Springfield Lakes
sustainable display houses:
a research report on design, costs, innovation and assessment

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Queensland

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Purpose

- To provide a summary of statistics and costs on the construction of three display homes that are more sustainable at Springfield Lakes that opened for public display in March 2004; and

- To analyse the financial and construction issues encountered in the design and construction phase of these houses, and to provide recommendations from these learning's.

The research presented in this report was carried out by Cooperative Research Centre for Construction Innovation scholar, **David Luxmoore** of Sustainable Development Strategies Pty Ltd.

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Executive summary

Three innovative houses, designed and built by Civic Steel Homes, are located at Springfield Lakes, 28 km South-West of Brisbane. They have succeeded in setting a new benchmark for project home construction. Innovation, through integration of passive design for small lots, rainwater capture and re-use, energy and water efficiencies, and many simple design initiatives that improve liveability outcomes has positioned these project homes as leaders in sustainable housing.

The houses feature improved sustainable design and off-the-shelf materials that can be taken up relatively easily by industry and mainstreamed as project homes. These features retain style and comfort in the home and also add to their performance in 'future-proofing' throughout their life-cycle operation. This means they also potentially offer a greater return on investment as a higher quality product in their market niche.

The objective of the research is to provide industry with practical examples of actual costs and these experiences from incorporating innovative design that could be used for decision-making in other project housing.

This case study describes the integrated design processes used in the construction of the sustainable houses and the cost/benefit assessments for the key energy and water initiatives and social inclusions (safety, security and universal design), as well as the problems encountered in the design and construction processes, along with possible solutions.

The percentage costs of including features that contribute to increased environmental, social and economic sustainability (as a combined average value for the three houses, or as otherwise stated) were:

- the passive design elements, such as orientation, insulation, window treatments, higher ceilings and shading, comprised 2.3% (or $6,277 of the total cost of the houses);
- the energy efficiency elements, such as Greenhouse gas efficient hot water systems, lighting, fans, appliances and smart meters comprised 1.0% (or $2,613 of the total cost of the houses). This does not include renewable

Leaders in sustainable housing

Lot 894

Lot 895

Lot 896

energy generation (photovoltaic cells) installed only in the largest house that cost an additional 2.2% (or $7,350 of the house cost);
- the liveability elements, including safety and security features, such as wider doors and hallways, level entry thresholds, slip resistant floors and good casual surveillance, comprised 0.2% (or $582 of the total costs in each of the houses);
- water efficiency elements, such as ‘AAA’ or higher rated shower roses, 6/3 litre dual flush toilets, internal tap flow restrictors, thermostatic mixers comprised 0.0% due to their product range and general acceptance as market standards;
- landscaping elements, such as automatic sub-surface irrigation, timers on external taps and mulch, comprised 0.4% of total costs;
- water storage and supply for whole-of-house use, including features such as 12,000 litre rainwater tanks, water quality devices, pumps and irrigation comprised 2.3% (or $6,314 of the total cost of the two houses on which they were placed); and
- no additional cost for superior air quality as a result of using non-toxic paint and very low toxicity floor and timber finishes.

Energy efficiency elements, such as Greenhouse gas efficient hot water systems and appliances, comprised 1.0% of the total cost of the houses.

Additionally, employing a triple bottom line approach in design and construction is expected to yield the following predicted annual average household performance in water and energy use, Greenhouse gas emissions and ongoing savings (per house):
- a 74% (270 kilolitres) predicted reduction in town water use, through the inclusion of a whole-of-house use of rainwater tank system (12,000 litre storage), compared to conventional housing. This includes a 35% predicted reduction due to increased water efficiency elements, such as ‘AAA’ or higher rated shower roses, water efficient appliances and appropriate landscaping. The quality of water supply can be maintained at safe levels with currently available devices and minimal maintenance;
- a 50% (4.1 tonnes) predicted reduction of Greenhouse gas emissions compared to conventional housing; and
- annual electricity savings of $504.

The predicted payback periods for these water and energy features are:
- passive design (orientation, insulation, glazing, higher ceilings, shading) – 12 years;
- energy efficiency (lighting, fans, whitegoods) – within the first year;
- Greenhouse gas efficient hot water system (2 x solar, 1 x instantaneous gas) – 7 years;
- water efficiency (‘AAA’ shower roses and taps, dual flush toilets, ‘AAA’ or higher rated whitegoods) – provide immediate savings;
- water supply for whole-of-house use (tanks, water quality devices/filters, pump, irrigation) – there is marginal payback to the individual householder within the life of these devices at current water pricing rates and government policy on permissible uses. However, it is recognised that there are environmental and infrastructure benefits associated with rainwater tanks that are difficult to determine; and
- all combined initiatives – 12 years (including cost of and rainwater supply system).

It should be noted that the costs and benefits presented are applicable only to the three houses at Springfield Lakes and, as such, should be interpreted as indicative figures for houses in other locations that may incorporate similar sustainable design features. Total context considerations such as site location, design proposals and prevailing local market conditions (eg. labour and materials; energy and water pricing) will determine specific costs and benefits for other houses.

1.0 Introduction

The construction of the Springfield Lakes sustainable demonstration houses was completed in March 2004.

The three sustainable houses[1] for public display at Summit Drive, Springfield Lakes were constructed on lots varying in area (332m^2, 415m^2 and 785m^2) and were completed in March 2004 after approximately 14 months of planning, design and construction. The houses are part of the second Housing Industry Association 'GreenSmart Village' in Delfin Lend Lease's Springfield Lakes district located in Ipswich City, and are 25 kilometres South-West of Brisbane's CBD.

