ENVIRONMENTALLY SUSTAINABLE DESIGN FOR SUBDIVISIONS IN REGIONAL VICTORIA

Proof of Concept and Cost Benefit Analysis

FINAL

Prepared for Wodonga City Council and partner Councils

17 May 2018

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ESD Subdivision in Regional Victoria

Client: Wodonga City Council and partner Councils

ABN: 63277160265

Prepared by

AECOM Australia Pty Ltd
Level 10, Tower Two, 727 Collins Street, Melbourne VIC 3008, Australia
T +61 3 9653 1234 F +61 3 9654 7117 www.aecom.com
ABN 20 093 846 925

17-May-2018

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Quality Information

Document ESD Subdivision in Regional Victoria

Prepared by Sarah Brennan, Lili Pechey, David Mahoney, Joanna Barnett, Pablo Sepulveda

Reviewed by Liz Johnstone

Revision History

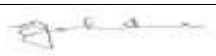
Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	25-Sep-2017	Draft 1 sent to client	Liz Johnstone	
1	20-Apr-2018	Final Draft	Liz Johnstone	
2	17-May-2018	Final	Liz Johnstone	

Table of Contents

Executive Summary

The project

Wodonga City Council together with Greater Geelong City Council, Greater Bendigo City Council, Ballarat City Council, Greater Shepparton City Council, Baw Baw Shire Council, Wangaratta Rural City Council and Moorabool Shire Council were awarded funding through the Collaborative Councils Sustainability Fund Partnership Program Round 3 to undertake a project to assess how greenfield subdivisions can be more environmentally sustainably designed and delivered to achieve multiple benefits in the most cost effective way over time.

These eight regional councils engaged AECOM to deliver this project, which seeks to identify and test the feasibility of embedding environmental sustainable development (ESD) in subdivisions.

This project has two parts:

- Proof of concept study (Stage 1A)
- Cost benefit analysis (Stage 1B)

The goals of this project are to:

- Define 'best practice' ESD with respect to greenfield subdivision and determine how it should be measured.
- Establish how 'best practice' ESD subdivisions are feasible in regional Victoria.
- Recommend a suite of tools and a model for collaborative implementation, with transferability across the State.

The project provides a basis to progressively improve the sustainability of subdivisions without creating an unreasonable burden on land developers or home owners. Coupled with gaps, or minimal requirements in current planning and building regulations, many subdivisions fall short of ESD principles and best practices. There are cost effective measures for greenfield subdivisions, that can be tailored for their regional contexts; supported by education, advocacy, communication, policy and regulation to improve the early uptake of ESD principles in both subdivisions and individual dwellings.

A way forward

There are clear social, economic and environmental benefits associated with ESD in regional subdivisions. These benefits differ across Victoria's climate regions, as does the nature and capacity of Councils and the residential development industry. While the period of analysis was 30 years, the life of a residential subdivision is much more enduring and so subdivision-wide sustainability measures warrant greater consideration.

The Roadmap in Section 6.2 identifies an extensive range of short, medium and longer-term actions to advance ESD subdivisions in Regional Victoria. These include actions for councils, groups of councils and for council advocacy. In the context of The Roadmap, the priority areas for short term action are:

- **Learn from the 'CASBE" model of implementation** through raising awareness and building capacity and move towards introducing local policy to drive ESD subdivisions. For advanced Councils, this could be achieved through a group amendment to introduce local policy coupled with the IDM to strengthen the overall case for requiring and guiding better ESD outcomes. For other councils, sharing resources and support for awareness raising would be the focus.
- **More research into the subdivision interventions** that have low operating / maintenance requirements, especially focused on understanding the difference in cost and benefits relative to Business as Usual (BAU). This could take the form of Cost Benefit Analysis (CBA) case studies

based on existing / or planned subdivisions that have incorporated ESD features and would help to strengthen the evidence base.

- **Direct engagement with land surveyors and development engineers** to understand the drivers of land subdivision plans and to educate them about the value created through orientation. This could include pilot projects between council's and developers to showcase ESD features at the subdivision scale.
- **Consideration of innovative funding models** for encouraging adoption of subdivision interventions, especially where this involves relatively large capital costs, such as green loans, deferred payments, or fast track approvals for ESD developments. For example, the Victorian Government will contribute up to $10 million in grant funding over four years to develop and implement state wide demonstration projects, using micro-grid models.[1]
- **Develop supportive education materials, governance arrangements and assessment systems** Support Council planners (and the residential and development community) with training, information and a collaborative forum (such as a rural group within CASBE) for support and up-skilling, and to clarify council's expectations. Other resources could target community members, particularly when buying, selling or renting a home; and to accelerate the learning rate for the local development industry.
- **Prepare Sustainable Subdivision Guidelines including a generic Local Policy (for both Clause 21 and 22)** considering schedules to the residential zone, neighbourhood character/design objectives, application requirements, decision guidelines; but that does not create an unreasonable burden for regional councils by creating a permit trigger for every single dwelling or restriction on title.
- **Support advocacy to strengthen the NCC** noting the CBA case study identified a range of cost effective opportunities to improve energy efficiency requirements in the Building Code.

Planning and Building ESD Subdivisions Findings

ESD in dwellings and subdivisions is controlled and influenced by a range of legislation, systems and planning requirements as well as market forces. The primary regulations and policies impacting on ESD subdivisions include the NCC, the VPP and local planning schemes. There are a number of gaps and inadequacies within each of these and also in how they relate to each other, with a substantial disconnect in how different policies and regulations apply to various parts of the subdivision process and subdivision itself (development, neighbourhoods, lots and dwellings).

Gaps

The gaps in the relationships between systems as well as their requirements include:

- **Relationship between the building code and planning**. The NCC does not relate to subdivisions but only to individual dwellings and therefore has no influence over subdivision design and planning. Planning has little to no role over a single dwelling on a lot.
- **Adequate international and national policy objectives not linked to local policy**. At the international and national level there are policy objectives that support ESD. These objectives are not translated into local policy which is used to assess developments.
- **Lack of state-wide policy and commitment**. There is no state-wide policy for improving ESD in the built environment or for subdivisions. The Environmental Efficiency Design Advisory Committee concerning the Environmentally Efficient Design Local Policies (7 April 2014) found that a state-wide approach for incorporating both planning and building approval systems would be the most effective way to facilitate an increased focus on ESD.
- **Current weaknesses in the planning system.** There is a general lack of statutory planning instruments to assess ESD (Moore, et al., 2017).

Overall, there is a clear absence of policy and control to ensure that ESD is delivered in the design of residential subdivisions. There is a risk that the absence of requirements acts as a barrier to ensuring

[1] See https://www.energy.vic.gov.au/microgrids. Accessed 25 March 2018.

that ESD practices are considered and implemented early in the design of residential subdivisions and throughout the development and post-construction phase of a residential subdivision.

Unless a new trigger is created for the development of a single dwelling on a lot over 300sqm, Councils remain limited in what can be assessed at the time of considering a planning application for subdivision. However creating a new permit trigger in this context would create an unreasonable burden for both councils and applicants.

Cost Benefit Analysis Findings

There are social, economic and environmental benefits associated with ESD in regional subdivisions. These benefits differ across Victoria's climate regions, as does the nature and capacity of the residential development industry.

Subdivision and development although two separate process in many instances are intrinsically linked in that a subdivision is completed for purpose of development occurring.

To address this, the scope of the CBA included both dwelling and subdivision-based interventions and a summary of the findings are discussed below.

Dwelling-based ESD interventions

The dwelling-based ESD interventions assessed included: dwelling orientation; installation of rainwater tanks plumbed to washing machines and toilets; solar panels; glazing; and insulation.

Dwelling-based ESD interventions primarily benefit home owners through improved comfort and reduced consumption of water and energy. The capital / construction cost associated with these interventions is borne by the builders and typically passed on to home owners. Therefore, such interventions are well-suited to a traditional 'beneficiary pays' funding model.

These up-front costs are lower if the ESD interventions are included in the dwelling design, rather than being retrofitted. Operating and maintenance costs associated with the ESD interventions tend to be zero, or relatively low, which is an important consideration when communicating the benefits of ESD interventions.

The analysis found that dwelling orientation is a no / low cost intervention that results in benefits across all the climate zones that were assessed. This suggests that councils should ensure north-facing orientation is optimised when considering applications under Clause 56.

For the other interventions that were assessed, all were found to facilitate a reduction in water and energy consumption; however, historic climate and the price of energy and water were found to be important factors in determining the cost-effectiveness of dwelling-based ESD interventions across the three climate zones considered. Regardless of the climate zone, the installation of solar panels was found to result in a positive Benefit Cost ratio (BCR) with short payback periods generally less than four years.

Should councils require these interventions to be incorporated into future developments, further research is recommended to better understand the interplay between climate change, energy and water prices, and the emission intensity of electricity supply and the effect these factors have on the cost-effectiveness of the interventions.

Subdivision-based interventions

Case studies obtained from the literature review provide evidence that there are quantifiable benefits from adopting subdivision-based ESD measures. Furthermore, the magnitude of the benefits are less driven by climate than the dwelling-based interventions and, therefore may be more appropriate for a wider number of climate zones.

The capital / construction costs of subdivision-based interventions are typically borne by developers, but the beneficiaries can include home owners, councils and the wider community. The operating and maintenance costs associated with these interventions can range from negligible (e.g. a second

footpath to facilitate active travel) to relatively high (e.g. maintaining Water Sensitive Urban Design (WSUD) features). It is difficult to apply a 'beneficiary pays' funding model because the beneficiaries are numerous (e.g. homeowners, wider community, councils) and they typically involve greater up-front costs compared to dwelling-based interventions.

The research, based on historic data of climate zones not projected data as well as current and previous pricing of water energy, identified a number of subdivision-scale interventions that are likely to confer benefits across current climate zones and involve no cost or similar (or lower) maintenance costs for councils, relative to BAU practices. These interventions may be considered low cost / low regrets interventions, if capital funding can be secured.

Low-cost / low regrets interventions include:

- subdivision has appropriate solar orientation, for both public areas and dwellings
- reduction in impervious surfaces throughout the subdivision (e.g. through implementation of the IDM SIG)
- reduction in construction waste (i.e. recycling and more accurate construction material estimation)
- recycled materials (where these are readily available)
- diversity of dwellings within the subdivision
- installation of footpaths on both sides
- installation of separated bicycle paths (or shared footpath / bicycle paths)
- continual shading of footpaths and roads
- installation of footpaths to provide connection to amenities and neighbouring areas
- more diversity in street / road design 'shared zone')
- provision to connect with local public transport
- use of drought tolerant and indigenous plants
- increased canopy cover
- retention of mature trees
- use of low-energy street lighting
- wider nature strips

Should councils require these interventions to be incorporated into future developments, further research is required to understand the difference in cost and benefits relative to BAU. This could take the form of CBA case studies based on existing / or planned subdivisions that have incorporated ESD features and would help to strengthen the evidence base.

The Options for strengthening ESD

The main options to bridge the disconnect between the subdivision and the housing being built are both statutory and non-statutory. A single statutory mechanism would not fully address this disconnect nor build community and industry understanding and support. A combination of measures and approaches is required and they will also need to be tailored to local conditions, and target the subdivision, the builders, the building and its owners and operation. This could include:

- Strengthening Clause 56 and State Policy
- Developing a specific local policy
- Enhancing the IDM and SIG - to incorporate other aspects of subdivisions and to trigger the consideration of the IDM
- Non-statutory measures such as education, information, tools and incentives
- Advocating for increased energy efficiency requirements in the National Construction Code (NCC)

Rather than recommend a single approach, which is difficult due to each Council's particular circumstances, a 'pathways' or road map approach, bringing a number of measures together is preferred, based on the experience of the CASBE group of councils is recommended.

Significant opportunity exists for cost effective measures to improve the environmentally sustainable design of subdivisions across regional Victoria.

Acronyms

BAU	Business as usual
BESS	Built Environment Sustainability Scorecard
CASBE	Council Alliance for a Sustainable Built Environment
CBA	Cost Benefit Analysis (also BCA)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EMP	Environmental Management Plan / **EMS** Environmental Management System
EPBC	Environment Protection and Biodiversity Conservation
ESD	Environmentally Sustainable Development or Design (note 'E' can be Ecologically)
GBCA	Green Building Council of Australia
GHG	Greenhouse Gas
IDM	Infrastructure Design Manual
IPCC	Intergovernmental Panel on Climate Change
IWCM	Integrated Water Cycle Management
LCA	Life Cycle Analysis
LEED	Leadership in Energy and Environmental Design
LGA	Local Government Area
LGIDA	Local Government Infrastructure Design Association
LPPF	Local Planning Policy Framework
Mbps	Mega Bits Per Second
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
NABERS	National Australian Built Environment Rating System
NatHERS	Nationwide House Energy Rating Scheme
NCC	National Construction Code
PV	Present Value
PPV	Planning Panels Victoria
PSP	Precinct Structure Plans
SDAPP	Sustainable Design Assessment in the Planning Process
SDS	Sustainable Design Scorecard
SIG	Sustainability Infrastructure Guidelines
SMP	Sustainable Management Plan
STORM	Stormwater WSUD best practice benchmark assessment tool.
UDIA	Urban Development Institute of Australia
VCAT	Victorian Civil and Administrative Tribunal
VPA	Victorian Planning Authority
VPP	Victoria Planning Provisions
WELS	Water Efficient Labelling Standards
WSUD	Water Sensitive Urban Design

1.0 Introduction

1.1 Background

Wodonga City Council together with Greater Geelong City Council, Greater Bendigo City Council, Ballarat City Council, Greater Shepparton City Council, Baw Baw Shire Council, Wangaratta Rural City Council and Moorabool Shire Council were awarded funding through the Collaborative Councils Sustainability Fund Partnership Program Round 3 to undertake a project to assess how greenfield subdivisions can be more environmentally sustainably designed and delivered to achieve multiple benefits, in the most cost effective way over time.

These councils engaged AECOM to deliver this project, which seeks to identify and test the feasibility of embedding environmental sustainable development (ESD) in subdivisions. This has been done through identifying principles, practices and tools, including both regulatory and non-regulatory measures such as information and training. Benefits and costs have been assessed to identify those measures that are likely to have the most impact for the least cost.

1.1.1 What are ESD subdivisions?

In this report the term subdivision refers to both the technical process of dividing parcels of land and also the urban form that results as a consequence of that process (sometimes referred to as a precinct or development). Subdivisions encompass dwellings, lots, street space, green spaces, shared and private utilities and any additional amenities such as shops, educational facilities, recreational facilities and town centres. For subdivisions, it is important to highlight the relationships between the larger subdivision estate, lots and dwellings which are intrinsically linked..

ESD subdivisions are located and designed to use resources more effectively and to improve quality of life. They aim to use resources so that the needs of today's communities are met, while ensuring that these same resources remain available to meet the needs of future generations.

The benefits of ESD include:

- By planning and designing for a hotter, drier climate, with intense and more frequent extreme weather events, the impacts of climate change can be reduced, improving amenity and liveability
- Designing for more efficient resource use can reduce costs and increase comfort, over the building's life
- Considering community connectedness can improve quality of life, health and well-being
- Passive design can make compliance with building requirements easier

Greenfield developments present an opportunity to create a more resilient system where there is reduced demand and more efficient use of water and energy, and reduced waste as listed in Table 1.

Table 1 A systematic approach to creating more resilient systems

Fragile system	Resilient system
- High needs - Grid dependent - Economically vulnerable (energy price variation) - Short term vision	- Reduced needs - Multisource energy supply - Energy efficiency as a low risk investment, more available income - Long term vision

Source: AECOM

There are examples of sustainable subdivisions across Victoria and nationally, as well as planning initiatives and tools that enable industry, government and communities to achieve better outcomes.

There are opportunities to improve sustainability at both subdivision and dwelling scales. Measures can be low cost – such as using passive design, selection of materials, insulation and glazing; or using newer technologies to meet energy, water and waste needs for the development.

Opportunities are often greatest early in the subdivision design process where benefits for the builder, home owner and the environment are most cost-effectively achieved. Significant resources such as the Australian Government's Your Home (Department of the Environment and Energy)are available to

assist in improving ESD in new urban development on previously rural or non-urban land (i.e. greenfield development).

1.1.2 What is the issue being addressed?

The key underlying issue which this project aims to address relates to the sustainability of the subdivision itself; rather than a focus on dwellings as most residential development in previously non-urban areas does not require planning approval after the rezoning and subdivision is approved for lots over 300m^2 (or 500m^2 in Wangaratta).

This is particularly so in regional and rural Victoria where the majority of lot sizes tend to be over the size that triggers a planning permit and housing consists of predominantly separate dwellings. Coupled with gaps, or minimal requirements in current planning and building regulations, many subdivisions fall short of ESD principles. For these reasons, greenfield subdivisions require a tailored approach for a regional context; supported by education, advocacy, communication, policy and regulation to ensure the uptake of ESD principles in both subdivisions and individual dwellings is improved.

There is a perception in some sectors that sustainable design and development can introduce higher up front capital costs; yet this may fail to consider future savings and benefits. The report found little data on what the anticipated reduced on-going operational costs are, as well as the potential social and environmental benefits and their associated cost-savings or value. This project through Phase 1B (see Appendix G for full report) aims to contribute to minimising this gap and highlight where further work is required.

There is growing recognition that 'housing affordability' should not simply focus on upfront construction costs and that ongoing operational costs such as energy, water and mobility directly impact on affordability. This is in line with the shift to acknowledging a more holistic approach of 'affordable living' (Department of the Environment and Energy). Who pays and who benefits upfront and over time also needs to consider the implications for the various parties involved including developers, builders, occupants and local councils.

1.2 Purpose of the project

This project identifies both regulatory and non-regulatory approaches, including education, advocacy and communication strategies to improve ESD outcomes for residential subdivision in regional Victoria. A key part of this work is to identify and quantify the costs and benefits of implementing better practice ESD compared to current requirements, or business as usual (BAU).

This project has two parts:

- Proof of concept study (Stage 1A)
- Cost benefit analysis (Stage 1B).

The goals of this project are to:

- Define 'best practice' ESD with respect to urban land subdivision and determine how it should be measured.
- Establish how 'best practice' ESD subdivisions are feasible in regional Victoria.
- Recommend a suite of tools and a model for collaborative implementation, with transferability across the State.

1.2.1 Stage 1A Proof of concept

Stage 1A – Proof of concept identifies current planning practices and case studies of better practices. The case studies have been used to identify key principles of best practice ESD subdivisions. These principles have been tested and agreed upon through a series of eight workshops, one held in each participating municipality[2] and one central workshop held with industry associations and State

[2] Ballarat and Moorabool held a joint workshop.

government representatives. For each principle, corresponding initiatives have been identified. A selection of these initiatives were tested in the cost benefit analysis (CBA) in Stage 1B.

1.2.2 Stage 1B Cost benefit analysis

Stage 1B – Cost Benefit Analysis qualifies and where possible quantifies the social and environmental benefits of 'best practice' ESD subdivision principles including health benefits, embodied energy and resource consumption. It assesses the impact of upfront development costs and benefits on short and medium term running costs of housing.

The scope of Stage 1B has entailed the following:

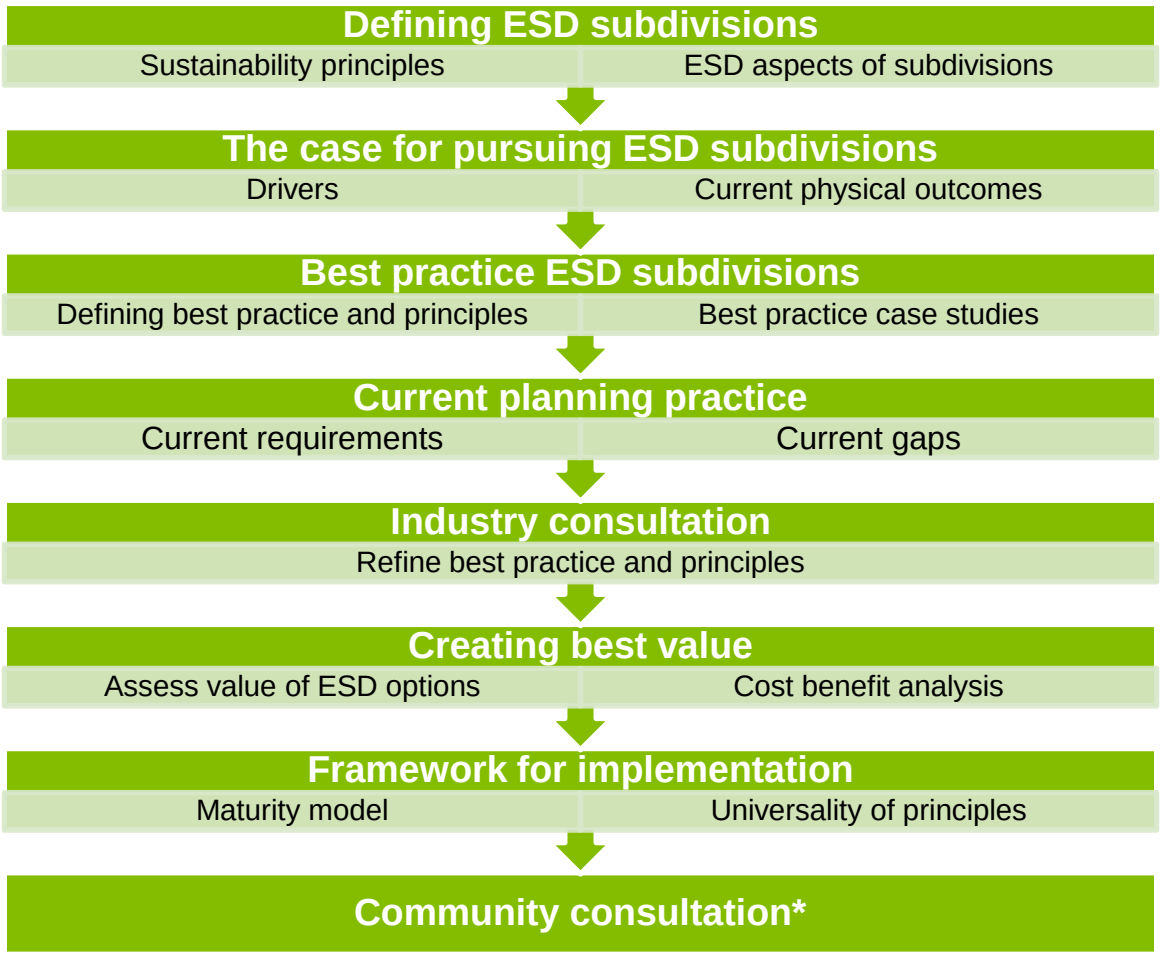
- Identifying data on the additional upfront capital cost required to meet 'best practice' ESD subdivision, compared to a BAU subdivision.
- Comparing the costs and benefits of a 'best practice' ESD subdivision to those of a BAU subdivision.
- Providing an indicative assessment of the likely pay-back period return on investment (ROI) if additional upfront capital investments are required for an ESD subdivision compared to BAU.

The analysis aims to provide the data and rationale for developing 'best practice' ESD subdivisions.

1.3 Project approach

The project stages are illustrated in Figure 1.

Figure 1 Project approach



***To be undertaken by councils following project conclusion.**
Source: AECOM

2.0 The significance of improving ESD in subdivisions

2.1 Overview

Subdivisions include lots and private dwellings as well as shared spaces, including streets, green spaces and for larger developments, places for commerce, play and community. The design, planning requirements, development and performance of subdivisions can have long term effects on the environment, liveability and health, and on affordability. These impacts are increasingly important in the context of a changing climate, rapid population and dwelling growth, demographic change and cost of living and housing affordability pressures. Despite significant progress in sustainable commercial buildings, housing is lagging (Moore T., 2012 in Moore, 2017). Additionally, housing design often fails to take full advantage of the sustainability attributes of the lot and subdivision.

2.2 Housing and built form for current climate, resilience and sustainability

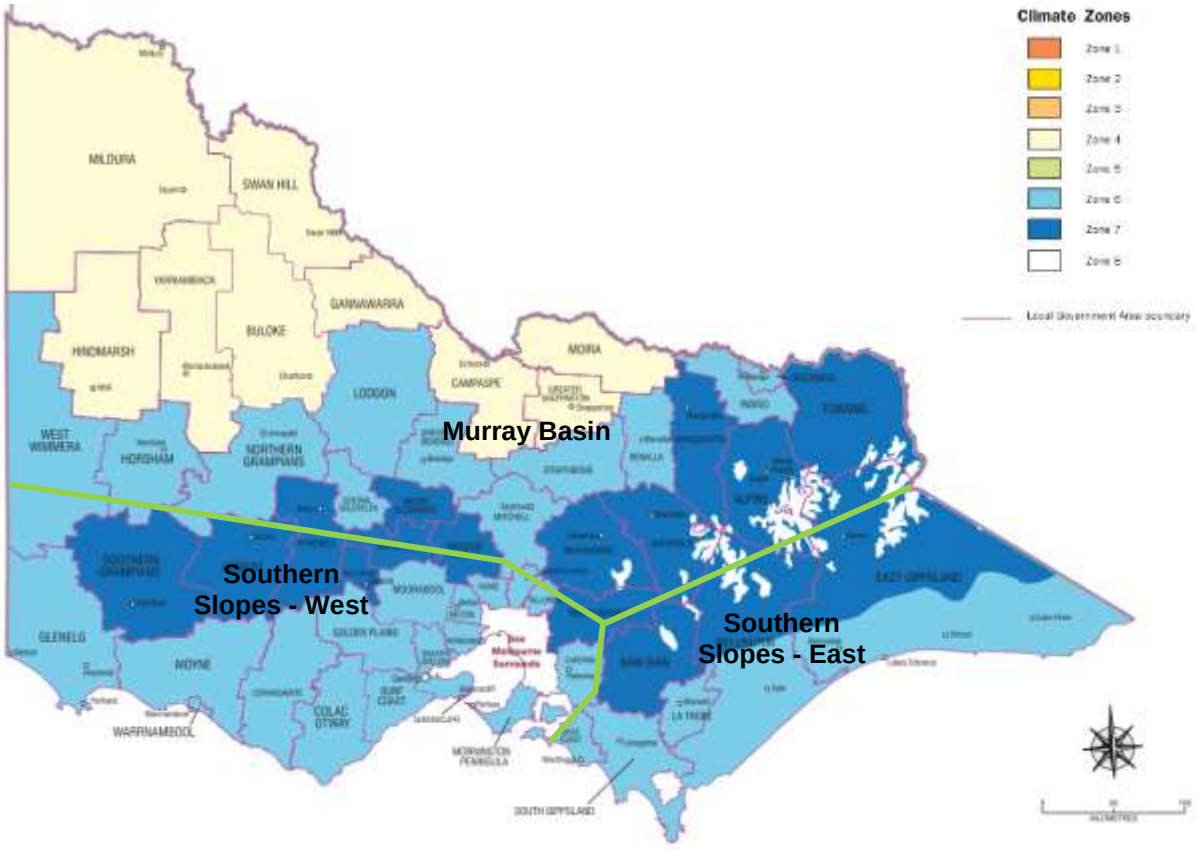
2.2.1 Current climate conditions and standards

Future focussed, risk sensitive land use planning is essential to mitigating climate change impacts, build resilience to other shocks and stresses and for sustainability. The current built environment including housing contributes significantly to human induced climate change (Moore T. M., 2017). In Australia, housing attributes 12 per cent of total final energy consumption and 13 per cent of greenhouse gas emissions (Schultz, 2011; Wang, 2010 in Moore, 2017).

Climate zones for each of the municipalities were identified drawing on the eight National Construction Code (NCC) Climate Zones that align with municipal boundaries and based on historic trends in climatic conditions and not future predictions. These zones guide the design of the building fabric to achieve the minimum standard in each climate zone[3]. NatHERS provides a minimum energy star rating for the overall building and its operation as designed.

[3] NatHERS have over 60 climate zones nationally recognising that localised climate can be highly variable

Figure 2 NCC Climate Zones for Victorian local government areas



Source: Australian Building Codes Board

2.2.2 Climate zones and profiles projections

Table 2 shows the current and forecast climate and rainfall profiles for the eight municipalities. It shows that Geelong and Moorabool share a similar climate zone, with similarities in average rainfalls, mean maximum temperatures and climate change projections out to 2090, with a projection from the extreme end of RCP4.5. For the purpose of responding to climate changes or considering climate related sustainability options, the two Councils can be assessed jointly.

Bendigo and Wodonga also align well in terms of climate profiles and changing climate projections and therefore can be considered together for the purposes of climate related sustainability options.

The remaining four Council regions have substantial climate differences to warrant individual assessments in relation to climate related sustainability options and future climate change projections. Future climate change impacts have not been considered as part of the cost benefit analysis which is based on historical data and not future climate projections.

Further details for each individual municipality can be found in Appendix B..

Table 2 Comparative climate profiles for each municipality to 2090

	Shepparton	Bendigo	Wodonga	Geelong	Moorabool	Wangaratta	Baw Baw	Ballarat
NCC Climate Zone	4	6	6	6	6	7	7	7
	Hot dry summer, Cool winter	Mild Temperate	Mild Temperate	Mild Temperate	Mild Temperate	Cool Temperate	Cool Temperate	Cool Temperate
CSIRO Climate Change Projection Region	Murray Basin	Murray Basin	Murray Basin	Southern Slopes - Vic West	Southern Slopes - Vic West	Murray Basin	Southern Slopes - Vic East	Southern Slopes - Vic West

	Shepparton	Bendigo	Wodonga	Geelong	Moorabool	Wangaratta	Baw Baw	Ballarat
July Avg. Rainfall	50-55	55-60	80-85	50-55	55-60	65-70	100+	70-75
Projected Rainfall	-40%	-40%	-40%	-25%	-25%	-40%	-10%	-25%
Extreme Rainfall	Increase	Increase	Increase	Increase	Increase	Increase	Increase	Increase
Mean Max Jan Temp	31.8	29.9	31.8	25	24.6	31.9	26.2	25.2
Projected temperature increase	2.4	2.4	2.4	1.9	1.9	2.4	2.2	1.9
Fire Weather	Increase	Increase	Increase	Increase	Increase	Increase	Increase	Increase
Grouping for climate similarity	1	2	2	3	3	4	5	6

Source: Australian Building Codes Board

In summary all regions are expected to experience variations of the following in the future:

- Decreased rainfall in winter and spring – increased drier periods
- Increased and more extreme temperatures including prolonged warm spells
- Harsher fire weather

Subdivisions need to respond to these changing conditions, especially as developments built now will remain in 50 years and possibly 100 years' time, and the subdivision itself for the foreseeable future. The forecast climatic trends also have implications for energy and water performance, as well as the thermal comfort of housing[4].

Construction waste

The construction of houses in Australia produces a considerable amount of waste to landfill. At present the construction and demolition sector accounts for 44 per cent of all waste to landfill, making it the largest contributor of waste (Infrastructure Victoria, 2016).

Transport emissions

The design of a subdivision layout can influence travel choices, reliance on private motor vehicles and the distance required to travel to local amenities such as shops, education, and recreation. The popular use of cul-de-sacs in subdivisions in the 1970's-1990s, as shown in Figure 3, can restrict permeability and require longer distances to be travelled to reach local amenities and destinations.

[4] These factors have not been included in the CBA due to insufficient information.

Figure 3 An example of subdivision layout with cul-de-sacs

Source: Wodonga City Council

It is anticipated that Australia's car emissions contribution to CO_2 will increase. While disruptive technologies such as transport on demand mini-buses and driverless and electric vehicles may alter this trajectory, this also illustrates the need for developments today to be flexible to be able to adjust to rapid changes in how we live and travel in the future.

The design of subdivisions and housing can have a significant impact on emissions, climate change and resource use. At present required minimum standards do not enable sufficient ESD outcomes to mitigate and respond to a changing climate, reduce construction waste to landfill, or minimise travel related carbon emissions. Further still the diversity of climate zones, physical geography and environmental issues across regional Victoria are diverse and need to be taken into account. For example, some places such as Wangaratta mainly comprise flat topographies near river confluences and experience periodic flooding, while other areas such as in Baw Baw have substantial slopes, creating the risk of landslides and extensive use of retaining walls in housing developments. The differing cost of water and water recycling practices are other key examples that affect what ESD initiatives may be of greatest value in different locations.

2.3 Meeting the housing needs of growing regional populations

Subdivisions planned and built today will comprise much of the built form in regional centres in years to come. By 2051, the population of Victoria's regions is expected to grow from 1.5 million to 2.2 million[5] (DELWP, 2016) with many of the participating councils expected to grow by 40 per cent over the next 20 years.

The eight municipalities have a current combined population of 667,419 residents representing 11 per cent of Victoria's population[6] (Australian Bureau of Statistics, 2017). Collectively, over the next 20 years these municipalities are expected to have an additional 240,574 residents.

Table 3 details the current and projected growth for each of the eight municipalities. With the exception of Wangaratta, all are expected to experience annual growth rates between 1.4-2.5 per cent.

Table 3 Population and forecast growth

[5] Based upon Victoria in Future 2016
[6] Based upon Victorian population of 5,926,624 ERP.

Municipality	Population (ERP)		Forecast total growth	Forecast total growth rate	Forecast annual growth rate
	2016	2036			
Wodonga	39,844	57,634	17,790	45%	2.2%
Bendigo	111,783	156,151	44,368	40%	2.0%
Baw Baw*	49,008	67,743	18,735	38%	1.9%
Shepparton	65,076	83,782	18,706	29%	1.4%
Wangaratta	27,040	27,804	764	3%	0.1%
Ballarat	103,407	145,197	41,790	40%	2.0%
Geelong	238,603	320,791	82,188	34%	1.7%
Moorabool	32,658	48,891	16,233	50%	2.5%

Source: id Consultants profiles. Baw Baw and Wangaratta references Victoria in Future for 2031. Growth rate for Baw Baw is calculated for 15 years, not 20 years.

Excluding Wangaratta and Baw Baw, an additional 99,307 dwellings over the next 20 years will be required, seeing most municipalities add between 16-22 per cent to existing dwelling stock. Table 4 details the growth in dwellings per municipality. Despite some infill development, the majority of new housing in regional centres will be greenfield subdivisions[7]. This highlights the importance that improving the sustainability of subdivisions is likely to have on overall new housing in regional areas.

Table 4 Current and forecast number of dwellings

Municipality	No. of dwellings			Additional dwellings btw 2016-2036
	2016	2026	2036	
Wodonga	16,521	19,727	23,087	6,566
Bendigo	48,636	57,868	66,580	17,944
Baw Baw	n/a	n/a	n/a	n/a
Shepparton	27,288	31,095	34,804	7,516
Wangaratta	n/a	n/a	n/a	n/a
Ballarat	44,821	53,406	62,615	17,794
Geelong	106,095	127,433	148,437	42,342
Moorabool	13,255	16,728	20,400	7,145
			Total	***99,307***

Source: id consultant data. Limited data available for Baw Baw and Wangaratta

Across the eight municipalities, development industries differ in size and composition. Some larger regional areas have larger developers and volume builders who may develop areas of 1000+ lots while smaller regional areas tend to have smaller scale developers and tend to see developments typically between 50-100 lots.

Rapid growth places significant demand on urban systems such as transport, community infrastructure and open space, and for essential goods such as potable water, energy and eco-system services. Urban expansion increases the separation of communities from their food systems. In areas with ageing communities, urban environments must be designed to support active ageing in place.

2.4 The disconnect between subdivision design and dwelling design

A range of factors contribute to the ‘disconnect’ between the subdivision design and the design of dwellings on the newly created lots. A common issue in regional Victoria is that a planning permit is rarely required for individual dwellings. Consumer choices are largely focused on aesthetic factors, rather than thermal comfort and energy efficiency considerations. Land subdivision and dwelling construction are generally separately developed and marketed through ‘house and land’ packages. The housing sector is largely driven by a volume build housing market, other than in smaller regional

[7] Some areas such as Ballarat are also experiencing infill development. Source: Ballarat City Council

areas or smaller scale developments, and for regional centres that are accommodating a larger proportion of infill development such as in Ballarat.

In many cases these factors combine to result in a disconnection between land subdivision, dwelling design and construction processes. Consumer preferences are generally driven by a selection of the preferred lot and then choosing an ‘off the plan’ dwelling design to optimise their floor area for their budget. The net effect is a lack of focus on the dwellings’ responsiveness to the site or to local climatic factors, so that dwelling design is not always site responsive, climate responsive, even when the subdivision may be well designed to meet the planning requirements or provide excellent opportunities for passive solar design.

Consumers and volume builders are largely driven by meeting the minimum requirements of the National Construction Code (6 star NatHERS rating). Due to the relative affordability of land in regional Victoria, consumer preferences generally favour substantial dwellings with small backyards, where the measure of value is driven by the floor area and number of bedrooms rather than future operational costs through the consideration of energy efficient design.

The following example demonstrates such 'disconnect' between subdivision design and dwelling design.

Whitebox Rise estate in Wodonga is considered a well-designed master planned subdivision established through a Development Plan.

The positive ESD elements of the subdivision layout included:

- proximity to central business area (3km)
- grid based layout of walkable streets enabling permeability for walking and cycling.
- integrated open space network with almost 40 per cent of the site area utilised for conservation and parks
- recycled water (stormwater capture and re-use on racecourse, dams and irrigation of public facilities)
- local destinations such as shops, park/playground, school, aquatic facility
- higher density housing around activity centre
- designed where possible for optimised solar orientation and encourage design features which would minimise resource consumption

Issues related to dwelling design:

Despite the availability of the design guidelines which encourage the use of eaves, many dwellings do not have eaves to shade windows from the sun.

A price-sensitive and highly competitive volume build housing market has led to many instances of cost reductions across the development process. There is significant opportunity for home builders to lower their life cycle costs of dwellings (reduced heating and cooling costs) and improve thermal comfort through greater uptake of passive solar orientation. There are opportunities to enhance liveability, amenity and sustainability through increased canopy cover in the streets and within lots.

Figure 11 Master plan for Whitebox, Wodonga

Source: Whitebox Rise http://www.whiteboxrise.com.au/

To address the disconnect between the land subdivision and dwelling design and construction despite a Development Plan implementing a detailed master plan, Wodonga City Council sought an application of a Design and Development Overlay (DDO) requiring single dwellings to comply with a range of design measures. The developer prepared non statutory design guidelines to give further direction to the DDO and restriction of title. The developer and individual landowners/builders seek exemptions from these controls and guidelines from time to time. As a result, despite the design controls which are in place, the outcomes of some of the dwellings are not considered satisfactory.

Key lessons

- Even when a subdivision is well designed at a master plan or estate scale, ESD initiatives do not always filter down to street and lot level. There is opportunity to increase greening and tree canopy cover through better street design.
- Different ESD initiatives need to be addressed at different scales
- There is an opportunity for developing clear guidelines/recommended planting list for canopy trees which are drought resilient and fit for purpose (size) in streetscapes and lots. This is particularly important in modern greenfield estates where shorter setbacks predominate and provide limited opportunity for canopy trees.
- There is an opportunity to improve governance arrangements to facilitate enhanced sustainability.
- Council should be more cautious about the potential impact on dwelling design when assessing any DDO exemption.
- Design guidelines do not provide certainty that environmental sustainable design features will be implemented in new dwellings
- There is a need to educate both the building industry and potential new home owners about the significance of passive solar design, e.g. building orientation, eaves, which could significantly reduce lifecycle costs of the dwelling.

Figure 12: Substantial dwellings; limited landscaping, Whitebox, Wodonga

Source: Wodonga City Council

Figure 13: Dwelling with no eaves, limited landscaping within lot, Whitebox, Wodonga

Source: Google Street View

3.0 Best practice ESD subdivisions

This section establishes principles to guide ESD subdivisions. The principles are based upon a review of reports, agreements and decisions relating to sustainability as well as best practice case studies and assessment frameworks. The purpose of identifying best practice is to understand what can be applied to raise the minimum standard of subdivisions. It should also be acknowledged that what is considered to be best practices changes over time as practices and technologies develop, become more affordable and are adopted more widely.

Physical elements such as site orientation and stormwater management are also identified that could be utilised to translate principles into physical improvements. Principles and elements have been tested and refined with stakeholders through workshops in each municipality and centrally in Melbourne.

3.1 What fundamental principles guide an ESD subdivision?

Key sustainability principles from international and national agreements provide the foundation for sustainable development (including greenfield subdivisions) and should be embedded within the development ethos and processes.

The foundational and most commonly accepted definition of sustainable development is contained in the '*Brundtland Report*[8]', the 1987 UN Report of the World Commission on Environment and Development titled "Our Common Future". It defines sustainable development as:

> ***"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."***

In Australia the addition of 'ecological' recognises the importance of the environment. *The National Strategy for Ecologically Sustainable Development*[9] (endorsed by COAG in 1992) defines ESD as:

> ***"Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends."***

The National Strategy is supported by Core Objectives and Guiding Principles which are:

Core Objectives

1. **Quality of life -** to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations
2. **Inter-generational and intra-generational equity -** to provide for equity within and between generations
3. **Conservation of biological diversity and ecological integrity -** to protect biological diversity and maintain essential ecological processes and life-support systems

Guiding Principles

- **Integration -** decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations
- **Precautionary principle**[10] - where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- **Sustainable use -** the global dimension of environmental impacts of actions and policies should be recognised and considered
- **Internalisation of external environmental costs** – (polluter pays) to ensure environmental costs are internalised wherever possible and externalities minimised

[8] http://www.lec.justice.nsw.gov.au/Documents/preston_principles%20of%20ecologically%20sustainable%20development.pdf
[9] http://www.environment.gov.au/about-us/esd/publications/national-esd-strategy-part1#Principles
[10] United Nations Conference on the Human Environment, 1992

- **Inclusive -** decisions and actions should provide for broad community involvement on issues which affect them

The guiding principles and core objectives must be considered as a package as no objective or principle predominates. ESD requires development to be designed with sustainability in mind from the outset and not as an "add on" to a conventional design through the imposition of permit conditions.

The *Sustainable Cities Report* (House of Representatives Standing Committee on Environment and Heritage, 2005) established a 'vision for a sustainable city' and 'a pathway to sustainability'. The key principles for sustainable cities include:

- Conserve bushland, significant heritage and urban green zones.
- Ensure equitable access to, and efficient use of energy, including renewable energy sources.
- Establish an integrated sustainable water and stormwater management system addressing capture, consumption, treatment and re-use opportunities.
- Manage and minimise domestic and industrial waste.
- Develop sustainable transport networks, nodal complementarity and logistics.
- Incorporate eco-efficiency principles into new buildings and housing.
- Provide urban plans that accommodate lifestyle, employment and business opportunities.

These principles should inform locational decisions, precinct or subdivision design as well as the siting and design of development.

3.2 Learning from best practice

While many councils encouraging ESD seek best practice, innovation and use of emerging technologies, few ESD local policies in Clause 21 or 22 of planning schemes are specific in requiring best practice. Neither is best practice defined or referenced in the relevant LPPF of Planning Schemes. There are limited single references to best practice within Clause 21 specifically in regards to WSUD principles, stormwater treatment and utility services however, as a whole best practice is not promoted through local policies. Rather, there are some Planning Schemes which generally encourage and support sustainable development through the local policies

Best practice has been defined as:

> **"A combination of techniques, methodologies and systems that, through experience and research, have reliably led to optimum ESD outcomes. Best practice in the built environment encompasses the full cycle, from clearing of existing site conditions, design, construction and ongoing occupation, through to final demolition or recycling[11]."**

Best practice is not intended to be prescriptive with regard to materials or technologies or to prescribe compliance with a performance benchmark or rating. It is intended to encourage innovation and provide flexibility for applicants to consider the site and the technical, logistical and financial considerations to determine the most effective way to achieve specified ESD policy objectives.

It is important to note that what is considered 'best practice' will change over time and will always be above the minimum standard. For example, if the NCC minimum were to require a 6.5 star rating, best practice would continue to exceed this minimum, as found by the Local Planning Policies for Environmentally Efficient Design Advisory Committee.

To determine appropriate principles and elements for an ESD subdivision, case studies were identified and ESD frameworks were reviewed. These are frameworks that are applied to development assessment or used for certification programs such as the Green Building Council of Australia (GBCA's) Green Star Communities or the UDIA's EnviroDevelopment. The following was also informed by meetings with staff of CASBE, Moreland City Council, UDIA and the GBCA.

[11] Local Planning Policies for Environmentally Efficient Design Advisory Committee Expert Witness Statement: Strategic Planning 10 Consulting Group – Rob Milner

3.2.1 Case studies

Six case studies were reviewed that represent best practices in subdivisions and master planned communities across Victoria, nationally or internationally. They reflect diverse geographies, climates and scales of developments (ranging from 20 ha to 1,660 ha) and are summarised in Table 5 below, with further details of each case study in Appendix D.

Table 5 Best practice case studies

Case Study	Area	Relevance to regional Victoria
Mullum Creek, Donvale, Victoria	20 ha / 56 lots	• Individual lot plans for each residence showing building and vegetation envelopes and setbacks • Design guidelines • Land conservation • EnviroDevelopment certification
Witchcliffe Ecovillage, Margaret River, Western Australia	120 ha / 320 lots	• Rural and regional development context • Urban master-planning for all aspects of the development include site orientation and infrastructure Micro-energy grid aspirations • Affordable housing strategy • Sustainability targets, such as being the world's first fully integrated village; to be self-sufficient in renewable energy, water, and fresh food produce.
The Cape, Cape Patterson, Victoria	40 ha / 220 lots	• Strict design guidelines for houses built, such as minimum WELS ratings and bushfire protection • Affordable 7.5 star housing designs • Conservation and protection of local wildlife
Lochiel Park, Campbelltown, South Australia	15 ha / 150 lots	• Association/close relationship with a university or research partner • Intensive urban design guidelines, including minimum energy, water and waste requirements • Sustainability targets
New City of Zenata, Greater Casablanca, Morocco	1,660 ha 300,000+ population	• Social rehousing programs for existing residents in shantytowns • City planning to capture natural cooling winds • Water storage in underground natural reservoirs during high rainfall periods
YarraBend, Alphington, Victoria	16.5 ha / 2500 dwellings	• Mixed residential and commercial development • Inclusion of innovative battery storage and energy initiatives • Permeability of precinct borders allows greater integration with active transport networks

Source: Various

The key findings from these case studies are that:

- ESD is applicable at all scales of subdivisions, however the scale of a development can effect which measures present the greatest opportunities and value for money.
- All case studies generate renewable energy onsite and have energy efficient dwellings and fixtures.
- Best practice developments are generally early adopters of technologies such as smart grids and battery storage. These are usually selling points of a development and can form part of the branding of the development.

- The majority of case studies were nearly or fully self-sustainable in terms of water, energy, and decentralised services.
- The developments fostered community cohesion and local economies through facilities and networks
- Services such as community facilities and public transport are provided from the outset and scaled up accordingly to meet demand.

The key drivers for best practice ESD from these case studies are:

- ESD was usually market and developer driven
- The majority of drivers were non-regulatory and included the vision and commitment of the developer, and for branding or creating a niche development.
- Assessment tools such as UDIA's EnviroDevelopment or GBCA Green Star were sometimes utilised as a framework to measure performance, however the majority of developments did not use assessment tools. Where they were used they were incorporated into the marketing of the development and achieved a premium.
- Support from council was critical to obtain approval for measures that may have required a slightly different approach.

Importantly the case studies illustrate that best practice is not able to be prescribed. They also highlight the usefulness (but not essential) use of ESD tools to set objectives, inform design and measure performance. ESD tools are described further in the following section.

3.2.2 ESD assessment and rating tools

Sustainable assessment tools provide a structured way of assessing the degree to which a development is sustainable and can provide a comparative assessment against other precincts and buildings. They usually:

- comprise a number of categories of environmental impact that relate to the sustainability of buildings and communities;
- set standards to measure the sustainability of a building or community in each category;
- target specific building or community types (e.g. residential developments) or particular aspects of sustainability (e.g. water), however it is common for different tools to evaluate the same key indicators;
- are based on a computer program or spreadsheet that enables details about the design, construction and operation of a building or development to be entered, to derive a rating or a score that measures the level of sustainability.

Most tools are different and have been designed for different purposes. They may include distinct categories and may incorporate different targets or standards. Generally, all tools which set the minimum standards required will result in a higher level of sustainability than the application of requirements such as the NCC.

Figure 4 Assessment tools

As a general principle, flexibility should be provided for developers to choose which tools they prefer to use. However, Councils will need to identify some form of objectives or targets to determine whether buildings meet the sustainability objectives the Council is seeking to achieve. Compliance with a tool is a straightforward way for a Council to indicate targets, as tools have targets built into them and avoids the need for the Council to undertake independent research to identify and to justify their own targets.

The Green Star (Communities, Design and As-Built and Performance) and the BESS (formally the STEPS and SDS) tools are commonly used throughout Victoria and generally include the

most complete range of considerations for assessing the sustainability of buildings, however other than Green Star Communities do not apply to subdivisions.

The benefits of achieving a certified rating include third party verification, assurance that designed outcomes are followed through to construction and operation and marketability in the sustainable design space, allowing comparison against other developments that have undergone the same process. They are also understood to yield higher rental rates (commercial) and increased saleability (residential) due to current market and personal focus on sustainability.

Sometimes these tools prescribe a set of benchmarks that can lead to inflexible design and a significant amount of project documentation, incurring additional project time and cost. It is for this reason that many councils may benchmark developments against rating tools rather than enforce certified rating. This allows for consideration on whether or not the development has met the intent of particular sustainability objectives, rather than a set of rules and guidelines, but this can create other challenges that third party verification can overcome.

Overview of precinct and subdivision scale tools

Precinct scale tools are generally applied during the early planning and design stages of a development. They offer a holistic framework with key target benchmarks that support decision makers to better understand and improve the influence their determinations will have upon the longer term environmental, social and economic aspects of the development; including flow-on effects to the buildings within the precinct or subdivision.

Assessing a development and achieving a rating under a precinct tool can be difficult given the number of stakeholders involved and their complex interactions with the project and one another. Precinct tools, although generally requiring development recertification over time, are still point in time ratings, which can be challenging for masterplans that may take years to develop.

The most locally used or highly recognised precinct tools in Victoria are Green Star Communities (developed by the GBCA) and EnviroDevelopment (developed by the UDIA). Green Star is widely recognised internationally, as are other international precinct tools such as One Planet Living, BREEAM for Communities and LEED for neighbourhood development.

Table 6 provides an overview of relevant precinct scale tools and demonstrates that they all address a broad range of criterion. It is important to note however that these tools are not all the same and have differing emphases as described in the table below.

Table 6: Precinct Scale Sustainable Assessment Tools (Source: AECOM)

Tools	Use/Application	Governance	Liveability	Economic Prosperity	Energy Efficiency	Water Efficiency	Stormwater Management	Transport	Waste Management
Green Star Communities	Large scale development projects at a precinct, neighbourhood and/or community scale. Australian based with ~20 certified projects (2 in Victoria).	✓	✓	✓	✓	✓	✓	✓	✓
Enviro-development	Typically used on large residential subdivisions; 2 tools specifically for subdivisions and master planned communities. Australian based with 100 projects certified nationwide with 19 in Victoria.	✓	✓	✓	✓	✓	✓	✓	✓
One Planet Living	For leading communities with high ambitions for sustainability, net zero energy, waste and water. Used in UK, US, Mexico, South Africa and Australia.	✓	✓	✓	✓	✓	✓	✓	✓
BREEAM for communities	Medium to large scale developments, including new communities and regeneration projects. Widely used in Europe, parts of The Middle East and Africa. 27 projects certified.	✓	✓	✓	✓	✓	✓	✓	✓
LEED for neighbourhood development	Whole neighbourhoods, portions of neighbourhoods, or multiple neighbourhoods. Often mixed-use. US based with nearly 230 certified projects.	✓	✓	✓	✓	✓	✓	✓	✓

Overview of built form tools

An array of sustainable assessment tools exists throughout Australia and the world, addressing buildings and their assets at the different stages of the building cycle inclusive of planning, design, construction and operation.

At a holistic level in Victoria, the Built Environment Sustainability Scorecard (BESS) is used to assess developments during the planning stage for planning approval for several councils in metropolitan Melbourne. For voluntary assessment and third-party verification, Green Star Design and As-Built is widely used, however it is generally used for higher value and higher density buildings.

Table 7 provides an overview of relevant built form tools and the criterion they address.

Table 7: Building Scale Sustainable Assessment Tools (Source: AECOM)

Tools	Use/Application	Indoor Environment Quality	Energy Efficiency	Water Efficiency	Stormwater Management	Transport	Waste Management	Sustainable Materials	Construction and Building Management
Green Star Design and As Built	Small to large scale and all building types. New tool released late 2015 with 55 projects already registered or certified. Buildings certified based on As-Built documentation. Similar tools - European BREEAM New Construction and US LEED Building Design and Construction.	✓	✓	✓	✓	✓	✓	✓	✓
BESS	An assessment tool created by Victorian councils (CASBE) to support SDAPP. Used at the planning permit stage. Replaces STEPS and SDS.	✓	✓	✓	✓	✓	✓	✓	✓
NABERS	Measures operational energy efficiency, water usage, waste management and IEQ of a building or tenancy and its impact on the environment.	✓	✓	✓			✓		
STORM	Generally submitted to statutory authorities in Victoria with planning applications to demonstrate compliance with objectives regarding stormwater.				✓				
NatHERS	Residential tool used to demonstrate energy efficiency compliance with NCC (building permit).		✓						
One Planet Living	For leading developments with high ambitions for sustainability, net zero energy, waste and water. Used in UK, US, Mexico, South Africa and Australia.	✓	✓	✓	✓	✓	✓	✓	✓
Living Building Challenge	Highly aspirational and holistic tool based on operational performance. Projects can achieve living certification or petal certification.	✓	✓	✓	✓	✓	✓	✓	✓
WELL	Evidenced based system for measuring, certifying and monitoring the performance of building features that impact health and wellbeing. Applicable to commercial and institutional buildings.	✓							
First Rate 5	Models residential building fabric thermal performance in meeting Volume 2 (energy efficiency of class 1 and 10 buildings) of the NCC		✓						

3.3 ESD in the Planning Scheme

This section identifies planning instruments currently utilised by other councils in Victoria that are not used by the participating project councils.

3.3.1 ESD Local Policy for built form outcomes

A number of metropolitan local councils have developed specific ESD local policies. The scope of local ESD policy objectives as developed by the SDAPP group of councils (which are generally written to apply to built form) relate to the key environmental impact categories of:

1. **Indoor environment quality** – airflow, daylight, lighting, toxicity of materials, noise.
2. **Energy efficiency**– energy efficiency, energy saving and alternative energy sources.
3. **Water efficiency**- Integrated water management and water sensitive urban design – conservation, wastewater reduction, stormwater management.
4. **Stormwater management** – to improve quality, encourage re-use and mitigate localised flooding
5. **Building materials** – minimal ecological or health impact, durability, recyclables, locally produced materials, use of pre-fabricated to reduce waste
6. **Transport** – connectivity, alternative modes, end of trip facilities, sustainable transport hierarchy i.e. walkability, cycling and public transport provision.
7. **Waste management** – reduce landfill waste, maximise recycling and provision of space for waste
8. **Urban ecology –** landscape and biodiversity
9. **Innovation** – to encourage innovative approaches or use of new technology
10. **Construction and building management** – vegetation retention, hazardous waste, contaminated land, environmental awareness training.
11. **Sustainable materials** –.renewable and low carbon materials

The categories developed by the SDAPP councils relate to built form and do not necessarily cover shared spaces associated with subdivisions such as:

1. **Subdivision layout and design (including lot design)** – this could potentially replace indoor environment quality category to emphasise the role of land/lot design and orientation in relation to indoor environmental quality.
2. **Public realm –** that enables access, walkability, local amenity and social connections.
3. **Amenity, services and employment –** such as local shops, schools, medical centres etc. for larger subdivisions.
4. **Shared infrastructure and services-** such as central service hubs for larger developments.

3.3.2 Principles established by Planning Panels Victoria (PPV) and VCAT

In establishing local policies for ESD, PPV have established the following principles for the development of local policy (*Manningham – Amendment C33PPV, 2003, p 91*) which should:

- clearly communicate its purpose and the outcomes it seeks to achieve.
- contain sufficient rigour to stand up to challenge with respect to its technical and statutory basis.
- at a minimum, ensure statutory obligations are met and support the implementation of standards established by government, research institutions and the like.
- deliver equitable solutions across different land uses and development sites while allowing for flexibility in site and building design.

- be capable of comparing 'apples with oranges' so that the value of different solutions, including innovative practices and technologies, can be evaluated for effectiveness in achieving broad ESD objectives and specific standards or performance targets.
- be capable of independent verification.
- be able to sustain the constructed or operational elements that justified the original approval of the proposal.
- identify responsibilities and the schedule for implementation of agreed outcomes and ensure that the agreed outcomes occur.
- enable the Council to monitor the effectiveness of its planning framework over time.

Across a number of Planning Panels and through VCAT hearings, there has been strong recognition that the objectives of planning and the SPPF support sustainability objectives, and in the absence of a State ESD policy it is appropriate for local policies to be developed and to pursue sustainability through both planning and building mechanisms. (See Section 4)

> ***While building regulations are intended to be the principal method of imposing certain types of sustainability measures in dwellings in Victoria, however they are not exhaustive nor the exclusive mechanism (Hasan v Moreland [2005]).***

Building on these decisions, principles to guide the development of ESD policies in planning have been identified (*100 Mason Street P/L v Hobsons Bay [2007*])

- **Strategic justification -** All levels of the planning system support the imposition of objectives, strategies and (perhaps) permit conditions which incorporate best practice ESD principles.
- **Nexus** - For an ESD condition to be placed on the permit it is preferable to have supporting policy at a local level. While the SPPF contains a reasonable level of support for ESD in the Planning Scheme, support and encouragement within the context of the LPPF would strengthen the justification /nexus.
- **Proportionality -** There is a need to be selective in applying such conditions and they should not be applied globally. They should be proportional and relevant to the scale and nature of the development.
- **Reasonableness -**The requirements imposed by, or as a result of, a condition should not exceed what is reasonable to expect of the developer.
- **Avoid duplication -** There is no need to apply conditions which are comprehensively dealt with by other legislation or regulation

Environmental sustainability has explicit support at all levels of the Victorian planning system and a requirement for an ESD Sustainable Design Assessment (SDA)or Sustainability Management Plan (SMP) is justified in certain circumstances (*Jolin Nominees v Moreland [2006*]), if required by a local policy setting where the scale or nature of the development warrants it. A SMP actively encourages building and subdivision design to achieve specific targets.

The process of developing and administering an ESD local policy can be resource intensive, posing a challenge for regional Victoria where resources are constrained and where the political support may not be strong.

3.4 What defines a best practice ESD subdivision for regional Victoria

Best practice for subdivisions can be defined as:

"A combination of techniques, methodologies and systems that, through experience and research, have reliably led to optimum ESD outcomes. Best practice in the built environment

encompasses the full cycle, from clearing of existing site conditions; design, construction and ongoing occupation, through to final demolition or recycling[12].”

3.4.1 An ESD subdivision defined

Sustainable subdivisions are located and designed to improve quality of life and use resources more effectively. They aim to use resources so that the needs of today’s communities are met, while ensuring that these same resources remain available to meet the needs of future generations.

Crucially best practice requires that ESD is embedded from the beginning of the subdivision process. Lot orientation, transport networks, biodiversity protection and integrated water management need to be considered at the framework planning, PSP and DPO stages This is where lot orientation and design play a key role in establishing the framework for development, which informs siting, house design, building and occupancy (comfort and cost savings). It is not enough to just consider the items that will directly affect housing development at the subdivision permit stage.

Sustainable subdivisions are carefully planned to achieve environmentally friendly and energy efficient places and buildings that can achieve the following objectives:

1. Improve quality of life
2. Protect and use resources efficiently
3. Improve the health of the environment and people

3.4.2 Principles and elements of an ESD subdivision

The following principles are proposed to guide better ESD outcomes of subdivisions in regional Victoria. They are based upon the above reviews of case studies, ESD frameworks and assessment tools, and have been refined through extensive stakeholder feedback. Table 8 details the agreed principles and elements that define and determine ESD in subdivisions in regional Victoria.

Table 8 Principles and elements for an ESD subdivision

Principle	Elements
Optimise site potential *Considering passive design principles and the local environment and site context early in the subdivision process enables efficient use of resources, minimises run-off and erosion and improves outcomes for residents.*	**Orientation & site layout** - Design to utilise topography, and to minimise earthworks and spoil - Design responds to the existing environment, weather conditions and terrain - Design prepares for the future climate and reduces impacts of the urban heat island effect (reduce hardstand area, roof reflectiveness, shade for roads, footpaths and bicycle paths; cool spaces in subdivision) - Utilise eco-system services: o Retains existing natural features(o Maximise solar access o Maximise natural ventilation - Enable access and connection to services, open space and amenities - Ensure space for quality public realm (open space, shade trees, landscaping and WSUD) - Landscape design to reduce maintenance requirements and benefit from natural features Consider ways to optimise green, permeable spaces (such as through undergrounding services under footpaths)
Reduced footprint *Increasing resource efficiency during*	**Water, stormwater and wastewater** - Stormwater retention and re-use (in parks, gardens and the landscape

[12] Local Planning Policies for Environmentally Efficient Design Advisory Committee Expert Witness Statement: Strategic Planning 10 Consulting Group – Rob Milner

Principle	Elements

construction and operations will avoid waste, improve amenity and reduce costs.	to mitigate flood risk and impacts of heat and drought)
	- Drought tolerant species/landscape design zoned to minimise water use
	- Protect water quality through treatment of waste from septic systems or alternative treatments
	- IWM/WSUD to
	  o Increase permeability
	  o Reduce impervious material
	  o Clean and use stormwater
	  o Retain water to cool the landscape
	Energy
	- Reduce demand for energy through
	  o Compact fluorescent / LED street lighting
	  o Smart technology to support demand management/ behavioural change (currently used in mini-grid trials)
	  o Solar orientation & insulation
	  o Shading
	- Generate and store renewable energy on site or at precinct scale
	- Utilise new and emerging technologies
	- Provide for redundancy
	Waste
	- Minimise construction waste and maximise reuse on site
	- On site separation of construction and operational waste to landfill (through using the use of locally sourced, recycled building and construction and infrastructure materials (see Infrastructure Design Manual Sustainable Infrastructure Guidelines)

Create places for people *Planning with future communities in mind better supports their economic and social wellbeing. Providing access to local amenities and spaces for people to meet and gather builds cohesive, inclusive and resilient communities.*	**Dwelling and lot diversity** - Provide varied lot sizes and dwellings that cater to a mix of housing needs and price points **Local economy** - Provide space for local economic opportunities (including small home-based businesses; shared spaces and incubator hubs etc.) - Offer good access to quality services and community spaces and facilities (including access to fresh food) **Connectivity** - Provide safe and shaded footpaths and bike-paths to connect to local amenities and neighbouring communities for residents and visitors - Design safe, inclusive, well-connected and welcoming places - Encourage shared spaces and shared use of space (such as for ride share; community gardens and community activities) - Enable technology to support social interaction.
Enhance ecology *Health and wellbeing and building performance benefit from ecosystem services such as shade, urban cooling, and access to open space.*	**Local ecology** - Retains existing established vegetation (especially native plants) - Strengthen local habitat and biodiversity connections to larger ecological assets. - Provide habitat for threatened species - Manage vegetation to minimise bushfire risk

Principle	Elements
Local ecosystems include public land and private gardens that support local flora, fauna & biodiversity.	- Allocating cool spaces/refuges within subdivisions. Consider the inter-relationship of the public and private realm for enhancing streetscapes for biodiversity and amenity
Encourage adaptability and innovation *Subdivisions built with tomorrow in mind are more resilient and adaptable to future changes in climate, demographics and technology.*	**Emerging trends and technologies** Consider and enable room for innovation and new technologies such as: - battery storage - electric vehicle charging points - micro-grid (energy trading within subdivision- peer to peer trading) - autonomous vehicles - high quality digital infrastructure to the home to support the local economy - working from home; virtual service delivery - wind modelling to inform natural cooling

3.4.3 ESD initiatives

Table 9 lists a number of initiatives that respond to the ESD principles and elements identified in Table 8 above. Further explanations of these initiatives are provided in Appendix C.

Costs and benefits have been assessed at a high level and are indicative only. The CBA in section 5.0 models a number of selected initiatives qualitatively and quantitatively to define the costs and benefits.

