your Home

DESIGN FOR LIFESTYLE AND THE FUTURE

TECHNICAL MANUAL FOURTH EDITION







Australia's guide to environmentally sustainable homes

Clovelly NSW

RENOVATION

ZONE 5: Warm temperate

Topics covered
Passive heating and cooling
Accessible design
Reduction in greenhouse gas emissions
Reduction in water use
Rainwater harvesting
Greywater treatment
Materials use
Indoor air quality

AccuRate (thermal comfort)	Existing 2.7 (regulatory)
AccuRate (thermal comfort)	Renovation 3.4 (regulatory)

This award-winning Sydney renovation turns site constraints into opportunities, creating a spacious, light-filled home that is a showcase for leading-edge domestic water management. The renovation reduces the existing home's environmental impact and incorporates innovative technologies as an integral part of the architectural expression.

In pursuit of their philosophy of making the principles of sustainability an essential element of the design approach, the designers extended their concerns to incorporate the principle of universal access and adaptability with the home designed to accommodate an occupant with limited mobility.

BACKGROUND

Location and site

The house is in Clovelly, an inner coastal suburb of Sydney. Located within a warm temperate climate zone, it enjoys mild winters and warm summers moderated by cooling sea breezes. Rainfall is relatively high at around 1,200mm per annum. The architect describes the site as 'complex and constrained' due to its tight 234m^2 area and east-west orientation, which limits the potential for easy solar access. The existing house was a small, 'dark and poky' semi-detached dwelling with its long façade facing south.

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Design brief

The owners wanted to open the house up to the garden and to natural light, a typical requirement for many inner-city renovations. Less typical was the need to meet the spatial and accessibility needs of an occupant with an ambulant disability. The owners were also keen to address key environmental issues and push boundaries where possible. They were particularly keen to 'do something significant' in response to Australia's pressing need to conserve water. [See: 7.2 Reducing Water Demand]

DESIGN RESPONSE

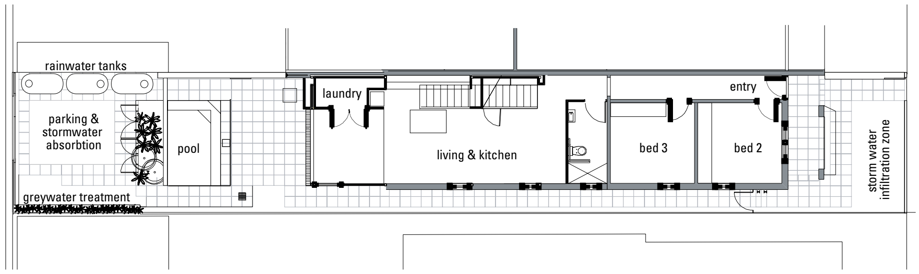
The key design challenges were to manage the site's poor solar access, maximise spaciousness on a tight site, and integrate the resulting open plan format with thermal and acoustic comfort.

Whilst the majority of the structure of the existing house was retained, the entire back wall was removed to accommodate a two storey addition. The addition encompasses a living area on the ground floor, and a home office, main bedroom, bathroom and kitchenette on the upper floor. At its centre are a staircase and void, creating a pivot around which the home operates. The northern wall along the staircase accommodates an extensive library.

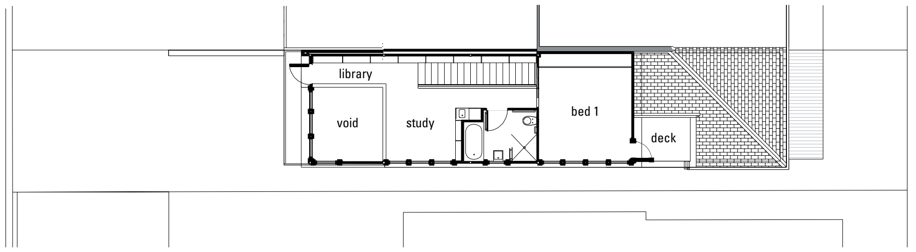
The geometry of the addition is based on a series of solid and open intersecting cubes, carried through into the design of the landscape. This underpinning design theme helps to provide a sense of unity, clarity and space. Urban design issues of privacy, scale and massing were respected and the approvals process was relatively straightforward. The house integrates a range of innovations including a vertical 'green wall' for greywater treatment, the first of its kind in Australia. [See: 5.13 Green Roofs and Walls]