Their brief was to include passive design, 'off the shelf' products, improved water and energy efficiencies, minimise site disturbance and good site management. The houses were also to incorporate new and appropriate technologies such as smart wiring, smart meters and a solar ventilator (which is a roof-mounted, solar powered, thermostat controlled, extraction fan). Another important consideration in designing and constructing the houses was comfort, liveability and flexibility to ensure each house accommodated the changing needs of residents through all stages of their lives.

The Springfield Lakes sustainable houses project was the result of a varied and extensive partnership between:

- Wesley Mission – project manager;
- Housing Industry Association (HIA) – 'GreenSmart' initiative;
- Delfin Lend Lease – master-plan developer and land contributor;
- Civic Steel Homes – architect and builder;
- Department of Housing – Smart Housing program;
- Environmental Protection Agency – Sustainable Industries Division;
- Ipswich City Council – Local Government Authority;
- Cooperative Research Centre for Construction and Innovation (CRC-CI) – scholarship support for research of the GreenSmart Village;
- CSIRO – technical support; and
- Various suppliers and trades – whose products and services were donated or substantially discounted.

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1. It is recognised that each of the three houses selectively incorporate a range of features that have been integrated into their planning and design to substantially improve their sustainability performance. While they are not considered to represent the end goal of fully 'sustainable housing', they do however set a significantly higher benchmark above conventional project housing in Queensland.

2.0 Desired outcomes

The following section outlines the strategies employed to achieve key sustainable housing outcomes with these houses.

Louvres provide cross-ventilation to overcome the summer heat.

2.1 Desired outcome: overcoming summer heat

Strategies:

- addressing house orientation to true North;
- insulation – roof, ceilings, walls;
- eaves and overhangs;
- shading – external structures, other buildings;
- windows – location, size, treatment, protection;
- cross-ventilation;
- roof and external wall colours and materials;
- room zoning; and
- thermal mass – shading in summer.

2.2 Desired outcome: overcoming cooler winter temperatures

Strategies:

- addressing house orientation to true north;
- insulation – roof, ceilings, walls;
- eaves and overhangs;
- windows – location, size, treatment, protection;
- weatherproofing;
- room zoning; and
- thermal mass – exposure in winter.

2.3 Desired outcome: improving energy efficiency

Strategies:

- natural day-lighting;
- compact fluorescent lights;
- efficient 12 volt task lights;
- dimmers;
- smart sensor lights;
- high star energy-rated whitegoods;
- smart meters that show energy use;
- solar or instantaneous gas hot water systems; and
- renewable energy – photovoltaics.

2.4 Desired outcome: improving water efficiency

Strategies:

- ‘AAA’ or higher water-rated whitegoods, shower roses and tap-ware;
- dual flush toilets;
- mixer taps in showers and baths;
- landscaping with native plants and well-mulched gardens incorporating water sensitive design (e.g. stormwater retention basin);
- limited lawn area;
- rainwater tanks for house and garden use; and
- smart meters that show water use.

Rainwater tanks were installed to achieve greater water efficiency.

2.5 Desired outcome: minimise long-term maintenance.

Strategies:

- use of good quality materials, paints and finishes;
- hardwearing floors and coverings; and
- use of galvanised steel framing and light organic solvent preservative (LOSP) treated timbers.

2.6 Desired outcome: responsive to changing needs

Strategies:

- level entry floor thresholds (where possible);
- hobless (step-free) showers;
- location and size of power points and light switches;
- wider door entrances and hallways;
- lever or D-shaped door handles;
- smart wiring that can provide telephone/computer access to most rooms;
- open plan living; and
- areas for home office or bedrooms.

Level entry floor thresholds accommodate the changing needs of residents.

2.7 Desired outcome: safe and secure.

Strategies:

- non-slip floor surfaces;
- casual surveillance of children's play areas;
- well-lit covered entrance;
- security locks;
- outdoor lighting;
- level entry floor thresholds (where possible);
- rounded and accessible bench tops and sinks; and
- hobless (step-free) showers.

Being able to see outside the door without unlocking it makes the house more secure.

2.8 Desired outcome: good indoor air quality

Strategies:

- low-toxic paints;
- low formaldehyde carpentry;
- non-toxic timber finishes;
- natural product blended carpets; and
- good ventilation.

2.9 Desired outcome: reduce on-site construction waste

Strategies:

- approved waste management plan with local government authority; and
- advise builders and contractors of its measures (e.g. place 'waste' material in recycle bins).

Overall Expected Benefits

These outcomes and strategies should lead to homes that are more comfortable, adaptable, accessible, safer and more cost-effective.

It was anticipated that all the above outcomes and strategies, when compared to current project housing approaches, would result in:

- more comfortable living spaces, reducing the need to mechanically cool and heat the houses;
- adaptable homes that are more accessible and convenient, as well as safer for people to live in, thereby improving their quality of life;
- more disposable annual income for the occupant(s) due to reduced operational costs and potential retrofit expenses; and
- greater investment potential through offering a higher quality product on the market given the house's style and future-proofed performance.

Note:

All Queensland houses in the future are highly likely to include energy and water efficient design features as partial measures to improve their operating performance (this may also include social design features). For example, New South Wales has legislated an energy and water building approval checklist for all future houses, known as BASIX. Victoria has adopted five-star energy rating for all new housing, with mandatory provisions for rainwater tanks and solar hot water systems. Also, house energy ratings are already required upon re-sale in Canberra through ‘mandatory disclosure’ (whereby houses with higher star ratings gain on average up to $20,000 above houses with lower stars). In Queensland, the State Government is currently developing a Sustainable Housing Policy Framework to determine which measures are appropriate for Queensland.

