone properties.
- Some houses have ongoing issues with damp caused by flooding and liquefaction; some may also have unidentified leaks contributing to dampness levels.
- Measures of displacement of households are very uncertain. It is not clear how many people are living in damaged homes and how many have moved on. Those that remain in damaged properties face the potential for a variety of housing related problems.
- There is uncertainty about the housing capacity for the workforce anticipated in Christchurch as well as uncertainty about the availability of temporary accommodation whilst repair and rebuilds are undertaken.
- There is concern about the dislocation of people from their communities during extended rebuilding timeframes.
- Land for 20,838 households has been rezoned in Greater Christchurch since the earthquakes (7,815 of these are within the City).

²⁶ <http://www.stuff.co.nz/the-press/news/christchurch-earthquake-2011/5981464/Code-will-govern-insulation-EQC>

²⁷ Personal Communication, Nick Collins CEO Beacon , February 2012

- It is estimated that developers will release up to 6,600 Greenfields²⁸ sections to the market in the next two years within Greater Christchurch (3,234 within the City) – this is likely to exceed the demand from red zone households seeking to relocate within Greater Christchurch.
- The rate of release of sections/houses will be highly dependent on the speed at which the development community releases land.
- Beyond the next two years, further land release will also be dependent on the ability to supply appropriate levels of trunk infrastructure.²⁹
- The now operative Regional Policy Statement identifies a total capacity for 41,370 households in Greenfield locations within the UDS area of Greater Christchurch (includes the land already zoned since the earthquakes began).

Christchurch Press 10 March, 2012

Landlords are renting unfit, filthy homes as Christchurch's rental problems worsen. Christchurch's post-earthquake shortage of rental homes has pushed up rents and led to long queues to view homes.

Helen Gatonyi, manager of Tenants Protection, said tenants were desperate and would take almost anything. Some unscrupulous landlords were taking advantage of the situation. She had seen homes rented with external walls full of holes, carpet wet from leaks, and mouldy curtains, and properties left dirty and unrepaired between tenancies. "It's really, really distressing for people. They are accepting rubbish, and staying in rubbish. They know if they don't take it, somebody else will.

"There's a whole market of dumpy, awful, substandard housing now emerging." Gatonyi expected the problem to get much worse as winter arrived, and said children and tenants with health problems were starting to suffer.³⁰

5.5 Temperature, humidity and ventilation

A healthy indoor environment is achieved through balancing temperature, moisture levels (relative humidity) and ventilation (see Figure 3). An imbalance of one factor alone can impact on the indoor environment to the detriment of the occupants.

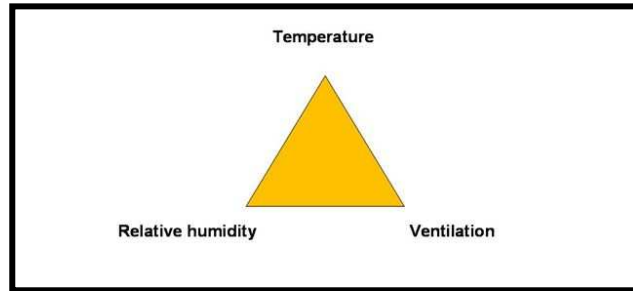
²⁸ Greenfield land is a term used to describe undeveloped land in a city or rural area either used for agriculture, landscape design, or left to naturally evolve. These areas of land are usually agricultural or amenity properties being considered for urban development.

²⁹ Trunk infrastructure includes water supply (e.g. wells and pumps), sewerage, stormwater and roads and footpaths. It may also include open space land & facilities for community purposes (e.g. parks)

³⁰ <http://www.stuff.co.nz/the-press/business/your-property/6553221/Top-dollar-asked-for-slum-flats> Accessed 16 March 2012

A healthy home will, ideally, be warm in winter and cool in summer. Insulation enables even temperatures to be maintained by providing a barrier that slows the movement of heat to the exterior of the house. Good insulation ensures that the energy used within the home can warm the home rather than the outdoors. Without insulation approximately 42 percent of heat escapes through the roof, 10 percent through the floor and 24 percent through the walls.

Figure 3: A healthy indoor environment requires a balance of factors

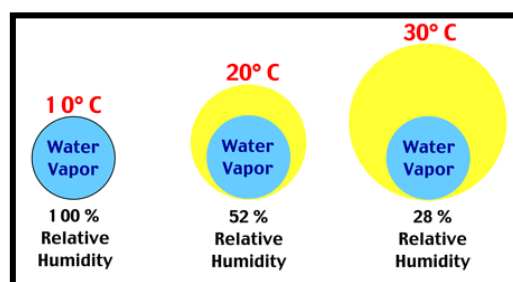


Source: Beacon Pathway³¹

Insulation also helps to reduce overheating in summer months – ceiling insulation contributes to this process particularly by acting as a buffer, to the ceiling cavity, and reducing the amount of radiant heat absorbed into the home through the roof.

The term humidity describes the fact that the atmosphere can contain water vapour. The amount of humidity found in the atmosphere varies because of a number of factors. Two important factors are evaporation and condensation. Relative humidity can be simply defined as the amount of water in the air relative to the saturation amount the air can hold at a given temperature multiplied by 100. Air with a relative humidity of 50 percent contains a half of the water vapour it could hold at a particular temperature. Figure 4 shows how relative humidity changes in a parcel of air with an increase in temperature. Increasing the temperature of this parcel of air, without adding or removing water, increases its ability to hold water vapour.

Figure 4: The concept of relative humidity



Source: Pidwirny, M.³²

³¹ http://www.beaconpathway.co.nz/further-research/article/balancing_temperature_humidity_and_ventilation

³² Pidwirny, M. 2006. *Fundamentals of Physical Geography*, 2nd Edition. Accessed March 2012. <http://www.physicalgeography.net/fundamentals/1b.html>

Mould thrives in conditions where humidity is greater than 70 percent and where there are cold surfaces on which condensation can form such as un-insulated walls, ceilings and windows.

Damp housing is linked to respiratory conditions in adults and children³³ and Fisk et al., found that building dampness and mould were associated with 30 to 80 percent increases in a variety of respiratory and asthma related health outcomes.³⁴

In addition to preventing condensation (through both insulation and the use of extractor fans in kitchens and bathrooms, vented driers etc) the opportunity for moisture to enter the home needs to be reduced by utilising appropriate ventilation techniques. Ideally modern ventilation methods ensure fresh air is provided to a household ensuring that, in spite of the increased airtightness of modern builds, moisture and other airborne pollutants do not build up within the house.

The World Health Organization has recommended a minimum indoor temperature of 18°C and a 2-3°C warmer minimal temperature for the very young and the very old.³⁵ Temperatures below 16°C, particularly in the presence of high humidity, are associated with adverse health consequences and temperatures below 12°C are a health risk for vulnerable groups. Cold homes have both direct and indirect effects on health.