Note that the table below does not include Principle 5: Encourage Adaptability and Innovation as achieving many of the initiatives below utilises emerging trends and technologies. Note also that the subdivision size column loosely relates to:

- Small – 10 lots
- Medium – 50 lots
- Large - 100+ lots

Table 9 Initiatives that could be undertaken to meet principles

Initiative	Relevance	Indicative Cost	Indicative Benefit	Scale	Subdivision size	Optimal timing
1. Optimise site potential						
Orientation and site layout						
Site layout and orientation	Allows good passive design of public spaces and buildings for solar access and thermal performance	Low	High	Subdivision	All	Masterplan stage
Lot design and dwelling positioning (orientation)	Critical for solar gain management and ventilation and can avoid significant energy use, improve comfort and reduce operating costs for occupants. Reduce overshadowing.	Low	High	Subdivision, lot and dwelling	All	Surveying, permit, development
Ventilation	Natural ventilation can minimise heating and cooling requirements. Supported by orientation and siting	Low	High	Subdivision, lot and dwelling	All	Surveying, permit, development
2. Reduce footprint						
Water, stormwater and wastewater						
Water Efficiency	High efficiency water design increasingly standard	Low	High	Dwelling	All	Masterplan Objectives for water

Initiative	Relevance	Indicative Cost	Indicative Benefit	Scale	Subdivision size	Optimal timing
						established in this stage
Stormwater Catchment	Utilisation of underutilised resource	Med	Med	Subdivision and dwelling	Medium to large	Masterplan
Wastewater Recycling	Utilisation of underutilised resource	Med	Med	Subdivision and dwelling	Large	Masterplan
WSUD	Reduces use of potable water, reduces impact on city infrastructure	Low	High	Subdivisions	Medium to large	Masterplan and development
Energy						
Smart Grid	Opportunity to engage with nation leading technology. Refer to Yackandandah.	Med	High	Subdivision	Medium – large	Masterplan
Energy Storage	Allows full utilisation of renewable energy sources. Builds resilience to changing shape of the grid.	Med	Med	Subdivision and dwelling	Medium - large	Master plan and Development
Photovoltaics	Highly applicable due to high roof to floor area ratio	Med	High	Subdivision and dwelling	All	Development
Tri-generation	Reduces cost and GHG of energy, reduced effect in context of changing electricity supply	High	Med	Subdivision and dwelling	Current limitations. Future potential	Master plan and Development
Fuel Cells	Nation leading technology	High	Low	Subdivision and dwelling	Feasibility to be determined	Master plan and Development
Building Energy Efficiency	Planning direction to drive efficiency	Low	Med	Dwelling	All	Master plan and Development
Central services hub	Reduces energy peak power, reducing size of plant and returning floor area	Med	High	Subdivision	Large	Masterplan stage
Waste management						
Waste to Energy	Requires addition of significant waste handling infrastructure. Nation leading.	High	Med	Subdivision and dwelling	Large. Future potential	Masterplan and Development
Construction waste	Reduce and reuse waste from construction	Med	High	Subdivision and dwelling	All	Construction
Composting food waste	Reduces methane associated with food waste going to landfill	Low	Med	Subdivision and dwelling	All	Operating
Infrastructure materials	Adoption of IDM Sustainable Infrastructure Guidelines	Low	Med	Subdivision	All	Master plan and Development
3. Create places for people						
Dwelling and lot diversity						
Lot diversity	Encourage people/ families to live in / build housing suitable to their household sizes, hence to reduce running costs/ energy consumption.	Low	High	Subdivision, lot and dwelling	All	Surveying permit, masterplan
Local Economy	Provides local services and opportunities for local employment	Low	Med	Subdivision	Large	Masterplan
Connectivity						

Initiative	Relevance	Indicative Cost	Indicative Benefit	Scale	Subdivision size	Optimal timing
Walkable areas	Reduce the reliance upon private vehicles, their associated costs and impacts and to improve health and safety through increased pedestrian activity and connectivity.	Low	Med	Subdivision	All	Masterplan
Cycling	Extensive cycling network that connected to the regional network. Should provide safe options for everyone from 8-80 years of age.	Low	Med	Subdivisions and regional centres	Med-large	Masterplan
Public transport provision	Provision for public transport such as bus stops and network planning from inception and scaled up accordingly assist with creating sustainable travel behaviours.	Med	Med	Subdivisions and regional centres	Med-Large	Masterplan
4. Enhance ecology						
Local ecology						
Biodiversity	Flora and fauna in private and public spaces. Ideally native species to support local biodiversity	Low	Med-High	Subdivision and lot	All	Objectives for energy would be established in this stage
Greening and shading	Benefits are twofold. Shading reduces energy consumption and running costs of individual lots and also reduces heat gain in built up areas (urban heat island). Greening can control heat gain of individual lots (e.g. west facing frontage can beefit by trees blocking out sun in late afternoon). This could also be translated into financial benefit through reduced energy use.	Low	Med-High	Subdivision and lot	All	Masterplan, construction and operation
5. Encourage adaptability and innovation						
Emerging trends and technologies to support many of the above initiatives						

Source: various

4.0 Current policy and regulations in regional Victoria

4.1 Overview

There is currently a range of statutory and non-statutory planning tools, policies and controls in place that affect the provision of sustainable residential development and subdivisions.

There is currently no state-wide sustainability assessment framework in place. All buildings require building approval but only a small percentage of new buildings require planning approval. Nonetheless the planning process has significant potential to influence land use and land subdivision, which building regulations cannot influence or manage. For large scale subdivisions, there is a need to clearly establish sustainability at the planning stage.

This section assesses the effectiveness of current regulatory tools, policies and controls that apply at various stages of the subdivision process. It attempts to identify gaps in requirements and gaps in implementation as reported by stakeholders. It concludes by identifying how regulations and policies apply to various spatial parts of the subdivision. Findings from this section inform the recommendations and tools in section 6.0.

4.1.1 The subdivision process

The process of subdividing involves the division of land inclusive of buildings and airspace into two or more parts which can be disposed of separately[13]. In Victoria, subdivisions are controlled through the planning system. The planning system is intended to ensure that land is used and developed in a sustainable manner, having regard to a range of environmental, social and economic considerations.

The ***Subdivision Act*, *1988*** principally focuses on the technical and legal aspects of subdivision which is to register a plan and establish separate titles.

Most subdivision applications require two processes – an application for planning permit to subdivide land under the Planning & Environment Act 1987 and an application for Certification under the Subdivision Act 1988

Table 10 sets out the statutory requirements in the subdivision application process.

Table 10 The subdivision application process

Subdivision application process	Applicable requirements, guidelines, certification
Planning permit issued under the *Planning and Environment Act 1987*	Subdivision plan endorsed and forms part of the approved plans forming part of the planning permit. Planning permit sets out conditional requirements to be achieved. Conditions may apply restrictions on title (such as Section 173 Agreements or building envelopes to be included on plan of subdivision) applying requirements to lots created.
Plan of Subdivision Certified under the *Subdivision Act 1988*. Plan of subdivision revised (if required) to consider all conditional requirements of planning permit then submitted for certification.	Plan prepared in accordance with the *Subdivision Act 1988* and the Regulations Plan certified after relevant authorities have consented and permit conditions have been met or can be met.
Statement of Compliance issued (SOC)	Council issues Statement of Compliance (SOC) after receiving a letter from each servicing Authority, specifying that all conditions of the planning permit have been met and a final inspection has been carried out by a Council officer. Subdivision is deemed to be complete.

[13] Source: http://classic.austlii.edu.au/au/legis/vic/consol_act/sa1988153/s3.html *Subdivision Act* (1988)

Subdivision application process	Applicable requirements, guidelines, certification
Titles issued for individual lots	The certified plan along with the SOC and any prescribed information are lodged with Land Victoria for new lots to be issued. Subdivision permit null in void A developer may apply a restrictive covenant through the *Transfer of Land Act 1958* following the issue of titles.
Construction of dwellings (Individual lots sold and houses constructed)*	Must meet minimum standards of the National Construction Code (Victoria)

*Outside subdivision process

Of note, the Supreme Court has ruled that subdivision permits are null in void once a title (for an individual lot) has been obtained. This makes it difficult for permit conditions to flow through to the dwelling. Mechanisms such as a Section 173 agreement or covenants can address this disconnect by setting out conditions or restrictions on the use of the land, which can be recorded on title to bind future owners and occupiers. With present arrangements, all the conditions need to be agreed upfront in the subdivision permit.

4.1.2 Scale of subdivisions and requirements

Subdivisions range significantly in size from 2 lots to 1,000+ lots. Different planning requirements, ESD initiatives and tools are relevant to different scales. Clause 56 requirements of the Victoria Planning Provisions (VPP) sets out different subdivision requirements for different scales of development generally as shown in Table 11. Subdivisions larger than 100 or 1,000 lots are typically master planned and have additional opportunities and challenges to achieve ESD outcomes. Different land developers and builders will subdivide at different scales which also needs to be considered in identifying appropriate engagement strategies for encouraging and/or regulating ESD measures in subdivisions.

Table 11 Clause 56 of all Victorian Planning Schemes sets classification or thresholds

Subdivision class
2 lots
3-15 lots
16-59 lots
60 or more lots

Source: Victoria Planning Provisions

4.2 Building regulations

The National Construction Code applies to dwellings and other buildings within a subdivision and sets out the minimum standards to be met. It does not apply to the public realm, or the process of subdivision including orientation of lots or diversity of size.

The NCC is overseen by the Australian Building Codes Board (ABCB), a joint initiative of all levels of Government. Although local councils have power over development assessments, they do not set building regulations.

4.2.1 Section J and First Rate 5 requirements for residential Building

First Rate 5 (6 star energy rating requirement) and compliance with Section J are the minimum standards required to meet the building code. They form part of the NCC for residential and non-residential developments respectively. First Rate 5 is the code compliant tool used in Victoria but there are also others such as Passive House. Changes to the minimum standards of the code is where the greatest improvements in the ESD built form can occur.

4.2.2 VCAT and PPV decisions on the role of building and planning in ESD

There have been various VCAT hearings and Planning Panel reports which have considered whether it is appropriate for environmental sustainability to be addressed through the planning process or other regulatory or development approval processes. It has been argued that ESD should be implemented through building regulations rather than town planning provisions (because the Building Code would facilitate ESD across all development (Taras v Yarra [2003])). The building regulations mandate minimum standards only and do not influence any aspects of subdivision development beyond buildings. It has also been argued that the minimum requirements within the NCC fall well short of what is required for low carbon housing (Moore et al., 2017). There has been support for the incorporation of ESD principles into the planning process which require above and beyond minimum ESD standards and which emphasise the need to incorporate sustainability techniques and principles from the beginning of a project rather than after design is completed and the development is approved. This is particularly true for subdivisions.

Despite inconsistency and ambiguity as to which code or system should be responsible for ESD in the built environment and public realm, planning and building control play complementary roles and are both necessary if ESD is to be improved across all aspects of subdivisions inclusive of public realm, shared resources and facilities, lots and individual dwellings.

4.3 Strategic and policy directions for sustainable development

There are broader objectives that support ESD development in international, national and state policies and strategies. In recent times there has been an increased focus on readying communities and the built environment to reduce exposure to identified climate risks, their severity and impacts. This section provides a brief overview of these instruments.

4.3.1 International and national policies and strategies

At the international level, the ***United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement*** of November 2016 sets the global policy context for climate change mitigation. Specifically, the Agreement aims to facilitate the ability of countries to mitigate their carbon emissions, adapt to climate change and foster climate resilience. Australia has ratified the Paris Agreement, committing to work towards limiting the increase in global average temperature to well below 2°C above pre-industrial levels. Australia has pledged to reduce greenhouse gas emissions by 26-28 per cent by 2020, supported by a renewable energy target.

Focusing on adaptation, Goal 13 of the ***UN Sustainable Development Goals*** (SDG) challenges all countries to act to combat climate change and its impacts. Goal 11: Sustainable Cities and Communities sets out a target to enhance inclusive and sustainable urbanisation by 2030.

The Australian Government released the ***National Climate Resilience and Adaptation Strategy in 2015*** which includes priorities related to checking and reassessing progress towards building resilience, as well as collaborating to identify emerging risks and interdependences. The ***National Strategy for Disaster Risk Resilience*** takes a resilience based approach to build capacity of people and natural and built assets to withstand and recover from natural disasters and emergencies, many of which are climate related.

At present, these objectives are not specifically reflected or drawn down into more local policy and requirements and therefore in practice have little bearing on the practical assessment and outcomes of subdivisions. For these objectives and directions to be of use, they need to be embedded in Planning Schemes as well as assessment tools for subdivisions.

4.4 Victorian planning schemes

The main planning tool used in Victoria to regulate and influence the design and implementation of ESD in residential subdivisions is the VPP and planning schemes.

The range of options for incorporating sustainability into the planning system include:

- Policy directions (such as Plan Melbourne and Regional Growth Plans)
- Providing direction and guidance through Practice Notes and Ministerial Direction

- Incorporating clear definitions in (Clause 70)
- Particular Provisions (Clauses 52-56)
- Including an ESD statement in the Municipal Strategic Statement (Clause 21)
- Reference documents under the Municipal Strategic Statement (Clause 21)
- Incorporating a Local ESD Policy at (Clause 22)
- Incorporated Documents (Clause 81)
- Choice of zones and overlays and varying their schedules

An application to subdivide land[14] must meet the requirements of Clause 56 and:

- Must meet all of the objectives included in the clauses specified and.
- Should meet all of the standards including in the clauses specified.

4.4.1 State Policy Directions

At present there is an underlying foundation within the Victoria Planning Provisions which supports sustainability and ESD at a state and local level in Victoria.

At a state level, the ***Planning and Environment Act 1987*** ('the Act') contains objectives which support the sustainable use and development of land within Victoria. The objectives of the Act seek to (amongst others) '*provide for the fair, orderly, economic and sustainable use and development of land'*.

The Victorian Government's ***Climate Change Framework*** recognises climate change as a complex and evolving challenge for the Government and the community, and as one of Victoria's most critical issues. The Government has revised the Climate Change Act (2017), established the Climate Change Framework (2017) and released ***Victoria's Climate Change Adaptation Plan 2017-2020*** (Adaptation Plan). As part of the Adaptation Plan the Government has committed to reviewing land-use planning policies and provisions to improve the way the land-use planning system manages natural hazards in the context of climate change.

These policies set the direction for reducing Victoria's greenhouse gas emissions (climate mitigation) and to prepare for the unavoidable risks and impacts of climate change (climate adaptation). The Climate Change Act 2017 sets the Victorian emissions reduction targets and stipulates that sectoral Adaptation Actions Plans (AAPs) will be required to be developed every five years, including for the built environment.

Plan Melbourne 2017-2050 anticipates population growth within regional Victoria and specifically identifies that this growth needs to be led at a local level. It also acknowledges the diverse range of opportunities and challenges that exist in different locations.

Plan Melbourne recognises that ESD, inclusive of energy efficiency and renewable energy, can assist in the delivery of cost-effective environmental outcomes and major emissions reductions, improve health and comfort, and support a reduced cost of living. Additionally, passive design measures, such as the orientation of buildings, layout, window placement and design, thermal mass, shading and ventilation can significantly reduce the need for active heating and cooling.

Plan Melbourne identifies that many local councils have incorporated ESD considerations into their planning processes whilst also recognising that there is a need for a state-wide framework in planning to achieve greater consistency throughout the planning process in implementing ESD.

While there has been a lack of state level commitment to strong ESD outcomes, an action resulting from Plan Melbourne is to identify options to strengthen the planning and building frameworks. A review is currently being undertaken to determine the most cost-effective approach for increasing the efficiency of new and existing building stock and require early consideration of ESD in the planning, design and building processes.

[14] other than an application to subdivide land into lots which each contain an existing dwelling or car parking space

4.4.2 Regional and local policies and strategy

While international, national and state level actions enable climate readiness outcomes, local level action remains critical for effective adaptation. The group of eight local councils have a range of local strategies that provide guidance on various aspects relevant to sustainable subdivisions. These include integrated transport strategies, urban forest strategies and other high level strategies that capture elements of sustainability, however there is no policies with teeth to drive sustainability in subdivisions. Some of these strategies are incorporated into their respective planning schemes. Regional Growth Plans such as those relating to the G21, Hume, Gippsland area or Central Highlands provide broad strategic direction for land use and development for regional areas.

4.4.3 State Planning Policy Framework

The State Planning Policy Framework (SPPF) currently includes high level strategic objectives and statements which encourage development to incorporate ESD and the need to consider the environment in land use and development. The following Clauses specifically support ESD in development and subdivisions:

In particular:

- **Clause 11.07 (Regional Victoria)** seeks to develop regions and settlements which are environmentally sustainable. In addition, **Clause 11.07** identifies key principles to guide settlement planning in Victoria's regions (including peri-urban areas). Specifically, it states strategies to respond to the impacts of climate change include:
  - Siting and designing subdivisions to minimise the impact on the natural environment.
  - Encouraging reduced energy and water consumption through environmentally sustainable subdivision and building design.

In addition:.

- **Clause 13 (Environmental risks)** recognises that planning should adopt a best practice environmental management and risk management approach which aims to avoid or minimise environmental degradation and hazards.
- **Clause 11 (Settlement)** states that planning is to recognise the need for and where practicable contribute towards (amongst others) health and safety, economic viability, a high standard of amenity, energy efficiency, prevention of pollution to land, water and air and land use and transport integration.
- **Clause 14.02-3 (Water conservation)** encourages the use of alternative water sources such as rainwater tanks, stormwater and recycled water by developers and households.
- **Clause 15.01-3 (Neighbourhood and subdivision design)** seeks to ensure that the design of subdivisions achieve (amongst others) sustainable neighbourhoods.
- **Clause 15.02-1 (Energy and resource efficiency)** supports land use and development which encourages efficient use of energy and the minimisation of greenhouse gas emissions. This Clause also seeks to ensure that subdivision design improves efficiency in energy use and seeks to improve efficiency in energy use through increased use of renewable energy.
- **Clause 19.01 (Renewable energy)** promotes the provision of renewable energy in a manner that ensures appropriate siting and design considerations are met.
- **Clause 19.03-3 (Stormwater)** seeks to incorporate water sensitive urban design techniques into developments.

As identified above, there is sound support for ESD at a State Planning Policy level. ESD is specifically encouraged to be incorporated into residential subdivisions, specifically at **Clause 11.07**, **Clause 15.01-3** and **Clause 15.02-1**.

4.4.4 Local Planning Policy Frameworks

There is differing policy support for sustainability and ESD amongst the planning frameworks for each of the participating Councils. While each Council generally supports sustainability and ESD in their Municipal Strategic Statement (in the LPPF) there is no specific policy or linkage to residential subdivisions specifically in greenfield areas.

Furthermore, these policies are not application requirements and therefore are not typically triggered by planning applications relating to residential subdivision. The local planning policies in the MSS listed below are considered to specifically support ESD in residential development and in some instances in residential subdivisions:

Wodonga

- **Clause 21.02-2 (Community vision)** seeks to create 'a City which responds to its temperate four season climate through environmentally sustainable design.'
- **Clause 21.07-3 (Sustainable Neighbourhood)** seeks to 'facilitate the design of healthy, safe and inclusive communities' by (amongst others) requiring 'neighbourhood and subdivision design to promote the principle of providing for a walkable catchment, with parks and neighbourhood centres and bus routes located within a radius of 400 metres unless significant constraints prevent it.' Furthermore, this Clause seeks to ensure that 'development includes best practice stormwater treatment measures through the use of water sensitive urban design' and requires 'the consideration of universal design principles in new development and open spaces.'
- **Clause 21.07-4** encourages new development 'to be energy, water and waste efficient and minimise resource consumption.' Additionally, this Clause requires new development proposals to be accompanied by a sustainability report.

Greater Geelong

- **Clause 21.02** specifically recognises the City of Greater Geelong's commitment to sustainable growth and states that Council will works towards reducing greenhouse gas emissions by (amongst others) working with the community and other agencies to identify and promote ways to reduce greenhouse gas emissions in homes and to strive for environmentally sustainable design in all urban development.
- **Clause 21.11-2 (Armstrong Creek Urban Growth Area)** encourages '*sustainable design and development to minimise energy and resource use within Armstrong Creek'* furthermore, this Clause requires planning permit applications for subdivision to demonstrate that subdivision '*will facilitate the orderly development of the precinct.'.*
- **Clause 21.013-2 (Lara)** seeks to '*ensure new development incorporates sustainability principles including environmentally sustainable design, energy efficiency, connectivity and water sensitive urban design.'*
- **Clause 21.014-2 (The Bellarine Peninsula)** strives to '*ensure new development incorporates sustainability principles including environmentally sustainable design, energy efficiency, connectivity and water sensitive urban design.'*

Greater Bendigo

- **Clause 21.05-6 (Greenfield development)** applies to Jackass Flat, Huntly, Strathfieldsaye, Maiden Gully North East and Forest Park Estate at Maiden Gully. This Clause seeks to *'ensure that walking, cycling and public transport infrastructure is provided to greenfield areas that link to the movement network external to the precinct.'* Further **Clause 21.05-7** seeks to '*create communities that promote social interaction and healthy living'.*
- **Clause 21.08 (Environment)** seeks to (amongst others) '*maintain and enhance ground and surface water quality'*, '*protect the environment from pollution and contamination through the appropriate management of domestic wastewater*' and '*to promote sustainable water management practices.'*

Greater Shepparton

- **Clause 21.03 (Vision, Sustainability principles and Strategic directions)** identifies Council's themes and principles to support the Council plan vision. This includes to '*enhance social connectedness, physical and mental health and well-being, education and participatory opportunities in order to improve liveability and provide a greater range of community services.'*
- **Clause 21.04-1 (Settlement)** seeks to minimise the impact of housing on the natural environment and encourages new subdivision and development which promotes walking and cycling between homes, schools, open spaces and shops.
- **Clause 21.04-2 (Housing Change Areas)** supports and encourages '*environmentally friendly technologies for new development and major renovations'* within Minimal Change Areas, and Incremental Change Areas.
- **Clause 21.04-4 (Urban Design)** identifies that Council '*wishes to ensure that sustainability principles will strongly influence the design, siting and servicing of dwellings.'* Furthermore, it is recognised that Council will encourage the *'adapting and reusing of existing buildings and materials, retention and reuse of storm water, and the promotion of solar and energy efficient designs and materials.'* It is also encouraged that new development within the precincts of Shepparton Town Entry-North Precinct, Shepparton Civic North Precinct, Lakeside Precinct, Shepparton South Village Precinct, and Kialla Park Boulevard Precinct enhance energy efficient and sustainable designs. This includes through energy efficient building designs, use of energy efficient appliances, rainwater harvesting, water wise landscaping. And protection of existing natural resources.

Baw Baw

- **Clause 21.03-1 (Settlement Vision)** identifies Council's vision 'to develop a network of integrated, sustainable and resilient communities where people will want to live, work and play, while providing for compatible growth and development.' Further **Clause 21.03-2** identifies that 'the crucial issue is to accommodate people within the main townships that have reticulated infrastructure, such as water, sewerage and stormwater drainage. '

Wangaratta

- **Clause 21.03 Vision** –has a section on environmental management. An amendment was recently exhibited C75 which implements the recommendations of a Planning Scheme Review, a revised 21.01 notes sustainability as one of the pillars of the community vision.
- **Clause 21.06 (Urban Development and Central Activities Area)** identifies that 'innovative subdivision and housing design will foster a sense of neighbourhood and community, a sense of place, adequate access, pedestrian and vehicular connectivity, attractive recreational spaces and interaction between people.' Additionally, this Clause encourages progressive and sustainable development which includes 'use of water sensitive urban design and environmentally sustainable design principles for new development'
- **Clause 21.10 (Environmental Management and Heritage)** recognises that design, siting and construction of buildings and works is required to minimise environmental impacts. Further, this Clause recognises that the 'use of clean, green energy and the reduction of potential greenhouse gas emissions will enhance the municipality's image as a liveable and environmentally sustainable area to live and work.' This Clause also identifies that there is a need to encourage water reuse and recycling.

Moorabool

- **Clause 21.02-1 (Natural Environment)** states that 'planning for development in Moorabool Shire must give deliberate consideration to environmentally sustainable development principals.
- **Clause 21.02-6 (Objective - Environmentally Sustainable Development)** seeks to manage land use in an environmentally sustainable way to support the reduction of the ecological footprint of land within Moorabool Shire. Furthermore, this Clause encourages the principles of 'energy efficient building design and site layout to be considered for new developments, to reduce reliance on artificial heating and cooling and therefore subsequently reducing greenhouse gas

emissions' and to 'ensure Best Practice Water Sensitive Urban Design principals are applied to all new development within the Moorabool Shire.'

- **Clause 21.03-2 (Objective – Urban Growth Management)** seeks to plan and manage urban growth and to avoid urban development where it is likely to impact on the long-term sustainability of natural resources.
- **Clause 21.03-3 (Objective- Residential Development)** seeks to 'achieve high quality living environments which balance the provision of residential development opportunities with the protection of productive agricultural land and environmental assets.'

The above identifies relevant clauses of the LPPF of the participating Councils.

While the abovementioned policies acknowledge there is some evidence of reference to sustainability and ESD within the LPPF, it is noted these policies are all situated within the MSS. This highlights the lack of local planning policies relating to sustainability and ESD at Clause 22 of the LPPF.

These do not specifically act as planning permit application requirements in relation to residential subdivision and as such Council has limited control over ESD aspects of residential subdivisions where built form does not require a planning permit. Where ESD policies and principles are identified within the planning schemes, these largely relate to residential development and are more overarching principles rather than planning permit requirements or mandatory requirements which can be enforced by Council.

There are currently no specific application requirements within the above planning schemes requiring demonstration of how best practice sustainable design can be achieved in residential subdivision.

4.4.5 Particular Provisions

Particular Provisions include some objectives which encourage development to incorporate ESD and the consideration of the environment in land use and development.

The following discusses Clause 54, 55 and 56 of the Particular Provisions and specific references to ESD in residential development and subdivisions.

Clause 54 and Clause 55

Clause 54 (One Dwelling on a Lot) and **Clause 55 (Two or more Dwellings on a Lot and Residential Buildings)** provide limited mechanisms to address sustainable design outcomes in residential subdivision as they relate to residential development and an assessment against **Clause 54** and **Clause 55** may not be required depending upon the zone and overlay requirements. In the majority of instances, an assessment against **Clause 54** or **Clause 55** is not required due to the lot sizes to be created (which largely do not require a planning permit for development of a dwelling on a lot between 300 m^2 and 500 m^2). As many lots resulting from subdivision in regional Victoria are above 500m^2, the majority of dwellings do not require permits. This reduces the scope that councils have to require better ESD outcomes for individual dwellings.

Clause 56 (Residential Subdivision)

While an application for residential subdivision is assessed under the relevant provisions of **Clause 56**, the standards contained at **Clause 56** are not mandatory requirements. If the responsible authority is satisfied that an application meets the relevant objectives of **Clause 56** but not the standards, it may consider alternative design solutions (including the Infrastructure Design Manual, see section 4.5).

Clause 56 contains specific objectives and standards which support ESD and sustainability in residential subdivision design. These include standards and objectives which support good solar access, integrated water management, wastewater management and walkable neighbourhoods:

- **Clause 56.03-1 (Compact and walkable neighbourhoods objectives)** seeks to create compact neighbourhoods that are oriented around easy walking distances to activity centres, schools and community facilities (such as ambulance stations, community centres, libraries), public open space and public transport.
- **Clause 56.03-5 (Neighbourhood character objective)** seeks to design subdivisions that respond to neighbourhood character.

- **Clause 56.04-2 (Lot area and building envelopes objective)** seeks to provide lots with areas and dimensions that enable the appropriate siting and construction of a dwelling, solar access, private open space, vehicle access and parking, water management, easements and the retention of significant vegetation and site features.
- **Clause 56.04-3 (Solar orientation of lots objective)** seeks to provide good solar orientation of lots and solar access for future dwellings.
- **Clause 56.05-1 (Integrated urban landscape objectives)** seeks to provide for integrated water management systems and contribute to drinking water conservation and, to protect and enhance native habitat and discourage the planting and spread of noxious weeds.
- **Clause 56.05-2 (Public open space provision objectives)** seeks to encourage healthy and active communities and, to ensure and provided for public open space that can be managed in an environmentally sustainable way and contributes to the development of sustainable neighbourhoods.
- **Clause 56.06-1 (Integrated mobility objectives)** seeks to contribute to reduced car dependence, improved energy efficiency, improved transport efficiency, reduced greenhouse gas emissions and reduced air pollution.
- **Clause 56.06-2 (Walking and cycling network objectives)** seeks to contribute to community health and well-being by encouraging walking and cycling as part of the daily lives of residents, employees and visitors. Furthermore, it seeks to reduce car use, greenhouse gas emissions and air pollution.
- **Clause 56.06-3 (Public transport network objectives)** seeks to encourage maximum use of public transport.
- **Clause 56.06-5 (Walking and cycling network detail objectives)** seeks to design and construct footpaths, shared path and cycle path networks that are safe, comfortable, well-constructed and accessible for people with disabilities.
- **Clause 56.06-6 (Public transport network detail objectives)** seeks to provide for the safe, efficient operation of public transport and the comfort and convenience of public transport users.
- **Clause 56.07-2 (Reused and recycled water objective)** seeks to provide for the substitution of drinking water for non-drinking purposes with reused and recycled water.
- **Clause 56.07-3 (Waste water management objective)** seeks to provide a waste water system that is adequate for the maintenance of public health and the management of effluent in an environmentally friendly manner.
- **Clause 56.08 (Site management objectives)** seeks to encourage the re-use of materials from the site and recycled materials in the construction of subdivisions where practicable.

Improving ESD

If an ESD lens were to be more embedded across Clause 56, particularly for a regional focus, the following could be considered.

- Within **Clause 56.06 Access and mobility** manage, considerations could be given for public transport provision in regional areas is low, and communities are generally car dependant. Greater emphasis on better and safer cycling infrastructure (separation from cars, end of trip facilities), cycling could become a more viable transport alterative, particularly for shorter trips. Connected walkable urban structures over cul-de-sacs is an important neighbourhood design feature which needs to be reinforced.
- In **Clause 56.07 Integrated water management** it could consider WSUD and the capacity to recycle water. Not all municipal areas have third pipe for recycled water as drainage capacity and cost vary across municipal areas as do water supply and treatment systems.
- Within **Clause 56.08 Site management**, it could encourage re-use of materials on site and recycled materials in subdivisions but uptake may be low.

Table 12 (overleaf) identifies the standards of Clause 56 relevant to the scales of residential subdivisions applicable within Planning Schemes. In effect the specified clauses relate to what the scale of a particular subdivision could be expected to influence in the broader street layout and neighbourhood.

Table 12 Objectives and standards to be met for various scales of subdivision

		Residential zones				Township Zone			IDM
Clause 56 standard	Relevant clause	2 lots	3-15 lots	16-59 lots	60 lots or more	2 lots	3-15 lots	16-59 lots	
C1 Strategic implementation	56.02-12			■	■			■	
C2 Compact & walkable neighbourhoods	56.03-1				■				
C3 Activity centre	56.03-2				■				
C4 Planning for community facilities	56.03-3				■				
C5 Built environment	56.03-4			■	■				
C6 Neighbourhood character	56.03-5	■	■			■	■		
C7 Lot diversity and distribution	56.04-1		■	■	■				
C8 Lot area & building envelopes	56.04-2	■	■	■	■	■	■	■	
C9 Solar orientation to lots	56.04-3	■	■	■	■	■	■	■	
C10 Street orientation	56.04-3		■	■	■		■	■	
C11 Common area	56.04-3	■	■	■	■	■	■	■	
C12 Integrated urban landscape	56.05-1		■	■	■		■	■	■
C13 Public open space	56.05-2			■	■			■	■
C14 Integrated mobility	56.06-1				■				
C15 Walking & cycling network	56.06-2		■	■	■		■	■	
C16 Public transport network	56.06-3				■				
C17 Neighbourhood street network	56.06-4		■	■	■		■	■	
C18 Walking & cycling network detail	56.06-5		■	■	■		■	■	■
C19 Public transport network detail	56.06-6			■	■				
C20 Neighbourhood street network detail	56.06-7		■	■	■		■	■	■
C21 Lot access	56.06-8	■	■	■	■	■	■	■	
C22 Drinking water supply	56.07-1	■	■	■	■	■	■	■	
C23 Reused & recycled water	56.07-2	■	■	■	■	■	■	■	
C24 Waste water management	56.07-3	■	■	■	■	■	■	■	■
C25 Urban run-off management	56.07-4	■	■	■	■	■	■	■	■
C26 Site management	56.08-1	■	■	■	■	■	■	■	
C27 Shared trenching	56.09-1	■	■	■	■	■	■	■	■
C28 Electricity, telecommunications & gas	56.09-2	■	■	■	■	■	■	■	
C29 Fire hydrants	56.09-3		■	■	■		■	■	
C30 Public lighting	56.09-4		■	■	■		■	■	■

Source: Victoria Planning Provisions

It is considered that Clause 56 is not sufficient alone to achieve sustainable subdivisions. The standards and requirements of Clause 56 are limited to certain aspects of ESD and do not form part of an integrated sustainable design approach which is informed by the LPPF.

Clause 56 standards and objectives also do not lend themselves to innovation or require best practice. As the requirements are not mandatory, it is anticipated that developers only provide the minimum under what is required under Clause 56.

Specifically, an application should meet the standards but it is not mandatory and alternative design solutions may be considered if the application meets the objective of the Clause. Therefore, compliance with the standards and objectives of these Particular Provisions are at the discretion of Council and subsequently, the enforcement of the Clause is not consistent across Councils. Extensive stakeholder engagement confirmed that there are issues in both the requirements and application of Clause 56. However no one was able to identify exactly what is not working. A lack of guidance on how to meet the Clause 56 objectives may be a contributing factor. Despite any short comings of Clause 56, the issue remains that any requirements attached to a subdivision permit do not flow through to individual dwellings on lots more than 500m^2.

4.5 Infrastructure Design Manual

The Infrastructure Design Manual (IDM) contains alternative design solutions to the standards set out in Clause 56. Clause 56 notes that the standards contained within it should be adhered to unless there are alternative design solutions, such as those set out in the IDM[15]. Clause 56 was designed for metropolitan councils, the IDM aims to provide standards that are more appropriate for regional settings. It is a joint initiative of rural and regional Councils. It documents and standardises Council requirements for the design and development of municipal infrastructure whether it is constructed by council or a developer.

The IDM covers the following types of infrastructure including municipal infrastructure in subdivisions:

- Traffic and roads; Mobility and access including paths
- Car parking
- Stormwater management
- Retardation basin / On-site detention systems
- Earthworks and lot filling
- Urban drainage
- Residential design and other design requirements
- Street tree spacing
- Public lighting
- Landscaping and public open space
- Environment management during construction
- Whole farm plans

The IDM is currently utilised by 44 councils in rural and regional Victoria. The IDM is currently included in at least ten planning schemes and is a reference document incorporated into the Greater Shepparton Planning Scheme (via Amendment C112). It is used widely across 44 councils including checklists, and is also regularly reflected in permit conditions reviewed by and issued at the direction of VCAT[16]. An Advisory Committee was held to consider the applicability of introducing the IDM into regional planning schemes and recommended that it be introduced via a 20(4) amendment. Current activity is underway to incorporate the IDM into other municipal planning schemes. While it currently only applies to municipal infrastructure, it potentially sets a precedent for sharing standards amongst

[15] Infrastructure Design Manual Presentation by John Kearney, March 1st2018, DELWP Benalla.
[16] ibid

the group of regional Councils as well as testing application to non-Council infrastructure such as in greenfield developments.

The IDM is also a living document, and is updated to reflect changes and feedback. For example the landscape clause has evolved quite extensively through the involvement of landscape designers. There is therefore potential to address some current ESD related infrastructure gaps in subdivisions through the IDM and the SIG (see below). This would need to be investigated further.

Assessment

The IDM has set a precedent for collaborating, sharing standards and creating consistency across municipalities. As it is a living document there is potential to broaden the scope of infrastructure related ESD aspects through the IDM and SIG. Doing so would need to be accompanied by strengthening policy and guidelines relating to broader design visions and communities – aspects that are not covered by the IDM or SIG. Alternatively, either incorporating a similar guide to subdivision design into the IDM could reduce current inconsistencies in the application of Clause 56 standards and objectives. A guide covering subdivision design could address standards for lot layout, orientation and other aspects that are not part of shared infrastructure or materials covered by the IDM. Such a guide could also be a stand-alone manual that aligns with the IDM.

4.6 Sustainable Infrastructure Guidelines

The Sustainable Infrastructure Guidelines (SIG) is currently an opt-in feature of the IDM. The guidelines have been prepared as a result of a funding grant from the Victorian Local Sustainability Accord. A key initiative of the accord is the Victorian Local Sustainability Advisory Committee (VLSAC).

VLSAC has identified five key issues for priority action which require action at both State and local government levels to facilitate sustainable outcomes. These issues are:

1. Planning issues
2. Building distributed energy and other systems
3. Sustainable local economies
4. Social impacts of climate change
5. Managing carbon emissions

These Guidelines seek to provide guidance on alternative design considerations and materials that will deliver more sustainable infrastructure through:

1. Using recycled materials
2. Reducing the carbon footprint of infrastructure projects
3. Reducing maintenance and operating costs
4. Utilising water in more efficient ways
5. Utilising materials from sustainable sources

At present the City of Greater Geelong and Colac Otway Shire use the SIG while Warrnambool City Council is currently undergoing a 12 month trial at the time of writing. The IDM governing body is also seeking expressions of interest from further councils to opt in. The next version of the IDM will show the number of councils using the SIG.

Assessment:

There is scope for the SIGs to be further adopted which could strengthen requirements in particular for use of recycled materials and reuse of materials and resources.

4.7 Precinct structure plans

Precinct Structure Plans (PSPs) are high level master plans for developments including large-scale greenfield subdivisions that require additional services such as shops, schools and community facilities. PSPs can be a useful tool for bridging the gap between high level aspirations for an area and detailed design plans. They can therefore be used to articulate tangible spatial visions for an area. There are potential opportunities to integrate ESD requirements into PSPs to influence dwellings which do not require a planning permit. Many of the PSPs include objectives and guidelines relating to

ESD categories. These elements typically include: image and character; housing; employment and town centres, community facilities; open space and natural systems; transport and movement; and utilities and energy. Some councils have opted to use a 'small lot housing code' within their PSPs. This can be a useful tool in facilitating housing diversity. Table 13 identifies PSPs in the participating project municipalities. All municipalities have subdivisions that are not captured through these instruments.

Table 13 Precinct Structure Plans

Municipality	Precinct Structure Plans
Ballarat	Alfredton West PSP 2011 Ballarat West PSP 2012
Baw Baw	Drouin PSP (Sept 2014) Warragul PSP (Sept 2014)
Bendigo*#	Jack Ass Flat Local Structure Plan DPO 21 Huntly Township Plan Strathfieldsaye Township Plan DPO 26
Geelong	Armstrong Creek East PSP May 2010 Armstrong Creek South PSP June 2015 Armstrong Creek West PSP September 2012 Armstrong Creek Horseshoe Bend PSP September 2014 Lara West PSP September 2013
Moorabool*	Bacchus Marsh Urban Growth Framework
Shepparton*	Shepparton South East Precinct Structure Plan
Wangaratta* #	Wangaratta North West and South Growth Areas and Development Contribution Plans (Am C71)
Wodonga*	Leneva-Baranduda Precinct Structure Plan

*In progress
Uses DPOs instead of PSPs

Assessment

The PSP Guidelines are currently being reviewed, there may be an opportunity through consultation to advocate for strengthening ESD requirements in these guidelines. PSPs only apply to certain large subdivisions and therefore do not apply to small to medium subdivisions unless determined by the Victorian Planning Authority (VPA). Urban Growth Frameworks have been utilised for a number of developments that are not large enough to warrant a PSP.

4.8 Strategic Documents

There are a number of strategic documents of relevance as follows.

- **Plan Greater Bendigo (January 2018)** was adopted 24 January 2018 and is a collaborative plan by the City of Greater Bendigo with the Victorian Planning Authority (VPA) and the regional office of the Department of Environment, Land, Water and Planning (DELWP).

There are also a significant number of other structure plans and township plans such as (but not limited to):

- **Jackass Flat Local Structure Plan (April 2007)** is a reference document and was amended October 2009.
- **Huntly Township Plan (February 2009)**
- **Township Plan (2009**) replaced the previous structure plan last amended in 2006.

4.9 Development plan overlays

Development Plan Overlays (DPOs) address specific site constraints and circumstances (Rowley, 2017). Overlays are typically directed at development controlling matters such as buildings,

earthworks, signage and tree removal. DPOs can also serve a similar function to PSPs in a modest population growth setting and be accompanied by Development Contributions Plans. Examples include Wangaratta North West and Wangaratta South Growth Areas. As an indication of the depth of use, the project municipal planning schemes have the following number of DPOs:

- Ballarat has 10 DPOs
- Baw Baw has 3 DPOs
- Bendigo has 17 DPOs
- Geelong has 28 DPOs
- Moorabool has 6 DPOs
- Shepparton has 23 DPOs
- Wangaratta has 7 DPOs
- Wodonga 20 DPOs

DPOs can vary greatly in the level of detail and complexity for example detail relating to lot layout, while others provide higher level guidance on land use, infrastructure servicing, transport, landscape layout. DPOs and PSPs require 'generally in accordance with' standards. DPOs require varying degrees of detail from higher order infrastructure requirements to the layout of individual lots. DPOs with lot level detail can lock in too much detail. This should ideally be left to the planning permit stage. DPOs are also cumbersome to amend. DPOs can be inflexible in that they can lock in requirements for years before a development comes forward and can preclude better ESD outcomes under current standards if development is 'generally in accordance' with approved DP.

Assessment

DPOs have the potential to provide directions on subdivision design in the same was as a PSP but on a smaller scale. DPOs and PSPs require 'generally in accordance with'. PSPs and DPOs may provide an opportunity to incorporate ESD principles at the beginning of the subdivision process.

4.10 Development/Infrastructure Contributions Plan Overlay

Generally accompanying a PSP, or as a result of a master planning process a Development or Infrastructure Contributions Plan Overlay (DCP or ICP). This sets out timing, funding and responsibility for the delivery of infrastructure to support a new or intensified urban use. They are generally only applied to large scale, generally greenfield development and can be expensive to prepare and administer, and take decades to be fully implemented. Most councils have DCPs but some are moving towards ICPs.

The state government is introducing regional ICPs over four tiers inclusive of population growth; standard and supplementary contributions.

4.11 Assessing the suitability of planning and educational tools

A high level assessment of the suitability of various statutory and strategic planning tools, and non-statutory information and educational approaches has been made. It is contained in Table 14. The assessment considers:

- the ability to influence dwelling design where permit is currently not required for single dwelling
- whether the same tool can be used by all councils across Victoria or whether different tools are required to deal with different local development/climate contexts or scale
- the relative administrative and resource burden
- the threshold for assessment at different scales of development

Table 14 Assessment of various planning and education tools

Tool/approach	Strengths *Will this change influence ESD at Subdivision and building scale?*	Weaknesses *Resource, effectiveness?*	Suitability *At what scale? (<10,100,500+)*	Summary of assessment) Resource (HML)	 State-wide or Local (S,L)
Regulatory – statutory & strategic planning (local)					
Use of Schedules to Residential Zones Residential Growth Zone (RGZ) General Residential Zone (GRZ) Neighbourhood Residential Zone (NRZ)	Applies to individual developments Could influence site coverage, landscaping, setback of dwellings and dwelling itself etc. Can be tailored to specific local requirements Additional application requirements could be inserted into the 'parent' zone provision (would require State-wide amendment)	Only applies when permit required for a single dwelling on a lot (and wouldn't apply to dwellings on a lot over 300 sqm in zone) Resource intensive Planning Scheme Amendment (PSA) to introduce or change and administer PSA requires State approval The residential zone schedule does not specifically allow for the type of controls likely required to achieve ESD 'best practice' in subdivision. The 'parent' zone control would likely need to be amended if specific controls were to be put in place for subdivision applications	Zones not applicable in all municipalities. Most applicable at council /development scale Could be included when doing a greenfield rezoning Could develop a State-wide 'default' schedule for sustainable subdivisions Applicable at all scales	**H**	**L**
Urban Growth Zone (UGZ)	Can include Small Lot Housing Code to facilitate housing diversity. Can apply permit conditions to subdivision for building envelopes to be secured by a Section 173 or restriction on plan of subdivision – potential to apply ESD requirements through this method e.g. Hume UGZ -Schedule 1.	Resource intensive PSA to introduce or change (Unless secondary consent applies) Enforcement - S. 173 Agreement is actioned once the developer sells the lots Linked to PSP therefore limited in areas where this could be applied to.	Is a legislative process and enforceable Can only be applied locally Most applicable 500+ lot scale	**H**	**L**
Use of Overlay controls Development Plan Overlay	Could insert additional requirements into a schedule which would require applicants to provide further information.	Resource intensive PSA to introduce or change Not suitable for smaller lots under multiple	May be suitable on a development by development basis, however	**H**	**L**

Tool/approach	Strengths *Will this change influence ESD at Subdivision and building scale?*	Weaknesses *Resource, effectiveness?*	Suitability *At what scale? (<10,100,500+)*	Summary of assessment) Resource (HML)	 State-wide or Local (S,L)
	A planning scheme amendment is not required to amend a Development Plan. Exhibiting the Development Plan is only limited to when the PSA is being applied for.	ownership. Does not have the ability to trigger itself, therefore would not work for single lot subdivisions	Council would need to apply for a DPO to be applied to the land. Can only be applied locally Not applicable <10 lots		
Design and Development Overlay	Work better where there are multiple landholders. Can create additional permit triggers for subdivision (and can determine what size of subdivision is triggered) and for single dwellings. Is already used in some areas to implement ESD requirements (e.g. Campaspe). Can apply permit application requirements – i.e. Sustainable Design Assessment or SMP Apply additional decision guidelines	Resource intensive PSA to introduce or change Additional permit application requirements would incur additional time to process applications.	May be suitable on a development by development basis, however Council would need to apply for a DDO to be applied to the land. Unlikely to be applicable <10 lots	**H**	**L**
Local Planning Policy Municipal Strategic Statement Local Policy at Clause 22	Would support Council Planning Officers requesting further information or imposing a permit condition/ refusal grounds. Would apply across the municipality If 'application requirements' for residential subdivisions are included in the policy, then this information would need to be provided at the application (or RFI) stage.	Resource intensive PSA to introduce or change Would need to educate planning officers on how this policy can be used to require applicants to provide further information around ESD for subdivision applications. Would only apply where a planning permit is triggered (i.e. subdivisions, more than one dwelling on a lot, dwelling on lot under 300sqm).	This method is currently being used by various metropolitan councils but for development applications not subdivisions Can only be applied locally. Applicable at all scales	**H**	**L**

Tool/approach	Strengths *Will this change influence ESD at Subdivision and building scale?*	Weaknesses *Resource, effectiveness?*	Suitability *At what scale? (<10,100,500+)*	Summary of assessment) Resource (HML)	 State-wide or Local (S,L)
	Applies additional decision guidelines. A generic local policy could be prepared for multiple councils use	Depending on how it is written, it may only need to be considered so may not carry as much statutory weight.			
Specific conditions for plan of subdivision (see restrictive covenant),	Enforceable. Developer cannot act on permit until conditions are satisfied. Ability to apply permit conditions 'post construction' if secured by restriction on title (such as building envelope on plan of subdivision secured by S173 agreement) Could link to IDM	May be resource intensive to introduce or change (e.g. to vary or remove a restrictive covenant, requires a planning permit; PSA or application to the Supreme Court unless secondary consent is provided within the covenant. Council cannot require something through a condition without support from a requirement/ policy in the planning scheme,	Likely to require a local policy to support the condition Applicable at all scales where triggered	**M**	**L**
Master Planned approach Precinct Structure Plan Master Plan Outline development Plan	This generally already occurs (linked to UGZ schedules) Established process understood by councils and applicants Guidelines could be readily modified / tailored for regional context	PSPs limited to where VPA/Minister determines they will be prepared PSP scale and complexity not common in regional Victoria	Suitable in some instances where the land is being rezoned and a PSP being prepared. Could potentially be applied at township scale Not applicable <10 lots	**L**	**L**
Subdivision Design Guidelines (incorporated document in planning scheme)	Enforceable. Could be applied to all areas if developed by State Readily referenced and applied through a Master Plan approach	Requires a planning scheme amendment to implement. Requires planning scheme amendment if document is required to be changed (cannot vary the Incorporated Document)	Suitable (could be prepared at State level to adjust PSP guidelines for a regional greenfield development context). Could be developed through	**M**	**S/L**

Tool/approach	Strengths *Will this change influence ESD at Subdivision and building scale?*	Weaknesses *Resource, effectiveness?*	Suitability *At what scale? (<10,100,500+)*	Summary of assessment) Resource (HML)	 State-wide or Local (S,L)
		Incorporated Plan Overlay may need to be applied to specific areas. Smaller developers who apply for planning permit application would need to be aware that an Incorporated Document exists (at Clause 81)	local pilots. Applicable at all scales, particularly 10+ lots		
Subdivision Design Guidelines (reference document in planning scheme)	Provides background information and has limited role in decision-making . Can be used as basis for preparing policy (including MSS, local planning policy or provision) (See Practice note on reference documents	Would require a planning scheme amendment Generally not a requirement. unless written into a planning scheme, they are only guidelines.	Suitable as a pilot approach towards statutory state-wide Guidelines Applicable at all scales, particularly 10+ lots	**M**	**S/L**
Design Guidelines (Section 173 Agreement)	Binding and generally specific Requires agreement Engages applicant	Do not sunset (unless sunset clause applies) May limit future ESD improvements Onerous process to amend s173 (unless secondary consent is provided in the agreement)	Can only be applied locally. Applicable at all scales, particularly 10+ lots	**M**	**L**
Regulatory – statutory & strategic planning (State)					
State-wide ESD Policy	Clarity across State Authoritative and educative Would be less resource burden on local councils in development, but may create implementation burden.	May not be tailored to Regional context May constrain local responses Lengthy process to develop and would require considerable consultation, particularly with developers. Reliant on State government policy reform	Not suitable in the short term. Applicable at all scales,	**H**	**S**
Improve Clause 56	Strengthens a particular provision which	Reliant on State government policy reform.	Not suitable in the short	**M**	**S**

Tool/approach	Strengths *Will this change influence ESD at Subdivision and building scale?*	Weaknesses *Resource, effectiveness?*	Suitability *At what scale? (<10,100,500+)*	Summary of assessment) Resource (HML)	 State-wide or Local (S,L)
	currently exists. Add specific further ESD requirements to acknowledge recent technology and state-wide climate variation Could specifically address regional issues/context	Would require support from State government Lengthy process to amend and would require considerable consultation	term. Applicable at all scales		
Ministerial Direction	Provides direction to the Planning Authority Can provide detailed guidance over issue of State importance Useful should State ESD policy or Cl. 56 be revised	No statutory weight Likely not be considered in a planning application	Not suitable in the absence of an issue of State concern Applicable at all scales	**L**	**S**
Practice notes and guidelines	Educative Assists in guiding discretion in assessing a permit application Useful should State ESD policy or Cl. 56 be revised	No statutory weight May not be considered in a planning application	Not suitable without changes to State policy or provisions Applicable at all scales	**L**	**S**
Non-Statutory / guidance					
Subdivision Design Guidelines (non-statutory)	Easier to develop, particularly by a group of councils Useful first step towards local or State policy Provides consistent guidance benefitting councils and applicants	No statutory weight Reasonably short process to develop Would require consultation or piloting with industry	Could be developed in the short term Applicable at all scales, particularly 10+ lots	**M**	**S/L**

Tool/approach	Strengths *Will this change influence ESD at Subdivision and building scale?*	Weaknesses *Resource, effectiveness?*	Suitability *At what scale? (<10,100,500+)*	Summary of assessment) Resource (HML)	 State-wide or Local (S,L)
	Useful in engaging industry				
Other					
Fact sheets	Provides an educational tool to developers and council Able to be developed as interim step in developing guidelines Useful in communicating key messages	No statutory weight Requires ongoing support to update and review	Suitable in the short term to raise awareness Applicable at all scales	**L**	**S/L**
App to optimise site potential of dwelling design	Could be tailored to local circumstances, climate and site Would be able to be used by land developer and home owners Educative Once developed can be modified and updated	No statutory weight Cost to develop and maintain May be technically complex due to modelling required for site optimisation May not be authoritative or utilised	Would be best developed in industry partnership and with Sustainability Victoria Applicable at all scales	**M**	**S**

4.12 Key learnings: Gaps analysis and opportunities

Context

The table above assesses the strength and weaknesses of various statutory and non-statutory tools and measures to improve ESD.

At present there is an underlying foundation within the Victoria Planning Provisions which supports sustainability and ESD at a State and local level in Victoria. However there is also a clear absence in policy and provisions contained in the participating Council's planning schemes to different extents. While some of the Council's (namely Geelong, Wodonga, Shepparton and Moorabool) have underlying sustainability and ESD principles, these only either apply to specific PSP areas, to development or at a broader level that do not necessarily apply to residential subdivision in an enforceable way (see Appendix Ffor details of individual planning schemes).

ESD in subdivisions and dwellings is controlled and influenced by a range of legislation, systems and planning requirements as well as market forces. The primary regulations and policies impacting on ESD subdivisions include the NCC, the VPP and local planning schemes. There are a number of gaps and inadequacies within each of these and also in how they relate to each other, with a substantial disconnect in how different policies and regulations apply to various parts of the subdivision process and subdivision itself (development, neighbourhoods, lots and dwellings).

This means that certain sustainability objectives are often not carried through to the final development.

ESD in subdivisions is also constrained by a lack of ESD policy and leadership at the state level (Moore et al., 2017), as well as resourcing limitations in regional councils. The resourcing limitations constrain options available to regional councils to improve ESD. For regional Victoria an alternative approach is required to complement the approach of many metropolitan councils (establishment and maintenance of BESS sustainability assessment tool and more stringent planning requirements). This is so that the resource burden on regional councils is not increased (such as by introducing a new permit trigger or assessment requirement for single dwellings on lots over 300sqm).

Gaps

The gaps in the relationships between systems as well as their requirements are summarised as follows:

- **Gaps in the relationship between the building code and planning**. There are roles for both the building code and planning. VCAT decisions ruled that there is a role for planning in improving ESD outcomes in the built environment. The NCC does not relate to subdivisions but only to individual dwellings and therefore has no influence over subdivision design and planning. Planning has little to no role over a single dwelling on a lot.
- **Adequate policy objectives at international and national levels not linked to local policy**. At the international and national level there are policy objectives that support ESD. These objectives are not translated into local policy which is used to assess developments.
- **Lack of state-wide ESD approach and commitment**. There is no state-wide ESD approach that includes a SPP, opportunity for localized context, and revised or new particular provision inclusion. CASBE and the SDAPP group of councils have filled this gap through the development of the BESS tool, SDAPP Guidelines and ESD Local Policies for respective Councils. The Environmental Efficiency Design Advisory Committee concerning the Environmentally Efficient Design Local Policies (7 April 2014) found that a state-wide approach for incorporating both planning and building approval systems would be the most effective way to facilitate an increased focus on ESD. There is a current review of ESD requirements in the Victoria as part of Plan Melbourne, which may result in increased support for ESD at the state level. If this succeeds it will require effective regulatory frameworks and governance across all levels of government (Moore et al., 2017) and to consider regional council needs separately.
- **There are current weaknesses in the planning system**. There is a general lack of statutory planning instruments to assess ESD (Moore, et al., 2017) such as:
    - Few regional councils have specific ESD subdivision policy or local provisions

- Relevant sustainability clauses of the councils LPPF(MSS) do not establish application requirements and are often not triggered by planning applications relating to residential subdivision
- There are significant variances in climate and sustainability issues across participating Councils.
- Councils have limited control over ESD aspects of residential subdivisions where built form does not require a planning permit.
- Clause 54 and Clause 55 provide limited mechanisms to address sustainable design outcomes in residential subdivision.
- The nature of the merits based assessment under Clause 56 and the ability to vary standards perpetuates BAU approaches

Overall, there is a clear absence of policy and control to ensure that ESD is delivered in the design of residential subdivisions. There is a risk that the absence of any requirements acts as a barrier in ensuring that ESD practices are considered and implemented early in the design of residential subdivisions and throughout the development and post-construction phase of a residential subdivision. It is important to be risk ready' to Climate projections rather than risk adverse and because of the uncertainty of future data, energy costing and water pricing not including projections when setting built form standard outcomes.

The consideration of incorporating ESD at the planning stage provides the opportunity to exceed minimum compliance. For dwellings, improving the sustainability requirements of the National Construction Code will also improve performance.

Options for strengthening ESD:

Unless a new trigger for the development of a dwelling on a lot is created, Councils are limited in what can be assessed at the time of considering a planning application for subdivision, however, at this time the design of a dwelling is largely unknown, and will be influenced by the person who purchases the lot.

The main options to bridge the disconnect between the subdivision and the housing being built are both statutory and non-statutory. A single statutory mechanism would not fully address this disconnect nor build community and industry understanding and support. A combination of measures and approaches is required and they will also need to be tailored to local conditions, and target the subdivision, the builders, the building and its owners and operation. This could include:

- Strengthening Clause 56 and State Policy
- Developing a specific local policy
- Enhancing the IDM and SIG - to incorporate other aspects of subdivisions and to trigger the consideration of the IDM
- Non-statutory measures such as education, information, tools and incentives.

Currently councils have the ability to request further information from applicants if an assessment against Clause 56 (or an assessment against the relevant local planning policy) is not considered appropriate. Failure to comply or demonstrate consistency with Clause 56 can be grounds for a refusal of a planning permit applications for the development of dwellings in some cases, and may provide an opportunity contribute to a refusal for a subdivision application.

A local ESD policy, similar to the policy adopted by several municipal councils but applying to residential subdivision, in conjunction with specific requirements inserted into DDOs and the UGZ (i.e. Section 173 agreement; or requirement for a Subdivision Sustainability Plan or Statement) may be an appropriate approach for some councils.

Rather than recommend a single approach, which is difficult due to each Council's particular circumstances, planning approach and current Scheme (and also the way in which DELWP regions may wish to treat DPOs, DDOs and reference documents) a 'pathways' or road map approach bringing a number of measures together is preferred supported by education and guidance.

These would also be varied according to the scale of subdivision proposed, so that a PSP is used for large scale subdivisions, and a DPO at a neighbourhood scale.

5.0 Estimating the benefits of ESD

The following section provides an overview of the research that underpinned the estimation of costs and benefits of ESD subdivision. The full Stage 1B report is contained in Appendix G.

5.1 Overview of methodology

Four key stages were completed, with Project Control Group (PCG) input at each stage, as follows:

1. High level literature review. This review was undertaken to identify case study subdivisions where cost and benefits of a range of ESD interventions had been estimated. The intention of this review was to provide an indication of the scope of costs and benefits that have been estimated (including whether they had been estimated at the dwelling or subdivision level) and which might be incorporated within the cost benefit analysis (CBA).
2. Defining ESD interventions. At the conclusion of Stage 1A, five broad ESD principles were identified (optimise site potential, reduce footprint, enhance ecology and adaptable and encourage innovation). From these principles, it was necessary to develop specific interventions for inclusion within the Stage 1B analysis. It was also necessary to establish key characteristics of the three subdivisions to be included in the CBA. An iterative process was used to establish the ESD interventions and the subdivision characteristics.
3. CBA modelling. Based on the agreed ESD interventions and subdivision characterisation, further research was undertaken to determine whether the interventions could be quantitatively incorporated within the CBA.

   The principles that were included in the dwelling and subdivision CBA were ‘optimise site potential’ and ‘reduce footprint’ and included the following interventions:

   - dwelling orientation
   - water use (e.g. the installation of rainwater tanks that were connected to different uses)
   - energy use (e.g. the installation of energy-saving and energy generating devices)

   To supplement the CBA, and to provide greater insights into the benefits of subdivision-based interventions, a breakeven analysis was undertaken for the following interventions:

   - Increased percentage of tree canopy
   - Increased use of recycled road material
   - Increased use of Water Sensitive Urban Design (WSUD) techniques

For those interventions that could not be incorporated, research was used to support a qualitative description of the costs and benefits. This included reference to case studies from publicly available literature.

5.2 Key findings

5.2.1 Dwelling-based water interventions

The results of the CBA suggest that the adoption of rainwater tanks that are plumbed for washing machine and toilet use are marginally cost-beneficial in climate zones 6 and 7, however the intervention is not cost beneficial in climate zone 4. This is because of the relatively low cost of water in climate zone 4 (Mildura), which means that potable water savings are not sufficiently large to offset the capital, operating and maintenance costs associated with pump operation over the assessment period. However, it should be noted that the analysis assumes that electricity is supplied via the grid, and not via, for example solar power.

The payback period was 10 years in climate zone 6 and 11 years in climate zone 7. In climate zone 4, which experiences significantly less annual rainfall, the interventions payback period was 24 years

because the value of water savings only just covers the extra cost incurred to plumb the tank to the washing machine and extra operating and maintenance costs associated with the connected appliances over the period of the assessment.

For climate zone 7 and 6 changes to any of the dis-advantageous sensitivity parameters (i.e. increasing the discount rate, higher capex costs, and lower utility costs) reduced the benefit cost ratio (BCR) to <1, suggesting that the results are sensitive to these parameters. For climate zone 4, changes to any of the advantageous sensitivity parameters (i.e. lower discount rate, lower capex costs and increased utility costs) did not result in a BCR>1.

5.2.2 Dwelling-based energy interventions

The results suggest that orientation is a no / relatively low cost intervention that results in benefits across all the climate zones that were assessed. The difference in energy use in an average single storey dwelling with best orientation (e.g. north-facing living spaces) and worst orientation (e.g. south-facing living spaces) was estimated as follows:

- Climate zone 4: 10 kW.h/m^2, which equates to approximately $760 per household per annum, based on current electricity prices
- Climate zone 6: 4 kW.h/m^2, which equates to approximately $300 per household per annum, based on current electricity prices
- Climate zone 7: 7 kW.h/m^2, which equates to approximately $460 per household per annum, based on current electricity prices

Orientation impacts the effectiveness of shading and solar interventions. For example, if the dwelling has poor orientation, the reduction in energy use associated with shading is greater, than if the dwelling has good orientation, where shading needs have been mitigated through design. Energy reduction interventions with poorer orientation have greater BCRs in the moderate climate (climate zone 6). Conversely, in the hot and cold climates (climate zones 4 and 7, respectively), having poorer orientation reduces the benefit of implementing most energy-related interventions, except shading.

- The installation of solar panels were found to result in a positive BCR in all climate zones, with payback periods as follows: 3.6 years (climate zone 4); 4.1 years (climate zone 6); and 3.8 years (climate zone 7). The results for the installation of shading, glazing and insulation are mixed and depend on the climate zone and assumptions regarding orientation:
- Shading results in a BCR <1 in climate zone 6 and 7, but in climate zone 4 the BCR >1, suggesting that it is cost-beneficial to adopt this measure in climate zone 4. Payback periods are as follows: climate zone 4 (3.8 – 5.7 years); climate zone 6 (8.8 - 19.7 years) and climate zone 7 (11.4 – 17.2 years), depending on orientation[17].
- Glazing results in a BCR <1 in all climate zones that were assessed. Payback periods are estimated as follows: climate zone 4 (40.0 – 26.7 years); climate zone 6 (30.7 years); and climate zone 7 (16.0 – 13.3 years), depending on orientation[18].
- Insulation results in a BCR > 2.8 in climate zone 7, suggesting that it is cost-beneficial to implement this measure. In climate zones 4 and 6, the results were less conclusive, with BCRs ranging between 0.82 and 1.26, suggesting that the benefits of insulation are more marginal in these climates. Payback periods are estimated as follows: climate zone 4 (13.8 – 10.4 years); climate zone 6 (11.9 – 15.9 years); and climate zone 7 (5.2 – 4.6 years).

The costs associated with the installation and operation of HRV and solar batteries were found to outweigh the benefits in all climate zones that were assessed. However, as these interventions become more common place, and demand increases, the capital costs are likely to decline, which will alter the cost benefit ratio and payback period.

[17] Shading results in greatest benefits to dwellings that have poor orientation. Hence the payback period is lower for dwellings with poor orientation.
[18] Glazing results in greatest benefits to dwellings that have good orientation. Hence the payback period is lower for dwellings with good orientation.

5.2.3 Subdivision-based interventions

It is difficult to accurately estimate non-dwelling interventions at the subdivision-based scale because to do so requires detailed information connecting the physical impact associated with the implementation of the ESD intervention and the associated financial impact, relative to the base case. This is challenging to do based on a hypothetical subdivision, where the financial impact is site specific, and where non-market valuation literature is not readily available (e.g. the value that people place on enhanced habitat as a result of the installation of bio-links / green corridors).

As a result, the subdivision-based CBA has focussed on scaling-up the results from the dwelling-based water and energy interventions. The results of the dwelling-based interventions were scaled up to reflect the size of the subdivisions considered in this study (i.e. 10 lots, 100 lots and 500 lots). The BCR and payback periods are therefore the same as for the dwelling-based assessment.

