Medium density
Adelaide

This case study shows how a mixed density community housing project addressed the lifestyle and environmental impact features listed below within a reasonable budget in a difficult inner-city context. These homes, like other case studies, cost less to run whilst providing year round thermal comfort and a healthier environment for the occupants.

BUILDING TYPE: Mixed density housing Mixed construction	
CLIMATE: Cool temperate - South Australia	
Topics covered	Success Level
Passive design	Excellent
Lifestyle modification	Excellent
Rainwater harvesting	Excellent
Waste reduction	Very Good
Wastewater recyc.(proposed)	Very Good
Greenhouse gas reductions	Excellent
Indoor Air Quality	Excellent
Reducing transport impacts	Excellent
Embodied Energy reduction	Very Good
Renewable Energy production	Excellent
Food Production	Good
NatHERS Rating (estimated average)	★★★★★

This Study is of 14 dwellings that include linked 3 storey townhouses with full solar orientation, a 3 storey block of six apartments with east-west orientation and a full roof garden, three 2 storey strawbale cottages and a 3 storey strawbale townhouse. At the time of writing development had just begun on a 5 storey apartment building containing 13 apartments with community facilities (meeting room, library, kitchen, toilet and 'interpretive room') that will serve the whole Christie Walk site.

The project was designed for a group of clients represented by a development cooperative, Wirranendi Inc., and created by the non-profit educational association, Urban Ecology Australia Inc. The purpose of the cooperative was to create community-based projects that maximise environmental performance and energy efficiency. The cooperative structure provided a means for people to build for themselves in urban environments where single house blocks are rarely available. The clients included first-time home buyers, investment purchasers, experienced home owners seeking the advantages of an urban lifestyle and older people wanting to retire in an active, mixed community.

With reduced car park provision and no internal traffic, the site was developed to take advantage of its inner-urban location within easy walking distance of Adelaide's Central Market and public transport services. [See: Streets & Communities]

The project is on a T-shaped site the size of two quarter-acre blocks in inner-city Adelaide, South Australia. The site is small, awkwardly shaped and severely constrained, with buildings hard on or close to most of the boundaries. The constraints of the site made it impossible to provide all the buildings with ideal passive solar orientation. [See: Choosing a Site, Orientation]

Adelaide's climate is 'Mediterranean' with warm to hot summers and cool winters. It is subject to 'cool changes' when temperatures can plummet from the high 30s to low 20s (degrees Celcius) in less than an hour. Although the City of Adelaide rarely experiences freezing temperatures it can feel very cold. Buildings need insulation to keep heat in during cold weather and keep heat out in hot weather. [See: Design for Climate]

The land was owned by the Wirranendi development cooperative during construction and individual properties were then sold on a community title. Each purchaser owns their own dwelling but also shares ownership and responsibility for the landscaped community areas that include a productive community garden and roof garden. On completion, the ground floor of the 5 storey apartment building will include a shared kitchen and laundry and small, general purpose hall for parties that won't fit in small apartments.

House and apartment prices were intended to include all the community areas and facilities that would eventually be provided and have ranged from the low $200,000s to $425,000. The non-profit structure of the development cooperative and its 'in-house' building company played a key role in keeping house prices in a range comparable to conventional inner-city properties in Adelaide.

DESIGN BACKGROUND

The brief demanded energy efficiency and high overall ecological performance. User participation in the development process and an ethical investment funding base were also important. It was intended to demonstrate and trial both the problems and possibilities of ecological, 'community-driven' development on urban sites.

Concerns ranged from broader issues of community participation to the detail of specifying materials to create non-toxic, healthy homes.

The site was purchased cheaply and this helped to keep development costs down, but because the buildings are relatively innovative and possess exceptional levels of insulation, etc., they each cost a little more. An individualised approach to each dwelling design also added costs.

The structure of the first completed building, a straw bale cottage, was built by volunteer labour. This helped reduce 'start up' costs in the building program. Most of the construction has been via a conventional building contract with some augmentation by volunteer labour. The timeline for the development was stretched by a series of unforseen circumstances and provided a series of financial challenges for the cooperative.