The Household Energy End-use project monitored room temperatures and found that the average temperature achieved in South Island living rooms was only 17°C and nearly one third of households were identified as having an average winter temperature in the living area below 16°C. Bedrooms were found to be mainly unheated with only 20% of households heating this area of the house.³⁶

Direct effects of cold homes on health include excess mortality from cardiovascular and respiratory disease amongst the elderly, increased respiratory problems in children, increased illnesses such as colds and flu, mental health problems, and the exacerbation of existing conditions such as

³³ Howden-Chapman, P. 2004. Housing standards: a glossary of housing and health. *Journal of Epidemiology and Community Health*, 58(3):162-8.

³⁴ Fisk, W., Quanhong, L., Mendell, M. *Meta-analyses of the associations of respiratory health effects with dampness and mold in homes*. Berkeley: Environmental Energy Technologies Division, Indoor Environment

³⁵ World Health Organization. 1987. *Health impact of low indoor temperatures*: Report on a WHO meeting, Copenhagen, 11-14 November 1985. Copenhagen: WHO.

³⁶ Wilton, E. 2004. *Warm Homes Technical Report: Home Heating Methods & Fuels in New Zealand*. Ministry for the Environment. Available at <http://www.mfe.govt.nz/publications/energy/warm-homes-home-heating-methods-fuels-nz-nov05/warm-homes-home-heating-methods-fuels-nz-nov05.pdf>

arthritis. Indirect effects include negative influences on children's educational achievement, emotional wellbeing and resilience.³⁷ Older people, young children and people with long term illness are the most vulnerable to the effects of cold homes and these groups also tend to spend the most time at home.³⁸

Retrofitting older New Zealand homes with insulation has been shown to increase indoor temperatures and decrease relative humidity. Howden-Chapman et al., (2007) designed an intervention to investigate whether insulating existing houses was associated with higher indoor temperatures and improved health and wellbeing of occupants. Seven low income communities in New Zealand, involving 1350 households, participated in the intervention. Participants lived in uninsulated dwellings and had at least one family member who had reported respiratory symptoms in the last year (or had a history of asthma, pneumonia or chest infections). The households were randomised to either the control or intervention group. The intervention group had their houses insulated after baseline measurements had been established. The retrofit involved the installation of ceiling insulation, draught stopping for windows and doors and the addition of sisalated paper fitted beneath the floor joists and a moisture barrier was also applied to the ground underneath the house. The exposure of householders to temperatures less than 10°C was reduced by 30 percent and mean relative humidity fell by 3.8% (to 64.8%) over the two year study period. Energy use was lowered in the intervention group and the self-reported health of occupants improved, reduced wheezing was reported, children had fewer days off school, households made fewer visits to the general practitioner and there were fewer hospital admissions for respiratory conditions.³⁹ Although the intervention did not seek to alleviate income poverty directly it illustrates the potential for interventions of this type to improve both fuel poverty and health.^{40,41}

³⁷ Marmot Review Team. 2011. *The Health Impacts of Cold Homes and Fuel Poverty*. London: Friends of the Earth & the Marmot Review Team.

³⁸ Baker, M., Keall, M., Au, E., Howden-Chapman, P. 2007. Home is where the heart is - most of the time. *The New Zealand Medical Journal*, 120(1264).

³⁹ Howden-Chapman, P., Matheson, A., Crane, J., Viggers, H., Cunningham, M., Blakely, T. et al. 2007. Effect of insulating existing houses on health inequality: cluster randomised study in the community. *BMJ*, 334(7591):460.

⁴⁰ Marmot Review Team. 2011. *The Health Impacts of Cold Homes and Fuel Poverty*. London: Friends of the Earth & the Marmot Review Team.

⁴¹ Godlee, F. 2007. Our unequal society. *British Medical Journal*, 334 doi: 10.1136.

Warm Up New Zealand: Heat Smart Programme Evaluation

A recent evaluation commissioned from Motu and partners by the Ministry of Economic Affairs looked at changes in the incidence and costs of health services, pharmaceutical usage and mortality in the first 46,655 houses retrofitted under the Warm Up New Zealand: Heat Smart programme, introduced in July 2009. The Report highlighted that concentrating initially on protecting the health of older people should be a priority. The evaluation was carried out by matching the addresses of people who have had their houses insulated and in some cases heaters installed, with their hospitalisation records and energy accounts and comparing these results with matched households in the same neighbourhoods, whose houses had not been insulated. Researchers at the University of Otago, Wellington were able to show that among those in the mortality sub-cohort, who had been hospitalised with circulatory conditions (ICD-10 chapter IX), those in the households who had had the energy retrofit, had a significantly lower mortality rate than those in the control households, who had not received the retrofits. The evaluation results suggest that nationally, the intervention prevented about 18 deaths among those aged 65 and over who had previously been hospitalised with circulatory illness, with a 95% confidence interval of 0 to 45 deaths prevented in the year following the intervention.

5.5.1 WHAT WE KNOW – Temperature, humidity and ventilation issues

- New Zealand homes tend to be cool. A New Zealand study found that, during the winter months, living room temperatures were below 20°C for 83% of the time (mean and median 17.9°C) and living rooms were typically the warmest room in the house.⁴²
- Some households have ongoing issues with damp caused by flooding and liquefaction; some may also have unidentified leaks contributing to dampness levels.
- Households have ongoing issues with keeping damaged properties weather tight.
- Some households are experiencing ongoing mould issues.
- Some households have lost their primary heating source.
- Some households are adjusting to a new primary heating source (most likely to be a heatpump).
- The cost of power is increasing.

⁴² French, L., Camilleri, M., Isaacs, N., Pollard, A. 2006. *Winter temperatures in New Zealand Houses. Comfort and Energy Use in Buildings - Getting Them Right*; 27-30 April; Cumberland Lodge, Windsor, United Kingdom: BRANZ.

Radio New Zealand Updated at 7:42 pm on 7 February 2012

Electricity consumers are being warned their bills will rise by up to 10% this year as power retailers bear the brunt of upgrades to the national grid.

Grid operator Transpower says the higher charges will come into effect from April, and it says customers should brace themselves for additional electricity increases until 2015, when most of its major projects will be completed. Transpower is refusing to give a figure for the total expenditure but says the projects are essential to a sustainable power supply.

All power retailers spoken to by *Radio New Zealand News* say price hikes across the country are inevitable, but the exact amount will be determined on a region-by-region basis later this year.

Christchurch lines company Orion has been handed a bill that is 20% up on last year. The impact on the average household in the region is calculated at about 5% or \$45 a year.

5.5.2 WHAT IS LIKELY – Temperature, humidity and ventilation issues

- Home owners may be struggling to heat their homes as a result of damage and or loss of a primary heat source.
- The internal environment of households may be negatively impacted by the use of poor heating sources as interim measures e.g. open fires, woodburners and unflued gas heaters.