3.0 Costs and benefits of desired outcomes

The percentage costs of including features that contribute to increased environmental, social and economic sustainability (as a combined average value for the three houses, or as otherwise stated) (Refer to Appendix 1):

- the passive design elements, such as orientation, insulation, window treatments, higher ceilings and shading, comprised 2.3% (or $6,277 of the total cost of the houses). If adopted, this would result in predicted annual savings of $522 per house/year compared to conventional approaches;
- the energy efficiency elements, such as Greenhouse gas efficient hot water systems, lighting, fans, appliances and smart meters comprised 1.0% (or $2,613 of the total cost of the houses). This does not include renewable energy generation (photovoltaic cells) in the largest house that cost an additional 2.2% (or $7,350 of the house cost);

Average cost of liveability features that make the home more accessible, safe and secure cost was only $582 of total costs.

- the liveability elements, including safety and security features, such as wider doors and hallways, level entry thresholds, slip resistant floors and good casual surveillance, comprised 0.2% (or $582 of the total costs in each of the houses);
- water efficiency elements, such as 'AAA' or higher rated shower roses, 6/3 litre dual flush toilets, internal tap flow restrictors, thermostatic mixers comprised 0.0% due to their product range and general acceptance as market standards;
- landscaping elements, such as automatic sub-surface irrigation, timers on external taps and mulch, comprised 0.4% of total costs;
- water storage and supply for whole-of-house use, including features such as 12,000 litre rainwater tanks, water quality devices, pumps and irrigation comprised 2.3% (or $6,314 of the total cost of the two houses on which they were placed) and
- no additional cost for superior air quality as a result of using non-toxic paint and very low toxicity floor and timber finishes.

It should be noted that the costs and benefits presented are applicable only to these houses and, as such, should be interpreted as indicative figures for houses in other locations that may incorporate similar sustainable design features. Total context considerations such as site location, design proposals and prevailing local market conditions (e.g. labour and materials; energy and water pricing etc) will determine specific costs and benefits for other houses.

Benefits/savings

Water efficiency features provide immediate savings.

Good on-site waste management during construction saved $100 per house.

The benefits and savings are summarised as:

- A 74% (270 kilolitres) predicted reduction in annual town water use for whole-of-house use tank system (12,000 litre storage) compared to a conventional house. This includes a 35% predicted reduction due to water efficiency elements, such as shower roses, appliances and landscaping.
- The predicted payback periods for these sustainability features are:
  - passive design (orientation, insulation, glazing, higher ceilings, shading) – 12 years;
  - energy efficiency (lighting, fans, whitegoods) – within the first year;
  - Greenhouse gas efficient hot water system (2 x solar, 1 x instantaneous gas) – 7 years;
  - water efficiency ('AAA' shower roses and taps, dual flush toilets, 'AAA' or higher rated whitegoods) – provide immediate savings;
  - water supply for whole-of-house use (tanks, water quality devices/filters, pump, irrigation) – there is marginal payback to the individual householder within the life of these devices at current water pricing rates and government policy on permissible uses. However, it is recognised that there are environmental and infrastructure benefits associated with rainwater tanks that are difficult to determine; and
  - all combined initiatives – 12 years (including cost of rainwater supply system).
- Insulation was five times more cost effective than glazing treatments like tinting, 'low e' glass and films.
- An annual predicted reduction of 50% (4.1 tonnes) of Greenhouse gas emissions for each house compared to conventional housing.
- Good on-site waste management during construction saved $100 per house.

4.0 Project innovations

4.1 Designs on small sloping lots

The size and the slope of the lots determined the orientation and design for each house.

Different orientations and designs were chosen for each house based on the size and slope of the lots. Orientation for two of the lots (area: 332m^2–width: 10 metres; and area: 415m^2–width: 12.5 metres) was rotated to within 20 degrees of true North, thereby giving better solar access. Fortunately this was possible before the final survey plans were lodged at Ipswich City Council by the developer.

For narrow lots, a North-South orientation is usually the optimum because it allows for northern zoning of living areas and uses the close proximity of adjoining housing as summer shade for the eastern and western walls. It is generally less feasible to incorporate northerly solar access along the longer side boundary due to the close proximity of the adjoining house.

For small narrow lots, the influence of adjoining housing is huge and if this is not known at the design stage, it needs to be predicted. In the case of the Springfield Lakes houses, adjoining lots identified zero lot line boundaries and the developer covenants were influential in these small lot house designs. The house design on one narrow lot (12.5metres wide) incorporated an innovative covered double car garage in a tandem formation. Half of one side was open to the entry courtyard for the house that allowed easy covered access to the house, as well as being able to easily dissipate heat and fumes.

The sloping land (1:8, 12% or 4 metre drop over 33 metres) influenced the design, resulting in a small amount of concrete slab combined with elevated floors to minimise earthworks and site disturbance. The elevated floors provided space below for the location of rainwater tanks and possible future general storage, as well as allowing for cooling effects in summer.

4.2 Achieving water efficiency

Predicted water savings of 74% savings can be achieved through the inclusion of rainwater tanks, water efficient devices and appliances, and appropriate landscaping.

It is predicted that these houses will save 74% in water consumption compared to an average home's water use through the combination of rainwater tanks, water efficient devices and appliances and appropriate landscaping.

Rainwater tanks

Two of the display houses (lot 894 and lot 895) have 12,000 litre rainwater storage each, in two 6,000 litre squat polyethylene tanks, which are located under their back 'summer room' decks. This tank water is pressure-pumped for all drinking, internal and external house uses, which is a first for any residential display home in Queensland.

