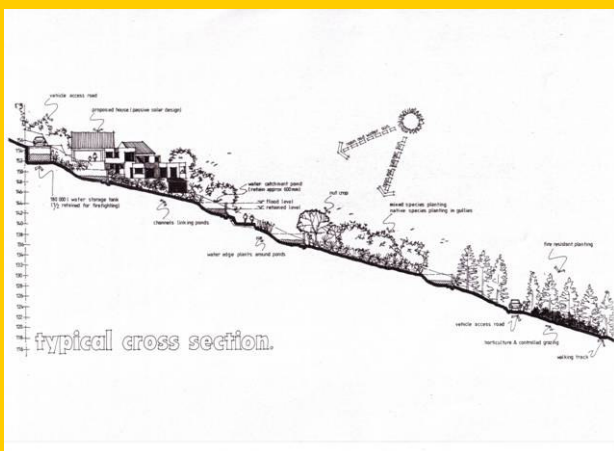


Kakariki Lane  
Christchurch  
New Zealand





The photo shows in red the development boundaries, in blue the storm water containment and distribution system and in yellow the existing and planned properties on the Kakariki site.

### The project

- The Kakariki\* Lane project consists of a small group of houses built on a 2.8ha steeply sloping (80m -170m elevation msl), north-west facing, originally bare erosion-prone urban site.
- The land is zoned by the City Plan for up to 26 houses. Instead, an eventual maximum of eight is intended – a decision based on minimising commuter travel, and providing a significant amount of open space around the houses for revegetation and recreational purposes
- Five houses have 1800m<sup>2</sup> sites; three average around 650m<sup>2</sup>. All are detached dwellings, located on the upper part of the land. The entire site is being progressively planted, predominantly with native species. Stormwater is collected from houses and other impervious surfaces within and above the site, and redistributed within the boundaries of the site.
- The average house size is around 220m<sup>2</sup>, and they are all privately/self built, for individual family ownership. Three have a substantial passive solar content, two less so but still quite good. The remaining three planned houses will be to high standards. The variability between the houses relates mainly to the amount of thermal storage and insulation (including double glazing), which reflect individual owner preferences.

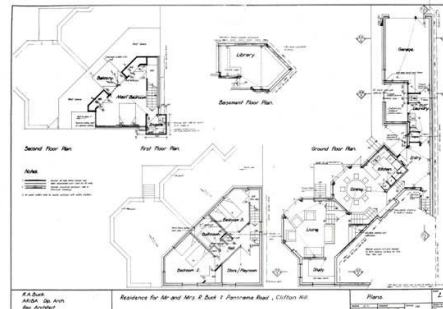
\* 'Kakariki' is Maori for 'green'

- The site was purchased in 1984, and all design and development has been carried out cooperatively by the five owners/occupiers. It has a fairly large self-build content. Work on site commenced about that time; three houses have yet to be built.
- Stormwater containment is achieved by a gravity drainage system that feeds at various levels into a 180,000 litre below ground tank (at the top of the site), four concrete dams of approximately 10,000litre capacity, and miscellaneous other storage providing a total capacity of around 250,000 litres. All these discharge by gravity into a piped system supplying some thirty overhead sprinklers which give a relatively uniform distribution of water over the lower half of the land. There is a choice of both source and discharge zones. The system is remotely operated from a single point, and allows for sources and discharge sectors to be selected as required.

### Objectives

To:

- demonstrate the benefits of thoughtful environmental and building design, and to provide a comparison between this and the generally poor quality of both to be found elsewhere;
- minimise erosion, by planting extensively and by managing stormwater runoff;



- share all this with others – for example, the hillside is highly visible from other parts of the city, and the planting is intended to provide a relief from the bleak wall-to-wall housing so loved by the city planners
- introduce a generally beneficial microclimate, and a supportive habitat for plants and wildlife, and the results of this are now evident;
- provide a high quality of life for the residents, affordably, through cooperative effort;
- encourage other self-build groups to do the same;
- recognise elements of sustainability in regard to the houses through the permanence of the buildings (eg use of concrete, brick, stone) or their potential for partial recycling (eg reuse of timber), and their relatively low energy demand in use.

#### Building construction

- Despite this variability, all perform better, or much better, than contemporary dwellings because of their design. There is a very close correlation between temperature swings within these houses and the amount of thermal mass, as would be expected.
- House costs reflected the individual self-build content and design complexity, and varied between modest to average in terms of the prevailing construction rates; however, all houses are built into the ground to a significant extent, which added unusual costs and this offset some of the savings achieved elsewhere. Three of the sites were excavated simultaneously, along with much of the roading, and the costs of this were shared based on machine hours. This led to significant savings.
- Some of the road construction and surfacing, and much of the excavation for and laying of services made use of the group's own manual labour.

#### Building Construction

- All five houses have a predominance of glazing orientated towards solar north, the midday solar position in the southern hemisphere. Three of them have very high mass (using concrete), the other two have a reasonable amount. The three still to be built are expected to have high or very high amounts of thermal mass.

