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victorian centre for climate change adaptation research

Project Report:

Design-led decision support for regional climate adaptation

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Executive summary

This document constitutes the final report of the research project Design-Led Decision Support for Regional Climate Adaptation. It outlines a decision support framework for policy makers to engage multiple perspectives in regional climate adaptation planning, and includes a project manual comprising both the methods used in the project and a how to guide for undertaking charrette-based, design-led decision support for climate adaptation planning.

The aim of this VCCCAR-funded project was to develop future design concepts at the landscape scale, in which regions are resilient to the impacts of climate change and are capable of dealing with unforeseen climate events. It takes a new approach to climate change adaptation at the (sub) regional scale by organising and conducting design-charrettes, a design-led, intensive workshop-based approach to adaptation that addresses the complexity and uncertainty in making decisions for climate change adaptation, and includes multiple disciplines through a co-development (or co-design) approach.

Design charrettes for climate change adaptation were undertaken in two Victorian communities:

- City of Greater Bendigo: 17 and 18 Nov 2011 (Charrette I); 26 Oct 2012 (Charrette 2)
- The regional community of Sea Lake: 15 and 16 June 2012 (Charrette I); 19 Oct 2012 (Charrette 2).

The charrettes were based on the following design principles:

- Establish a community that is safe, i.e. is protected from climate hazards
- Provide ecological and hydrological systems that are resilient and provide mitigating effects in times of heat and drought as well as during severe rainfall events and floods
- Design an urban development strategy, which is based on the natural features of the landscape and is therefore better able to react to climate disasters
- Accommodate population and economic growth in a way that acknowledges and incorporates projected climate change impacts, while enhancing spatial quality and sustainability.

Based on a review of literature, the three key overarching concepts of adaptive capacity, maladaptation and sustainability frame the appraisal approach used to assess the design outputs from the charrettes in terms of ‘good adaptation’. The purpose of the appraisal of is to:

- Assess each design concept at a conceptual level
- Enable the effects and impacts of the proposed futures to inform the second charrette
- Suggest preferred future designs (or elements of designs) from the charrette.

During the Sea Lake charrette, futuring methods of forecasting, backtracking and backcasting were used to facilitate discussion of the past, present and future of each region and thereby identify desirable qualities that stakeholders may wish to retain, or amplify, and qualities that they may want to reorientate. Competitive benchmarking or ‘concept scoring’ was used to assign value to the design solutions for both Bendigo and Sea Lake based on the design criteria developed by charrette participants, and assess areas for further investigation. Concept scoring, from maladaptive (-2) to adaptive (+2), was applied across five overarching elements relevant to climate adaptation, Social, Environment, Wet, Drought and Heat Stress, and within each element, a further four to eight critical areas, including food, energy, water, built environment/shelter, human health, transport, population and biophysical health.

Outcomes of the Bendigo charrette resulted in two concept designs for a local Business Park that address criteria for energy, transport connectivity, water sensitive urban design, flooding, design integration, internal cohesion, regional connectivity, wind, risk management, waste and post-peak oil and mitigation. The appraisal identified features of each design concept that exhibited positive adaptation, areas for further resolution to be adaptive, and features that are potentially maladaptive.

Outcomes of the Sea Lake charrette resulted in eight landscape plans, including two town level plans,

two regional level plans and four models detailing a combination of town and regional scale initiatives. From the landscape plans, six major themes were identified and used as the basis of a thematic compilation of conceptual design solutions. The six themes are:

- 1 Land use and agriculture
- 2 Lake Tyrell and tourism
- 3 Renewed town centre and community garden
- 4 Silo and railway station redevelopment including art precinct
- 5 Aged care accommodation and services
- 6 Education development and accommodation

The thematic appraisal of design solutions enabled the Advance Sea Lake Inc. committee to:

- Identify themes/initiatives that would **not** be in the interest of Advance Sea Lake Inc.
- Revisit areas that the charrette appraisal viewed to be 'maladaptive' and identify how the existing designs may be modified to become more 'adaptive'
- Categorise concepts from each theme with respect to costs (low, medium or high) and timeframes (short, medium and long) to identify potential initiatives that could be developed further by the Advance Sea Lake community.

Based on the Bendigo and Sea Lake charrettes, the following seven principles have been identified to guide the application of the design-led approach to adaptation planning:

1. Synchronising with existing planning processes
2. Engaging local government commitment
3. Engaging other government departments and agencies
4. Engaging the 'right' mix of stakeholders
5. Making space for tacit knowledge
6. Setting timing and expectations
7. Undertaking and resourcing communications.

In testing a design-led process for adaptation planning, this project provides the following policy recommendations:

1. Reframe climate adaptation from risks to opportunity
2. Provide an inclusive environment for co-design
3. The key is process and engagement rather than prescriptive solutions
4. Appraisal adds to the value of the design-led exercise
5. Adaptation and mitigation efforts should be complementary
6. Ongoing coordination and financing is required.

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1 Introduction

The Victorian Centre for Climate Change Adaptation Research (VCCCAR), which was established in 2009 and is funded by Victorian Government, aims to improve government and community understanding about the potential impacts of climate change and adaptation options. It does this through the funding of interdisciplinary and multi-institutional research projects, which address priorities identified by the Victorian Government. Climate change adaptation has become an important consideration when discussing future development trajectories for cities and regions in Victoria.

The aim of the research project "Design-led Decision Support for Regional Climate Adaptation" ("this Project") is to develop future design concepts at the landscape scale, in which regions are resilient to the impacts of climate change and are capable of dealing with unforeseen climate events. The design is undertaken in collaboration with local stakeholders, state government representatives, designers and researchers. The project takes a new approach to climate change adaptation at the (sub-) regional scale by organising and conducting design-charrettes, addressing the positively and optimistic framed question: "What might a 'climate-proof' future look like?" instead of the more common and negatively framed question: "How do we become resistant and protect ourselves against the impacts of climate change".

Adapting to scenarios of multiple stressors and impacts across a variety of sectors is a critical challenge for Australia (Park et al. 2011). A design-led approach to adaptation is one way to address the complexity and uncertainty in making decisions for climate change adaptation, and including multiple disciplines through a co-development (or co-design) approach. Design thinking is a process for solving complex (or wicked) problems that has origins in product design and architectural processes. It involves the synthesis of various and often disparate ideas into multiple plausible solutions. Swann describes the synthesis process as 'intuition, inspirational guesswork and holistic thinking' (2002, p.51). Cross (1989) articulates the difference between design and engineering suggesting that designers solve complex problems through synthesis in the generation of multiple solutions; many quick solutions are generated until one works while in science or engineering disciplines, problems are solved through analysis. The synthetic creative process is explained by Schön as continuous on-the-fly 'reflection in action' (1991). Further detail of the design process related to the generation of adaptive solutions, and the charrette procedure are outlined in the Bendigo Design Brief (Roggema et al. 2011) and Sea Lake Design Brief (Roggema et al. 2012).

The Design-Led Decision Support project involved undertaking design-led decision making for climate change adaptation in two Victorian communities:

- City of Greater Bendigo: 17th and 18th November 2011 (Charrette I); 26th October 2012 (Charrette 2)
- The regional community of Sea Lake: 15th and 16th June 2012 (Charrette I); 19th October 2012 (Charrette 2).

The two charrette locations differ significantly. The Bendigo charrette was hosted by the City of Greater Bendigo (CoGB) who were interested in integrating climate adaptation into their development strategy, with Charrette 2 specifically focused on developing Marong Business Park. The Sea Lake charrette was hosted by Advance Sea Lake Inc., a community group that represents the interests of the Sea Lake community, both within the Buloke Shire and beyond. The focus for Advance Sea Lake Inc. was on identifying strategies that the community group could mobilise. The context specific nature of the host organisations meant that the charrettes differed slightly in delivery and appraisal.

1.1 Aim

This document constitutes the Final report of the research project Design-Led Decision Support for Regional Climate Adaptation. It outlines a decision support framework for policy makers to engage multiple perspectives in regional climate adaptation planning.

1.2 Project outputs and structure of this final report

This document is the Final Report of the Design-led Decision Support for Regional Climate Adaptation project. It is one of a number of outputs of the project and a summary of these outputs is as follows:

- Work Package 1.1: Progress report on outcomes of data collection and Bendigo case study preparations
- Work Package 1.2: Case study 1 baseline report
- Work Package 1.3: Case study 2 baseline report
- Work Package 2.1: Policy brief on 'Design-led approaches to spatial planning for climate adaptation'
- Work Package 2.2: Completion of charettes
- Work Package 3.1: Scoping Appraisal reports for charettes
- Work Package 3.2: 2 outputs: (1) Report: Methodology for the sustainability appraisal of design-led responses to climate adaptation, and; (2) Policy brief on 'Incorporating sustainability metrics in climate adaptation planning'
- Work Package 3.3 (additional added work package): Report: Design-led decision support, process and engagement.
- Work Package 4.1: 2 outputs: (1) Final report: "Design-led Decision Support for Regional Climate Adaptation" *including* project manual (chapter 3), and; (2) A policy brief 'Designing a climate resilient future: a guide to integrating multiple perspectives in spatial planning'

This document incorporates elements of other deliverables for the project and is structured as follows. Section 1 provides an Introduction and context for the report and the project. Section 2 provides an introduction to climate adaptation and charrettes as a design-led approach to adaptation planning. It acknowledges the traditional approach represented by risk and/or vulnerability assessments

Section 3 presents the 'Project Manual' comprising both the methods used in the project and a 'how to' guide for undertaking charrette-based, design-led decision support for climate adaptation planning. The Design Charrette is the central exercise and this Section presents the six typical stages of the design charrette as outlined by Condon (2008):

(Preparation phase):
1. Stakeholder engagement and planning
2. Climate science and identifying risk
(Visioning charrette I):
3. Running design charrette I
4. Appraising the design outcomes
(Implementation charrette 2):
5. Follow up design charrette 2
6. Implementation into planning

The methodology does not differentiate the ideation process from the decision making process. The participatory process of the charrette is intended to assist in local council decision making by engaging multiple stakeholders simultaneously in negotiating approaches to climate adaptation. The design charrette therefore simultaneously becomes the decision support framework.

The methodology section is followed by an overview of the outcomes of two sets of design-led charrettes for climate change adaptation delivered in Bendigo (Section 4) and Sea Lake (Section 5). These sections include an appraisal of the planning outcomes for each case study and summarise work from earlier work packages accordingly.