5.6 Overcrowding

Statistics New Zealand has used the Canadian National Occupancy Standard (no more than two people per bedroom; couples share a room; children under five of either gender, or under 18 of the same gender can share a room; children aged five to 17 should not share a room with a child under five of the opposite gender; single adults and unpaired children require a separate room) which defines household crowding as a deficit of at least one bedroom when the standard is applied to a household.⁴³ This standard has been used internationally but is not an official New Zealand standard. It is recognised

⁴³ Statistics New Zealand. 2003. *What is the extent of crowding in New Zealand? An analysis of crowding in New Zealand households 1986-2001*. Wellington: Statistics New Zealand.

that such a definition of crowding is more likely to reflect the dominant ethnic group.⁴⁴

Consequently when applying this standard the 2006 census revealed that household crowding amongst Māori was four times that of NZ Europeans, whilst overcrowding amongst Pacific peoples was eight times that of New Zealand Europeans.⁴⁵ A number of common characteristics of crowded households were identified in a 2003 Statistics New Zealand report investigating overcrowding.⁴⁶ Crowding was found to be more common amongst Māori or Pacific peoples, those on a low income and those in rental accommodation, particularly state-owned rental accommodation.^{36,37}

Households were also more likely to be crowded if they had a younger age structure, had more dependent children, contained two or more families or were a single parent family. Both Pacific and Māori whānau are more likely than European families to live in extended family groups representing more than two generations and are often living in homes built to house a traditional European nuclear family.^{36,37} Household crowding may therefore be affected by both affordability and suitability.

Crowding is associated with a range of infectious diseases, including meningococcal disease, hepatitis B, tuberculosis, acute rheumatic fever, respiratory and skin infections and helicobacter pylori.^{47,48,49} A recently published study has found that infectious diseases make the largest contribution to acute hospital admissions of any cause. As well as identifying increasing age-standardised rates for infectious diseases compared with rates for non-infectious disease admissions the study found that the risk of an infectious disease, was heightened in Māori and Pacific peoples, amongst the youngest and oldest age groups and in the most economically deprived populations. The authors suggest that the pattern of increasing incidence of infectious diseases in addition to rising inequalities are likely to be caused by

⁴⁴ Koloto & Associates Ltd. 2007. *Pacific Housing Experiences: Developing Trends and Issues*. Wellington: Centre for Housing Research Aotearoa New Zealand and the Ministry of Pacific Island Affairs

⁴⁵ Flynn, M., Carne, S., Ma'anaima, S-L. 2010. *Maori Housing Trends 2010*. Wellington: Housing New Zealand Corp.

⁴⁶ Statistics New Zealand. *What is the extent of crowding in New Zealand? An analysis of crowding in New Zealand households 1986-2001*. Wellington: Statistics New Zealand; 2003.

⁴⁷ Baker, M., McNicholas, A., Garrett, N., Jones, N., Stewart, J., Koberstein, V. et al. 2000. Household crowding a major risk factor for epidemic meningococcal disease in Auckland children. *The Pediatric Infectious Disease Journal*, 19(10):983-90.

⁴⁸ Gray, A. 2001. *Definitions of crowding and the effects of crowding on health: a Literature Review*. Wellington: Ministry of Social Policy.

⁴⁹ Rankine, J. 2005. *Housing and health in Auckland: a summary of selected research*. Auckland: Auckland Regional Public Health Service.

'fundamental social determinants such as disparities in income, housing conditions, and access to health services'(p.7).⁵⁰

5.6.1 WHAT IS LIKELY – Earthquake-related overcrowding

- Anecdotally we know that many households continue to be more crowded than they were prior to the September and February earthquakes as friends and family members are accommodated due to earthquake-related issues.
- The reduced availability of rental properties and rent price increases may contribute to ongoing overcrowding and to two or more families sharing a dwelling or alternative accommodation regardless of its lack of suitability.
- Those living in crowded households are likely to have an increased risk of illness, particularly when living in cold, damp dwellings, including current illnesses of particular concern in Canterbury such as pertussis (current epidemic) or measles, and the threat of influenza in the upcoming winter period.

5.7 Affordability

When the proportion of income spent on housing becomes too great accommodation can become unaffordable and result in compromises being made regarding living arrangements. It can also limit a household's ability to acquire basic necessities such as food, clothing and health care.

The Ministry of Social Development 'Social Report'⁵¹ defines affordable housing as housing costs that do not exceed 30 percent of the disposable income of a household. The proportion of New Zealand households spending more than 30 percent of their disposable income on housing costs has risen since the 1980s, affecting 27 percent of households in 2009. Experiencing high housing costs in relation to income occurs most in low income households. Housing costs in excess of 30 percent of income are more common in households with at least one non-European adult.

Renting is associated with poorer health outcomes, including increased risk of mortality,⁵² while high levels of home ownership are associated with

⁵⁰ Baker, M., Barnard, L., Kvalsvig, A., Verrall, A., Zhang, J., Keall, M., Wilson, N., Wall, T., Howden-Chapman, P. (2012) Increasing incidence of serious infectious diseases and inequalities in New Zealand: a national epidemiological study. *Lancet*, DOI:10.1016/S0140-6736(11)61780-7

⁵¹ <http://socialreport.msd.govt.nz/documents/economic-standard-of-living-social-report-2010.pdf> Accessed March 2012

⁵² Sundquist, J., Johansson, S.E. 1997. Self reported poor health and low educational level predictors for mortality: a population based follow up study of 39,156 people in Sweden. *Journal of Epidemiology and Community Health*, 51(1):35-40.

improved community cohesion due to neighbourhood stability, social ties and investment.⁵³

5.7.1 WHAT WE KNOW – Current housing affordability issues

- A shortage of available rental housing has resulted in both challenges for those seeking a rental property and a rent price hike. Households are consequently more likely to compromise on their property requirements and to pay more than they can afford to secure tenure or they may remain in unsatisfactory situations.
- Unaffordable housing costs encourage overcrowding and acceptance of poorer quality housing (e.g. too small, substandard or in an unsuitable location)⁵⁴
- The 2012 Demographia International Household Affordability Survey⁵⁵ rated housing in Christchurch as ‘severely unaffordable’ with median house prices at 6.3 times the gross annual median household income for the 3rd quarter 2011.
- House prices have increased in New Zealand since 1991, relative to increases in household incomes.⁵⁶
- High outgoings-to-income ratios in relation to housing costs are often associated with insufficient income to meet basic needs including food, health care, clothing, transport and education.⁵⁷

5.8 Fuel Poverty

Fuel poverty is defined as the need to spend more than 10 percent of net annual household income to heat a residential dwelling to an adequate standard of warmth.⁵⁸ Fuel poverty arises from a combination of three factors: household income, fuel or energy costs and the energy efficiency of the house. Although a household may be in fuel poverty on a relatively high income, if fuel costs are high and the home is energy inefficient, fuel poverty is more

⁵³ Robert Wood Johnson Foundation. 2009. Chapter 5: Create Healthy Homes and Communities. In *Beyond Health Care: New Directions to a Healthier America*. commissiononhealth.org: Robert Wood Johnson Foundation.

⁵⁴ Mitchell, I., O'Malley, S. How affordable is housing in New Zealand and what strategies are available to reduce housing stress? *The Social Policy, Research and Evaluation Conference, 25-26 November 2004*: Available at <http://www.chranz.co.nz/pdfs/how-affordable-is-housing-in-nz.pdf> Accessed March 2012.

⁵⁵ <http://www.demographia.com/dhi.pdf> Accessed March 2012.

⁵⁶ Statistics New Zealand. 2009. *Review of housing statistics report 2009*. Wellington: Statistics New Zealand.