STRATEGY

The overall strategy was to use high internal mass within highly insulated envelopes with multiple user-controlled ventilation options and thermal flues. Vegetation and outdoor spaces were included as an integral part of the passive house design approach. Smaller house plan areas were favoured with quality of space considered more important than mere quantity. This is most clearly demonstrated in the first cottage built on the site, a two-storey, two bedroom straw bale house of just 55 square metres.

A range of dwelling types are represented in the project with differing configurations, orientations and construction systems that demonstrate the effectiveness of environmental design for various conditions and lifestyles.

The 2 and 3 storey cottages are detached structures but the 3 storey townhouses are linked. Solar control for the cottages and the first six apartments is limited to controlling east/west sun penetration (traditional timber shutters are planned for the apartments). The other dwellings have ideal solar orientation. Solar access angles dictated building heights and form within the site. Solar access to the neighbouring childcare centre was protected by careful design of roof profiles.

Plan and orientation

Each dwelling was individually designed but also planned to fit with its neighbours to create an urban environment of secluded gardens. Balancing privacy with shared community space was a requirement addressed by the creation of an internal pedestrian street based on the theme of a walled garden.

Shell fabric

Construction includes 300mm thick load-bearing autoclaved, aerated concrete for all external walls on the six apartments and linked four townhouses. 400mm load-bearing, low-strength concrete ('earthcrete') was used for much of the internal mass party walls between townhouses. There is some steel framing in the apartment building construction and these have reinforced concrete slabs on all floors. Timber-framed non-load-bearing, rendered 500mm straw bale walls were used for the cottages. [See: Construction Systems]

Pinus radiata proprietary trussed joists are used in the townhouses with plantation pinus or recycled timbers for joists in the cottages. Floor decking is generally pinus radiata. Joinery makes extensive use of Ecopanel, a compressed straw equivalent to particle board, containing no woodchips or formaldehyde. Unfortunately, the Australian company that made the sheets no longer operates and any equivalent product would now have to be imported.

All the buildings are set on stiff reinforced concrete slabs designed to resist the effects of Adelaide's notoriously unstable clay soils. The high volume of material content of the slabs was necessary to carry the townhouses and apartments and is justified by the small building footprints and their long life span.

Each house works as a 'thermal flue' allowing controlled release of warm air whilst drawing in filtered, cooled air from the vegetated, landscaped surroundings. In a real sense, the development is not complete until the accompanying landscaping is complete. The apartments rely on good cross-ventilation and high thermal mass for cooling with the roof garden adding a thermal buffer to the upper floor apartments.

The planned life of the buildings is in excess of 100 years. During this time the shells are expected to remain much the same but internal partitions, doors and windows - made mostly from renewable materials - may be changed.

Thermal mass

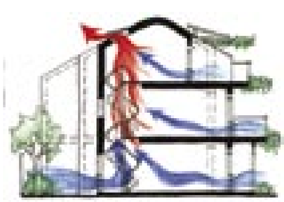
The concrete slabs provide substantial internal mass, particularly to the cottages and apartments. With no freezing days, perimeter insulation of the slabs was not regarded as necessary. The Earthcrete' walls place additional thermal mass between the townhouses and assist in noise reduction between dwellings. The cost and logistical problems associated with poured concrete technology prompted a change to thick masonry walls in the apartment and townhouse buildings. [See: Thermal Mass]

Ventilation

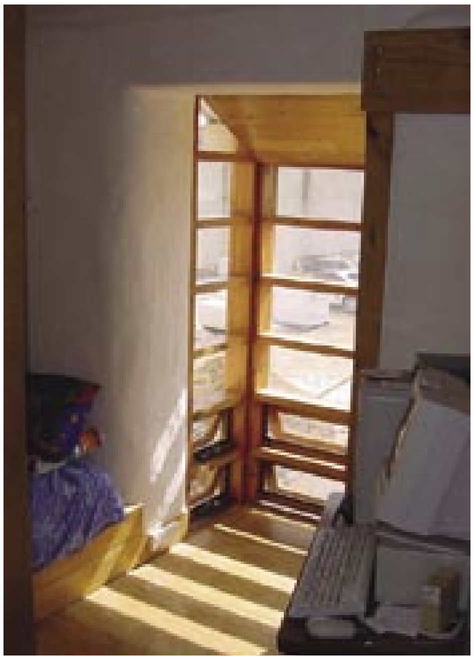
Good ventilation is critical to the performance of these buildings. Fresh air is filtered and cooled by surrounding vegetation and landscaping and drawn through the dwellings by convection. Many opening windows are small, top-hung and set low in sets of two or three to draw in the low lying cooler air. Purpose designed vents, high level louvres, or ventable skylights exhaust warm air at the top of the dwellings. They create outlets for the thermal flues formed by the stairwells of each dwelling. [See: Passive Cooling]

Windows and glazing

Windows are all purpose-made from recycled timber.