Section 6 is drawn from an additional work package 3.3 "Design-led decision support, process and engagement". This presents proposed principles for undertaking design led decision support exercises, drawn from the experiences of the research for this project. Section 7 concludes by reporting the implications of the research outcomes, in particular, drawing attention to the implications of the research findings regarding:

- Engaging councils in the charrette process;
- The value of the design led decision support process to facilitate climate adaptive futures for regional Victoria; and
- Mobilising the outcomes of charrette based design approaches such as those used in this project.

Appendices are included in order to provide background information, much of which is drawn from other Work Package outputs indicated above.

1.3 Definitions

This project involved a variety of disciplines and professions including social science, landscape architecture, product design, climate science, public policy and professional sectors such as council officers and planners. Establishing a common language to work throughout the project was important for an interdisciplinary audience. Table 1 presents the glossary of terms used in the project.

Table 1 Definitions for an interdisciplinary team

Term	Definition		Example for our use
Climate change assessment	A way of understanding the stressors, impacts, risks and vulnerabilities of climate change		Climate impact assessment Vulnerability assessment Risk assessment
Adaptation terms	*Hazard*- threats to a system, comprised of perturbations and stress (and stressors), and the consequences they produce (Turner et al. 2003). *Risk*- the product of hazards and vulnerability with consideration for consequence and likelihood (Fünfgeld and McEvoy 2011). *Vulnerability*- The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity' (McCarthy et al. 2001) *Resilience*- the ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change (Adger 2000).		
Temporal	The time frame of an impact, stressor or adaptation measure including the onset and duration.	<u>Duration</u> Short term Medium term Long term	<u>Onset</u> Sudden Continuous
Spatial	Location of stressor, impact or measure	International, national, state, regional, local	
Stressors	Climatic and non-climatic including influences of human agency, technology and infrastructure and the natural environment.	<u>Climatic</u> Storm surges Increased/ changed precipitation Extreme temperatures Average temperature increase	<u>Non-climatic</u> Electricity grid Water and sewer infrastructure
Impacts	An outcome of the climate stressor and perceived risk; can be direct or indirect	<u>Direct</u> Sea level rise Heat waves Bush fires Drought Torrential rain	<u>Indirect</u> Flooding/ inundation / erosion Heat stress Fire damage Drinking/ irrigation water scarcity Flood damage to built environment
Systems	Human and biological systems affected by stressors and impacts	Food, Energy, Transport, Water and sewerage, Housing, Biodiversity, Vegetation	
Type (within a typology)	The kind of adaption measure being suggested or used	Behavioural, Technical, Financial, Institutional	
Spheres of influence	What group the stressor or impact has an effect on and can effect	Individual, family/ household, neighbourhood, business, local government, regional groups, state government, federal government, national/global community	

2 Climate change, design thinking and good adaptation

2.1 Dominant approaches to climate change adaptation

Policymaking for climate change adaptation is relatively new in the Australian institutional landscape, and has already been incorporated into a number of Australian Government policy areas including water, agriculture and emergency management.

In the State of Victoria, the Climate Change Act 2010 (Victorian Parliment 2010) guides the Victorian Government's actions on climate change mitigation and adaptation. It requires the Government to develop a Climate Change Adaptation Plan every four years (the first is due by 31 December 2012) and to report every two years on climate change science and emissions data. The Plan will assess the climate change risks faced by various regions in Victoria and discuss strategies to adapt to their potential impacts. The Act also requires the State Government to take climate change into account in specified areas of decision-making. A review of the Act was completed in December 2011 (DPC 2011).

Within Australia, state and territory governments have implemented a range of policies relating to climate change. In most cases, they focus on climate change research, information provision on climate change impacts (risks) and adaptation, and vulnerability assessments. However, at present there is no overarching framework guiding local government in Australia when it comes to assessing and responding to the impacts of climate change (Productivity Commision 2012). Increasingly, councils (and the public and private sector) are using a risk management approach to plan for climate adaptation. The most standard framework for assessing climate change risks is based on the Australian and New Zealand Standard AS/NZS 4360 and has the following steps:

1. Context — identify responsibilities of local authorities, their structure, goals and services they provide, and take into account how climate change will affect them.
2. Identify risk — consider different hazard event scenarios (including the risks associated with each scenario) for each region and/or activity while taking into account the specific characteristics of each community.
3. Analyse risks — identify sources of risks, their impacts, and the probability of these impacts occurring at some point during the lifetime of the development, asset or infrastructure.
4. Evaluate risks — assign a risk rating to each climate change impact. The risk rating ranges from almost certain to rare and depends on the consequence and likelihood of an event.
5. Treat risks — identify objectives, targets and relevant risk management and/or adaptation options.

Communication, consultation, monitoring and evaluation are required at each step of the risk assessment process—a communication plan should address climate change issues, the associated risks and how to manage them. Continuous review is also important to ensure that climate change plans remain relevant (AGO 2006; Environment 2008; DCCEE 2010). A limitation of this approach is the inherent difficulty integrating climate change adaptation considering the full relational complexity of the problem. For example, the World Bank report Economics of Climate Adaptation states (2009, p.137, emphasis added):

> *'To date the work…has focused mostly on vulnerable populations. For example, in India, we focused on drought-prone subsistence farmers. In Mali, we focused on populations living at the edge of encroaching desert, which are under pressure to migrate. However, we did not attempt to be exhaustive by systematically addressing the range of livelihood issues that these populations face.* ***A critical area for further development is to extend our basic analytical approach to evaluate the impacts of climate risk on other aspects of the economy*** *(for example, leisure); on lives and livelihood (beyond health); on ecosystems'.*

Applying a risk assessment of the effects of one climatic stressor on an obviously vulnerable population or infrastructure suggests a reason to act, however; it does not suggest what 'good adaptation' would be. In addition to having a narrow focus on risk, traditional adaptation research

places an emphasis on assuming and maintaining the 'status quo' and 'business as usual' rather than extensively addressing the opportunities to explore distinctive creative and innovative ways of dealing with the predicted climate impacts; not solely from a risk management perspective but additionally from an open-minded (and not solely solution-focused) perspective. Schon (a leader in design thinking) describes this as the 'defence of the stable state':

> *'It does not matter, then, if change may be seen in retrospect to have been harmless or even beneficial. Before the fact, the threat of disruption plunges individuals into an uncertainty more intolerable than any damage to vested interest. The self then puts its own conservative energies at the service of the system's conservation' (Schon 1971, p. 49)*

2.2 Design thinking

Design as a process is a way of thinking characterized by the capacity to use intuition and creativity for generating insights and solutions, rationality to analyze the necessary information and fit solutions in relation to a particular context, and empathy to understand the complexity of a problem from multiple perspectives. Design seesaws between subjective and objective knowledge and draws from a conscious inclusion of subjective perceptions and hunches and relates them to analysis and factual knowledge.

The traditional notion of Design is often associated with a 'product'. This design led decision support project extends the understanding of the scope of design as a thinking process and mode of action (Manzini 2006; Seggern et al. 2008).

This requires a broadening of design around two key concepts. First, Herbert Simon's notion, that design does not just create new objects and artefacts and plans, they attempt to 'change existing situations into preferred ones' (Simon 1969, p. 129). Design is about improving the current situation and has a history of acting to improve existing conditions. Design seeks change, and the amplification of change. Tim Brown, CEO of one of the world's leading design and innovation consultancy firms and an advocate for design thinking highlights:

> *'The natural evolution from design doing to design thinking reflects the growing recognition on the part of today's business leaders that design has become too important to be left to designers.'* (Brown 2009, p.8)

The second concept is that we are all designers:

> *'The practice of design as a thing that people do predates professions. In fact, the practice of design—making things with a useful goal in mind— actually predates the human race. Making things is one of the attributes that made us human in the first place'. (Friedman 2000, p. 9)*

If we acknowledge that everyone is a designer then it is logical that a broader range of people can be involved in the design process. It can become a participatory process that can be facilitated. A central element to facilitating design thinking is a participatory process fostering creativity, an essential ingredient to design.

The optimistic design-led objective within this project sets out to accommodate population and economic growth in a way that climate change impacts are seen as an opportunity and will inform growth in a way that enhances spatial quality and sustainability. This implies the generation of ideas that accommodate far more than one impact (i.e. rising sea level) on economic grounds only. Our approach to designing for and appraising climate change adaptation design is based on the principles that good adaptation should avoid maladaptation, be sustainable, and adaptive in that it decreases risks, hazards and vulnerability while increasing resilience.

The above description presents climate change, and the associated economical, ecological and social challenges, as a 'wicked' (Rittel and Webber 1973) or 'super-wicked' problem (Bernstein et al 2007). Rittel & Webber already in 1973 discussed that 'wicked problems' cannot be addressed by scientific

approaches aiming for the 'right solution. The openness and complex character of the described planning problems need an open, complexity-inclusive approach. Climate change adaptation is characterised by a great amount of relational complexity, uncertainty and unpredictability that the linear model may not do justice. As Hallegatte states "uncertainty in future climate change is so large that it makes many traditional approaches to designing infrastructure and other long-lived investments inadequate" (2008, p. 246). The effects of climate change are well known, but potential solutions for how to deal with them are not:

> *"the overwhelming scale of the problem, massive uncertainty, scientific abstraction, and the predominantly global nature of the available modelling and scenarios. […] There is therefore an urgent need for better frameworks, tools and processes to help communities and local agencies make sense of and organize emerging information on climate change, to become more informed on local impacts and policy choices related to climate change, and to feed into planning processes. We need a new type of capacity-building process and decision support tools on climate change." (Moser and Dilling; Nicholson-Cole: cited in Sheppard et al. 2011, p.401).*

Given the complexity and uncertainty of environmental problems, policy-making and governance of complex environmental problems should be conceived as a collective and more or less permanent learning process (Haug et al. 2011). Roberts (2010) points out that such complex challenges 'are best addressed using collaborative approaches and processes that are non-linear, open-ended and based on learning across institutional boundaries, involving a wide range of stakeholders'. Fünfgeld & McEvoy (2011, p. 13) state further that 'responding to climate change therefore necessitates governance arrangements that can facilitate collaboration and integration across different levels of government, different geographic scales, and different sectors and professional backgrounds'.