Case studies obtained from the literature review provide evidence that there are benefits from adopting ESD measures. Furthermore, the magnitude of the benefits are less driven by climate than the dwelling-based interventions and, therefore may be more appropriate for a wider number of climate zones.

The breakeven analysis suggests that scale is important when considering the costs and benefits of implementation of ESD measures within subdivisions.

A summary of the results from the breakeven analysis are contained in Table 15. It highlights the breakeven value varying in non-linear ways, which is, in part, due to the physical assumptions used to characterise the subdivisions.

Table 15 Summary breakeven analysis results (present value benefit per lot)

	10 lots	100 lots	500 lots
Enhanced canopy cover	$994	$1,114	$1,114
Increased use of recycled road material	$ 606	$561	$561
Increased use of WSUD	n.a*.	$2,913	$1,551

* Costs have not been estimated for raingardens within 10 lot subdivisions as the area of public realm space would not support this type of WSUD.

The estimates contained in Table 15. reflect the combined value that the benefits from the interventions would have to take over a 30 year period to be cost-beneficial. Based on the assumptions used to undertake the assessment, the results suggest that the increased use of recycled road material has the lowest break even value of all the interventions analysed. This result provides further support for the findings of the IDM Sustainable Infrastructure Guidelines (Pitt&Sherry, 2014).

5.3 Implications for policy

5.3.1 What are the low-cost, low regrets interventions?

While the dwelling-based ESD interventions facilitate a reduction in resource use, the results of the CBA suggest that the benefits of adopting these interventions do not always exceed the costs in the three climate zones included in the study.

However, the analysis suggest that orientation is a no / low cost intervention and results in benefits across all the climate zones that were assessed.

In addition, there are a number of subdivision-scale interventions that are likely to confer benefits across current climate zones and involve no cost or similar (or lower) maintenance costs for councils, relative to BAU practices and which therefore may be considered low cost / low regrets interventions, if capital funding can be secured.

The low-cost, / low regrets interventions, could include:

- subdivision has appropriate solar orientation, for both public areas and dwellings
- continual shading of footpaths and roads

- reduction in impervious surfaces throughout the subdivision (e.g. through implementation of the IDM SIG)
- reduction in construction waste (i.e. recycling and more accurate construction material estimation)
- recycled materials (where these are readily available)
- diversity of dwellings within the subdivision
- installation of footpaths on both sides
- installation of separated bicycle paths (or shared footpath / bicycle paths)
- wider nature strips
- installation of footpaths to provide connection to amenities and neighbouring areas
- more diversity in street / road design 'shared zone')
- provision to connect with local public transport
- use of drought tolerant and indigenous plants
- increased canopy cover
- retention of mature trees
- use of low-energy street lighting

Other dwelling-based interventions (such as window placement and size, use of thermal mass, zoning of spaces and draft-proofing / building sealing) have not been modelled, but have potential to reduce energy consumption and are relatively inexpensive, especially when considered in the design / planning phase.

5.4 What factors influence the results?

Climate and the price of energy and water are important factors in determining the BCR and payback period associated with the dwelling-based interventions. However, the results from this analysis have not taken the following into account:

Climate change projections – future climate change projections have not been included in the analysis, which has implications for the anticipated benefits from the adoption of the ESD measures. More extreme weather events and a trend towards a hotter, drier climate is likely to improve the results from interventions designed to reduce energy and water use.

Trends in energy and water prices – which influences the value of the savings achieved with the interventions. Increases in energy and water prices over time has the potential to improve the results from interventions designed to reduce energy and water use.

Reducing emissions intensity of the electricity supply grid – which influences the potential greenhouse gas reduction possible as the proportion of energy from renewables increases.

Interventions such as heat recovery ventilation and batteries for storing solar energy, currently involve high capital costs, relative to the benefits that are associated with these interventions, which results in particularly high payback periods relative to other interventions. Over time, the cost of such technologies has the potential to fall, which may mean that they become more cost-beneficial; e.g. the cost of lithium-ion batteries is predicted to halve in seven years. However, it is important to note that, for HRV, climate will still play an important role in determining the overall benefits.

This suggests measures to encourage the adoption of ESD interventions may need to be more nuanced than a 'one size fits all' approach across Victoria's climate regions for water and energy.

5.5 Who bears the costs and who benefits?

Dwelling-based ESD interventions primarily benefit home owners through improved comfort and reduced consumption of water and energy. The capital / construction cost associated with these interventions is borne by the developer and typically passed on to home owners.

These up-front costs are lower if the ESD interventions are included in the dwelling design, rather than being retrofitted afterwards. Operating and maintenance costs associated with the ESD interventions tend to be zero, or relatively low, except for rainwater tanks with pumps and HRV. This may be an important consideration when communicating the benefits of ESD interventions.

The capital / construction costs of subdivision-based interventions are typically borne by developers, but the beneficiaries can include home owners, councils and the wider community. The operating and maintenance costs associated with these interventions can range from negligible (e.g. a second footpath to facilitate active travel) to relatively high (e.g. maintaining WSUD features). This provides challenges for funding such interventions.

6.0 A roadmap for achieving ESD subdivisions

6.1 Learning from the CASBE journey

Improving performance is a continuum and requires an incremental approach. CASBE"s journey began with Councils seeking to improve the sustainability of their own buildings and operations, and then providing support for developers seeking voluntary assessments. Regulation has typically been brought in as the local industry's knowledge and skills establish. While there are exceptions to this, in general for those councils that have introduced mandatory ESD requirements, it has been a smoother transition in municipalities with prior voluntary assessments and frameworks in place.

ESD champions and leadership support within council are also essential.

Where councils do not have the resources for an ESD officer, a resource is often shared between councils, similar to how heritage officers may work across multiple councils to make up a full-time position.

Learning and knowledge sharing of ESD officers and member councils is supported through CASBE organised phone conferences and face-to-face meetings where officers can bring in applications they are processing to seek advice from peers who may have dealt with a similar issue. Building networks to assist to build capacity across councils and mobilise support for new tools, policies and practices has been a key aspect to the success of CASBE.

The work of CASBE and member councils has been grass-roots, bottom-up supported through knowledge sharing and other resources. There was a group of early adopters of local ESD policies which has resulted in rolling group amendments across other councils. Given the diversity of the regional councils involved, this approach may have merit in working together on a shared framework that is flexible enough to accommodate the different needs of different municipalities.

The CASBE journey provides a solid path for the regional councils to consider. It is illustrated in Figure 5 and summarised as follows.

Short term: Model taken up by early adopters (a range of defined elements and tools)

- Raises awareness of benefits of ESD
- Build a peer-to-peer knowledge network
- Engage with industry and community
- Begin with voluntary tools and assessments
- Demonstrate through council owned buildings and assets

Medium term: Testing and refining model

- Refine tools
- Continue all of the above

Longer term: Regulating, replicating and advocating for larger scale changes

- Regulate and create certainty
- Scale up and replicate across councils through proven methods, guidance and leadership. Model is refined enough to allow for flexibility to accommodate different contexts
- Mainstream better ESD in all dwellings and subdivisions

Figure 5 Journey to improving ESD in the built environment as demonstrated by the experience of CASBE

Source: Based on the journey of CASBE

6.2 The ESD Subdivisions Roadmap

This model acknowledges that different councils are at different stages along the ESD journey and builds on the CASBE approach. As some councils are more progressed along the ESD journey than other, and face different drivers such as more intense population growth and development pressures, they are well placed to provide a leadership role and pursue regulatory measures sooner.

As CASBE was initiated at a time of limited State ESD policy or strategic objectives, it should be noted that the policy landscape has changed, with strong state government commitment to ESD and climate change adaptation and mitigation policy.

The following definitions accompany the roadmap for ESD in regional Victoria.

Table 16 Definitions for the Regional Victoria ESD Roadmap

Council role	
Council Responsibility – Actions the council implements	
Council Advocacy – Actions where the council influences others to act	
Council Collaboration – Actions where the council collaborates with other stakeholders such as CASBE, MAV, or other councils with a common interest	
Action type	
Policy/Strategy – Requires review or preparation of a policy, strategy or other strategic or investigatory document	
Advocacy/Partnership – Requires working with other people, agencies and communities and developing partnerships to influence outcomes	
Strategic direction – A course of action or position that will lead to achievement of the vision and/or objectives	
Systems and procedures – Development ore refinement of systems and procedures that will support better ESD	
Capacity building – Requires development of the abilities of individuals, communities, organisations or systems to increase involvement, decision-making	
Timing	
Immediate	Within the next year
Short	1 to 2 years
Medium	2 to 4 years
Long	4 years +
Ongoing	

Source: Adapted from Wodonga Growth Strategy

Table 17 A road map for ESD subdivisions

Recommendation/Action	Timing	Action type	Council role
Step 1 – Raise awareness			
Direct engagement with land surveyors and development engineers through local developer forums to better understand the drivers of land subdivision plans and to educate them about the value created through ESD, particularly orientation**.**	Short term - ongoing	Capacity Building	Council Responsibility
Develop case studies of 'better practice' and 'best practice' ESD greenfield subdivisions in each municipality and more broadly, including case studies showcasing innovation similar to the Yackandandah Mini-grid trial and Wodonga Community Solar farm	Short – medium term	Partnership / Capacity Building	Council Collaboration
Inform the development community (through developer forums) about state government incentives and funding opportunities to support innovation (such as mini-grid funding)	Immediate - ongoing	Capacity Building/ Policy	Council Responsibility
Identify financial barriers and innovative funding models to support ESD. This could include research into Special Rate Charges	Medium term	Strategic Direction	Council Collaboration
Advocate to peak bodies such as Engineers Australia, the Institution of Surveyors Victoria, Master Builders Association of Victoria, Real Estate Institute of Victoria the value of ESD in subdivisions and site optimisation.	Medium – long term	Advocacy	Council Advocacy/ Council Collaboration
Advocate to Sustainability Victoria for a **regional pilot of the Carbon Neutral volume build pilot project.**	Short-medium term	Advocacy / Capacity Building	Council Advocacy/ Council Collaboration
Support community champions to improve ESD in subdivisions and housing (such as the Yackandandah Innovative Housing Forum)	Short term - ongoing	Partnership	Council Advocacy/ Council Collaboration
Explore **case studies or research projects to collate longitudinal data** to be able to more accurately compare BAU to ESD subdivision over time. This could be done through collaborations with tertiary institutions.	Short-medium term	Partnership / Capacity Building	Council Collaboration
Investigate barriers to expanding the uptake of the **Infrastructure Design Manual's Sustainable Infrastructure Guidelines** including barriers to developing a viable recycling aggregates recycling industry in more remote regional and rural areas	Short-medium term	Partnership	Council Collaboration
Step 2 – Demonstrate			
Implement energy efficiency and other ESD measures in council buildings	Short-term - ongoing	Strategic Direction	Council Responsibility
Establish innovative demonstration projects through council-local industry partnerships similar to the La Trobe Valley Community Power Hub	Short-term - ongoing	Strategic Direction / Partnership / Capacity Building	Council Responsibility
Develop case studies to showcase energy efficiency/ESD in council buildings	Short-term - ongoing	Strategic Direction/ Capacity Building	Council Responsibility

Recommendation/Action	Timing	Action type	Council role
Advocate to the Local Government LGIDA/VPA to develop cross sections and resources to allow for enhanced greening – allowing for larger canopy trees in road reserves.	Short term	Advocacy	Council Advocacy/ Council Collaboration
Support or partner with local environmental/energy groups to facilitate bulk buys for solar panels, solar hot water and batteries.	Short term - ongoing	Partnership	Council Collaboration
Investigate funding mechanisms to incentivise ESD such as green loans and environmental upgrade agreement**s.**	Short - medium term	Strategic Direction	Council Advocacy
Partner with Greenhouse Alliances to facilitate study tours for local developers to learn from leading ESD subdivision developments.	Short – medium term	Partnership / Capacity Building	Council Collaboration
Investigate programs to engage with local builders to establish ESD display homes focused on energy efficiency.	Short – medium term	Partnership / Capacity Building	Council Responsibility/ Council Collaboration
Establish pilot projects between councils and developers to showcase ESD features at the subdivision scale including the value created by good orientation	Medium term	Strategic Direction / Partnership / Capacity Building	Council Responsibility
Investigate bulk buy schemes for solar panel, solar hot water and batteries for new housing estates & the barriers to take up so new dwellings can access more affordable renewable energy technologies. This may include ways to improve processes and timing of new builds and electricity connections to facilitate the feasibility of bulk buys.	Short – medium term	Partnership / Strategic Direction	Council Collaboration
Step 3 – Educate			
Develop education resources for home builders as they apply to each climate region.	Short term	Capacity building	Council Responsibility
Develop new home owner kits identifying recommended plant species, waste information and other relevant information for how to maximise the ESD of their new home i.e. operation and maintenance.	Short term	Capacity building	Council Collaboration
Seek funding to explore a regional pilot of the Cool StreetsTM Initiative.	Short term	Capacity Building	Council Advocacy/ Council Collaboration
Seek funding to develop an app to optimise lot potential and easily assess ESD of a lot & dwelling. Such an app may target first home buyers and home builders. Engage builders to encourage home buyers to view prior to commencing design process.	Short term	Capacity building	Council Collaboration/ Council Responsibility
Advocate to State government for an ESD advisory service or ESD hotline.	Medium – long term	Advocacy	Council Advocacy/ Council Collaboration
Step 4 – Regulate			
Develop a voluntary assessment framework to provide metrics improving ESD in subdivisions and reducing resource consumption	Short term	Capacity Building/ Policy	Council Collaboration

Recommendation/Action	Timing	Action type	Council role
Promote the adoption of the Infrastructure Design Manual's **Sustainable Infrastructure Guidelines** for a 12 month trial. Monitor results of projects and if feasible, adopt the IDM SIG on a permanent basis.	Immediate - ongoing	Policy	Council Responsibility/ Council Collaboration
Advocate to the state government to review Clause 56 to more robustly consider ESD. This could include stronger objectives and standards, decision guidelines to assist with the application of discretion and responding to issues associated with greenfield development**.**	Immediate - ongoing	Advocacy	Council Advocacy / Council Collaboration
Consider opportunities to strengthen ESD in planning scheme reviews including the Municipal Strategic Statement (every four years).	Short – ongoing	Policy	Council Responsibility
Advocate to the VPA to strengthen ESD in PSP Guidelines.	Immediate	Advocacy	Council Advocacy / Council Collaboration
Consider ESD in any review of PSPs (every five years).	Short - ongoing	Policy	Council Responsibility
Develop local tree species lists which consider survival under future climate projections**.**	Short - Medium term	Strategic Direction	Council Responsibility
Develop canopy targets and establish greening program to reduce urban heat island effect.	Short - Medium term	Strategic Direction	Council Responsibility
Review residential zones to consider opportunities to embed ESD in the objectives, application requirements and decision guidelines and vary Clause 54 and 55 standards within the schedule to the zones for infill and dwellings on lots under 300sqm or multi-dwelling on a lot	Short - Medium term	Policy	Council Advocacy / Council Collaboration
Review overlays and identify new overlay opportunities for ESD. This could be part of planning scheme reviews completed every 4 years - current DELWP deadline for current review is completion by 31 Dec 2018	Short –long term	Policy	Council Advocacy / Council Collaboration
Develop ESD provisions for DPO schedules which can be used as a template for broader use in regional areas.	Medium – long term	Policy	Council Responsibility / Council Collaboration
Advocate to the State Government for the development of State-wide ESD planning tool for subdivisions	Medium – long term	Advocacy	Council Advocacy / Council Collaboration
Advocate to Strengthen the NCC in line with the recommendations of the ASBEC and ClimateWorks research.	Short term - ongoing	Advocacy	Council Advocacy / Council Collaboration
Unless a State-wide ESD planning tool is developed, introduce a LPP planning tool to provide an 'alternate design solution' to clause 56 to improve ESD	Medium – long term	Policy	Council Responsibility
Advocate to the state government for changes to the subdivision act which would allow conditions to be applied to single dwellings.	Long term	Advocacy	Council Advocacy / Council Collaboration

Recommendation/Action	Timing	Action type	Council role
Step 5 – Mainstream			
Advocate to state government for resources to assist with the effective implementation of ESD in decision-making for greenfield subdivisions (such as practice notes and design guidelines).	Short term	Advocacy	Council Advocacy / Council Collaboration
Advocate for the mandatory disclosure of energy ratings at the time of building design and time of sale in Victoria (as has been adopted in the ACT).	Short term - ongoing	Advocacy	Council Advocacy / Council Collaboration
Develop protocol for a fast track approval process for developments that are achieving 'better' or 'best practice' ESD with clear criteria for eligibility.	Short – Medium term	Strategic Dir/System Procedures	Council Responsibility
Investigate shared resource for an ESD officer across councils to provide advice on voluntary assessments	Medium – long term	Capacity building	Council Responsibility / Council Collaboration
Work holistically across Council. Coordination between departments is highly valued as enabling better ESD subdivisions. There should be internal support for processing applications with a high-level of ESD objectives.	Immediate - ongoing	Capacity building	Council Responsibility

6.3 Transferability of ESD road map to other municipalities

The transferability of the road map to other Councils beyond those participating in this project is assessed below, for urban fringe and rural council areas. Interviews with Hume City Council and Mansfield Shire Council informed this assessment.

Table 18 Testing the transferability of the ESD model

Transferability criteria	Urban Fringe	Rural areas
Development and growth context	Higher growth rates and rates of greenfield subdivision developments Greater proportion of volume builders Range of subdivision sizes from 50 to 10,000 lots	The participating councils had a range of growth rates that broadly reflect other rural areas The scale of growth may be lower, and fewer volume builders Range of subdivision sizes <100
Key local ESD issues and applicability of principles *– informs local ESD priorities and any refinement of principles*	Some principles are well established Higher population densities that can support local employment clusters, destination and walkable communities Higher quality open spaces are used to establish points of different for marketing purposes	Some principles are well established Community sustainability and resource conservation practices are often well established in rural areas and some rural communities
Awareness of ESD **–** *informs which actions should be undertaken along the road map*	ESD often used as a point of difference and in the marketing of a subdivision.	Generally more in the awareness phase of ESD, although some highly mobilised communities and industries.
Is the ESD model transferable?	Rates of development favours early adoption of ESD model.	Rates of growth and resource constraints mean Local Policy unlikely

If so, what adjustments and key focuses are foreseen?	Focus on planning tools applicable to large subdivisions Focus on working with key volume builders	Focus on peer support for information development and education to benefit to rural areas

6.3.1 Check list for other Councils seeking to pursue the ESD subdivision roadmap

The following is a check list to guide decisions for other Councils beyond those of the pilot group seeking to become involved in future collaboration.

4. **Identify current performance of subdivisions – what are the key issues and opportunities for improvement in your municipality?**
    - Assess population and dwelling growth rates including scale of subdivisions, characteristics of local development industry
    - Identify how the local climate zone profile and physical geography affect the development and operation of subdivisions.
    - Use the ESD Principles to identify priorities within the municipality i.e. urban greening.
5. **Identify current understanding, support for, and implementation of subdivisions**
    - Hold a workshop with the local development industry and other stakeholders (such as local sustainability groups)
    - Identify what local subdivisions are doing well and what could be improved in terms of outcomes and processes.
    - Identify local industry 'champions' or 'developments' that go beyond minimum requirements for local knowledge sharing activities
    - Socialise ESD subdivisions with Council Officers and Councillors (if applicable)
    - Obtain support of Councillors and leaders within Council
    - Use the CASBE model to identify where the local municipality is along the ESD journey.
6. **Ensure clarity**
    - Ensure you can clearly articulate exactly what it is Council is looking for
    - Provide information to show a developer how they could achieve that
7. **Identify statutory and non-statutory tools to support improved ESD subdivisions, and plan for their implementation**
    - Consider the scale of subdivision you are wanting to influence
    - Identify and liaise with like Councils and Councils who have addressed similar issues at similar scales
    - Investigate regional support (such as from DELWP, Referral authorities, local Industry bodies)
    - Develop an action plan and mechanisms for review
    - Align actions with Council planning and policy review cycles and Planning Scheme reviews

6.4 Further research and applied learning

There is a growing body of research building an evidence base for improving ESD, as well as testing the feasibility of particular aspects of ESD. This includes:

- Urban Heat Island (UHI) Research – University of Swinburne
- Swinburne are working on an app for infill developments called 'Optimise my lot'. The software is expected to launch in the near future.
- Sustainability Victoria and the University of Melbourne are undertaking separate research projects into housing sustainability and volume builders.
- CRC for a Low Carbon Future are investigating Greening the Greyfields with Maroondah City Council

- The community of Yackandandah and Mooroolbark are trialling smart grid technology with the aim of becoming self-sufficient for energy.
- YourHome: Australia's Guide to Environmentally Sustainable Homes
- Sustainability Victoria project 'Zero Net Carbon Homes Program & Design Assessment Tool': pilot program to develop and market Zero Net Carbon homes in Victoria in collaboration with Volume Home Builders;
- DELWP has recently commissioned SGS to review of Victoria's land use planning and building systems with a view to making recommendations for actions to improve management of exposure to natural hazards in the context of climate change
- DELWP has also commissioned CSIRO's Climate Science Centre (CSC) to develop a high-resolution climate projections data and guidance package. This work is currently in progress

The Proof of Concept and CBA of this project identified further gaps and opportunities for potential research. The CBA was limited by the availability of current data including quantified social and environmental benefits and was based on historical climate data. The following further research initiatives would benefit the understanding and implementation of ESD subdivisions, including costs and benefits.

- **Investigate collating longitudinal data** through potential case studies or research projects to be able to more accurately compare BAU to ESD subdivision outcomes over time, particularly for the purposes of informing a CBA.
- **Build upon the CSIRO's climate projection research to be adapted for input into the CBA.** This would assist with understanding how the benefits associated with ESD subdivisions contribute to climate change adaptation and mitigation, for example, more sustainable dwellings are better able to cope with extreme temperatures. This is likely to make the case for implementing ESD subdivision interventions more compelling.
- **Undertake research to quantify social and environmental benefits** for the purposes of a CBA model (such as Victoria University's Green Infrastructure Economic Framework as found here). While there is an extensive body of research that estimates the costs and benefits of dwelling-based interventions, research into subdivision-based interventions is less comprehensive. Selecting 2-3 subdivision interventions and robustly developing costs and benefits (rather than attempting to develop costs and benefits for multiple interventions) could be a useful starting point.
- **Investigate the value of tree density and coverage.** The CBA identified a lack of quantitative data relating to trees that could be readily applied to a CBA. The Cool Streets TM initiative could be furthered to investigate tree density versus tree maturity in increasing canopy cover. Alternatively councils could seek funding to explore a regional pilot of the Cool Streets TM project. This pilot could focus on streets lacking vegetation in existing urban or greenfield areas, and engage local developers and real estate agents regarding the value of suitable trees in terms of size, canopy cover, and survival under future climate projections.
- **Pilot and adapt Sustainability Victoria's Carbon Neutral volume build** pilot project to regional Victoria.
- **Research subdivision interventions that have low operating / maintenance requirements**, to better understand the difference in cost and benefits relative to BAU. This could take the form of CBA case studies based on existing / planned subdivisions that have incorporated ESD features and would help to strengthen the evidence base.
- **Investigate alternative funding for ESD interventions through households and to offset up-front costs**. As the majority of interventions benefit 'householders', there is an opportunity to investigate alternative funding via 'householders'. For example, Special Rate Charges may be an existing tool that could be used when Council is a 'payee'. The CBA of this report implies that financial benefits for 'householders' could offset additional costs that would be incurred through a Special Rate Charge. Furthermore, Government rebates of these Special Rate Charges may be

able to be sought particularly as further information becomes available enabling qualitative benefits to be better quantified.

- **Analyse the implementation of assessment tools across different councils**, after tools (whether voluntary or involuntary) have been established and implemented. This should include the cost implications of tools and assess whether such practices are leading to better outcomes (as suggested in Moore et al., 2017). This could form an important element of review and monitoring performance. It could also potentially inform transferability of assessment tools to other councils and speed up lessons learned and tool refinement.

7.0 Next steps

There are clear social, economic and environmental benefits associated with ESD in regional subdivisions. These benefits differ across Victoria's climate regions, as does the nature and capacity of Councils and the residential development industry. While the period of analysis was 30 years, the life of a residential subdivision is much more enduring and so subdivision-wide sustainability measures warrant greater consideration.

The Roadmap in Section 6.2 identifies an extensive range of short, medium and longer-term actions to advance ESD subdivisions in Regional Victoria. These include actions for councils, groups of councils and for council advocacy. In the context of The Roadmap, it is recommended that to advance ESD subdivisions in regional Victoria the following short term actions be prioritised:

- **Follow the 'CASBE' model of implementation** through raising awareness and building capacity and moving towards introducing local policy to drive ESD subdivisions. For advanced Councils, this could be achieved through GC amendments for a group of councils as for the SDAPP councils in metropolitan Melbourne. Introducing policy coupled with the IDM which provides the 'how-to' may strengthen the overall case for requiring and guiding better ESD outcomes. For other councils, sharing resources and support for awareness raising would be the focus.
- **More research into the subdivision interventions** that have low operating / maintenance requirements, especially focused on understanding the difference in cost and benefits relative to BAU. This could take the form of CBA case studies based on existing / or planned subdivisions that have incorporated ESD features and would help to strengthen the evidence base.
- **Direct engagement with land surveyors and development engineers** to understand the drivers of land subdivision plans and to educate them about the value created through orientation. This could include pilot projects between council's and developers to showcase ESD features at the subdivision scale.
- **Consideration of innovative funding models** for encouraging adoption of subdivision interventions, especially where this involves relatively large capital costs, such as green loans, deferred payments, or fast track approvals for ESD developments. For example, the Victorian Government will contribute up to $10 million in grant funding over four years to develop and implement state wide demonstration projects, using micro-grid models.[19]
- **Develop supportive education materials, governance arrangements and assessment systems** Support Council planners (and the residential and development community) with training, information and a collaborative forum (such as a rural group within CASBE) for support and up-skilling, and to clarify council's expectations. Other resources could target community members, particularly when buying, selling or renting a home; and to accelerate the learning rate for the local development industry.
- **Prepare Sustainable Subdivision Guidelines including a generic Local Policy (for both Clause 21 and 22)** considering schedules to the residential zone, neighbourhood character/design objectives, application requirements, decision guidelines; but that does not create an unreasonable burden for regional councils by creating a permit trigger for every single dwelling or restriction on title.
- **Support advocacy to strengthen the NCC** noting the CBA case study which identified a range of cost effective opportunities to improve energy efficiency requirements in the Building Code.

[19] See https://www.energy.vic.gov.au/microgrids. Accessed 25 March 2018.

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ENVIRONMENTALLY SUSTAINABLE DESIGN FOR SUBDIVISIONS IN REGIONAL VICTORIA

Proof of Concept and Cost Benefit Analysis

FINAL - APPENDICES

Prepared for Wodonga City Council and partner Councils

17 May 2018

AECOM Imagine it. Delivered.

Table of Contents

Appendix A

Development profiles

Appendix A Development profiles

Land area and population density

Table 1 Land area and population density per municipality

Municipality	Land area (ha)	Population density (pp/ha)
Baw Baw	403,100	n/a
Wangaratta	363,900	n/a
Bendigo	299,903	0.37
Shepparton	242,136	0.27
Moorabool	210,952	0.15
Geelong	124,692	1.91
Ballarat	73,867	1.40
Wodonga	43,433	0.92

Source: id profiles. Wangaratta and Baw Baw other sources.

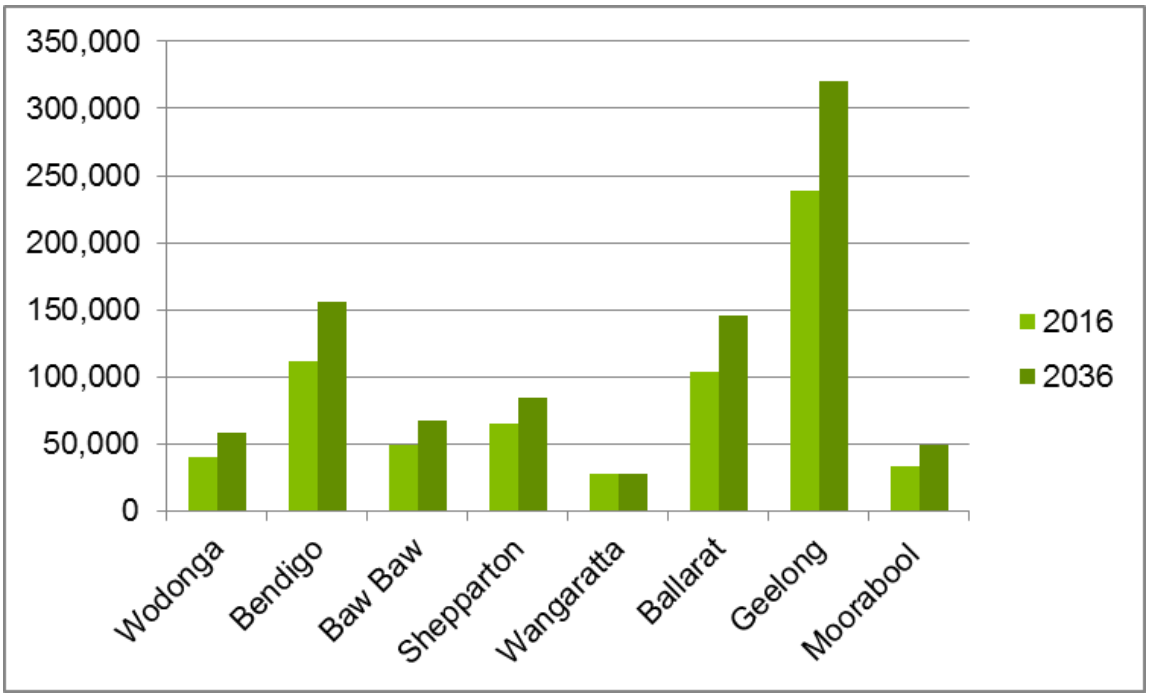
Current and forecast population

Table 2 Population and forecast growth

Municipality	Population (ERP)		Forecast total growth	Forecast total growth rate	Forecast annual growth rate
	2016	2036			
Wodonga	39,844	57,634	17,790	45%	2.2%
Bendigo	111,783	156,151	44,368	40%	2.0%
Baw Baw	49,008	67,743	18,735	38%	1.9%
Shepparton	65,076	83,782	18,706	29%	1.4%
Wangaratta	27,040	27,804	764	3%	0.1%
Ballarat	103,407	145,197	41,790	40%	2.0%
Geelong	238,603	320,791	82,188	34%	1.7%
Moorabool	32,658	48,891	16,233	50%	2.5%

Source: id Consultants profiles. Baw Baw and Wangaratta references Victoria in Future for 2031. Therefore growth rate calculated over 15 years, not 20 years.

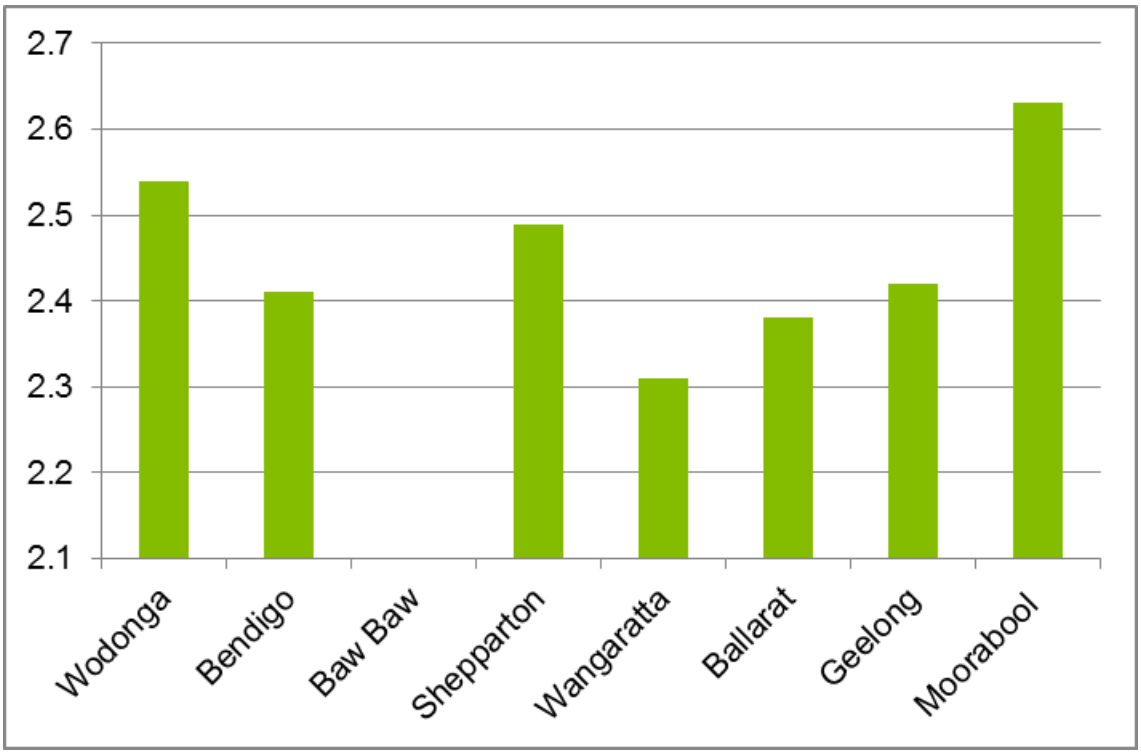
Table 3 Forecast population growth per municipality



*** Drawn from id forecast data, however Wangaratta anticipates 1.1% annual growth in a high growth scenario to 2031.**

Number of households and average household size

Figure 1 Average household size 2016



Source: id Consultants

Current and forecast number of dwellings

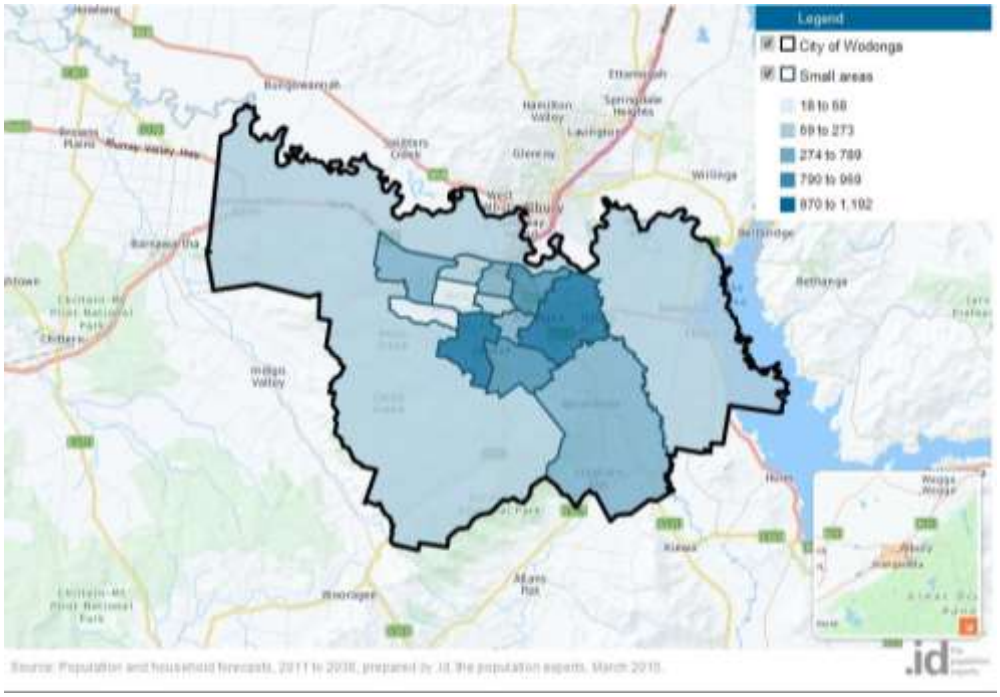
Table 4 Current and forecast number of dwellings

Municipality	No. of dwellings			Additional dwellings btw 2016-2036
	2016	2026	2036	
Wodonga	16,521	19,727	23,087	6,566
Bendigo	48,636	57,868	66,580	17,944
Baw Baw	n/a	n/a	n/a	n/a
Shepparton	27,288	31,095	34,804	7,516
Wangaratta	n/a	n/a	n/a	n/a
Ballarat	44,821	53,406	62,615	17,794
Geelong	106,095	127,433	148,437	42,342
Moorabool	13,255	16,728	20,400	7,145
			Total	**99,307**

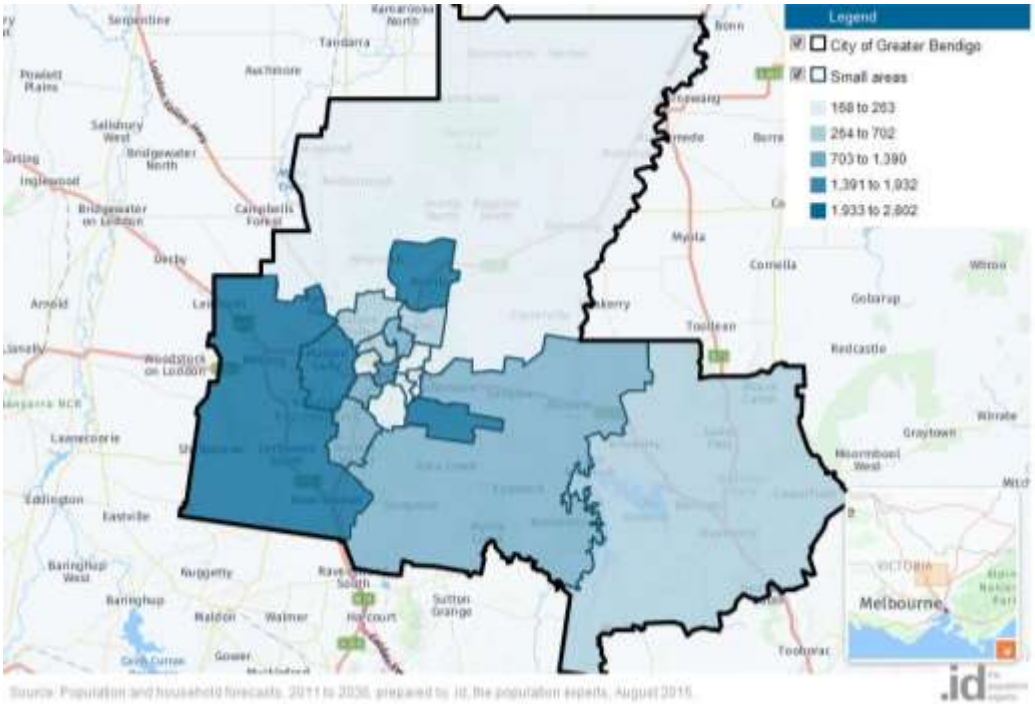
Source: id Consultants

The following maps show the number of additional dwellings that are expected to be built over the 20 years between 2016 and 2036.

Wodonga



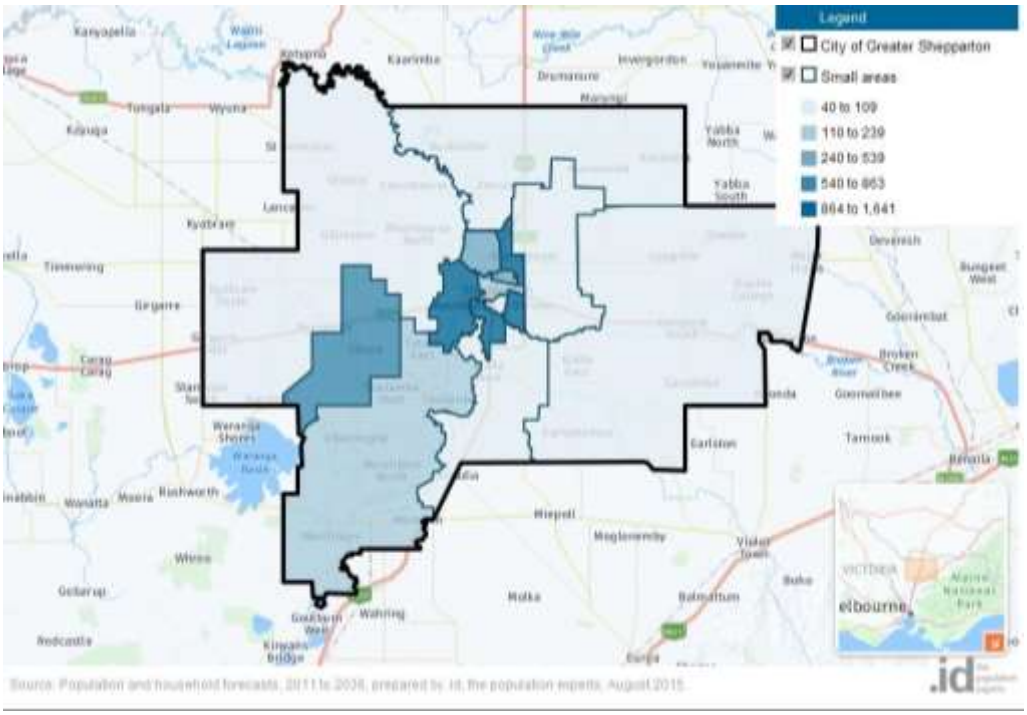
Bendigo



Baw Baw Shire

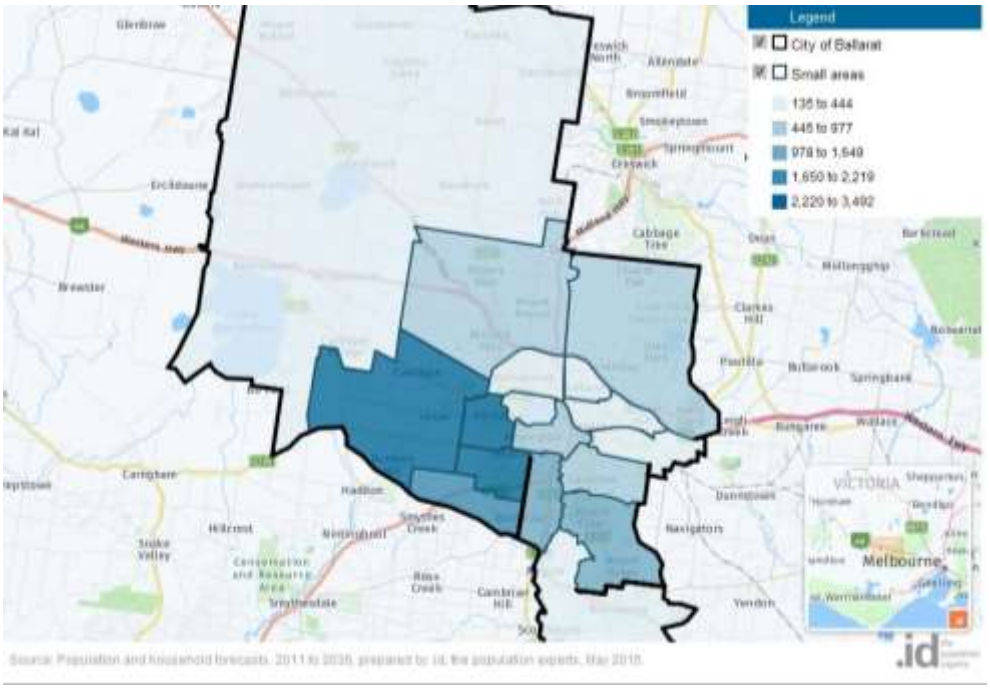
n/a

Greater Shepparton

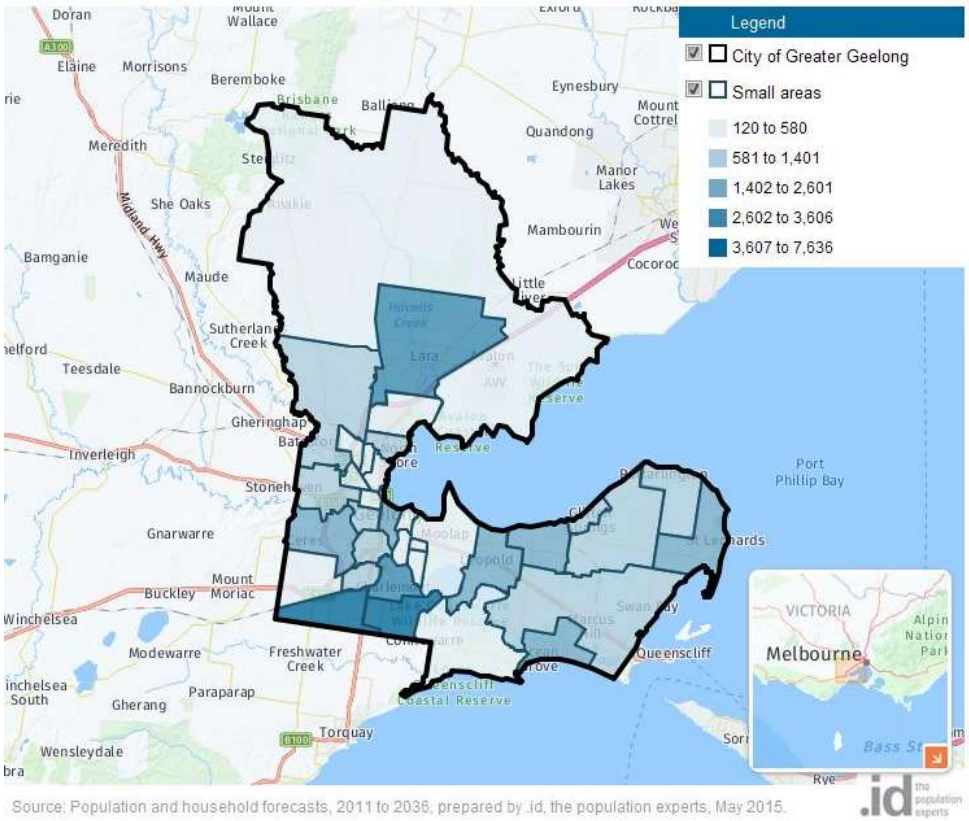


Wangaratta

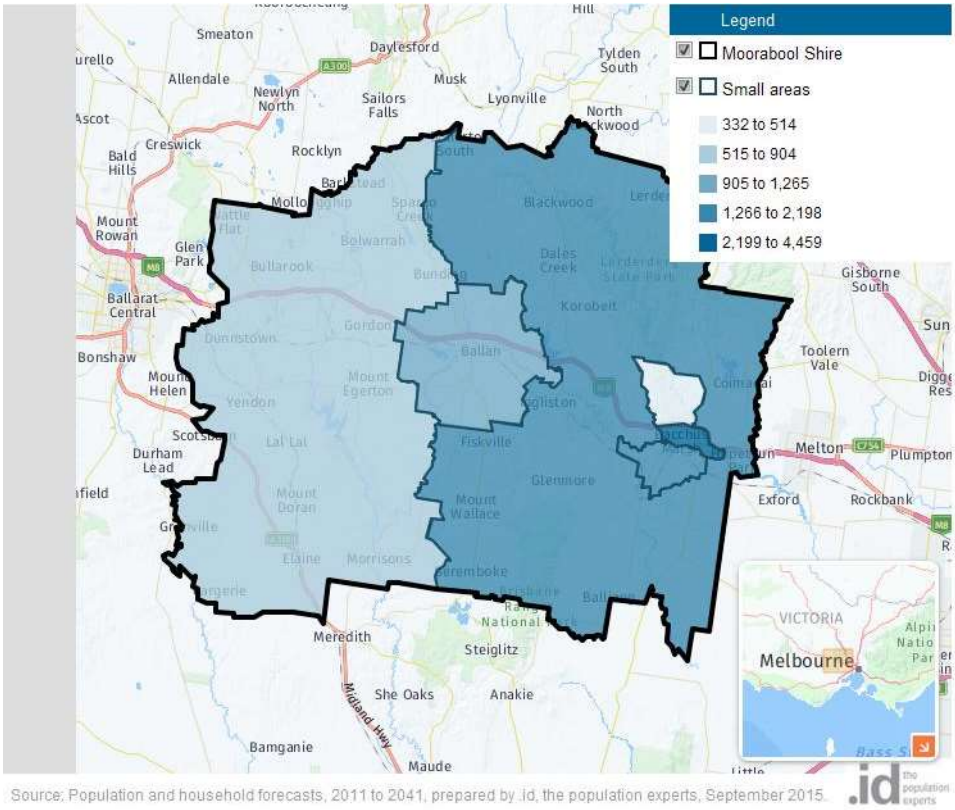
Ballarat



Greater Geelong



Moorabool


Legend
Moorabool Shire
Small areas
332 to 514
515 to 904
905 to 1,265
1,266 to 2,198
2,199 to 4,459
Smeaton
Daylesford
Allendale
Newlyn North
Sailors Falls
Musk
Lyonville
Tylden South
Creswick
Rocklyn
Bald Hills
Mount Rowan
Glen Park
Ballarat Central
Bonshaw
Durham Lead
Blackwood
Bolwarrah
Bullarook
Dunnstown
Ballan
Korobeit
Dales Creek
Gisborne South
Toolern Vale
Melton
Plumpton
Exford
Rockbank
Fiskville
Glenmore
Mount Wallace
Mount Doran
Elaine
Morrisons
Meredith
Steiglitz
She Oaks
Anakie
Bamganie
Maude
Midland Hwy
VICTORIA
Melbourne
Source: Population and household forecasts, 2011 to 2041, prepared by .id, the population experts, September 2015

Appendix B

Climate profiles

Appendix B Climate profiles

NCC Climate Zone	BOM Current Data	CSIRO Climate Cluster	CSIRO Projections
Wodonga City Council			
6 - Mild temperate	**Average Rainfall** 81.7mm (July) 39.1mm (Feb) **Mean Max Temperature** 31.8°C (January) 12.6°C (July) **Mean Min Temperature** 15.2°C (February) 3.1°C (July)	Murray Basin	**Rainfall** Decrease in rainfall for winter and spring The projected decreases are up to 40 per cent in winter and up to 15 per cent in spring by 2090 under high emissions **Temperature** Increases in projected mean, maximum and minimum temperatures 2030 – increase of 0.6 to 1.3°C (above climate of 1986-2005) 2090 (RCP8.5) – increase of 2.7 to 4.5°C 2090 (RCP4.5) – increase of 1.3 to 2.4°C **Extreme Temperature** Extreme temperatures are projected to increase at a similar rate to mean temperature, with an increase in the frequency of hot days and the duration of warm spells **Extreme Rainfall and Drought** Increase in intensity of extreme rainfall events Tine spent in drought is projected to increase over the course of the century **Fire Weather** Harsher fire weather in the future **Humidity and Solar Radiation** 2030 – small changes 2090 – increase in winter and spring radiation and decreased relative humidity
Greater Geelong City Council			
6 - Mild temperate	**Average Rainfall** 51.9mm (July) 30.8mm (Feb) **Mean Max Temperature** 25.0°C (January) 13.6°C (July) **Mean Min Temperature** 13.8°C (February) 5.2°C (July)	Southern Slopes (Victoria West)	**Rainfall** Decrease in rainfall for winter and spring The projected decreases are up to 25 per cent in winter and up to 45 per cent in spring by 2090 under high emissions **Temperature** Increases in projected mean, maximum and minimum temperatures 2030 – increase of 0.4 to 1.1°C (above climate of 1986-2005) 2090 (RCP8.5) – increase of 2.4 to 3.8°C 2090 (RCP4.5) – increase of 1.1 to 1.9°C **Extreme Temperature** Extreme temperatures are projected to increase at a similar rate to mean temperature, with an increase in the frequency of hot days and the duration of warm spells **Extreme Rainfall and Drought** Increase in intensity of extreme rainfall events

NCC Climate Zone	BOM Current Data	CSIRO Climate Cluster	CSIRO Projections
			Tine spent in drought is projected to increase over the course of the century **Marine and Coast** Mean sea level will continue to rise and height of extreme sea-level events will also increase 2030 – 0.08 to 0.18m above the 1986-2005 level 2090 (RCP4.5) – 0.29 to 0.64m rise 2090 (RCP8.5) – 0.39 to 0.84m rise Seas surface temperature is projected to increase in the range of 2.6 to 3.4°C by 2090 (RCP8.5) posing significant threat to marine environment **Fire Weather** Harsher fire weather in the future **Humidity and Solar Radiation** Increase in solar radiation and a decrease in relative humidity is projected in the cool seasons
Greater Bendigo City Council			
6 - Mild temperate	**Average Rainfall** 55.9mm (July) 30.2mm (March) **Mean Max Temperature** 29.9°C (January) 12.6°C (July) **Mean Min Temperature** 14.4°C (February) 2.7°C (July)	Murray Basin	**Rainfall** Decrease in rainfall for winter and spring The projected decreases are up to 40 per cent in winter and up to 15 per cent in spring by 2090 under high emissions **Temperature** Increases in projected mean, maximum and minimum temperatures 2030 – increase of 0.6 to 1.3°C (above climate of 1986-2005) 2090 (RCP8.5) – increase of 2.7 to 4.5°C 2090 (RCP4.5) – increase of 1.3 to 2.4°C **Extreme Temperature** Extreme temperatures are projected to increase at a similar rate to mean temperature, with an increase in the frequency of hot days and the duration of warm spells **Extreme Rainfall and Drought** Increase in intensity of extreme rainfall events Tine spent in drought is projected to increase over the course of the century **Fire Weather** Harsher fire weather in the future **Humidity and Solar Radiation** 2030 – small changes 2090 – increase in winter and spring radiation and decreased relative humidity
Ballarat City Council			
7 - Cool temperate	**Average Rainfall** 74.1mm (August)	Southern Slopes (Victoria West)	**Rainfall** Decrease in rainfall for winter and spring The projected decreases are up to 25 per cent in winter and up

NCC Climate Zone	BOM Current Data	CSIRO Climate Cluster	CSIRO Projections
	39.4mm (January) **Mean Max Temperature** 25.2°C (January) 10.1°C (July) **Mean Min Temperature** 11.5°C (February) 3.2°C (July)		to 45 per cent in spring by 2090 under high emissions **Temperature** Increases in projected mean, maximum and minimum temperatures 2030 – increase of 0.4 to 1.1°C (above climate of 1986-2005) 2090 (RCP8.5) – increase of 2.4 to 3.8°C 2090 (RCP4.5) – increase of 1.1 to 1.9°C **Extreme Temperature** Extreme temperatures are projected to increase at a similar rate to mean temperature, with an increase in the frequency of hot days and the duration of warm spells **Extreme Rainfall and Drought** Increase in intensity of extreme rainfall events Tine spent in drought is projected to increase over the course of the century **Fire Weather** Harsher fire weather in the future **Humidity and Solar Radiation** Increase in solar radiation and a decrease in relative humidity is projected in the cool seasons
Greater Shepparton City Council			
4 - Hot dry summer, cool winter	**Average Rainfall** 50.3mm (Nov) 27.7mm (January) **Mean Max Temperature** 31.8°C (January) 13.3°C (July) **Mean Min Temperature** 15.2°C (January) 3.3°C (July)	Murray Basin	**Rainfall** Decrease in rainfall for winter and spring The projected decreases are up to 40 per cent in winter and up to 15 per cent in spring by 2090 under high emissions **Temperature** Increases in projected mean, maximum and minimum temperatures 2030 – increase of 0.6 to 1.3°C (above climate of 1986-2005) 2090 (RCP8.5) – increase of 2.7 to 4.5°C 2090 (RCP4.5) – increase of 1.3 to 2.4°C **Extreme Temperature** Extreme temperatures are projected to increase at a similar rate to mean temperature, with an increase in the frequency of hot days and the duration of warm spells **Extreme Rainfall and Drought** Increase in intensity of extreme rainfall events Tine spent in drought is projected to increase over the course of the century **Fire Weather** Harsher fire weather in the future **Humidity and Solar Radiation** 2030 – small changes 2090 – increase in winter and spring radiation and decreased relative humidity

NCC Climate Zone	BOM Current Data	CSIRO Climate Cluster	CSIRO Projections
Baw Baw Shire Council			
7, 8 - Cool temperate, alpine	**Average Rainfall** 105.8mm (October) 52.4mm (Feb) **Mean Max Temperature** 26.2°C (February) 12.9°C (July) **Mean Min Temperature** 13.2°C (February) 3.8°C (July)	Southern Slopes (Victoria East)	**Rainfall** Decrease in rainfall for winter and spring Increased intensity of extreme rainfall events **Temperature** Increases in projected mean, maximum and minimum temperatures 2030 – increase of 0.5 to 1.2°C (above climate of 1986-2005) 2090 (RCP8.5) – increase of 2.7 to 4.3°C 2090 (RCP4.5) – increase of 1.3 to 2.2°C **Extreme Temperature** Extreme temperatures are projected to increase at a similar rate to mean temperature, with an increase in the frequency of hot days and the duration of warm spells **Fire Weather** Harsher fire weather in the future **Humidity and Solar Radiation** Increase in solar radiation and a decrease in relative humidity is projected in the cool seasons
Wangaratta Rural City Council			
7 - Cool temperate	**Average Rainfall** 66.1mm (July) 39.1mm (April) **Mean Max Temperature** 31.9°C (January) 12.9°C (July) **Mean Min Temperature** 14.2°C (February) 2.6°C (July)	Murray Basin	**Rainfall** Decrease in rainfall for winter and spring The projected decreases are up to 40 per cent in winter and up to 15 per cent in spring by 2090 under high emissions **Temperature** Increases in projected mean, maximum and minimum temperatures 2030 – increase of 0.6 to 1.3°C (above climate of 1986-2005) 2090 (RCP8.5) – increase of 2.7 to 4.5°C 2090 (RCP4.5) – increase of 1.3 to 2.4°C **Extreme Temperature** Extreme temperatures are projected to increase at a similar rate to mean temperature, with an increase in the frequency of hot days and the duration of warm spells **Extreme Rainfall and Drought** Increase in intensity of extreme rainfall events Tine spent in drought is projected to increase over the course of the century **Fire Weather** Harsher fire weather in the future **Humidity and Solar Radiation** 2030 – small changes 2090 – increase in winter and spring radiation and decreased relative humidity

NCC Climate Zone	BOM Current Data	CSIRO Climate Cluster	CSIRO Projections
Moorabool Shire Council			
6 - Mild temperate	**Average Rainfall** 58.0mm (October) 34.0mm (January) **Mean Min Temperature** 10.3°C (February) 2.8°C (July)	Southern Slopes (Victoria West) and Murray Basin	**Rainfall** Decrease in rainfall for winter and spring The projected decreases are up to 25 per cent in winter and up to 45 per cent in spring by 2090 under high emissions **Temperature** Increases in projected mean, maximum and minimum temperatures Victoria West 2030 – increase of 0.4 to 1.1°C (above climate of 1986-2005) 2090 (RCP8.5) – increase of 2.4 to 3.8°C 2090 (RCP4.5) – increase of 1.1 to 1.9°C Murray Basin 2030 – increase of 0.6 to 1.3°C (above climate of 1986-2005) 2090 (RCP8.5) – increase of 2.7 to 4.5°C 2090 (RCP4.5) – increase of 1.3 to 2.4°C **Extreme Temperature** Extreme temperatures are projected to increase at a similar rate to mean temperature, with an increase in the frequency of hot days and the duration of warm spells **Extreme Rainfall and Drought** Increase in intensity of extreme rainfall events Tine spent in drought is projected to increase over the course of the century **Fire Weather** Harsher fire weather in the future **Humidity and Solar Radiation** Increase in solar radiation and a decrease in relative humidity is projected in the cool seasons

Appendix C

ESD initiatives

Appendix C ESD initiatives

This appendix outlines a 'shopping list' of possible sustainability initiatives. Indicative cost and benefit have been defined relative to each other.

Site and street layout and orientation

Site layout and orientation is critical for solar gain management and ventilation and can avoid significant energy use, improve comfort and reduce operating costs for occupants.

Solar load on buildings and places has a significant impact on their thermal performance and for thermal comfort. That load is primarily determined by asset orientation and form. Early consideration of the orientation and shape of building plots is essential to maximise the size of the north/south orientated dimension and minimise the east/west orientated dimension and of massing to avoid overshadowing of open space and solar access. This should be coupled with design guidelines to encourage external shading on the northern orientation to set the groundwork for good thermal performance.

Applicability: all subdivisions

Initiative	Relevance	Cost	Benefit	Scale	Subdivision scale	Optimal timing
Site layout and orientation	Allows good passive design of public spaces and buildings for solar access and thermal performance	Low	High	Subdivision	All	Masterplan stage

Green and open space

Open space is generally divided into public or private, and then into active or passive spaces. In urban areas councils are seeking to increase the amount of green open space (that is, space with substantial vegetation) for 'ecosystem services' including amenity, fresh air and cooling. Increased provision of public gardens, private roof gardens, green roofs and walls and the use of Water Sensitive Urban Design (WSUD) can support this objective.

Open spaces provide ecosystem services, recreational and social benefits and help to filter water and regulate the climate. Designing a subdivisions urban landscape to trap and filter water will green open spaces, create cooler and moister environments and assist to limit the impact of drought and the urban heat island effect.

Applicability: all subdivisions

Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) measures can improve the quality of storm water through the filtration of pollutants. WSUD in a precinct can be enhanced by replacing small percentages of impervious surface area with porous and permeable pavements. As subdivisions develop WSUD can be enhanced by utilising stormwater collected for irrigating public open space, particularly active recreation areas. The benefit would largely reduce the impact of stormwater entering the downstream natural water system by reducing its pollutant loadings.

Applicability: medium to large subdivisions

Roof gardens

Green roof gardens can reduce the Urban Heat Island Effect, preserve and enhance biodiversity and improve air quality, aesthetics and stormwater quality. Roof gardens can also help to regulate internal building temperatures by acting as thermal insulation with studies showing that indoor temperatures in buildings with green roof gardens can be between 3°C and 4°C lower than outside temperatures of 25-30 °C (Wong et al., 2003; Getter et al. 2006). Green roof gardens can also improve the electricity production of photovoltaic panels because the evapotranspiration of vegetation has a similar effect to

evaporative air conditioning (Appl et al. 2004). The maintenance requirements of both roof gardens and photovoltaic systems should also be taken into account.

In the design of a roof garden, consideration needs to be given to the micro-climate at roof level, particularly wind speed, available sunlight and the structural impact of the additional load a roof garden may generate. Green roofs can be sited around building plant and equipment and it may be feasible to utilise Australian native plants for biodiversity benefits.

Other benefits of green roofs are qualitative, benefitting the wider community and not necessarily the building occupants, or developers. Ongoing governance controls using planning guidelines may be required to maximise the uptake of this approach to support precinct ecological targets. For example Toronto's local authority has created by-laws mandating green roofs (Wordpress 2009a).

Applicability: Premium subdivisions. Application limited by cost and novelty of application to residential buildings in Victoria.

Initiative	Relevance	Cost	Benefit	Scale	Scale applicability	Optimal timing
Green and open space	Provides amenity and reduces heat island effect	Low	High	Subdivision	All subdivisions	Masterplan stage
WSUD	Reduces use of potable water, reduces impact on city infrastructure	Low	Med-High	Subdivision	Medium to large subdivisions	Masterplan and development stage
Roof gardens	Provides amenity and reduces heat island effect	Med-High	High Low	Dwelling	Premium subdivisions	Development stage

Integrated infrastructure services

Central Services Hub

A Central Services Hubs (CSH) is required to generate and harvest energy and water resources and reticulate throughout the precinct. They require approximately 800 square metres (sqm) each, access to ventilation, sewer, power grid and gas supply, baffling for noise and vibration, vehicle access and proximity to buildings that will use the generated resources. Depending on soil conditions they can be above or below ground and can be sited and designed to support community education and interaction with sustainability principles.

A CSH generally contains water treatment and tri-generation plants; however at certain scales tri-generation is not very successful and as they are gas fuelled, they are high emitters and may become stranded technology as the electricity supply decarbonises.

A CSH generally produces electricity, hot water, chilled water and recycled water primarily from gas:

- sewerage is treated and reticulated as recycled water and as chilled water to reduce the quantity of potable water and energy consumed
- storm water is collected, and after a series of treatments to potable water quality, heated and reticulated as potable hot water
- hot/cold water is centrally supplied for district heating and cooling
- electricity is generated via a co/tri-generation plant from high pressure natural gas and fed back into the grid
- heat from returned chilled water is rejected via the most efficient system (sewer heat exchanger, tri-generation plant or chillers).Where additional heat is required waste heat is captured for reuse via the tri-generation plant.
- cooling towers in the tri generation process consume a significant volume of water generally supplied by recycled water.

The network of service pipes entering and exiting each CSH are generally distributed underground via new service tunnels which can be constructed under the precinct streets.

This would enable additional utility infrastructure to be accommodated such as vacuum sewerage and recycling systems within the tunnel; however this technology requires further investigation.