Passive design strategy

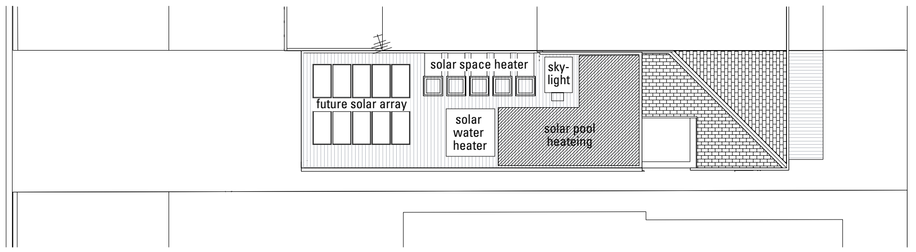
The renovated house is designed to minimise the need for artificial heating, cooling and lighting and avoids reliance on mechanical systems like air conditioning in order to achieve ongoing cost savings and environmental benefits.



Ground floor



First floor



Roof top

Natural cooling in summer is achieved through strategic placement of openings for cross ventilation. The double height void, as well as providing a sense of space, creates natural ventilation through the 'chimney effect'. Warm air is exhausted through high-level glazing and skylights, which in turn pulls fresh cooler air through the house at ground level. The west-facing wall can be opened up at night to encourage heat loss.

Shading on the west-facing glazing minimises unwanted heat gain in summer. On the ground floor, a deep recess provides protection. At a higher level, adjustable external louvres screen out low angle western sun in summer whilst admitting it to warm the living areas in winter. [See: 4.6 Passive Cooling]

Double height voids and large glazed areas can be particularly problematic in terms of heat loss. This is counteracted to an extent by the solar powered heating system, however in retrospect the architect would have decreased the amount of south-facing glass and incorporated double-glazing to improve winter comfort. Draught protection on doors and windows helps to retain heat in winter. [See: 4.5 Passive Solar Heating]

Thermal insulation under the roof and above the ceiling is an important part of the passive design strategy, minimising unwanted heat loss and gain.

The concrete ground slab is covered with a battened timber floor. This reduces utilisation of the slab's heat storing properties, but allows quicker warming and cooling of the space. Similarly, the metal-clad brick veneer wall construction reduces the ability of the bricks to store heat but allows quicker warming and cooling of the space. [See: 4.9 Thermal Mass]

Light-coloured internal walls, skylights and clerestory glazing minimise the need for artificial lighting during the day.

'ACTIVE' SOLAR ENERGY SYSTEMS

Space heating and cooling

A proprietary solar-powered heating and cooling system is used to enhance indoor comfort without creating any greenhouse gas emissions. The system is a recent Australian invention and consists of two solar-powered fans and a heat collector on the roof. The heat collector is a metal and glass box, similar in principle to a solar hot water panel. The system works by raising the ambient indoor temperature in winter and extracting hot air in summer.

In winter the fans draw air from ceiling level, heat it to about 50º Celsius in the collector, and pump it back to floor level via insulated ducts. In summer the fans draw hot air from ceiling level out through an opening flap on the collector. For this home, one heat collector panel was installed as a trial, however in retrospect two panels would have been more appropriate. The cost of the system was approximately $2,500. Ceiling fans are also used to keep the home cool in summer. There is no air-conditioning or auxiliary heating used.

Water heating

The home uses an electrically boosted solar hot water system located on the roof. Heating for the small therapeutic pool is provided by a solar pool heating system, consisting of a series of heat-absorbing collector pipes located on the roof.

WATER MANAGEMENT

One of this project's special attributes is its treatment of sustainable water management technologies as an integral part of the design rather than aesthetic or conceptual 'add-ons'.

The owners were particularly committed to reducing their mains water use, firstly through a high level of water efficiency, and secondly through the capture and treatment of alternative water sources. The latter added approximately $20,000 to the cost of the renovation but enabled an estimated 80 per cent reduction in mains water use.