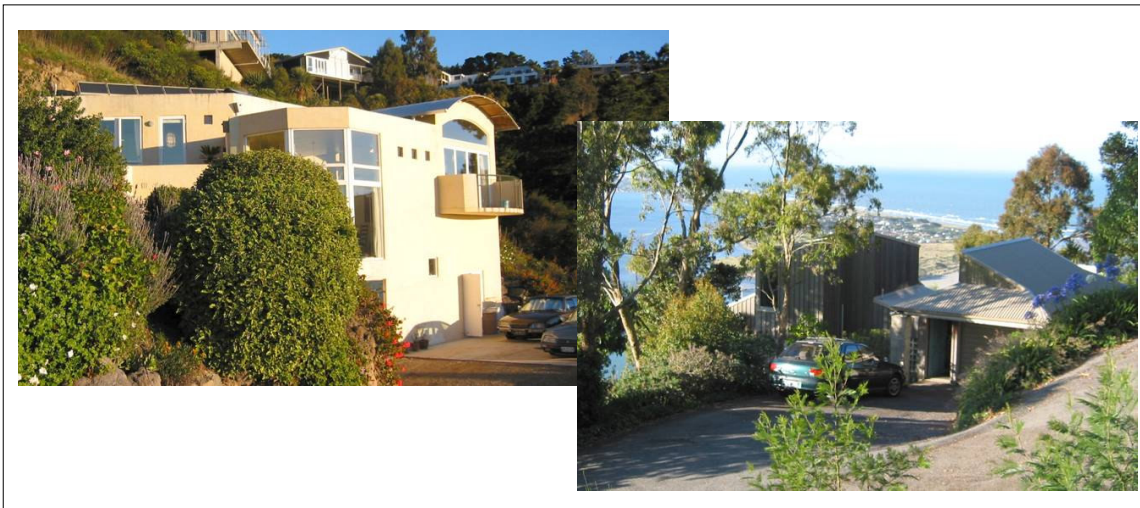
- Insulation levels were reasonable at the time of design by NZ standards (but relatively poor by international standards: houses range between R1.8 - 3.0 m<sup>2</sup>C/W (walls), R2.0 - 3.5 (roofs), R0.6 - 2.0 (floors) – these were individual owner-influenced decisions); three have double glazing throughout, two have less than 50%. Four have timber window frames, one has pvc. The three planned houses will have higher insulation levels and full double glazing.

#### Technical systems

All the houses use passive solar effects for space heating purposes, optimised by their design. One has a Stirling engine, used experimentally (it burns gas, which produces electricity and hot water); this same house has a heat recovery shower base. Another has a ducted air heat recovery system, taking warm air from the highest part of the house and circulating it under the ground slab of the lowest part. The three solar water-heating systems are pump assisted (two houses do not have solar hot water installations). All houses are grid-connected; waste water is piped to the city system (done today, on-site treatment would have been considered); potable water is obtained from the normal city supply.

#### Energy performance

Note that the New Zealand climate is mild, and rarely extreme. Christchurch has periodic relatively high temperatures, but this is usually associated with low humidity and light-to-moderate winds. Winter temperatures are relatively mild – the site microclimate (close to the ocean, north west facing and 26deg slope) means that sub-zero ground surface temperatures (ie frosts) are rare. Sunshine hours average more than 2,000hrs a year, and are spread fairly evenly through the seasons. These conditions make the job of using natural effects very easy: mechanical cooling is unnecessary, and heating loads can be greatly reduced by designing to use these natural effects efficiently.



None of the houses has been subject to a formal analysis of any type. Only one has been monitored. Energy used for all purposes by this house has varied according to occupation over twenty years, and has ranged from approximately 7,000kWhr/yr (two adults) to 12,000kWhr/yr (four adults). The entire house (240m<sup>2</sup>) is maintained continuously at comfortable temperatures, but it is zoned to have warmer living areas and cooler bedrooms. A trombe wall and conservatory are presently being added, and the effects of these will be measured. Most lights are now of the low-energy type.

#### **Costs**

Costs were comparable to, or below prevailing construction rates for flat site houses.

#### **Innovative products**

##### *Structure*

+ Polyblock walls and roof formwork (Supplier Insulform - [www.insulform.co.nz/](http://www.insulform.co.nz/))

##### *Ventilation and cooling*

+ Entirely passive mechanisms: thermal mass; natural ventilation

##### *Controls*

+ Temperature control: Trombe wall, and conservatories

##### *Space heating and DHW*

+ WhisperGen - hot water (engine coolant) used for space heating (Supplier WhisperTech Ltd. - [www.whispergen.com](http://www.whispergen.com))

+ Heat recovery shower base - tempers incoming water (Canterbury University, Don Clucas)

+ Embedded electric wall heating ('Thermofloor' system - [www.homeideas.co.nz/floor/thermofloorframe.htm](http://www.homeideas.co.nz/floor/thermofloorframe.htm))

##### *Site Development*

+ Water saving: All stormwater is retained - total capacity 250,000litres in tanks and dams - and is used for irrigation and as bushfire standby. Computer managed disposal system. Designers: Roger Buck (architect), Harman Halliday (civil and structural engineer), Simon Sloane (electronics engineer)

#### **Planning tools**

For the houses design was based on intuition, experience, and reference to/involvement with studies conducted, in particular, by Dr Alan Tucker (Canterbury University), and Dr. Breuer (NZERDC contract 3420).

For the development as a whole the aim was to create a comparatively benign urban environment using simple techniques that could be adopted readily by others. Principal amongst these were the on-site stormwater management, the provision of beneficial microclimates through the introduction of appropriate planting, and the construction of reasonably low-energy buildings. No particular planning tools were required for this as it is mostly common sense.

#### **Other**

No formal research has been conducted, and therefore no academic papers have been produced, but various articles have been written, and the development is occasionally visited by interested outside parties.

The project has been self-financed and managed by the owners - the site collectively and the houses individually. Three sites have been sold to outside parties, all known to members of the development group.

The low cost/affordability side of the development is obscured by the natural characteristics of the site which has views across the city to the mountains, and out over the Pacific Ocean. This adds a perception of value that is unrelated to the actual development costs. It is worth noting that, at the time of purchase by the group the site was regarded as too difficult to develop conventionally and its price reflected that.

#### **Contact Person**

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Project team: the group of five families.