The benefits of this approach can include:

- reduced point sources of pollutants from refrigerants, cooling towers and smoke stacks
- a deferred need to increase the capacity of power plants and reduced transmission losses
- greater efficiencies than building by building approaches due to lower energy losses with a central plant
- greater efficiencies of centralised wastewater treatment and recycling than a building by building approach
- improved management of the wastewater treatment processes by removing the need to install treatment plants at the building level to achieve this objective

Applicability: large scale subdivisions

Services tunnel

A CSH is best supported by a services tunnel to house the many service pipes and conduits to be installed in developing the precinct and operate the CSH. This requires an initial investment that derives benefits over time. They are often located under the road network at a depth of three metres and are (approximately) two metres in diameter. The water strategy alone potentially involves five separate water pipes: potable water, potable (hot) water, non-potable (chilled) water, non-potable (recycled) water, and sewer. Other utilities such as electricity, gas, telephone and broadband are also located in the services tunnel.

The benefits of a services tunnel can include:

- central quality control at the precinct scale and ease of access to service the asset
- less disruption from road closures when retrofits, maintenance or technology upgrades are required
- simplified services allowing for the improved cross- connection of services
- increased ability to monitor and repair water leakages

Applicability: large scale subdivisions

Vacuum sewers

Vacuum sewers can be constructed at grade and located within the services tunnel. New water tight sewers can significantly reduce inflow and infiltration thus allowing for smaller diameter pipes. This technology is not capable of transporting sewage over very long distances, but the waste could be pumped from the subdivision into the closest major sewer line. The benefits of a vacuum sewer are:

- Co-locate in services tunnel or sewers may be laid in the same trench with other services (including potable water or storm water), as well as in water protection areas.
- reduce inflow and infiltration when combined with new water tight sewers, allowing for smaller diameter pipes
- usually requires only a single vacuum pump station rather than the multiple stations required for gravity and low pressure networks (this releases land for other purposes and reduces energy and operational costs)
- trenching can be shallow and close to the surface
- no odours occur along the closed vacuum sewers

- stormwater infiltrates gravity feed systems, with vacuum systems no infiltration occurs (this creates less load to manage at the treatment stations)

Initiative	Relevance	Cost	Benefit	Scale	Scale applicability	Optimal timing
Central services hub	Reduces energy peak power, reducing size of plant and returning floor area	Medium	High	Subdivision	Large	Masterplan stage
Services tunnel	Provides central access and coordination of services	Medium	Low	Subdivision	Large	Masterplan stage
Vacuum Sewers	Possible, but services exist in the precinct	High	Low	Subdivision	Large	Masterplan stage

Energy initiatives

With approximately 71 per cent of Victoria's grid electricity generated by burning fossil fuels (coal is 72 per cent of that fuel mix) and with buildings being a majority of Victoria's non-transport related greenhouse gas emissions, de-carbonising electricity generation represents the greatest single opportunity for emissions reduction in the built environment.

There is an opportunity to shift from supply-side solutions involving large, centralised systems to smaller decentralised systems. The emerging concept of a 'virtual power plant' integrates an intelligent power supply and demand management system with energy storage and smaller scale decentralised systems which provide a consistent, reliable source of low carbon power at a precinct level. Distributed power generation is widely expected to be an increasing component of our nationwide energy system in the future.

A virtual power plant could consist of:

- subdivision wide 'smart grid' supply and demand side power management
- energy storage systems, including batteries and integration of future electric car capacity
- extensive photovoltaics solar panels
- micro wind turbines
- tri-generation system

This would have many benefits including:

- improved energy supply reliability, security and flexibility through decentralised forms of electricity generation
- substantial improvements in the cleanliness, efficiency and security of meeting energy needs - efficiency of energy generation is increased by 30-40 per cent by avoiding transmission losses and capturing waste heat (SEAV, 2004)
- increased utilisation of energy assets compared to standby generation
- reduced carbon footprint compared to traditional fossil fuel centralised power generation.

There are regulatory barriers and the Australian Energy Regulator (AER) provides guidelines to encourage distributed generation. Embedded generators are direct competitors of the Distribution Network Service Providers (DNSP) and incentives are not in place for DNSPs to upgrade the network for distributed generation connections. A connection agreement is required to supply electricity to the grid (this agreement sets out the connection costs and the standards of service that the connecting party will receive), however this regulatory framework is currently under review.

Smart grid

An intelligent automated management system across the energy grid is a central part of the smart grid concept. It enables a broader distributed energy system function more efficiently, securely and reliably by managing both demand and supply of energy. This enables practices such as 'peak chopping' and 'trough filling' to overcome the intermittent nature of renewable energy sources such as photovoltaic solar or wind. It involves the management of different types of distributed energy systems, such as tri-generation or photovoltaic solar, with energy storage and demand management controls via an integrated management system. By doing so, the grid can balance the various strengths and weaknesses of each individual system to deliver a stable sustainable grid. This can dramatically reduce the carbon footprint of a subdivision without adversely affecting the reliability of the grid.

The physical infrastructure of the smart grid itself is typically limited to additional smart metering coupled with additional computing power. As such it can be distributed through the subdivision. Computing power could be centralised in the CSH.

Applicability: medium to large subdivisions

Energy Storage

Significant advances in the cost and efficiency of energy storage systems, particularly batteries, have improved the applicability of battery storage for the precinct. An integrated battery storage system could be permanently included in the smart grid system, and could leverage electric vehicles in future for additional energy storage (a Vehicle to Grid System).

Any form of electrical storage can charge when electricity supply outstrips demand, and then discharge electricity back into the grid during peaks in demand. This is described as 'peak chopping' and 'trough filling' and can dramatically improve the viability of renewable energy based systems by better matching demand to supply.

The current power grid essentially has no storage, so generation and transmission/distribution must be continuously managed to match a fluctuating customer load. This is generally accomplished by turning large generators on and off, or increasing or decreasing their power output, some on a minute-by-minute basis. This process can be both carbon and financially expensive as large power stations attempt to adjust to rapidly changing demand profiles. Power stations are a long way from demand centres and the system suffers from significant distribution costs and transmission losses. By contrast providing distributed energy storage throughout the energy system allows both demand and supply side management; better matching demand with supply and reducing the distribution loses associated with transmission.

Applicability: medium to large subdivisions

Vehicle to Grid System

The use of vehicle-to-grid (V2G) systems will be enabled by the emergence of electric drive vehicles (EDV), which is likely to occur over the next 20 years. EDVs reduce greenhouse gas emissions and ambient air pollution if the electricity they consume produces less emissions than the cars which they replace (that is, cars with internal combustion engines). Therefore, EDV's emissions reduction potential will be determined by broader moves towards less greenhouse gas intensive electricity generation. Another benefit of EDVs is likely to be a reduction in Australia's exposure to crude oil prices and oil import dependency.

EDV power plants can be battery-electric, a fuel cell or a plug-in petrol (or diesel) electric hybrid (Kempton and Tomić 2005). Plug-in hybrid electric vehicles, or those with battery-electric power plants, can function identically to integrated grid battery systems when plugged in, charging when demand is low and supplying when demand is high. All three EDV types can provide peak chopping by supplying energy to the grid in times of high demand. Utilising EDVs in this manner may accelerate a transition towards these vehicles by improving their commercial viability.

Vehicle to grid (V2G) systems can reduce operational costs of electric vehicles and generate revenue for owners of electric vehicles. Other benefits include:

- reducing demand charges for electrical consumers

- increasing the stability and reliability of the electricity grid
- lowering electrical system costs and spreading infrastructure investment costs
- acting as inexpensive storage for intermittent renewable electricity
- reducing greenhouse gas emissions

Private vehicles are parked on average 95 per cent of their lifetime. Each parked vehicle contains underutilised energy and fuel (or battery) storage capacity and generating V2G power from parked vehicles could better utilise an expensive investment. V2G may provide a means to utilise the spare power capacity available in each parked vehicle and reduce the need to maintain the excess conventional electricity generation capacity which is currently required (Kempton and Tomić 2005; Sovacool and Hirsh 2009).

Further investigation needs to be undertaken to determine the merits of an electric vehicle-to-grid (V2G) approach to determine consistency with the precinct's emissions reduction strategy.

Applicability: To be determined

Photovoltaics

The energy output of photovoltaic systems is determined by solar access, the size of the array and the photovoltaic technology chosen.

Photovoltaics are a reliable technology requiring minimal maintenance that provides a source of renewable electricity. The cost of photovoltaic panels are steadily approaching parity with traditional energy sources, with payback on systems steadily becoming more reasonable. However, photovoltaic systems produce an intermittent, variable supply of electricity according to the available solar energy. This weakness can be overcome with the integrated battery and power management 'smart grid' systems outlined above.

The choice of a proper location for photovoltaic systems is partly determined by ensuring that the modules are exposed to direct sunlight without shadowing from at least early morning to late afternoon. To maximise the power generating capacity of photovoltaic systems, they must be installed with a tilt angle calculated to expose the panels to as much direct sunlight as possible. As shading will reduce the electricity output of photovoltaic systems, there needs to be consideration of any shading from surrounding buildings and height restrictions may be required to allow adequate solar access on building roof tops to minimise the impact of overshadowing.

An objective relating to the installation of photovoltaic systems could be to cover 50 per cent of the roof area of new developments.

photovoltaic can also be integrated into building elements such as the photovoltaic noise wall installed along the Tullamarine Freeway at the Calder Interchange, adjacent to Essendon Airport.

Applicability: all subdivisions

Micro Wind Turbines

The ideal position to install micro wind turbines (MWT) is in open spaces unobstructed by structures and trees, while being open to the prevailing southerly winds. In installing MWT, consideration needs to be given to the weight and power output of the turbines, wind turbulence, obstructions, vibration, noise and wind speed. The structural integrity of the intended mounting structure needs careful consideration due to the particular structural loads imposed by wind turbines. The bottom of the sweep of the moving rotor blades should be at least 6 m above any obstacle that is within 76 m of the mounting tower (Energy Matters, 2009) limiting the number of suitable sites.

The available wind resource is the most important factor in calculating the economic viability of a wind turbine, which is very difficult to predict in an urban area. For MWT to be effective Energy Matters (2009) recommends correct siting and a wind speed of at least 4.5 meters per second (m/s) average or more, with the best results being achieved with average wind speeds of 5.4 m/s.

Applicability: Limited by site suitability – requires large spaces.

Tri-generation

Cogeneration or Combined Heat and Power (CHP), is the generation of both electricity and heat at or near the point of use. A tri-generation system is the addition of an absorption chiller to provide cooling. Absorption chillers provide a way of using thermal energy to deliver cooling and air-conditioning as an alternative to conventional electrically driven refrigeration. By using the heat stream from a co-generation system as the thermal energy source, absorption cooling offers the potential to expand the range of co-generation's applications. The system should be optimised to ensure the design meets heat demands, as the cost to transport heat is greater than the cost to transport electricity. Figure 2 is a schematic diagram of a tri-generation system.

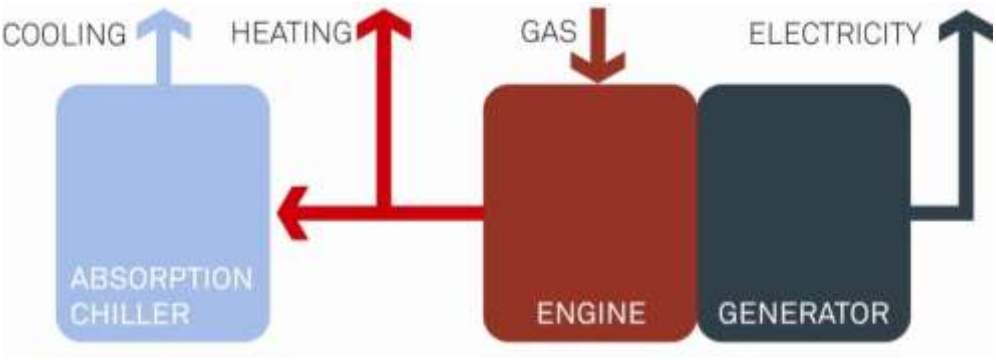


Figure 2: Schematic diagram of input puts and outputs from the tri-generation plant

There are many forms of fuel suitable for a tri-generation system, including municipal solid waste, biomass, biogas, natural gas and coal. Biomass and biogas are the preferred fuel sources from a sustainability perspective, however guaranteeing a secure supply of these fuels may be difficult. Integrating the production of alternative gasses into the waste management system, through gasification of municipal solid waste and bio digestion of waste water provides a source of alternative fuels.

As markets for biomass, waste gasification and biogas fuel are immature currently in Australia, it may not be possible to provide a reliable quantity of feedstock to generate energy to fully meet the demand of the precinct.

The most common form of fuel utilised in tri-generation systems is natural gas as there is a reliable supply and it has lower greenhouse gas intensity than grid powered electricity currently supplied. However, natural gas is not a zero carbon energy source and will face increased pressure to be phased out as Victoria transitions to a carbon neutral energy system in the coming decades. This fact, coupled with the increasing cost of natural gas means that a complimentary alternative fuel supply should be considered alongside any combustion based power generation system.

Site-specific benefits of tri-generation include:

- the use of an established technology, with continued incremental efficiency improvements (through reciprocating engines and turbines)
- provision of electricity from a less greenhouse gas intensive generation source.
- possibility of integrating municipal waste management to provide an alternative fuel source

There are several economic, regulatory and technical barriers to the implementation of tri-generation systems. A major economic barrier is the extent to which the benefits of avoided transmission losses can be captured, which is primarily a question of regulation barriers. There is a disparity between the connection costs embedded generators are charged in comparison to transmission-connected generators, as new transmission-connected generators are not required to pay for downstream transmission augmentation.

Tri-generation systems that run on natural gas are not zero carbon and therefore do not represent a truly long term solution.

Siting considerations are as for a central services hub.

Applicability: current limitations. Future potential for larger subdivisions or as part of municipal initiatives.

Fuel cells

A fuel cell is a device that generates electricity by a non-combustion chemical reaction. While CSIRO has undertaken research on a range of fuel cell technologies for a number of years, from which Ceramic Fuel Cells Ltd (CFCL) emerged and put to market a fuel cell based electricity generator suitable for households, called the BlueGEN, this company closed in 2015.

The technology had been expected to emerge over the past decade which has not been the case largely due to advances in solar and battery storage, and despite some benefits that include:

- generating and consuming electricity at the point of use
- efficiently converting fuel to electrical energy, even at partial loads
- depending on the fuel source, may be low emissions
- emit little noise, are modular in nature, so the size of a generating station can be built up gradually as needed without losing economies of scale
- generate waste heat which can be used to run steam turbines or other heat consuming processes (high temperature fuel cells only)

Fuel cells are not as energy and cost efficient per kWh as centralised co-generation plants.

Applicability: unknown

Initiative	Relevance to	Cost	Benefit	Scale	Scale of subdivision applicable	Optimal timing
Smart Grid	Opportunity to engage with nation leading technology	Med	High	Subdivision	medium to large subdivisions	Masterplan Objectives for energy established in this stage
Energy Storage	Allows full utilisation of renewable energy sources. Builds resilience to changing shape of the grid.	Med	Med	Subdivision and dwelling	medium to large subdivisions	Master plan and Development
Photovoltaics	Highly applicable due to high roof to floor area ratio	Med	High	Subdivision and dwelling	All	Development
Micro Wind Turbines	Not suitable in an urban environment	High	Low	Subdivision and dwelling	Limited by site suitability – requires large spaces.	Master plan and Development
Tri-generation	Reduces cost and GHG of energy, reduced effect in context of changing electricity supply	High	Med	Subdivision and dwelling	current limitations. Future potential	Master plan and Development t
Fuel Cells	Nation leading technology	High	Low	Subdivision and dwelling	Feasibility to be determined	Master plan and Development
Building Energy Efficiency	Planning direction to drive efficiency	Low	Low	Dwelling	All	Master plan and Development

Integrated water supply services

Similarly to an integrated energy system, significant benefits can be achieved by integrating water management across various services in a subdivision. To that end, the following methodologies would allow a subdivision to grow while minimising potable water consumption:

- demand reduction through high efficiency building design
- diversification of water supply sources, including harvesting water whenever possible
- precinct wide infrastructure to enable the above

Water supply services

With climate change expected to reduce future rainfall and hence Victoria's water supply (CSIRO, 2015), reduced water storage coupled with future population growth will likely lead to greater water scarcity. In an uncertain climate, having a range of water supply options will create more certainty and provide alternatives should one option fail.

Through initiatives such as recycling, water conservation, Water Sensitive Urban Design (WSUD) and stormwater harvesting, new and better ways of managing water resources within a subdivision can be implemented.

There are a number of potential sources of water that can help diversify sources of potable water and which can be utilised for a number of purposes where potable water is not required (subject to appropriate treatment). They include cooling towers, toilet flushing, laundry and the irrigation of open space and gardens.

A key consideration is the level of projected water demand for the precinct and the potential level of supply from available options. Seasonality is a critical factor as peak demand occurs during the hotter months of the year and are often not synchronised with supply periods.

Applicability: all subdivision incl. as part of broader area based initiatives

Distributed stormwater catchment and storage

By rethinking and reinvesting in the design of stormwater infrastructure to capture and store, rather than dispose of rainwater, and by reusing wastewater, potable water consumption can be significantly reduced. This also improves the quality of stormwater run-off and reduces the energy used to pump water and sewage for treatment.

Stormwater could be stored within a distributed, intelligent storage network and existing stormwater infrastructure utilised to collect and distribute stormwater.

Applicability: all subdivision incl. as part of broader area based initiatives

Storage

An intelligent storage network combined with a decrease in impervious area and attenuation through WSUD and roof top gardens can reduce localised flooding issues and increase the reuse of stormwater in the precinct. Distributed underground storage tanks could be located under open spaces and be operated via an intelligent storage network to manage peak storm events and water demand.

Onsite tanks could also be installed as header tanks for firefighting with the added benefit of buffering peak demands on the reticulation system. These tanks would most likely be connected to the supply source for firefighting (which could be recycled water) but could also be connected to both potable and non-potable supplies.

Applicability: medium to large subdivisions

Treatment

The following identifies levels of stormwater treatment:

- removal of sediments, nutrients and other contaminants through water sensitive urban design
- source pre-treatment at the distributed underground network of storage units

- tertiary treatment and disinfection at the Central Service Hub (CSH).

The stormwater collected through the distributed underground network of storage units could then be supplied to the tri-generation plant before being reticulated through the precinct to supplement the supply of hot water. Additionally, all elements arising from the water sensitive urban design, including open space and rooftop gardens, should draw from the distributed storage systems.

Wastewater

An onsite sewage treatment plant could be constructed to process precinct wastewater. The wastewater could be extracted from the primary sewage pipes and treated through anaerobic digestion.

Recycled water could then be reticulated to users through a dual pipe network; to supply toilets, open space, laundries, firefighting assets, cooling towers and the tri-generation plant for use in heat exchangers. This approach has the potential to reduce potable water demand significantly, while supplying a source of biogas, bio solid fuel and fertilisers for municipal green space. The viability of subdivision level bio digestion for energy will be dependent on the possible capacity of waste and size of applicable system.

Applicability: large subdivisions

Initiative	Relevance	Cost	Benefit	Scale	Scale of subdivision applicable	Optimal timing
Water Efficiency	High efficiency water design increasingly standard	Low	High	Dwelling	All	Masterplan Objectives for water would be established in this stage
Stormwater Catchment	Utilisation of underutilised resource	Med	Med	Subdivision and dwelling	medium to large subdivisions	Masterplan
Wastewater Recycling	Utilisation of underutilised resource	Med	Med	Subdivision and dwelling	large subdivisions	Masterplan

Resource recovery

Waste management objectives are set in council and State policy and guidelines, and seek improved performance within municipal solid waste, dumped rubbish, public place recycling and waste management from buildings. Improving diversion rates of materials from landfill can be supported by Alternative Waste Technologies (AWTs) or Advanced Resource Recovery Technologies (ARRTs). These facilities have the capacity to take the residual waste stream (currently going to landfill) and, through a process of sorting and treatment, enable the recovery of materials for recycling and the production of other useful by-products. The AWT and ARRT facilities generally have some level of residual material that would need to be disposed of to landfill.

These facilities are generally provided at a regional scale and overcome the need for source separation by householders of organics from the residual landfill stream, utilising a two-bin system of commingled recycling and residual material and avoiding the need to implement a three bin system.

Urine separation

Urine separation reduces water use and nutrient discharges to sewage treatment systems and the receiving environment, and increase the potential for closing the nutrient loop as the stored urine can be used as a fertiliser (which is increasingly expensive) This could best be implemented initially as pilot study which could be rolled out more widely pending successful results.

Urine is the fraction of urban waste containing the largest amounts of nutrients, contributing approximately 70 per cent of the nitrogen and 50 per cent of the phosphorus and potassium of all

household waste and wastewater. Levels of heavy metals are expected to be very low in the urine, making it a very clean fertiliser. Urine separation has the potential benefits of:

- decreasing the nutrient load of the sewage system and reducing the discharge of nitrogen and phosphorus
- efficiently replacing mineral fertilisers,
- reducing water consumed in flushing away the urine and decreasing the energy required to pump wastewater by decreasing its volume
- reducing the volume of chemicals required to remove phosphorus from wastewater

Waste to Energy

It may be viable to implement a waste to energy scheme to combust waste from building occupants to power electricity and heat generation. This would best be conducted through a gasification process. This process produces clean burning synthetic gas from the combustion of waste in a high temperature, oxygen rich environment. This 'Syngas' can then be used in turbines for electricity generation or in boilers or tri/co-generation systems produce heat.

This technology is relatively immature in the Australian market but has seen widespread use through Europe, particularly the Nordic countries.

Initiative	Relevance	Cost	Benefit	Scale	Scale of subdivision applicable	Optimal timing
Urine Separation	Innovative technology to utilise underutilised resource.	High	Low	Subdivision and dwelling	Large subdivisions. Future potential	Development
Waste to Energy	Requires addition of significant waste handling infrastructure. Nation leading.	High	Med	Subdivision and dwelling	Large subdivisions. Future potential	Masterplan and Development

Appendix D

Case studies

Appendix D Case studies

Mullum Creek, Donvale, Victoria

Location	Donvale, Victoria
Council:	Manningham City Council
Contact:	
Project Area:	20 hectares / 56 lots
Population:	225 (Approx)
Developer:	Private Development – Matthews family
Builder:	Pre-approval required
Type:	Residential, 1-2 story houses

Context:

The Mullum Creek estate is located along the western bank of the Mullum Mullum Creek in Donvale, approximately 20 km east of the city of Melbourne. The land was formerly comprised of orchard, farm and remnant bush, owned by the same family for many years. The area is classed as Climate Zone 6 according to the NCC with climate change projections aligning with the Southern Slopes cluster.

ESD Goals:

The Mullum Creek development aims to help residents make a positive contribution towards protecting the environment. Central to the development is the developer's goal of constructing buildings that demonstrate environmentally sensitive passive design.

The developers are targeting minimum 7.5 star energy efficient homes through the use of onsite energy generation and storage and passive site and building elements.

Social and environmental practice within the development area includes the use of responsible construction materials and practices, and installation of high capacity rainwater tanks for domestic and garden needs.

Further to the above, the developers are targeting an EnviroDevelopment rating.

Drivers:

The parents of the developers of the estate bought and moved to the property in 1958, where they raised their children, which is where the inspiration and development philosophy has grown from. The family have a strong desire to preserve and protect the natural environment of the site which they were able to enjoy as children.

Mullum Creek cherishes the landscape on which it is located and wants to foster a sense of connection to nature by creating homes that blend with the natural environment. Mullum Creek promotes resource efficiency and environmental sensitivity and values economy and quality of design over the quantity and size of buildings.

The development aims to respond to Melbourne's changing climate, including higher temperatures and drought stress. With thermal efficiency, good light and flow-through ventilation, these homes will be comfortable and pleasurable to live in, while significant reductions in energy and water consumption means they will be less expensive to operate well into the future.

Implementation

Education: Mullum Creek provides a range of services free of charge to meet the design requirements. These include consultations with experts on a Design Review Committee, documents and guides to assist in the design and construction of homes, and incentives offering consultations with architectural and landscape design specialists.

Incentives for ESD and thermal performance are also used to encourage implementation

Design Guidelines: The objectives and requirements of the Mullum Creek estate are provided in the 'Mullum Creek Design Guidelines' to ensure the vision of Mullum Creek is realised. These guidelines apply to all dwellings on the development, with a high focus on sustainability. Key features in the guidelines pertain to:

- 7.5 star energy efficiency ratings for all homes
- Generation and use of solar power
- Rainwater tanks for domestic and other uses
- Building materials and construction techniques that minimise environmental impact
- Generous building envelopes on each lot to promote the best home location and protect neighbours' access to sunlight and views
- Measures to ensure high-quality aesthetic character and appearance across the estate

Further Guidelines:

- Sourcing of sustainable timber
- Selecting steel, clay and concrete with lower environmental impacts
- Garden and plant selection

Design Review Committee: The Mullum Creek Design Review Committee (DRC) was established to oversee and approve the design of proposed houses and landscapes within the development. The committee consisted of a panel of architectural, landscape and sustainability experts, where designs were assessed based on the core elements of the design guidelines.

Table 5: ESD outcomes for the Mullum Creek development

ESD Category	Outcome	Cost
Energy	7.5 star energy efficiency ratings for all homes Minimum 4kW of rooftop solar on every dwelling	
Water	Minimum 20kL rainwater tanks for toilet reuse, garden and laundry purposes. This not only reduces potable water, but also mitigates peak stormwater discharge events, reducing pressure on local infrastructure and negative flow-on effects to the nearby creek.	
Waste		

Food	
Technology	
Movement	
Education	
Conservation	Half of the land in the development has been donated to the council for use as public reserve, increasing community space and amenity.
Sustainable Enterprise	
Architecture	Sustainable use of building materials including timber, cement and concrete significantly lower life-cycle impacts in the built form.
Planning	Constrained inter-lot fencing protects the amenity and openness of the estate, providing the community with a greater connection to nature Prescribed 3D building envelopes on each lot are used to promote the best home location and protect neighbours' access to sunlight and views, critical for achieving the targeted 7.5 star ratings, and also for solar photovoltaic energy generation. Inter-lot low winter sun access is preserved.
Community	
Ratings / Tools	Development certified by the nationally recognised EnviroDevelopment Certification Programme of the Urban Development Institute of Australia (UDIA).

Relevance to regional Victoria subdivisions:

- Planning of lots, building envelopes and setbacks
- Design guidelines
- EnviroDevelopment certification
- Land conservation

Relevant Resources:

Mullum Creek Design Guidelines

Mullum Creek Masterplan

Witchcliffe Ecovillage, Margaret River, Western Australia

Location:	Witchcliffe, Western Australia
Council:	Shire of Augusta-Margaret River
Contact:	
Project Area:	120ha / 320 lots
Population:	
Developer:	Perron Group
Builder:	Not Appointed
Type:	Residential, various housing types

Context:

Located 10kms south of Margaret River, Witchcliffe is a rural, semi-coastal region of southern Western Australia; historically known for its timber industry. Witchcliffe lies within the NCC Climate Zone 5 and the southern and south-western flatlands climate change projection zone.

ESD Goals:

The Witchcliffe Ecovillage aims to be the world's first fully integrated village to be self-sufficient in renewable energy, water, and fresh food produce. The Witchcliffe Ecovillage vision is to create a model of a highly sustainable, self-reliant community in a regional village setting, incorporating the best of 21st century technology and human settlement design to enable the Ecovillage community to produce as much energy as it consumes; be self-sufficient in water; care for the local environment; generate ongoing economic and social opportunities for the area; be socially diverse; and be self-sufficient in fresh food produce.

Drivers:

The driving force behind the developers is to demonstrate just how sustainable a residential development can be with good planning, strong environmental principles, sensible financial management and technological innovation. The goal is to develop a model that can be replicated throughout Australia easily and affordably.

Implementation

The project developers are implementing the sustainable development largely through careful planning and management of all aspect of the project. The urban master-planning of the site consists of 11 clusters of homes, each surrounding a central open space consisting of community gardens, vegetable and herb garden, cyclist paths and chook pens. All family lots are on an east-west axis to maximise solar access to each home. Each cluster of homes incorporates diversity in dwelling type, occupant age and socio-economic circumstances. Similar to other developments of the same scale, sustainable building design guidelines are to be developed for all dwelling types within the village. Education of residents and business owners will be provided to ensure they get the most out of the energy and water facilities, as well-as the local resources available.

The developers have also considered a number of environmental rating tools for the project, but have instead chosen not to spend the extra money and time earning these credentials but rather let the

development speak for itself with its achievements on display every day. The project is currently undergoing a scheme amendment approval by the minister, prior to the Stage 1 sales set for release in May 2018. The outcomes listed below therefore align with the goals and aspirations of the development.

Table 6: ESD outcomes for the Witchcliffe Eco Village

ESD Category	Outcome	Cost
Energy	100% renewable power generation on site including a local micro energy grid that utilises smart grid technology. The renewable energy goals have been assessed by an energy specialist, which outlines 3 pathways to achieving the goals.	$$$
Water	100% self -sufficiency in water through onsite rainwater harvesting (rainwater tanks and dams) All waste water recycled on site	$$ $$$
Waste		
Food	All infrastructure required to enable self-sufficiency in seasonal fresh foods provided by the developer	$$
Technology	NBN fibre to each home and business provided	$$
Movement	Extensive shared path network to encourage and prioritise pedestrians and bikes	$
Education	Education provided to all residences and businesses on how to get the most out of the local energy, water and food resources	$
Conservation	Revegetation and protection of remnant vegetation and creek lines to create wildlife corridors	$$
Sustainable Enterprise	Sustainable employment, small business and education opportunities within the ecovillage	$
Architecture	Highly efficient solar passive homes that all front public open space and/or community gardens	$
Planning	Carefully urban master=planning for all aspects of the development include site orientation and infrastructure	$$$
Community	All aspects of the development are centred around creating an integrated community	$
Ratings / Tools	Strategic decision not to pursue environmental rating credentials	Cost Positive

Relevance to regional Victoria subdivisions:

- Rural and regional development context ; Urban planning features
- Micro-energy grid aspirations
- Affordable housing strategy

Relevant Resources:

Witchcliffe Development Concept Plan

Energy Infrastructure Report Sustainability Features Report

The Cape, Cape Patterson, Victoria

Location:	Cape Patterson, Victoria
Council:	Bass Coast Shire Council
Contact:	Brenden Condon
Project Area:	40 ha / 220 Lots
Population:	
Developer:	Brendan Condon, Small Giants
Builder:	TS Constructions, Martin Builders
Type:	Typically 2-3 bedroom standalone dwellings

Context:

The Cape Ecovillage is located in Cape Patterson on the Bass Coast in regional south-east Victoria. Cape Patterson lies in the NCC Climate Zone 6, common to about 30% of Victoria. The areas climate projection sub-cluster region is Southern slopes Victoria East. The area is generally known for farming and lies close to the Victorian coal mining and energy generation regions.

ESD Goals:

A benchmark in sustainable living the Cape development aims to bring together local builders and sustainability experts to create a modern community, integrating with the environment. The development has a focus on creating open community space while developing eco-friendly off-the-plan house designs.

Targets for the development include a minimum 7.5-star dwelling energy rating, minimum solar installations on each house of 2.5kW and 10kL rainwater tanks on every property.

Drivers:

The Cape development is located in a pocket of Victoria that has attracted Melbourne residents looking for a more relaxed lifestyle or winding back on full-time working commitments. The local community has seen a number of standard practice residential developments in recent years that haven't contributed anything to the area, leaving residents with distaste for more developments detracting from the local beauty of the surrounding environment.

Brendon Condon and Small Giants saw an opportunity to deliver a residential development of a different kind that would add to the local landscape and contribute to the community rather than continue on the same path as previous developments. Their vision has been welcomed by members of the community and has set a benchmark for future developments in the area.

Implementation

Master-planning, education and flexibility in off-the-plan designs have played a large part in the implementation of the developments sustainability goals.

The Cape developers have implemented project design guidelines for buyers which strictly cover requirements for dwellings including:

- Siting and orientation of buildings for passive solar access and winter sun setback guidance

- Bushfire protection and site maintenance
- Planting to avoid over-shadowing
- Minimum WELS ratings for fixtures and fittings and grey water connection requirements
- Shading, glazing, envelope, natural ventilation, thermal massing requirements
- Embodied energy guidance

All housing designs that are not off-the-plan must be pre-approved by the development team and strictly abide by the design guidelines.

Table 7: ESD outcomes for the Cape development

ESD Category	Outcome	Cost
Energy	House energy ratings from 7.5 to 9.5 correlating to around 85% less costly to run.	$$$
Water	Minimum 10kL tanks at each residential site	$
	230kL rainwater tank for supply to the community garden	$$
Waste		
Food	5000m^2 community garden including raised garden beds, orchards and poultry which lowers food bills	
Technology	All homes connected directly to NBN via optical fibre	
Movement	50% open space, walking trials, parks and wetlands.	
Education		
Conservation	Pet cats banned from the site to protect resident wildlife including wallabies, echidnas and coast bird species	Nil
Architecture	Sustainable building design from off-the plan minimum 7.5 star energy rated designs	
	Maximum building allowance of 200m^2	
Community	Community gardens including compost areas, tool shed, public art and playgrounds which enhance social cohesion and wellbeing	$$
	50% Open space in the development	
Ratings / Tools		

Relevance to regional Victoria subdivisions:

- Design guidelines
- Affordable 7.5 star housing designs
- Conservation

Relevant Resources:

The Cape Masterplan

Lochiel Park, Campbelltown, South Australia

Location:	Campbelltown, South Australia
Council:	Campbelltown City Council
Contact:	
Project Area:	15 ha / 150 lots
Population:	Up to 500
Developer:	Renewal SA
Builder:	Multiple builders
Type:	1-2 storey residential dwellings

Context:

Lochiel Park is located 8 kilometres from the Adelaide CBD, sited alongside the River Torrens in Campbelltown, South Australia. Campbelltown fall in the NCC climate zone 5 and climate projections align with the sub-cluster region southern and south-western flatlands east.

The site is a former TAFE college, originally earmarked for a typical suburban housing development; however an alternate plan was proposed by Renewal SA, resulting in the current medium density development 30% of the original size.

ESD Goals:

The Lochiel Park development has been designed to align with South Australia's greenhouse gas emissions targets, and to prepare the society and economy for climate change and a carbon constrained world. The goal was to create Australia's first green village that could be used as a model for future developments.

Sustainability Strategies and Features:

Drivers:

The main driver behind the Renew SA development is to deliver a sustainable residential development model to align with the states ambitious greenhouse gas emissions targets and can be replicated by similar projects in the state and across the country.

Implementation

Embedded in the development is a large partnership with the University of South Australia. The partnership has seen hundreds of individual research projects focus on the development which has allowed a level of monitoring and data collection on such a development that hasn't been possible before. The volume of information has created a feedback loop to Renew SA and residents whereby initial goals and targets can be measured against and strategies developed if performance is lacking.

In the early stages of building design and residential sales, design guidelines were produced to which all buildings had to comply with. This included minimum energy, water and waste requirements.

Table 8: ESD outcomes for the Lochiel Park development

ESD Category	Outcome	Cost
Energy	Minimum 7.5 Star energy ratings Minimum solar photovoltaic requirements for every dwelling of 1kW coupled with energy demand management software to reduce peak electricity loads. Solar hot water requirements for each dwelling Homes achieve a target of 74% reduction in greenhouse gas emissions when compared to an average 2004 Adelaide home	
Water	Water strategies including stormwater recycling for flushing, washing and irrigation Stormwater wetlands	
Waste		
Food	Community food-gardens provide a local food-bowl, reducing household food costs	
Technology		
Movement		
Education	Large involvement from the University of South Australia, developing environmental targets, monitoring performance and undertaking extensive research programs An onsite Sustainability Centre was established for 3 years to educate the community on the benefits of environmentally sustainable design.	Nil $$$
Conservation	Two-thirds of the site (10ha) has been established as an urban-forest comprising tens of thousands of trees, creating a biodiversity corridor, which also assists in offsetting greenhouse gas emissions	$$$
Sustainable Enterprise		
Architecture	Australia's first Zero-carbon home	
Community	Community food-gardens provide a local food-bowl, reducing household food costs	
Ratings	UDIA EnviroDevelopment – 6 leaves	

Relevance to regional Victoria subdivisions:

- Association/close relationship with a university or research partner
- Intensive urban design guidelines

Relevant Resources:

Lochiel Park Urban Design Guidelines 2009

Lochiel Park Achievements Brochure

New City of Zenata, Greater Casablanca, Morocco

Location:	Northern Greater Casablanca, Morocco
Council:	Unknown
Contact:	Limited
Project Area:	1,660 ha
Population:	300,000+
Developer:	Zenata Development Company
Builder:	Unknown
Type:	Residential houses and apartments, Commercial

Context:

Zenata is located in a strategic geographical position on the crossroad of Morocco's two largest cities: Rabat, the administrative and Casablanca, the economic capital. It is also located in the centre of the country's main infrastructural networks, which includes road, rail, air and logistical hubs.

Local climate can fluctuate between floods and drought in small time periods.

ESD Goals:

The aim of the large-scale project is to create an innovative and sustainable city model in line with national development goals as well as the National Charter for Environment and Sustainable Development and to present a possible solution to North African urbanisation.

The city aims to align with the International Sustainable Development goal to achieve a job-to-inhabitant ratio of 1:3. The core project goals are centred on maximising air-quality, treatment and management of sewerage, accessible and affordable transport and job creation.

Drivers:

Morocco has seen a population increase from 15 Million in 1971 to 32 Million in 2012, significant in such a period of time. Most of this growth has centred around urbanization and the major cities, and placed huge pressure on the environment and the country's ability to react.

The region suffers from spatial and socio-economic issues which include increased housing pressures and affordability as a lack of essential services in businesses, leisure, education and health sectors.

Morocco is tackling those issues by pursuing a thorough economic, social and environmental policy characterised by various urban planning programs and strategic plans in order to boost its economy and improve living conditions for its citizens. Among such plans, a dozen new cities are planned, including the New City of Zenata in the Greater Casablanca region.

Implementation

Zenata is a citizen project, created to develop an entire new city, beneficial for current and future generations in Morocco. As such, the city planning and implementation is driven by the people who live there. A local development group has been established, Zenata Development Company, which wholly consists of local citizens with appropriate backgrounds and skills.

A large contribution from the European Union includes the provision of expertise and technically qualified people to assist with the implementation and development of the sustainability goals.

Table 9: ESD outcomes for the New City of Zenata development

ESD Category	Outcome	Cost
Energy	Atlantic Ocean wind modelling to inform natural cooling	
Water	Canals to transport water from flood prone areas to drought affected areas and replenish groundwater stocks	
Waste		
Food	Central markets in each neighbourhood community replicating the traditional way of living in Morocco	
Technology	Exhibition centre	
Movement	High performance network of public transport with buses, trams and trains. The city's aim is that only 20% of journeys within the city will be by car in the future.	
Education	World-class university	
Conservation	30% of land set aside for green space, including a large coastal park and internal central city garden	
Sustainable Enterprise	International sustainable development goal to achieve a job-to-inhabitant ratio of 1:3 130,000 jobs to be created	
Planning	Aligning city streets and building corridors to enable capture of cool ocean breezes to lower heat island effects during summer periods	
Architecture		
Community	Social rehousing programs for 7000 households	
Ratings		

Relevance to regional Victoria subdivisions:

- Social rehousing programs
- City planning to capture natural cooling winds
- Water storage in underground natural reservoirs during high rainfall periods

Relevant Resources:

The New City of Zenata Masterplan

The New City of Zenata Urban Concept

YarraBend, Alphington, Victoria

Location	Alphington, Victoria
Council:	City of Yarra
Contact:	
Project Area:	16.5ha / 2500 dwellings
Population:	4,800
Developer:	Glenvill Development
Builder:	Glenvill Development
Type:	Residential apartments, townhouses and houses

Context:

The YarraBend site is located 6.5km north-east of Melbourne CBD, on the banks of the Yarra River. Located in Climate Zone 6 of the NCC and also in the Southern Slopes climate change projections region, the climate is typical of the greater Melbourne area.

ESD Goals:

This 16.5 hectare site is aiming to integrate commercial, community, hospitality and retail areas into a primarily residential development. The developer is targeting all six elements of the Urban Development Institute of Australia's EnviroDevelopment rating system. Located along the Yarra River it is to be integrated with the environmental heritage surrounding the site.

There is a strong focus on future-proofing the development with aims to deliver a high level of sustainability and efficiency whilst promoting technology to increase liveability, easy control of energy systems and improve access to community and transport options.

Drivers:

The YarraBend development is located in a unique area of Melbourne; close to the CBD, on the bank of the Yarra River and furthermore, bordering some exclusive suburbs such as Kew and Studley Park. The demand for new land and dwellings in the area is very high, with young professional residents demanding more from their building stock, community and associated technologies.

By assessing the demands of the area and refining the target market, Glenvill have developed the project to achieve high sustainability outcomes and deliver leading technology throughout the precinct. An initial indicator of the internet and demand for such a development came from the first release of dwellings, where 55 of 60 houses sold within the first hour.

Implementation

Off the plan houses, designed by leading boutique architects, are included in the development, which embed the sustainability principles of the project within their design. Master-planning is also integral to the large precinct, where careful consideration has been given to residential and commercial layouts.

How the public infrastructure integrates with natural environment and greater surrounding area will also assist in the implementation of strategies.

An innovative approach to the technology aspects of the design includes an onsite technology concierge, who will be available 24 hours a day to assist residents with anything tech related including the photovoltaic and storage facilities, electric car charging, the YarraBend app and public Wi-Fi access.

Table 10: ESD outcomes for the YarraBend development

ESD Category	Outcome	Cost
Energy	Targeting a 34% reduction of energy use and Inclusion of battery storage (Tesla Powerwall) and solar photovoltaic as standard on the current release.	
Water	Targeting a 43% reduction in potable water use	
Waste	Targeting an 80% reduction of waste to landfill	
Technology	Tesla power-walls in every dwelling Electric car charging points strategically placed through the development YarraBend app, connecting residents to community features such as public transport, car-pooling and social events	
Movement	Greater permeability at the precinct border and increased provision for cycling and walking through broader roads/footpaths will encourage sustainable transport options.	
Conservation	The site will integrate with the Yarra river green corridor to provide high quality green spaces	
Community	A diverse range of housing is to be provided, with 50% of the site to be dedicated to conventional townhouses and homes and the rest to apartment living, encouraging a diverse range of residents. A 1,500m^2 centrally located building is to be vested to Council for a mixed use community centre, improving community wellbeing. Incorporation of cycling trials, running tracks and a wellness centre	
Ratings / Tools	If it the precinct, which is still in planning, achieves the targeted 6-star rating it will be the first inner city Melbourne development to be certified under EnviroDevelopment.	

Relevance to regional Victoria subdivisions:

- Mixed residential and commercial development
- Inclusion of innovative battery storage and energy initiatives
- Permeability of precinct borders allows greater integration with active transport networks

Relevant Resources:

YarraBend Masterplan

Appendix E

ESD Assessment Tools

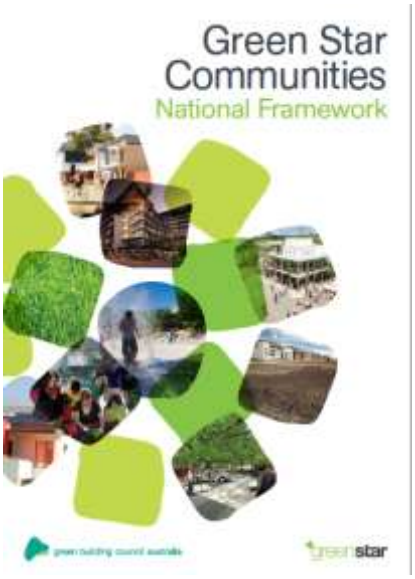
Appendix E ESD Assessment Tools

The scope and application of both precinct and building level tools most relevant to the Regional Victorian councils are described in more detail below. The tools explained include:

- Green Star Communities
- UDIA EnviroDevelopment – Master-planned Communities
- Green Star Design and As-Built
- Built Environment Sustainability Scorecard (BESS)

Green Star Communities

Green Star – Communities assesses the planning, design and construction of large scale development projects at a precinct, neighbourhood and/or community scale. Compliance at the strategic planning stage can include a requirement / commitment to include sustainability initiatives at all future stages (rather than bringing forward investment in design documentation too early in the process). Later on in the permitting / building approval stage, compliance may be through as-built documentation.



The Green Star – Communities tool provides a rigorous and holistic rating across five impact categories; governance, liveability, economic prosperity, environment and innovation. It represents a conscious move from the Green Building Council of Australia to expand its verification tools outside the building space and to emulate other leading sustainable assessment tool providers such as BREEAM and LEED.

There are 3 rating classes under all Green Star tools; 4 Star (Best Practice), 5 Star (Australian Excellence) and 6 Star (World Leadership), dependent on the number of points achieved through the certification process.

Figure 3 Green Star Communities Assessment Categories

As precincts and subdivisions can take years to build, the communities tool is a continuous cycle of ratings. Recertification is required every 5 years; assessing design changes and implementation. Recertification is not required to be under the most recent tool; however, it is expected that communities will continue to achieve best practice, Australian excellence or world leadership standing by referencing the most current tool available.

The assessment tool provides a project inception checklist which is a useful framework for the consideration of early requirements. The checklist prompts the project team and key stakeholders to consider critical issues, opportunities and the potential required responses. The checklist also provides a framework for the applicant to consider the key disciplines and, therefore practitioners that should be involved in the early planning of the project in order to influence the outcomes of future decisions.

UDIA EnviroDevelopment – Master-planned Communities

UDIA Enviro Developer tool – Master-planned tool is geared towards projects that are primarily used for residential purposes and contain more than 1,500 dwellings, while subdivision projects typically would have less than or equal to 1,500 dwellings.

The UDIA prepared and launched the EnviroDevelopment Standards and rating tool in in Queensland in early 2007. This tool was set up due to a lack of environmental planning or reporting tools within the Queensland planning system or in the development industry.

EnviroDevelopment is a voluntary sustainability certification tool for developers to self-assess and operates predominantly at a residential subdivision level and at a dwelling level, focussing heavily on residential, master-planned, greenfield communities.

Figure 4: EnviroDevelopment logo, representing the 6 key elements addressed by the tool

The tool includes a choice of rating on 6 key elements; ecosystems, waste, energy, materials, water and community; however, it is heavily weighted toward environmental aspects of sustainability. The tool is fixed on current sustainable design concepts which can generally be classed as 'business as usual' and 'best practice' and does not appear to encourage innovation.

Application for a rating under this scheme is made post development completion and annual recertification is required by the developer who submits a completed renewal form, a signed statement, documentation of any changes in the project that may affect the basis upon which the EnviroDevelopment license was granted from the time of the initial certification to the end of the period of renewal and payment of the annual renewal fee.

Green Star Design and As-Built

Having provided independent sustainability verification for Australian buildings for over ten years, the Green Building Council of Australia's (GBCA) latest tool assesses and certifies completed buildings, with options for project review at the design stage. This ensures that good intentions at the planning and design stage are followed through with and verified. The new assessment tool addresses all building types and is less document and process driven than its predecessors, with many options to demonstrate sustainability using performance pathways. The benchmarks have been increased, with the aim of fostering innovation in the industry.

Overall, the assessment tool addresses the sustainability considerations of a building in nine different categories; Management, Indoor Environment Quality, Energy, Transport, Water, Materials, Land Use and Ecology, Emissions and Innovation under which points are awarded. The same three levels of certification can be achieved as per the Green Star - Communities tool ; however, no recertification is required.

Figure 5 Green Star Design and As-Built Assessment Categories

Source: Green Building Council of Australia

The Green Building Council of Australia have provided significant documentation to demonstrate the business case for Green Star Design & As-Built; including higher returns on investment, lower operating costs and tenant attraction.

BESS

The Built Environment Sustainability Scorecard (BESS) assesses nine elements relating to energy and water efficiency, thermal comfort, and overall environmental sustainability performance of new buildings and alterations at the planning stage. It is governed by the Council Alliance for a Sustainable Built Environment (CASBE), an association of 26 urban, regional and rural councils.

BESS replaces Sustainable Design Assessment in the Planning Process (SDAPP) tools STEPS (developed by Moreland City Council to assess residential buildings) and Sustainable Design Scorecard (SDS) which was developed by the City of Port Phillip to assess non-residential buildings. These tools have been used by various councils over the past decade to assess planning applications for developments and have required evaluations using NatHERS (for residential energy) and STORM (for residential and commercial WSUD).

The BESS tool assesses single dwellings, single dwelling extensions, multi dwellings (townhouses etc.), multi-unit developments, mixed use development and non-residential developments. It is unsuitable in assessing subdivisions and does not address future adaptation and resilience. The assessment tool can require a significant amount of information at the planning stage including for heating and cooling performance, façade performance, renewable energy contributions, daylight modelling, selection of fixtures and fittings, vegetation etc. This can be problematic given the number of changes a development might go through. Not governed post planning stage, the BESS tool risks developments committing or aspiring to sustainability initiatives without following through. This is natural given the number of design iterations, value management and buildability assessments that typically occur for development.

Figure 6 BESS categories

Source: CASBE

Appendix F

Planning reviews

Appendix F Planning reviews

Review of SPPF and LPPF

Note: This information has been obtained from the relevant planning schemes and is correct as of December 2017.

Clause	Section/heading	Objectives	Relevant strategies/ policies
Clause 11.07 Regional Victoria	Clause 11.07-1 Regional planning	*'To develop regions and settlements which have a strong identity, are prosperous and are environmentally sustainable.'* (Loddon Mallee South (Greater Bendigo) -G21 – Geelong Region Alliance Regional Growth Plan	***Strategies*** • *'Identify and assess the spatial and land use planning implications of a region's strategic directions in Regional Strategic Plans.'* • *'Ensure regions and their settlements are planned in accordance with any relevant regional growth plan.'* ***Environmental health and productivity*** *'Maintain and provide for the enhancement of environmental health and productivity of rural and peri-urban landscapes by:* • *Managing the impacts of settlement growth and development to deliver positive land use and natural resource management outcomes'* ***Regional Victoria's competitive advantages*** • *'Providing adequate and competitive land supply, including urban regeneration, redevelopment and greenfield sites, to meet future housing and urban needs and to ensure effective utilisation of land.'* ***Climate change, natural hazards and community safety*** *'Respond to the impacts of climate change and natural hazards and promote community safety by:* • *'Siting and designing new dwellings, subdivisions and other development to minimise risk to life, property, the natural environment and community infrastructure from natural hazards, such as bushfire and flood.* • *Developing adaptation response strategies for existing settlements in hazardous and high risk areas to accommodate change over time.* • *Encouraging reduced energy and water consumption through environmentally sustainable subdivision and building design.*

Clause	Section/heading	Objectives	Relevant strategies/ policies
			• *Encouraging a form and density of settlements that support sustainable transport to reduce greenhouse gas emissions.'*
	Clause 11.07-2 Peri-urban areas	*'To manage growth in peri-urban areas to protect and enhance their identified valued attributes.'*	• *'Site and design new development to minimise risk to life, property, the natural environment and community infrastructure from natural hazards such as bushfire and flooding.'*
Clause 11.08	Central Highlands	*'To plan for population growth in sustainable locations throughout the region.'*	
Clause 11.09	Geelong	*'To build and support diversity, knowledge and innovation.'*	
Clause 11.10	Gippsland	*To promote a healthy environment by valuing Gippsland's environmental and heritage assets, and by minimising the region's exposure to natural hazards and risks.*	*'To promote a healthy environment by valuing Gippsland's environmental and heritage assets, and by minimising the region's exposure to natural hazards and risks.'* *'Plan for settlement growth to limit impact on agricultural productivity, natural and earth resources and ecological values.'*
Clause 11.12 Hume	11.12-3 Planning for growth	'*To focus growth and development to maximise the strengths of existing settlements.'*	*'Facilitate growth and development specifically in the regional cities of Shepparton, Wangaratta and Wodonga, and in Benalla.'*
Clause 11.14 Loddon Mallee South	Clause 11.14-1 (Planning for growth)	*'To manage population growth and settlements.'*	
Clause 13		*'Planning should adopt a best practice environmental management and risk management approach which aims to avoid or minimise environmental degradation and hazards.'* *'Planning should identify and manage the potential for the environment, and environmental changes, to impact upon the economic, environmental or social well-being of society.'*	
Clause			*'the development of new urban areas and green spaces takes advantage of any*

Clause	Section/heading	Objectives	Relevant strategies/ policies
14.02-3 (Water conservation)			*opportunities for effluent recycling. '*
Clause 15	Built Environment and Heritage	*'Planning should ensure all new land use and development appropriately responds to its landscape, valued built form and cultural context, and protect places and sites with significant heritage, architectural, aesthetic, scientific and cultural value.'* *'Creating quality built environments supports the social, cultural, economic and environmental wellbeing of our communities, cities and towns.'* *'Land use and development planning must support the development and maintenance of communities with adequate and safe physical and social environments for their residents, through the appropriate location of uses and development and quality of urban design.'*	
	Clause 15.01-1 Urban Design	'*To create urban environments that are safe, functional and provide good quality environments with a sense of place and cultural identity.'*	• *'Ensure new development or redevelopment contributes to community and cultural life by improving safety, diversity and choice, the quality of living and working environments, accessibility and inclusiveness and environmental sustainability.'* • *'Require development to respond to its context in terms of urban character, cultural heritage, natural features, surrounding landscape and climate.'* • *'Encourage retention of existing vegetation or revegetation as part of subdivision and development proposals.'*
	15.01-3 Neighbourhood and subdivision design	*'To ensure the design of subdivisions achieves attractive, liveable, walkable, cyclable, diverse and sustainable neighbourhoods.'*	*'In the development of new residential areas and in the redevelopment of existing areas, subdivision should be designed to create liveable and sustainable communities by:* • *Contributing to an urban structure where networks of neighbourhoods are clustered to support larger activity centres on the regional public transport network.*

Clause	Section/heading	Objectives	Relevant strategies/ policies
			• *Creating compact neighbourhoods that have walkable distances between activities and where neighbourhood centres provide access to services and facilities to meet day to day needs.* • *Creating a range of open spaces to meet a variety of needs with links to open space networks and regional parks where possible.* • *Providing a range of lot sizes to suit a variety of dwelling and household types to meet the needs and aspirations of different groups of people.* • *Contributing to reducing car dependence by allowing for:* • *Convenient and safe public transport.* • *Safe and attractive spaces and networks for walking and cycling.* • *Subdivision layouts that allow easy movement within and between neighbourhoods.* • *A convenient and safe road network.* • *Creating a strong sense of place because neighbourhood development emphasises existing cultural heritage values, well designed and attractive built form, and landscape character.* • *Protecting and enhancing native habitat.* • *Environmentally friendly development that includes improved energy efficiency, water conservation, local management of stormwater and waste water treatment, less waste and reduced air pollution.* • *Being accessible to people with disabilities.* • *Developing activity centres that integrate housing, employment, shopping, recreation and community services, to provide a mix and level of activity that attracts people, creates a safe environment, stimulates interaction and provides a lively community focus.'*
	Clause 15.01-6 Healthy neighbourhoods	*'To achieve neighbourhoods that foster healthy and active living and community wellbeing.'*	'*Design neighbourhoods that foster community interaction and make it easy for people of all ages and abilities to live healthy lifestyles and engage in regular physical activity by providing:* • *Connected walking networks and cycling networks.* • *Streets with direct, safe and convenient access to destinations.* • *Conveniently located public spaces for active recreation and leisure.* • *Accessibly located public transport stops.* • *Amenities and protection to support physical activity in all weathers.'*
	15.02-1	'*To encourage land use and development that is*	• '*Ensure that buildings and subdivision design improves efficiency in energy use.*

Clause	Section/heading	Objectives	Relevant strategies/ policies
	Energy and resource efficiency	*consistent with the efficient use of energy and the minimisation of greenhouse gas emissions.'*	• *Promote consolidation of urban development and integration of land use and transport.* • *Improve efficiency in energy use through greater use of renewable energy.* • *Support low energy forms of transport such as walking and cycling.'*
16.01	16.01-1 Integrated Housing	'*To promote a housing market that meets community needs.'*	• *'Ensure that the planning system supports the appropriate quantity, quality and type of housing, including the provision of aged care facilities, supported accommodation for people with disability, rooming houses, student accommodation and social housing.'* • *'Encourage housing that is both water efficient and energy efficient.'*
	16.01-5 Housing affordability	'*To deliver more affordable housing closer to jobs, transport and services.'*	*'Improve housing affordability by….* • *Promoting good housing and urban design to minimise negative environmental impacts and keep down costs for residents and the wider community.'*
	16.02-1 Rural residential	'*To identify land suitable for rural living and rural residential development.'*	'*Ensure planning for rural living avoids or significantly reduces adverse economic, social and environmental impacts by:* • *Maintaining the long-term sustainable use and management of existing natural resource attributes in activities including agricultural production, water, mineral and energy resources.* • *Protecting existing landscape values and environmental qualities such as water quality, native vegetation, biodiversity and habitat.* • *Minimising or avoiding property servicing costs carried by local and State governments…'*
Clause 19	Clause 19.03-3		*'incorporate water-sensitive urban design techniques into developments to:* • *Protect and enhance natural water systems.* • *Integrate stormwater treatment into the landscape.* • *Protect quality of water.* • *Reduce run-off and peak flows.* • *Minimise drainage and infrastructure costs.'*

Summary of Planning Permit Triggers

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
ZONES					
Low Density Residential Zone (LDRZ) ***Clause 32.03***	Clause 32.03-1 (Table of Uses) Dwelling (other than Bed and breakfast): A permit is not required (Section 1) if the following conditions are met. • Must be the only dwelling on the lot. • Must meet the requirements of Clause 32.03-2. Dwelling (other than Bed and breakfast) if the Section 1 conditions are not met: A permit is required (Section 2) given the following conditions are met. • Must result in no more than two dwellings on the lot. • Must meet the requirements of Clause 32.03-2.	Clause 32.03-3 (Subdivision) A permit is required to subdivide land. Each lot must be at least the area specified for the land in a schedule to this zone. Any area specified must be at least: • 0.4 hectare for each lot where reticulated sewerage is not connected. • 0.2 hectare for each lot with connected reticulated sewerage. A permit may be granted to create lots smaller than 0.4 hectares if the subdivision: • Excises land which is required for a road or a utility installation. • Provides for the re-subdivision of existing lots and the number of lots is not increased.	Clause 32.03-4 (Buildings and Works) A permit is required to construct or carry out buildings and works associated with a use in Section 2 of Clause 32.03-1.		Minimum Subdivision Area • **Wodonga** • **Ballarat** • **Greater Shepparton** • **Baw Baw** • **Moorabool** LDRZ Schedule: None Specified. • **Greater Geelong** LDRZ1: 0.4 hectares LDRZ2: 0.2 hectares • **Greater Bendigo** Huntly: 5 hectares Township of Axedale / 212 Guys Hill Road, 184 and 277 Ryalls Lane, 359, 361, 385 and 409 Tannery Lane and 29 Emu Creek Road, Strathfieldsaye: 2 hectares Eaglehawk/Myers Flat Area: 1.5 to 2.0 hectares Maiden Gully: 1 hectare • **Wangaratta** LDRZ Schedule 1: 1 hectare where reticulated sewerage is not connected to lots (Waldara

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
					LDR Precinct land fronting Reith Road and Roanoke Drive, Wangaratta / Oxley Township / All other land). LDRZ Schedule 2: 1 hectare where reticulated sewerage is not connected to lots (Waldara LDR Precinct) 0.4 hectares where reticulated sewerage is connected to lots (Waldara LDR Precinct / Oxley Township). LDRZ Schedule 3: 0.6 hectares where reticulated sewerage is connected to lots.
Residential Growth Zone (RGZ) ***Clause 32.07***	Clause 32.07-2 (Table of Uses) A permit is not required (Section 1) for a dwelling (other than Bed and breakfast).	Clause 32.07-3 (Subdivision) A permit is required to subdivide land. Refer Note 1.	Clause 32.07-4 (Construction and extension of one dwelling on a lot) A permit is required to construct or extend one dwelling on a lot of less than 300 square metres. A development must meet the requirements of Clause 54.	Clause 32.07-5 (Construction and extension of two or more dwellings on a lot, dwellings on common property and residential buildings) A permit is required to construct two or more dwellings on a lot. A development must meet the requirements of Clause 55. This does not apply to a development of five or more storeys, excluding a basement. An apartment development of	• **Greater Geelong** • **Greater Bendigo** • **Ballarat** • **Greater Shepparton** • **Wangaratta**

Permit Trigger					Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
				five or more storeys, excluding a basement, must meet the requirements of Clause 58.	
General Residential Zone (GRZ) ***Clause 32.08***	Clause 32.08-2 (Table of Uses) A permit is not required (Section 1) for a dwelling (other than Bed and breakfast).	Clause 32.08-3 (Subdivision) A permit is required to subdivide land. An application to subdivide land that creates a vacant lot capable of development for a dwelling or residential building, must ensure that each lot created contains the minimum garden area (Refer Note 2). Where vacant lot less than 400 square metres is created, that lot must contain at least 25 percent of the lot as garden area. This does not apply to land where an approved precinct structure plan or an equivalent strategic plan applies. Refer Note 1.	Clause 32.08-5 (Construction and extension of one dwelling on a lot) A permit is required to construct or extend one dwelling: • A lot of less than 300 square metres. • A lot of between 300 square metres and 500 square metres if specified in a schedule to this zone. A development must meet the requirements of Clause 54.	Clause 32.08-6 (Construction and extension of two or more dwellings on a lot, dwellings on common property and residential buildings) A permit is required to construct two or more dwellings on a lot. A development must meet the requirements of Clause 55. This does not apply to a development of five or more storeys, excluding a basement. An apartment development of five or more storeys, excluding a basement, must meet the requirements of Clause 58.	Under the GRZ, a permit is required to construct or extend one dwelling on a lot of between 300 & 500 sqm: No • **Ballarat - GRZ1** • **Greater Geelong - GRZ1** • **Moorabool - GRZ1** None Specified • **Greater Shepparton - GRZ1** • **Baw Baw - GRZ1** • **Greater Bendigo - GRZ1** • **Wodonga - GRZ1** • **Greater Geelong - GRZ2** • **Moorabool - GRZ2 and GRZ3** Yes - **Wangaratta - GRZ1**
Neighbourhood Residential Zone (NRZ) ***Clause 32.09***	Clause 32.09-2 (Table of Uses) A permit is not required (Section 1) for a dwelling (other than Bed and breakfast).	Clause 32.09-3 (Subdivision) A permit is required to subdivide land. An application to subdivide land that creates a vacant lot capable of development for a dwelling or residential building, must ensure	Clause 32.09-5 (Construction and extension of one dwelling on a lot) A permit is required to construct or extend one dwelling:	Clause 32.09-6 (Construction and extension of two or more dwellings on a lot, dwellings on common property and residential buildings) A permit is required to construct two or more	• **Greater Geelong** Minimum Subdivision Area: NRZ1: None Specified. NRZ2: 300 square metres NRZ3: None Specified. Construct or extend one dwelling on a lot:

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
		that each lot created contains the minimum garden area set (Refer Note 2). Where vacant lot less than 400 square metres is created, that lot must contain at least 25 percent of the lot as garden area. This does not apply to land where an approved precinct structure plan or an equivalent strategic plan applies. A schedule to this zone may specify a minimum lot size to subdivide land. Each lot must be at least the area specified for the land, except where an application to subdivide land is made to create lots each contain an existing dwelling or car parking space, where an application for the existing dwelling or car parking space was made or approved before the approval date of the planning scheme amendment that introduced this clause 32.09 into the planning scheme. Refer Note 1.	• A lot of less than 300 square metres. • A lot of less than the lot size specified in a schedule to this zone. A development must meet the requirements of Clause 54.	dwellings on a lot. A development must meet the requirements of Clause 55.	NRZ1: NRZ2: NRZ3: None Specified. • **Ballarat** <u>Minimum Subdivision Area:</u> NRZ1: 800 square metres NRZ2: 800 square metres <u>Construct or extend one dwelling on a lot:</u> NRZ1: None specified. NRZ2: 800 square metres • **Greater Shepparton** <u>Minimum Subdivision Area:</u> NRZ1: None Specified. <u>Construct or extend one dwelling on a lot:</u> NRZ1: None Specified. • **Wangaratta** <u>Minimum Subdivision Area:</u> NRZ1: None Specified. <u>Construct or extend one dwelling on a lot:</u> NRZ1: 500 square metres • **Moorabool** <u>Minimum Subdivision Area:</u> NRZ1: 800 square metres <u>Construct or extend one dwelling on a lot:</u> NRZ1: None Specified.
Urban Growth	<u>Clause 37.07-1 (Part A – Provisions for land where no</u>	<u>Clause 37.07-3 (Subdivision)</u>	<u>Clause 37.07-4 (Buildings and works)</u>		• **Wodonga**

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
Zone (UGZ) ***Clause 37.07***	Precinct Structure Plan applies)(Table of Uses) A permit is not required for a dwelling (other than B&B) if the following conditions are met. • Must be the only dwelling on the lot. • The lot must be at least 40 hectares. • Must meet the requirements of Clause 37.07-2. A permit is required if the Section 1 conditions are not met for a dwelling (other than B&B) if the following conditions are met. • Must be no more than 2 dwellings on the lot. • Must meet the requirements of Clause 37.07-2.	A permit is required to subdivide land. Each lot must be at least 40 hectares. A permit may be granted to create smaller lots if any of the following apply: • The subdivision is to create a lot for an existing dwelling. The subdivision must be a two lot subdivision. • The subdivision is the re-subdivision of existing lots and the number of lots is not increased. • The subdivision is by a public authority or utility service provider to create a lot for a utility installation.	A permit is required to construct or carry out building and works associated with a use in Section 2 of Clause 37.07-1.		• **Greater Bendigo** • **Greater Shepparton**
	Clause 37.07-9 (Part B – Provisions for Land where a Precinct Structure Plan applies) (Table of Uses) Any requirement in the Table of uses and any	Clause 37.07-10 (Subdivision) A permit is required to subdivide land. Any requirement in the schedule to this zone or the precinct structure plan must be	Clause 37.07-11 (Buildings and Works) If the schedule to this zone specifies: • That the provisions of a zone apply to the development of land, the provisions of the zone apply to land in the circumstances specified in the schedule.		• **Greater Geelong** • **Ballarat** • **Baw Baw**

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
	requirement specified in the schedule to this zone must be met. A permit granted must be generally in accordance with the precinct structure plan applying to the land.	met. A permit granted must: • Be generally in accordance with the precinct structure plan applying to the land. • Include any conditions or requirements specified in the schedule to this zone or the precinct structure plan.	• Provisions relating to the development of land, those provisions apply to land in the circumstances specified in the schedule. If the schedule to this zone specifies that a permit is required to construct a building or construct or carry out works, a permit granted must: • Be generally in accordance with the precinct structure plan applying to the land. • Include any conditions or requirements specified in the schedule to this zone or the precinct structure plan.		
OVERLAYS					
Environmental Significance Overlay (ESO) ***Clause 42.01***	None specified	Clause 42.01-2 (Permit requirement) A permit is required to subdivide land. This does not apply if a schedule to this overlay specifically states that a permit is not required.	Clause 42.01-2 (Permit requirement) A permit is required to construct a building or construct or carry out works.		• **Wodonga** • **Greater Geelong** • **Greater Bendigo** • **Ballarat** • **Greater Shepparton** • **Baw Baw** • **Moorabool**
Heritage Overlay (HO) ***Clause 43.01***	None specified	Clause 43.01-1 (Permit requirement) A permit is required to subdivide land.	Clause 43.01-1 (Permit requirement) A permit is required to construct a building or construct or carry out works.		• **Wodonga** • **Greater Geelong** • **Greater Bendigo** • **Ballarat** • **Greater Shepparton** • **Baw Baw** • **Wangaratta** • **Moorabool**

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
Design and Development Overlay (DDO) ***Clause 43.02***	None specified	Clause 43.02-3 (Subdivision) A permit is required to subdivide land. This does not apply if a schedule to this overlay specifically states that a permit is not required. Subdivision must occur in accordance with any lot size or other requirement specified in a schedule to this overlay.	Clause 43.02-2 (Buildings and Works) A permit is required to construct a building or construct or carry out works. This does not apply if a schedule to this overlay specifically states that permit is not required.		• **Wodonga** • **Greater Geelong** • **Greater Bendigo** • **Ballarat** • **Greater Shepparton** • **Baw Baw** • **Wangaratta** • **Moorabol**
Neighbourhood Character Overlay (NCO) ***Clause 43.05***	None specified	None specified	Clause 43.05-2 (Permit requirement) A permit is required to construct a building or construct or carry out works		• **Greater Bendigo**
Erosion Management Overlay (EMO) ***Clause 44.01***	None specified	Clause 44.01-4 (Subdivision) A permit is required to subdivide land.	Clause 44.01-1 (Buildings and works) A permit is required to construct a building or to construct or carry out works.		• **Greater Bendigo** • **Ballarat** • **Greater Shepparton** • **Baw Baw**
Salinity Management Overlay (SMO) ***Clause 44.02***	None specified	Clause 44.02-2 (Subdivision) A permit is required to subdivide land.	Clause 44.02-1 (Buildings and works) A permit is required to construct a building or to construct or carry out works. This does not apply if a schedule to this overlay specifically states that a permit is not required.		• **Greater Bendigo** Buildings and works: A permit is required for the construction of a single dwelling or two or more dwellings on a lot. • **Ballarat** Buildings and works: None specified • **Greater Shepparton**

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
					Buildings and works: A permit is not required to construct or carry out works in accordance with the *Earthworks Controls in the Shire of Campaspe, City of Greater Shepparton and Moira Shire – August 2010* at Clause 81.
Floodway Overlay (FO) ***Clause 44.03***	None specified	Clause 44.03-2 (Subdivision) A permit is required to subdivide land. A permit may only be granted to subdivide land if the following apply: • The subdivision does not create any new lots, which are entirely within this overlay. This does not apply if the subdivision creates a lot, which by agreement between the owner and the relevant floodplain management authority, is to be transferred to an authority for a public purpose. • The subdivision is the re-subdivision of existing lots and the number of lots is not increased, unless a local floodplain development plan incorporated into this scheme specifically provides otherwise.	Clause 44.03-1 (Buildings and works) A permit is required to construct a building or to construct or carry out works.		• **Wodonga** • **Greater Geelong** • **Ballarat** • **Greater Shepparton** • **Baw Baw** • **Wangaratta**

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
Land Subject to Inundation Overlay (LSIO) ***Clause 44.04***	None specified	Clause 44.04-2 (Subdivision) A permit is required to subdivide land.	Clause 44.04-1 (Buildings and works) A permit is required to construct a building or to construct or carry out works.		• **Wodonga** • **Greater Geelong** • **Greater Bendigo** • **Ballarat** • **Greater Shepparton** • **Baw Baw** • **Wangaratta**
Bushfire Management Overlay (BMO) ***Clause 44.06***	None specified	Clause 44.06-1 (Permit requirement) A permit is required to subdivide land. This does not apply if a schedule to this overlay specifically states that a permit is not required.	Clause 44.06-1 (Permit requirement) A permit is required to construct a building or construct or carry out works associated with accommodation.		• **Wodonga** • **Greater Geelong** • **Greater Bendigo** • **Ballarat** • **Greater Shepparton** • **Baw Baw** • **Wangaratta** • **Moorabol**
Restructure Overlay (RO) ***Clause 45.05***	None specified	Clause 45.05-1 (Subdivision) A permit is required to subdivide land. A subdivision must be in accordance with a restructure plan for the land listed in the schedule to this overlay. This does not apply if the subdivision is for one of the following purposes and no additional lots or subdivision potential is created: • To realign boundaries between lots that have been	Clause 45.05-2 (Dwellings and other buildings) A permit is required to construct or extend a dwelling or other building. A permit must be in accordance with a restructure plan for the land listed in a schedule to this overlay. This does not apply if: • No restructure plan is listed in the schedule and the permit is required to extend an existing dwelling or other building. • The land is a lot for which a permit has been granted under Clause 45.05-1.		• **Baw Baw**

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	**Residential Subdivision**	**Construction of a single dwelling on a lot**	**Construction of two or more dwellings**	
		consolidated in accordance with the restructure plan. • To consolidate a restructure lot with a section of closed road or other land not included in a proposed restructure lot. Each lot must be provided with reticulated sewerage if available. If reticulated sewerage is not available, the application must be accompanied by: • A land assessment report which demonstrates that each lot is capable of treating and retaining all waste water in accordance with the State Environment Protection Policy (Waters of Victoria) under the Environment Protection Act 1970. • A plan which indicates the building envelope and effluent disposal area for each lot. Before deciding on an application to subdivide land into residential lots, the responsible authority must consider Clause 56.			
Development Plan Overlays					• **Ballarat has 10 DPOs** • **Baw Baw has 3 DPOs** • **Bendigo has 17 DPOs**

	Permit Trigger				Planning Scheme
	Use of one or two dwellings	Residential Subdivision	Construction of a single dwelling on a lot	Construction of two or more dwellings	
Development Plan Overlays	The DPO does not have a permit trigger and can only apply where a permit is triggered by the zone. Development must be 'generally in accordance with' development plan. Exempts permit applications from notice and review when 'generally in accordance with' the development plan. A development plan that provides for residential subdivision must meet the requirements of Clause 56 as specified in the zone. ***Note: DPOs vary in level of detail and complexity. DPs range from higher order strategic plans establishing design principles, major land uses, transport and open space networks to detailed plans specifying individual lot level (i.e. similar to subdivision plan).***				• **Ballarat has 10 DPOs** • **Baw Baw has 3 DPOs** • **Bendigo has 17 DPOs** • **Geelong has 28 DPOs** • **Moorabool has 6 DPOs** • **Shepparton has 23 DPOs** • **Wangaratta has 7 DPOs** • **Wodonga 20 DPOs**

NOTE 1

An application to subdivide land, other than an application subdivide land into lots each containing an existing dwelling or car parking space, must meet the requirements of Clause 56 and:

- Must meet all of the objectives included in the clauses specified in the following table.
- Should meet all of the standards including in the clauses specified in the following table.