⁵⁷ <http://socialreport.msd.govt.nz/documents/economic-standard-of-living-social-report-2010.pdf> Accessed March 2012.

⁵⁸ Marmot Review Team. 2011. *The Health Impacts of Cold Homes and Fuel Poverty*. London: Friends of the Earth & the Marmot Review Team.

closely linked to low incomes as those on low incomes tend to live in poorer quality, less energy efficient homes.⁵⁹

A 2009 study estimated that 40 percent of Christchurch households, in 2008, had the potential to experience fuel poverty (i.e. the need to spend more than 10% of annual household income on all household fuel use).⁶⁰ The inability of households to be able to afford heating at a reasonable cost is believed to be a significant problem in New Zealand which is, as yet, under-researched.⁶¹

5.8.1 WHAT WE KNOW & WHAT IS LIKELY – Fuel poverty

- In 2008 it was estimated that 40% of Christchurch households had the potential to experience fuel poverty.
- Three of the main factors that have exacerbated fuel poverty are the poor thermal efficiency of New Zealand dwellings, the relatively high levels of income inequality (compared with other OECD countries) and an increase in the real price of electricity.^{47,62}
- Low-income households are more likely to be renting and are also more likely to spend a high proportion of household income on residential energy. Additionally, rental properties may be substandard and there are no requirements for private landlords to insulate or heat their properties.⁴⁷
- Job losses associated with the earthquakes could worsen fuel poverty and loss of business premises means it is likely that more people are spending more time at home and that many are working from home awaiting the return to business premises (resulting in higher home heating bills).

6.0 Home Heating

Although a warm home is vital for comfort and good health many New Zealand homes tend to be cold and temperatures regularly fall below the World Health Organization's recommendations. Although traditional forms of heating are increasingly being replaced by more energy-efficient choices heating can prove costly for households. Some of the more traditional methods of home heating can result in indoor air pollutants which can adversely affect health including airborne particles from fireplaces and wood

⁵⁹ Scottish Government Communities Analytical Services. 2010. *A select review of literature on the relationship between housing and health*. Analytical Paper Series. Available at: www.scotland.gov.uk/Resource/Doc/1035/0104565.doc accessed March 2012.

⁶⁰ Lloyd, B., Callau, M. 2009. *Research Report: Retrofit interventions to enable healthy living conditions in existing NZ houses*. Confidential report for EECA. Dunedin: Energy Studies University of Otago.

⁶¹ Howden-Chapman, P., et al., 2011. Tackling cold housing and fuel poverty in New Zealand: A review of policies, research, and health impacts. *Energy Policy*, doi:10.1016/j.enpol.2011.09.044

⁶² Howden-Chapman, P., & Viggers, H., et al., 2009. Warm homes: Drivers of the demand for heating in the residential sector in New Zealand. *Energy Policy*, 37(9), 3387-3399

stoves. Noxious fumes such as carbon monoxide and nitrogen from unflued gas heaters, leaking chimneys and wood and gas stoves can also pollute the indoor atmosphere.

To date limited research has been undertaken to estimate the impacts of indoor air quality, although the relationship between indoor and outdoor particulate pollution has been investigated in relation to traffic-related pollution. In this context indoor sources (e.g. solid fuel burners) can expose residents to more particles than those beyond the home.⁶³ Fisher et al., also note that New Zealand is unique due to the limited insulation in many New Zealand homes which can allow increased infiltration of particulate matter from the outdoors to the indoor environment and the high use of unflued gas heaters and wood for home heating. Also of note is that high pollution days in Christchurch are likely to occur when indoor housing conditions (i.e. cold and damp, and possibly indoor particulate matter, depending on home heating method) are also likely to be at their worst, potentially exacerbating health problems.

Digipoll completed a telephone survey of domestic heating methods and fuels in Christchurch during December 2004.⁶⁴ One hundred and fifty households were surveyed across the 2001 census area units in the Christchurch TLA. Of the households surveyed most (72%) were using electricity to heat the main living area with 18% of households indicating that they had no insulation. Many households also reported using more than one method to heat this area. The most common types of electric heating were oil column heaters and fan heaters. Thirteen percent of households were using heat pumps.

Among those surveyed only 19% reported using a woodburner. Previous surveys for Christchurch have found higher proportions of woodburner use (34% in 1999 and 30% in 2003) and the authors of this report propose that the findings of the Digipoll survey suggest a sampling bias (28% non-response rate and potential for income bias) rather than a sudden decrease in the number of households using woodburners.⁵⁴

Open fires are a significant source of outdoor pollutants. Newer woodburners are less polluting than open fires and older woodburners but they still emit particulate matter into the local environment.

⁶³ Fisher et al., 2002. *Health effects due to motor vehicle air pollution in New Zealand*. Report to the Ministry of Transport.

⁶⁴ Wilton, E. 2004. *Warm Homes Technical Report: Home Heating Methods & Fuels in New Zealand*. Ministry for the Environment. Available at <http://www.mfe.govt.nz/publications/energy/warm-homes-home-heating-methods-fuels-nz-nov05/warm-homes-home-heating-methods-fuels-nz-nov05.pdf>

The cheapest way to heat homes is to harness the sun's energy. Homes can be designed to consider the orientation of the house, window sizing and placement, and can utilise modern materials and design techniques to gather and store the sun's energy providing an excellent source of passive heating. Significant investment is required to utilise solar energy to heat water although EECA⁶⁵ Energywise subsidies are currently available to assist households to do so.⁶⁶

Case Study – Beacon Pathway Society Incorporated - Designing and building a sustainable home. Monitoring revealed that the house:

- performed better than similar sized houses in the area: warmer, drier, healthier, used fewer resources: less electricity and gas, less water,
- cost the same as a similar house to build/purchase but less to run

The house was fully insulated, windows were double-glazed, a polished concrete floor absorbed heat energy, radiated as warmth at night and a solar water heater provided hot water to the household. Further details at:

http://www.beaconpathway.co.nz/being-homesmart/article/a_vision_of_better_living

Beacon is leading the **Build Back Smarter Project** in Christchurch.