All fixed windows are double-glazed. Sealed units are used throughout except for the first 2 storey cottage. Louvred windows are single glazed because they represent a small proportion of the glazed area and are expected to be open most of the year and will thus only lose a small amount of heat during cold periods.



Materials

Non-toxic construction and finishes are used throughout, avoiding formaldehyde almost completely and with minimal amounts of PVC. Timbers are plantation Pinus radiata or recycled (typically, oregon). The environmental plus cost criteria for materials led to unexpected choices with aesthetic benefits, eg. purpose-built spiral stairs in steel and recycled jarrah. [See: Materials Use Introduction, Waste Minimisation]

All concrete in slabs and mass walls contains the maximum percentage of flyash that the engineers and suppliers (Pioneer Concrete) would allow. Flyash is a waste product from power stations and its use reduced the amount of new cement used in the construction. Cement production is one of the largest contributors to global greenhouse gas emissions.

Insulation

Insulation is provided to the townhouses and apartments by 300mm Thermalite walls. 450mm straw bales insulate the cottages. A basement in one of the townhouses is insulated by earth berming and provides additional 'coolth' to that dwelling. Ceilings generally follow the roof-lines and are insulated with reflective foil sarking and 150mm Tontine polyester batts. The preferred option of cellulose fibre (recycled paper) insulation was not appropriate due to the sloping ceilings. [See: Insulation]

Floorings and finishes

Flooring throughout is generally Marmoleum by Forbo, a modern variant of linoleum that was selected on its aesthetic merit and environmental credentials. It consistently tops the list of 'green' proprietary flooring materials in studies around the world and allows a rich design palette of colour and pattern. Wet areas are tiled with ceramic tiles. Some clients have chosen ceramic tiles for living areas and others, including the owner of the first straw bale cottage, chose bamboo flooring in some areas. This attractive and environmentally promising material is currently only available as an imported product but Australian plantations and production are supposedly imminent.

All finishes are chosen on the basis of environmental and non-toxic criteria. Externally, it has been found necessary to use more conventional formulations to cope with Australian conditions. [See: Indoor Air Quality]

Lighting
Considerable effort was made to ensure naturally well-lit rooms and spaces. Light fittings are conventional, with a mixture of compact fluorescents supplemented with incandescent globes. [See: Glazing Overview]

Heating and cooling systems
Some ceiling fans are included to assist in maintaining air flow on still days, but no heaters or air-conditioners were provided and the expectation was that none would be needed to supplement the passive heating and cooling of the houses. [See: Passive Solar Heating; Passive Cooling]

Stormwater
Water shed by the roofs, balconies and other impervious surfaces is collected for use on site in two 20,000 litre underground tanks situated beneath the carports. The water is used for irrigation and toilet flushing, reducing total water importation to the site. [See: Rainwater]

Greywater & Blackwater
Chlorine-free sewage treatment was planned. A Coast and Clean Seas grant enabled the provision of a sewage mining system (by Resource Recovery) but its running costs were such that the community corporation decided to retire its use. The Christie Walk community is planning to revisit the challenge of on-site treatment of black and grey water. [See: Wastewater Re-use]

Hotwater and fittings
All dwellings have solar hot water with electrical backup. The apartments have a shared system with banked solar panels and a gas-fired boiler backup. Low water use shower heads help control the water supply. Some proprietors have installed under-bench filters that provide drinking water at low flow rates.

Energy supply
Mains electricity is drawn from the grid but photovoltaic panels set on pergolas over the Stage 2 apartments' roof garden and on the roof of the Stage 3 apartments will generate electricity for sale to the local energy utility. The expectation is that the site will export energy for much of the year because the dwellings require little energy for space and water heating, cooling or lighting.