Without questioning the necessity and importance of risk assessment and management in any way, the Climate Change Act 2010 does not include a framework for developing visionary future thinking in a broader sense. The design-led decision support project posits design thinking as a potential means to counter the limitations of the traditional risk assessment framework.

2.3 Fostering creativity

Creativity is an intrinsic part of design thinking that can be fostered. The Latin term *creatio* is the origin of both the terms creativity and creature. The earliest Western conception of creativity is the Biblical story of a creator and his creation of the world given in Genesis that has for a long time led to the belief of creativity as a divine attribute not accessible to 'limited' human beings. Although creativity still has an aura of mystery, it is nowadays commonly agreed that creativity is a fundamental evolutionary attribute of all human beings to develop and continue life.

Modern scientific interest in creativity is relatively young and has taken place in three waves over the last 50 to 60 years (Sawyer 2012). The first wave focused on studying the personalities of exceptional creators. Creativity was described as a rather mysterious, innate human feature of only certain talented people and discussed as "the unique pattern of traits" (Guilford 1950p. 444) that only creative individuals held and demonstrated in their creative behaviour.

The second wave, in the 70s and 80s, shifted attention to the cognitive approach. Based in cognitive psychology, it focused on the internal mental processes that occur while people are engaged in creative behaviour. This approach is significant as it suggests that creativity can be fostered.

The third wave was the emergence of a sociocultural approach that complemented the cognitive. Contrary to the individualist approach, which only concentrated on what happened in a person's head, the sociocultural approach looked at "real-world creativity" (Sawyer 2012), acknowledging that labelling a product as creative, novel, appropriate, useful, or valuable depends on the judgment of a knowledgeable social group (Amabile 1996; Sawyer 2012).

Most recently, an interdisciplinary approach to creativity brings the individualist, cognitive and sociocultural approaches to creativity together with a focus on creative social systems—groups of people in cultural and social contexts. In the context of climate change adaptation, Sawyer

emphasises that due to the complex social and economic trends we are facing in the 21st century, we need an interdisciplinary approach to creativity that embraces its complexity and ambiguity (Sawyer, 2012).

Cropey & Cropey (2009) expand on Wallis (1926) to articulate the creative process in seven phases:

1. *Preparation stage* - we define the problem, need, or desire, gather any information the solution or response needs to account for, and define criteria for verifying the solution's acceptability.
2. *Information* phase - knowledge regarding the problem is extended through convergent learning and thinking.
3. *Incubation stage* - we step back from the problem and let our minds contemplate and work it through. Like preparation, incubation can last minutes, weeks, even years.
4. *Illumination stage* - ideas arise to provide the basis of a creative response. These ideas can be pieces of the whole or the whole itself. Illumination is often very brief, involving a tremendous rush of insights within a few minutes or hours. In
5. *Verification* - activities to assess whether or not what emerged in illumination satisfies the need and the criteria defined in the preparation stage.
6. *Communication phase* - display the novel outcome to others and to receive feedback
7. *Validation stage* - creative outcomes receive judgment in terms of relevance and effectiveness from external judges.

Besides coming to a better understanding that creative processes are not arbitrary, the stages of the creative process help in thinking about if and how individual phases can be fostered and augmented in a participatory setting. Drawing on this process, the project team developed the approach to co-design and participation used in the charrettes.

Co-design and participation

In many Australian instances, local authorities have lacked the resources or in-house expertise necessary to carry out climate risk assessments. To date, they have tended to rely on outside consultants to undertake the necessary work. (Fünfgeld and McEvoy 2011)[1]. A co-design process enables external consultants to 'foster the creativity' of individuals within the local authorities to co-develop solutions for climate adaptation. This process values local and tacit knowledge.

Wierdsma (1999) describes this as the co-creation of change that can be experienced in optimal form in design charrettes (introduced in full in the methodology section). In the charrette, a variety of people are brought together, maintaining their diversity in professional expertise as well as in their own values and visions in a well-organised and directed process. Individual competences merge into a collective competence, crystallised by the collective drive to design the desired future.

The implication of locating 'design thinking' described above as an alternate approach to climate adaptation, places the capacity to ideate and decide on futures with respect to climate adaptation within the local municipality. Any decision making for climate adaptation is required to be grounded in an understanding of what 'good climate adaptation' is. This is introduced in the next section.

2.4 What is good climate adaptation?

The focus of the design-led decision support project is to generate solutions for 'climate adaptation' in regional areas. This section discusses climate adaptation with particular respect to what 'good climate adaptation' would be.

Contemporary definitions of climate adaptation include Adger et al. (2005, p.77) who suggest:

> *'Societies, organisations and individuals have adjusted their behaviour in response to past climatic changes, and many are now contemplating adapting to altered future climatic conditions. Much of this adaptation is reactive, in the sense that it is triggered by past or*

[1] http://theconversation.edu.au/adapting-to-climate-change-how-will-we-learn-to-do-it-346

current events, but it is also anticipatory in the sense that it is based on some assessment of conditions in the future'.

The definition of adaptation has evolved over time as the concept has been taken up by broader segments of society, yet it remains contested (Levina and Tirpak 2006).

The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as an:

> *'adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts…[and] changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change'* (McCarthy et al. 2001).

The definition from the National Centre for Climate Change Adaptation Research Facility (NCCARF) implies that adaptation actions should reduce adverse consequences of climate change, including climate stressor-related impacts on human and natural systems, while at the same time harnessing beneficial opportunities (NCCARF 2011). The Victorian Centre for Climate Change Adaptation Research (VCCCAR) defines adaptation as 'anticipating or monitoring change and undertaking actions to address the consequences of that change' (2012, p.1) .

The above definitions refer to what needs to be adapted to, whom or what is doing the adapting, and how adaptation might occur. However, unlike climate change mitigation, there are no broader protocols, targets or measurement systems in place in Australia that govern adaptation. The following literature review is presented as a means to elicit 'good adaptation'. The review is framed around three concepts emerging from the literature, which indicate that 'good climate change adaptation' is: adaptive, avoids maladaptation and is sustainable from a triple bottom line perspective.

Design for adaptation

The way we plan and design our landscapes, both public and private, significantly influence our capacity to adapt to climate change. Good climate change adaptation should address hazard and risk, decrease vulnerability, and increase resilience in the adapting communities (McCarthy et al. 2001; Turner et al. 2003; Adger et al. 2005; Fünfgeld and McEvoy 2011). These elements of good adaptation are linked in the planning literature to objectives such as liveability, sustainability and productivity (Parsons Brinckerhoff 2004). Australia's National Measures for Climate Adaptation (DEECC 2012) are largely based on vulnerability and risk assessment at a macro level and include:

- National Coastal Risk Assessment;
- Biodiversity Vulnerability Assessment;
- Implications of climate change for Australia's World Heritage properties;
- Implications of climate change for Australia's National Reserve System; and
- Interactions between climate change, fire regimes and biodiversity in Australia.

Questions of who is doing the adapting, and to what (climatic and/or non-climatic stressors) are central to good adaptation, and are context specific. Climate adaption as such will require responses at a local level. For example, rural Australian towns have experienced a general decline in population for the past decades which was a key concern of the Sea Lake charrette. To achieve the objective of liveability and productivity, stopping or reversing population decline in rural areas would be a central objective. Population decline often develops a vicious cycle as emigration leads to 'reduced service demand, reduced employment opportunities and further out-migration' (Adger 2006, p.255). Changes in climate stressors such as precipitation levels in towns dependent on agriculture present further challenges for adaptation. Altering agricultural practices in response to climate by increasing the water retention capacity of soils (Adger 2000) and diversifying from a reliance on agriculture for a town's livelihood may be seen as adaptive responses.

This contrasts with urban environments where low density fringe development is often considered to be inefficient for infrastructure provision (Trubka et al. 2010) and linked to poor health and social outcomes (Ewing et al. 2003; Giles-Corti et al. 2005; Trubka et al. 2010)–a concern raised in the Bendigo charrette. This urban form presents specific challenges as a result of these inefficiencies and

outcomes. In principle, higher density urban forms could coincide with increased walkability (and other non-motorised transport) which is considered to be one of the most important factors in improving the health and wellbeing outcomes of urban environments (Giles-Corti et al. 2005; Southworth 2005; Guite et al. 2006; Forsyth and Southworth 2008). Designing for density potentially leads to environmental and economic benefits if approached from the perspective of sustainability. The ideal outcome is that employment becomes localised, travel times are reduced, productivity increases and greenhouse gas emissions decrease (Trubka et al. 2010).

Identifying appropriate contexts enables 'informed rules of thumb' or 'measures' for the appraisal of climate adaptive urban landscapes. Such rules are based on the three key overarching concepts of adaptive capacity, maladaptation and sustainability. The informed rules developed for this project are introduced in the methodology section and in detail in the appendix.

Adaptive capacity

Adaptive capacity has been defined as 'the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences' (IPCC 2007). Adaptation is often approached, and therefore understood, by those doing the adapting from a perspective of risk, hazard, vulnerability and/or resilience (Fünfgeld and McEvoy 2011). Each approach, whether used explicitly or implicitly, frames the problem and thereby the potential solutions in a particular way which constrains the possible outcomes. These four approaches can be understood as follows:

- Hazard- Threats to a system, comprised of perturbations and stress (and stressors), and the consequences they produce (Turner et al. 2003).
- Risk- the product of hazards and vulnerability with consideration for consequence and likelihood (Fünfgeld and McEvoy 2011).
- Vulnerability- The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. A function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity' (McCarthy et al. 2001).
- Resilience- The magnitude of disturbance that can be absorbed within a social-ecological system before the system changes to a different state as well as its ability to reorganise and adapt to new circumstances (Adger 2006); in a climate change context it is the ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change (Adger 2000).

The Department of Primary Industries' 'adaptive capacity index' (Table 2) identifies features of rural communities that influence their capacity to adapt to risks and hazards (Sietchiping 2006). The adaptive capacity index is useful for two puroposes: first, the broad range of indicators highlights the complexity of adapting to climate change in that the capacity to adapt varies 'depending on factors such as access to resources, institutional/infrastructure support, community strength, availability of locally relevant scientific outputs and technology' (Sietchiping 2006, p. 21); second, the index provides measures that enable the adaptive capacity to be quantified and weighted if desired. This approach to measuring adaptive capacity provides a useful frame that is applied within the appraisal methodology of this design led project.