Clause of Subdivision	Objectives and standards to be met
60 or more lots	All except Clause 56.03-5.
16 – 59 lots	All except Clauses 56.03-1 to 56.03-3, 56.03-5, 56.06-1 and 56.06-3.
3 – 15 lots	All except Clauses 56.02-1, 56.03-1 to 56.03-4, 56.05-2, 56.06-1, 56.06-3 and 56.06-6.

NOTE 2

Minimum garden area requirement

Whether or not a planning permit is required for the construction or extension of a dwelling or residential building on a lot, a lot must provide the minimum garden area at ground level as set out in the following table.

Lot size	Minimum percentage of a lot set aside as garden area
400 – 500 square metres	25%
501 – 650 square metres	30%
Above 650 square metres	35%

Review of Panel Reports and VCAT Decisions

Panel Report Title/ Members	Purpose	Panel Members	Important matters
Advisory Committee and Panel Report Environmentally Efficient Design Local Policies Dated 7 April 2014 Panel Members Nick Wimbush (Chair), Ian Coles, Gaye McKenzie, Sue Porter	To provide advice to the Minister for Planning on the applicability and suitability of including environmental sustainability requirements in planning schemes generally as proposed in the following local policies: • Banyule Planning Scheme (Amendment C73); • Moreland Planning Scheme (Amendment C71); • Port Phillip Planning Scheme (Amendment C97); • Stonnington Planning Scheme (Amendment C177); • Whitehorse Planning Scheme (Amendment C130); and • Yarra Planning Scheme (Amendment C133) The basic objective of introducing the proposed local policies is that development should achieve best practice in environmentally sustainable development, including from the design stage through construction and operation. It also aims to encourage innovative technology, design and processes in all development, which positively influence the sustainability of buildings. The proposed policies set out qualitative objectives for each of the following indicators:	**Summary of Issues** Key issues raised in submissions and at the hearing included: • Costs and benefits associated with the proposed policies; • Whether the policies should be implemented state- wide; • The financial burden on applicants, Councils and to the building industry; • The 'triggers' for the policies and if they should apply across all municipalities; • The appropriateness of the assessment tools and SDAPP Fact Sheets; • Whether sustainability is a role of planning or building or both. **Sustainability in Planning Scheme** The Committee concluded that sustainability and sustainable development has a long history in planning; and that consideration of the issue has evolved to the point where many Councils are seeking to advance sustainable outcomes. The Committee considers that in principle, a State-wide approach is the best way to facilitate this increased focus on sustainability. In the interim the Committee is supporting the six Amendments and has recommended accordingly in the report. 'Sustainability' is a very broad and well recognised concept and is frequently used to cover a wide range of environmental, social and economic issues. '*Its modern usage arguably dates to the 1987 Our Common Future report (also known as the 'The Brundtland Report' after the Chair of the Commission) which defined 'sustainable development' as Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'* This broad understanding is picked up in the Victoria Planning Provisions (VPP) at clause 10.04 where integrated decision making is required to consider net community benefit and sustainable development in the interest of current and future generations. **Best Practice** *Rob Milner:* *'is inherently performance based and implies evolving and innovative practices resulting in continually improved outcomes. That said the term and concept is not specifically or clearly defined, or consistently used in the Victorian planning framework. Historically planning provisions and policies have relied on strategies, actions or standards to measure attainment of explicit objectives while retaining latitude to demonstrate that alternative approaches may be capable of*	

Panel Report Title/ Members	Purpose	Panel Members	Important matters
	• Energy efficiency; • Water resources; • Indoor environment quality; • Stormwater management; • Transport; • Waste management; and • Urban ecology For the specified types of development, applications must be accompanied by either a Sustainable Design Assessment (SDA) or Sustainability Management Plan (SMP) which: • Utilises the relevant assessment tools; and • Addresses relevant policy objectives The SDA or SMP is the means by which the applicant is to demonstrate best practice in achieving the policy objectives. *Refer to terms of reference below.		*satisfying an objective. The reliance upon 'best practice' is a similar approach. A range of objectives are set but the demonstration of adequate performance is left open to allow for the application of tools and assessment techniques that may not have yet been established.'* *Mr Healy* • *'Best in class – for example, top 25% of the market (definition of best practice for the Green Star rating scheme)* • *Achieving outcomes to the extent that it is cost effective – for example, EPA Victoria definition* • *Beyond minimum requirements – e.g. Housing Industry Association GreenSmart House Protocol (voluntary guidelines)'* *Ms Forsyth* *'A combination of commercially proven techniques, methodologies and systems, appropriate to the scale of development and site specific opportunities and constraints, which are demonstrated and locally available and have already led to optimum ESD outcomes. Best practice in the built environment encompasses the full life of the build.'* The Committee considers the term 'best practice'; as opposed to 'sustainable development' is one where a consistent definition in the planning context is useful. The Committee has reviewed the version put forward by the Councils and considers it is a reasonable definition for planning. It encompasses: • Commercially proven – so whilst innovative and experimental technologies or processes may be used; they are not required; • Appropriate to the scale of development – so that small scale development should not be forced to adopt possibly expensive solutions suited to larger developments; • Are demonstrated and locally available – so there is a 'track record' locally; and • Have already led to optimum ESD outcomes – that is, they work. The Committee considers the definition should provide for achieving sustainable development outcomes without requiring applicants to be held to unreasonably stringent standards that are not proven in local application. The Committee recommends this definition be adopted in the policies. **Assessment Tools** Different assessment tools are preferred by different Councils, governments and organisations. • STEPS- Moreland Sustainable Tools for Environmental Performance Strategy -residential dwellings & SDS - Sustainable Design Scorecard -Port Phillip and Moreland - Non-Residential

Panel Report Title/ Members	Purpose	Panel Members	Important matters
			• Green Star Green Building Council – Office (pilot for health care and supermarkets) • NatHERS administered by the Federal Government - It is now mandatory to achieve a 6 star NatHERS rating in Victoria for new dwellings; and a combined 6 star rating and 5 star individual rating for apartments and a dwelling that is part of a non-residential building. • Model for Urban Stormwater Improvement Conceptualisation (MUSIC), developed by the Cooperative Research Centre for Catchment Hydrology (CRC) - designed to simulate urban stormwater systems. • STORM tool was developed by Melbourne Water The Committee found that the range of tools available are appropriate to assist in assessing the environmental impact of residential and commercial development. Despite some limitations, like many forms of computer software, the Committee is satisfied these tools are recognised by the sustainable development industry as current 'best practice'. **Sustainability in development** There are many factors that go into designing a development that is considered 'sustainable'. SDAPP outlines ten key and widely used elements or design criteria. It should be recognised that developments do not need to embrace all elements to achieve an acceptable level of sustainability, however the more that are embraced the more sustainable the development will be. All development can be designed to be sustainable, whether it is a single dwelling or a high rise apartment, factory or warehouse, hospital or shopping centre and there is sound justification for this. <u>The real issues is where in the planning and building system context the maximum gain can be achieved for the least cost.</u> **Broader legislative and policy framework** The Councils submitted that sustainability should be incorporated into development, citing reasons such as international agreements and legislative requirements, to deliver tangible environmental, social and economic benefits. There is no specific national legislation which requires development and land use to be undertaken in an environmentally sustainable manner, or be addressed in decision making. The Committee considers this policy and strategic work provides a sound underlying base from which to explore the future continuing implementation of sustainable development. The challenge now is perhaps to go to the next level of detail in implementation. The planning and building legislation clearly identify both systems have a role to play in not only ensuring buildings are built in a sustainable and energy efficient manner, but also include consideration of concepts such as 'safety', 'health', 'amenity' and 'pleasant' environments for living, working and recreation.

Panel Report Title/ Members	Purpose	Panel Members	Important matters
		The Committee notes the Government response to the VCEC Enquiry that the building system will be the primary and most efficient means for addressing the environmental performance of buildings. The Committee considers that there is little disagreement on this point; that is the minimum standards approach in the NCC is the 'bottom line' on this issue. The Committee does not consider this precludes, or should preclude, those Councils wishing to achieve a better outcome, provided it is not done via a mandatory control which imposes standards inconsistent with the NCC. There is a strong legislative and policy framework that supports the need for sustainable development and which recognises that both planning and building have a significant role to play in achieving it. Achieving sustainability in planning and development should be undertaken using the most efficient mechanisms to minimise cost to consumers and industry. **Planning and Sustainability** As specified in section 6(1) of the Planning and Environment Act 1987, all planning schemes must seek to achieve the objectives of planning in Victoria as defined in section 4 of the Act. As one of the objectives of planning is sustainable development, a planning scheme must seek to achieve this, amongst other things. The Committee notes sustainable development operates at two major levels in planning. Strategic planning seeks to ensure settlement patterns and the inter-relationships between land use and infrastructure provision are undertaken in an integrated manner to achieve sustainable outcomes. It is through this 'big picture' strategic approach that significant upfront sustainability gains can be achieved. The role of statutory planning is to ensure development is designed and built in a manner which is sustainable. A number of municipalities have been implementing the SDAPP program on a voluntary basis aimed at improving the environmental efficiency of certain types of development. The SDAPP program refers to the inclusion of key environmental performance considerations into the planning permit approval process in order to achieve more sustainable building outcomes for the long-term benefit of the wider community **General Notes** The Committee notes the term 'sustainable development' and associated terms have not been used consistently by Councils in their Municipal Strategic Statements (MSS) and local planning policies using different terminology for related issues.	

Panel Report Title/ Members	Purpose	Panel Members	Important matters
Panel Report Darebin and Manningham Planning Schemes Amendment GC42 Environmentally Sustainable Development Policy	The Amendment to the Darebin and Manningham Planning Schemes seeks to introduce a new Clause (22.12) to both Planning Schemes. The Amendment builds on the overarching ESD objectives of the SPPF, MSS and local policies within the Darebin and Manningham Planning Schemes. The policy seeks to ensure that all development that requires a planning permit achieves best practice across ESD principles, including energy efficiency, water resources, indoor environment quality, stormwater management, transport, waste and urban ecology. The Amendment seeks to provide statutory weight to the current voluntary approach adopted for applications under SDAPP program and sets out application requirements for residential, mixed us and non-residential development.	**Strategic planning context** Amendment is supported by the following clauses in the SPPF: • Clause 11.04-4 – Settlement – Liveable communities and neighbourhoods • Clause 11.04-5–Settlement –Environment and Water • Clause 12–Environment and Landscape values - Protection of biodiversity • Clause 14.02 and 14.03 – Water – Water quality and Water conservation • Clause 15.02-1 – Built Environment and Heritage – Sustainable development – Energy and Resource Efficiency • Clause 16.01-1 Residential development – Integrated housing • Clause 16.01-4 – Residential development – Housing diversity • Clause 16.01-5 Residential development – Housing affordability. • Clause 17 – Economic development • Clause 18.01-1 – Integrated transport – Land Use and Transport Planning • Clause 18.02-01 Integrated transport – Sustainable personal transport • Clause 18.02-2 Integrated transport – Cycling • Clause 19.01-1 Infrastructure – Provision of renewable energy • Clause 19.01-2 Infrastructure – Water supply, sewerage and drainage • Clause 19.03-3 – Infrastructure – Stormwater Particular provisions were also cited relating to bicycle facilities, Clause 54 and Clause 55. **HIA Concerns** Whether ESD local policies are required.	
Manningham C33 (PSA) [2003] PPV 94 (2 October 2003)		This Amendment sought to put in place a statutory framework to give effect to the strategic intent expressed in the Doncaster Hill Strategy, part of which related to ecologically sustainable development. In considering the issue of sustainability, the Panel commented: *..experience has demonstrated that where developers do not apply ESD principles 'from the ground up', but treat ESD as an add-on and the Council is forced to apply these principles by means of planning permit conditions, a much less happy outcome is the result*. The Panel agrees that the onus should be placed on the developer to design with sustainability in mind from the outset rather than regarding sustainability as an 'add-on' that can be achieve by retrofitting a conventional design or achieved through the imposition of conditions. This concept should be included in the MSS as it is so important to the way in which ESD will be implemented in Doncaster Hill.	

*__Terms of Reference__ Pursuant to paragraph 9 of the Terms of Reference, the Committee must:

- Review and assess all submissions made in regard to the draft policies;
- Review and assess all relevant building and planning issues relating to the draft policies;
- Review and assess the issues relating to EED beyond planning, as appropriate including the respective roles of the building and planning systems in relation to the regulation of EED matters;
- Review and assess the effect of the policies, having regard to:
  - The appropriateness of the recommended assessment tools including their efficacy when compared with nationally recognised rating tools such as FirstRate;
  - The effect on any existing intergovernmental agreements relating to the role and function of planning and building systems;
  - The ambit of the policies and interaction with building system requirements and other relevant legislation;
  - Whether the policies are more appropriately applied through consistent State-wide requirements;
  - Appropriate thresholds for applying the application requirements;
  - Effect of policies when used in conjunction with a range of non-statutory measures aimed at encouraging environmentally efficient development. For example, educating residents and applicants, assisting applicants to use EED tools, leading by example with Council projects, promotion of exemplary private projects, promotion of use materials with favourable life cycle impacts
  - Whether quantitative assessment is more appropriate in a local policy;
  - Whether mandatory or discretionary controls are appropriate and in what form;
  - The ability of Councils to assess applications and support applicants.
- Assess the costs and benefits of the policies with regard to the effect of:
  - Implementing the new provisions on the resource and administrative costs of the Council;
  - Policy requirements on applicants at application stage/building stage;
  - The policy on life cycle of building costs (including operational costs);
  - The policy on removing cost of retrofitting buildings in the future, with regard to future proofing;
    - The additional regulatory cost burden imposed on applicants.
    - Define what ‘Best Practice’ means in relation to the objectives of the policy and whether that term is appropriate.

VCAT Reference	
Taras Nominees v Yarra CC [2003] VCAT 1952 (19 December 2003)	This is the first hearing that considered ESD in detail. This was an appeal against a request for further information, most relevantly an ESD report. In his decision, Justice Morris stated (at paragraph 6): *‘If environmentally sustainable design is to be incorporated into buildings, this should be required by the building regulation system and not be principally required by the town planning system*. *The reason for this is that, if environmentally sustainable design is important, as I believe it is, it ought to be incorporated in all buildings, regardless whether those buildings require a planning permit or not. ‘*
Golden Ridge v Whitehorse City Council (7 September 2004)	This was an appeal against Council’s refusal to grant a permit for two residential towers. Justice Morris, who heard this matter, reiterated his support for a greater focus on ESD for all buildings and that this can only be

VCAT Reference	
	achieved through the building control system. In addition, Justice Morris noted (at paragraph 100): '*..environmentally sustainable design often turns on the matter of detail, such as the thickness of insulation, the use of drapes and the type of glass used in windows*.' This detail is often unavailable when a building is submitted for approval; and it would be unreasonable to require it to be available. Justice Morris directed the permit include a condition which required an ESD Plan which would require the development to achieve an average 5 star rating.
Carlos Constructions Pty Ltd v Moreland CC [2004] VCAT 1752 (9 September 2004)	This was an appeal against Council's refusal to grant a permit for the construction of shops and dwellings in a 10 storey building. In considering proposed conditions, the Tribunal stated it had reservations about specifying the need to achieve a 5 star energy rating given this had recently been introduced into the Building Code of Australia; and not all dwellings are treated equally under the planning scheme. The Tribunal also stated (at paragraph 103): Not all aspects of ESD are dealt with under the current regulatory regime in the BCA, and there may be circumstances in which a higher standard than that set out in the BCA is warranted. However, if a higher energy rating is to be required, then such a requirement will require a higher level of justification.
100 Mason Street Pty Ltd v Hobsons Bay CC [2005] VCAT 1221 (22 June 2005)	This was an appeal against a condition on a permit which required the use of grey water for toilet flushing. Deputy President Gibson, who heard this matter, agreed it is important for new developments to be as environmentally sustainable as possible, however did not support a condition which would require an individual developer to take a risk on specific cutting edge ESD technology which was not properly tested or proven. She stated (at paragraph 8): *'..it is undesirable to impose conditions on individual developers in the name of environmental sustainability unless the techniques are well established and are demonstrably effective in achieving ESD objectives and represent common best practice.'* This was the first decision which recognised the need for ESD to be considered as part of the planning and design stage in order to achieve genuine ESD objectives. In considering this issue, Deputy President Gibson commented (at paragraph 7): '*Effective ESD requires developments to be designed with sustainability in mind from the outset rather than regarding sustainability as an 'add on' that can be achieved by retrofitting a conventional design or through the imposition of conditions.'*
Hasan v Moreland CC [2005] VCAT 1931 (16 September 2005)	This was an appeal against conditions imposed on a permit requiring solar hot water systems, rainwater tanks and a 5 star energy rating. The Tribunal reiterated the building regulations were the appropriate mechanism given they cover all buildings In its decision, the Tribunal raised the question of equity saying (at paragraph 21): We think in applying sustainability conditions it is unfair to discriminate between dwellings that require a planning permit and dwellings that do not .. For the sake of consistency and clarity the planning system should generally not prescribe operational or detailed sustainability requirements that are being, or will be addressed, by other regulatory systems
Jolin Nominees PL v Moreland CC (Red Dot) [2006] VCAT 467 (31 March 2006)	This was an appeal against conditions which required compliance with 5 star energy rating, provision of a gas boosted solar hot water system and the preparation of an Environmental Sustainable Development Management Plan. Deputy President Gibson and Member Kearney stated (at paragraph 54): • *There is justification at all levels of the planning system for the imposition of objectives, strategies and (perhaps) permit*

VCAT Reference	
	conditions which incorporate best practice ESD principles. …. • *There is a need to be more selective in applying such conditions and they should not be applied 'globally'. They should be proportional and relevant to the scale and nature of the development.* • *The requirements imposed by, or as a result of, a condition should not exceed what is reasonable to expect of the developer.* • *There is no need to apply conditions which are comprehensively dealt with by other legislation or regulation.* • *The usual vehicle to deliver planning permit outcomes is a plan and/or report, commonly referred to an ESD management plan.* • *Such a vehicle should be linked to identified targets that are framed in a way to actively encourage developers to design buildings, subdivisions and other developments to achieve targets.* • *Unless a council can show that an ESD type condition has a nexus with a transparent council strategy or guidelines, the Tribunal would be reluctant to allow such a condition just for the sake of it.* The Tribunal emphasised that **sustainability techniques and principles should be embraced from the outset rather than after design** is completed and the development approved. The Tribunal further commented that **Councils should not be applying more sustainability measures than already required by other legislation, unless there is a highly developed statutory and strategic basis for doing so**. The Tribunal commented that for smaller developments, sustainability objectives will sometimes be best achieved by simply complying with the building regulations.
Richmond Icon Pty Ltd v Yarra CC (includes Summary) (Red Dot) [2011] VCAT 2175 (8 November 2011)	This was an appeal against Council's refusal to grant a permit for the redevelopment of the Dimmey's site. In considering ESD features, the Tribunal made the following comment (at paragraph 153): *The goal posts have shifted since Hasan in terms of the potential for the planning system to actively contribute at a broader design level to the aim of greater built form sustainability. I am conscious here that there can be limits to the sustainability gains at the subsequent building permit stage if the planning approval constitutes poor sustainability i.e. the horse may have already half bolted. For example, the sustainability requirements at the building permit stage will always be very compromised if a new dwelling is sited on its lot so as to have very poor solar orientation*.
	This was an appeal against Council's failure to determine an application to construct a 10 storey mixed use building. In considering the issue of ESD, there was **debate about the target to be achieved and what Star rating would constitute 'best practice'**. Tribunal comment that (at paragraph 112): *Now that the **Building Code of Australia requires a 6 star energy rating for apartment buildings and a 5 star rating for individual apartments** the Tribunal has made it clear that there is no benefit in the planning system duplicating and doubling up the requirements of the building approval system. Hence precisely what is to be achieved and how it is to be attained is a matter of detail to be largely resolved at the building approval stage*.

Summary of Precinct Structure Plans

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**
Baw Baw Shire	***Drouin PSP*** ***September 2014***	**Integrated Water Management - Guideline 46 (G46)** Where practical, development should include integrated water management initiatives to reduce reliance on potable water and increase the utilisation of storm and waste water, contributing to a sustainable and green urban environment. **Housing – Requirement 6 (R6)** Residential subdivisions must deliver a broad range of lot sizes capable of accommodation a variety of housing types. **Housing – Requirement 10 (R10)** Residential subdivision applications must demonstrate how the subdivision has been designed to minimise adverse amenity impacts on any existing low-density lots directly abutting the development, as appropriate. **Housing – Guideline 13 (G13)** The design of residential subdivisions abutting existing low-density areas should provide for a sensitive interface to those existing low-density areas by minimising the number of new lots abutting an existing low-density lot and providing sufficient space within new lots to allow screen planting along the interface. **Housing – Condition 1 (C1)** <u>Conditions for subdivision permits that allow for the creation of a lot of less than 300 square metres</u> Any permit for subdivision that allows the creation of a lot less than 300 square metres must contain the following conditions: • Prior to the certification of the plan of subdivision for the relevant stage, a plan must be submitted for approval to the satisfaction of the Responsible Authority. The plan must identify the lots that will include a restriction on title allowing the use of the provisions of the Small Lot Housing Code incorporated pursuant to Clause 81 of the Baw Baw Planning Scheme; and • The plan of subdivision submitted for certification must identify whether type A or type B of the Small Lot Housing Code applies to each lot to the satisfaction of the responsible authority, **Utilities – Requirement 65 (R65)** Residential subdivision proposing any unsewered low-density lots must: • Obtain the consent of both Gippsland Water and Council. • Demonstrate how groundwater and surface water will be protected from contamination. • Demonstrate how the design of the subdivision allows for the efficient future re-subdivision should sewer become available. • Demonstrate how the development complies with the development sequencing requirements in this PSP.

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**
	Warragul PSP ***September 2014***	**Housing – Requirement 6 (R6)** Residential subdivisions must deliver a broad range of lot sizes capable of accommodation a variety of housing types. **Housing – Requirement 10 (R10)** Residential subdivision applications must demonstrate how the subdivision has been designed to minimise adverse amenity impacts on any existing low-density lots directly abutting the development, as appropriate. **Housing – Guideline 13 (G13)** The design of residential subdivisions abutting existing low-density areas should provide for a sensitive interface to those existing low-density areas by minimising the number of new lots abutting an existing low-density lot and providing sufficient space within new lots to allow screen planting along the interface. **Housing – Condition 1 (C1)** Conditions for subdivision permits that allow for the creation of a lot of less than 300 square metres Any permit for subdivision that allows the creation of a lot less than 300 square metres must contain the following conditions: • Prior to the certification of the plan of subdivision for the relevant stage, a plan must be submitted for approval to the satisfaction of the Responsible Authority. The plan must identify the lots that will include a restriction on title allowing the use of the provisions of the Small Lot Housing Code incorporated pursuant to Clause 81 of the Baw Baw Planning Scheme; and • The plan of subdivision submitted for certification must identify whether type A or type B of the Small Lot Housing Code applies to each lot to the satisfaction of the responsible authority, **Utilities – Requirement 60 (R60)** Above-ground utilities (such as electricity substations and sewer pump stations) must be identified at the subdivision design stage to enable their appropriate integration into the subdivision layout and minimise any adverse amenity impacts. **Utilities – Requirement 61 (R61)** Residential subdivision proposing any unsewered low-density lots must: • Obtain the consent of both Gippsland Water and Council. • Demonstrate how groundwater and surface water will be protected from contamination. • Demonstrate how the design of the subdivision allows for the efficient future re-subdivision should sewer become available. Demonstrate how the development complies with the development sequencing requirements in this PSP.

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**
City of Greater Geelong	***Armstrong Creek East PSP*** ***May 2010***	**3.1 Integrated Neighbourhood Design** ***3.1.6 Climate Change and Environmental Sustainability*** The aim for the Armstrong Creek Urban Growth Area (ACUGA) and thus also Armstrong Creek East Precinct (ACEP), is to deliver a sustainable community that is designed to: • Maximise passive solar design through lot orientation and building design. • Reduce car dependence through a convenient network of walking/cycling links to local employment opportunities and community infrastructure. • Retain native vegetation where possible in an urban context. • Provide for the availability of recycled water. **4.2 Subdivision and Housing** ***4.2.3 Planning and Design Guidelines: Subdivision and Housing*** The following planning and design guidelines must be met: • Each dwelling must be connected to a reticulated recycled water supply system (where connected to the lot) for toilet flushing and garden watering. **4.7 Utilities and Energy** ***4.7.1 Objectives: Utilities and Energy*** The objectives for the provision of utilities as an essential part of the development of ACEP are: • To facilities innovative, sustainable and energy efficient approaches to the provision of such servicing. ***4.7.3 Planning and Design Guidelines: Utilities and Energy*** The following planning and design guidelines for utilities and energy must be met. • Permits for the subdivision of land into lots must include a condition requiring the installation of infrastructure to the satisfaction of the Responsible Authority and the relevant water authority for the delivery of recycled water to each lot.
	Armstrong Creek South PSP ***June 2015***	**4.2 Subdivision and Housing** ***4.2.1 Objectives: Subdivision and Housing*** The objectives for housing as an essential part of the development of Armstrong Creek South Precinct (ACSP) are to:

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**
		• Provide lot sizes and housing types which are responsive to the character of the natural and built environment in the area and respond to principles of environmental sustainability. ***4.2.3 Planning and Design Guidelines: Subdivision and Housing*** The following planning and design guidelines must be met. • Each dwelling must be connected to a reticulated recycled water supply system (where connected to the lot) for toilet flushing and garden watering. **4.6 Utilities and Energy** ***4.6.1 Objectives: Utilities and Energy*** The objectives for the provision of utilities as an essential part of the development of ACSP are to: • Facilitate innovative, sustainable and energy efficient approaches to the provision of such servicing. ***4.6.3 Planning and Design Guidelines: Utilities and Energy*** The following planning and design guidelines for utilities and energy must be met. • Permits for the subdivision of land into lots must include a condition requiring the installation of infrastructure to the satisfaction of the Responsible Authority and the relevant water authority for the delivery of recycled water to each lot. • Each dwelling must be connected to a reticulated recycled water supply system (where connected to the lot) for toilet flushing and garden watering.
	Armstrong Creek West PSP ***September 2012***	**3.1 Integrated Neighbourhood Design** ***3.1.6 Climate Change and Environmental Sustainability*** The aim for the ACUGA and thus also Armstrong Creek West Precinct (ACWP), is to deliver a sustainable community that is designed to: • Maximise passive solar design through lot orientation and building design. • Reduce car dependence through a convenient network of walking/cycling links to local employment opportunities and community infrastructure. • Retain native vegetation where possible in an urban context. • Provide for the availability of recycled water.

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**
		The drainage study has south to maximise environmental sustainability through integrated systems analysis techniques to develop a stormwater management strategy tailored specifically to the unique topography and stream corridor within ACWP. **4.2 Subdivision and Housing** ***4.2.1 Objectives: Subdivision and Housing*** The objectives relation to subdivision and housing that are essential parts of the development of ACWP are: • To provide lot sizes and housing types which are responsive to the character of the natural and built environment in the area and respond to principles of environmental sustainability. ***4.2.3 Planning and Design Guidelines: Subdivision and Housing*** The following planning and design guidelines must be met. • Each dwelling must be connected to a reticulated recycled water supply system (where connected to the lot) for toilet flushing and garden watering. • The subdivision of land for housing that creates a lot less than 300 square metres, and where the responsible authority has approved application of the Small Lot Housing Code, must contain a building envelope that is in accordance with the Small Lot Housing Code. **4.7 Utilities and Energy** ***4.7.1 Objectives: Utilities and Energy*** The objectives for the provision of utilities as an essential part of the development ACWP are to: • Facilitate innovative, sustainable and energy efficient approaches to the provision of such servicing. ***4.7.3 Planning and Design Guidelines: Utilities and Energy*** The following planning and design guidelines for utilities and energy must be met. • Permits for the subdivision of land into lots must include a condition requiring the installation of infrastructure to the satisfaction of the Responsible Authority and the relevant water authority for the delivery of recycled water to each lot.
	Armstrong Creek Horseshoe Bend PSP	**3.1 Integrated Neighbourhood Design** ***3.1.6 Climate Change and Environmental Sustainability*** The aim for the ACUGA and thus also Horseshoe Bend Precinct (HBP), is to deliver a sustainable community that is designed to:

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**
	September 2014	• Maximise passive solar design through lot orientation and building design. • Reduce car dependence through a convenient network of walking/cycling links to local employment opportunities and community infrastructure. • Retain native vegetation where possible in an urban context. • Provide for the availability of recycled water. **4.2 Subdivision and Housing** ***4.2.1 Objectives: Subdivision and Housing*** The objectives for housing as an essential part of the development of HBP are to: • Provide lot sizes and housing types which are responsive to the character of the natural and built environment in the area and respond to principles of environmental sustainability. ***4.2.3 Planning and Design Guidelines: Subdivision and Housing*** The following planning and design guidelines must be met. • Residential development must include a range of dwelling densities, including conventional, small lot/medium density. • Each dwelling must be connected to a reticulated recycled water supply system (where connected to the lot) for toilet flushing and garden watering. **4.4 Public Open Space, Natural Systems and Biodiversity** ***4.4.3 Planning and Design Guidelines: Public Open Space and Natural Systems*** The following planning and design guidelines must be met. • A building which is to be connected to a potable water supply must be connected also to a reticulated recycled water supply (where connected to the lot) for toilet flushing and garden watering. **4.7 Utilities and Energy** ***4.7.1 Objectives: Utilities and Energy*** The objectives for the provision of utilities as an essential part of the development HBP are to: • Facilitate innovative, sustainable and energy efficient approaches to the provision of such servicing.

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**
		4.8 Drainage and Floodplain Management ***4.8.3 Planning and Design Guidelines: Drainage and Floodplain Management*** The following planning and design guidelines for drainage and floodplain management should be met. • Rainwater tanks are recommended for each dwelling and other relevant building structures.
	Lara West PSP ***September 2013***	**3.1.6 Climate Change and Environmental Sustainability** The aim of the Lara West Precinct (LWP) is to deliver a sustainable community that is designed to: • Maximise passive solar design through lot orientation and building design. • Manage on site stormwater collection and treatment. **4.2.1 Objectives: Subdivision and Housing** The objectives for subdivision and housing are: • To provide a diversity of lots size that can accommodate different housing types. • To provide lot sizes and housing types which are responsive to the character of the natural and built environment in the area and respond to principles of environmental sustainability. • To ensure subdivision and lot layouts maximise solar efficiency through the orientation of lots. **4.2.3 Planning and Design Guidelines: Subdivision and Housing** The following planning and design guidelines should be met. • Subdivision design is to accord with Sustainable Communities Infrastructure Guidelines, October 2010. **4.7.1 Objectives: Utilities and Energy** The objectives for the provision of utilities as an essential part of the development of LWP are: • To facilitate innovative, sustainable and energy efficient approaches to the provision of such servicing. **4.5.3 Urban Design Framework** An urban design framework should: • Set out guidelines to address positively environmental sustainability including integrated water management and energy conservation. **4.7.3 Planning and Design Guidelines: Utilities and Energy**

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**
		The following planning and design guidelines for utilities and energy must be met. • Permits for the subdivision of land into lots must include a condition requiring the installation of infrastructure to the satisfaction of the responsible authority. **4.8.3 Planning and Design Guidelines: Integrated Water Management** The following planning and design guidelines for Integrated Water Management must be met: • Development must meet stormwater quality best practice guidelines.
City of Ballarat	***Alfredton West PSP*** ***2011***	**4.2 Housing and Subdivision** ***4.2.1 Objectives*** The objectives for housing and subdivision are as follows. • To maximise solar orientation and other energy efficiencies. ***4.2.3 Planning and Design Guidelines*** The following planning and design guidelines should be met. • Connect each dwelling to a rainwater tank for garden watering and toilet flushing. **4.4 Public Open Space and Natural Systems** ***4.4.7 Integrated Water Management Plan Objectives*** The objectives for the integrated water management plan are as follows. • To encourage the use of recycled water and stormwater within the Precinct. • To encourage household initiatives such as the installation of rainwater tanks for toilet flushing and garden irrigation to reduce demand for potable water, particularly if a third pipe system is not implemented. • To implement WSUD treatment measures where appropriate throughout the precinct. ***4.4.9 Integrated Water Management Planning and Design Guidelines*** The following planning and design guidelines should be met. • Develop initiatives such as the installation of rainwater tanks for toilet flushing and garden irrigation to reduce demand for potable water.

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**
		4.7 Utilities and Energy ***4.7.3 Planning and Design Guidelines*** The following planning and design guidelines for utilities and energy must be met. • Provide utility services to each new lot at the time of development. • Design and arrange lots to maximise solar efficiency through orientation.
	Ballarat West PSP ***2012***	**4.2.7 Deliver Environmentally Sustainable Communities** The Ballarat West PSP provides a framework for subdivision design that promotes solar access, to minimise the energy use of dwellings, community infrastructure and buildings in the activity centres. Water Sensitive Urban Design (WSUD) aims to reduce the quantity of stormwater and improve the quality of water that is either discharged or re-used on site. WSUD techniques are to be incorporated through measures such as a network of retarding basins and wetlands that are integrated with the existing drainage lines and creeks. Utilising the existing drainage systems on the site reduces the requirement for piping and channelling of water and maintenance costs. **5.1.3 Planning and Design Guidelines** ***General*** The following planning and design guidelines must be met: • Development must consider the orientation of buildings and maximise opportunities to reduce energy consumption and water use. The following planning and design guidelines should be met. • Design and arrange lots to maximise solar efficiency through orientation. **5.2 Housing** ***5.2.1 Housing Objectives*** The objectives for housing are: • To encourage flexibility in subdivision design and planning/building approvals to enable better adaptation of housing to changing needs and create interesting and diverse living environments throughout the Precinct. • To ensure subdivision and lot layouts provide creative and innovative design solutions for fragmented land ownership.

Completed Precinct Structure Plans (PSP)		
Location	**Project Name**	**References to ESD / Sustainability / Subdivision**

		• To ensure subdivision and lot layouts maximise solar efficiency through the orientation of lots.
		5.7.3 Integrated Water Management planning and design guidelines
		Each planning permit application submitted must include an Integrate Water Management Statement which addresses how the objectives and guidelines of the Integrated Water Management Plan are achieved.
		5.10 Utilities and Staging
		5.10.1 Utilities and Staging Objectives
		The utilities and staging objectives are:
		• To provide all developed lots, to the satisfaction of the Relevant Authority, with:
		  • Potable water services
		  • Electricity
		  • Reticulated sewerage
		  • Drainage
		  • Gas
		  • Telecommunications

In-Progress Projects	
Project Name	**Location**
Leneva-Baranduda Precinct Structure Plan	City of Wodonga
Shepparton South East Precinct Structure Plan	Greater Shepparton City Council
Bacchus Marsh Urban Growth Framework	Moorabool Shire Council

Appendix G

Cost Benefit Analysis

ENVIRONMENTALLY SUSTAINABLE DESIGN FOR SUBDIVISIONS IN REGIONAL VICTORIA

Cost Benefit Analysis

Final

Prepared for Wodonga City Council

20 April 2018

AECOM Imagine it. Delivered.

ESD Subdivision in Regional Victoria

Client: Wodonga City Council

ABN: 63277160265

Prepared by

AECOM Australia Pty Ltd
Level 10, Tower Two, 727 Collins Street, Melbourne VIC 3008, Australia
T +61 3 9653 1234 F +61 3 9654 7117 www.aecom.com
ABN 20 093 846 925

24-Apr-2018

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document ESD Subdivision in Regional Victoria

Ref 60553561

Date 24-Apr-2018

Prepared by Gareth Taylor, Lili Pechey, Maxine Catchlove

Reviewed by Sarah Brennan, Liz Johnstone

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	23/02/18	Preliminary draft		
1	06-Mar-2018	Draft report	Liz Johnstone Associate Director - Sustainability	
2	29-Mar-2018	Draft final report	Liz Johnstone Associate Director - Sustainability	
3	19-Apr-2018	Final report	Liz Johnstone Associate Director - Sustainability	
4	24-Apr-2018	Final report - revisions	Liz Johnstone Associate Director - Sustainability	

Table of Contents

Executive Summary

What are ESD subdivisions

ESD (environmentally sustainable design) subdivisions are located and designed to use resources more effectively and to improve quality of life. They aim to use resources so that the needs of today's communities are met, while ensuring that these same resources remain available to meet the needs of future generations.

There are examples of sustainable subdivisions across Victoria and nationally, as well as the planning initiatives and tools that enable industry, government and communities to achieve them.

There are opportunities to improve sustainability at both subdivision and building scales. Measures can be low cost – such as using passive design, selection of materials, insulation and glazing; or using newer technologies to meet energy, water and waste needs for the development.

Opportunities are often greatest early in the subdivision design process where benefits for the builder, home owner and the environment are most cost-effectively achieved. Significant resources are available to support decision-making to achieve ESD in new urban development on previously rural or non-urban land (i.e. greenfield development).

Purpose of the project

The purpose of Stage 1B – Cost Benefit Analysis (this report) is to qualify, and where possible, quantify the social and environmental benefits of 'best practice' ESD subdivision principles including health benefits, embodied energy and resource consumption. It assesses the impact of upfront development costs and effects on long term running costs of housing.

The scope of Stage 1B includes:

- Identifying data on the additional upfront capital cost required to meet 'best practice' ESD subdivision, compared to a BAU subdivision.
- Comparing the costs and benefits of a 'best practice' ESD subdivision to those of a BAU subdivision.
- Providing an indicative assessment of the likely pay-back period return on investment if additional upfront capital investments are required for an ESD subdivision compared to BAU.

The analysis aims to provide the data and rationale for developing 'best practice' ESD subdivisions.

Overview of methodology

Four key stages were completed, with Project Control Group (PCG) input at each stage, as follows:

1. High level literature review. This review was undertaken to identify case study subdivisions where cost and benefits of a range of ESD interventions had been estimated. The intention of this review was to provide an indication of the scope of costs and benefits that have been estimated (including whether they had been estimated at the dwelling or subdivision level) and which might be incorporated within the cost benefit analysis (CBA).
2. Defining ESD interventions. At the conclusion of Stage 1A, five broad ESD principles were identified (optimise site potential, reduce footprint, enhance ecology and adaptable and encourage innovation). From these principles, it was necessary to develop specific interventions for inclusion within the Stage 1B analysis. It was also necessary to establish key characteristics of the three subdivisions to be included in the CBA. An iterative process was used to establish the ESD interventions and the subdivision characteristics.
3. CBA modelling. Based on the agreed ESD interventions and subdivision characterisation, further research was undertaken to determine whether the interventions could be quantitatively incorporated within the CBA.

The principles that were included in the dwelling and subdivision CBA were 'optimise site potential' and 'reduce footprint' and included the following interventions:

- dwelling orientation
- water use (e.g. the installation of rainwater tanks that were connected to different uses)
- energy use (e.g. the installation of energy-saving and energy generating devices)

To supplement the CBA, and to provide greater insights into the benefits of subdivision-based interventions, a breakeven analysis was undertaken for the following interventions:

- Increased percentage of tree canopy
- Increased use of recycled road material
- Increased use of Water Sensitive Urban Design (WSUD) techniques

For those interventions that could not be incorporated, research was used to support a qualitative description of the costs and benefits. This included reference to case studies from publicly available literature.

Key findings

Dwelling-based water interventions

The results of the CBA suggest that the adoption of rainwater tanks that are plumbed for washing machine and toilet use are marginally cost-beneficial in climate zones 6 and 7, however the intervention is not cost beneficial in climate zone 4. This is because of the relatively low cost of water in climate zone 4 (Mildura), which means that potable water savings are not sufficiently large to offset the capital, operating and maintenance costs associated with pump operation over the assessment period. However, it should be noted that the analysis assumes that electricity is supplied via the grid, and not via, for example solar power.

The payback period was 10 years in climate zone 6 and 11 years in climate zone 7. In climate zone 4, which experiences significantly less annual rainfall, the interventions payback period was 24 years because the value of water savings only just covers the extra cost incurred to plumb the tank to the washing machine and extra operating and maintenance costs associated with the connected appliances over the period of the assessment.

For climate zone 7 and 6 changes to any of the dis-advantageous sensitivity parameters (i.e. increasing the discount rate, higher capex costs, and lower utility costs) reduced the benefit cost ratio (BCR) to <1, suggesting that the results are sensitive to these parameters. For climate zone 4, changes to any of the advantageous sensitivity parameters (i.e. lower discount rate, lower capex costs and increased utility costs) did not result in a BCR>1.

Dwelling-based energy interventions

The results suggest that orientation is a no / relatively low cost intervention that results in benefits across all the climate zones that were assessed. The difference in energy use in an average single storey dwelling with best orientation (e.g. north-facing living spaces) and worst orientation (e.g. south-facing living spaces) was estimated as follows:

- Climate zone 4: 10 kW.h/m^2, which equates to approximately $760 per household per annum, based on current electricity prices
- Climate zone 6: 4 kW.h/m^2, which equates to approximately $300 per household per annum, based on current electricity prices
- Climate zone 7: 7 kW.h/m^2, which equates to approximately $460 per household per annum, based on current electricity prices

Orientation impacts the effectiveness of shading and solar interventions. For example, if the dwelling has poor orientation, the reduction in energy use associated with shading is greater, than if the dwelling has good orientation, where shading needs have been mitigated through design. Energy reduction interventions with poorer orientation have greater BCRs in the moderate climate (climate

zone 6). Conversely, in the hot and cold climates (climate zones 4 and 7, respectively), having poorer orientation reduces the benefit of implementing most energy-related interventions, except shading.

- The installation of solar panels were found to result in a positive BCR in all climate zones, with payback periods as follows: 3.6 years (climate zone 4); 4.1 years (climate zone 6); and 3.8 years (climate zone 7). The results for the installation of shading, glazing and insulation are mixed and depend on the climate zone and assumptions regarding orientation:
- Shading results in a BCR <1 in climate zone 6 and 7, but in climate zone 4 the BCR >1, suggesting that it is cost-beneficial to adopt this measure in climate zone 4. Payback periods are as follows: climate zone 4 (3.8 – 5.7 years); climate zone 6 (8.8 - 19.7 years) and climate zone 7 (11.4 – 17.2 years), depending on orientation[1].
- Glazing results in a BCR <1 in all climate zones that were assessed. Payback periods are estimated as follows: climate zone 4 (40.0 – 26.7 years); climate zone 6 (30.7 years); and climate zone 7 (16.0 – 13.3 years), depending on orientation[2].
- Insulation results in a BCR > 2.8 in climate zone 7, suggesting that it is cost-beneficial to implement this measure. In climate zones 4 and 6, the results were less conclusive, with BCRs ranging between 0.82 and 1.26, suggesting that the benefits of insulation are more marginal in these climates. Payback periods are estimated as follows: climate zone 4 (13.8 – 10.4 years); climate zone 6 (11.9 – 15.9 years); and climate zone 7 (5.2 – 4.6 years).

The costs associated with the installation and operation of HRV and solar batteries were found to outweigh the benefits in all climate zones that were assessed. However, as these interventions become more common place, and demand increases, the capital costs are likely to decline, which will alter the cost benefit ratio and payback period.

Subdivision-based interventions

It is difficult to accurately estimate non-dwelling interventions at the subdivision-based scale because to do so requires detailed information connecting the physical impact associated with the implementation of the ESD intervention and the associated financial impact, relative to the base case. This is challenging to do based on a hypothetical subdivision, where the financial impact is site specific, and where non-market valuation literature is not readily available (e.g. the value that people place on enhanced habitat as a result of the installation of bio-links / green corridors).

As a result, the subdivision-based CBA has focussed on scaling-up the results from the dwelling-based water and energy interventions. The results of the dwelling-based interventions were scaled up to reflect the size of the subdivisions considered in this study (i.e. 10 lots, 100 lots and 500 lots). The BCR and payback periods are therefore the same as for the dwelling-based assessment.

Case studies obtained from the literature review provide evidence that there are benefits from adopting ESD measures. Furthermore, the magnitude of the benefits are less driven by climate than the dwelling-based interventions and, therefore may be more appropriate for a wider number of climate zones.

The breakeven analysis suggests that scale is important when considering the costs and benefits of implementation of ESD measures within subdivisions.

A summary of the results from the breakeven analysis are contained in Table 1. It highlights the breakeven value varying in non-linear ways, which is, in part, due to the physical assumptions used to characterise the subdivisions.

Table 1 Summary breakeven analysis results (present value benefit per lot)

	10 lots	100 lots	500 lots

[1] Shading results in greatest benefits to dwellings that have poor orientation. Hence the payback period is lower for dwellings with poor orientation.
[2] Glazing results in greatest benefits to dwellings that have good orientation. Hence the payback period is lower for dwellings with good orientation.

	10 lots	100 lots	500 lots
Enhanced canopy cover	$994	$1,114	$1,114
Increased use of recycled road material	$ 606	$561	$561
Increased use of WSUD	n.a*.	$2,913	$1,551

* Costs have not been estimated for raingardens within 10 lot subdivisions as the area of public realm space would not support this type of WSUD.

The estimates contained in Table 42 reflect the combined value that the benefits from the interventions would have to take over a 30 year period to be cost-beneficial. Based on the assumptions outlined in Section 2.4, the results suggest that the increased use of recycled road material has the lowest break even value of all the interventions analysed. This result provides further support for the findings of the IDM Sustainable Infrastructure Guidelines (Pitt&Sherry, 2014).

Implications for policy

What are the low-cost, low regrets interventions?

While the dwelling-based ESD interventions facilitate a reduction in resource use, the results of the CBA suggest that the benefits of adopting these interventions do not always exceed the costs in the three climate zones included in the study.

However, the analysis suggest that orientation is a no / low cost intervention and results in benefits across all the climate zones that were assessed.

In addition, there are a number of subdivision-scale interventions that are likely to confer benefits across current climate zones and involve no cost or similar (or lower) maintenance costs for councils, relative to BAU practices and which therefore may be considered low cost / low regrets interventions, if capital funding can be secured.

The low-cost, / low regrets interventions, could include:

- subdivision has appropriate solar orientation, for both public areas and dwellings
- reduction in impervious surfaces throughout the subdivision (e.g. through implementation of the IDM SIG)
- reduction in construction waste (i.e. recycling and more accurate construction material estimation)
- recycled materials (where these are readily available)
- diversity of dwellings within the subdivision
- installation of footpaths on both sides
- installation of separated bicycle paths (or shared footpath / bicycle paths)
- continual shading of footpaths and roads
- installation of footpaths to provide connection to amenities and neighbouring areas
- more diversity in street / road design ‘shared zone’)
- provision to connect with local public transport
- use of drought tolerant and indigenous plants
- increased canopy cover
- retention of mature trees
- use of low-energy street lighting
- wider nature strips

Other dwelling-based interventions (such as window placement and size, use of thermal mass, zoning of spaces and draft-proofing / building sealing) have not been modelled, but have potential to reduce energy consumption and are relatively inexpensive, especially when considered in the design / planning phase.

What factors influence the results?

Climate and the price of energy and water are important factors in determining the BCR and payback period associated with the dwelling-based interventions. However, the results from this analysis have not taken the following into account:

Climate change projections – future climate change projections have not been included in the analysis, which has implications for the anticipated benefits from the adoption of the ESD measures. More extreme weather events and a trend towards a hotter, drier climate is likely to improve the results from interventions designed to reduce energy and water use.

Trends in energy and water prices – which influences the value of the savings achieved with the interventions. Increases in energy and water prices over time has the potential to improve the results from interventions designed to reduce energy and water use.

Reducing emissions intensity of the electricity supply grid – which influences the potential greenhouse gas reduction possible as the proportion of energy from renewables increases.

Interventions such as heat recovery ventilation and batteries for storing solar energy, currently involve high capital costs, relative to the benefits that are associated with these interventions, which results in particularly high payback periods relative to other interventions. Over time, the cost of such technologies has the potential to fall, which may mean that they become more cost-beneficial; e.g. the cost of lithium-ion batteries is predicted to halve in seven years. However, it is important to note that, for HRV, climate will still play an important role in determining the overall benefits.

This suggests measures to encourage the adoption of ESD interventions may need to be more nuanced than a 'one size fits all' approach across Victoria's climate regions for water and energy.

Who bares the costs and who benefits?

Dwelling-based ESD interventions primarily benefit home owners through improved comfort and reduced consumption of water and energy. The capital / construction cost associated with these interventions is borne by the developer and typically passed on to home owners.

These up-front costs are lower if the ESD interventions are included in the dwelling design, rather than being retrofitted afterwards. Operating and maintenance costs associated with the ESD interventions tend to be zero, or relatively low, except for rainwater tanks with pumps and HRV. This may be an important consideration when communicating the benefits of ESD interventions.

The capital / construction costs of subdivision-based interventions are typically borne by developers, but the beneficiaries can include home owners, councils and the wider community. The operating and maintenance costs associated with these interventions can range from negligible (e.g. a second footpath to facilitate active travel) to relatively high (e.g. maintaining WSUD features). This provides challenges for funding such interventions.

Next steps

There are social, economic and environmental benefits associated with ESD in regional subdivisions. These benefits differ across Victoria's climate regions, as does the nature and capacity of the residential development industry. While the period of analysis was 30 years, the life of a residential subdivision is much more enduring and so subdivision-wide sustainability measures warrant greater consideration.

To advance ESD subdivisions in regional Victoria will require:

- More research into the subdivision interventions that have low operating / maintenance requirements, especially focused on understanding the difference in cost and benefits relative to BAU. This could take the form of CBA case studies based on existing / or planned subdivisions that have incorporated ESD features and would help to strengthen the evidence base.
- Direct engagement with land surveyors and development engineers to understand the drivers of land subdivision plans and to educate them about the value created through orientation. This

could include pilot projects between council's and developers to showcase ESD features at the subdivision scale.

- Consideration of innovative funding models for encouraging adoption of subdivision interventions, especially where this involves relatively large capital costs, such as green loans, deferred payments, or fast track approvals for ESD developments. For example, the Victorian Government will contribute up to $10 million in grant funding over four years to develop and implement state wide demonstration projects, using microgrid models.[3]
- Exploration of potential case studies or research projects to collate longitudinal data so as to be able to more accurately compare BAU to ESD subdivision over time.

[3] See https://www.energy.vic.gov.au/microgrids. Accessed 25 March 2018.

1.0 Introduction

1.1 Background

Wodonga City Council together with Greater Geelong City Council, Greater Bendigo City Council, Ballarat City Council, Greater Shepparton City Council, Baw Baw Shire Council, Wangaratta Rural City Council and Moorabool Shire Council were awarded funding through the Collaborative Councils Sustainability Fund Partnership Program Round 3 to undertake a project to assess how greenfield subdivisions can be more sustainably designed and delivered to achieve multiple benefits, in the most cost effective way over time.

These eight regional councils engaged AECOM to deliver this project, which seeks to identify and test the feasibility of embedding environmentally sustainable design (ESD) in subdivisions. This is done through identifying principles, practices and tools, including both regulatory and non-regulatory measures, such as information and training. Benefits and costs have been assessed to identify those measures that are likely to have the most impact for the least cost.

What are ESD subdivisions?

ESD (environmentally sustainable design) subdivisions are located and designed to use resources more effectively and to improve quality of life. They aim to use resources so that the needs of today's communities are met, while ensuring that these same resources remain available to meet the needs of future generations.

There are examples of sustainable subdivisions across Victoria and nationally, as well as the planning initiatives and tools that enable industry, government and communities to achieve them.

There are opportunities to improve sustainability at both subdivision and building scales. Measures can be low cost – such as using passive design, selection of materials, insulation and glazing; or using newer technologies to meet energy, water and waste needs for the development.

Opportunities are often greatest early in the subdivision design process where benefits for the builder, home owner and the environment are most cost-effectively achieved. Significant resources are available to support decision-making to achieve ESD in new urban development on previously rural or non-urban land (i.e. greenfield development).

What is the issue being addressed?

The key underpinning issue which this project aims to address relates to the sustainability of the subdivision itself; rather than a focus on the dwelling as most residential development in previously non-urban areas does not require planning approval after the rezoning and subdivision is approved. This is particularly so in regional and rural Victoria where lot sizes tend to be over 500m^2 and housing consists of predominantly separate dwellings. Coupled with gaps, or minimal requirements in current planning and building regulations, many subdivisions fall short of ESD principles. For these reasons, greenfield subdivisions require a tailored approach for a regional context; supported by education, advocacy, communication, policy and regulation to ensure the uptake of ESD principles in individual dwellings is improved.

There is a perception in some sectors that sustainable design and development can introduce higher up front capital costs; yet this may fail to consider future savings and benefits. There appears to be little data on what the anticipated reduced on-going operational costs are, as well as the potential social and environmental benefits and associated cost-savings. This project through Stage 1B (this report) aims to contribute to filling this gap.

There is also growing recognition that 'housing affordability' should not focus on upfront construction costs alone and that ongoing operational costs such as energy, water and mobility directly impact on affordability. This is in line with a shift to acknowledging a more holistic approach of 'affordable living'. This also needs to consider the implications for various parties involved in subdivisions including developers, builders, occupants and local councils.

1.2 Purpose of the project

This project identifies both regulatory and non-regulatory approaches, including education, advocacy and communication strategies to improve ESD outcomes for residential subdivision in regional Victoria. A key part of this work is to identify and quantify the costs and benefits of implementing better practice ESD compared to current requirements (business as usual, BAU).

This project has two parts:

- Proof of concept study (Stage 1A)
- Cost benefit analysis (Stage 1B).

The goals of this project are to:

- Define 'best practice' ESD with respect to urban land subdivision and determine how it should be measured.
- Establish how 'best practice' ESD subdivisions are feasible in regional Victoria.
- Recommend a suite of tools and a model for collaborative implementation, with transferability across the State.

1.2.1 Stage 1A scope

Stage 1A – Proof of concept identified current planning practices, case studies of better practices. The latter was used to identify key principles of best practice ESD subdivisions. These principles were tested and agreed to through a series of seven workshops, one held in each participating municipality[4] and one central workshop held with industry associations and state government representatives. For each principle, corresponding initiatives were identified that formed the basis for initiatives to be tested in the cost benefit analysis (CBA) in Stage 1B. A separate report has been established for Stage 1A.

1.2.2 Stage 1B scope

Stage 1B – Cost Benefit Analysis qualifies and where possible quantifies the social and environmental benefits of 'best practice' ESD subdivision principles including health benefits, embodied energy and resource consumption. It assesses the impact of upfront development costs and effects on long term running costs of housing.

The scope of Stage 1B includes:

- Identifying data on the additional upfront capital cost required to meet 'best practice' ESD subdivision, compared to a BAU subdivision.
- Comparing the costs and benefits of a 'best practice' ESD subdivision to those of a BAU subdivision.
- Providing an indicative assessment of the likely pay-back period return on investment if additional upfront capital investments are required for an ESD subdivision compared to BAU.

The analysis aims to provide the data and rationale for developing 'best practice' ESD subdivisions.