More information available at:

http://beaconpathway.co.nz/index.php/news/article/building_back_smarter_in_christchurch

6.1 WHAT WE KNOW – Home heating issues

- The Building Code only has temperature-related requirements for aged-care facilities and childcare centres. These buildings must be able to maintain an indoor minimum temperature of 16°C.⁶⁷
- The Household Energy End-use Project estimated that 500,000 (34%) New Zealand households had a portable LPG heater in 2004 (this is likely to be an underestimate given the underrepresentation of rental homes in the survey sample)⁶⁸
- Households can create a stable living room temperature with a medium heat pump set point over extended periods and can meet the minimum WHO recommended temperature. Selecting a high set point to get a quick increase in temperature (up to 26%) and then switching off a heat pump results in large temperature fluctuations.⁶⁹
- Issues of restricted heater use, house design and economic and cultural circumstances can impact on temperatures achieved in homes.⁵⁹

⁶⁵ Energy Efficiency and Conservation Authority

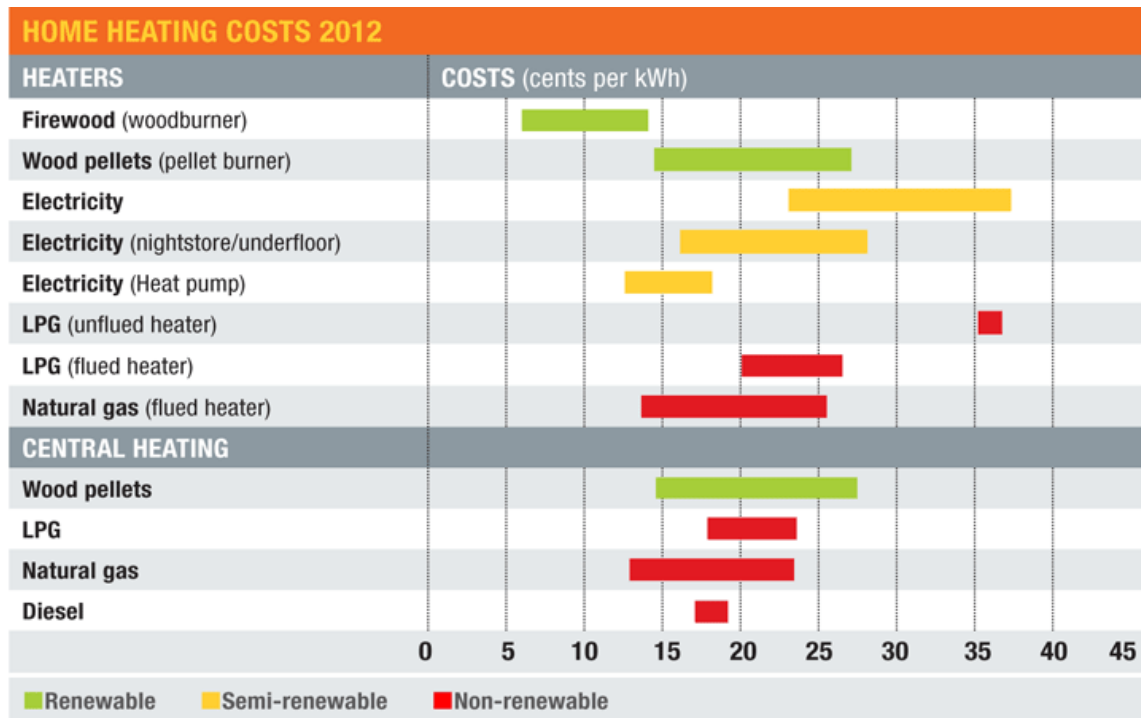
⁶⁶ <http://www.energywise.govt.nz/how-to-be-energy-efficient/your-house/hot-water/solar-water-heating>

⁶⁷ <http://www.dbh.govt.nz/bcr-part5-type2-indoor-climate> Accessed March 2012

⁶⁸ Cowan, V., Burrough, L., Ryan, V. 2010. *Unflued Gas Heater Factbank*: Beacon.

⁶⁹ http://www.branz.co.nz/cms_show_download.php?id=6d1b6703c0f2af6a32a1a883f54f1351ca3e658f

Figure 4: Heating Options: Fuel prices compared as at March, 2012 (no solar options)⁷⁰



Source: Consumer

6.2 WHAT WE KNOW – Post-earthquake/current housing/heating issues

- Approximately 13,000 homes lost their primary heating source in the earthquakes.
- There has been an increase in the number of heat pumps installed (anecdotally these may not always have gone to the right places).
- Heat pumps are perceived as expensive to run (and will not function during a power cut).
- There is public awareness of and concern about escalating power prices
- Desire by some residents in Clean Air zones, who must rebuild post-earthquake, to have woodburners in their new homes; those repairing may install an approved appliance but replacement homes are treated as a 'new home'.

6.3 WHAT IS LIKELY – Post-earthquake/current housing/heating issues

- Damaged homes may already be damper due to previous flooding and liquefaction and unidentified leaks. These homes will continue to be vulnerable to inclement weather conditions.
- A reduction in the number of wood burner and open fires due to housing and chimney damage.

⁷⁰ Of note is that the costs involved for Electric (heat pump) and Firewood (woodburner) were on a par in the 2009 Consumer Fuel comparison – this provides an indication of the impact of electricity price increases in recent years.

- There is concern that low income households may resort to using unsafe heating methods causing dampness and mould as well as increasing fire risk.
- Concern about power cuts both in relation to earthquakes and a predicted energy crisis.
- Increasing anxiety about escalating power prices

7.0 Air Quality

While the quality of housing that people live in is significantly associated with their health and wellbeing, neighbourhoods and the wider physical environment also affect people's health.⁷¹ Air quality, water quality, land use and waste management can all affect human health and protecting and improving environmental health is an essential public health function.⁷² For Māori and many others the wider physical and natural environment is intrinsically connected to health and wellbeing.

Clean air is a requirement for health and wellbeing. Urban outdoor air pollution is the eighth most common risk factor for death in high income countries.⁷³ There is considerable international evidence that air pollution causes excess morbidity and mortality through increases in the incidence of respiratory and cardiovascular illness. A Christchurch study has shown increased respiratory admissions to hospital in the days following high air pollution.⁷⁴

Air quality is ascertained through testing the amount of particulate matter (PM₁₀ and PM_{2.5}) in the air. To date no safe level of PM₁₀ exposure has been identified although high levels of PM₁₀ occur regularly in urban areas. The World Health Organization advises that there are no levels of PM₁₀ below which adverse effects are not observed and consequently the aim is to reduce levels as low as possible.⁷⁵ PM₁₀ particles are very easily inhaled, can remain suspended in the air for extended periods, even under calm conditions, and are readily absorbed in the lungs.

⁷¹ Pickett, K.E., Pearl, M. 2001. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *Journal of Epidemiology and Community Health*. 55(2):111-22.

⁷² Public Health Advisory Committee. 2010. *Healthy Places, Health Lives: urban environments and wellbeing*. Wellington: Ministry of Health.

⁷³ World Health Organization. 2009. *Global Health Risks: Mortality and burden of disease attributed to selected major risks*. Geneva: WHO.

⁷⁴ McGowan, J.A., Hider, P.N., Chacko, E., Town, G.I. 2002. Particulate air pollution and hospital admissions in Christchurch, New Zealand. *Australian and New Zealand Journal of Public Health*. 26(1).

⁷⁵ <http://www.who.int/mediacentre/factsheets/fs313/en/> Accessed March 2012

Particulate Matter - 2.5 to 10 micrometers

These particles are between 2.5 and 10 micrometers (or micron) (approximately 25 to 100 times thinner than a human hair). These particles are called PM₁₀ (i.e. Particulate Matter up to 10 micrometers in size).