Table 2 Adaptive capacity index

Socio-Cultural		Economic		Institutional and Infrastructure [environment]	
indicator	measure	indicator	measure	indicator	measure
Demography and Age	New residents, growth, median farmer age, >75 living alone, age dependency ratio	Income	Family farm income, income diversity, disadvantage index, family income <50k, child living .$600 household	Water resources	Water access
Family Status	Mean household, lone household	Industrial & Farm wealth	Farm worth >300k, ration farm/land value	Communicatio n & IT	Internet access, computer use, broadband demand, local papers
Education & Knowledge	Graduates, management capacity	Regional wealth	Economy diversity index (SLA), council review	Transport & Access	Remoteness (ARIA index)
Social Capital & Leadership	Membership, safety, mutual help, volunteering, participation, leadership	Employment	Unemployment, agricultural workforce, tourism workforce, tradespeople workforce	Energy	Electricity usage
Wellbeing	Youth suicide, single ratio (MF)	Managerial practices	Landcare on properties. Trees planting	Community Services	Pop/service ration, events participation, community activities
				Govt. Services, educ. & health	Ratio health professional. Public housing stock, access to TAFE
				Research & Development	funding, grains research funding

Source (Sietchiping 2006)

Maladaptation

Maladaptation has been defined as 'action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups' (Barnett and O'Neill 2010). Fünfgeld and McEvoy (2011) argue that due to the absence of evidence for what makes good adaptation then avoiding maladaptation is a good starting point. In order to avoid maladaptive outcomes, Barnett and O'Neill (2010) suggest adaptation should avoid:

- Measures that increase greenhouse gas emissions;
- Measures that disproportionately burden the most vulnerable social groups;
- Measures that come with high opportunity costs, i.e. high social, economic or environmental costs in comparison with alternatives;
- Measures that reduce the incentive for actors to adapt, e.g. by increasing the reliance of actors on others' actions; and
- Measures that create a path dependency, i.e. that adopt trajectories that are difficult to change in the future due to high costs involved in such change.

The spatial and temporal complexity of climate change mean that the adaptations considered to be successful by one group might be judged by others in different places and times to be unsuccessful (Adger et al. 2005). Understanding good adaptation through the lens of maladaptation is one way to

assess adaptive measures with a broader spatial and temporal perspective.

Sustainability

Approaches to assess successful climate change adaptation are broadly based on sustainability indicators of the triple bottom line in social, economic and environmental sustainability. For example, the IPCC states that 'Adaptation measures are seldom undertaken in response to climate change alone but can be integrated within, for example, water resource management, coastal defence and risk-reduction strategies' (IPCC 2007). It is implicit that good adaptation should also provide positive outcomes for sustainability.

Keating and Handmer (2011) identify a trend towards integrated assessment methods to understand the impacts of various adaptation measures and note that they generally include socio-economic and biophysical models. They suggest that assessment methods for costing climate change should account for uncertainties, intangibles and surprises. For example, the increased use of air-conditioning to protect vulnerable people from heatwaves may cause peak demand for electricity over time and lead to loss of power supply. This can be regarded as a maladaptive response to heatwaves and illustrates the importance of moving beyond traditional linear approaches to assessing actions towards those that can account for relational complexity.

Farber et al. (2002) describe a method that applies economic value to ecosystem services in order to assess climate change mitigation and adaptation measures. They note the non-linear nature of ecosystems and use this model as an attempt to capture more than the traditional economic value of something by also considering its sustainability value. By assigning a value to ecosystem 'services' (such as trees, based on their effect on CO2, the water table and biodiversity), we can then determine the relative merits of a measure that will either displace or conserve trees.

DEFRA, UK suggests that along with the principles for sustainable development they developed in 2005, adaptation measures should be sustainable, proportionate and integrated, collaborative and open, effective, efficient and equitable (DEFRA, 2005). There are strong similarities to the guiding principles of DEFRA's adaptive measures and the Design Briefs delivered for the Bendigo and Sea Lake charrettes (Roggema et al. 2011; Roggema et al. 2012). The design principles applied within these charrettes attempt to use the creativity of the design process to develop integrated socio-technical responses to identified stressors and ultimately, desirable solutions that increase the adaptive capacity of the communities they are designed for.

The appraisal methodology introduced in the following section has been developed to provide practical design solution appraisals in accordance with the concepts presented in the background section. That is; that good adaptation should avoid maladaptation, be sustainable, and adaptive in that it decreases risks, hazards and vulnerability while increasing resilience.

3 Project manual: design charrettes for climate adaptation planning

This manual should be read in conjunction with Section 6, which provides suggested principles for undertaking design led decision support exercises, drawn from the experiences of the research for this project.

The overarching methodology used in this project is the "Design charrette". The term 'charrette' is originally from France. At the end of the nineteenth century the Architectural Faculty of the *Ecole des Beaux-Arts* issued problems that were so difficult few students could successfully complete them in the time allowed. As the deadline approached, a pushcart (or charrette in French) was wheeled past students' work spaces in order to collect their final drawings for jury critiques while students frantically put finishing touches on their work. To miss 'the charrette' meant an automatic grade of zero (Condon, 2008).

In this project, we define design charrettes as: *two- or more -day intensive design workshops in which a mixed group of participants work collaboratively towards designing climate adaptation future scenarios.*

Charrettes are successfully used in many controversial and complicated design and planning problems. Examples of these from the National Charrette Institute (NCI) include:

- High stakes projects involving substantial public and private investment;
- Volatile yet workable political environments – situations that are 'hot' but manageable;
- Complex design problems; and
- Real projects that include imminent development.

(Lennertz and Lutzenhiser 2006)

The NCI defines the charrette as "a collaborative design and planning workshop that occurs over four to seven consecutive days, is held on-site and includes all affected stakeholders at critical decision-making points" (Lennertz and Lutzenhiser 2006). Building on this, Condon formulates it as: "a time-limited, multiparty design event organised to generate a collaboratively produced plan for a sustainable community" (2008), that has the following attributes:

- Integrates intuitive, rational and emotional knowledge;
- Is an inventive approach, includes idea-generating forces and results in envisioning futures;
- Is set up in a creative atmosphere to allow many different stakeholders to collaborate;
- Alternates between plenary discussions and small mixed design teams to provide a creative environment to think about the future in unlimited ways;
- Creates an environment in which out-dated frameworks, often related to individual beliefs or 'silo' policies, can be overcome; and
- Makes use of maps and other visual tools to allow people to collaborate and integrate topographical, ecological as well as social and economic aspects.

A charrette is part of a dynamic planning process, which starts with the preparation phase, followed by the charrette and concluding with the implementation phase. The process, as derived from both Condon (2008) and Lennartz and Lutzenhiser (2006), consists of the following three phases:

1. Preparation phase

The preparation phase addresses everything that is required to hold a successful design charrette. The main focus in this phase is the preparation of the design brief and the selection of participants, as well as the development of required materials, booking the venue and other preparatory tasks. The Design Brief clearly defines the assignment, including goals and objectives, design principles, quantitative requirements (if possible) and performance targets.

Selecting the right 'mix' of people to participate is essential. A combination of scientists, local experts and stakeholders, decision makers and knowledge brokers, designers and technical experts contributes to the dynamism of the event.

2. Visioning charrette (Charrette I)

The main goal of the visioning charrette is to envision the desired future. A typical visioning charrette includes the following elements: opening event; site tour; the design stages—during which iterative phases of conceptualisation, drawing alternatives and refinement of the vision take place (or in the words of Condon (2008) "talk-doodle-draw"); public meetings; and some form of out of session non-work engagement. The purpose of Charrette I is to shift from attractive sounding prospects to real solutions, which, in this phase, are represented in designs. During the charrette, a common language for solutions is developed and, because no implementation questions will be raised at this stage, the risk that ideas will be rejected is minimal. However, it may be expected that policy contradictions will emerge in the openness of the process.

3. Implementation charrette (Charrette 2)

The implementation charrette typically involves (mainly) design facilitators and stakeholders. The aim is to develop a shared understanding of the desired future and what is needed to realise this future. During this charrette, barriers to change that may exist (so-called 'windows-of-no') are also addressed. The implementation charrette is a fast, efficient and participatory process that integrates a range of stakeholders and, as such, provides a powerful tool to challenge these 'windows'. The integration of charrette participants, who, in their regular work, are often not connected, helps to generate co-investment in the emergent solutions, which can in turn help to fast track approval processes, potentially saving years in development time.

Our appropriation of the charrette methodology for the Design-led Decision Support for Climate Adaptation project follows a six steps step process as outlined by Condon (2008):

(Preparation phase):
1. Stakeholder engagement and planning
2. Climate science and identifying risk
(Visioning charrette I):
3. Running design charrette I
4. Appraising the design outcomes
(Implementation charrette 2):
5. Follow up design charrette 2
6. Implementation into planning

3.1 Stakeholder engagement and planning

Sound stakeholder engagement and planning is central to recruiting and delivering the Design-led Decision Support project process. Early engagement and sustained interaction with senior staff in the planning process is critical and further commentary on this is provided in Section 6.

3.2 Climate data and risk identification

This project starts with the premise that knowing about possible hazards and assessing their risk is an important step in understanding and dealing with climate change; however, this understanding does not provide answers on how to design our landscapes and societies accordingly. Risk is the dominant concept in dealing with uncertainties in local government and the private sector (Fünfgeld and McEvoy 2011), and some argue it should be the predominant approach when assessing climate change adaptation (Jones and Preston 2010).