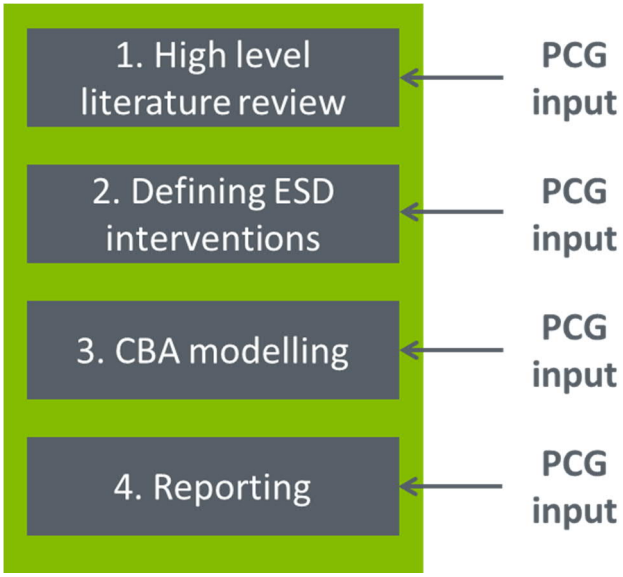
[4] Ballarat and Moorabool held a joint workshop.

2.0 Methodology

2.1 Overview

Figure 1 contains an overview of the methodology used to complete Stage 1B. Four key stages, with Project Control Group (PCG) input at each stage have been completed:

Figure 1 Overview of project methodology



1. High level literature review. This review was undertaken to identify case study subdivisions where cost and benefits of a range of ESD interventions had been estimated. The intention of this review was to provide an indication of the scope of costs and benefits that have been estimated (including whether they had been estimated at the dwelling or subdivision level) and which might be incorporated within the Stage 1B CBA.
2. Defining ESD interventions. At the conclusion of Stage 1A, five broad ESD principles were identified (optimise site potential, reduce footprint, enhance ecology and adaptable and encourage innovation). From these principles, it was necessary to develop specific interventions for inclusion within the Stage 1B analysis. It was also necessary to establish key characteristics of the three subdivisions to be included in the CBA. An iterative process was used to establish the ESD interventions and the subdivision characteristics. The final version is contained in Appendix A.
3. CBA modelling. Based on the agreed ESD interventions and subdivision characterisation, further research was undertaken to determine whether the interventions could be quantitatively incorporated within the CBA. For those interventions that could not be incorporated, research was used to support a qualitative description of the costs and benefits..
4. Reporting. The results for both the subdivision CBA and dwelling level CBA have been included in a draft report (this document). Following receipt of PCG comments, the report was finalised.

The following sections provide a further detail on the methodology used to develop the dwelling level and subdivision level CBA.

2.2 Dwelling scale modelling methodology

To understand the implications of incorporating ESD interventions related to resource use at the subdivision scale it was first necessary to estimate the dwelling scale implications.

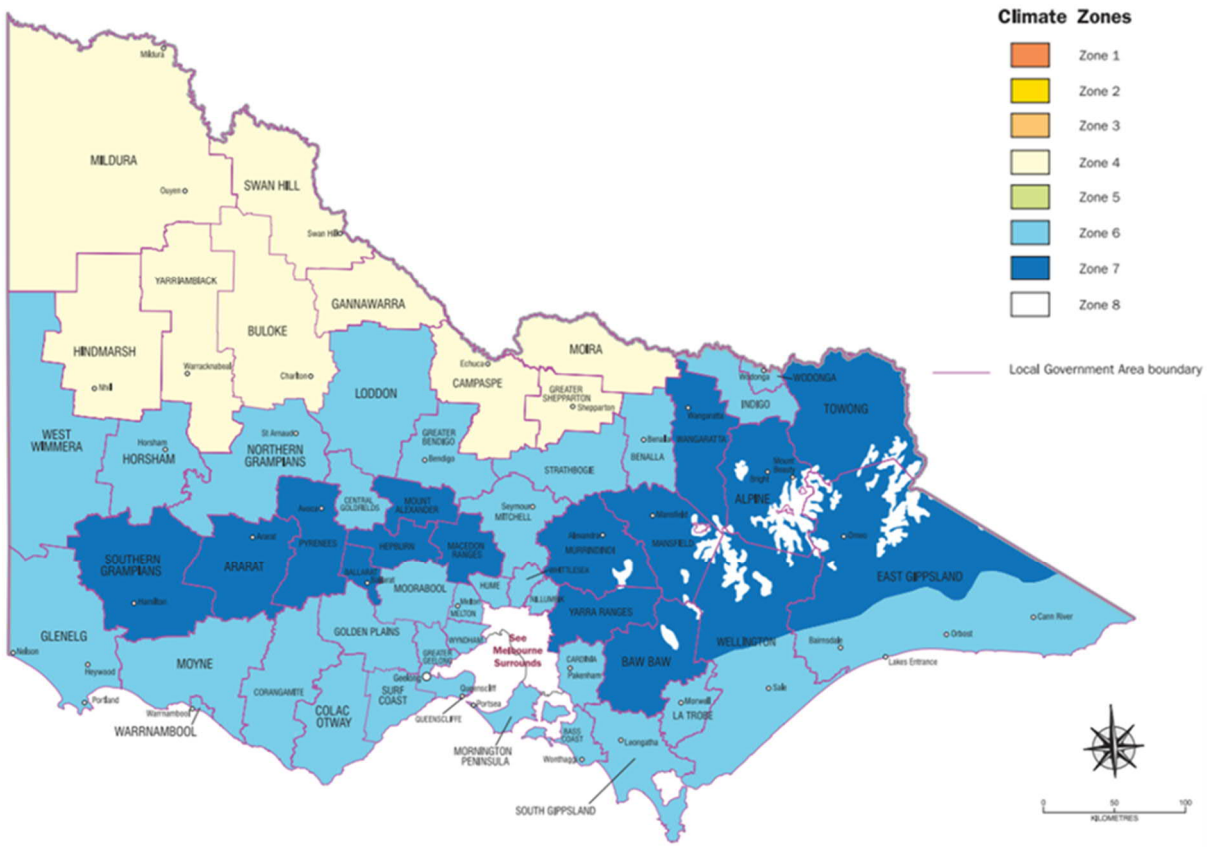
2.2.1 Overview

Economic modelling was performed to determine the economic viability of implementing various ESD interventions at the dwelling scale for the three National Construction Code (NCC) climate zones that the eight local government areas are within. These were:

- climate zones 4: e.g. Shepparton
- climate zone 6: e.g. Wodonga, Geelong, Bendigo, and Moorabool
- climate zone 7: e.g. Ballarat, Baw Baw, and Wangaratta

For the purposes of modelling, the weather files for the following locations were used to represent the climate zones of interest: Ballarat (climate zone 7), Melbourne (climate zone 6), and Mildura (climate zone 4).

Figure 2 NCC Climate Zones and selection of areas for CBA model



Source: NCC Climate Zones

The modelled interventions are:

- Water use
  - Rainwater tank – irrigation and toilet use (base case)
  - Rainwater tank – all uses (base case plus washing machine use)
- Energy use
  - 6 star NatHERS (base case)
  - Enhanced shading
  - Enhanced windows
  - Enhanced insulation
  - Heat recovery ventilation (HRV)
  - Solar panels
  - Solar panels with battery storage
  - All energy reduction options

2.2.2 Inputs and assumptions

A 30 year appraisal period and a real discount rate of 7 per cent per annum formed the basis for the economic modelling. Interventions were assumed to be implemented in financial year (FY) 2019 (year end 30 June 2019) with cost savings (benefits) accruing from FY 2020 through to FY2049.

The cost and benefit types that were used to model the economic viability of each intervention are in Table 2.

Table 2 ESD cost and benefit categories

Costs	Benefit
Capital expenditure (CAPEX)	Utility cost savings
Operating expenditure (OPEX)	Feed in tariff (solar options)
Residual asset value (negative cost in final year)	

Capital land operating expenditure

Estimated CAPEX for each intervention was obtained from supplier quotations. These values, shown in Table 3, were then inflated at 2 per cent CPI to FY2019 values. The only interventions assumed to incur OPEX were the rainwater tank interventions and the HRV system. CAPEX or OPEX were assumed not to vary with location.

Table 3 Estimated capital expenditure, $FY 2018

Intervention	Cost, $ FY2018
Rainwater tank unit cost	1,050
Tank installation cost – irrigation and toilet	1,000
Tank installation cost – all uses (includes washing machine)	1,300
6 star NatHERS	17,000
Enhanced shading and 6 star NatHERS	19,200
Enhanced windows and 6 star NatHERS	23,000
Enhanced insulation and 6 star NatHERS	20,115
HRV and 6 star NatHERS	24,700
All energy reduction interventions	38,965
Solar panels and 6 star NatHERS	21,250
Solar panels, battery and 6 star NatHERS	35,650

Residual asset value

Residual asset values were included in the modelling where there was remaining asset life of an intervention at the end of the 30th year. Asset replacements were included for interventions with less than a 30 year life. The value was calculated using the straight line method which assumes the asset's value depreciates linearly from the original CAPEX value to zero at the end of its useful life. It was reported as a negative cost in the final year of appraisal.

Benefits: Utility cost savings

Water and energy consumption modelling was performed by AECOM for each intervention in each climate region. The results formed the inputs for quantifying the benefits in the economic model. In each case the BAU (Water: Rainwater tank for irrigation and toilet use and Energy: 6 star NatHERS) formed the base case against which water and energy savings arising from each intervention were quantified. The quantity of resource savings were then multiplied by the resource costs shown in Table 4 and Table 5 to obtain annualised cost savings (benefits).

Water use modelling

The water consumption modelling assumed the following:

- A 5,000L rainwater tank
- Water consumption is162 L/person/day
- A typical dwelling of 3 persons and 220 square meters
- Irrigation use savings of 15% total consumption
- Irrigation and washing machine use savings of 27% total consumption
- Irrigation and toilet use savings of 21% total consumption
- All uses savings of 32% total consumption

Table 4 Water use parameters and costs by region

Parameter	Unit	Ballarat	Melbourne	Mildura
Cost of water	$/kL[5]	1.86	2.67	1.03
Water service charge	$ p.a[6]	195.13	121.08	203.20
Annual rainfall	mm p.a[7]	690	648	291
Reuse potential	%[8]	45	45	65

Energy use modelling

The energy modelling used a hypothetical north-facing, single storey house of 220 m^2 to provide indicative energy consumptions of a typical dwelling. The Melbourne climate was used as the base model. The window area was assumed to total 40 m^2, 16 m^2 for the main living space, and 8 m^2 on the other three walls.

The building fabric composition assumed a heat transfer value to approximate the equivalent of a 6 star NatHERS rating in the Melbourne climate. The modelling was performed in a parametric simulation tool that takes into account the local weather conditions (https://energyplus.net/weather-region). The hypothetical house was then modelled in climate zone 4, 6 and 7 involving eight different orientations to test the varying energy saving potential.

In accordance with NatHERS star band ratings, the energy consumption modelling considered heating and cooling costs to quantify total consumption on a kilowatt hour per square metre per year ($kW.h/m^2/y$) basis. The different energy results are in relative terms and the main purpose is to provide guidance in choice of most effective strategies to reduce energy demand in a particular situation. This simulation does not replace NatHERS modelling.

Electricity was assumed to account for 100 per cent of power input. Table 5 outlines the energy costs and consumptions that were used as inputs in the analysis.

Table 5 Energy parameters and costs by region

Parameter	Unit	Ballarat	Melbourne	Mildura
Cost of electricity	$/kW.h[9]	0.34	0.30	0.34
Annual supply charge	$ p.a[10]	526.05	472.00	526.05

[5] Sourced from each region's water utility provider cost sheets
[6] Sourced from each region's water utility provider cost sheets
[7] Annual rainfall data sourced from http://www.bom.gov.au/
[8] AECOM modelling assumption
[9] Citipower and Powercor price sheets from Origin Energy
[10] Citipower and Powercor price sheets from Origin Energy

Solar energy output (4kW system)	kW.h /day[11]	12.5	12.5	14.9
Intervention	**Unit**	**Ballarat**	**Melbourne**	**Mildura**
6 star NatHERS – best orientation	kW.h/m^2/y	57	41	50
6 star NatHERS – worst orientation	kW.h/m^2/y	61	48	60
Enhanced shading – best orientation	kW.h/m^2/y	53	37	38
Enhanced shading – worst orientation	kW.h/m^2/y	55	39	42
Enhanced windows – best orientation	kW.h/m^2/y	51	38	47
Enhanced windows – worst orientation	kW.h/m^2/y	56	45	58
Enhanced insulation – best orientation	kW.h/m^2/y	48	38	46
Enhanced insulation – worst orientation	kW.h/m^2/y	53	44	57
HRV – best orientation	kW.h/m^2/y	48	37	46
HRV – worst orientation	kW.h/m^2/y	53	43	57
All energy reduction options – best orientation	kW.h/m^2/y	32	23	27
All energy reduction options – worst orientation	kW.h/m^2/y	34	28	33

'Solar Only' as well as 'Solar with Battery Storage' interventions were modelled using the base case energy consumption. They assumed a 4kW system and a 13.5 kW.h battery. Both interventions produced varying amounts of electricity based on the different solar exposure of each of the 3 climate zones.

Under the 'Solar Only' option, 50 per cent of the electricity produced in each location was assumed to be used to heat/cool the house. The remaining 50 per cent was assumed to be exported back to the grid at a feed-in tariff price of $0.113/kW.h.

Zero percent of the electricity produced was exported in to the grid under the 'Solar with Battery Storage' intervention.

2.2.3 Economic modelling process and outputs

For each intervention including the base cases, a discounted cash flow was created. This comprised the initial capital cost associated with the intervention followed by the annualised operational and maintenance costs and energy or water use costs. Asset replacement costs were accounted for in the appropriate year.

The annual incremental costs and benefits were then used to evaluate the economic viability of each intervention. The incremental CAPEX, the cost of the intervention less the cost of the BAU approach, formed the major cost component for each intervention. The rainwater tank interventions and the HRV also incurred OPEX costs which contributed to the value of costs. The total cost outlay in each year was then discounted and summed to produce the present value of the costs of each intervention.

The annual incremental benefits (the water or energy use cost for each intervention less the usage cost for the corresponding base case), were similarly discounted and summed to produce the present value of benefits for each intervention.

The present value of costs and benefits of each intervention were then evaluated to produce the Net Present Value (NPV), payback period, and Benefit-Cost Ratio (BCR). A positive NPV and a BCR greater than 1.0 indicate the intervention is economically viable (i.e. benefits are greater than costs); conversely a negative NPV or BCR less than 1.0 indicate the intervention is not economically viable (i.e. costs are greater than benefits).

[11] https://www.solarchoice.net.au/blog/melbourne-solar-panels-compare-system-prices-and-installers/

It should be noted that the economic modelling was undertaken to provide indicative guidance on the costs and benefits of implementing ESD initiatives. A risk assessment has not been undertaken and therefore the CBA does not consider the implications of, for example, increased costs / time delays from the potential need for building / planning permits for some interventions.

2.2.4 Sensitivity tests

Table 6 shows the sensitivity tests that were conducted for each of the energy interventions to understand the implications of changes in the values used for these key variables within the CBA.

Table 6 Sensitivity test variables and values

Variable	Lower bound value	Upper bound value
Discount rate	4%	10%
Capital cost	-20%	+20%
Utility costs (e.g. cost of water and energy)	-20%	+20%
All energy interventions (ex. HRV and solar battery storage)	n.a.	n.a

2.3 Subdivision scale cost benefit analysis

The subdivision scale assessment drew on a very similar methodology to the dwelling scale assessment.

2.3.1 Overview

The subdivision modelling was scaled up from the dwelling based modelling by factors of 10, 100 and 500, representing the number of lots in each of the three subdivisions modelled.

2.3.2 Inputs and assumptions

All interventions that were modelled at the dwelling level were subsequently modelled at the subdivision scale. No changes were made to account for potential economies of scale that may apply when a larger number of dwellings are constructed. This is discussed further Section 5.2.

Other opportunities to improve ESD of subdivisions have been qualitatively assessed in the next section due to the lack of input data.

2.3.3 Economic modelling process and outputs

The present value of costs and benefits and hence the NPV of each intervention were scaled up by factors of 10, 100 and 500.

The BCRs and payback periods remained the same as under the dwelling scale. This is because these parameters indicate the ratio, or relative amounts of costs to benefits for each intervention, and hence do not change with respect to the number of dwellings.

2.3.4 Sensitivity tests

The same sensitivity tests that were performed at dwelling scale were performed at each subdivision scale.

2.4 Subdivision scale breakeven analysis

2.4.1 Overview

Breakeven analysis is a common analytical technique, which can be used when quantifying and valuing the benefits of a given intervention.

In consultation with the PCG, it was decided that a breakeven analysis should be undertaken to provide an indication of the costs associated with ESD subdivision interventions and the magnitude of benefits that these interventions would have to provide for the intervention to be considered cost

beneficial. The breakeven analysis was also intended to provide an indication of the influence of scale on the relative costs and benefits of the ESD interventions.

Three interventions were selected for inclusion in the breakeven analysis. These were:

- Increased percentage of tree canopy (Enhance tree canopy)
- Increased use of recycled road material
- Increased use of Water Sensitive Urban Design

2.4.2 Inputs and assumptions

Table 7 contains the assumptions and parameters that were common to all breakeven analyses.

Table 7 Assumptions / parameters underpinning the breakeven analysis

Assumptions / Parameters	Value	Source
Timeframe	30 years	Assumed
Discount rate	7 %, real	Assumed, standard practice
Assessment year	2019	Assumed
Lot sizes (no.)	• 10 • 100 • 500	Agreed with client
Lot area (m^2)	• $600m^2$ • 80% $600m^2$ and 20% $350m^2$ • 80% $600m^2$ and 20% $350m^2$	Assumed
Area of subdivision (ha)	• 10 Lot: 6,000 • 100 Lot: 55,000 • 500 Lot: 275,000	Assumed
Area of green space (m^2)	• 10 Lot: N/A • 100 Lot: 3,612 • 500 Lot: 18,051	Assumed
Area of road surfaces (m^2)	• 10 Lot: 1,010 • 100 Lot: 9,343 • 500 Lot: 46,713	Assumed
Area of streetscape (inclusive of road surfaces) (m^2)	• 10 Lot: 1,600 • 100 Lot:17,205 • 500 Lot: 86,025	Assumed
Number of residents	• 10 Lot: 24 • 100 Lot: 236 • 500 Lot: 1,180	www.abs.gov.au

Table 8 contains the inputs that were used to undertake the analysis of enhanced tree canopy.

Table 8 Inputs underpinning analysis of enhanced tree canopy

Input	Value	Source
Capital cost	$500 for first two years – assumed $400 year 0, $50 in each of year 1 and 2.	Wodonga City Council
O&M cost	$10 per year after year 2	Wodonga City Council
Lifespan of trees	50+ years	(City of Melbourne, 2013)

Input	Value	Source
No. of additional trees	• 10 Lot:17 • 100 Lot:187 • 500 Lot:934	Calculated

The number of additional trees was obtained by calculating the number of trees required to achieve a streetscape canopy cover of 25 per cent and subtracting the business as usual number of trees of 1 tree per dwelling. The capital and maintenance costs for each tree are the same; the difference in cost is based on the higher number of trees in the subdivision.

Canopy targets generally apply to public realm (including streetscapes and open spaces) and currently range from 25 per cent to 40 per cent in strategic plans in participating council areas. Given only streetscapes were modelled, the 25 per cent canopy cover was selected, which is aligned with the target contained in the City of Greater Geelong Urban Forest Strategy 2015-2025 (City of Greater Geelong, n.d.). Sensitivity testing was undertaken for 30 and 40 per cent canopy coverage to reflect the higher targets across the municipalities (e.g. 40 per cent canopy cover reflects the targets in Greater Shepparton City Council Urban Forest Strategy 2017- 2037 (Urban Forest Consulting, 2017) and Today Tomorrow Together The Ballarat Strategy Our Vision for 2040 (Ballarat, 2013))Residual asset value of trees has not been included because it should be treated as a benefit, which is not specifically quantified as part of the breakeven analysis.

In some instances increasing the number of trees will not be possible, without, for example, compromising driveway space. In such cases, planting fewer, more mature trees could achieve the same canopy cover. The feasibility of both these approaches will vary depending on the location and availability of the required number of juvenile and mature species. The relative trade-offs between these two approaches could be an area for further research and would build on work already started by the Cool Streets™ initiative[12].

Table 9 contains the inputs that were used to undertake the analysis of increased use of recycled road material. The values contained in Table 9 are values that are additional to the cost of conventional road material. It was assumed that there is no difference in availability of recycled material or the maintenance costs from using recycled materials relative to conventional materials, which assumes that they are available locally.

Table 9 Inputs underpinning analysis of increased use of recycled road material

Input	Value	Source
Additional capital cost ($)	6/m^2	(Pitt&Sherry, 2014)
Additional maintenance cost ($)	-	Assumed

Table 10 contains the inputs that were used to undertake the analysis of implementing raingardens for Water Sensitive Urban Design (WSUD). The cost of implementing WSUD first required estimation of the public realm. Based on AECOM experience, it was assumed that 75 per cent of the public realm acts as a catchment area to feed the raingardens. The raingardens were then assumed to occupy 10 per cent of the catchment region. The area of land required was therefore assumed to be 7.5 per cent of the public realm area.

Costs have not been estimated for raingardens within 10 lot subdivisions as the area of public realm space would not support this type of WSUD.

Table 10 Inputs underpinning analysis of increase use of WSUD

Input	Value	Source
Capital cost ($)	10 Lot: N/A 100 Lot: \$1,125/m^2 500 Lot: \$565/m^2	(Melbourne Water, 2013)*

[12] https://www.coolstreets.com.au/

Input	Value	Source
Maintenance cost, first two years ($)	10 Lot: N/A 100 Lot: $59/m^2 500 Lot: $17/m^2	(Melbourne Water, 2013)
Maintenance cost, remaining years ($)	10 Lot: N/A 100 Lot: $39/m^2 500 Lot: $11/m^2	(Melbourne Water, 2013)

*Costs from 2013 were inflated at 2 per cent CPI to obtain 2018 estimates

2.4.3 Economic modelling process and outputs

For each intervention a discounted cash flow was created. This comprised the initial capital cost associated with the intervention followed by annualised operational and maintenance costs. Replacement costs were accounted for in the appropriate year.

The cash flow allowed the estimation of the total present value of costs associated with each intervention to be calculated, and, hence the value that the benefits would have to be equal to or greater to be cost beneficial.

For each intervention, the results are presented based on the number of lots and the number of residents for each subdivision.

2.4.4 Sensitivity tests

Sensitivity tests were conducted for each of the interventions to understand the implications of changes in the values used for key variables within the breakeven analysis. Table 11 contains the values of the variables used in the sensitivity tests.

Table 11 Sensitivity test variables and values

Variable	Lower bound value	Upper bound value
Discount rate	4%	10%
Capital cost	-20%	+20%
O&M cost	-20%	+20%

3.0 Qualitative findings

The following sections provide a qualitative summary of key benefits and costs for ESD interventions associated with the five broad ESD principles identified in Stage 1A of the overarching project:

- Optimise site potential
- Reduce footprint
- Places for people
- Enhance ecology
- Adaptable and encourage innovation

For each benefit and cost, beneficiaries and payees have been identified (i.e. householders, developers, councils, and the wider public).

Where possible, references to publicly available literature have been included to provide evidence of the benefits and costs. In addition, illustrative case studies have been provided, which reference quantitative research into the benefits and costs.

3.1 Optimise site potential

Table 12 ESD interventions to optimise site potential of subdivisions: impacts, benefits and costs

			Beneficiaries					Payees			
ESD intervention	Impact(s)	Benefits	Householders	Developers	Council	Wider public	Costs	Householders	Developers	Council	Wider public
Subdivision has appropriate solar orientation	• Improved energy efficiency	• Avoided energy use for cooling and heating • Improved thermal comfort • Glare reduction • Reduced construction (i.e. site optimisation can reduce the glazing requirements for meeting the residential design building code)	X X X	X		X X	• No cost for the majority of subdivisions • Potential cost to developer from orientation constraint (i.e. having to design the site layout, which may be more costly when orientation is prioritised) • Potential increase in street and road costs • Potential decrease in land value if orientation results in less attractive views	X X	X X		

			Beneficiaries					Payees			
ESD intervention	Impact(s)	Benefits	Householders	Developers	Council	Wider public	Costs	Householders	Developers	Council	Wider public
Dwellings optimise design to take full advantage of solar access	• Improved energy efficiency	• Avoided energy use for cooling and heating	X				• Potential reduction in size of dwelling to benefit fully from site	X			
		• Improved thermal comfort	X								
		• Reduced cost of construction (site optimisation reduces need for some building code requirements, such as glazing)		X							
		• Noise reduction	X			X					
		• Glare reduction	X			X					

Case Study – Benefits of optimised orientation

Orientation of the dwelling can have a significant bearing on the total energy used in households. A study (Szatow, 2011) into the Cape Paterson Ecovillage found that, depending on orientation alone, total MJ thermal load (heating and cooling) ranged from 142.4 MJ / m^2 to 158.4 MJ / m^2, or the difference between a 5.2 and a 5.6 star rating for that climate zone.

Further details regarding the Cape Paterson Ecovillage are contained in Appendix B.

3.2 Reduce footprint

Table 13 ESD interventions to reduce the footprint of subdivisions: impacts, benefits and costs

			Beneficiaries					Payees			
ESD intervention	Impact(s)	Benefits	Householders	Developers	Council	Wider public	Costs	Householders	Developers	Council	Wider public
Rainwater tank installed and connected for domestic toilets, washing machines and gardens	• Reduced potable water consumption	• Potable water savings • Reduced demand on water supply network (does not reduce headworks charges) • Avoided stormwater runoff treatment	X		 X	 X X	• Installation and maintenance of rainwater tank	X	X		
Installation of WSUD within the subdivision	• Improved stormwater quality • Cooling effects on microclimates • Flood mitigation	• Reduced water treatment costs • Large scale (wetland) biodiversity value • Improved water quality for receiving environments • Increased visual and recreational amenity of developments • Increased property values (potentially)	 X X	 X X	X X X	X X X X 	• Installation and maintenance of WSUD • Public risk (e.g. from open water)		X X	X 	
Reduction in impervious surfaces throughout the subdivision	• Reduced incidence of surface flooding • Improved stormwater quality	• Avoided flood damage • Avoided stormwater treatment costs • Reduced health costs	X X		X X 	X X	• Cost of installing and maintaining non-impervious surface		X	X	

				Beneficiaries						Payees			
ESD intervention	Impact(s)	Benefits		Householders	Developers	Council	Wider public	Costs		Householders	Developers	Council	Wider public
	• Reduced Urban Heat Island (UHI) effect												
Precinct scale stormwater treatment for irrigation or toilet flushing in public spaces	• Reduced potable water consumption	• Potable water savings • Reduced treatment costs for potable water treatment				X X	X X	• Installation and maintenance of stormwater treatment plant (does not reduce headworks charges)			X	X	
Installation of sealing, glazing and sun shading on dwellings	• Improved energy efficiency • Improved thermal comfort	• Avoided energy use for healing and cooling • Living environments that support human health		X X			X	• Installation and maintenance of sealing, glazing and sun shading on dwellings		X			
Installation of Photovoltaic cells on dwellings	• Reduced non-renewable energy use	• Avoided non-renewable energy use for heating and cooling • Reduced demand on the energy grid • Potential to sell excess back to grid (Nogrady, 2017)		X X			X X	• Installation and maintenance of Photovoltaic cells		X			
Installation of smart grid technology within the subdivision scale	• Reduced non-renewable energy use	• Avoided non-renewable energy use		X			X	• Installation and maintenance of smart grid technology			X		

				Beneficiaries					Payees			
ESD intervention	Impact(s)	Benefits		Householders	Developers	Council	Wider public	Costs	Householders	Developers	Council	Wider public
Installation of battery storage at subdivision level	• Reduced non-renewable energy use	• Avoided non-renewable energy use	X			X	• Installation and maintenance of battery storage.		X		
		• Potential to sell excess energy back to the grid (Utility Magazine, 2017)	X								
Reduction in household waste to landfill	• Reduced waste to landfill	• Reduced requirements of landfill sites	X		X	X	• Installation and maintenance of on-site food and garden waste composting		X	X	
		• Avoided GHG emissions	X			X					
		• Avoided soil contamination			X	X	• Opportunity cost of land		X		
		• Resource recovery	X		X	X	• Fire risk from on-site composting	X			X
		• Reduced transport of waste to landfill			X	X	• Increased presence of flies and odour from on-site composting	X			X
Reduction in construction waste	• Reduced construction waste	• Avoided use of resources		X		X	• Labour costs of more detailed resource use estimation and designing to standard material sizes		X		
		• Avoided labour costs of reduced materials handling and construction time		X							
Reduction in construction waste to landfill	• Reduced waste to landfill	• Avoided disposal of waste at landfill sites			X	X	• Cost of recycling construction waste	X	X	X	
		• Avoided cost of disposing waste at landfill sites		X			• Cost of estimating materials more accurately		X		
							• Cost of separating waste		X		

Case Study – The costs and benefits of sustainable subdivision interventions: Armstrong Creek

The study provides the results of the business case which was undertaken to assess opportunities to achieve better environmental outcomes for the new urban community of Armstrong Creek while not compromising the economic and social objectives of Greater Geelong City Council.

This business case considers two scenarios for infrastructure delivery against these objectives:

- a 'Business as Usual' (BAU) case
- an 'Alternative Approach' that reflects leading edge sustainability objectives and outcomes.

The principle criteria against which each of the two cases were assessed are:

- Minimisation of water use
- Minimisation of greenhouse gas (GHG) production
- Reductions in energy consumption at household and commercial levels
- Improvements to affordability levels for all of the 22,000 planned new homes.

The business case found that the Alternative Approach is likely to yield significantly higher economic, social and environmental benefits, at a lower total infrastructure cost and with lower annual operating costs over a 15-year time horizon. An additional $466 million of benefits (NPV) can be generated, including a capital cost saving of $48 million over a 15-year development period, should the sustainable development strategy be followed.

An important additional finding was that in terms of the total benefits to be derived from the alternative, sustainability-based approach to the development of Armstrong Creek, more than 80 per cent of the total benefits are expected to flow to homeowners in the Armstrong Creek Urban Growth Area.

Further details regarding this case study can be found in Appendix B.

Case Study – Improving dwelling energy efficiency

ASBEC and ClimateWorks (ASBEC and ClimateWorks, 2018) undertook research to identify a range of energy efficiency measures for which the capital cost outweighs the financial benefits from a societal perspective over the lifetime of the relevant building elements, in most cases a 10-15 year period.

Key findings from the research include:

- There are immediate and cost-effective opportunities to improve energy efficiency requirements in the Building Code. Reducing air leakage is a major opportunity for many building types assessed, along with ceiling fans and roof insulation in some cases. Across a range of climate zones and building types, these measures could individually deliver bill savings of up to $150 per household per year, with savings more than offsetting additional capital costs.
- Combined, cost-effective measures could reduce energy consumption for heating and cooling by an estimated 28 to 51 per cent across a range of

Case Study – Improving dwelling energy efficiency

housing types and climates. This is equivalent to between 1 and 2.5 stars on the NatHERS scheme. In most jurisdictions, implementing these improvements would mean setting minimum requirements at the equivalent of 7 star NatHERS or higher.

The opportunities described above were found to be most cost-effective with current energy prices and technology costs. A range of other opportunities could become cost-effective if energy prices increase, or technology costs come down. Additional opportunities that have a significant energy impact but were not assessed to be cost-effective on current economic assumptions include:

- Increased requirements for wall insulation (particularly in cooler climates)
- Stronger specifications for window performance
- Installation of roller shutters and larger eaves in certain orientations (particularly in warmer climates)
- Increased thermal mass
- Tighter standards for lighting
- Improved efficiency of domestic hot water systems.

Further information, including detailed explanation of the assumptions underpinning the findings and additional case studies of energy efficient dwellings from around Australia are contained here: http://www.asbec.asn.au/publications/

Case Study – Reducing carbon footprint through use of recycled materials

The Infrastructure Design Manual (IDM) Group developed the Sustainable Infrastructure Guidelines to delivering sustainable infrastructure (Conley & Dowson, 2014). The core tenets of the guidelines are to encourage use of recycled materials, reduce the carbon footprints of infrastructure projects, reduce maintenance and operating costs, utilise water in more efficient ways and use materials from sustainable sources. Three case study projects were selected to investigate the effectiveness of the guidelines, develop a list of sustainability KPIs, and compare sustainable design approaches to conventional methods.

The first project involved Steampacket Place, a laneway for vehicles and pedestrians in Geelong. The laneway needed pavement replacement. In addition to using low carbon concrete and steel for pavement replacement, the design elements aimed to increase net flora and utilise recycled material. The existing pavement was demolished and reusable excavation materials were crushed to be used as a sub base layer underneath a new layer of low carbon concrete reinforcements that was constructed using 100% recycled water. WSUD elements were used to construct a bio-filter system to increase rainwater capture and a raingarden pit was positioned to collect stormwater runoff. As a result, the development achieved a reduction of 4,900 kg of CO_2e, in contrast to the conventional method. The cost of implementing the sustainable design approach incurred an additional $27,721 more than the conventional approach and represents approximately 10 per cent of total project costs.

The additional costs were mostly due to the extra concrete required for the bio-retention trench. However, the inclusion of bio-retention trench, trees and other landscaping elements has provided a number of benefits that have not be estimated, including:

Case Study – Reducing carbon footprint through use of recycled materials

- improving the general appearance of the laneway by providing lighter neutral tones accompanied by green natural elements and creative lighting.
- sequestrating carbon dioxide and therefore contributing to the reduction of carbon in the atmosphere.
- reducing the impervious areas with corresponding reduction in stormwater runoff and also aiding groundwater recharge.

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The second project involved the Colac Otway Shire constructing a footpath in Grant Street, Colac. The footpath was constructed using low carbon concrete and resulted in CO_2e savings of 7,800kg compared to a conventional approach. The cost of implementing the sustainable design approach was $3,006 greater than the conventional approach, representing around 3% of overall project costs.

The third project involved Geelong City Council using FoamMix recycled asphalt technologies for two pavement rehabilitation sites. This approach reuses the existing pavement material to make 95 per cent of the new pavement that is then mixed with foamed bitumen. For both pavements the subgrade was of poor quality and needed to be stabilised with lime at an extra cost. Even with this additional cost, the sustainable design approach resulted in a saving of $52 / m^2, relative to the conventional method, reducing project costs by 30%. The sustainable design approach also reduced CO_2e by 22,130kg.

The findings from the case studies suggest that by following the Guidelines it is likely that the carbon footprint of any project can be reduced at a cost that is comparable to a conventional design. Furthermore, as the uptake of sustainable materials increases, these cost differentials are likely to be minimised or removed.
However, the report also notes that in the case of recycled materials, challenges remain in developing commercially viable aggregate recycling operations in smaller and more remote regional areas as there is typically not enough raw material generated in a centralised area within a manageable timeframe to develop an economy of scale
For further information, refer to Appendix B of this report and (Conley & Dowson, 2014).

Case Study – Third pipe / stormwater harvesting at the subdivision scale

A lack of existing water services infrastructure and a desire for sustainable community development has driven a shift at Aurora Estate in Epping, Melbourne to include five core objectives for greenfield residential development of 8,500 dwellings (Davis, 2009). The project design development was led by VicUrban, a State Government owned company, in partnership with the City of Whittlesea, Yarra Valley Water, the EPA and the Aurora Community Association.

The development includes sustainable water elements focused on the following components. Demand management via rainwater tanks and efficient fixtures in houses. Wastewater is treated to class A and reused throughout the development for toilet flushing and outdoor irrigation. Finally, stormwater retention and treatment for household raingardens, streetscape swales, bio-filtration systems and precinct wetlands detain and treat stormwater before entering local waterways.

This development was the first time that third-pipe infrastructure had been used to supply customers with class A recycled water throughout an entire

Case Study – Third pipe / stormwater harvesting at the subdivision scale

estate. The findings of Aurora have since informed policy changes on water management by illuminating the policy and regulatory gaps that have constrained the adoption of this sustainable innovation in the past.. The project demonstrates the importance of building and maintaining good relationships with all key actors, in particular regulatory bodies, to facilitate the approval process. The innovative approach of this project has allowed participants to learn and then replicate certain aspects of the Aurora project, improving trust, confidence and understanding in technologies and peer-reviewed innovation.

Decentralised service arrangements, such as third-pipe infrastructure, was shown to produce the lowest total community cost, including environmental, capital and operating costs.

For further information, refer to (Davis, 2009).

Case Study – Maintaining public open space with less water

Increased demand for public open spaces (POS) and reduced availability of irrigation water due to groundwater depletion, means that local governments in Perth face mounting pressure to investigate alternative irrigation solutions (Water Sensitive Cities, 2018). Typically, governments look to reduce water use or source alternative water sources, but in Perth local governments opted to investigate improving water efficiency by applying different water saving technologies. Analysis was done on the various water saving techniques and included calculation of the volume of water saved per dollar spent on the technique over the lifespan of the technique.

Findings showed that for each type of park, the cost of each technique varied substantially. The broad types of central irrigation control options, including rain shut-off devices, tend to be relatively low cost options while hydro zoning/ eco zoning and irrigation system upgrades tend to be relatively high cost options. Implementing the efficiency solutions within small pocket parks was found to be relatively cost-ineffective.

For the specific mix of parks within the City of Nedlands the project found that a five per cent reduction in water use on POS cost $0.38/ kl; a ten per cent reduction cost $0.43/ kl; and a 15 per cent reduction cost $0.62/ kl. A business as usual approach of relying on groundwater supply was found to cost $2.09/kl, making the efficiency solutions significantly more favourable.

For further information, refer to (Water Sensitive Cities, 2018).

3.3 Places for people

Table 14 ESD interventions to create places for people: impacts, benefits and costs

			Beneficiaries					Payees			
ESD intervention	Impact(s)	Benefits	Householders	Developers	Council	Wider public	Costs	Householders	Developers	Council	Wider public
Diversity of dwelling types within the subdivision	• Better alignment between housing stock demand and supply • Improved social cohesion (Thompson, 2007)	• Reduced resource use (house fabric and contents) • Reduced running costs • Increased housing affordability • Perceived attractiveness of the subdivision (potentially)	X X X X	X X	 X X	X X	• More design for dwelling types (i.e. costs associated with offering multiple dwelling designs) • Reduction in property values (potentially)	 X	X 	 	
Installation of footpaths on both sides of the street	• Increased physical activity • Reduced conflict on roads • Air quality benefits from reduced car dependency (Thompson, 2007) • Reduced social isolation	• Health benefits from increased exercise • Increased safety from reduced pedestrian road crossings • Reduced healthcare costs associated with inactivity • Reduced GHG emissions from vehicle use	X X X X	 	 	 X X X	• Installation and maintenance of footpaths on both sides of the street • Increased impervious surfaces • Opportunity cost of land or capital cost of construction on open space, or space for canopy trees	 	X X	X X 	 X

			Beneficiaries				Payees			
ESD intervention	Impact(s)	Benefits	Householders	Developers	Council	Wider public	Householders	Developers	Council	Wider public
Installation of separated bicycle path	• Increased physical activity • Increase modal share of cycling for local transport (Infrastructure Australia, 2009)	• Health benefit from increased exercise • Reduced healthcare costs associated with inactivity • Increased safety on roads and for cyclists • Reduced GHG emissions from vehicle use	X X X X			X X X		X X	X	
Continual shading of footpaths and roads	• Increased physical activity • Reduced urban heat island effect	• Health benefits from increased exercise • Reduced GHG emissions from vehicle use • Reduced cooling costs associated with high temperatures • Reduced healthcare costs associated with high temperatures	X X X X			X X X		X	X X	X
Installation of footpaths to provide connection to amenities and neighbouring areas	• Increased physical activity (National Heart Foundation of Australia, 2012)	• Health benefit from regular exercise • Potential to increase pedestrian access to local businesses • Increased safety • Reduced GHG emissions from vehicle use • Reduced road maintenance (potentially)	X X X X		X	X X X X		X X	X	

			Beneficiaries				Payees			
ESD intervention	Impact(s)	Benefits	Householders	Developers	Council	Wider public	Costs	Householders	Developers	Council	Wider public
Provision to connect with local public transport (e.g. bus shelters and footpaths to train stations)	• Reduced car dependency (Infrastructure Australia, 2009) • Reduced fossil fuel use	• Avoided GHG emissions • Reduce economic and environmental costs associated with car travel (Thompson, 2007) • Reduced costs associated with car use • Improved mobility for young, disabled and elderly	X X X		X X	X X X	• Installation and maintenance of connectivity to local transport		X	X	
More diversity in street / road design (e.g. 'shared zones')	• Decrease impervious area	• Reduced material use and maintenance/ renewal costs • Improved drainage • Improved amenity	X X	X	X X	X X	• Installation and maintenance of impervious surfaces (if additional to traditional surfaces)		X	X	

Case Study – Monetising health outcomes of increased walking and cycling

A review of previous studies (The Australian Prevention Partnership Centre, 2015) found evidence of associations between urban form and physical activity outcomes among adults. The review reported that health-related monetary values varied between $1.04 and $2.08 for every kilometre walked, and $0.02 to $1.12 for every kilometre cycled.

The number of destinations within walking and cycling distance was found to have the greatest economic outcomes which are associated with health-related benefits worth an average $14.65 per adult annually (range $0.42 to $42.50) depending on the destination and context. The economic value of increasing neighbourhood walkability was found to be worth an average $1.62 per adult annually (range $0.11 to $15.73). The report concluded that the health-related economic benefits of changes to urban form are modest at an individual level, but when multiplied for whole populations, these figures are significant.

Case Study – Monetising health outcomes of increased walking and cycling

Another recent study (Zapata-Diomdi, 2018) summarised the findings from a range of recent studies that have estimated activity-related health benefits, as follows: (see over)

	Values per km (A$ 2016)	Mortality	Morbidity	Health care costs	Health care costs in added life years	Productivity
Australian Transport Assessment and Planning (ATAP) (2016)	Walking: $2.92	✓	✓	✓		
	Cycling: $1.46					
Transport for New South Wales (2013)	Walking: $1.79	✓	✓			
	Cycling: $1.26					
SKM & PWC (2011)	Walking: $2.03	✓	✓	✓		
	Cycling: $1.35					
Mulley et al. (2013)	Walking: $2.03	✓	✓	✓		
	Cycling: $1.35					
PWC (2010)	Walking: $2.36	✓	✓			
AECOM (2010)	Cycling: $0.26	✓				✓
PWC (2009)	Cycling: (1) $0.01 and (2) $0.71	✓				
This study (Zapata-Diomdi, 2018)	Walking: $0.98	✓	✓	✓	✓	
	Cycling: $0.62					

Source: (Zapata-Diomdi, 2018)

Case study – The costs of installing footpaths on both sides of the street

The Local Government Infrastructure Design Association (LGIDA) (Local Government Infrastructure Design Association, 2017) published a draft discussion paper that included the results from research into the impact of a number of infrastructure standards on the overall viability of development across Victoria, including the requirement to include footpaths on both sides of every street.

The analysis considered the difference in cost to the development by comparing the cost of providing footpaths to one side of the street relative to both sides of the street. The analysis assumed that footpaths would be provided on one side only regardless of classification whereas in reality if Clause 56 of the Planning Scheme was applied this would only apply to Access Place and Access Lanes.

The analysis found that the additional footpath cost is approximately 7 per cent of the total cost of assets that are handed over to Council. When other development costs, such as lot filling and grading, public open space contributions, water, sewer, power, telecommunications, gas costs and the cost of the land are included, the cost of the additional footpath was estimated to be 2 – 5 per cent of the total development costs. From the developer's perspective this results in an additional cost per allotment of about $1,300. Depending on where the development occurs, this reflects an increase in the final purchase price of 0.6 – 1.4 per cent per allotment, depending on where the allotment is located.

The LGIDA concluded that these cost are not significant to affect the viability of the development.

Case Study- Willingness to Pay for improved community health opportunities (Selandra Rise)

In 2008 the Victorian Government and the Planning Institute of Australia formed a partnership to facilitate a blueprint for residential greenfield development projects. Residential developer, Stockland, joined this partnership to create Selandra Rise, a demonstration project that focused on the principles of health and well-being. The main wellness features introduced to the development were:

- **Residential proximity to parks and community wellness facilities:** All homes are within 300 metres of parkland, easily connecting residents to either small pocket parks or larger destination parks by foot or bike. The centrally located Hilltop Park includes an outdoor fitness station. Heritage Park also incorporates a community garden that was planned and designed by residents.
- **Design for pedestrians and bicyclists:** Walkability within Selandra Rise was a key development principle. This includes a street network that ensures direct connections between residents, open spaces, community facilities and footpath lined with trees.
- **Wellness programming and social interaction:** Selandra Community Place (SCP) is a community facility operated by the City of Casey and centrally located within the Selandra Rise development. The SCP organises and promotes health, wellness and social activities for residents.

The health promoting features of Selandra Rise were found to cost no more than comparable projects. The cost of the wellness components was 1-2 per cent of the total project cost, which was sourced from Stockland's balance sheet and partnerships entities. It should be noted that Stockland had to commit significant time to ensuring the development was aligned the aspirations of its partners The market response to Selandra Rise has been favourable with the average house price selling for $7,000 - $12,000 higher than competitor projects, and, at the time, was the fastest selling community project in Australia. For more information refer to (Lassar, et al., 2014).

Case Study- Gallagher Studios 'Beyond Green Streets'

Gallagher Studio's research identified the gaps in theory and practice for residential street design initiatives. Streets, as relatively stable components of urban environments, are essential functional entities spanning large areas and thus offer substantial climate change mitigation potential. The research found that although references to 'green' and 'sustainable' design are prominent in policy and planning literature, objectives are often vague. . A focus on drawing together the natural and constructed features for streets could mitigate CO_2e, but this is made difficult through the lack of street design and emission performance data.

Using data from residential streets in Sydney, the research aims to draw together different street components and layouts to evaluate CO_2e profile and abatement potential. An integrated CO_2e model was developed based on the current physical layout and operational use and included construction elements, such as kerbs, lanes and parking bays, and the natural elements, such as street trees.. Sequestration and shading performance for a range of street tree species was estimated using a combination of modelling techniques to simulate street retrofit scenarios to develop and evaluate new street designs. Results showed that substantial mitigation of CO_2e can be achieved through street design modification. Street retrofits that rely only on street trees can achieve seven times more CO_2e abatements than a standard street design. When moderate design changes were adopted for street layouts this number increased to 10 times more CO_2e abatement.

The research was utilised in the 'Cool Streets^{TM,} Blacktown Pilot Project in 2015-16. The pilot project was developed to measure not only the environmental outcomes of improved street tree design but economic and social outcomes as well. This project found that not only could street trees achieve seven times more CO_2e reductions, they can also effectively reduce electricity bills by over $400 per annum when compared to a standard street design. The project also fostered community participation to improve tree longevity and encouraged social interactions to strengthen neighbourhood relationships. Although fundamental obstacles remain, such as complicated management and ownership contexts, consistent comparable data has been identified and proven to provide leverage for CO_2e mitigation and adaptation of urban forms. These findings provide opportunities for further research, policy and improved implementation practice.

For more information refer to (Gallagher, 2018)

3.4 Enhance ecology

Table 15 ESD interventions to enhance ecology, impacts, benefits and costs - summary

			Beneficiaries					Payees			
ESD intervention	Impact(s)	Benefits	Householders	Developers	Council	Wider public	Costs	Householders	Developers	Council	Wider public
Use of drought tolerant and/or indigenous plants	• Increased provision for habitat, and indigenous animals (Goddard, et al., 2013) • Increased resilience due to plants being adapted to local climates and soil (State Flora, 2013)	• Value of habitat for indigenous animals	X			X	• Installation and maintenance of drought tolerant and indigenous species		X	X	
		• Reduced irrigation requirements / greater resilience to drought		X	X	X	• Cost of replacement plants (potentially high if mature trees are required)		X	X	
		• Reduced maintenance requirements	X	X	X		• Cost of selecting location-appropriate species and product sourcing (e.g. potentially more time consuming than for exotic species)		X		
		• Reduced demand for fertilizer	X	X	X						
		• Improved property values (potentially)	X	X	X						
		• Improved amenity and recreation value (potentially)	X			X					

			Beneficiaries					Payees			
ESD intervention	Impact(s)	Benefits	Householders	Developers	Council	Wider public	Costs	Householders	Developers	Council	Wider public
Increased canopy cover	• Increased provision of habitat • Provision of wildlife connectivity (Moreton Bay Regional Council, 2017) • Mitigating the UHI (Livesley & Davern, 2014)	• Value of habitat • Reduced UHI • Improved property value (potentially) • Improved amenity (potentially)	X X X X			X X X X	• Opportunity cost of land used to create a canopy that could have otherwise been utilised for another development purpose • Installation and maintenance of trees • Design research for case-specific landscape connectivity capabilities/ requirements • Fire risk (potentially)	X X X	X X X	X X X X	
Creation of a bio-link/green corridor	• Increased provision of habitat	• Value of habitat • Improved property value (potentially) • Reduced wildlife fragmentation (Moreton Bay Regional Council, 2017) • Improved air quality (Thompson, 2007) • Reduction in wind damage (potentially)	X X X X X		X X	X X X X	• Installation and maintenance of bio-link green corridor • Opportunity cost of land that could be utilised in other ways • Fire risk (potentially)	 X	X X X	X X	 X

			Beneficiaries					Payees			
ESD intervention	Impact(s)	Benefits	Householders	Developers	Council	Wider public	Costs	Householders	Developers	Council	Wider public
Retention of mature trees and native vegetation	• Increased provision of habitat trees that preserve ecological biodiversity (Kirkpatrick, 2011).	• Value of habitat • Improved property value (potentially) • Enhanced cultural and heritage value (potentially)	X X X		X	X	• Opportunity cost of land that could have been utilised in other ways • Design costs (e.g. having to design the site layout around mature trees)		X X		
Wider nature strips	• More room for larger trees	• Increased percentage of pervious area • Improved amenity (potentially).	 X	 X	X	X	• Opportunity cost of land that could have been utilised in other ways • Maintenance of nature strip	 X	X		

Case Study- Calculating the value of trees

The National Heart Foundation (National Heart Foundation, 2013) conducted a study to measure the economic benefits of street trees in Adelaide. The study found that older trees provide up to 60 per cent more effective pollution reduction than young/small trees through CO_2 reduction, storm water control, cooling effects through transpiration, house value and street pavement stabilisation.

The study also looked at four year old trees in Adelaide and found they can generate a gross annual benefit of $171/tree. The benefit includes energy savings, air quality improvements, stormwater management, aesthetics and other considerations. The study calculated that for every $1 invested in planting and maintaining trees, $3.81 of environmental and property benefits can be created.

Case Study- Water savings with indigenous and drought tolerant plants

Mildura Rural City Council undertakes a maintenance activities on public grounds, including garden maintenance. The Council has planted native and indigenous plants to create a unique aesthetic, improve ecological outcomes in the area and to save on watering costs. This initiative has been so successful that exotic plants in council grounds are being reduced. Native and indigenous gardens do not require as regular watering as exotic garden do. The Parks & Gardens Coordinator at Mildura Rural City Council suggests that, over a lifetime, native plants require around one third of the water required for exotics. This results in savings in terms of water saved and reduced Council costs (e.g. labour and transportation)

Case Study- Creating Bio- links /green corridors early in strategic planning stage: The Wodonga Retained Environmental Network

The Wodonga Retained Environment Network (WREN) is a series of protected areas totalling more than 900ha within the regional city's growth area. The WREN was born out of a need overcome the traditionally fragmented and incremental site by site / permit by permit approach to vegetation removal and retention that often resulted in poor environmental outcomes and lead to conflict and delays for applicants.

It was formed based on a strategy collaboratively prepared in 2006 with the Albury Wodonga Development Corporation, the City of Wodonga and the State government. The strategy guided creation of the reserve network that protects significant areas of remnant vegetation, biodiversity corridors, waterways and connects them to one another and the broader landscape alongside areas where native vegetation will be removed when housing projects commenced.

The WRENs was in essence, a pilot project that involved the identification and protection of native vegetation and ecosystem function within an urban growth corridor at a stage preceding the zoning of land for urban development. It was designed to provide clarity to community and developers, avoid conflict and mitigate approval delays.

The WREN strategy is implemented through the planning scheme via a native vegetation precinct plan. Reserves provide the offsets from vegetation removal during development and removes the need for permits for vegetation removal in most circumstances. The network now informs the Precinct Structure Plan which provides a framework for future development and is considered to add significant value to the growth area in the form of improved community access to nature and lifestyle appeal.

For further information please refer to (Albury Wodonga Corporation, City of Wodonga & DELWP, 2006).

Case Study – Adelaide Living Laboratory – Value Proposition: Low Carbon Housing Policy

The report shows that low carbon housing policies provide benefits across areas of health, wellbeing, productivity, energy and public budgets. The report finds that many impacts cannot be easily monetised with confidence, however from a macroeconomic perspective a Government that develops effective low carbon housing measures will experience a net increase in local employment, reduction in energy prices and increase economic activity within a more efficient economy better placed to compete with world energy prices.

The report highlights the importance of industry learning and the discount rate. As the housing industry adopts new technologies and practises,

Case Study – Adelaide Living Laboratory – Value Proposition: Low Carbon Housing Policy

increases low carbon building system production and develops new skills and knowledge across the industry, the net economic benefits to the community increase. The report concludes that the value proposition of low carbon living is overwhelmingly positive for the South Australian Government with a conservative net present value of $1.31 billion for a 10 year policy action with a benefit cost ratio of 2.42.

For more information refer to (Berry & Davidson, 2016).

3.5 Adaptable and encouraging innovation

This principle is intended to recognise the role of innovation and new technologies in the achievement of more sustainable subdivisions that can adapt over time. Subdivisions built with tomorrow in mind are more resilient and adaptable to future changes in climate, demographics and technology.

Such innovations could include:

- dwelling based or precinct-wide battery storage
- electric vehicle charging points
- micro-grid (energy trading within subdivision- peer to peer trading)
- autonomous vehicles
- high quality digital infrastructure to the home to support the local economy
- working from home; virtual service delivery
- wind modelling to inform natural cooling
- establishing cool refuges within subdivisions

selecting tree species which will survive under future climate change projections The diversity of possible interventions is substantial and will likely be market-led. Some of these interventions are closer to be implemented than others, for example, dwelling-based or precinct-wide battery storage, electric vehicle charging points and working from home.

The current analysis has not attempted to identify the benefits and costs associated with such interventions.

Case Study - Changes in renewable generation and storage

A report published by the Climate Council of Australia discusses the way in which energy storage technologies has become an increasingly prominent focus for policy makers and future market strategies (Climate Council of Australia, 2018).

Energy storage technologies include batteries, pumped hydro power and solar thermal power. The report finds that Australia is on the cusp of an energy storage boom driven by supportive policies and rapidly falling costs. This has led Australian households to increasingly embrace battery storage units to complement household solar.

The report looked at the storage technology industry and found that declining costs have made a significant contribution to the increase in demand. For example, the cost of lithium-ion batteries fell by 80 per cent between 2010 and 2018. In 2016, 6,750 new household batteries were installed which is expected to have tripled to over 20,000 installations in 2017. At the state-level, the Victorian, Queensland and Northern Territory governments are also investing in grid-scale battery storage technology, which has further increased demand.

This increased demand is anticipated to result in a further halving of the cost of lithium-ion batteries by 2025. This has the potential to significantly improve the cost-effectiveness of this technology at both the household and subdivision scale.

For further information, please refer to (Climate Council of Australia, 2018).

4.0 Quantitative findings

The following sections present the cost benefit analysis (CBA) results from the adoption of ESD interventions at the dwelling and subdivision level.

The dwelling-based results are presented for three climate regions: Climate zone 7 (colder climate), climate zone 6 (moderate climate) and climate zone 4 (hotter climate). The subdivision-based results are presented for climate zone 6[13] and three different subdivision scales: 10 lots, 100 lots and 500 lots.

The present value of benefits and costs of each intervention are incremental to the BAU activities.

4.1 Dwelling-based ESD interventions

4.1.1 Climate zone 7 (e.g. Ballarat, Baw Baw, and Wangaratta)

Table 16 contains the results of the CBA for the installation of rainwater tanks that are plumbed for different uses in climate zone 7.

Table 16 CBA results for dwelling-based rainwater tank interventions: Climate zone 7

	ESD intervention: Rainwater tank
	All uses
Present value benefits ($)	356
Present value costs ($)	327
Net present value ($)	29
Benefit cost ratio	**1.09**
Payback period (years)	10.7

Table 17 contains the results of the sensitivity analysis for the installation of rainwater tanks that are plumbed for all uses in climate zone 7.

Table 17 Sensitivity results for dwelling-based rainwater tank interventions: Climate zone 7 – all uses

Sensitivity parameter	PV benefits ($)	PV costs ($)	NPV ($)	BCR
Discount rate of 4%	496	341	155	**1.45**
Discount rate of 10%	270	318	-47	**0.85**
CAPEX +20%	356	392	-36	**0.91**
CAPEX -20%	356	261	95	**1.36**
Utility costs +20%	427	327	100	**1.31**
Utility costs -20%	285	327	-42	**0.87**

[13] Climate zone 6 was selected as it is considered to represent a mid-point between the relatively extreme temperatures in climate zone 4 and 7.

Table 18 contains the results of the CBA for energy reduction interventions (i.e. shading, glazing, insulation, heat recovery ventilation (HRV)) in climate zone 7. In addition, it presents the results for the inclusion of solar panels and solar battery storage.

Table 18 CBA results for dwelling-based energy interventions: Climate zone 7

	ESD intervention: Energy measures							
	Shading	Glazing	Insulation	HRV	All energy reduction interventions	Solar	Solar with battery	All interventions
PV benefits ($) Worst orientation	5,697	4,748	7,596	7,596	25,638	14,177	21,956	47,594
PV benefits ($) Best orientation	3,798	5,697	8,546	8,546	23,739	14,256	22,115	45,853
PV costs ($)	7,032	5,798	3,009	13,046	28,885	5,803	25,467	54,352
NPV ($) Worst orientation	-1,335	-1,051	4,588	-5,450	-3,248	8,373	-3,511	-6,758
NPV ($) Best orientation	-3,234	-101	5,537	-4,500	-5,147	8,453	-3,352	-8,499
BCR Worst orientation	**0.81**	**0.82**	**2.52**	**0.58**	**0.89**	**2.44**	**0.86**	**0.88**
BCR Best orientation	**0.54**	**0.98**	**2.84**	**0.66**	**0.82**	**2.46**	**0.87**	**0.84**
Payback period Worst orientation (years)	11.4	16.0	5.2	12.8	10.8	3.8	10.8	10.8
Payback period Best orientation (years)	17.2	13.3	4.6	11.4	11.7	3.8	10.7	11.2

Table 19 contains the results of the sensitivity analysis for shading, glazing and insulation in climate zone 7. It presents the results based on the implementation of all of these energy efficiency (energy reduction) interventions, except HRV. It does not include solar panels as this is an energy generation measure, not an energy efficiency or reduction measure.

Table 19 Sensitivity results for dwelling-based energy interventions: Climate zone 7 – Shading, glazing and insulation only

Sensitivity parameter	PV benefits ($) Worst orientation	PV benefits ($) Best orientation	PV costs ($)	NPV ($) Worst orientation	NPV ($) Best orientation	BCR Worst orientation	BCR Best orientation
Discount rate of 4%	25,141	25,141	16,207	8,934	8,934	**1.55**	**1.55**
Discount rate of 10%	13,706	13,706	15,479	-1,773	-1,773	**0.89**	**0.89**
CAPEX +20%	18,041	18,041	19,007	-966	-966	**0.95**	**0.95**
CAPEX -20%	18,041	18,041	12,672	5,370	5,370	**1.42**	**1.42**
Utility costs +20%	21,650	21,650	15,839	5,810	5,810	**1.37**	**1.37**
Utility costs -20%	14,433	14,433	15,839	-1,406	-1,406	**0.91**	**0.91**

Table 20 contains the results of the sensitivity analysis for energy interventions in climate zone 7. It presents the results based on the implementation of all interventions. The implications of removing HRV and solar battery from the interventions has been tested, owing to the relatively high up-front costs associated with these particular interventions.

Table 20 Sensitivity results for dwelling-based energy interventions: Climate zone 7 – all interventions

Sensitivity parameter	PV benefits ($) Worst orientation	PV benefits ($) Best orientation	PV costs ($)	NPV ($) Worst orientation	NPV ($) Best orientation	BCR Worst orientation	BCR Best orientation
All interventions except HRV and battery	32,218	32,298	21,643	10,575	10,655	**1.49**	**1.49**
Discount rate of 4%	66,322	63,897	60,961	5,361	2,936	**1.09**	**1.05**
Discount rate of 10%	36,156	34,834	50,128	-13,972	-15,294	**0.72**	**0.69**
CAPEX +20%	47,594	45,853	64,716	-17,123	-18,863	**0.74**	**0.71**
CAPEX -20%	47,594	45,853	43,988	3,606	1,865	**1.08**	**1.04**
Utility costs +20%	57,112	55,024	54,352	2,760	672	**1.05**	**1.01**
Utility costs -20%	38,075	36,683	54,352	-16,277	-17,669	**0.70**	**0.67**

4.1.2 Climate zone 6 (e.g. Wodonga, Geelong, Bendigo, and Moorabool)

Table 21 contains the results of the CBA for the installation of rainwater tanks that are plumbed for different uses in climate zone 6 (e.g. Wodonga, Geelong, Bendigo, and Moorabool).

Table 21 CBA results for dwelling-based Water ESD interventions: Climate zone 6

	ESD intervention: Rainwater tank
	All uses
Present value benefits ($)	378
Present value costs ($)	327
Net present value ($)	52
Benefit cost ratio	**1.16**
Payback period (years)	10.0

Table 22 contains the results of the sensitivity analysis for the installation of rainwater tanks that are plumbed for all uses in climate zone 6.

Table 22 Sensitivity results for dwelling-based rainwater tank interventions: Climate zone 6 - all uses

Sensitivity parameter	PV benefits ($)	PV costs ($)	NPV ($)	BCR
Discount rate of 4%	527	341	186	**1.55**
Discount rate of 10%	287	318	-30	**0.90**
CAPEX +20%	378	398	-20	**0.95**
CAPEX -20%	378	255	123	**1.48**
Utility costs +20%	454	327	127	**1.39**
Utility costs -20%	303	327	-24	**0.93**

Table 23 contains the results of the CBA for energy reduction interventions (i.e. shading, glazing, insulation, heat recovery ventilation (HRV)) in climate zone 6. In addition, it presents the results for the inclusion of solar panels and solar battery storage.

Table 23 CBA results for dwelling-based energy interventions: Climate zone 6

	ESD intervention							
	Shading	Glazing	Insulation	HRV	All energy reduction interventions	Solar	Solar with battery	All interventions
PV benefits ($) Worst orientation	7,429	2,476	3,302	4,127	16,510	13,049	19,701	36,211
PV benefits ($) Best orientation	3,302	2,476	2,476	3,302	14,859	13,270	20,141	35,000
PV costs ($)	7,032	5,798	3,009	13,046	28,885	5,803	25,467	54,352
NPV ($) Worst orientation	397	-3,322	293	-8,918	-12,375	7,246	-5,766	-18,141
NPV ($) Best orientation	-3,730	-3,322	-532	-9,744	-14,026	7,466	-5,325	-19,352
BCR Worst orientation	**1.06**	**0.43**	**1.10**	**0.32**	**0.57**	**2.25**	**0.77**	**0.67**
BCR Best orientation	**0.47**	**0.43**	**0.82**	**0.25**	**0.51**	**2.29**	**0.79**	**0.64**
Payback period Worst orientation (years)	8.8	30.7	11.9	23.6	16.8	4.1	12.0	14.2
Payback period Best orientation (years)	19.7	30.7	15.9	29.5	18.7	4.1	11.7	14.7

Table 24 contains the results of the sensitivity analysis for shading, glazing and insulation in climate zone 6. It presents the results based on the implementation of all of these energy efficiency interventions, but does not include solar panels as these are not an energy efficiency measure.

Table 24 Sensitivity results for dwelling-based energy interventions: Climate zone 6 – Shading, glazing and insulation only

Sensitivity parameter	PV benefits ($) Worst orientation	PV benefits ($) Best orientation	PV costs ($)	NPV ($) Worst orientation	NPV ($) Best orientation	BCR Worst orientation	BCR Best orientation
Discount rate of 4%	18,405	11,503	16,207	2,198	-4,703	**1.14**	**0.71**
Discount rate of 10%	10,034	6,271	15,479	-5,445	-9,208	**0.65**	**0.41**
CAPEX +20%	13,208	8,255	19,105	-5,897	-10,850	**0.69**	**0.43**
CAPEX -20%	13,208	8,255	12,574	634	-4,319	**1.05**	**0.66**
Utility costs +20%	15,849	9,906	15,839	10	-5,934	**1.00**	**0.63**
Utility costs -20%	10,566	6,604	15,839	-5,273	-9,236	**0.67**	**0.42**

Table 25 contains the results of the sensitivity analysis for energy interventions in climate zone 6. It presents the results based on the implementation of all interventions. The implications of removing HRV and solar battery from the interventions has been tested, owing to the relatively high up-front costs associated with these particular interventions.