Four main issues needed to be addressed:

1. Water Quality

There were several components involved in maintaining water quality:

- pre-painted steel roofing and guttering, being stable and inert providing a safe collection surface;
- gutter-guards and rain-heads on downpipes provided filtering for most foreign objects, and the rain-heads include screens to keep out mosquitoes;
- first-flush devices to remove small impurities which would build up on the roof and in gutters between rain events. These were sized to allow for about 1mm of rain to flush the roof and gutters. The first-flush devices were placed underground thereby creating 'dry systems', which were made feasible because of the sloping lots;
- drinking-quality standard and chemically stable polyethylene tanks;
- a carbon filter was placed on the cold water tap in the kitchen to provide cleaner and better tasting drinking water; and
- ongoing maintenance would include 'bottom of tank' flushing (every 10-15 years), regular checking of gutter guards, rain-head screens, first-flush device outlets and pump operation with the replacement of pump when necessary.

2. Guaranteed supply

The unique pumping system uses a seamless switching process to allow pressured town water to bypass the tank water system as a contingency when there is a power failure, pump problem or the level in the tank reaches a pre-set low threshold. The system returns to tank water once the level rises above the minimum threshold. This guarantees supply as well as optimising tank water use.

3. Local Council approval

The unique pump switching system incorporates a backflow prevention device; however, the Ipswich City Council also requested another backflow prevention device (dual-check valve) at the property boundary. Council considers tank water a low hazard (class A), as they have a large number of households in their jurisdiction that use stored rainwater as their only supply.

4. Costs

There are two main costs: the initial system components and the ongoing pump energy, system maintenance and replacement costs. The system components were $6,300 (gutter guards, rain heads, first flush devices, tanks, pump, switching device and additional labour) with predicted annual electricity and maintenance costs of $98 and water cost savings of $81. Obviously, significant subsidies and mandating by governments and/or developers could be required to support broad-based introduction of safe and effective rainwater tank systems.

Devices and appliances (internal features)

The first two of these are essentially standard in all new houses:

- 'AAA' or higher rated shower roses and taps;
- dual flush 3/6 litre toilets;
- flow restrictors and aerators for selected taps and mixer taps for long flow situations; and
- 'AAA' or higher rated whitegoods (washing machines and dishwashers).

Appropriate landscaping

- well-mulched native gardens with little or no lawn; and
- pumped sub-surface irrigation.

Note:

It was envisaged that selected greywater (from showers, basins and washing machine) would be kept available for sub-surface use when State legislation amended to allow for this on-site use (i.e. expected after 1 July 2005). Plumbing for this direct dispersal was incorporated in each of the houses and remains an operational option for the future.

4.3 Liveability features

Each of the three display homes incorporates a range of liveability features that enhances the style and performance of the houses, which included universal housing design, safety and security measures. The following simple features were incorporated at minimal or zero additional costs:

- wider door entrances and hallways;
- hobless (step-free) showers;
- lower light switches and higher power points (both large rocker style);
- lever or D-style handles for doors and drawers;
- logical layouts with kitchens not used as thoroughfares;
- task lighting where appropriate;
- sun protected outdoor living area;
- large visible street number;
- well-lit and covered door entrances visible from the street;
- security glass and visitor viewing at a solid core front door;
- locks on windows and doors – keyed alike;
- catches for swing doors;
- reduced slip floor surfaces;
- hard wired smoke detectors with battery backups ;
- lockable cupboards for poisonous products;
- adequate storage to prevent clutter;
- visible children's play areas away from driveways;
- no poisonous landscaping; and
- sturdy, narrow and vertical balcony railings.

Large rocker type switches are one of the liveability features included in the homes.

Lot 896 was specifically designed to be accessible for people with a range of abilities. Key additional design elements for this house were:

- a ramp from the street (accessible path);
- easy access from the garage into the house – special wide sliding door;
- easy access to main toilet;
- reinforced walls in the bathrooms for future grab rails;
- level thresholds (floor); and
- lower benches and vanities with access under for sitting position.

Bathroom walls are reinforced to accommodate grab rails if needed.

Hebel flooring allowed for level thresholds into the bathrooms to be achieved easily.

5.0 Issues encountered and recommendations

Issue and recommendation 1: *There is no perfect house for a particular block.*

Conflicting design elements needed to be rationalised, such as:
- shaded outdoor living and solar access;
- views and glazing exposure;
- car access and house zoning; and
- ventilation and privacy.

There are many variables to balance but an open minded, ethical, educated, 'do the best you can' approach leads to a better outcome, and teaches new lessons. This approach is recommended to be adopted with all constructions.

Design elements such as car access, views and solar access need to be carefully balanced.

Issue and recommendation 2: *Energy and water efficiency inclusions are becoming standard while universal design, safety and security design elements need to be further promoted.*

Talking to product suppliers and trades people during the construction process revealed a reasonable understanding of energy and water efficiency products and their purpose. However, knowledge of universal design, safety and security elements were not well understood or appreciated. This is probably indicative of industry and the broader community's awareness of these initiatives and demonstrates that more awareness is required to encourage their adoption.

Universal design, safety and security design elements need to be further promoted.

Issue and recommendation 3: *Preparation of a simple 'services plan' would have identified problems.*

A services plan was not prepared for the display houses but would have been an ideal tool to draw attention to the locations, linkages, as well as the possible problems for installing the smart meters, rainwater systems, hot water systems, photovoltaic cells and landscaping. It would have focused all people involved on the interconnection that needed to be achieved. Most sub-contractors (plumbers, electricians, and landscapers) literally construct or modify the plan or system on site as they go. With any new process there are always challenges and better planning via a 'services plan' would provide the shortcut and minimise problems through improved coordination of service providers.