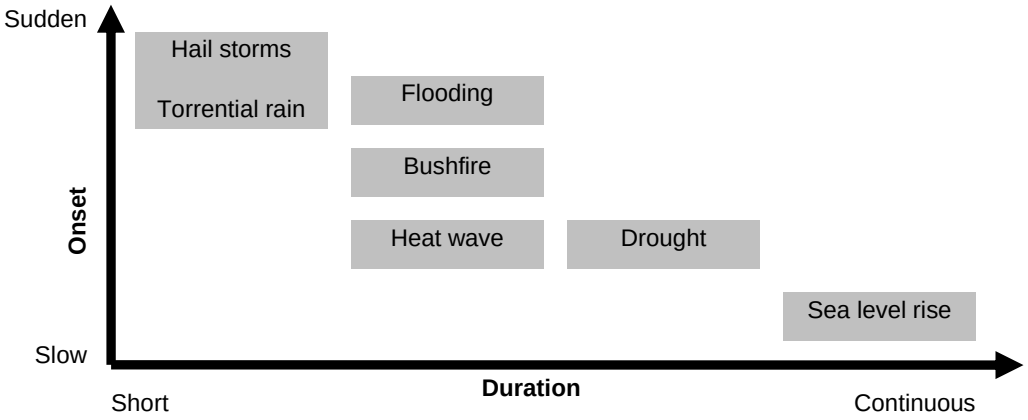


Figure 1 Climate change impacts (Fünfgeld and McEvoy 2011. p26)

Figure 1 present an overview of recognisable impacts of climatic stressors in Australia in terms of onset and duration (Fünfgeld and McEvoy 2011). Climate change impacts for each region were identified in advance of the charrettes by analysing historical climate data for each region, using CSIRO (2012) prediction models for Victoria, and drawing on the expertise of the project team's climate scientists. The climate change predictions from CSIRO offer low, median and high scenarios for the following measures:

- Temperature
- Precipitation
- Solar radiation
- Relative humidity
- Potential evaporation

CSIRO also provides projections for drought, wind and fire, which enabled future climate and risk projections to be discussed in the charrette. Jones (2011) proposes that human-induced warming is non-linear as analysis of temperature records indicates that under climate change, heat is stored in the oceans surrounding Australia for decades before being released into the atmosphere in short bursts. This has an immediate impact both on temperature and rainfall. Regional climate does not change gradually. Step changes in warming of a few tenths to 1°C can produce rapid changes in risks such as extreme heat and fire danger (Jones, cited in Roggema et al. 2011).

The charrette process relied heavily on tacit knowledge of individual participants. Although participants may not have directly experienced changes in climate, it is probable that they have at least indirect familiarity with the potential impacts of climate change in the form of heat waves, bush fires, drought, and torrential rain. Even though significant sea level rise has not occurred, glimpses of the impact of sea level rise can be conveyed by the understanding that today's king tides may be the 'normal' tide of the future (Green Cross Australia 2012). So called 'extreme weather' provides a framework to discuss what the impacts of climate change may be like, and to imagine what possible responses for adaptation may be required if extreme events become the new 'normal'. It is under this proposition that the Design-led charrettes were conducted.

3.3 Running the charrette

The design charrettes for this project aimed to develop concepts for a climate adaptive region in response to changing climatic stressors affecting the region, which may include more severe summer rain, extended drought, increased heat stress, or rising sea levels. The charrettes were based on the following design principles (Roggema et al. 2011, p. 21):

- Establish a community that is safe, i.e. is protected from climate hazards;
- Provide ecological and hydrological systems that are resilient and provide mitigating effects in times of heat and drought as well as during severe rainfall events and floods;

- Design an urban development strategy, which is based on the natural features of the landscape and is therefore better able to react to climate disasters; and
- Accommodate population and economic growth in a way that acknowledges and incorporates projected climate change impacts, while enhancing spatial quality and sustainability

In facilitating design charrettes, four of Condon's (2008) nine rules for a good charrette are seen as critical for this project:

8. Design with everyone: Despite the fact that becoming a designer requires thorough training and very specific skills, the design process as undertaken during charrettes is integrative and contains a variety of possible solutions. This is partly an intuitive and judging activity, which makes it accessible for many individuals. In this sense, everyone is a designer;
9. Start with a blank sheet: If the group of participants are standing around the table on which a large map of the site is laid down, the simple action of overlaying this map with a blank piece of transparent paper presents an instant invitation and challenge to all participants. Everyone is invited to 'fill in' the future and a shared vision will, in the hours to follow, occupy the formerly empty paper;
10. Provide just enough information: Too much information causes decision paralysis and too little produces bad proposals. Just enough is mainly arranged through the expertise of the participants and will be provided during the charrette in a concise and easy to grasp way (maps, schemes); and
11. Drawing is a contract: All drawings produced during the charrette embody the consensus as experienced and achieved by the participants. They represent a well-understood agreement, or contract, in images between the participants—a commitment, which cannot be broken without the consent of the group.

The way design charrettes are organised helps to create an atmosphere that differs from regular and day-to-day working environments, and fosters the creativity of the participants. This environment allows participants to enter a different mind-set and draw on a broad range of ideas, values and habits.

A simplified, generic charrette running sheet is presented in Figure 2, with actual agendas available in Appendices I and 2. The charrette shifts between developing landscape solutions at various scales (see Figure 2). For example, after focusing on a specific site in detail, a group may shift to a broader regional plan. The VCCCAR design led charrettes involved participants from academia (landscape design and climate), community organisations, industry, local government, and state government departments (DSE, DPCD and DPI).

Example running sheet

Day One:

- Welcome event, introduction to project, climate projections.
- Defuturing warm up exercise. Describe that past present and future for the region.
- Exploration of landscapes from multiple levels through drawing.

Day Two

- Continuation and refinement of landscape from multiple levels through drawing.
- Combination of landscapes levels into final plasticine models.

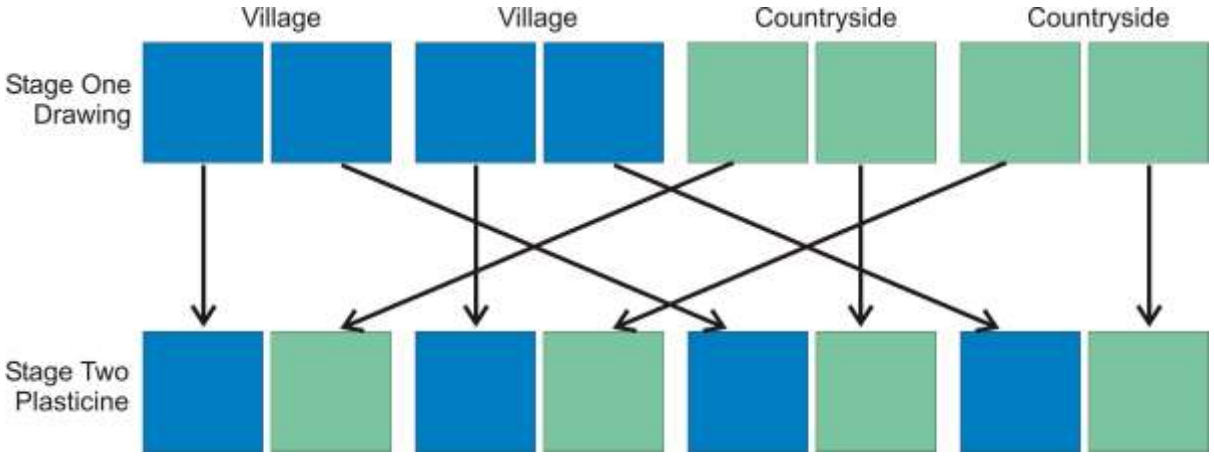


Figure 2 Example running sheet and shifting design scales and formats

3.4 Appraising the design outcomes

The appraisal of the design outputs aims to:

- Assess each design concept at a conceptual level;
- Enable the effects and impacts of the proposed futures to inform the second charrette; and
- Suggest preferred future designs (or elements of designs) from the charrette.

Data collected to complete the appraisal include; photographs of the final models, maps produced over the course of the charrette, researcher field notes, final PowerPoint presentations, and feedback on adaptation measures from the participants. The following commentary outlines the three stages of the appraisal process in more detail:

I. Development of criteria in a participatory process;
II. Appraisal of the design outcomes in a participatory process;
III. Assessment against appraisal criteria; and comparison of results.

Develop the appraisal criteria in a participatory process

A participatory approach to identifying additional assessment criteria for adaptation is important in all charrettes. Futuring methods of forecasting, backtracking and backcasting are also important to facilitate discussion of the past, present and future of the region and thereby identify desirable qualities that stakeholders may wish to retain, or amplify, and qualities that they may want to reorientate. The three distinct themes are outlined as follows:

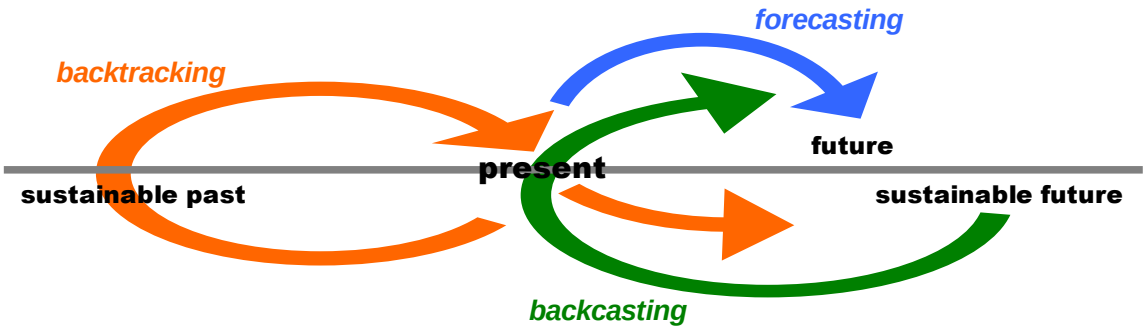


Figure 3 Futuring methods

Each theme is 'brainstormed' within the charrette to ultimately contribute to the appraisal criteria. The process by which this occurred in this Project was as follows:

Past: 30 years back; what was the region like in 1982?

By discussing the economy, people, climate and technology of the region in 1982, a mindset of change was established and precedents for adaption and resilience were teased out. The past was then evaluated in terms of desirable and undesirable events that had occurred.

Present: What is the present situation in the region?

Several analytical maps were prepared beforehand and presented, including land-use, topography, planning zones, transport network, green land cover, (absence of) water. These maps were annotated by the participants with specific qualities enriching the maps with stories and facts.

Future: How do we expect the region to have developed in 2042?

This session identified the expectations as opposed to the desires for the future. As in the 'Past' theme, by exploring themes of economy, people, climate, and technology, we established what the region was expected to look like in 2042. The future can again be critiqued for desirable themes that can be transformed into both goals for the design charrette, and criteria for evaluating the conceptual design scenarios.