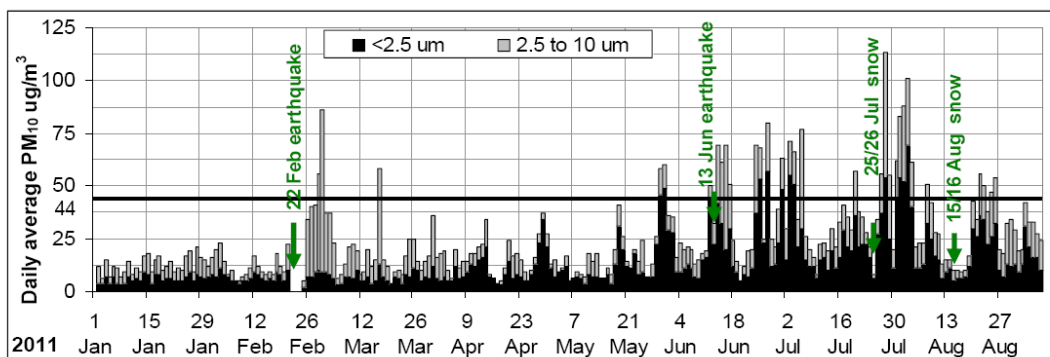
Particulate Matter - less than 2.5 micrometers

These particles are smaller than 2.5 micrometers and are called PM_{2.5} (i.e. Particulate Matter up to 2.5 micrometers in size).

Larger particulate matter (between 2.5 and 10µm, PM₁₀) can be deposited in the upper airways whilst the smaller or finer particulate matter (<2.5µm, PM_{2.5}) can reach the very small airways, deeper in the lungs.

Due to the environmental risk to human health as a result of air pollution the World Health Organization has introduced Air Quality Guidelines which recommend targets for air quality to levels at which evidence indicates health risks will be significantly reduced. By reducing particulate matter (PM₁₀) from 70 to 20 micrograms per cubic metre it is estimated that globally air quality related deaths will be reduced by approximately 15%.

Figure 5: Daily concentrations of PM₁₀ (column height) comprising PM_{2.5} and PM_{2.5-10} concentrations, measures at St Albans



Dust

Two high pollution days in March 2011 at the St Albans monitoring site include two related to windblown silt. Another day in March and all the high pollution days reported from mid-June appear to include some component of natural coarse (2.5 to 10µm) particles together with fine combustion (<2.5µm) particles.

Source: ECan <http://ecan.govt.nz/publications/Reports/airReportsCanterburyOct2011.pdf>

During 2011 Christchurch city experienced more high pollution days (28 days) in comparison with previous five years but less than in 2005 when 32 high pollution days were recorded. Monitoring during 2011 indicates that 16

of the 32 high pollution days are attributable to earthquake-related dust from silt, damaged roads and grit. The additional 12 high pollution days are similar to figures recorded in the previous few years and indicate pollution related to home heating emissions.

In New Zealand most PM₁₀ emissions come from the burning of solid fuels (i.e. coal and wood) for home heating. Emissions can vary depending upon the number of households using solid fuels, the type and quantity of the fuel utilised and the type of appliance being used. Vehicle exhaust emissions are also a significant source of PM₁₀ in larger cities. Industry may also contribute to emissions as can natural sources such as pollen, sea salt and mineral dust.

Some population groups appear to be more sensitive to PM₁₀ exposure including infants and children, older persons and those with pre-existing respiratory illness, chronic conditions and/or heart disease. In addition Māori and Pacific peoples are over-represented in health statistics associated with particulate exposure, together with those experiencing high levels of deprivation.⁷⁶ Although it has been ascertained that ambient particulate matter exposure can pose a smaller relative risk⁷⁷ for cardiovascular disease than other risk factors such as obesity or tobacco smoking research has established that the absolute number of people affected is very high due to the total population being exposed, representing a large health burden.⁷⁸

The Ministry for the Environment report a range of health effects associated with exposure to particulate matter and note that understanding regarding the impact on children remains incomplete. Children are more susceptible due to a number of factors including their higher rates of respiration which result in a higher intake per unit of body weight, their immature lungs, and immature metabolic systems and defence mechanisms. Additionally children tend to have activity patterns which mean they are exposed to more particulate matter and as a result higher doses reach their lungs. Morbidity and mortality in children related to air pollution may be associated with interactions with respiratory infections which tend to be common in children.⁷⁷

⁷⁶ Environment Waikato & Waikato District health Board. 2002. *Tokoroa warm homes clean air project: health and wellbeing impact assessment*. EW ISSN: 1177-9284. Hamilton: Environment Waikato and WDHB

⁷⁷ In this example Relative Risk is the percentage change in health outcome per unit change in Particulate Matter concentration.

⁷⁸ Ministry for the Environment. 2009. *Air Quality – Getting the Balance Right*. Report of the Technical Advisory Group on National Air-Quality Standards. Ministry for the Environment.

A 2007 research project estimated that 1100 New Zealanders die prematurely each year from air pollution in urban areas with long-term exposure to fine particles (i.e. PM₁₀) identified as the largest contributor to this outcome. Additionally the report estimated some 1.9 million restricted-activity days (days on which people were not able to do what they might have done because of the air pollution; includes absence from school or work due to respiratory symptoms).⁷⁹ The study did not investigate the impact of poor air quality on recreational activity although any restriction of physical activity, due to air pollution, has direct and obvious public health implications for communities and society generally.

The Christchurch arm of the study estimated the annual average exposure in each census area unit within the urban areas. The association found between exposure and mortality was then adjusted for potential confounders (e.g. age and smoking) suggesting that there is an annual increase in mortality of 8% in Christchurch per 10µm/m³ increase in PM₁₀.⁷⁹

In Christchurch the meteorology and topography mean that we experience lengthy periods of calm together with many low-level inversions. In combination with the high level of emissions of PM₁₀ from domestic solid fuel heating appliances these conditions exacerbate particulate air pollution with the very small particles remaining suspended for extended periods.

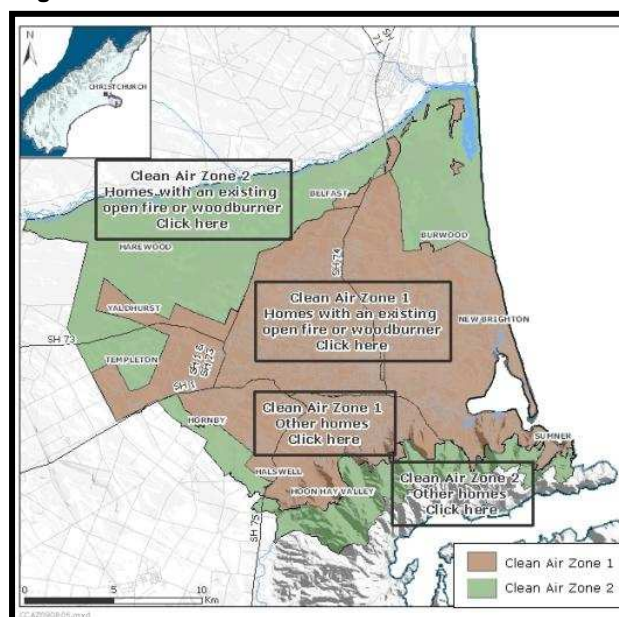
Christchurch has experienced pollution problems since early last century. In the first half of the century suspended particulate matter and sulphur dioxide were the main pollutants. Over the years this altered with suspended particulate matter, carbon monoxide and nitrous oxides being the main contaminant emissions impacting on current air quality.