Issue and recommendation 4: *Various passive design elements were considered a high priority for thermal performance but additional simulations showed their interrelated importance was mixed.*

After completion of the houses, many subsequent thermal simulations showed that some marginal improvements in annual energy use could be achieved by changes contrary to the normal passive design strategies. All houses were well insulated and ventilated to combat summer heat but insufficient passive solar heating was available during winter. Each house required significantly more winter heating energy than summer cooling energy and removal of some glazing treatments to northern facing windows would have improved passive winter heating. Not venting the eaves would have reduced the energy required during winter.

Annual energy use could have been reduced slightly by using darker roof and external wall finishes in some instances. Reductions in the large expanses of living area windows would have certainly reduced the need for expensive glazing options to achieve low annual energy use. This would be a compromise with architectural and aesthetic decisions.

However, caution should be exercised in using findings from current computer simulations to address energy efficiencies and design responses for Queensland houses. This is because they are southern-based programs for southern based conditions and/or limit the value of cross-ventilation requirements.

For project home builders it is not practical to carry out simulations of the countless inter-related options for every house but achieving an appropriate five-star energy efficiency rating would ensure an excellent thermal result. It is understood that this should be available for Queensland housing design requirements in the near future through 'AccuRate'.

Issue and recommendation 5: *Car access onto sloping lots needs a conservative approach.*

The car access on lot 896, while complying with the statutory code, appears too steep. In hindsight, the floor level of the house could have been raised at minimal additional cost. It should be noted that the design was based on engineering design levels as the road was not constructed when the design was substantially completed. A conservative slope calculation would have overcome this steep access problem.

Issue and recommendation 6: *Windows and glazing treatment impacts and costs need to be carefully monitored.*

Window treatments are expensive and could be offset with different window sizing, placement and additional external shading. There was a premium paid for the glazing treatments ('low-e' glass and films and tinting) which positively assisted the energy ratings for the three display houses (i.e. north facing windows). A significant price reduction could have been achieved if there was some reduction of the large window areas, glazing treatments were applied to selected windows only, and additional external protection was added to some windows.

A significant price reduction could have been achieved if there was some reduction of the large window areas.

Issue and recommendation 7: *Adjoining buildings influence house design and need to be taken into account, especially for small lots*.

Having three houses adjoining gave control over their inter-relationships but the design on one adjoining side in particular was not known. Shading influences and privacy issues from adjoining buildings need to be predicted and planned for in each house design.

Issue and recommendation 8: *New products are continuously appearing in the marketplace and need investigation.*

Time to thoroughly investigate new products would have facilitated better results from different product selection. Pre-arranged sponsorship also restricted product choices in some cases.

Issue and recommendation 9: *The size, style (wet or dry system), supply requirements and location of rainwater tanks and first-flush devices are recommended to be included early in the house design.*

This was not the case with the display homes. It would have been more beneficial to include the rainwater tanks in the initial design rather than adding them later in the evolutionary design process. Initially the tanks were to be for garden use but this was upgraded to whole house use. However, had this use been considered in the early stages, the tanks could have been integrated with a plumber's involvement, avoiding any problems.

Issue and recommendation 10: *Sloping sites provide the opportunity of 'dry systems' for roof water.*

The three display houses initially had 'wet systems' (water remaining in underground piping after rain). These were converted to 'dry systems' with the first-flush devices being placed underground at the tanks and ultimately being drained to the rear of the properties. This was only possible because of the sloping sites. This 'dry system' reduced the amount of water needed to be flushed and therefore wasted.

Issue and recommendation 11: *Rain heads on downpipes should be placed for easy cleaning and inspection.*

This was the case for a few of the rain heads; however, many could have been located closer to ground level for practical future maintenance.

Issue and recommendation 12: *Non standard landscaping elements need close supervision.*

Stormwater detention ponds were placed towards the rear of the garden in each of the three houses but their effectiveness was compromised because the contouring did not focus overland stormwater towards the ponds. The landscaper and the plumber both needed to fully understand the proposed concept before its construction. Time pressure to complete the landscaping was also a negative influence with their construction.

Site management is directly related to builder attitude.

Issue and recommendation 13: *Site management success is directly related to builder attitude.*

While the site management (including the on-site waste management plan) did not impact significantly on financial return, it did produce environmental and social returns. The plan intended for 80% of building waste to be recycled, the three sites to remain clean, tidy and safer during construction, silt and erosion to be managed, and delivery locations and site entries to be used and monitored.

These were all addressed with varying degrees of success with the conclusion being that their effectiveness and success was directly related to the attitude of the builder and their priorities under the stress of 'boom' conditions to finish the job as quickly as possible.

Issue and recommendation 14: *There are no official indicators for assessing how good or bad a house may be relative to an agreed benchmark and the marketplace needs the feedback for effective change.*

There are national energy rating tools and various recommended strategies for residential house design to move towards sustainability; however, Queensland does not have a holistic performance indicator to consider the environmental, social and economic impacts of houses.

The South East Queensland Regional Organisation of Council (SEQROC) Draft Sustainable Housing Code (SHC) has been prepared in response to this situation. An assessment of the Springfield Lakes sustainable houses against the SHC (current Version 8) is presented in Table 1. Given the results of this assessment, it is concluded that the SHC has set relatively easy performance measures and that these requirements are too low for best practice.

Issue and recommendation 15: *Signage is important to convey the education message.*

The signage in and around the display homes defining triple bottom line sustainability and the GreenSmart initiative is considered limited in its potential. Additional signage and improved explanations could have been displayed to raise visitor's awareness and understanding on the sustainability features and the innovative house design.