Table 25 Sensitivity results for dwelling-based energy interventions: Climate zone 6 – all interventions

Sensitivity parameter	PV benefits ($) Worst orientation	PV benefits ($) Best orientation	PV costs ($)	NPV ($) Worst orientation	NPV ($) Best orientation	BCR Worst orientation	BCR Best orientation
All interventions except HRV and battery	26,257	21,524	21,643	4,614	-118	**1.21**	**0.99**
Discount rate of 4%	50,460	48,773	60,961	-10,502	-12,188	**0.83**	**0.80**
Discount rate of 10%	27,509	26,589	50,128	-22,619	-23,539	**0.55**	**0.53**
CAPEX +20%	36,211	35,000	64,814	-28,603	-29,814	**0.56**	**0.54**
CAPEX -20%	36,211	35,000	43,890	-7,680	-8,890	**0.83**	**0.80**

Sensitivity parameter	PV benefits ($) Worst orientation	PV benefits ($) Best orientation	PV costs ($)	NPV ($) Worst orientation	NPV ($) Best orientation	BCR Worst orientation	BCR Best orientation
Utility costs +20%	43,453	42,000	54,352	-10,899	-12,352	**0.80**	**0.77**
Utility costs -20%	28,968	28,000	54,352	-25,384	-26,352	**0.53**	**0.52**

4.1.3 Climate zone 4 (e.g. Shepparton)

Table 26 contains the results of the CBA for the installation of rainwater tanks that are plumbed for different uses in climate zone 4.

Table 26 CBA results for dwelling-based rainwater tank interventions: Climate zone 4

	ESD intervention: Rainwater tank
	All uses
Present value benefits ($)	159
Present value costs ($)	327
Net present value ($)	-167
Benefit cost ratio	**0.49**
Payback period (years)	23.9

Table 27 contains the results of the sensitivity analysis for the installation of rainwater tanks that are plumbed for all uses in climate zone 4.

Table 27 Sensitivity results for dwelling-based rainwater tank interventions: Climate zone 4 – all uses

Sensitivity parameter	PV benefits ($)	PV costs ($)	NPV ($)	BCR
Discount rate of 4%	222	341	-119	**0.65**
Discount rate of 10%	121	318	-197	**0.38**
CAPEX +20%	159	398	-239	**0.40**
CAPEX -20%	159	255	-96	**0.62**

Sensitivity parameter	PV benefits ($)	PV costs ($)	NPV ($)	BCR
Utility costs +20%	191	327	-135	**0.59**
Utility costs -20%	127	327	-199	**0.39**

Table 28 contains the results of the CBA for energy reduction interventions (i.e. shading, glazing, insulation, heat recovery ventilation (HRV)) in climate zone 4. In addition, it presents the results for the inclusion of solar panels and solar battery storage.

Table 28 CBA results for dwelling-based energy interventions: Climate zone 4

	ESD intervention: Energy measures							
	Shading	Glazing	Insulation	HRV	All energy reduction interventions	Solar	Solar with battery	All interventions
PV benefits ($) Worst orientation	17,092	1,899	2,849	2,849	25,638	14,819	26,279	51,916
PV benefits ($) Best orientation	11,395	2,849	3,798	3,798	21,840	15,049	26,829	48,668
PV costs ($)	7,032	5,798	3,009	13,046	28,885	5,803	25,467	54,352
NPV ($) Worst orientation	10,059	-3,899	-160	-10,197	-3,248	9,015	812	-2,436
NPV ($) Best orientation	4,362	-2,950	790	-9,248	-7,046	9,246	1,362	-5,684
BCR Worst orientation	**2.43**	**0.33**	**0.95**	**0.22**	**0.89**	**2.55**	**1.03**	**0.96**
BCR Best orientation	**1.62**	**0.49**	**1.26**	**0.29**	**0.76**	**2.59**	**1.05**	**0.90**
Payback period Worst orientation (years)	3.8	40.0	13.8	34.2	10.8	3.6	9.0	9.9
Payback period Best orientation (years)	5.7	26.7	10.4	25.7	12.7	3.6	8.8	10.6

Table 29 contains the results of the sensitivity analysis for shading, glazing and insulation in climate zone 7. It presents the results based on the implementation of all of these energy efficiency interventions, but does not include solar panels as these are not an energy efficiency measure.

Table 29 Sensitivity results for dwelling-based energy interventions: Climate zone 4 – Shading, glazing and insulation only

Sensitivity parameter	PV benefits ($) Worst orientation	PV benefits ($) Best orientation	PV costs ($)	NPV ($) Worst orientation	NPV ($) Best orientation	BCR Worst orientation	BCR Best orientation
Discount rate of 4%	30,433	25,141	16,207	14,227	8,934	**1.88**	**1.55**
Discount rate of 10%	16,591	13,706	15,479	1,112	-1,773	**1.07**	**0.89**
CAPEX +20%	21,840	18,041	19,105	2,735	-1,064	**1.14**	**0.94**
CAPEX -20%	21,840	18,041	12,574	9,266	5,467	**1.74**	**1.43**
Utility costs +20%	26,207	21,650	15,839	10,368	5,810	**1.65**	**1.37**
Utility costs -20%	17,472	14,433	15,839	1,632	-1,406	**1.10**	**0.91**

Table 30 contains the results of the sensitivity analysis for energy interventions in climate zone 4. It presents the results based on the implementation of all interventions. The implications of removing HRV and solar battery from the interventions has been tested, owing to the relatively high up-front costs associated with these particular interventions.

Table 30 Sensitivity results for dwelling-based energy interventions: Climate zone 4– all interventions

Sensitivity parameter	PV benefits ($) Worst orientation	PV benefits ($) Best orientation	PV costs ($)	NPV ($) Worst orientation	NPV ($) Best orientation	BCR Worst orientation	BCR Best orientation
All interventions except HRV and battery	36,658	33,090	21,643	15,016	11,448	**1.69**	**1.53**
Discount rate of 4%	72,346	67,819	60,961	11,384	6,858	**1.19**	**1.11**
Discount rate of 10%	39,440	36,972	50,128	-10,688	-13,156	**0.79**	**0.74**
CAPEX +20%	51,916	48,668	61,009	-9,093	-12,341	**0.85**	**0.80**
CAPEX -20%	51,916	48,668	47,695	4,222	973	**1.09**	**1.02**

Sensitivity parameter	PV benefits ($) Worst orientation	PV benefits ($) Best orientation	PV costs ($)	NPV ($) Worst orientation	NPV ($) Best orientation	BCR Worst orientation	BCR Best orientation
Utility costs +20%	62,300	58,402	54,352	7,948	4,050	**1.15**	**1.07**
Utility costs -20%	41,533	38,935	54,352	-12,819	-15,418	**0.76**	**0.72**

4.2 Subdivision-based ESD interventions

4.2.1 Water interventions

Table 31 contains the results of the CBA for subdivision-based rainwater interventions (for all uses) based on climate zone 6 for three subdivision scales.

Table 31 CBA results for subdivision-based rainwater tank interventions

	ESD intervention: Rainwater tank, All uses		
	10 lots	100 lots	500 lots
Present value benefits ($)	3,783	37,828	189,141
Present value costs ($)	3,265	32,653	163,267
Net present value ($)	517	5,175	25,874
Benefit cost ratio	**1.16**	**1.16**	**1.16**

Table 32 contains the results of the sensitivity analysis for subdivision-based rainwater tank interventions (for all uses) based on climate zone 6 for three subdivision scales.

Table 32 Sensitivity results for subdivision-based rainwater tank intervention

	10 lots				100 lots				500 lots			
Sensitivity parameter	PV benefits ($000)	PV costs ($000)	NPV ($000)	BCR	PV benefits ($000)	PV costs ($000)	NPV ($000)	BCR	PV benefits ($000)	PV costs ($000)	NPV ($000)	BCR
Discount rate of 4%	5	3	2	**1.55**	53	34	19	**1.55**	264	170	93	**1.55**
Discount rate of 10%	3	3	0	**0.90**	29	32	-3	**0.90**	144	159	-15	**0.90**
CAPEX +20%	4	4	0	**0.95**	38	40	-2	**0.95**	189	199	-10	**0.95**
CAPEX -20%	4	3	1	**1.48**	38	25	12	**1.48**	189	127	62	**1.48**
Utility costs +20%	5	3	1	**1.39**	45	33	13	**1.39**	227	163	64	**1.39**
Utility costs -20%	3	3	0	**0.93**	30	33	-2	**0.93**	151	163	-12	**0.93**

4.2.2 Energy interventions

Table 33 contains the results of the CBA for subdivision-based energy interventions (all interventions) based on climate zone 6 for three subdivision scales.

Table 33 CBA results for subdivision-based energy interventions

	ESD intervention: Energy, All uses		
	10 lots	100 lots	500 lots
Present value benefits ($) Worst orientation	362,106	3,621,060	18,105,299
Present value benefits ($) Best orientation	350,003	3,500,031	17,500,154
Present value costs ($)	543,521	5,435,205	27,176,026
Net present value ($) - Worst orientation	-181,415	-1,814,145	-9,070,727
Net present value ($) - Best orientation	-193,517	-1,935,174	-9,675,872
Benefit cost ratio – Worst orientation	**0.67**	**0.67**	**0.67**
Benefit cost ratio – Best orientation	**0.64**	**0.64**	**0.64**

Table 34 contains the results of the sensitivity analysis for subdivision-based energy interventions (for all interventions) based on climate zone 6 for three subdivision scales.

Table 34 Sensitivity results for subdivision-based energy interventions – best orientation

	10 lots				100 lots				500 lots			
Sensitivity parameter	PV benefits ($000)	PV costs ($000)	NPV ($000)	BCR	PV benefits ($000)	PV costs ($000)	NPV ($000)	BCR	PV benefits ($000)	PV costs ($000)	NPV ($000)	BCR
All interventions except HRV and battery	215	216	-1	**0.99**	2,152	2,164	-12	**0.99**	10,762	10,821	-59	**0.99**
Discount rate of 4%	488	610	-122	**0.80**	4,877	6,096	-1,219	**0.80**	24,387	30,481	-6,094	**0.80**
Discount rate of 10%	266	501	-235	**0.53**	2,659	5,013	-2,354	**0.53**	13,295	25,064	-11,769	**0.53**
CAPEX +20%	350	648	-298	**0.54**	3,500	6,481	-2,981	**0.54**	17,500	32,407	-14,907	**0.54**
CAPEX -20%	350	439	-89	**0.80**	3,500	4,389	-889	**0.80**	17,500	21,945	-4,445	**0.80**
Utility costs +20%	420	544	-124	**0.77**	4,200	5,435	-1,235	**0.77**	21,000	27,176	-6,176	**0.77**
Utility costs -20%	280	544	-264	**0.52**	2,800	5,435	-2,635	**0.52**	14,000	27,176	-13,176	**0.52**

Table 35 Sensitivity results for subdivision-based energy interventions – worst orientation

	10 lots				100 lots				500 lots			
Sensitivity parameter	PV benefits ($)	PV costs ($)	NPV ($)	BCR	PV benefits ($)	PV costs ($)	NPV ($)	BCR	PV benefits ($)	PV costs ($)	NPV ($)	BCR
All interventions except HRV and battery	263	216	46	**1.21**	2,626	2,164	461	**1.21**	13,129	10,821	2,307	**1.21**
Discount rate of 4%	505	610	-105	**0.83**	5,046	6,096	-1,050	**0.83**	25,230	30,481	-5,251	**0.83**

	10 lots				100 lots				500 lots			
Sensitivity parameter	PV benefits ($)	PV costs ($)	NPV ($)	BCR	PV benefits ($)	PV costs ($)	NPV ($)	BCR	PV benefits ($)	PV costs ($)	NPV ($)	BCR
Discount rate of 10%	275	501	-226	**0.55**	2,751	5,013	-2,262	**0.55**	13,754	25,064	-11,310	**0.55**
CAPEX +20%	362	648	-286	**0.56**	3,621	6,481	-2,860	**0.56**	18,105	32,407	-14,302	**0.56**
CAPEX -20%	362	439	-77	**0.83**	3,621	4,389	-768	**0.83**	18,105	21,945	-3,840	**0.83**
Utility costs +20%	435	544	-109	**0.80**	4,345	5,435	-1,090	**0.80**	21,726	27,176	-5,450	**0.80**
Utility costs -20%	290	544	-254	**0.53**	2,897	5,435	-2,538	**0.53**	14,484	27,176	-12,692	**0.53**

4.2.3 Enhanced canopy cover

Enhanced canopy cover is associated with a range of benefits, including reductions in the urban heat island effect, improved property value (potentially), improved amenity, and from the provision of habitat.

Table 36 contains a breakeven analysis of enhancing canopy cover. The results reflect the value that the benefits from enhancing canopy would have to be, to equal the costs associated with the intervention over the 30 years of the assessment. Results are presented on a per lot basis and a per person basis for the three subdivision sizes considered.

The results suggest that the combined benefits would have to be equal to, or greater than, $994 per lot to be cost beneficial, for a 10 lot subdivision over 30 years. For the larger subdivisions, the benefits would have to be equal to, or greater than, $1,114 – $556,899 per lot. This reflects the larger number of trees required to achieve canopy cover of 25 per cent.

It should be noted that economies of scale have not been included within the capital or maintenance costs, owing to a lack of information to support this. The 100 lot and 500 lot subdivisions have been assumed to have the same ratio of trees to lots and trees per capita hence there is no difference in the overall cost values.

Table 36 Breakeven analysis of enhancing canopy cover

	10 lots	100 lots	500 lots
CAPEX ($)	8,333	93,375	466,875
O&M costs ($)	4,667	52,290	261,450
Present value costs ($)	9,940	111,380	556,899

	10 lots	100 lots	500 lots
Breakeven value of present value benefits per lot ($)	994	1,114	1,114
Breakeven value of present value benefits per person ($)	414	472	472

Table 37 contains the results of sensitivity testing of key inputs to the breakeven analysis. Sensitivity testing was undertaken for 30 and 40 per cent canopy coverage to reflect the higher targets across the municipalities (e.g. 40 per cent canopy cover reflects the targets in Greater Shepparton City Council Urban Forest Strategy 2017- 2037 (Urban Forest Consulting, 2017) and Today Tomorrow Together The Ballarat Strategy Our Vision for 2040 (Ballarat, 2013).

The results suggests that the analysis is sensitive to assumptions regarding canopy coverage target and O&M costs, which account for a relatively high component of the overall costs.

Table 37 Sensitivity results for capital, O&M costs, and discount rate: Enhanced canopy cover

	10 lots	100 lots	500 lots
Capital costs (+20%) ($)			
Breakeven value of present value benefits per lot ($)	1,157	1,297	1,297
Breakeven value of present value benefits per person ($)	482	550	550
Capital costs (-20%) ($)			
Breakeven value of present value benefits per lot ($)	831	931	931
Breakeven value of present value benefits per person ($)	346	394	394
O&M costs (+20%) ($)			
Breakeven value of present value benefits per lot ($)	1,029	1,153	1,153
Breakeven value of present value benefits per person ($)	429	489	489
O&M costs (-20%) ($)			
Breakeven value of present value benefits per lot ($)	959	1,074	1,074
Breakeven value of present value benefits per person ($)	399	455	455
Discount rate of 4%			
Breakeven value of present value benefits per lot ($)	1,081	1,211	1,211

	10 lots	100 lots	500 lots
Breakeven value of present value benefits per person ($)	450	513	513
Discount rate of 10%			
Breakeven value of present value benefits per lot ($)	939	1,053	1,053
Breakeven value of present value benefits per person ($)	391	446	446
Canopy area of 30%			
Breakeven value of present value benefits per lot ($)	1,312	1,456	1,456
Breakeven value of present value benefits per person ($)	547	617	617
Canopy area of 40%			
Breakeven value of present value benefits per lot ($)	1,948	2,140	2,140
Breakeven value of present value benefits per person ($)	812	907	907

4.2.4 Increased use of recycled road material

The use of recycled road material is associated with a range of benefits, including avoided use of virgin materials, avoided disposal of waste at landfill sites, avoided cost of disposing waste at landfill sites, reduced GHG emissions.

Table 38 contains a breakeven analysis of increasing the use of recycled road material. The results reflect the value that the benefits from using recycled material would have to be, to equal the costs associated with the intervention over the 30 years of the assessment. Results are presented on a per lot basis and a per person basis for the three subdivision sizes considered.

The results suggest that the combined benefits would have to be equal to, or greater than, $253 per lot, for a 10 lot subdivision over 30 years. This amount falls slightly when considering larger subdivisions. It should be noted that challenges remain in developing commercially viable aggregate recycling operations in smaller and more remote regional areas as there is typically not enough raw material generated in a centralised area within a manageable timeframe to develop an economy of scale (Pitt&Sherry, 2014).

Table 38 Breakeven analysis of increasing the use of recycled road material

	10 lots	100 lots	500 lots
CAPEX ($)	6,060	56,055	280,275
O&M costs ($)	-	-	-
Present value costs ($)	6,060	56,055	280,275

	10 lots	100 lots	500 lots
Breakeven value of present value benefits per lot ($)	606	561	561
Breakeven value of present value benefits per person ($)	253	238	238

Table 39 contains the results of sensitivity testing of key inputs to the breakeven analysis. It suggests that the analysis is sensitive to assumptions regarding capital costs. This is because there is not an assumed difference in O&M between recycled and conventional materials. This also has implications for the sensitivity of the results to the discount rate.

Table 39 Sensitivity results for capital, O&M costs, and discount rate: Increased use of recycled road material

	10 lots	100 lots	500 lots
Capital costs (+20%) ($)	7,272	67,266	336,330
Breakeven value of present value benefits per lot ($)	727	673	673
Breakeven value of present value benefits per person ($)	303	285	285
Capital costs (-20%) ($)	4,848	44,844	224,220
Breakeven value of present value benefits per lot ($)	485	448	448
Breakeven value of present value benefits per person ($)	202	190	190
O&M costs (+20%) ($)	6,060	56,055	280,275
Breakeven value of present value benefits per lot ($)	606	561	561
Breakeven value of present value benefits per person ($)	253	238	238
O&M costs (-20%) ($)	6,060	56,055	280,275
Breakeven value of present value benefits per lot ($)	606	561	561
Breakeven value of present value benefits per person ($)	253	238	238
Discount rate of 4%			
Breakeven value of present value benefits per lot ($)	606	561	561
Breakeven value of present value benefits per person ($)	253	238	238

	10 lots	100 lots	500 lots
Discount rate of 10%			
Breakeven value of present value benefits per lot ($)	606	561	561
Breakeven value of present value benefits per person ($)	253	238	238

4.2.5 Increased use of WSUD

The use of WSUD is associated with a range of benefits, including from reduced water treatment costs, large scale (wetland) biodiversity value, improved water quality for receiving environments, increased visual and recreational amenity of developments.

Table 40 contains a breakeven analysis of increasing the use of WSUD. The results reflect the value that the benefits from improving management of water flows would have to be, to equal the costs associated with the intervention over the 30 years of the assessment. Results are presented on a per lot basis and a per person basis for the three subdivision sizes considered.

The results suggest that the combined benefits would have to be equal to, or greater than, $3,824 per lot to be cost beneficial, for a 100 lot subdivision over 30 years. For a 500 lot subdivisions, economies of scale in construction reduce the required benefits to $2,037 per lot.

Table 40 Breakeven analysis of increased use of WSUD

	10 lots*	100 lots	500 lots
CAPEX ($)	n.a.	304,930	762,324
O&M costs ($)	n.a.	160,088	533,627
Present value costs ($)	n.a.	382,362	1,018,290
Breakeven value of present value benefits per lot ($)	n.a.	3,824	2,037
Breakeven value of present value benefits per person ($)	n.a.	1,620	863

* Costs have not been estimated for raingardens within 10 lot subdivisions as the area of public realm space would not support this type of WSUD.

Table 41 contains the results of sensitivity testing of key inputs to the breakeven analysis. It suggests that the analysis is sensitive to assumptions regarding capital costs.

Table 41 Sensitivity results for capital, O&M costs, and discount rate: increased use of WSUD

	10 lots	100 lots	500 lots
Capital costs (+20%) ($)	n.a.	365,916	914,789
Breakeven value of present value benefits per lot ($)	n.a.	4,433	2,342
Breakeven value of present value benefits per person ($)	n.a.	1,879	992
Capital costs (-20%) ($)	n.a.	243,944	609,859
Breakeven value of present value benefits per lot ($)	n.a.	3,214	1,732
Breakeven value of present value benefits per person ($)	n.a.	1,362	734
O&M costs (+20%) ($)	n.a.	304,930	762,324
Breakeven value of present value benefits per lot ($)	n.a.	3,978	2,139
Breakeven value of present value benefits per person ($)	n.a.	1,686	906
O&M costs (-20%) ($)	n.a.	304,930	762,324
Breakeven value of present value benefits per lot ($)	n.a.	3,669	1,934
Breakeven value of present value benefits per person ($)	n.a.	1,555	820
Discount rate of 4%	n.a.		
Breakeven value of present value benefits per lot ($)	n.a.	4,056	2,186
Breakeven value of present value benefits per person ($)	n.a.	1,719	926
Discount rate of 10%	n.a.		
Breakeven value of present value benefits per lot ($)	n.a.	3,679	1,942
Breakeven value of present value benefits per person ($)	n.a.	1,559	823

5.0 Discussion and limitations

5.1 Dwelling-based ESD interventions

5.1.1 Key findings

Water interventions

The results of the CBA suggest that the adoption of rainwater tanks that are plumbed for washing machine and toilet use are marginally cost-beneficial in climate zones 6 and 7, however the intervention is not cost beneficial in climate zone 4.. This is because of the relatively low cost of water in climate zone 4 (Mildura), which means that potable water savings are not sufficiently large to offset the capital, operating and maintenance costs associated with pump operation over the assessment period. However, it should be noted that the analysis assumes that electricity is supplied via the grid, and not via, for example solar power.

The payback period was 10 years in climate zone 6 and 11 years in climate zone 7). In climate zone 4, which experiences significantly less annual rainfall, the interventions payback period was 24 years because the value of water savings barely covers the extra cost incurred to plumb the tank to the washing machine and extra operating and maintenance costs associated with the connected appliances over the period of the assessment.

For climate zone 7 and 6 changes to any of the disadvantageous sensitivity parameters (i.e. increasing the discount rate, higher capex costs, and lower utility costs) reduced the BCR to <1, suggesting that the results are sensitive to these parameters. For climate zone 4, changes to any of the advantageous sensitivity parameters (i.e. lower discount rate, lower capex costs and increased utility costs) did not result in a BCR>1.

Energy interventions

The results suggest that orientation is a no / relatively low cost intervention and that results in benefits across all the climate zones that were assessed. The difference in energy use in an average single storey dwelling with best orientation (e.g. north-facing living spaces) and worst orientation (e.g. south-facing living spaces) was:

- Climate zone 4: 10 kW.h/m^2, which equates to approximately $760 per household per annum, based on current electricity prices
- Climate zone 6: 4 kW.h/m^2 , which equates to approximately $300 per household per annum, based on current electricity prices
- Climate zone 7: 7 kW.h/m^2, which equates to approximately $460 per household per annum, based on current electricity prices

Orientation impacts the effectiveness of shading and solar interventions. For example, if the dwelling has poor orientation, the reduction in energy use associated with shading is greater, than if the dwelling has good orientation, where shading needs have been mitigated through design. Energy reduction interventions with poorer orientation have greater BCRs in the moderate climate, climate zone 6. Conversely, in the hot and cold climates, climate zones 4 and 7 respectively, having poorer orientation reduces the benefit of implementing most interventions except shading.

- The installation of solar panels were found to result in a positive BCR in all climate zones, with payback periods as follows: 3.6 years (climate zone 4); 4.1 years (climate zone 6); and 3.8 years (climate zone 7). The results for the installation of shading, glazing and insulation are mixed and depend on the climate zone and assumptions regarding orientation:
- Shading results in a BCR <1 in climate zone 6 and 7, but in climate zone 4 the BCR >1, suggesting that it is cost-beneficial to adopt this measure in climate zone 4. Payback periods are

as follows: climate zone 4 (3.8 – 5.7 years); climate zone 6 (8.8 - 19.7 years) and climate zone 7 (11.4 – 17.2 years), depending on orientation[14].

- Glazing results in a BCR <1 in all climate zones that were assessed. Payback periods are estimated as follows: climate zone 4 (40.0 – 26.7 years); climate zone 6 (30.7 years); and climate zone 7 (16.0 – 13.3 years), depending on orientation[15].
- Insulation results in a BCR > 2.8 in climate zone 7, suggesting that it is cost-beneficial to implement this measure. In climate zones 4 and 6, the results were less conclusive, with BCRs ranging between 0.82 and 1.26, suggesting that the benefits of insulation are more marginal in these climates. Payback periods are estimated as follows: climate zone 4 (13.8 – 10.4 years); climate zone 6 (11.9 – 15.9 years); and climate zone 7 (5.2 – 4.6 years).

The costs associated with the installation and operation of HRV and solar batteries were found to outweigh the benefits in all climate zones that were assessed. However, as these interventions become more common place, and demand increases, the capital costs are likely to decline, which will alter the cost benefit ratio and payback period. For example, the cost of lithium-ion batteries has fallen by 80 per cent since 2010 and costs are expected to halve again by 2025 (Climate Council of Australia, 2018) .

Sensitivity analysis results

Sensitivity testing was undertaken to understand the impact that changes in assumptions relating to key variables may have, for example discount rate, capital costs and the price of water and energy.

In the colder and moderate climate zones , (7 and 6 respectively) reducing the discount rate and capital cost and increasing water costs resulted in a BCR>1. The opposite movements in sensitivity tests for these climate zones resulted in a BCR<1. This indicates the financial viability of the intervention is marginal. In climate zone 4 under all sensitivity tests, rainwater tanks connected for washing machines and toilets resulted in a BCR <1, indicating it is not viable.

When considering just shading, glazing and insulation in all climate zones, a discount rate of 4 per cent; a reduction in capex of -20 per cent; and an increase in utility costs of 20 per cent all resulted in BCR equal to or greater than 1.

In all climate zones, excluding HRV and solar batteries from the suite of other energy interventions resulted in BCR >1. Removing HRV and solar batteries made the biggest difference in climate zone 4, where the BCR became 1.7 (for worst orientation). This suggests that installing shading, glazing, insulation and solar panels as a package of interventions is cost-beneficial.

In climate zone 4, an increase in utility costs by 20 per cent results in all energy interventions (excluding HRV and solar batteries) just breaking even (i.e. BCR = ~1). This suggests that, of all the regions assessed, climate zone 4 seems more likely to achieve BCRs >1, with the implementation of energy interventions. Further, more detailed case studies, relating to the implementation of energy use interventions from this climate zone will strengthen the evidence base.

5.2 Subdivision-based ESD interventions

5.2.1 Key findings

It is difficult to accurately estimate non-dwelling interventions at the subdivision-based scale because to do so requires detailed information connecting the physical impact associated with the implementation of the ESD intervention and the associated financial impact, relative to the base case. This is challenging to do based on a hypothetical subdivision, where the financial impact is site specific, and where non-market valuation literature is not readily available (e.g. the value that people place on enhanced habitat as a result of the installation of bio-links / green corridors).

[14] Shading results in greatest benefits to dwellings that have poor orientation. Hence the payback period is lower for dwellings with poor orientation.
[15] Glazing results in greatest benefits to dwellings that have good orientation. Hence the payback period is lower for dwellings with good orientation.

As a result, the subdivision-based CBA has focused on scaling-up the results from the dwelling-based water and energy interventions. The results of the dwelling-based interventions were scaled up to reflect the size of the subdivisions considered in this study (i.e. 10 lots, 100 lots and 500 lots). The BCR and payback periods are therefore the same as for the dwelling-based assessment.

Case studies obtained from the literature review provide evidence that there are benefits from adopting ESD measures. Furthermore, the magnitude of the benefits are less driven by climate than the dwelling-based interventions and, therefore may be more appropriate for a wider number of climate zones. Examples of the benefits associated with the ESD principles include:

- optimise site potential, see section 3.1 for case study on:
  - The benefits of optimised orientation
- reduced footprint, see section 3.2 for case studies on:
  - The costs and benefits of sustainable subdivision interventions: Armstrong Creek
  - Improving dwelling energy efficiency
  - Reduced carbon footprint through the use of recycled materials in infrastructure
  - Maintaining public open space with less water
  - Third pipe / stormwater harvesting at the subdivision scale
- places for people, see section 3.3 for case studies on:
  - Monetising health outcomes of increased walking and cycling
  - The costs of installing footpaths on both sides of the street
  - Willingness to pay for community health opportunities
  - The benefits of improved street design
- enhanced ecology, see section 3.4 for case studies on:
  - Calculating the value of trees
  - Water savings with indigenous and drought tolerant plants
  - Creating bio-links / green corridors early in strategic planning stage
  - The value of low-carbon housing policy

The results of the qualitative assessment of the subdivision interventions suggest a number of the interventions result in up-front costs that would likely be borne by developers and require on-going expenditure on operation and maintenance that would likely be borne by council. Therefore requiring developers to install these interventions will address only part of the challenge of achieving widespread adoption.

Interventions that are likely to involve significantly more operating and maintenance costs to BAU as usual practices include:

- Installation of small scale dispersed WSUD within the subdivision not aligned with open space
- Precinct scale stormwater capture and treatment for public space irrigation and toilets
- Installation of battery storage at the subdivision scale (off-set by sale of power)
- Subdivision scale organic waste management
- Creation of a bio-link / green corridor, where this is not part of a BAU requirement

Interventions that are likely to confer benefits across current climate zones and to involve no cost or similar (or lower) maintenance costs for councils, relative to BAU practices and which therefore may be considered low cost / low regrets interventions include:

- subdivision has appropriate solar orientation, for both public areas and dwellings
- reduction in impervious surfaces throughout the subdivision
- reduction in construction waste (i.e. recycling and more accurate construction material estimation). It may also include sustainable infrastructure.
- construction with recycled materials e.g. for roads
- diversity of dwellings within the subdivision
- installation of footpaths on both sides
- installation of separated bicycle paths (or shared footpath / bicycle paths)
- continual shading of footpaths and roads
- installation of footpaths to provide connection to amenities and neighbouring areas
- provision to connect with local public transport
- use of drought tolerant and indigenous plants
- increased canopy cover
- retention of mature trees
- use of low-energy street lighting

All of the interventions are likely to result in benefits for house owners. These are either direct benefits (such as potential improvements in property value, improved amenity and connectivity) or indirect benefits (such as use reduced household waste to landfill).

Many of the interventions also result in benefits for the wider community (of which developers are part) and councils. These benefits include reduced health care costs associated with increased physical activity, improved safety from separated bicycle paths, and reduced resource use and greenhouse gas emissions associated with reduced construction waste.

This mix of direct and indirect beneficiaries makes a beneficiary- pays approach to funding ESD subdivision-based interventions challenging and requires innovative thinking if widespread adoption is to be achieved.

The breakeven analysis suggests that scale is important when considering the costs and benefits of implementation of ESD measures within subdivisions.

A summary of the results from the breakeven analysis are contained in Table 42. It highlights the breakeven value varying in non-linear ways, which is, in part, due to the physical assumptions used to characterise the subdivisions.

Table 42 Summary breakeven analysis results (present value benefit per lot)

	10 lots	100 lots	500 lots
Enhanced canopy cover	$994	$1,114	$1,114
Increased use of recycled road material	$ 606	$561	$561
Increased use of WSUD	n.a*.	$2,913	$1,551

* Costs have not been estimated for raingardens within 10 lot subdivisions as the area of public realm space would not support this type of WSUD.

The estimates contained in Table 42 reflect the combined value that the benefits from the interventions would have to take over a 30 year period to be cost-beneficial. Based on the assumptions outlined in Section 2.4, the results suggest that the increased use of recycled road material has the lowest break even value of all the interventions analysed. This result provides further support for the findings of the IDM Sustainable Infrastructure Guidelines (Pitt&Sherry, 2014).

5.3 Limitations

The results presented in this report are based on high level assessment involving a hypothetical 'typical dwelling' and is intended to provide an indication of the relative costs and benefits of each of the dwelling-based ESD interventions. The assessment has not been based on a detailed master plan,

concept plan or any detailed design specifications and therefore should be considered indicative of potential savings rather than actual savings.

It has been necessary to make a number of assumptions regarding the hypothetical dwelling, which are discussed in Section 2.0. Different assumptions will lead to different results; however we have used sensitivity testing to attempt to understand the impact that changes in assumptions relating to key variables may have, for example discount rate, capital costs and the price of water and energy.

The nature of the CBA framework requires detailed description of the base case and intervention that are the subject of the analysis. This project has involved attempting to estimate the cost and benefits of different ESD interventions applied to three hypothetical greenfield subdivisions. It has not been possible to establish a robust basis for estimating the cost and benefits of particular ESD interventions in these hypothetical subdivisions. Instead, a literature review has been performed to identify qualitative and quantitative costs and benefits. Therefore, it has not been possible to explore the impact of size of the subdivision on the costs and benefits.

Instead, a breakeven analysis on selected subdivision ESD interventions has been undertaken. The results provide an indication of benefits that would have to be obtained for the interventions to be cost-beneficial. It should be noted that the results of the breakeven analysis are highly dependent on the assumed physical characteristics of the three subdivisions. Caution should be exercised when interpreting the results.

From a hypothetical perspective, a larger subdivision tends to increase the range of ESD interventions that could be cost-effectively implemented because of the opportunities to take advantage of economies of scale in construction, or different technologies that may allow a greater quantum of benefits to be obtained (e.g. grid-scale storage).

5.4 Implications for policy

What are the low-cost, low regrets interventions?

While the dwelling-based ESD interventions facilitate a reduction in resource use, the results of the CBA suggest that the benefits of adopting these interventions do not always exceed the costs in the three climate zones included in the study.

However, the analysis suggest that orientation is a no / low cost intervention and results in benefits across all the climate zones that were assessed.

In addition, there are a number of subdivision-scale interventions that are likely to confer benefits across current climate zones and involve no cost or similar (or lower) maintenance costs for councils, relative to BAU practices and which therefore may be considered low cost / low regrets interventions, if capital funding can be secured. These include:

- subdivision has appropriate solar orientation, for both public areas and dwellings
- reduction in impervious surfaces throughout the subdivision (e.g. through implementation of the IDM SIG)
- reduction in construction waste (i.e. recycling and more accurate construction material estimation)
- recycled materials (where these are readily available)
- diversity of dwellings within the subdivision
- installation of footpaths on both sides
- installation of separated bicycle paths (or shared footpath / bicycle paths)
- continual shading of footpaths and roads
- installation of footpaths to provide connection to amenities and neighbouring areas
- more diversity in street / road design (e.g. ‘shared zone’)
- provision to connect with local public transport
- use of drought tolerant and indigenous plants
- increased canopy cover
- retention of mature trees
- use of low-energy street lighting

- wider nature strips

Other dwelling-based interventions (such as window placement and size, use of thermal mass, zoning of spaces and draft-proofing / building sealing) have not been modelled, but have potential to reduce energy consumption and are relatively inexpensive, especially when considered in the design / planning phase.

What factors influence the results?

Climate and the price of energy and water are important factors in determining the BCR and payback period associated with the interventions. However, the results from this analysis have not taken the following into account:

- Climate change projections – future climate change projections have not been included in the analysis, which has implications for the anticipated benefits from the adoption of the ESD measures. More extreme weather events and a trend towards a hotter, drier climate is likely to improve the results from interventions designed to reduce energy and water use.
- Trends in energy and water prices – which influences the value of the savings achieved with the interventions. Increases in energy and water prices over time has the potential to improve the results from interventions designed to reduce energy and water use.
- Reducing emissions intensity of the electricity supply grid – which influences the potential greenhouse gas reduction possible as the proportion of energy from renewables increases.

Interventions such as heat recovery ventilation and batteries for storing solar energy, currently involve high capital costs, relative to the benefits that are associated with these interventions, which results in particularly high payback periods relative to other interventions. Over time, the cost of such technologies has the potential to fall, which may mean that they become more cost-beneficial; e.g. the cost of lithium-ion batteries is predicted to halve in seven years (Climate Council of Australia, 2018). However, it is important to note that, for HRV, climate will still play an important role in determining the overall benefits.

This suggests measures to encourage the adoption of ESD interventions may need to be more nuanced than a ‘one size fits all’ approach across Victoria’s climate regions for water and energy .

Who bares the costs and who benefits?

Dwelling-based ESD interventions primarily benefit home owners through improved comfort and reduced consumption of water and energy. The capital / construction cost associated with these interventions is borne by the developer and typically passed on to home owners.

These up-front costs are lower if the ESD interventions are included in the dwelling design, rather than being retrofitted afterwards. Operating and maintenance costs associated with the ESD interventions tend to be zero, or relatively low, except for rainwater tanks with pumps and HRV. This may be an important consideration when communicating the benefits of ESD interventions.

The capital / construction costs of subdivision-based interventions are typically borne by developers, but the beneficiaries can include home owners, councils and the wider community. The operating and maintenance costs associated with these interventions can range from negligible (e.g. a second footpath to facilitate active travel) to relatively high (e.g. maintaining WSUD features). This provides challenges for funding such interventions.

Next steps

There are social, economic and environmental benefits associated with ESD in regional subdivisions. These benefits differ across Victoria’s climate regions, as does the nature and capacity of the residential development industry. While the period of analysis was 30 years, the life of a residential subdivision is much more enduring and so subdivision wide sustainability measures warrant greater consideration.

To advance ESD subdivisions in regional Victoria will require:

- More research into the subdivision interventions that have low operating / maintenance requirements, especially focused on understanding the difference in cost and benefits relative to

BAU. This could take the form of CBA case studies based on existing / or planned subdivisions that have incorporated ESD features and would help to strengthen the evidence base.

- Direct engagement with land surveyors and development engineers to understand the drivers of land subdivision plans and to educate them about the value created through orientation. This could include pilot projects between council's and developers to showcase ESD features at the subdivision scale.
- Consideration of innovative funding models for encouraging adoption of subdivision interventions, especially where this involves relatively large capital costs, such as green loans, deferred payments, or fast track approvals for ESD developments. For example, the Victorian Government will contribute up to $10 million in grant funding over four years to develop and implement state wide demonstration projects, using microgrid models.[16]
- Exploration of potential case studies or research projects to collate longitudinal data so as to be able to more accurately compare BAU to ESD subdivision over time.

[16] See https://www.energy.vic.gov.au/microgrids. Accessed 25 March 2018.

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Appendix A

ESD interventions and the subdivision characteristics

Appendix A ESD interventions and the subdivision characteristics

Table 43 provides the overarching assumptions about the subdivisions for each of the cost benefit analysis scenarios.

Table 43 Assumed physical characteristics of scenarios

	Scenario #1 10 lots	Scenario #2 100+ lots	Scenario #3 Master planned 500+ lots
Lots	10 lots	100 lots	500 + lots
Population*	24 residents	236 residents	1,180+ residents
Dwellings	Separate 4 bedroom dwellings	• 80% separate 4 bedroom dwellings on 600m^2 lots • 20% townhouses or units 350m^2 lots	• 80% separate 4 bedroom dwellings on 600m^2 lots • 20% townhouses or units on 350m^2 lots
Greenspace - recreation	No additional open space (5% public open space contribution as cash in lieu)	1 pocket park with minimum dimension of 50m	1 park or oval and pocket parks (400m walkable catchment)
Green canopy and corridors	• Street trees as mature and continuous as possible; of diverse species suited to future climate change projection scenarios • Specify 25% of canopy cover	• Street trees as mature and continuous as possible; of diverse species suited to future climate change projection scenarios • Specify 25% of canopy cover	• Street trees as mature and continuous as possible; of diverse species suited to future climate change projection scenarios • Specify 25% of canopy cover • 1 -2 green corridors /walkways

* Population assumptions are based upon the average household size for regional Victoria (ABS Census 2016) being 2.36 persons per dwelling http://profile.id.com.au/australia/household-size?WebID=190

Table 44 provides the assumptions used define the cost benefit analyses for each scenario.

Table 44 Proposed ESD scenarios for CBA modelling

Principles	Subdivision intervention	BAU	Scenario #1 **10 lots** 24 residents	Scenario #2 **100 lots** 236 residents	Scenario #3 **Master planned** **500+ lots** 1,180+ residents
Optimise site potential	Improved lot design	At least 70% appropriate solar orientation (Cl. 56)	80% appropriate solar (and 100% of dwellings optimise their design accordingly)	80% appropriate solar orientation (and 100% of dwellings optimise their design accordingly)	80% appropriate solar orientation (and 100% of dwellings optimise their design accordingly)
Reduce footprint	Reduced potable water use	Rainwater tank installed and connected for flushing appliances is an optional requirement	100% of households with RWT connected for toilets, washing machine, and gardens	100% of households with RWT connected for gardens, toilets, washing machine	100% of households with RWT connected for gardens, toilets, washing machine
	Improved management of stormwater run-off	Generally a Stormwater Management Strategy is required for development (IDM). Specifics dependent upon surrounding development context etc.	Stormwater Management Strategy	Use of WSUD and 30% reduction in impervious surfaces throughout subdivision.	• Use of WSUD and 30% reduction in impervious surfaces integrated with subdivision public open space. • Precinct scale stormwater treatment for irrigating or toilet flushing in public spaces
	Thermal performan	NatHERS 6 star or	NatHERS 7.5	NatHERS 7.5 and higher star	NatHERS 7.5 and higher star

Principles	Subdivision intervention	BAU	Scenario #1 **10 lots** 24 residents	Scenario #2 **100 lots** 236 residents	Scenario #3 **Master planned** **500+ lots** 1,180+ residents
	ce and reduced demand	higher to be achieved through combination of: - sealing - glazing - sun shading		rating	rating
	Enhanced energy generation and storage	Currently no requirements. Widespread voluntary uptake	• 100% dwellings with Photovoltaic cells (solar) (4kW system) • Installation of : - smart grid technology or other - battery storage	• 100% dwellings with Photovoltaic cells (solar) (4kW system) • Installation of : - smart grid technology or other - battery storage	• 100% dwellings with Photovoltaic cells (solar) (4kW system) • Installation of : - smart grid technology or other - battery storage
	Minimise household waste to landfill	Provision of municipal waste collection and management services	Provision of municipal waste collection and management services	On-site / subdivision management of food and garden waste, and municipal services	On-site / subdivision management of food and garden waste, and municipal services
	Minimise constructio	Significant earthworks	50% reduction in earthworks	50% reduction in earthworks	50% reduction in earthworks

Principles	Subdivision intervention	BAU	Scenario #1 **10 lots** 24 residents	Scenario #2 **100 lots** 236 residents	Scenario #3 **Master planned** **500+ lots** 1,180+ residents
	n waste to landfill	and construction waste to landfill	spoil and construction waste to landfill and 80% of waste recycled	spoil and construction waste to landfill and 80% of waste recycled	spoil and construction waste to landfill and 80% of waste recycled
Places for people	Improved dwelling and lot diversity	Current practice – PSPs, master planning can cater. If no plan required, no diversity requirement.	Not applicable	• Mixed-densities and dwelling sizes i.e. 80% standalone dwelling, 20% townhouses and units	• Mixed-densities and dwelling sizes i.e. 80% standalone dwelling, 20% townhouses and units
	Improved connectivity	Provision of footpaths on both sides and non-separated bicycle lane (IDM)	Provision of footpaths on both sides and non-separated bicycle lane	• Footpaths both sides, • Separated bicycle lanes • Continual tree shading of footpaths • Connections to amenities and neighbouring areas • Subdivision design encourages walking • Provision to connect to local public transport services	• Footpaths both sides, • Separated bicycle lanes • Continual tree shading of footpaths • Connections to amenities and neighbouring areas • Subdivision design encourages walking • Provision to connect to local public transport services
Enhance ecology	Improve flora and fauna	Local requirements vary. Generally	• Street trees incl. provision of at least 70%	• Street trees as per previous scenarios	• Street trees as per previous scenarios

Principles	Subdivision intervention	BAU	Scenario #1 **10 lots** 24 residents	Scenario #2 **100 lots** 236 residents	Scenario #3 **Master planned** **500+ lots** 1,180+ residents
		juvenile street trees utilised	drought tolerant and indigenous species • Specify 25% of canopy cover • Resident education of plant species for private yards	• Bio-link / green corridor. • Specify 25% of canopy cover • Resident education of plant species for private yards	• Mature trees retained and protected • Specify 25% of canopy cover • Bio-link / green corridor. • Resident education of plant species for private yards
Adaptable and encourage innovation			No requirements	Information provided regarding potential technologies, pre-application	Information provided regarding potential technologies, pre-application

Sources: IDM http://www.designmanual.com.au/assets/files/documents/idm/IDM_Version_5.10_.pdf

Appendix B

Literature review

Appendix B Literature review

Introduction

Purpose

The purpose of the literature review is to identify studies and data that could be used to inform the cost benefit analysis of ESD interventions at both the lot / dwelling level and at the subdivision level.

Overview of approach

At the time that the literature review was undertaken, the recommended ESD interventions to be included in the cost benefit analysis had not been determined. Therefore, the literature review was undertaken as a high level review to understand the extent of literature that could be drawn on to support the cost benefit analysis.

The literature review focused on identifying literature relating to the broad ESD elements of:

- Site layout and orientation
- Energy
- Water
- Stormwater
- Urban ecology
- Transport
- Waste management
- Construction and building materials
- Community

The literature relating to lot / dwelling level costs and benefits is relatively well-developed, therefore, the review focused on identifying subdivision level costs and benefits. This involved a more detailed review of the literature relating to the ESD case studies that were identified in Stage 1a. The exception to the subdivision focus is the expert evidence provided by Pitt&Sherry (Phil Harrington) in relation to small multi-residential buildings and large residential buildings.

Summary of findings

Table 45 contains a summary of the literature review findings in relation to the key ESD elements.

Table 45 Summary of literature review findings and relevance for cost benefit analysis

ESD element	Findings and relevance to subdivision cost benefit analysis.
Site layout and orientation	Research is primarily focused on estimating the benefits of dwelling orientation Lot level results can be scaled up to provide an indication of subdivision benefits from improved orientation.
Energy	Research exists on dwelling (e.g. Harrington expert evidence) and subdivision (e.g. Armstrong Creek) costs and benefits.
Water	Research exists on dwelling (e.g. Harrington expert evidence) and subdivision (e.g. Armstrong Creek) costs and benefits.
Stormwater	Stormwater initiatives such as rainwater tanks and rain gardens are often reflected in water efficiency measures, and therefore reflected in lot level analyses. Research on the costs and benefits of stormwater management (e.g. WSUD) exists (e.g. Melbourne Water life cycle costs)
Urban ecology	Research is largely qualitative, or, where quantitative, it is highly site specific. Harrington expert evidence estimates the value of temperature reductions (in terms of reduced dwelling operating costs) provided by well positioned vegetation.

ESD element	Findings and relevance to subdivision cost benefit analysis.
Transport	Research is largely qualitative. Harrington expert evidence estimates the costs of providing bicycle spaces in non-residential buildings relative to car spaces. Szatow estimates the relative costs / benefits of electrical vehicle use based on The Cape subdivision.
Waste management	Research suggests that waste avoidance, waste reuse / recycling and waste separation can provide a net benefit. Benefits are not typically valued in monetary terms in the literature.
Construction and building materials	Research often combines 'construction and building materials' with 'waste management'. Benefits are not typically valued in monetary terms in the literature.
Community	Research is largely qualitative and centres on attributes such as amenity and well-being. These are not typically valued in monetary terms in the literature.

Review

The following section provides an overview of the following subdivisions for which detailed costs and benefits have been reported:

- Armstrong Creek
- The Cape

In addition, a summary of the Pitt&Sherry ' Environmentally Efficient Design Planning Policies – Cities of Banyule, Moreland, Port Phillip, Stonnington, Whitehorse and Yarra. Expert evidence – benefit cost analysis' findings are presented.

Armstrong Creek

The study provides the results of the business case which was undertaken to assess opportunities to achieve better environmental outcomes for the new urban community of Armstrong Creek while not compromising the economic and social objectives of Greater Geelong City Council.

This business case considers two distinct scenarios for infrastructure delivery against these objectives:

- a 'Business as Usual' (BAU) case
- an 'Alternative Approach' that reflects leading edge sustainability objectives and outcomes.

The principal criteria against which each of the two cases were assessed are:

- Minimisation of water use
- Minimisation of greenhouse gas production
- Reductions in energy consumption at household and commercial levels
- Improvements to affordability levels for all of the 22,000 planned new homes.

Table 46 provides further details regarding the details of the BAU and Alternative Approach characteristics that were assessed within the business case.

Table 46 Overview of BAU and Alternative approach at Armstrong Creek

Subdivision characteristics	Business as usual	Alternative (more sustainable) approach
Water and wastewater	Provided from centralised delivery by the water authority Incorporates centralised delivery methods for potable water and sewerage No water or wastewater recycling	Regional provision for both water and wastewater, incorporating a regional recycled water plant that includes the use of rainwater tanks, water efficient appliances and gardens, and wastewater reuse from the existing Black Rock Wastewater Recycling Plant
Energy	Development access to traditional centralised electricity and gas infrastructure through traditional infrastructure providers	Decentralised cogeneration plants providing heat and electricity. This approach offers scope to reduce a wide range of greenhouse gas (GHG) emissions and to reduce energy consumption costs for homeowners
Planning and phasing	Concurrent land releases to enable urban development on a range of fronts	The multiple development of commercial, retail, service and residential uses at the Activity Centre and at the other localised centres, thus maximising the utilisation of water/sewer/energy/transport services. Early introduction of primary and secondary schools to limit out-of-precinct commuting
Public transport infrastructure	The rate at which land sales and house construction/settlement can be achieved is perceived as fundamentally dependent upon the extent to which an effective public transport service is available to the new residential communities in Armstrong Creek.	The embedding of public transport infrastructure and utilisation at the design stage, allowing for: additional rail use; a transit bus system to ferry passengers from a transit centre located in the Activity Centre to the Marshall train station (and later to the Armstrong Creek train station); minimisation of the use of private vehicles for commuting to Geelong and Melbourne; the provision of a regular mini-bus system of public transport services across the urban area; and increased participation in walking and cycling with designated paths.

Source: Noakes, R.R. and Collins, J. (2009) Sustainability Envelope for Armstrong Creek: Business case development and planning issues

Key findings

The business case found that the Alternative Approach is likely to yield significantly higher economic, social and environmental benefits, at a lower total infrastructure cost and with lower annual operating costs over a 15-year time horizon.

An additional $466 million of benefits (NPV) can be generated, including a capital cost saving of $48 million over a 15-year development period, should the sustainable development strategy be followed (see Table 47).

An important additional finding was that in terms of the total benefits to be derived from the alternative, sustainability-based approach to the development of Armstrong Creek, more than 80 per cent of the total benefits are expected to flow to homeowners in the Armstrong Creek Urban Growth Area.

Table 47 Summary results

	BAU ($million, 2009)	Alternative approach ($million, 2009)
Period of assessment	2011/12 to 2025/26 (15 years)	
Capital cost	545.93	492.42
Operational & maintenance costs	0.40 to 22.80	0.37 to 15.19
Capital costs (NPV @ 6.5%)	497.05	449.42
Economic benefits (NPV @ 6.5%)	737.31	1,098.24
Economic costs (NPV @ 6.5%)	668.81	563.30
NPV	68.81	534.94
Economic Internal Rate of Return	8.45%	24.19%
BCR	1.10	1.95

Source: Noakes, R.R. and Collins, J. (2009) Sustainability Envelope for Armstrong Creek: Business case development and planning issues

The Cape, Cape Paterson, Victoria

This study was commissioned to test key assumptions and outputs of a Zero Carbon Study prepared for the Cape Paterson Partnership. The study consists of an:

- Analysis of the calculations and assumptions used to determine the star ratings of the sample house designs
- Analysis of the calculations and assumptions used to determine the construction costs of the sample houses
- Analysis of the calculations and assumptions used to determine the energy savings and zero emissions status of the precinct
- Analysis of the benefits to residents and community identified by the authors
- Evaluation of the project's feasibility and likely benefits to residents

Sustainability features that were included in the assessment comprise:

- Minimum 7.5-star rating for all homes
- Minimum 2.5kW solar photovoltaics, but sized to at least cover the energy demand of a home over 20 years
- Space heating and cooling systems with coefficient of performance of 4.5
- Evacuated tube solar hot water system with an efficient electric heat pump boost containing a greenhouse-neutral refrigerant
- 10,000L rainwater tank
- Electric vehicles

Key findings

The authors found that the proposed Cape Paterson Ecovillage development offers "very good value" for buyers when the long run costs of home energy, transport energy and water use are considered.

Compared to a standard new home sustainability features proposed for the Cape Paterson project is estimated to provide investment returns of between 5.9 per cent and 10 per cent, after tax, based on future energy and water savings.

Table 48 contains a summary of the NPVs associated with different types of benchmark homes, relative to a Cape Paterson home, based on three energy price scenarios.

It is estimated that Cape Paterson buyers could save between 2.5 years and 5.5 years on a 25 year mortgage, compared to a new 6-star house of the same size, when in-home energy and water savings accrued by virtue of sustainability features are used to accelerate mortgage repayments.

Table 48 NPV of Cape Paterson home relative to benchmark homes

No.	Description of Benchmark options	Energy scenario 1	Energy scenario 2	Energy scenario 3
1	Pre-existing Victorian home with a 4-star building fabric, all electric off-peak hot water system and heating / cooling systems with coefficient of performance of 2.8/2.6 respectively	$54,985	$58,780	$62,870
2	New Victorian home with 6-star building fabric, combined flat plate solar and electric storage hot water system, 2000l rain tank and heating/cooling systems with COP of 3.67.	$195	$3,300	$8,250
3	Same as benchmark 2 but has a larger footprint by 50m². This means it costs more to build, heat and cool but is comparable to benchmark 2 in every other way	$67,350	$70,570	$75,630

Source: Szatow, A. (2011) Cape Paterson Ecovillage: Zero Carbon Study Peer Review. Report prepared for The Cape Paterson Partnership and Sustainability Victoria

Expert Evidence: Phil Harrington (pitt&sherry)

The report focuses on the benefits and costs attributable to the Environmentally Efficient Design (EED) planning policies that were proposed to be incorporated within the planning schemes of the Moreland, Port Phillip, Yarra, Stonnington, Banyule and Whitehorse Councils. The policies encourage 'best practices' in each of these six areas. These best practices are described in Fact Sheets published by the councils.

The quantitative analysis was undertaken with reference to four representative building/development types that are commonly found in each of the Joint Council areas, albeit with a differing mix of developments in each one. The analysis has been conducted at the level of square meters of building space, as well as whole dwellings or buildings, in order to facilitate generalisation about the scale of benefits and costs associated with different building types and sizes. The building / development types are outlined in Table 49.

Table 49 Types of development triggering EED design requirements

Representative development types	Description
Small residential – new	A small residential / mixed use development of a new building or buildings containing 1 to 9 dwellings
Small residential – extension	Buildings and works creating 50 square metres or more of additional floor area
Large residential	A large residential / mixed use development containing 10 or more dwellings or 4 or more storeys
Small non-residential	A non-residential development with gross floor area between $50m^2$ and $1000m^2$

Source: Pitt&sherry (2013) Environmentally Efficient Design Planning Policies – Cities of Banyule, Moreland, Port Phillip, Stonnington, Whitehorse and Yarra. Expert evidence – benefit cost analysis – Phil Harrington

Findings for small residential buildings

Indicative cost and benefit estimates for new small residential building are based on a three storey apartment building with five dwellings totalling 469 square meters.

Energy efficiency

Table 50 highlights the costs and benefits associated with a 11.5 per cent improvement in energy efficiency or approximately one additional star from 6 star to 7 star energy rating in the Melbourne climate zone. This implies a 23 per cent improvement in thermal performance. The savings are assumed to apply equally to gas and electricity consumption however it should be noted that gas share of total energy usage is 63 per cent.

The annual energy consumption savings equate to $1.20 per square meter. Factoring in reduced exposure to peaking of electricity prices (assuming a conservation load factor of 0.02), the total annual saving per square meter was around $2.30.

Table 50 Energy efficiency BCA - Small multi-unit residential

Results – energy efficiency	$ per sqm	$ per building
PV of savings	30.09	14,112
PV of incremental costs	8.44	3,960
PV of net benefits	21.65	10,152
BCR		3.6

Source: Pitt&sherry (2013) Environmentally Efficient Design Planning Policies – Cities of Banyule, Moreland, Port Phillip, Stonnington, Whitehorse and Yarra. Expert evidence – benefit cost analysis – Phil Harrington

Water efficiency

Table 51 outlines the present value (PV) of costs and benefits of implementing best practice measures (defined by council SDAPP fact sheets) to achieve a targeted reduction of 25 per cent from the business as usual water usage of 240kL water usage per building per year. This equates to 2.4kL per square meter per year.

Annual water cost savings are approximately $2.75 per square meter with additional savings of $0.30 per square meter attributable to reduced hot water energy costs (assuming 50 per cent water is hot). Most water consumption savings are attributed to low-flow shower heads, however this also assumes a 15,000L rainwater tank.

Table 51 Water efficiency BCA - Small multi-unit residential

Results – water efficiency	$ per sqm	$ per dwelling	$ per building
PV of savings	43.77	4,106	20,530
PV of incremental costs	20.96	1,966	9,831
PV of net benefits	22.81	2,140	10,699
BCR 2.1			

Source: Pitt&sherry (2013) Environmentally Efficient Design Planning Policies – Cities of Banyule, Moreland, Port Phillip, Stonnington, Whitehorse and Yarra. Expert evidence – benefit cost analysis – Phil Harrington

Stormwater management results

Stormwater management interventions include:

- 15,000L rainwater tank incl. full installation – approximate cost of $8,000 (this is attributed to water efficiency analysis)
- Two square meter rain garden – cost of around $600 plus $150 for STORM rating, requiring renewal every 15 years

Stormwater benefits were not directly quantified however include reduced environmental impacts and communal costs associated with treating peaking wastewater volumes. The present value of stormwater management costs (not including rainwater tank costs) was approximately $1,300.

Urban ecology (Shading and passive cooling) results

This report assumed a 5 per cent reduction in annual electricity consumption equating to $0.32 per square meter per year. Factoring in reduction of peak demand, and peak price, electricity consumption savings rise to $2 per square meter.

Findings for large residential buildings

Indicative cost and benefit estimates for new large residential buildings are based on a six storey apartment building with 61 dwellings totalling 4,620 square meters and an average dwelling size of 63 square meters.

Energy efficiency results

Table 52 highlights the costs and benefits associated with a 11.5 per cent improvement in energy efficiency or approximately one additional star from 6 star to 7 star energy rating in the Melbourne climate zone.

The annual energy consumption savings equate to $1.70 per square meter. Factoring in the reduced exposure to peaking of electricity prices, the total annual saving per square meter was around $3.40.

Table 52 Energy efficiency BCA - Large residential

Results – energy efficiency	$ per sqm	$ per building
PV of savings	44.05	203,524
PV of incremental costs	12.31	56,868
PV of net benefits	31.74	146,656
BCR 3.6		

Source: Pitt&sherry (2013) Environmentally Efficient Design Planning Policies – Cities of Banyule, Moreland, Port Phillip, Stonnington, Whitehorse and Yarra. Expert evidence – benefit cost analysis – Phil Harrington

Water efficiency results

Table 53 outlines the present value of costs and benefits of implementing best practice measures (defined by council SDAPP fact sheets) compared to the business as usual water usage of 142kL water usage per dwelling per year. Most water consumption savings are attributed to five star WELS rated equipment (against three star in business as usual), however this also assumes one 24,000L rainwater tank.

Annual water cost savings are approximately $1.40 per square meter with additional savings of $0.29 per square meter attributable to reduced hot water energy costs (assuming 50 per cent water is hot).

Table 53 Water efficiency BCA - Large residential

Results – water efficiency	$ per sqm	$ per dwelling	$ per building
PV of savings	23.92	1,510	92,093
PV of incremental costs	4.89	309	18,843
PV of net benefits	19.03	1,201	73,250
BCR 4.9			

Source: Pitt&sherry (2013) Environmentally Efficient Design Planning Policies – Cities of Banyule, Moreland, Port Phillip, Stonnington, Whitehorse and Yarra. Expert evidence – benefit cost analysis – Phil Harrington

Stormwater management results

Stormwater management interventions include:

- 24,000L rainwater tank incl. full installation – approximate cost of $9100 (this is attributed to water efficiency analysis)

Stormwater benefits were not directly quantified however include reduced environmental impacts and communal costs associated with treating peaking wastewater volumes.

Urban ecology (Shading and passive cooling) results

Shading from trees and awnings are not applicable to a six storey building so were not quantified.

Sustainable Infrastructure Guidelines

To investigate and promote alternative design considerations and materials, the Infrastructure Design Manual (IDM) Group developed the Sustainable Infrastructure Guidelines (Pitt&Sherry, 2014). These guidelines were designed to deliver more sustainable infrastructure by using recycled materials, reducing the carbon footprint of infrastructure projects, reducing maintenance and operating costs, utilising water in more efficient ways and using materials from sustainable sources. The IDM Group selected three demonstration projects that were based on the guidelines and commissioned a case study to develop key performance indicators (KPI) to assess effectiveness of the guidelines and compare the sustainable design and construction approach with a conventional approach by assessing costs and emissions. The KPI checklist included carbon footprint reduction, use of sustainable materials, net flora increase and sustainable design initiatives.

The following provides a summary of each of the demonstration projects.

Steampacket Place, Geelong

Steampacket Place is a laneway near the waterfront of Geelong that caters to service vehicles and pedestrians. The project involved removing old pavement, constructing new pavement involving sustainable elements. Outcomes of the project were then compared with a conventional approach of demolish and replacement.

The existing pavement was demolished and reusable excavation material was taken to a recycling plant. New reinforced low carbon concrete ECO-Reo^{TM} pavement was constructed with reinforcement. The sub-base layer was recycled crushed concrete rather than crushed rock and 100% recycled water was used. A multi-layered bio-filter was also used in place of gutter and kerb drainage systems. Rainwater runoff is filtered through surface vegetation that then percolates through a well-graded sand filter and then collected in a perforated pipe for discharge into existing stormwater infrastructure. Finally, a central raingarden pit was also constructed which is positioned to collect stormwater runoff and filter through multi-layered soil systems. Further landscaping included eight trees and 31m2 of tufting plants. The plants will increase carbon dioxide capture and add aesthetic effects. The garden beneath the trees reduced impervious areas and stormwater runoff aiding groundwater recharge.

The use of low carbon concrete pavement and steel led to a reduction of 7,773kg CO_2e. The use of recycled concrete as a sub-base rather than a conventional base reduced CO2e by a further 598kg. The Water Sensitive Urban Design (WSUD) principles utilised in the drainage system is designed to improve collection of runoff and stormwater retention. The system has a higher carbon footprint than traditional gutter and kerb, but provides water quality benefits that cannot be achieved with a kerb and gutter approach. The concrete requirement of a bioretention trench meant the overall emission reduction associated with the sustainable design approach was 4,900kg CO_2e. Overall the development under the sustainable elements increased costs of the project by $27,721 from the conventional method. The overall cost of the redevelopment was $46,700, when sustainable design elements were included. The majority of this was due to the bioretention trench. The additional cost of the low carbon concrete mix was estimated at $6/m^2, compared to conventional concrete.

Grant Street Forrest Footpath

The Colac Otway Shire carried out construction of 334m long and 1.5 m wide footpath at Grant Street and upgraded the adjacent carpark. The footpath was constructed using 3.5mm thick 3 Green Star

Rated concrete. The car park had no sustainable elements applied. Granular pavement was used with an asphalt wearing surface after an attempt to re-use existing granular material proved to be of poor quality.

The low carbon Green Star Concrete also uses Eco-ReoTM rather than conventional reinforcement. By using these materials the project resulted in a 7,800kg reduction in embodied CO_2e. Overall, the sustainable elements of the development increased the cost by $3,006 (or $6/m^2$) compared to the conventional approach.

Foamed Bitumen Asphalt

Geelong City Council utilised FoamMix Recycled asphalt technologies in two pavement rehabilitations at Grange Park Drive in Waurn Ponds and Townsend Road in Moolap. Both pavements needed upgrading due to visible pavement defects and sustainable approaches were proposed that involved reconstruction using FoamMix as a stabilised base layer, followed by an asphalt seal. This treatment produces a bound pavement with increased stiffness by stabilising the existing material rather than a conventional approach of increasing the pavement thickness with new material.