Major appliances
All new appliances have high energy efficiency ratings. Companies with a recycling program were favoured when specifying appliances. 5 of the dwellings have gas cooktops, all dwellings have high efficiency electric ovens. Gas was initially favoured for its energy efficiency but the improved efficiency of electric cookers and concerns regarding indoor air quality led to the developer specifying electric-only appliances in the latter stages of the project. [See: White Goods]

Site impact
The site was occupied for predominantly commercial and some residential use prior to redevelopment. The overall site impact might be regarded as positive as the project retains nearly all stormwater on-site and there is already a considerably more productive and vegetated landscape after redevelopment than before. [See: Biodiversity On-site]

Landscaping
Native and indigenous species and plants with low water requirements were used. Some exotics were used where appropriate to suit passive design considerations (the largest tree will be a deciduous Neem). Exotics and productive food plants are supported by on-site water recycling that assists in maintaining minimal overall water consumption. The project's 'intensive' roof garden (the first in South Australia) is an important contribution to biodiversity and site amenity. [See: Sustainable Landscape]

Waste minimisation
Paving, and feature elements incorporate bricks, stone, steel and timber retrieved from demolition of pre-existing structures on the site. [See: Waste Minimisation]

Noise control

The highly insulated external skins, double glazed windows and massive party walls make this a much better acoustic environment than might be expected in a dense urban setting. The passive cooling strategy requires windows to be open much of the time but the baffling effect of vegetation and absence of hard road surfaces contribute to relatively good noise control.

Transport and food

Reduction of transport demand and provision of food production capability were part of the strategy for this project. The site's location within walking distance of good public transport meant fewer cars were needed so Council planners supported a lower than usual car park provision, 11 spaces for fourteen 2 or 3 bedroom dwellings. Despite extreme site limitations it was possible to include a small community garden to demonstrate that even the tightest urban site can produce food. [See: Transport]

EVALUATION

The non-profit development structure, ethical investment base and community involvement enabled this experimental project to proceed and withstand delays and personal tragedies. It survived where a conventional development would probably have been abandoned or changed beyond recognition.

The 'earthcrete' wall was difficult to construct and cost more than anticipated. As an attempt to provide affordable high-mass construction and as an alternative to rammed earth, it is moderately successful.

The building designs are being proven through occupation and use and the signs are that they are mostly successful. There is a tremendous sense of ownership and understanding about the designs that both reflects and reinforces the community basis of the development approach. People have been able to purchase much more than just a house in the city.

The community facilities will be an important part of the project, providing a meeting place and a laundry. These facilities are planned to be part of the project's third stage of development – a small 5 storey building containing 13 apartments.

The use of recycled material and the requirement that residents lay the external paving has contributed to the creation of a creative, attractive environment. Any project not able to tap the same level of commitment and goodwill from its clients would be more expensive.

Rigorous cost planning requires good information that was not available the first time around but details and costs associated with the innovative approaches to construction and design have now been tested and refined. It should be much easier to predict programming and costing for future developments and to manage the interface between community engagement and conventional building processes.

Independent studies by Monica Oliphant through Urban Ecology Australia and by Veronica Soebarto of Adelaide University (available from Ecopolis Architects) indicate that the buildings demonstrate a very high level of performance that can be significantly dependent on the patterns of use by their occupants. This reinforces an observation being made by a number of designers working on sustainable domestic design.

PROJECT DETAILS	
Architecture and Urban Design	Ecopolis Architects Pty Ltd.
Project Architect	Paul F Downton.
Project Manager	Wirranendi Inc. (Ed Wilby) and Fradenduit (Stages 2 & 3)
Structural & Mechanical Engineer	Sagero Consulting, Adelaide (Stages 1 & 2).
Builder	EcoCity Developments Pty Ltd, (formed specifically for the project) with sub-contractors.
Community processes	Urban Ecology Australia Inc.
Landscaping	Ecopolis Architects Pty Ltd (Chérie Hoyle) supporting on-site community initiatives.
Documentation architects	ADS Architects, Adelaide (Stage 1), Ecopolis Architects Pty Ltd (Stages 2 & 3).