Asking the participants to present the outcomes of their group discussions in terms of favourable and unfavourable elements of the past, present and future provided criteria that could then be used within the design exercises as prompts for concept generation. This technique can assist participants to generate additional criteria that are specific to their region. For example, population decline was a new criterion for maladaptation derived by the Sea Lake charrette participants. This was important to recognise in this instance because measures that decrease the town's population or number of visitors will in turn reduce the critical mass required to maintain services essential to the sustainability of the town.

Appraisal of the design outcomes in a participatory process

During the final session of the first Design charrette for each case study, participants are asked to appraise the concepts using two differently coloured post-it notes to signify 'good' or 'desirable' adaptation (indicated by green post it notes), and adaptation they view with 'hesitation' or considered 'bad (indicated by orange post it notes). In this Project they were asked to identify features of the design solutions accordingly and articulate why specific design features were viewed as 'good or 'bad' for adaption. In essence, this was a session that allowed participants to accept or reject design ideas.

This process was performed for two reasons. First, to acknowledge the importance of local knowledge and expertise, and second, projects that take place without community support and engagement are unlikely to be successful and therefore should not be prioritised for further development unless redesigned.

Participants' perspectives, illustrated in Figure 4, were incorporated into the social element of the triple bottom line assessment. They account for various adjustments to the concept scoring received during the appraisal and inform the design challenges to be included in future charrette design briefs.

Figure 4 Community appraisal of concept design

Assess the design outcomes against the 'good adaptation' appraisal criteria

The design aspect of this methodology used competitive benchmarking or 'concept scoring' as a starting point to assign value and assess areas for further investigation. At this stage of the design process, the appraisal is within the synthetic creative 'reflection in action' phase, as explained by Schön (1991). That is, designers solve complex problems by the generation of multiple solutions that are continually reflected on and expanded upon until the final concept is developed. The method for appraisal at this phase should enable a progression of design ideas as they are not yet final. Positive elements of the design solution may be amplified; negative aspects may be re-orientated or removed. Concept scoring has a strong history in Industrial Design (Ulrich and Eppinger 2000, p.82) as a means to compare between product concepts, and provides a means of communicating the strengths and weaknesses of a range of solutions. The process of concept scoring involves:

- Step 1: Prepare the selection matrix metrics: (based on customer needs – in this appraisal based on adaptation and sustainability needs).
- Step 2: Rate the concepts against a scale (e.g. -2 = negative +2 = positive).
- Step 3: Score and rank the concepts: using a weighted system (appraise the concepts).
- Step 4: Combine and improve concepts.
- Step 5: Select one or more concepts (implementation).
- Step 6: Reflect on the results of the process.

Step 2 'Rate the concepts against a scale' uses principles similar to content analysis, a method that can be appropriated to cater to the visual form (Rose 2001). Content Analysis in its simplest form asks whether the conceptual design solution has the certain attribute or set of interrelated attributes that un-mistakably fit those categories— either 'Yes' or 'No' (Weber 1990, p.32). The appraisal (Step 3 'concept scoring') is completed between charrette I and charrette 2. Step 4 'Combine and improve concepts' and Step 5 are completed within the second charrette.

Step 1: Preparing the selection of matrix metrics

The matrix metrics for 'concept scoring' were based around the three concepts of Adaptation, Maladaptation and Sustainability, and a description of each concept is presented below. The matrix was flexible to include adaptive objectives of the community that result from step 4.1.

Adaptation Matrix

The metrics for adaptation used to assess the overall designs and specific design features consider the risks to each system (human and natural) according to climate change hazards that require adaptation measures (See Table 3). Each system can be understood in the context of the relevant hazard. As in traditional risk assessment, the consequences and likelihood of each hazard are considered within this method. For example, what are the consequences to the food system if it is affected by fire and what is the likelihood of this occurring?

Table 3 Risk/Hazard assessment

		System					
		Food	**Transport**	**Energy**	**Water/Sewer**	**Shelter**	**Land use**
Hazards	**Severe Wet**						
	Drought						
	Heat						
	***Design feature**						

This traditional risk/hazard approach to climate change adaptation is typical in local government and emergency management, and is also often used in situations with high levels of uncertainty (Fünfgeld and McEvoy 2011). This assessment method is flexible in that the hazards and systems can be altered according to the local and regional context. It also allows for design features (or adaptation measures) that are unique or controversial to be assessed through a hazard/risk lens. Elements were assigned metrics in the concept scoring as follows:

-2 = identified as having a high risk,
0 = neutral,
+2 = identified as averting a risk and creating resilience.

Maladaptation and sustainability matrix

Barnett and O'Neill's (2010) measures for maladaptation (see page 11) include measures that increase greenhouse gas emissions, and measures that place a burden on the most vulnerable social groups. Such measures closely align with triple bottom line sustainability indicators.

Maladaptation and sustainability metrics have been combined and extrapolated into a maladaptive assessment matrix (Table 4). The left column lists the impacted system and the remaining columns measure what might be considered unsuccessful adaptation (or maladaptation). Again, the measures were appraised on a scale from -2 to +2. If the measures were overwhelmingly positive they were awarded +2 points, 0 if neutral or not affected, and -2 if overwhelmingly negative. The maladaptive matrix is framed from a negative perspective. Inverting each question allows the table to be used as an adaptive framework (given that adaptation is the polar opposite of maladaptation).

The major difficulty in the sustainability appraisal of design-led responses to climate adaptation is the complexity of sustainability, and the requirement to establish criteria representative of positive or negative adaptation that will always be partially context specific. Informed rules of thumb were drawn from sustainability literature to develop the matrix based on contemporary best practice. Expanded detail on establishing the informed rules of thumb is presented in Appendix IV.

Table 4 Maladaptive assessment matrix

Impacted systems	Social sustainability	Environment sustainability	Economic sustainability	Hazard and Risk
General questions	Does the design increase burdens on vulnerable social groups? Does the design decrease incentives to adopt more sustainable measures? Does the design increase path dependency?	Does the design increase $CO2_{-eq}$ emissions? Does it increase spatial footprint? Does it impact on biodiversity?	Does the design have high opportunity costs? i.e. what does the design prevent from happening? What are the costs/benefits of proposed solution? Does the design create externalities?	Does the design increase the susceptibility to, or consequences of, climate change impacts (e.g. severe wet, drought, heat stress)
Transport	Does it increase car dependence, reduce accessibility, exclude social groups? Is it unsafe or difficult to use? Is the cost of the design evenly distributed?	Does it increase in $CO2_{-eq}$ emissions?	Does the design increase total transport cost compared to BAU?	As above
Food	Does it decrease food security? Does it increase poor lifestyle factors?	Does it increase $CO2_{-eq}$ emissions, does it impact on biodiversity?	Does the design increase total food costs?	As above
Energy	Does the design lead to prohibitive costs?	Does it increase $CO2_{-eq}$ emissions?	Does the design increase total costs associated with energy?	As above
Water/sewer	Does it decrease the quality of social spaces?	Does it impact on biodiversity?	Does the design increase total costs associated with energy?	As above
Land use & Agriculture	Does it decrease the quality of social spaces?	Does it increase soil degradation, salinity or acidity, decrease water quality and/or biodiversity?	Does the design decrease the productivity of land across time?	As above
Shelter	Does the design lead to higher energy use? Does it create path dependency for particular energy sources (e.g. Gas)? Is the design future proof?	Does it increase $CO2_{-eq}$ emissions? Does it increase spatial footprint?	Does the design increase the total cost of shelter?	As above
Inverting each question – and applying a metric allows the table to be used as an adaptive framework (given that adaptation is the polar opposite of maladaptation).				

Step 2: Rate the concepts against a scale

An example of how the concepts were appraised against the scale is provided in Table 5.

Table 5 Sample of the final appraisal matrix for the Bendigo appraisal

category	system		16 the shining heart concept scoring justification
social	transport	2	emphasis on public transport is positive
social	food	0	food producing land is protected, although not explicitly integrated into the community
social	energy	2	community powered energy is resilient
social	water	2	community managed water is resilient
social	built environment / shelter	1	best practice passive design two storey houses –only deals with new, what about remaining houses?
social	human health	2	strong connectedness, cultural opportunities
environmental	transport	1	public transport oil based - no human powered
environmental	food	-1	agriculture land protected for sheep, cows, and pigs, may not be appropriate use of land for reducing $CO_{2\text{-eq}}$ emissions
environmental	energy	2	community managed decentralised energy reduces $CO_{2\text{-eq}}$ emissions
environmental	water	2	community managed decentralised water increases storage
environmental	built environment / shelter	2	uses minimal energy
environmental	human health	2	outdoors protected
environmental	biophysical health	-1	natural flows may be affected by increased retention and piping of water
fire	transport	-1	access routes during fire could be at risk – how do public transport and evacuation plans work?
fire	food	0	no different
fire	energy	2	100% renewable - assume different power lines (how solar copes with fire needs to be answered)
fire	water	0	for the most part not addressed
fire	built environment / shelter	-1	no explicit strategy mentioned
fire	human health	-1	no strategy mentioned
fire	biophysical health	0	for the most part not addressed
flood	transport	-1	emergency routes may be blocked - impact on food systems?
flood	food	0	for the most part not addressed
flood	energy	0	for the most part not addressed
flood	water	0	for the most part not addressed
flood	built environment / shelter	0	for the most part not addressed
flood	human health	0	for the most part not addressed
flood	biophysical health	-1	altering river flows and stream health
water scarcity	food	-1	does not discuss reduced water and food production
water scarcity	energy	1	renewables (depending on selection of renewables and their efficiency reduces water for energy production)
water scarcity	water	2	captured and re-used for multiple purposes - why we need so much water is not questioned
water scarcity	built environment / shelter	2	captured and re-used for multiple purposes
water scarcity	human health	2	captured and re-used for multiple purposes
water scarcity	biophysical health	-1	impacts on stream health from reducing water flows
heat stress	transport	0	for the most part not addressed
heat stress	food	0	for the most part not addressed
heat stress	energy	2	assumed to have removed risk of lines sparking
heat stress	water	0	for the most part not addressed
heat stress	built environment / shelter	2	well-designed passive buildings
heat stress	human health	2	positive in passive buildings
heat stress	biophysical health	-1	Not addressed

Step 3: Score and rank the concepts

Once all the concepts were appraised (scored) the results were ranked using a weighting system. For this project, the ranking of concepts according to their final scores was omitted as the visual presentation of results side by side enabled the strengths and weakness of each concept to be easily identified, as shown in Figure 5.