Issue and recommendation 16: *Good communication leads to better understanding and fewer problems.*

Better communication in the initial stages could have prevented some of the problems that arose from using new products and technologies in the construction of the homes. The construction process occurred during 'boom' conditions and this along with other pressures also hampered communication. One of the main purposes of the Springfield Lakes Houses is as an education tool to learn about new products and processes. To ensure that the project met this aim, more education and communication was needed throughout the construction process.

6.0 Findings

The following findings were made through the course of the design and construction of the houses:

Most cost effective	Least cost effective
Passive design elements Solar hot water systems	Window treatments Rainwater tank systems
Fittings and appliances	Photovoltaic roof panels
Universal design, safety and security elements	Automatic irrigation systems
Non-toxic paint, timber and floor finishes	Higher ceilings

The most cost effective additions were:

- passive design elements – solar orientation, window size and location, external shading (eaves) and insulation;
- solar hot water systems;
- Fittings and appliances – water ('AAA' or higher products and appliances, flow restrictors); energy (lighting, fans, 4 or 5 star rated appliances);
- universal design, safety and security elements (wider doors and hallways, level entry thresholds (all doors and showers), lever door and tap handles, safety and security design approach); and
- non-toxic paint and non-toxic timber and floor finishes.

The least cost effective additions were:

- window treatments – low emissivity glass or films or tinted windows. These products are useful if large expanses of glass are desired or to avoid direct summer sun on western facing windows. Special glazing treatments can be avoided or minimised with careful window design and external shading;
- rainwater tank systems – given present water pricing and government policy on permissible uses, the additional $6,300 for this whole of house system will limit uptake of this choice. Government, developer or even builder incentives (rebates, subsidies, covenants, policies, legislation) are required to instigate the broad scale adoption of rainwater tanks. For effective use, storage of at least 10,000 litres should be adopted and an efficient system installed to ensure the water gets used;
- photovoltaic roof panels – this product could be greatly reduced in price once consumer demand increases, which could be government and/or developer driven;
- automatic irrigation systems – use of controllers to automatically trigger pumping to the underground dripper system could have been replaced by a manual system incorporating a self-timer. This would also require the occupier to remain in-tune with the water needs of the garden; and
- higher ceilings – at a current additional cost of $30/m^2$, higher ceilings could be eliminated without seriously affecting thermal comfort. However, attention still needs to be given to achieving through-flow ventilation. In two of the display homes, higher ceilings were an integral part of their design for style and performance.

7.0 Conclusion

The main conclusion derived from the design and construction of the Springfield Lakes sustainable display houses is that incorporating all the above described features and resource efficiencies incurs an additional upfront cost at an average of 6.7% total house only cost (over the three houses). These total costs can be recouped within 12 years, with many features providing more immediate paybacks. This additional cost and payback period could be substantially reduced by eliminating or modifying some of the more expensive elements, for example, photovoltaics.

From a home provider's perspective, more sustainable housing design that incorporates social design elements reduces environmental impact and resource consumption largely results from common sense and a commitment to a better result, rather than technical knowledge and application. Project houses can achieve five-star ratings for energy efficiency and include universal design, safety and security elements with relatively small additional costs and small payback periods. The increased proportion of more liveable and resource efficient houses can be achieved through increased community awareness and government and industry promotion, resulting in consumer and industry acceptance.

Given the nature of the site and regional location, these sustainable display houses provide excellent examples of comfortable, flexible, safe, energy and water efficient project housing in the middle to upper price range market. As demonstrated by the sustainability assessment with SEQROC's draft Sustainable Housing Code, their life-cycle operating features will future-proof the homes for residents well into the long-term. The eventual home-owners are also expected to gain a higher return on investment given the higher product quality in this market.

8.0 References

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Appendix 1

Sustainability Assessment

An assessment of each display house using SEQROC's Draft Sustainable Housing Code (Version 8) performance criteria was completed with results shown in Table 1.

As indicated in Table 2, each of the display houses satisfied the 'graded points' requirement such that the ultimate level set for 2013 was reached relatively simply. This demonstrates how easily a significant improvement in the sustainability of project housing may be achieved, but also indicates that the scale of initial assessment appears to be set too low for achieving meaningful change for conventional project housing.

Table 1: Springfield Lakes sustainable display homes assessment against SEQROC's Draft Sustainable Housing Code (version 8)

Lot #	Lot area (m^2)	House gross floor area (m^2)	Required points	Springfield Houses points achieved		
				Social (blue)	Environmental (red)	TOTAL
894	785	271	**18**	25	36	**61**
895	415	218	**14**	16	23	**39**
896	332	154	**14**	36	19	**55**

Table 2: SEQROC's Draft Sustainable Housing Code (version 8) Progressive Minimum Graded Points Required

Year	Gross floor area of house		
	<130m²	<260m²	>260m²
2005–6	10	**14**	**18**
2007–8	12	16	20
2009–10	14	18	22
20011–12	16	20	24
2013 +	18	22	26