Although the problem was widely recognised little was done until 1972 when the Clean Air Act 1972 (repealed by The Resource Management Act (RMA) 1991) provided authorities with legislation that included provisions for local authorities to control emissions. With the introduction of the RMA regional authorities became responsible for air quality. The Christchurch Air Plan developed in consultation with residents acknowledges that home heating, mainly from open fires and older inefficient woodburners, is the major contributor to PM₁₀ and PM_{2.5} emissions. As a result, a ban on the use of open fires and solid fuel burners, fifteen years and older, between 1 April and 30

⁷⁹ Fisher, G., et al., 2007. *Health and Air Pollution in New Zealand*. A research project funded by the Health Research Council of New Zealand, Ministry for the Environment, Ministry of Transport.

September each year was introduced in April, 2010. The Plan designates various clean air zones with different 'heating rules'.⁸⁰

Figure 6: Christchurch Clean Air Zone



Source: ECan

To assist households to change their home heating source from an open fire or older woodburner Environment Canterbury (ECan) introduced the Clean Heat Programme and a Clean Heat subsidy. By the conclusion of the project in 2010 over 19,000 of the approximately 40,000 fires identified as requiring replacement had been removed. Forty-six million dollars was spent on this initiative.

The Christchurch Air Plan is designed to manage the changes demanded by the National Environmental Standards for Air Quality which is based on air quality guidelines set by the World Health Organization. In June 2011 the targets were revised by the government and it is now expected that by 2016 (previously 2013) the city will have no more than three exceedances in any given year and by 2020 the expectation is that there will be no more than one exceedance annually.

7.1 WHAT WE KNOW – Christchurch Clean Air Zone 1 – Existing open fire

- The use of open fires is banned from 1 April to 30 September each year (came into place in April 2010).

⁸⁰<http://ecan.govt.nz/advice/your-home/home-heating/home-heating-rules-canterbury/Pages/home-heating-for-christchurch.aspx#caz1-open>

- No resource consent is required to install a heat pump, nightstore heater, fixed-flued gas or liquid fuel heater (includes oil and diesel) or a low-emission burner or pellet fire on the ECan approved burners list.
- A resource consent is necessary for any burner or pellet fire not approved by ECan and for any new cooker using wood or coal.

7.2 WHAT WE KNOW – Christchurch Clean Air Zone 1 – Existing solid fuel burner (including homes with earthquake damaged solid fuel burners)

- From 1 April 2010, the use of solid fuel burners that are 15 years or older in Christchurch is banned from 1 April to 30 September each year.
- No resource consent is required for a heat pump, nightstore heater, a fixed-flued gas or liquid fuel heater (includes oil and diesel) or a low-emission burner or pellet fire on the ECan approved burners list.
- A resource consent is necessary for any burner or pellet fire not approved by ECan and for any new cooker using wood or coal.
- Residents cannot install an open fire or any non-compliant woodburner without resource consent.

7.3 WHAT WE KNOW – Christchurch Clean Air Zone 1 – Homes currently without an open fire, woodburner or other solid fuel burner (new homes are included as are full rebuilds resulting from earthquake demolition)

- Heating options include installing a heat pump, nightstore heater or a fixed-flued gas or liquid fuel heater.
- Resource consent is necessary for any pellet fire.
- Residents cannot install an open fire or any new woodburner.

7.4 WHAT WE KNOW – Christchurch Clean Air Zone 1 – Earthquake

- For rebuilds on the same site or a new site woodburners cannot be installed even if the home had one previously.

7.5 WHAT WE DON'T KNOW – Air Quality

- There is uncertainty about how long dust will remain at high levels in the Christchurch atmosphere, particularly with ongoing demolition.
- It is uncertain how many domestic heating appliances are yet to be replaced by either modern woodburners or heat pumps.
- It is uncertain how many have already replaced their appliance with a modern woodburner or a heat pump.
- The impact of these un-quantified changes in household heating methods on air quality is as yet unknown.
- It is unknown how many households, who are rebuilding homes in Clean Air Zone 1 actually wish to replace a previously owned woodburner.

7.6 WHAT WE KNOW – Air Quality

- Christchurch's meteorology and topography result in conditions that exacerbate the effects of PM₁₀ emissions from domestic heating appliances.
- Some people are more vulnerable to the effects of PM₁₀.
- Air pollution in Christchurch has been estimated to result in 158 premature deaths annually in those aged 30 years and over. The proportion of premature deaths associated with smoke, caused by woodburners, was calculated as 78% or 124 of these deaths.⁸¹ PM₁₀ exposure estimates were calculated by census area unit and based on modelled concentrations validated using monitoring. Non-mortality effects were also investigated, including chronic obstructive pulmonary disease and allied conditions (bronchitis, emphysema, bronchiectasis, extrinsic allergic alveolitis and chronic airways obstruction), and daily respiratory admissions to Christchurch hospital attributed to PM₁₀.⁸²
- According to inventories of emissions to air domestic home heating is principally responsible for the P_{M10} and P_{M2.5} emissions on weekdays and also at weekends. View the 2006 summary of contaminant emissions at <http://www.ecan.govt.nz/publications/Reports/PU1C7017InventoryEmissionsAirChristchurch.pdf>.
- Christchurch city experienced more high pollution days in 2011 in comparison with recent years. Monitoring revealed that 16 high pollution days can be attributed to earthquake-related dust from silt, damaged roads and grit. The additional 12 high pollution days are related to emissions from combustion only and are similar to the findings of previous years.⁸³
- Emissions from home heating are usually the major cause of wintertime air pollution in Canterbury. Home heating contributes approximately 80% of particulate pollution (PM₁₀). Motor vehicle and industrial emissions each contribute approximately 10% each.⁸⁴

7.7 WHAT WE KNOW – Air Quality

- When cities reduce their pollution mortality rates fall. In 1990 Dublin reduced emissions by banning non-smokeless coal. There were 15.5% (p<0-0001) fewer respiratory and 10.3% (p<0-0001) fewer cardiovascular deaths in the 6 years after the ban, compared with the previous 6 years

⁸¹ Fisher, G., et al., 2005. *Health and Air Pollution in New Zealand: Christchurch Pilot Study*. Prepared for Health Research Council, Ministry for the Environment, Ministry of Transport, Available at <http://www.hapinz.org.nz/HAPINZ%20Report%20-%201%20Sept%202005.pdf>

⁸² Please see above - Christchurch Pilot Study - for full explanation of methodology.

⁸³ <http://ecan.govt.nz/publications/Reports/airReportsCanterburyOct2011.pdf>

⁸⁴ <http://ecan.govt.nz/our-responsibilities/air/pages/key-issues.aspx>

(resulting in 116 fewer respiratory and 243 fewer cardiovascular deaths per year)⁸⁵

- Air quality inside buildings can be just as bad as the outside on heavily polluted evenings. A study investigating the health effects of heavily polluted winter air on boys attending a central city boarding school in Christchurch concluded that there is 'no escape' from the smoke caused largely by woodburners. The study found this was particularly true for smaller particulate matter. The particulate matter was found to affect boys who had problems with asthma with small, but statistically significant, decreases in lung function noted on very high pollution days. The majority of boys did not experience any respiratory problems although all students coughed more on high pollution nights. Small but statistically significant effects of pollution on ear, nose and throat symptoms were also identified in this student group.⁸⁶

8.0 The CDHB & housing, home heating & air quality

Since the late 1990s Community and Public Health (C&PH, the Public Health Unit division of the CDHB) has supported ECan's initiatives to improve air quality in Christchurch and Canterbury, including the development of the Christchurch Air Plan.