FoamMix consists of 95 per cent recycled materials and foamed bitumen which are combined using specialised equipment. The process involves excavating the old pavement to a depth of 200mm, collecting the material and putting it through a recycler which combines the reclaimed material with a foamed bitumen mixture to then be returned to the site and spread. The FoamMix stabilisation method reuses the excavated base course and mixes it with foamed bitumen to increase stiffness in the material and thus the layer can then be thinner than in the conventional method.

For both pavements the existing subgrade was found to be of poor quality and had to be stabilised by adding lime in order to reuse the materials. Even allowing for this, the FoamMix option was cheaper than the granular pavement replacement. Both pavements cost $120/m^2$ with additional stabilising. The conventional method of granular pavement replacement is estimated to cost $172 /m^2$. The overall cost savings were $52/m^2$ while the carbon reduction associated with using the FoamMix method was 22,130kg CO_2e.

Summary from other literature

Table 54 contains a summary of other studies that were identified during the literature review and potential relevance to Stage 1B.

Table 54 Summary findings from selected literature

Study	Focus area	Comments
Melbourne Water (2013) Water Sensitive Urban Design: Life cycle costing data	WSUD	This Fact Sheet includes a life cycle costing data table to assist councils in estimating costs associated with stormwater treatment asset planning during the design, construction, establishment, maintenance and renewal phases. The data are highly relevant for Stage1b.
AECOM (2012) Economic Assessment of the Urban Heat Island Effect	Urban heat island effect	The study estimates the economic impacts associated with the: impacts of heat; impacts of heatwaves; and contribution of the Urban Heat Island to the above impacts. The assessment is focused on the direct impacts of heat within the study area – the City of Melbourne but recognises that these localised heat impacts can produce economic impacts beyond the study area. The impacts for which a monetary estimate is provided are: Health – i.e. the costs in responding and treating heat-affected members of the community Transport – i.e. the costs associated with rail delays Energy – i.e. the costs associated with changes in energy demand (for cooling) and costs associated with increased maintenance due to faults in the electricity network Anti-social behaviour – i.e. the costs associated with violent crime Flora and fauna – i.e. the costs associated with irrigating parks and gardens

Study	Focus area	Comments
		The study provides useful information about the costs of the UHI effect and therefore provides an indication of the avoided costs associated with ESD interventions such as green spaces, trees and other green infrastructure. It's not clear the extent to which these data can readily be applied to Stage 1b.
Australian Housing and Urban Research Institute (2004) Affordability and sustainability outcomes: a triple bottom line assessment of traditional development and master planned communities – Volume 1	General sustainability	This report presents research on the extent to which housing affordability is impacted by sustainable practices. The research which focused on several case studies had two key outcomes: • Triple Bottom Line comparison of traditional regulatory subdivision (TRS) of suburban development and the master planned community (MPC). • Evaluation of the economic, environmental and social characteristics of the MPC and TRS CBA was not chosen as a method to measure sustainability due to the number of assumptions required to convert non-economic costs and benefits to monetary terms.
SGS Economics and Planning, 2016. Comparative costs of urban development: a literature review	Infrastructure provision at subdivision scale	This report only makes conclusions about the costs of providing infrastructure to service a population of 25,000 in different development settings. This report is too high-level in its focus to be relevant to Stage1b.
Urban Development Institute of Australia, 2014. Mullum Creek – Innovative subdivision and design guidelines to address sustainability	General sustainability of subdivision	This report focuses on Mullum Creek site, 20ha in area and approximately 20km from Melbourne. It highlights best practice requirements that will be implemented. The site was subdivided into 56 lots averaging 1,535sqm with the smallest lot being 1,120sqm. Prices range between $650,000 and $1,180,000. This report is too site-specific and not sufficiently detailed to be relevant to Stage1b.
Tanner, C.J. (2007) A case study for the Ecovillage at Currumbin – integrated water management planning, design and construction. Water Resources Management IV. Online https://www.witpress.com/	Ecovillage at Currumbin, Gold Coast, Australia	Cost and benefit data have not been calculated.
(no date) Mullum Creek Subdivision Design Case Study. Report for Urban Development Institute of Australia Western Australia Division Incorporated. Online: http://www.udiawa.c	Mullum Creek Subdivision	Cost and benefit data have not been calculated

Study	Focus area	Comments
om.au/assets/source/		
(2015) Affordable Housing Strategy: Witchcliffe Ecovillage. Online. https://www.amrshire.wa.gov.au/	Witchcliffe Ecovillage	Cost and benefit data have not been calculated
EPA, 2013. Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs	Low impact development and green infrastructure	This report focusses on Low Impact Development and green infrastructure (GI) programs for stormwater stakeholders with the intent to promote LID/GI where appropriate to supplement grey stormwater infrastructure. The objectives were to highlight the different evaluation methods that have been successfully applied and to demonstrate where LID/GI has been shown to be economically beneficial. Thirteen case studies were compiled. The report highlights: Public benefits from reduced stormwater management costs Private benefits The study is American and may not be directly relevant to the Victorian context.
Bureau of Environmental Services City of Portland, 2008. Cost Benefit Evaluation of Ecoroofs	Ecoroofs	The Bureau of Environmental Services in Portland calculated the NPV of its ecoroof program to the public. The present value of public benefits at year 5 was $100K and $200K at year 40. This was due to a 56% stormwater volume reduction. The private benefits of ecoroofs do not exceed costs until year 20 when conventional roofs require replacement. Ecoroofs have a 40 year life at which point net private value was $404,000 in 2008 dollars. Ecoroofs generate private energy savings for cooling and heating by better insulating buildings. This case study showed a 12% reduction in heating and cooling energy consumption. These were calculated to be $7,500 over 5 years and about $43,500 over 40 years. The roof area associated with these values was 40,000 square-foot or approximately 3,700 sqm. The construction cost ($630,000) was 58% more expensive than a conventional roof ($400,000) and was 150% more expensive to maintain ($1000 p.a. compared to $400 p.a). The study is American and may not be directly relevant to the Victorian context.
Land Management Corporation, South Australian Government (no date) Lochiel Park: Case Study of a Green Village – South Australia. Case study within the Garnaut Climate change Review	Lochiel Park	Cost and benefit data have not been calculated. It is estimated that, overtime, resource cost savings will include a 40% reduction in water bills, and 66% in energy use bills from water and energy saving designs implemented throughout the subdivision.
Low Carbon Living CRC 2015, Adelaide Living Laboratory Value Proposition: Low Carbon Housing Policy	South Australia	This report finds clear evidence there are multiple benefits associated with a low carbon living housing policy of mandating net zero energy homes. The Government investor would expect to achieve multiple policy outcomes across areas as diverse as health and wellbeing, productivity, energy, as well as the public budget. From a macro-economic perspective, although many impacts were not able to be monetised with sufficient confidence, the Government investor will experience a net increase in local employment, downward pressure on energy prices, and increased economic activity within a more efficient economy better able to respond to world energy price increases. This report concludes that the value proposition of low carbon living is overwhelmingly positive to the South Australian Government with a conservative NPV of $1.31 billion for

Study	Focus area	Comments
		a 10 year policy action, and a benefit/cost ratio of 2.42. The empirical evidence demonstrates that low carbon living will provide many benefits including improved energy efficiency, energy network infrastructure savings, improved human health and wellbeing, carbon emission reductions, and benefits from increased social capital. The benefits far outweigh the costs associated with creating low carbon housing. The report highlights the importance of two factors: (a) industry learning; and (b) the discount rate. As the housing industry adopts new technologies and practices, increases low carbon building system production volumes, improves industrial processes, and develops skills and knowledge across the various building industry professions, the net economic benefits to the community increase. The value of future costs and benefits is greatly impacted by the rate of discount applied for policy analysis, and in light of the intergenerational impact of anthropogenic climate change, the 7% rate applied in this report should be considered a worst case scenario. Lower discount rates provide increased benefits from the proposed low carbon housing policy.
-	YarraBend, Melbourne	No literature relating to costs and benefits identified.
-	New City of Zenata	No literature relating to costs and benefits identified.

References

Conley, D. & Dowson, J., 2014. *IDM Sustainable Infrastructure Guidelines: Case Study,* s.l.: Sustainability in Public Works Conference.

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Pitt&sherry (2013) Environmentally Efficient Design Planning Policies – Cities of Banyule, Moreland, Port Phillip, Stonnington, Whitehorse and Yarra. Expert evidence – benefit cost analysis – Phil Harrington

Pitt&Sherry (2014) IDM Sustainable Infrastructure Guidelines: Final Report. Report to Local Government Infrastructure Design Association.

Szatow, A. (2011) Cape Paterson Ecovillage: Zero Carbon Study Peer Review. Report prepared for The Cape Paterson Partnership and Sustainability Victoria

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Appendix H

Consultation Report

AECOM Imagine it. Delivered.

ESD Greenfield Subdivisions in Regional Victoria
Wodonga City Council
14-Dec-2017
Doc No. Document No

ESD Greenfield Subdivisions in Regional Victoria

Report on stakeholder consultation

ESD Greenfield Subdivisions in Regional Victoria

Report on stakeholder consultation

Client: Wodonga City Council

ABN: 63277160265

Prepared by

AECOM Australia Pty Ltd
Level 10, Tower Two, 727 Collins Street, Melbourne VIC 3008, Australia
T +61 3 9653 1234 F +61 3 9654 7117 www.aecom.com
ABN 20 093 846 925

14-Dec-2017

Job No.: 60553561

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Quality Information

Document ESD Greenfield Subdivisions in Regional Victoria

Ref 60553561

Date 14-Dec-2017

Prepared by Sarah Brennan

Reviewed by Liz Johnstone

Revision History

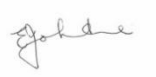
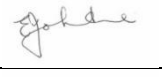
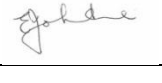
Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	11- Dec- 2017	Draft for comment	Liz Johnstone	
1	13- Dec -2017	Final	Liz Johnstone	
2	14- Dec - 2017	Final – minor changes	Liz Johnstone	

Table of Contents

1.0 Introduction

1.1 Purpose and broader project

The consultation process outlined in this report was part of a project to establish the feasibility and costs and benefits of improving Environmentally Sustainable Design (ESD) outcomes in greenfield subdivisions in regional Victoria.

Greenfield subdivisions constitute a large proportion of new housing development across Victoria. The design of urban areas has long-term impacts on the environment, resources, community health and household running costs. Subdivision design is therefore important to the long-term sustainability of Victoria's regional centres and their communities. There is growing consensus that current minimal requirements and practices need to be lifted to improve the longer-term sustainability, liveability and life-cycle costs of building, living in and maintaining greenfield subdivisions in regional Victoria.

To improve the sustainability of greenfield subdivision across Victoria, eight regional cities joined together to identify and test the evidence for embedding ESD in subdivisions. The project lead is Wodonga City Council on behalf of the City of Greater Geelong; Greater Bendigo City Council, Ballarat City Council, Greater Shepparton City Council, Baw Baw Shire Council, the Rural City of Wangaratta and Moorabool Shire Council.

Focussing on the key elements of ESD subdivisions, this project examined the principles, practices and tools, including both regulatory and non-regulatory measures such as information, training and demonstration projects that can contribute to improving ESD.

There is a strong evidence base along with case studies that demonstrate how ESD can be achieved in residential developments, such as through the Sustainable Design Assessment in the Planning Process (SDAPP) framework established by a partnership of metropolitan councils. Similarly, much work and progress has been made in building sustainability using rating tools such as NABERS and NaTHers. In addition, industry accreditation frameworks (UDIA – EnviroDevelopment; HIA Greensmart; GBCA – Green Star) support voluntary better practice. Despite these efforts, there is a knowledge and tool gap relating to the best measures to apply to subdivisions of various scales. The project aims to contribute to building working knowledge to close this gap.

The main components of the project are to:

- Define best practice ESD with respect to urban land subdivision and determine how it should be measured.
- Identify and analyse the feasibility of embedding ESD in subdivisions (including at the dwelling, lot and across the development area to incorporate broader precinct systems such as district energy generation, WSUD and urban greening).
- Analyse the benefits and costs of implementing better or best practice compared to business as usual. This will assist to identify low cost, high benefit measures.
- Recommend a suite of potential regulatory and non-regulatory measures for council to use to encourage better ESD outcomes. This includes a model for collaborative implementation and transferability across the state.

The 'Best practice' principles for ESD subdivisions were refined through consultation. The consultation process consisted of a total of eight workshops with select interviews to test initial findings with industry stakeholders.

Aside from refining best practice principles the workshops assisted to gain information about what is happening in different regional areas in Victoria, what ESD priorities should be and what would assist to improve ESD outcomes – both regulatory and non-regulatory mechanisms.

1.2 Objectives

The workshops enabled Councils to engage their local development industry (surveyors, builders, developers, consultants etc.) to explore issues and opportunities to progress more environmentally sustainable subdivisions in regional Victoria.

The objectives of consultation were to:

- Understand where local areas, industries and communities are at in understanding and applying ESD in greenfield subdivisions
- Understand local differences i.e. some places are flat while others are hilly; water supplies and pricing vary;

More specifically, the workshops delivered both practical and experiential outcomes.

Practical objectives

- Explained the purpose and context for the project
- Explored the key elements of an ESD subdivision
- Outlined benefits and costs of alternative measures
- Discussed options to achieve ESD and the pros and cons, barriers and enablers of alternative approaches

Experiential objectives

- Fostered broader awareness of ESD for regional Victoria
- Generated enthusiasm and fostered collaboration for opportunities presented by ESD subdivisions in regional Victoria
- Built consensus around priorities and next steps

1.3 Stakeholders

Between the eight workshops and interviews 200 people were consulted. Invitations to the regional workshops were sent to the local development industry. This included surveyors, builders, developers, real estate agents, consultants, environmental community groups and others. Peak industry bodies were invited to the central workshop.

A list of attendees for all workshops is provided in Appendix A.

1.4 Engagement process

Seven workshops were held in each of the regional centres as detailed in Table 1.

Table 1 Regional workshops dates and times

Location	Date and time
Wodonga	Monday 20 November 8: 30am – 10am
Wangaratta	Monday 20 November 2pm – 3:30pm
Shepparton	Tuesday 21 November 10am – 11:30am.
Bendigo	Tuesday 21 November 2pm – 4pm.
Ballarat / Moorabool	Wednesday 22 November 10am – 12pm.
Geelong	Wednesday 22 November 2: 30pm – 4:30pm
Baw Baw	Friday 24 November 11:00am – 12:30pm.

Following the regional workshops a central workshop was held in Melbourne for peak industry organisations.

Table 2 Central workshop dates and times

Location	Date and time
Melbourne	1 December 8am for 8.30 – 10.30am

Feedback forms and contact details were provided for any additional comments that participants had.

A number of select interviews were held with individuals engaged in similar processes or undertaking related research. These interviews details are provided in Table 3.

Table 3 Interview details

Person	Organisation	Date and time
Natasha Palich Executive Officer	Council Alliance for a Sustainable Built Environment	18 October 2pm - 3pm CASBE Office
Bernardo Cuter Project Lead – Sustainable Homes **Erika Bartak** ESD Consultant	Sustainability Victoria Filter ESD	11 October 4pm – 5pm Sustainability Victoria Office
Gavin Ashley Principal- Sustainable Energy and Urban Development	Moreland Energy Foundation Limited (MEFL)	29 November 2017 10am- 11am MEFL Office
Ricki Hersburgh Sustainability and EnviroDevelopment Manager	Urban Development Institute of Australia (UDIA)	11 December 2017 2:45pm – 3:30pm AECOM Office

2.0 Regional workshops

2.1 About

The presentation outlined what an ESD subdivision is, current practice and project findings to date. The workshop agenda and presentation is attached in Appendix B.

2.2 Activity 1 – exploring key elements of an ESD subdivision

2.2.1 Activity explanation

Workshop participants were presented with a list of core ESD elements and examples of what measures those elements may entail. Attendees were asked the following questions which were discussed in small groups and recorded.

1. Which elements are most relevant to subdivisions locally?
2. What is being done well?
3. Where is there room for improvement?
4. Which elements provide the best value?

In discussing these questions, participants were also asked to think about the implications and trade-offs of various elements for example: urban greening/shading for urban heat island could impact land budgets due to wider road reserves for larger trees.

Participants were asked to identify the indicative cost and benefit of improving practice. Groups then presented what they learnt or found most surprising to the broader group.

2.2.2 Which elements are most relevant to subdivisions locally?

The regions differ vastly in socio-economically as well as in climate and topography and other aspects that affect local ESD priorities and the feasibility of implementing different elements. For example Wodonga reaches high temperatures in the warmer months, while Ballarat has a more temperate climate. This has implications for variations in orientations, shading and thermal comfort measures. While Shepparton is dry, water efficiency improvements are difficult to sell because water is cheaper in an irrigation district. Baw Baw has higher levels of rain, while flooding is an issue for a number of areas particularly those located near river floodplains such as Wangaratta.

2.2.3 What is being done well?

The areas that were generally considered to be working well were:

- Water and stormwater
- Connectivity (aspects of)
- Planning and coordination (aspects of)

Stormwater reuse and water efficiency measures were seen as working well across most of the municipalities. A notable example was Ballarat West where water harvesting on private lots equates to 40 per cent of water use.

In a number of localities there were good examples of the provision of community facilities, open space and shops; however these tend to be held up as exceptional examples that need to be demonstrated more broadly within each municipality.

While asked to focus on the elements presented, the majority of workshops reported that aspects of the planning process and coordination of multiple parties is working well. Master planning and Precinct Structure Plans were seen as beneficial tools to improving subdivisions. These planning processes were seen to enable coordination between multiple stakeholders from the start of the subdivision process. Lack of coordination was noted as a significant barrier to achieving ESD outcomes.

In addition, resources and support that enable consumers to make informed decisions were also seen as working well in Geelong. Greater Geelong City Council (with Government agencies) provides

advice on home plans to first home owners and demonstration projects such as Sustainable House Day and Smarter Homes, Smarter Living.

2.2.4 Where is there room for improvement?

The areas that were considered requiring room for improvement were:

- **Orientation and site layout**: there is a disconnect between subdivision and lot layout intent and dwelling plans and construction. Driveways are a typical example, placed to optimise solar access of the dwelling, but then often reconstructed to match chosen dwelling/garage configuration.
- **Diversity of lots and dwellings**: including provision of medium density living in key locations; providing for intergenerational communities and ageing in place.
- **Local economy**: including employment opportunities, community infrastructure, putting land aside for long-term facilities such as schools, fire stations etc., and increasing local community spaces.
- **Connectivity**: car-centric developments, integration with existing urban fabric including surrounding older parts of the city, public transport is infrequent and there is not the density to support improved services; bicycle lanes and footpaths, while improving, could be better.
- **Ecology**: vegetation retention in corridors and vegetation management to minimise bushfire risk; insufficient room in road reserve to accommodate mature street trees; expanding urban forest strategies to newer areas, acknowledging and communicating benefits of ecology to health, wellbeing and building comfort and encourage use of active transport.
- **Planning, coordination and education (aspects of)**:
    - Communicate benefits (including savings and pay back periods) of ESD; education of buyers particularly first home buyers.
    - There is a tension between innovation and regulation. Planning needs to respond to changes such as incorporating localised energy and stormwater systems in Development Plans and PSPs. There also needs to be more consistency across Council department and more policy support for statutory planning decisions.
    - Upfront infrastructure services and works need to be better coordinated to remove duplication of works such as trenches for different services, or minimise duplication of assets such as retardation basins when a subdivision is developed out of sequence.

2.2.5 Which elements provide the best value?

The elements where improvements could offer the greatest benefits for the least cost were identified:

- Layout and orientation
- Mixture of lot sizes to enable a mix of price points and meet the needs of different households
- Retaining and maintaining existing ecological assets
- Connectivity (footpaths, integrated transport to limit car parking)
- Coordination (i.e. out of sequence development requires civil infrastructure which increases cost)
- Education alongside increased requirements is crucial. An example noted previous increased regulations that were not accompanied by education, resulting in Builders meeting the requirements but not in the most cost effective way, fuelling perceptions that improved ESD increase costs of building and house prices.

In all the above, discussions were underpinned by concern for where costs accrue and who benefits, as these are not always the same parties. Often decisions are made on short-term costs especially where housing affordability across the state is of heightened concern.

In Activity 2 a number of suggestions were made that could address this disconnect between upfront costs to both the builder and buyer and benefits that accrue over the life of a house.

2.3 Where are we now – what's already happening?

In preparation for Activity 2, participants were presented with case studies of better or best practice ESD subdivisions within Victoria and nationally. This part of the presentation also included an informative overview of sustainability tools and the experiences of the SDAPP and CASBE groups of councils to show what is happening and what is possible.

This prompted participants to identify what they would like to see happen and what they think is feasible in their local region.

2.4 Activity 2 - What would be required to improve ESD outcomes?

2.4.1 Activity explanation

Participants were asked to discuss in small groups the following questions:

1. What should the focus for improvement be?
2. What would be required to support improvements?
3. What should local industry, council and others do?

2.4.2 What should be the focus for improvement?

Suggestions on the focus for improvement varied broadly and encompassed physical elements as well as mechanisms to improve planning and practices (detailed below)

- Site layout and orientation
- CFA best practice for subdivision layout and design. Investigate alternate fire service provision i.e. home sprinkler systems
- Building a 'sense of village' through co-location of community spaces
- Including lower cost housing i.e. 10 per cent of blocks should be for affordable housing and DDA compliant)
- Education: council staff, development industry, buyers and the local community "*people do not seem to know what ESD means in practice*" (Shepparton)
- Connectivity including within the subdivision and to other parts of the city through provision of bicycle lanes, footpaths and permeable subdivision design.

2.4.3 What would be required to support improvements?

It was noted that further changes in regulations or requirements must be accompanied with education and support to support the transition and improve planning and building practices.

Regulation

- Some developers support regulation as a way of providing certainty and creating a level playing field.

Education and information

- Lead by example: ESD display homes focused on energy efficiency; demonstration project as council-local industry partnership; facilitate tour for local developers to ESD subdivision developments.
- Buyers: need to be able to compare non-sustainable houses with sustainable in terms of performance and cost savings (as well as amenity and space). Support and information to buy off the plan and make informed decisions i.e. costs of extra insulation vs bedroom vs PVCs, such as:
    - A guide to buying a new house; an app to assess site potential (similar to those that exist for dwellings).
    - New home owner kit including plant species recommended for planning and other ESD information

    - Mechanism to offset up-front costs: such as green loans through rates, favourable interest terms for ESD homes i.e. Bendigo Bank and Bank of South Australia.

- Data to support better practice and demonstrate return on investment and market viability
- Life cycle costs*:* identify and communicate the running costs of a home

Strengthening planning

- Improve Cl. 56
- Introduce or strengthen local policy to drive ESD development
- Building envelopes or required lot/dwelling performance as part of the subdivision plan approval
- Facilitate applications with ESD innovations; doing things differently
- Improve relationship between planning system and NCC

Market mechanisms

- Disclosure of energy rating at time of building design and at time of sale to provide buyers with best information and incentives. A similar example is mandatory disclosure in the ACT.
- Create a brand (such as Nightingale which is known as a 'green' or 'sustainable' apartment option for regional Victoria that can create a win-win for improving sustainability and publicity for the region and developers.
- ESD is seen as 'bespoke'. Need to make ESD more affordable and accessible, particularly first home buyers.

Advocacy

- Advocate for state planning policy and other changes, and program support

Other

- Alternative models for maintenance i.e. partnerships for infrastructure and parks

2.4.4 What should local industry, council and others do?

There needs to be a range of 'stick and carrot' measures. Suggestions included:

- identifying local champions within industry and council
- involving all levels of government in setting direction and change
- local forums for developers and builders to provide avenues to share learnings and issues

It was noted that there needs to be a greater definition of ESD requirements and expectations for different scales of subdivisions.

The role of council

The following suggestions were made for the role and responsibilities of Councils in enabling change.

- Provide direction through a clear vision that is communicated to local industry so that they can respond and have certainty in doing so. This includes where future growth will occur and expectations of ESD subdivisions (at different scales).
- Lead by example and partner to facilitate learning and demonstrate outcomes
- Provide support: through pre-application meetings
- Work holistically across Council. Coordination between departments is highly valued by participants as a requirement for enabling better ESD subdivisions. Internal support for processing applications with high ESD objectives.
- Provide incentives such as fast track process for developments that are achieving 'better or best' ESD practice. Need to reward good outcomes

- *Advocate and partner for change*. This could include supporting the strengthening of the NCC, creating a state ESD policy or actions required by peak organisations.

3.0 Central workshop

3.1 Activity 1 – ESD elements

The elements below set out a framework for measuring ESD practices. These were tested in seven workshops held across Victoria. Two groups discussed the elements and provided feedback on their robustness, gaps or priorities, implications and if any changes or additions were required.

3.1.1 Overall comments

- Role of Market – Ideally ESD should be valued and market led, including need to understand why buyers buy into an ESD subdivision.
- Affordability – upfront, new home buyers, barrier is entering the market even though long term savings.
- Utility providers – VPA tried to minimise space for utilities within subdivisions. Under footpaths unlikely to be supported. Utility providers are proving difficult.
- Overall agreement on inclusion and layout of the themes and key elements. A couple of aspects for inclusion were noted as detailed in the table below.
- Council dealings with developers – regional stormwater system. Trying to hand maintenance to Council. Same issue with micro-grid. Who owns and maintains the assets?

Table 4 Comments referring to specific ESD elements

		Action
1. Optimise site potential		
Orientation and site layout	· Trees – subdivision design around trees, but removed after as no tree controls apply. Contextual – if its neighbourhood character then it becomes important and will become retained. · Use topography to control the whole development water flow. · Even with Cl. 56 it is difficult to mandate orientation · Providing estimated energy costs of a lot/orientation could be a useful influencing strategy · Education – how vegetation within lots can improve thermal comfort and energy efficiency.	Comment Example
2. Reduced footprint		
Water, stormwater and wastewater	WSUD has taken off in Victoria Retarding basins. If subdivision is developed out of sequence, need to build interim basins which are resource intensive. Basin should be completed upfront to avoid unnecessary resource use and cost. Difficult in rate capped environment. Challenges with on-going maintenance. Third pipes are not applicable everywhere in regional Vic, i.e. where water is already recycled	Comment
Energy	No incentive for local energy providers etc. Energy level – might be best dealt with at local level.	Comment

		Action
Waste	Waste – looking at Precinct wide - land development issues – collection trucks etc. House scale. Allocation of land – land that the developer can't subdivide. Create another barrier for the user. Reverse collection, centralised recycling – Beaconsfield.	Comment
Places for people		
Diversity	Subdivisions need to future proof and enable ageing in place. Lot/housing diversity to encourage people to choose household size appropriate dwellings which reduce energy consumption and running/maintenance costs. Subiaco Park – townhouses on a common green space. Central city with higher density, with subdivision further out. Focal point with community benefit and different urban form to create higher usage.	Example
Local economy	Various capabilities and scales of local development industry. Unlikely for dispersed services to be viable when travel times are short to town. Viability of CBD in regional area is important. Local shops don't really survive in these areas.	Comment Example
Connectivity	Design the urban place and allow for people moving through the urban place. Safe paths, shelter, shade throughout the urban fabric. Car usage is the reality. Less walking. Useful references to follow up: VicRoads Street Walk Code of Practice which reinstates services to make room for trees; VicRoads Movement and Place	Comment
Enhance ecology		
Local ecology	Many regional municipalities have urban forest strategies incl. Shepparton Precedent – established trees should be put in (at 1.2m) NSW has tree envelops Include management of vegetation to minimise bushfire risk	Example Inclusion
Adaptability and encourage innovation		
Emerging trends and technologies	Include future proofing	Inclusion

3.2 What should guide future action in regional Victoria?

The second activity referred to other industry guidance, assessment tools and programs as detailed in the presentation in Appendix B, which includes lessons learned from Armstrong Creek, BESS and CASBE and other case studies.

3.3 Activity 2 - Identifying appropriate planning (and other) mechanisms

Various planning mechanisms can improve ESD subdivisions. Some examples include Precinct Structure Planning, master planning, development plans, DDOs, ESD policies etc.

Two groups discussed what planning mechanisms may be available and how / when they may be applied to improve ESD outcomes. Discussion gave consideration to:

- The applicability to the regional Victoria context,
- Resourcing required to administer,
- The degree of flexibility and scalability for different sizes of subdivisions and different LGAs.

Participants were also asked what would enable/block progress. Participants identified and discussed non-planning mechanisms that would support ESD subdivisions such as education, mandatory energy disclosure in sales advertising, and how these measures may complement, duplicate or deter from preferred planning mechanisms.

Role of planning

- Planning can set up a framework for good development. It requires engagement of builders and peer to peer learning was seen as most effective way

Prioritising/sequencing mechanisms

- Explore sequence of opportunities
- Begin with voluntary tools and regulate later (similar to SDAPP, BESS experiences)
- An ESD policy or initiative needs to be reflected through the entire subdivision process.

Different points along subdivision process

- Supreme Court has ruled that subdivision permits are null in void once a title (for an individual lot) has been obtained, making it difficult for permit conditions to flow through. Mechanisms such as a section 173 agreement or covenants can address this disconnect by setting out conditions or restrictions on the use of the land, which can be recorded on title to bind future owners and occupiers.
- With present arrangements, need to get all the conditions upfront in the subdivision permit
- Put building envelops into subdivisions
- Dwelling ESD should be strengthened through NCC. Action to advocate for strengthening of NCC as an outcome of project
- Improve relationship between Planning Scheme and NCC.
- Long term - amend Subdivision Act to contain further conditions for dwellings/buildings

Structure plans

- Precinct Structure Planning (PSP) guidelines – context – developing the urban structure. VPA try not to overlap with Clause 56. Applicable for large scale to lay out town centres, road alignment, parks.
- Triggers the need for a PSP – political will. Statement of expectations identifies the locations for PSPs. Methodologies for greenfield PSPs.
- Development Plan Overlays (DPOs) – guide urban structure and co-ordinate infrastructure at neighbourhood and estate scale. DPOs can also serve a similar function to PSPs in a modest population growth setting and be accompanied by Development Contributions Plans (i.e. Wangaratta North West and Wangaratta South Growth Areas).
- Action: map out the appropriate subdivision scales for PSPs, Master Plans, DPOs against Cl. 56 requirements.

Regional infrastructure plans

- Government – introducing regional infrastructure contributions plans (ICP) – 4 tiers (Population growth; Standard and supplementary contributions)
- What can ICPs contribute to ESD? Best to use as many ways as possible – need a combination of planning, non-regulatory measures as long as do not add to the regulatory burden.
- Return on product – from the bank to fund the development. None of the big banks will support.

Clause 56

- Clause 56 was comprehensive and innovative when it was established, accompanied by education for Councils on how to apply and use it.
- There are inconsistencies in meeting objectives – lack of guidance on how to meet Clause 56 objectives. Ticking the box exercise.
- Target land surveyors and engineers as they design the subdivision. Australian Consulting Surveyors – Beverage Williams, Reeds, Taylors.
- Look at existing mechanism – and how they can be improved. Use 'adaptation' to climate change, as people might understand this a bit better. Resilience.
- **Recommendation**: review existing Cl.56 and identify why it does not work as it should. Take actions to make it work as planned – i.e. outcomes are reflective of Cl. 56 objectives.

Other

- Resilient buildings, wellbeing as motivator.
- SV – spending time in Armstrong Creek to speak with prospective buyers (planning aid service).
- Recent study – should we move to 7 stars. How do we make people achieve 6 stars on the ground. Do we look at the existing planning mechanism and how to best achieve this?
- Also a compliance and capability issue.
- Ministers Direction, Practice Note, VPA. Fact Sheets. Guidance note that sits outside of the planning scheme, a manual.
- Raise knowledge – builder, developer, stat planners.
- Education – to community and development industry
- Stat planners don't feel they have enough policy support for them to refuse a permit. Disconnect between subdivision and housing being built. How to link the approved subdivision and the builders and the building.
- Private certification in Building, Report and consent/ performance standards in building. Is it too easy to vary these? Building services less privatised in the regional areas.

Infrastructure Design Manual (IDM)

- IDM is used by 44 councils in regional Victoria.
- IDM is a reference document incorporated in the Shepparton Planning Scheme (via Amendment C112). An Advisory Committee was held to consider the applicability of introducing the IDM into regional planning schemes and recommended that it be introduced via a 20(4) amendment.
- IDM incorporates Sustainability Infrastructure Guidelines.
- IDM should reduce time application is in planning.
- There is crossover with the IDM tool and potential to embed above minimum ESD standards for subdivisions into the IDM.

3.3.1.1 Additional data sources mentioned

- Urban Heat Island (UHI) – Swinburne have data
- Swinburne – working on an app for infill developments. ‘Optimise my lot’. Software is 6 months away from launching.

4.0 Select interviews

4.1 Council Alliance for Sustainable Built Environment (CASBE)

Discussion entailed the role and evolution of CASBE including developing and implementing BESS, and the different experiences of member councils.

Key points:

- Improving performance is a journey and requires an incremental approach beginning with support for developers and voluntary assessments. Regulation should only be brought in when there is adequate learning and knowledge within the local industry. For those councils that have introduced mandatory ESD requirements, it has been a smoother transition in municipalities with prior voluntary assessments and frameworks in place.
- ESD champions and leadership support within council are essential. Where councils do not have the resources for an ESD officer, another option is to share a resource between councils, similar to how heritage officers may work across multiple councils to make up a full-time position.
- Learning and knowledge sharing of ESD officers and member councils is supported through CASBE organised phone conferences and face-to-face meetings where officers can bring in applications they are processing to seek advice from peers who may have dealt with a similar issue.
- The work of CASBE and member councils has been grass-roots, bottom-up but supported through knowledge sharing and other resources. [After note: Given the diversity of the regional councils involved, this approach may have merit in working together on a shared framework that is flexible enough to accommodate nuances of different municipalities].
- The work (this project) that the group of councils is undertaking is really needed. There is a gap in understanding how to improve subdivisions, lots and their relationships to the dwelling.
- **Recommendation**: Regional councils group with a focus on SD subdivisions may be a useful on-going forum

4.2 Sustainability Victoria

Discussion focused on explaining the ESD subdivision project and purpose, Sustainability Victoria's recently commenced project and Erika's research on volume builders.

Key points:

- Sustainability Victoria have recently commenced a four year project that will identify ways to improve the sustainability of volume building and growth areas. The project will include in depth research of four areas in Victoria, one of which is likely to be in Geelong.
- Need better ways to communicate the benefits of ESD housing including the language we use to convey benefits. Erika's research is looking at how messages are explained in terms of health, comfort, liveability and affordability.
- The Australian dream of owning a large home is a major hurdle to improving ESD. Even with the evidence of reducing floor area by 10% will save $x in energy, it is still a hard sell, as people want the extra living space over saving money on bills. As energy prices rises and buyers become more aware this may change, but there is a lot of work to be done.

Additional resources:

- Zero Net Carbon tool – information. Sustainability Victoria is developing this tool
- Community Power Hubs information - http://www.sustainability.vic.gov.au/services-and-advice/funding/pilot-community-power-hub
- Link to HIA information / publications - https://hia.com.au/BusinessInfo/economicInfo/EcoPublications

- South East Councils Climate Change Alliance (SECCCA) New Home Energy Advisory Service (NHEAS)
- The Liveability Real Estate: https://liveability.com.au/book-a-liveability-appraisal/; https://liveability.com.au/book-a-liveability-appraisal-2/; https://liveability.com.au/lres/
- https://www.archistarr.com/
- https://www.theurbandeveloper.com/world-first-technology-changes-game-development-site-planning/?subscribe=subscriber_no_lightbox&utm_medium=email&utm_campaign=191017%20VIC&utm_content=191017%20VIC+CID_bc939e27c0ca9a136fb260fa6365a424&utm_source=Campaign%20Monitor&utm_term=Continue%20Reading

4.3 Moreland Energy Foundation Limited (MEFL)

Discussion included MELF's previous work on the SDAPP Rollout and identifying further cost information and case studies to inform cost-benefit analysis. The focus of discussion was identifying cost and benefit information given the project phase in which the interview was held.

Key points:

- Renewal South Australia may have cost data as it was led by state government
- Discussed the rate of learning when standards are lifted (this is the focus in MEFL's 2017 report). There is an initial cost associated with industry learning to adapt, this then flattens out as new ways of improving performance become normalised and supply chains also adapt. As per the report, it is easier for large volume builders to adapt designs for better ESD outcomes as part of their continual design improvement (i.e. some designs that have not sold well will not be continued, while more popular ones will be updated).

4.4 Urban Development Institute of Australia (UDIA)

The discussion focused on understanding the details and application of EnviroDevelopment. This included who is using it, what are common drivers for developers to apply for EnviroDevelopment, and key learnings.

Key points:

- EnviroDevelopment can be applied across all scales of development. Residential comprises the majority of developments but there is an increase in mixed-use, commercial and other developments that are choosing to use EnviroDevelopment. Developments are recertified every 12 months.
- UDIA ideally try to commence application of the tool as early as possible including prior to a PSP being developed. So the tool can be used for visioning through to construction, and operation.
- Incentivising ESD developments could include fast tracking applications and provide support pre-application.
- A recent EnviroDevelopment survey found that end-users value (in this order): community, ecosystems, water and energy. A university study (RMIT or UoM) found that people are willing to pay 2-5% more if they know the house is sustainable and will save them operating costs.
- The elements that are generally found to be the most difficult to achieve are waste and materials.
- Things get lost between intent and what happens on the ground.

Additional resource

- Supply Chain Sustainability School- a tool and online learning forum to assist the construction sector assess sustainability of their supplies, activities and buildings http://www.supplychainschool.org.au/

5.0 Recommendations

5.1 Refining elements

Based upon the workshops, the elements were generally considered robust. The following insertions or modifications were recommended as per the table below.

- Include management of vegetation to minimise bushfire risk
- Asked to clarify what was meant by diversity
- It was also recommended to include future proofing under adaptability and innovation; however the explanation describes the need to future proof, so it is considered that the concept of future proofing is included sufficiently.

Themes	Elements
1. *Optimise site potential* *Considering passive design principles and the local environment and site context early in the subdivision process enables efficient use of resources, minimises run-off and erosion and improves outcomes for residents.*	***Orientation & site layout*** - *Design to utilise topography, and to minimise earthworks and spoil* - Design responds to the existing environment, weather conditions and terrain - Design prepares for the future climate and *reduces impacts of the urban heat island effect (reduce hardstand area, roof reflectiveness, shade for roads, footpaths and bicycle paths; cool spaces in subdivision)* - Utilise eco-system services: o *Retains existing natural features(* o *Maximise solar access* o *Maximise natural ventilation* - *Enable access and connection to services, open space and amenities* - *Ensure space for quality public realm (open space, shade trees, landscaping and WSUD)* - *Landscape design to reduce maintenance requirements and benefit from natural features* *Optimise green, permeable spaces (such as through undergrounding services under footpaths)*
2. *Reduced footprint* *Increasing resource efficiency during construction and operations will avoid waste, improve amenity and reduce costs.*	***Water, stormwater and wastewater*** - *Stormwater retention and re-use (in parks, gardens and the landscape to mitigate flood risk and impacts of heat and drought)* - ~~*Water to cool the landscape*~~ - *Drought tolerant species/landscape design zoned to minimise water use* - *Protect water quality through treatment of waste from septic systems or alternative treatments* - *IWM/WSUD to* o *Increase permeability* o *Reduce impervious material* o *Clean and use stormwater* o *Retain water to cool the landscape* ***Energy*** - *Reduce demand for energy through* o *Compact fluorescent / LED street lighting* o *Smart technology to support demand management/ behavioural change (currently used in mini-grid trials)* o *Solar orientation & insulation*

Themes	Elements
	o *Shading* - *Generate and store renewable energy on site or at precinct scale* - *Utilise new and emerging technologies* - *Provide for redundancy* ***Waste*** - *Minimise construction waste and maximise reuse on site* - *On site separation of construction and operational waste to landfill (through using the use of locally sourced, recycled building and construction and infrastructure materials (see Infrastructure Design Manual Sustainable Infrastructure Guidelines)*
3. *Places for people* *Planning with future communities in mind better supports their economic and social wellbeing. Providing access to local amenities and spaces for people to meet and gather builds cohesive, inclusive and resilient communities.*	***Dwelling and lot diversity*** - *Provide varied lot sizes and dwellings that cater to a mix of housing needs and price points* ***Local economy*** - *Provide space for local economic opportunities (including small home-based businesses; shared spaces and incubator hubs etc.)* - *Offer good access to quality services and community spaces and facilities (including access to fresh food)* ***Connectivity*** - *Provide safe and shaded footpaths and bike-paths to connect to local amenities and neighbouring communities for residents and visitors* - *Design safe, inclusive, well-connected and welcoming places* - *Encourage shared spaces and shared use of space (such as for ride share; community gardens and community activities)* - *Enable technology to support social interaction.*
4. *Enhance ecology* *Health and wellbeing and building performance benefit from ecosystem services such as shade, urban cooling, and access to open space.* *Local ecosystems include public land and private gardens that support local flora, fauna and biodiversity.*	***Local ecology*** - *Retains existing established vegetation (especially native plants)* - *Strengthen local habitat and biodiversity connections to larger ecological assets.* - *Provide habitat for threatened species* - *Manage vegetation to minimise bushfire risk* - *Allocating cool spaces/refuges within subdivisions.* *Consider the inter-relationship of the public and private realm for enhancing streetscapes for biodiversity and amenity*
5. *Are adaptable and encourage innovation* *Subdivisions built with tomorrow in mind are more resilient and adaptable to future changes in climate, demographics and technology.*	***Emerging trends and technologies*** *Consider and enable room for innovation and new technologies such as::* - *battery storage* - *electric vehicle charging points* - *micro-grid (energy trading within subdivision- peer to peer trading)* - *autonomous vehicles* - *high quality digital infrastructure to the home to support the local economy* - *working from home; virtual service delivery*

Themes	Elements
	- *wind modelling to inform natural cooling*

Appendix A

Workshop attendees

Appendix A Workshop attendees

Wodonga

Name	Organisation	Occupation/Position
Brendan Collins	Lightwood Group	Developer
Kate Sleeman	Precision One	Developer
Henry Dinning	Nordcon	Developer
Bert Eastoe	Nordcon	Developer
Felicia Davis	Land Urban	Development Consultant (engineering)
David Larkin	Land Urban	Development Consultant (engineering)
David Hunter	Habitat Planning	Development Consultant (planning)
Stuart Neave	Development Outcomes	Development Consultant (engineering)
Jack Bond	Development Outcomes	Development Consultant (engineering)
Simon Eakin	Spiire	Development Consultant (Landscape Architect)
Jonathon Keys	SJE Consulting	Development Consultant (engineering)
John Forrest	SJE Consulting	Development Consultant
Ian Bignell	Eslers and Associates	Development Consultant (engineering)
Jason Schneider-Fuller	Ibuildinvestments	Development Consultant
Glen Johnson	DELWP	Referral agency
Marike Van Nouhuys	DELWP	Referral agency
Natalie Dando	North East Catchment Management Authority	Referral agency
Julie Brooks	North East Region Water Corporation	Referral agency
Delia Naughton Phommathet	North East Region Water Corporation	Referral agency
Arun Nirmalaraja	North East Region Water Corporation	Referral agency
Darren Viney	CFA	Referral agency
Matthew Charles Jones	Mondo (commercial arm AusNet services)	
Suzanne Pasko	RAW (Renewable Albury Wodonga) Energy	Environmental group
Bronwyn Chapman	Goulburn Broken Greenhouse Alliance Executive Officer	Environmental group

Name	Organisation	Occupation/Position
Darren Parker	Energy Raters	Energy Rater
Matthew Dudley	Albury City Council	Planning and Environment
Bridie Guy	City of Wodonga	Strategic planner
Ken Chan	City of Wodonga	Team Leader Strategic planning
Timothy Cheetham	City of Wodonga	Strategic planning
Laura Hawkins	City of Wodonga	Statutory planning
David Seal	City of Wodonga	Team Leader Building Services/ Municipal Building Surveyor
Conwae Knight	City of Wodonga	Engineering
Anne Visser	City of Wodonga	Engineering

Wangaratta

Name	Organisation	Occupation/Position
Tony Lane	Wangaratta Sustainability Network	n/a
Charles Szeligiewicz	Charles by Design	Building designer
Matt Sammon	North East Survey Design	Development consultant
Matt Fischer	Tomkinson	Development consultant
Emma Avery	Wangaratta City Council	Sustainability Education Officer
Pat McMahon	Oxley and Company	Development consultant
Peter Joyce	Stockdale Leggo	Real Estate Agent
Tracey Toohey	Tracey Toohey Design and Drafting	Architect/Building Design
Jayden Bosch	Wangaratta City Council	Development Engineer
Paul Smithwick	Development Engineer	Development consultant
India-Rose Hutchison	District Property Group	Real Estate Agent
Pauline Rhodes	District Property Group	Real Estate Agent
Paula Jenkin	Oxley and Company	Development consultant
Joe McKenzie	Harcourts	Real Estate Agent
Ben Thomas	Wangaratta City Council	Technical Services Coordinator
Jeff Whitehead	Wangaratta City Council	Deputy Municipal Building Surveyer

Shepparton

Name	Organisation
Grace Docker	Greater Shepparton City Council
Gavin Pogue	Opteon Property Group
James Hudson	Laurie McGoldrick Consulting
Robert Duncan	Greater Shepparton City Council
Carl Byrne	Greater Shepparton City Council
John Xu	Goulburn Valley Water
Tony Flammea	CAF Consulting
Jeremy Rath	CAF Consulting
Ed Twining	Goulburn Valley Water
Duncan Lowis	Chris Smith & Associates
Paul Kerrins	Goulburn Valley Water
John Dunn	Rural Works
Gary Steigenberger	Chris Smith & Associates
Pradeep Rajasekaran	Greater Shepparton City Council
Sharon Terry	Greater Shepparton City Council
Juliann Pell	Opteon Property Group
Elizabeth Tuson	Department of Environment, Land, Water and Planning

Bendigo

Name	Organisation	Occupation/ position
Aaron Lindsay	City of Greater Bendigo	Coordinator Public space
Andrea Tomkinson	Tomkinson Group	Director Bendigo Surveyors and development consultants
Bernie Gamboni		
Cameron Clarke	Spiire	
Cr Jennifer Anderson	Macedon Ranges Shire Council	Mayor
Damien Tangey	Birchgrove Property group	President UDIA Victoria Board of Directors
Damien Cranage	Total Property Developments	Director
Elise Snell	Department of Environment Land Water Planning (DELWP)	State Government
Eliza Hughes	Haven Home Safe	
Grant Penno	Penno Drafting and Design	Director
Jane Marriott	City of Greater Bendigo	Public space design
Jordan Sens	Terraco	
Kahlia Reid	NCCMA	Town Planner

Name	Organisation	Occupation/ position
Karim Khodja	CSI Engineers	Director
Kevin Jackson	Conceptz	Director
Linda Hermens		Drafts person
Louise Johnston	Mount Alexander Shire Council	Planning Coordinator
Matthew Elliot	Tomkinson Group	Surveyors and development consultants
Michelle Hutchings	Mount Alexander Shire Council	Subdivision Planner
Michelle Pollard		
Ming Yang	Opticare	
Morgan James	City of Greater Bendigo	Amendments Planner
Paul Bowe	Terraco	Civil engineers development consultants Director
Peter Brasier	City of Greater Bendigo	Development engineer
Peter Martin	Private developer	Developer
Peter O'Brien	City of Greater Bendigo	Planning coordinator
Rebecca Stockfield	Mt Alexander Shire Council	Planning Coordinator
Remi Rauline	The Paddock Eco Village	Project Manager
Rimmon Martin	E+ Architecture	Architect
Ros Woodburn	Living Lightly Design	
Scott Jackman	Solutions Consultants	Development consultant and financial advisor
Stephen Pole	Spiire	Surveyors and development consultants
Terry Mitton	E+ Architecture	Architect/Director
Tony Knox	Developer	Director
Tony Lethlean	Rocky Rises Pty Ltd	Director
Vanessa Wild	Wild Homes	Construction owner
Zachery Powell	Conceptz	Graduate Planner
Zoe Porlai	Spiire	Surveyors and development consultants

Ballarat/Moorabool

Name	Organisation
Andrew Ferguson	Bentley Property Group
Eddie Harwood	Bentley Property Group
Scott McQueen	Bentley Property Group
John Ciavarella	City of Ballarat
Donna Johnston	City of Ballarat
Sam Magill	City of Ballarat
Karl Sass	City of Ballarat
Belinda Coates	CoB (Councillor)
Daniel Moloney	CoB (Councillor)
Jim Rinaldi	CoB (Councillor)
Grant Tillett	CoB (Councillor)
Brendan Gillett	CVI
Imogen Ritchie	Elmstone Property Group
Nick Grylewicz	Integra
Tim Oldaker	Integra
Mike Kaufmann	Kaufmann Property Consultants
Paul McCusky	Macneil Group
Justin Horne	Moorabool Shire
Barry Hughes	Pickwick Design Pty Ltd
Deon van Baalen	SED Regional Advisory
Adam Criddle	TGM Group

Geelong

Name	Organisation	Occupation/Position
James Ramsey	Ramsey Property Group (Batesford South)	
Greg Bursill	Lovely Banks Development Group	Developer
Chris Banks	Lovely Banks Development Group	Developer
Kris Wilson	Lovely Banks Development Group	Developer
Nathan Hull	St Quentin Consulting	Surveyor
Nathan Campbell	St Quentin Consulting	Surveyor
Rodd Missen	St Quentin Consulting	Surveyor
Matthew McGrath	St Quentin Consulting	Surveyor
Brendan O'Loan	St Quentin Consulting	Town Planner
Alexander Schmidt	Spiire	Landscape Architect
Lisette Schlesinger-Hunt	Spiire / Lovely Banks Development Group	Urban Designer
Vivienne Burke	Geelong Sustainability	Community group
Vicki Perrett	Geelong Sustainability	Community group
Ryan Thompson	Ryan Thompson Architect	Architect
Geoffrey Fulton	Architects Fulton & Salomon	Architect
Doug Gow	Select Group	
Kate Milburn	Barwon Water	Water authority
Charlotte Beresford	Clearwater Victoria	Developer
Sam Smith	City of Greater Geelong	ESD Officer
Verity Bright	City of Greater Geelong	Statutory Planning
Erin Jones	City of Greater Geelong	Statutory Planning
Jani Chalmers	City of Greater Geelong	Strategic Planner
Fernanda Suarez	City of Greater Geelong	Urban Designer

Baw Baw

Name	Organisation	Occupation / Position
Danii Finlayson	TRW	Consultant
Greg Dyer	Dyer Consulting Engineer	Consultant
Geoff Fedderson		Consultant
Travis Gibson	SK Spatial	Consultant
Adam Dunn	WGCMA - Traralgon	Referral Agency
Murray Cook	Environmental Voice	Community Group
Dalene Salisbury	Environmental Voice	Community Group
Andrea Klindworth	Environmental Voice	Community Group
Mathew Burcombe	Miles Civil Design	Architect / Designer
Samuel Wilkinson	Miles Civil Design	Architect / Designer
Rodney Smythe	Miles Civil Design	Architect / Designer
Denise Panozzo	Noztech	Architect / Designer
Matthew Cripps	Baw Baw Shire Council	Planning & Economic Development
Luke Cervi	Baw Baw Shire Council	Strategic Planning
Leanne Khan	Baw Baw Shire Council	Strategic Planning
Robyn Begg	Baw Baw Shire Council	Statutory Planning
Robyn Begg	Baw Baw Shire Council	Statutory Planning
Sunny Shan	Baw Baw Shire Council	Statutory Planning
Lyndal Farrar	Baw Baw Shire Council	Subdivision Officer
Greg Hollis	Baw Baw Shire Council	Environment
Jessie Ablett	Baw Baw Shire Council	Environment
Cr Mikaela Power	Baw Baw Shire Council	Councillor
Cr Joe Gauci	Baw Baw Shire Council	Councillor
Cr Keith Cook	Baw Baw Shire Council	Councillor

Central workshop- Melbourne

Attendee	Organisation
Mike Hermon	Housing Industry Association (HIA)
Jon Griffin	Local Government Infrastructure Design Association (IDM)
William Bartley	Planning Institute of Australia (PIA)
Nick Alsop	Green Building Council of Australia (GBCA)
Peter Durkin	DELWP
James Walsh	DELWP
John Casey	VPA
Natasha Palich	CASBE
Stephen Glackin	Low Carbon CRC /Swinburne
Jennifer Witheridge	Low Carbon CRC
Ellen Davies	VicRoads
Kenneth Chan	Wodonga City Council
Liz Johnstone	AECOM
Sarah Brennan	AECOM
Jo Barnett	AECOM
Pablo Sepulveda	AECOM

Apologee	Organisation
Bridie Guy	Wodonga City Council and ESD Project Coordinator
Erika Bartak	ESD Researcher
Sally Capp	Property Council of Australia
Bernardo Cuter	Sustainability Victoria
Kathryn Skidmore	Moreland Council ESD Officer
Ricki Herburgh	Urban Development Institute of Australia (UDIA) Victoria
Tom Roe	Urban Development Institute of Australia (UDIA) Geelong Chapter
Andrea Tomkinson	Urban Development Institute of Australia (UDIA) Bendigo Chapter
Emlyn Breese	MAV
Gavin Ashley	Moreland Energy Foundation
Lili Pechey	AECOM

Venues and time

Council	Date and time	Location	Contact details
Wodonga	Monday 20 November 8: 30am – 10am	The Cube 118 High Street Wodonga	Bridie Guy bguy@wodonga.vic.gov.au P: 02 60 229 321 Ken Chan kchan@wodonga.vic.gov.au P: 02 60 229 274
Wangaratta	Monday 20 November 2pm – 3:30pm	Council Chambers - Wangaratta Government Centre 62 - 68 Ovens Street	Meghan Kelly meghan.kelly@wangaratta.vic.gov.au P: 03 5722 0726
Shepparton	Tuesday 21 November 10am – 11:30am.	Mechanics' Institute 227 Wyndham Street Shepparton	Grace Docker Grace.Docker@shepparton.vic.gov.au P: 03 5832 9554
Bendigo	Tuesday 21 November 2pm -4pm.	Reception Room First floor Town Hall 189-193 Hargreaves Street Bendigo	Simon Francis s.francis@Bendigo.vic.gov.au P: 03 4408 6533
Ballarat / Moorabool	Wednesday 22 November 10am – 12pm.	Humffray Room Mechanics Institute 4th Floor, 117 Sturt Street Ballarat Central	John Ciavarella johnciavarella@ballarat.vic.gov.au P: 03 5320 5697 | M: 0419 108 257 Karl Sass KarlSass@ballarat.vic.gov.au P: 03 5320 5119 Justin Horne Jhorne@moorabool.vic.gov.au P: 03 5366 7100 | M: 0438 055 266
Geelong	Wednesday 22 November 2:30pm – 4:30pm	Council Offices 100 Brougham Street, Geelong	Jani Chalmers JChalmers@geelongcity.vic.gov.au 03 5272 4167
Baw Baw	Friday 24 November 11:00am – 12:30pm.	West Gippsland Healthcare Group - Community Services - 31 - 35 Gladstone St, Warragul	Greg Hollis greg.hollis@bawbawshire.vic.gov.au P: 03 5624 2532 | M: 0400 304 551 Jessie Ablett Jessie.Ablett@bawbawshire.vic.gov.au P: 03 5625 0255 | M: 0408 234 352
Melbourne	1 December 8am for 8.30 – 10.30am	AECOM Level 10, 727 Collins Street Melbourne	Sarah Brennan 0476 258 440

Appendix B

Workshop agendas

Appendix B Workshop agendas

Regional workshops

No	Item	Lead	Time
1	**Welcome and background**	Council	5 min
2	**Overview** - Agenda and introductions - Session objectives - Context & drivers for project - ESD basics – sustainable subdivisions - essential elements	AECOM	10min
3	**Activity 1 – exploring ESD** - Explore the key elements of an ESD subdivision - What is being done well now? Where is there room for improvement? - Implications of various elements - Explore cost benefit of alternative measures	AECOM	15min /25min
	Feedback	All	5min /10min
4	**Where are we now – what should guide future action?** - Using examples from the case studies and background paper, point out existing ESD initiatives - Refer to other industry guidance, tools and programs - Present draft best practice principles:	AECOM	10min
5	**Activity 2** - **Draft best practice principles** Discuss the high-level draft best practice principles and how these might be applied in the short, medium and longer terms (maturity model) - Discussion of draft principles to guide ESD - Groups identify areas where objectives align and where they vary. - What role would participants like to see Councils take in this area? - How can we collaborate for mutual benefit? - What would enable/block progress?	All	25 min /35min
	Feedback	All	10 mins/ 15min
6	**Thank you and next steps**	AECOM	5 mins

Central industry workshop

Agenda

No	Item	Lead	Time
1	**Welcome & introductions**	AECOM	5 min
2	**Overview** · Agenda and background · Workshop objectives · Context & drivers for project; work to date · ESD basics - sustainable subdivisions - essential elements · What is currently happening - existing ESD initiatives in Victoria	AECOM	20 min
3	**Discussion 1 – Draft ESD elements** The elements set out a framework for measuring ESD practices (see separate background reading). These were tested in seven workshops held across Victoria. · Discuss the elements and provide feedback on the robustness of the elements, gaps or priorities, implications and if any changes or additions should be made.	All	20 min
	Feedback	All	10 min
4	**Where are we now – what should guide future action in regional Victoria?** · Lessons learned - from Armstrong Creek, BESS and CASBE · Refer to other industry guidance, assessment tools and programs	AECOM CASBE Moreland City Council	10 min
5	**Discussion 2** – **Appropriate planning (& other) mechanisms** Various planning mechanisms can improve ESD subdivisions – from Precinct Structure Planning, master planning and development plans. Often the scale of the subdivision may not justify a PSP or masterplan. · Discuss what planning mechanisms may be available and how / when they may be applied. · Give consideration to: · Resourcing to administer · Flexibility to apply to a range of areas, scales and councils · What would enable/block progress? What other mechanisms would support ESD subdivisions?	All	30 min
	Feedback	All	10 min
6	**Thank you and next steps** · Including any additional data available for cost benefit analysis for ESD subdivisions	AECOM	5 min

Appendix C

Workshop responses by topic

Appendix C Workshop responses by topic

A1. Q1 - What is being done well locally?

Working well a number of localities reported that early engagement in the subdivision process is working well.

Elements	Wodonga	Wangaratta	Shepparton	Bendigo	Ballarat /Moorabool	Geelong	Baw Baw
Optimise site potential							
Orientation and site layout	Floodplains are being reserved Lot sizes Protection of natural environment		Orientation- living areas tend to be towards the south and garages towards the north	Recent improvements in using existing topography for larger developments incl. walking and cycling paths.			
Reduce footprint							
Water, stormwater and wastewater	Sewer and water design		Leader in stormwater retardation – use in wetlands and public spaces	WSUD stormwater is ok	Ballarat West water harvesting on private lots 40% water use.	Recycled water /purple pipes	Wetlands are being upgraded Retardation
Energy				LED Lighting			Sustainable energy design (solar panels increase).
Waste							
Places for people							
Diversity				Building diversity	There is more mixed use development occurring		
Local economy		Local example: Appin St shops as			Co-location of communities,		Public space provided

Elements	Wodonga	Wangaratta	Shepparton	Bendigo	Ballarat /Moorabool	Geelong	Baw Baw
		community anchor			schools, shops etc. Scaling up of facilities i.e. Schools as communities grow.		
Connectivity	Engineering and construction of roads	Road connections, walking and extensive off-road cycling network		Commute times	Planning for '10 minute suburbs' - starting to see benefits.	Transport links are improving – cycling, walking and external connectivity of subdivisions	Walking paths
Enhance ecology							
Local ecology			Improving ecology in new subdivisions	'City in the forest' – retaining the forest			Established trees are staying in Drouin (Ficifolia).
Adaptability and encourage innovation							
Emerging trends and technologies							
Other- what is working well							
	Bringing stakeholders together from the beginning There is good communication between agencies Albury Wodonga Development Corporation		Growth corridor plans - coordinated planning up front for communities - schools and childcare provided at the same time as residential development	PSPs and DCPs are working well in larger precincts	Preplanning and consideration of potential for development (and prior to purchasing by developers). Good strategic plan., master planned EnviroDevelopment	Demonstrations , learning and free advice on home plans ie through Sustainable House Day and Smarter Homes, Smarter Living • Geelong statutory planner provides advice to first home buyers about what to look for • Infrastructure is	Precinct Structure Plans (PSP) - stick with it. Aesthetics - the newer estates. Parks are linked as well - waterway corridors. More connectivity.

Elements	Wodonga	Wangaratta	Shepparton	Bendigo	Ballarat /Moorabool	Geelong	Baw Baw
					Council's early engagement and understands commercial drivers of development. The Ballarat West PSP as an integrated plan.	being put in that can be scaled as demand grows ie footpaths will transition to bike paths in future • CoGG has a coordinating group for Armstrong Creek that gathers every couple of weeks and address issues from multiple perspectives. It also has good relationships with referral agencies and other authorities.	
			Centralised infrastructure				

What could be improved?

Disconnect between lot layout and house orientation

	Wodonga	Wangaratta	Shepparton	Bendigo	Ballarat / Moorabool	Geelong	Baw Baw
Optimise site potential							
Orientation and site layout	Lot orientation and solar passive design	Site layout and orientation Driveways are problematic. Force better solar access, but ripped out if does not suite house/garage layout	Gap between lot and house orientation		Disconnect and council control over sub process to influence house orientation.		Orientation of lots.
Reduce footprint							
Water, stormwater and wastewater	Integrated water management stormwater; third pipe system- reuse in subdivision; Stormwater reuse			Stormwater use			Stormwater interpretation of PSP Retard stormwater could be improved and retention. Recycled water available to new subdivisions.
Energy	Use less energy		Performance review against First Rate energy ratings?				
Waste							
Places for people							

	Wodonga	Wangaratta	Shepparton	Bendigo	Ballarat / Moorabool	Geelong	Baw Baw
Diversity	Diversity of lots Medium density living	Planning for life-stages and intergenerational communities	Mixture of lot sizes - lacking demand for smaller lots or a range of lot sizes. Larger lots on average. Buyers want comparability of subdivision as protection on investment (i.e. want the same size lots as their neighbours).	Affordability			
Local economy	Employment opportunities community infrastructure/community hubs/local destinations;		Lack of local shops and services		Put land aside for long term facilities e.g. Schools, cemeteries, fire stations, earlier intervention by gov. so that it's not overlooked		More community space
Connectivity		Car-centric External access to subdivisions	Public transport – frequency and routes Connectivity between older and newer subdivisions	Bicycle lanes Footpaths		• Public transport priority and density to support	Higher density closer to transport and shops etc. (variety of lot density)
Enhance ecology							
Local ecology	vegetation retention in corridors and vegetation management to			Acknowledge benefits of ecology ie on health and		• Urban forest strategy review	Enhance permeability

	Wodonga	Wangaratta	Shepparton	Bendigo	Ballarat / Moorabool	Geelong	Baw Baw
	minimise bushfire risk.			wellbeing			
Adaptability and encourage innovation							
Emerging trends and technologies				Innovation – being risk ready	Behaviour change to encourage uptake of new technology and overcome resistance to new tech Inc. water harvesting at localised level.	• Supporting innovation	
Other- what could be improved							
	Master planning Guidelines don't always consider cost impact; public understanding is low/limited. Info sharing of expert knowledge/input; balancing making money and liveability/Land outcomes Council resourcing and finances - Resources for VCAT,	Constraints of the IDM (policy context and rules) Rural vs urban not well done Reduce additional long-term maintenance Education	Education of first home buyers	Improve understanding of sustainability and ESD within the general public Tension between innovation and regulation Life-cycle – what is efficient today may not be best outcome longer term Need incentives	story telling around the benefits of better ESD building and payback period. Better estimation of timelines eg. X years for shops or schools. Government/Council needs to be willing to take on a new (blue/green) type of asset. PSPs to consider localised energy and stormwater systems.	Councils to provide direction • How do you set goals in policy? • End-user market wants ESD and affordability but can't get it Consistency across council departments • More policy support for statutory planning decisions • Policy in scheme that supports innovation • Commitment to implementation • Best practice	Coordination of works i.e. trenching for multiple services Upfront infrastructure - service authorities. Policy alignment. Form alliance with stakeholders. Design guidelines.

	Wodonga	Wangaratta	Shepparton	Bendigo	Ballarat / Moorabool	Geelong	Baw Baw
	Development in sequence Lag in older strategic plans now being developed that don't meet current standards				Need to talk with builders, issues around price points, eaves, black roofs	/innovation being bogged down by maintenance • Fast track process • Create platform for research and innovation	

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