The different qualities of water available are carefully matched to appropriate uses. Mains water is used for drinking and cooking only. Rainwater is used to supply showers, baths, bathroom taps and the small pool. Greywater is collected from the bath, basin and shower and treated for use in toilets, the washing machine and garden irrigation. Water from the toilet, kitchen and washing machine is discharged to the sewer.

The home has a 'triple pipe' reticulation system for mains water, rainwater and greywater. Installing this was relatively easy given the significant scale of the renovation.

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Water efficiency

Water demand is reduced through the use of water efficient taps and showers, dual flush toilets, a water efficient washing machine and outdoor planting with low water needs.

Rainwater collection and use

Three rainwater tanks with a collective capacity of 9,000L were specially manufactured to fit the limited space available and form a 'wall' along the northern boundary of the garden. Rainwater is collected from a roof area of approximately 100m^2 for use in showers, baths, basins and the pool. When asked about tank capacity, the architect suggests engaging a hydraulic engineer to do a water balance report. This takes into account factors such as the uses for rainwater, the roof area for rainwater collection and the amount of local rainfall to determine suitable storage capacity. The inclusion of a greywater system as part of the sustainable water management strategy allowed the storage capacity for rainwater to be reduced, compared to using rainwater only.

The rainwater system is outperforming expectations in terms of water quality. Analysis suggests the rainwater is of potable standard, but Sydney Water and NSW Health do not support the use of rainwater for potable purposes. [See: 7.3 Rainwater]

Greywater treatment and re-use

The 'green wall' system for greywater treatment was developed in association with environmental engineers ENVDS. It combines the popular European concept of 'green walls' as landscape elements with greywater treatment technology to produce a system appropriate for small urban lots – claimed to be the only vertical greywater system of its type in the world.

Water from the bath, shower and bathroom basin is stored in a holding tank and then pumped to the top of the green wall. Using gravity, the water trickles through a series of three planter troughs which act as filters, removing nutrients, polluting compounds and organic matter from the water. The sand in the filters does most of the work, whilst the plants are selected partially to enhance the treatment process and partially on the basis of being able to survive in a nutrient-rich sand base. The final stage of treatment is UV filtration, which was a requirement for approval of the system but has been found through monitoring to be unnecessary. The treated water is stored in a tank underneath the green wall for re-use in toilets, the washing machine and the garden. Any excess greywater overflows to the sewer.

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The green wall is approximately 6m long, 2.1m high and 400mm wide. It consists of a galvanised steel frame and 3 horizontal folded steel sheet trays, and is designed specifically to save space and utilise gravity feed. The green wall is not yet an 'off the shelf' product, and expert input is required to determine the size and composition of the filters relative to the specific situation.

The treated greywater is non-potable, and regular testing confirms it meets NSW Health requirements for use in the toilet and washing machine. The green wall does not have the capacity to treat the nutrient-laden water generated by the washing machine, so this is discharged direct to the sewer. The green wall cost around $10,000. Because it was a prototype, future versions are likely to cost less and be smaller. [See: 5.13 Green Roofs and Walls; 7.4 Wastewater Re-use]

Stormwater management

Excess stormwater not captured by the rainwater system is directed to underground absorption pits in both the front and rear garden, to recharge the aquifer and ensure that there is virtually no run-off from the site. [See: 7.5 Stormwater]

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RENEWABLE ENERGY

Suitable roof space was incorporated into the design to facilitate future installation of a photovoltaic system, recognising that the costs of installing such a system are likely to decrease over time.

LIGHTING AND APPLIANCES

Energy efficient compact fluorescent lighting is installed throughout the home. LED (light emitting diode) lighting, another very energy efficient technology, is also used in selected locations. Appliances have been chosen for their energy and water efficiency ratings. The fridge has a 5 star energy rating and an external clothesline prevents the need for an energy-hungry clothes drier. [See: 6.4 Appliances]

CONSTRUCTION MATERIALS

Attention has been paid to the ecological and health impacts of materials and finishes. Plant-based 'bio paints' have been used for internal walls and ceilings. These bio paints improve indoor air quality, as they do not off-gas toxic volatile organic compounds (VOCs). Similarly, floors have been finished with natural vegetable-based oils instead of polyurethane, to avoid VOCs.