Additionally C&PH played an important role in the setting up of the Warm Families Project (funded by EECA and co-funded by the CDHB), and works closely on shared health promotion strategies with Community Energy Action who provide home insulation retrofits, free curtains, household home energy checks and advice about how to conserve energy to Cantabrians including those with a particular health risk.

A C&PH health promoter with expertise in housing improvement interventions has also assisted with projects undertaken in Christchurch by the Housing and Health Research Programme based at the Department of Public Health, University of Otago, Wellington including studies involving retrofitting Christchurch State houses with insulation and exploring impacts on temperature, relative humidity and the health of residents. She is currently supporting the Warm Homes for Elder New Zealanders (Christchurch study arm) which is evaluating whether fuel subsidies reduce exacerbations of

⁸⁵ Clancy, L., Goodman, P., Sinclair, H., & Dockery, D. W. 2002. Effect of air-pollution control on death rates in Dublin, Ireland: an intervention study. *The Lancet*, 360(9341), 1210-1214.

⁸⁶ Epton, M. et al., 2008. The effect of ambient air pollution on respiratory health of school children: a panel study. *Environmental Health*, 7(16)

COPD⁸⁷ among people aged over 55 and whether or not the provision of subsidies is a cost-beneficial policy initiative.

C&PH staff have been working together with both the Council and CERA, advocating for decisions that impact positively on health outcomes, particularly in relation to housing quality and community wellbeing concerns.

9.0 For Consideration

Although this paper has presented available information about housing, home heating and air quality the reality is that much remains unknown about the impact of the earthquakes on these areas. It is evident that there are layers of complexity in all our current undertakings, and many unknowns.

The central concern is the potential for any of the issues considered in each arena to impact upon the most vulnerable of our citizens and on the health system itself, particularly over the upcoming winter period, but also in the years ahead. How should we as a health promoting DHB respond?

9.1 WHAT WE KNOW

- Winter peak in hospital admissions is the norm.
- Excess winter mortality is an annual occurrence.
- The CDHB is responding to the challenges of the post-earthquake environment as well as dealing with extensive damage to buildings necessitating closures, repairs and ongoing disruption.
- A severe energy crisis has been predicted for this winter.
- A cold winter has also been predicted.
- Numbers of vulnerable people are higher post-earthquake. Going into year two psychosocial issues are reported to be increasing.
- Many households are over-crowded and may also be living in earthquake-damaged homes or other poor quality housing.
- The CDHB mounted an impressive community care/acute demand management programme (CREST) which has resulted in a significant reduction in admissions. These patients represent an extremely vulnerable group in the face of a prolonged cold snap.
- There are demographic change implications for the health system arising from a reduction in population in the short term and uncertainty as to the future age structure, the nature of future migration, and rates of population growth.

⁸⁷ Chronic obstructive pulmonary disease

9.2 ARE THERE OPPORTUNITIES TO ADVOCATE FOR BETTER HEALTH OUTCOMES? Housing, home heating, air quality and the health system

- Are there opportunities to highlight CDHB contributions to healthy housing? e.g. the proposed Acute Demand Management Project based on the Warm Families, Warm Babies Projects, the first significant scale project led by the health sector in New Zealand, to focus on healthy home conversions (subsidised insulation and heating) through identifying and prioritising vulnerable discharged hospital patients – pilot programme of 511 planned.
- Are there opportunities for high-level health advocacy or awareness raising? e.g. advocate for the need for all EQC repairs to homes to include adequate insulation and a home health check with appropriate action supported; consider advocating for electricity subsidies for the most vulnerable, advocating for rebuilt housing to be sustainably designed and built, the utilisation of a Healthy Housing Index, Lifemark⁸⁸ standards etc.
- Do some issues demand high level policy or structural change at a national level? e.g. energy costs and increasing fuel poverty; What contingencies could there be for the most vulnerable?
- Could home health checks be further linked with health referral services?
- Are there opportunities to combine messages? e.g. influenza vaccination campaign
- Are there opportunities to advocate for energy efficiency education? e.g. dressing warmly, using curtains, using heating efficiently etc.
- Are there opportunities to promote the use of community services? e.g. curtain banks
- The CDHB should be a regular attender and contributor to the Sustainable Homes Working Party which is currently funded by CCC and the DBH, but is led by Rob Kerr from CERA.
- Are there opportunities in the short-term? Long-term?
- Is there an opportunity to advocate for those struggling with insurance challenges?
- Are there opportunities to support changes to the building code regarding insulation or local bylaws related to rental housing etc?
- Are there opportunities to profile CDHB healthy housing understandings through Healthy Christchurch; and to utilise the Champions across the Healthy Christchurch signatories to highlight housing issues in relation to health? Consider hosting a conference or forum highlighting health in

⁸⁸ The Lifemark™ is an independent seal of approval awarded to homes that have been designed and built to achieve specific quality design standards. The standards ensure the home can adapt to the changing needs of households providing easy access for all regardless of age and/or degree of disability. Incorporating the standards into new builds is significantly cheaper than the cost involved in retrofitting. It is estimated that ACC and the Ministry of Health spend over \$33 million annually to modify homes to accommodate older and disabled people.

relation to housing and home heating; possibly linking through Healthy Christchurch and the signatories.

- Encourage all CDHB divisions to be mindful of the potential for housing issues to be exacerbating health issues; link with community-based health and social workers to ensure action as required.

10.0 Recommendations

1. That the CDHB continues to fully support the Christchurch Air Plan in acknowledgement of the health benefits for Christchurch citizens.
2. That the CDHB highlights the risks that the affordability and fragility of our electricity system pose to the health of the most vulnerable community members and works with partner agencies to develop mitigation strategies.
3. That the CDHB develops an action plan, including the development of a communications strategy, to address the following matters and explore opportunities for advocacy at a national, local and community level:
 - Providing active leadership in the wider housing arena, informed by understandings of the health implications of housing quality, home heating options and air quality.
 - Pursuing partnerships with CERA, the Christchurch City Council and others to focus both attention and resources towards healthy housing and the associated positive health outcomes.
 - Advocating for healthy housing and seeking to make the links between housing and health explicit in the public arena, recognising the significant social and health costs associated with substandard housing.
 - Advocating for the best possible repair alternatives that maximise warmth and minimise damp, through retrofitting insulation and utilising clean heat options.
 - Advocating for the application of sustainable building principles in all new builds (or rebuilds) for both temporary and long-term housing solutions, for the protection of human health.
 - Advocating for healthy rental housing and seeking to establish opportunities to protect the health of those living in rental accommodation.