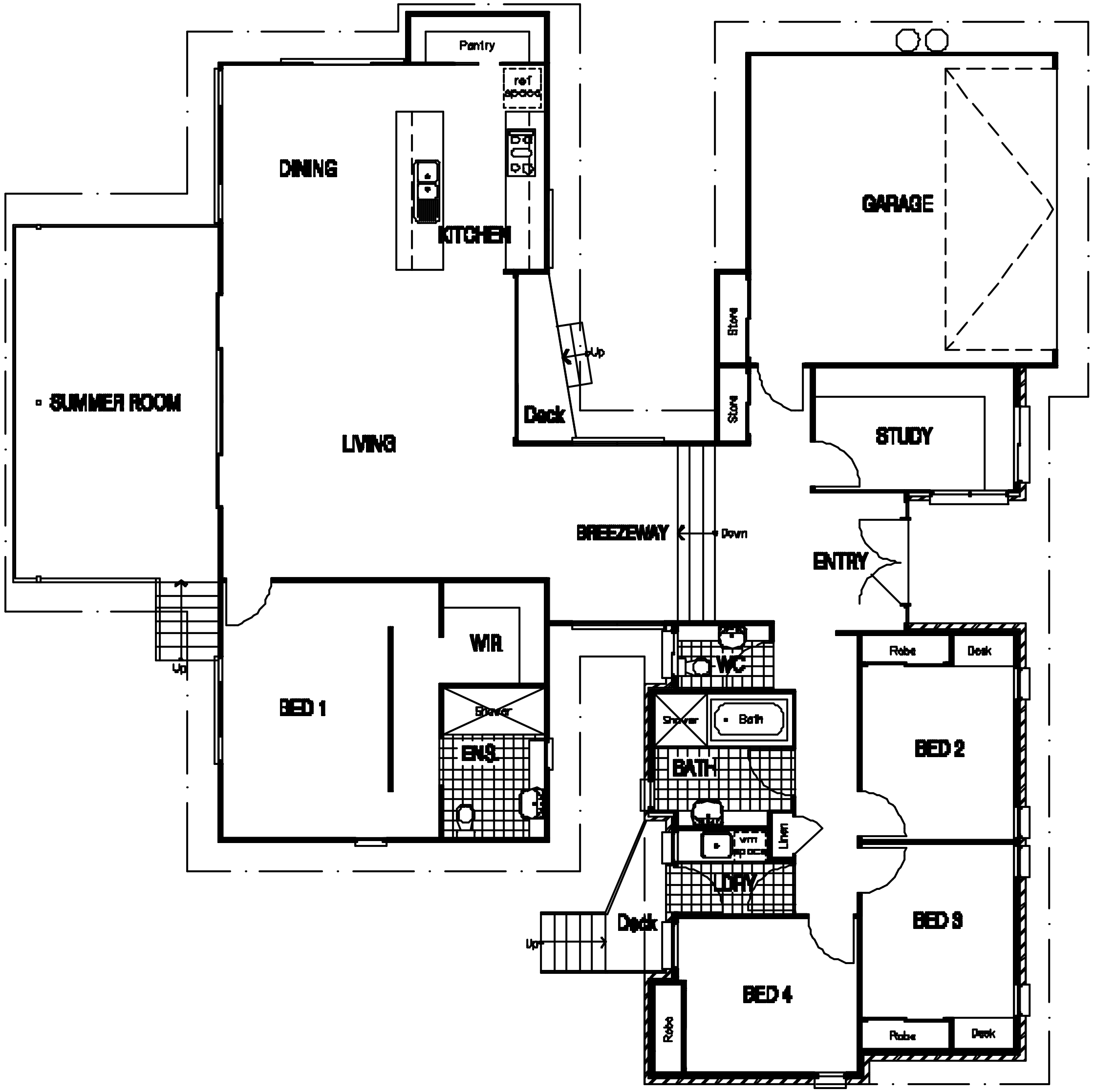
Note:
The Department of Housing's Smart Housing Design Objectives and the HIA's 'GreenSmart' criteria are advisory tools only and do not provide a points rating or measurable indicator (but can provide acceptable solutions for individual design issues). As such, they do not provide feedback on how socially acceptable, resource efficient or environmentally friendly housing performance can be evaluated in terms of its overall sustainability.

There is an urgent need for a sustainable housing indicator to assess the design and operation of Queensland houses. At present there is only the Building Code of Australia (BCA) requirements for energy efficiency in terms of design and building material requirements. To ensure the broader sustainability elements in housing become a residential standard in Queensland's housing stock, a holistic assessment tool is required that will rate a building's environmental impact, ongoing cost efficiency and liveability. Such a tool needs to be easily understood by industry and consumers.