Sustainable timbers, including spotted gum timber flooring, have been selected for use in the home. Databases such as Ecospecifer now make the task of researching the sustainability credentials of such timbers much easier.

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Because of their lower embodied energy, polypropylene pipes are used for water supply plumbing rather than copper.

External pavers have been selected for their low embodied energy and are laid so as to allow stormwater infiltration through the paving joints. [See: 5.2 Embodied Energy]

ACCESSIBLE 'UNIVERSAL' DESIGN

The home demonstrates an important aspect of social sustainability – the ability to accommodate occupants with varied levels of mobility. In response to the needs of a client with an ambulant disability, the bathroom, master bedroom, home office, stairs, kitchen and living spaces are all wheelchair accessible. The bathroom has the generous door width and layout needed for compliance with AS1428.1. The kitchen contains an island bench on castors that can be moved to make more space.

The home office is upstairs in the centre of the house, overlooking the living area and garden, and has been cleverly designed to reduce the need for physical movement. It includes a control for the front door, and is adjacent to a kitchenette and bathroom. A wide staircase with a gentle gradient, fitted with a stair-climber, provides easy access to the upper level. [See: 3.2 The Adaptable House]

LANDSCAPE

The rear garden is divided into two equal courtyard spaces, based on the same geometry as the home extension. The courtyard closest to the house is designed as an extension of the living space. It contains a 7,500L therapeutic pool, supplied exclusively with rainwater. The rear courtyard functions as a garden and service area, accommodating water storage and treatment and an off-street car parking space. It is flanked by rainwater storage along one boundary wall and the 'green wall' along the other – both of which are treated as a vibrant part of the landscape design rather than hidden from sight.

An intermediate wall between the two courtyards houses pumps and other equipment to support the pool and water treatment. It incorporates a feature wall, a fountain and a slate-covered planter box. The fountain, pool and water wall help to condition the air on hot dry days through evaporative cooling, dropping the temperature outside the living areas by several degrees.

Local native plants and groundcovers are used throughout the garden, chosen in part for their low water needs. It includes native trees such as Blueberry Ash and Lilli Pilli which both grow rapidly and afford considerable shade to the west facing windows. The expectation is that the combination of these trees plus the substantial trees on the adjoining property will mean that within a few years the windows will receive very little summer heat load. [See: 2.4 Sustainable Landscapes]

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EVALUATION

The renovation was completed prior to the implementation of BASIX, however retrospective scoring using BASIX estimates the home uses 25 per cent less energy and 54 per cent less water than the average NSW home. Onsite metering and records kept by the occupants show the home is achieving a reduction of 75-80 per cent in mains water use, compared to the home's consumption before the renovation. The occupants are pleased with the radical cuts in water consumption, claiming that they have never run out of tank water despite being in a period of almost constant drought since the house was occupied.

Although there were some teething problems associated with the renovation's innovative approach, the experience was largely a positive one. The plumber initially contracted was not receptive to the sustainable water management initiatives, so a new more committed plumber was found. After initial caution, the builders became interested in trying a fresh approach. Local Council staff were enthusiastic and helpful, and the mayor has since visited the house and showcased it in presentations.

Completed in 2004, the house has won a range of awards including the Gold Medal at the NSW Green Building Awards and the Royal Australian Institute of Architects' Sustainable Architecture award, and it has featured in print publications and television news and lifestyle programs.

The home is proving easy to maintain, meeting the goal of making its owners' lives easier rather than harder.

PROJECT DETAILS	
Architects:	Steve Kennedy, Simon Anderson and Erin Owens, Kennedy Associates
Environmental Engineer:	Toby Gray, ENVDS
Hydraulic Engineer:	Javid Nasseri, Nasseri Associates
Structural Engineer:	Cosmo Farinola, Low and Hooke Partners
Landscape Architects:	Mike Horne, Turf Design Studio
GreyWater System:	Garden Saver – Ken Pepyat

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