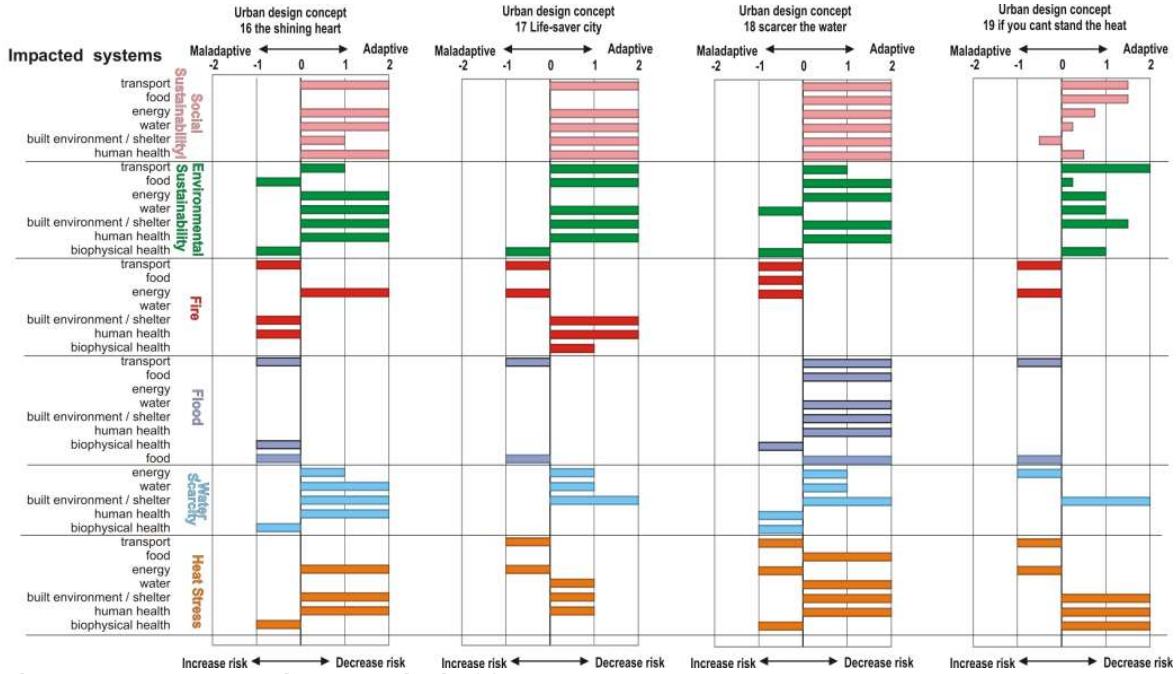


Figure 5 Concept scoring appraisal of four concepts.

Step 4: Compare results to inform further iterations

Locating the concept scoring appraisal within the design process enables the potential incorporation of multiple design elements into future designs to strengthen their adaptive potential. Charrette 2 aimed to merge and concentrate the results of the first charrette into one or two regional plans on the basis of the appraisal report and provided an opportunity to advance ideas of merit, and reorient ideas that could potentially be maladaptive.

Step 5: Select one or more concepts.

Charrette 2 also aimed to deliver a strategy for catalyst projects that were selected by further developing ideas of merit from charrette I. In the case of Bendigo, conceptual design solutions from charrette I were applied to the proposed Marong Business Park. The Sea Lake Charrette 2 took a more direct approach by identifying strategies that Advance Sea Lake Inc. could progress into the future.

Step 6: Reflect on the results of the process

The outcomes of the charrette process are reflected on and evaluated for their capacity to provide climate change adaptation. This reflection is based on the appraisal criteria for ‘good climate change adaptation’, i.e. the solutions are adaptive, they avoid maladaptation and are sustainable from a triple bottom line perspective.

4 Case study 1: City of Greater Bendigo charrette

The City of Greater Bendigo hosted charrettes on 17 and 18 Nov 2011 (Charrette I), and 26 Oct 2012 (Charrette 2). This section provides an overview of the Bendigo charrettes including:

- Background to the City of Bendigo
- Results of charrette I
- Emerging Themes
- Appraisal of the charrette outcomes
- Results of charrette 2
- Reflections

4.1 Background: City of Greater Bendigo

Bendigo is a major regional centre in north central Victoria located about 150 kilometres northwest of Melbourne. It is the fourth largest city in Victoria (after Melbourne, Geelong, and Ballarat) with a population of almost 100,000. Originally inhabited by the Jaara people, European settlement in Bendigo (then known as Sandhurst) grew through pastoral activity in the1830s and even more rapidly in the 1850s when gold was first discovered. Water was needed to carry out mining activity, and at the time of the gold rush, the typically either dry or flooding Bendigo Creek was the only local source of water. Since that time, Bendigo remains generally dependent on external sources of water. Today Bendigo is a bustling modern city characterised by nineteenth century architecture, tree-lined streets and picturesque parks and gardens. Some key characteristics of the City that are relevant to this project are as follows:

- In 2050 the population will have grown by approximately 55,000 from the current 105,000, making the population approximately 160,000 people. Growth of 1.6% per annum
- In 2050 the number of houses would have grown from current 42,000 to over 60,000. Needed new houses (e.g. the program) from now until 2050 is 18,000
- Gross regional product $3,944 Million [2010] 1.5% Vic GSP
- Largest employment centre – Health Care and Social Assistance
- Largest value add – Manufacturing
- Largest output – Manufacturing

While some predictions of the impacts of climate change on temperature and especially water availability are dire, summer heat, drought and reduced water availability have been experienced many times in the past. Bendigo has been suffering from drought and hence subject to water restrictions since 2002 with Stage 4 water restrictions since 2004. Stage 4 water restrictions include no outdoor watering of public and private parks and gardens and no refilling of pools, unless an exemption is granted (Coliban Water, 2008).

Residential Development Strategy

The current Residential Development Strategy for the City of Greater Bendigo (Parsons Brinckerhoff, 2004) describes the overarching vision for the city as a:

Progressive city evidenced by the growth in the economy and subsequent increase in socio--economic status, knowledge and skills base of the community.

Vibrant city with a rich and diverse cultural and social life in which all members of the community are healthy and feel safe.

Caring city in which the natural environment has been preserved to create both recreational opportunities and habitat for native flora and fauna, and the heritage assets have been conserved and enhanced.

Bendigo's design charrette incorporates five strategic components for future residential development:

1. Urban Containment: The intent of the urban containment component of the strategy is to encourage higher density development in potential infill locations where up to 6000 people can be accommodated.

2. Core Development: Core development will primarily take the form of higher density, multi--level dwellings within the Central Business District of Bendigo. Opportunities will be provided within this area for developments of up to 4 storeys with scope in some areas to develop 5 or 6 storeys depending on the locality and subject to neighbourhood character guidelines. Up to 1500 people can potentially be accommodated.

3. Community Focused Development (CFDs): Development that is focused around community centres allows for the development of a wide variety of housing types and related mixed use developments at higher densities along the main transport nodes. Up to 1500 people can potentially be accommodated.

4. New Development Areas: The development of new areas within the urban growth boundary at Huntly, Jackass Flat, Maiden Gully North East and Strathfieldsaye, as shown in Figure 3.4, requires the use of greenfield sites. The intended population capacity per precinct can provide a meaningful focus for the community and allows for the development of a wide variety of dwelling types with varying development densities. There are also opportunities to satisfy some demand for larger allotments (up to 1000sqm) in areas for which the protection of landscape features is important. An estimated 20,500 people could be accommodated through new developments.

5. Satellite Development: The satellite component of the Strategy provides an opportunity to incorporate highly sustainable and liveable urban design and housing outcomes in designated development areas located outside the Bendigo urban area (e.g. Marong). Future planning for the satellite developments will place a strong emphasis on sustainable design features. An estimated 8000 people could be accommodated.

According the Residential Strategy, Bendigo's projected growth boundaries aim to accommodate an additional 38,390 people by the year 2030. 'Predicting' future developments, especially regarding urban growth, is always difficult. Looking ahead 30, 60 or even 100 years (Figure 2) estimating Business as Usual, i.e. unchanged spatial policy, provides us with a realistic scenario for future urban developments. Under this scenario, it is likely that the majority of developments entering the landscape would exert an on-going outward pressure of growth. Despite the fact that current policies emphasise the need for urban infill and intensified densities within the existing urban boundaries, practical constraints often lead to the 'easier' choice to develop greenfield sites on the urban fringes. This process is represented in Figure 2, with steady growth of urban areas around the edges of Bendigo's existing boundary. The major development directions are induced by the current Residential Strategy, e.g. to the west, northwest, northeast and southwest.

Given the fact that Bendigo is surrounded by forests, which also provide one of its primary assets, the urban development tends to be designated in bushfire prone areas. The northern developments are also bordering areas designated as flood prone. It may be concluded that in a Business as Usual scenario, urban development is increasingly located in vulnerable landscapes. This, in combination with the fact that the vulnerability of these landscapes is increasing due to a changing climate over the next 100 years, means that the risk level for future inhabitants of these areas will also increase.