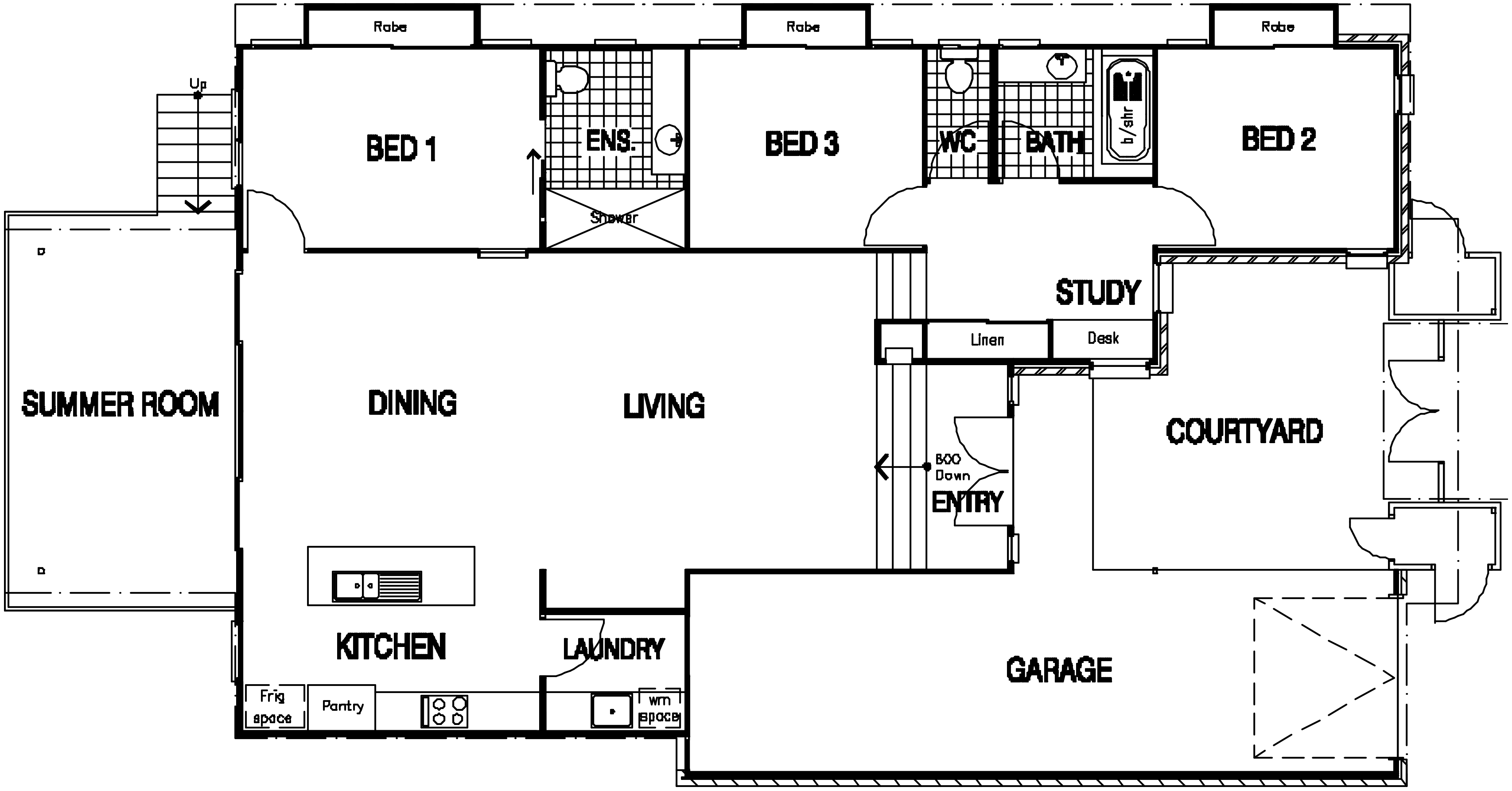
Appendix 1 – Summary of costs and savings (All Houses)

FEATURE	Lot 894 - 271m^2 GFA				Lot 895 - 218m^2 GFA				Lot 896 - 154m^2 GFA			
	Outlay costs ($)	Percent of house (%)	Annual saving ($)	Annual costs ($)	Outlay costs ($)	Percent of house (%)	Annual saving ($)	Annual costs ($)	Outlay costs ($)	Percent of house (%)	Annual saving ($)	Annual costs ($)
Passive design												
orientation/zoning etc.	0.0	0.0	?	0.0	0.0	0.0	?	0.0	0.0	0.0	?	0.0
insulation	2,752.0	0.8	427.0	0.0	1,751.0	0.7	459.0	0.0	1,705.0	0.9	393.0	0.0
glazing treatments	2,484.0	0.7	124.0	0.0	647.0	0.3	30.0	0.0	983.0	0.5	115.0	0.0
other (higher ceilings etc)	6,050.0	1.8	-1.0	0.0	1,508.0	0.6	-6.0	0.0	880.0	0.5	28.0	0.0
Sub Total	11,286.0	3.4	550.0	0.0	3,906.0	1.6	483.0	0.0	3,568.0	1.8	536.0	0.0
Water												
rainwater tank	6,227.0	1.9	97.0	112.0	6,401.0	2.7	66.0	97.0	2,749.0	1.4	18.0	35.0
efficiency elements	64.0	0.0	55.0	0.0	32.0	0.0	55.0	0.0	32.0	0.0	55.0	0.0
landscaping & irrigation	990.0	0.3	19.0	150.0	1,290.0	0.5	13.0	150.0	650.0	0.3	10.0	100.0
Sub Total	7,281.0	2.2	171.0	262.0	7,723.0	3.2	134.0	247.0	3,431.0	1.8	83.0	135.0
Energy												
lighting & fans	870.0	0.3	567.0	10.0	740.0	0.3	234.0	12.0	540.0	0.3	327.0	8.0
appliances	1,300.0	0.4	97.0	2.0	1,300.0	0.5	89.0	2.0	1,050.0	0.5	88.0	2.0
water heating	800.0	0.2	170.0	19.0	840.0	0.4	170.0	19.0	400.0	0.2	39.0	195.0
photovoltaic cells	7,350.0	2.2	238.0	0.0	-	-	-	-	-	-	-	-
Sub Total	10,320.0	3.1	1,072.0	31.0	2,880.0	1.2	493.0	33.0	1,990.0	1.0	454.0	205.0
Liveability												
safety/security etc.	620.0	0.2	0.0	18.0	560.0	0.2	0.0	18.0	566.0	0.3	0.0	18.0
Site Management												
waste/erosion	-50.0	0.0	0.0	0.0	-50.0	0.0	0.0	0.0	-50.0	0.0	0.0	0.0
Toxicity												
wall/floor/timber finish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOTAL	**29,457.0**	**8.8**	**1,793.0**	**311.0**	**15019.0**	**6.3**	**1,110.0**	**298.0**	**9,505.0**	**4.9**	**1,073.0**	**358.0**

Appendix 2 – Lot 894 Floor plan



Appendix 3 – Lot 895 Floor plan



Appendix 4 – Lot 896 Floor plan