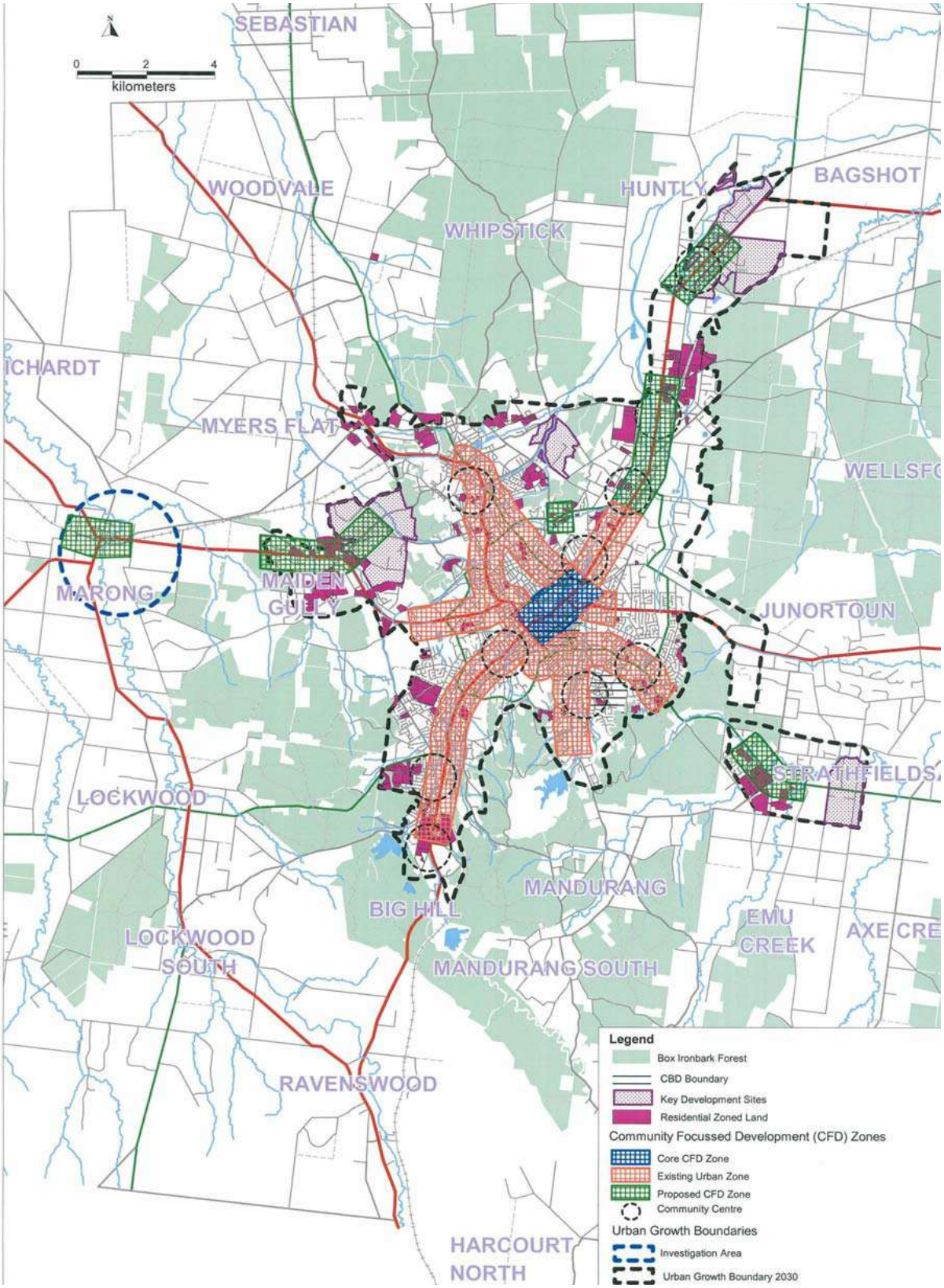


Figure 1 Strategic components of the Residential Development Strategy (Parsons Brinckerhoff, 2004)

Figure 6 Business as Usual – a scenario speculative development of Bendigo over time (30, 60 and 100 year time-frames) in a BAU-scenario [Source: Newman et al., 2011]

4.2 Climate change and Bendigo

The Bendigo Region has many natural assets including a generally moderate climate, rolling hills and valleys, unique gold-fields flora and fauna as well as gold itself. It also has a number of vulnerabilities including fire-prone forests and grasslands, an intermittent water supply, declining agricultural production, toxic legacies of gold mining and episodes of extreme heat. The broad design problem addressed in the charrette is:

> ***Current unsustainable urban and peri-urban growth subdivides green-field sites without due regard for the landscape's natural assets. This erodes those assets. If current and future risks are inadequately planned for, people are put at risk; especially if the hazards and the number of people exposed to those hazards change quickly.***

Using available data for Greater Bendigo, an overview of past weather patterns and extreme weather events, covering extreme temperatures, fire, heat waves, drought and floods was developed. The following sections present a summary of each.

Temperature Forecast

By 2020, climate projections indicate that Bendigo is likely to experience approximately 20 more days of high fire danger or above, more than 1°C of warming, a small reduction in winter-spring rain, and a 10-15% increase in the intensity of extreme rainfall events. Historically, since 1996-97, the average number of days above 35°C and 40°C has risen from 10 to 14, and from 0.7 to 2.4 respectively (Figure 7).

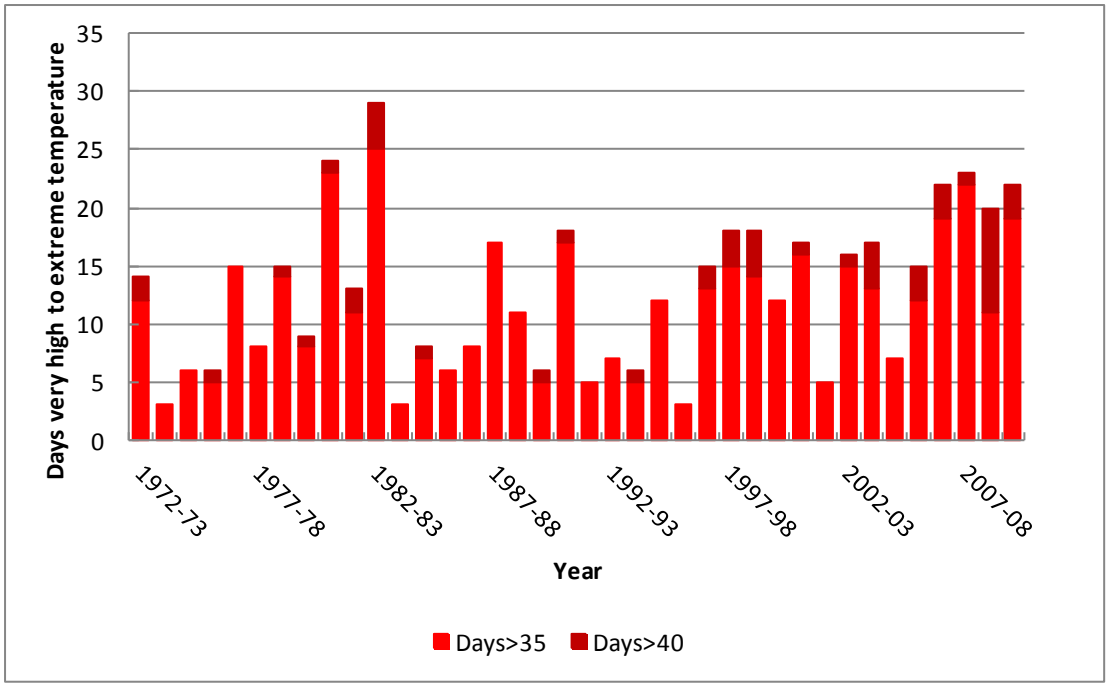


Figure 7 Historical days with very high to extreme temperatures

Fire

Records of Forest Fire Danger Index (FFDI) from Bendigo reflect a significant shift after 1997. 'Very high' FFDI days or above increased by 40%, from 8 to 29 days per year (Figure 8). A projected increase in the number of very high fire days by 2020 makes fire a key climate risk for inclusion in the Bendigo charrette.

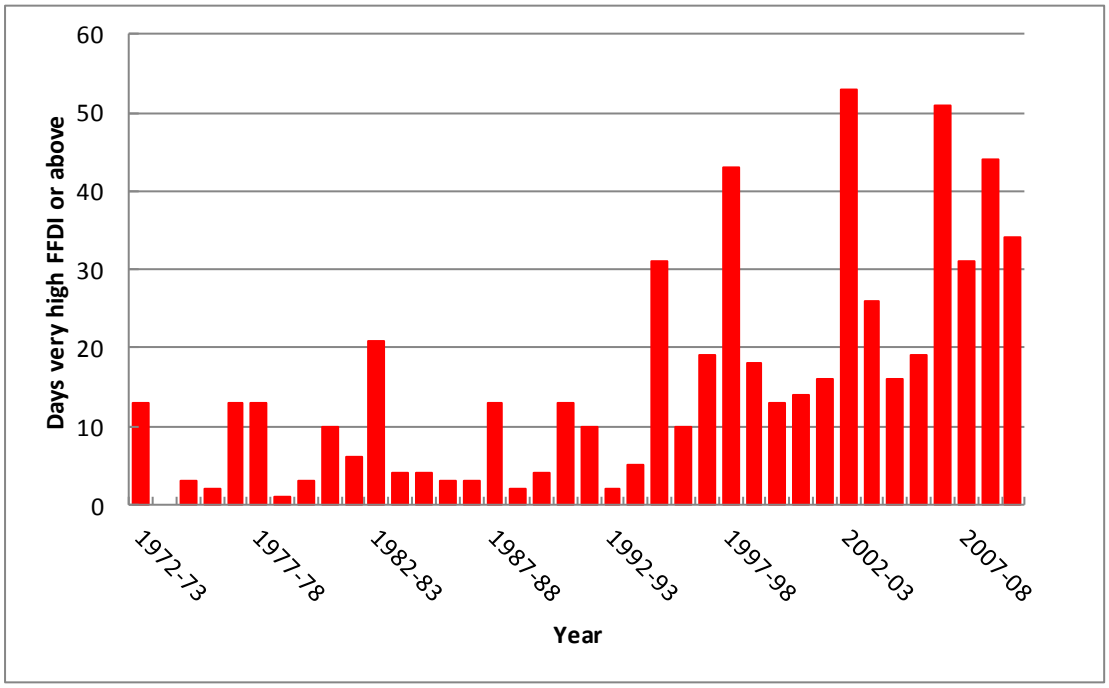


Figure 8 Historical days of very high firefighting danger index

Heat Stress and Drought

Generally hotter and drier conditions since 1997 have increased the prevalence of drought conditions. Research indicating less storm generation over southern Australia suggests that dry conditions will, on average, continue. Heavy daily rainfall has already decreased by more than 25 mm since the 1970s. Wet conditions earlier this year (2012) were exceptional and were associated with a negative Indian Ocean Dipole and La Nina. Eleven such events in northern Victoria since 1900 have caused moderate to major flooding. A simple model based on IOD-ENSO indices suggests that this recent event was much wetter than would otherwise have been anticipated. Therefore drier conditions are expected to lead to fewer very wet events but such extreme events will be more intense, i.e. wetter.

Flood

The flood-prone regions of Greater Bendigo (Figure 9) occur along the banks of Bendigo Creek. The areas highlighted in blue are those with the highest probability of 1-in-100-year floods, as well as main flood-ways. These areas, though not located within the main urban development zone, are located along the main north-eastern urban growth corridor.

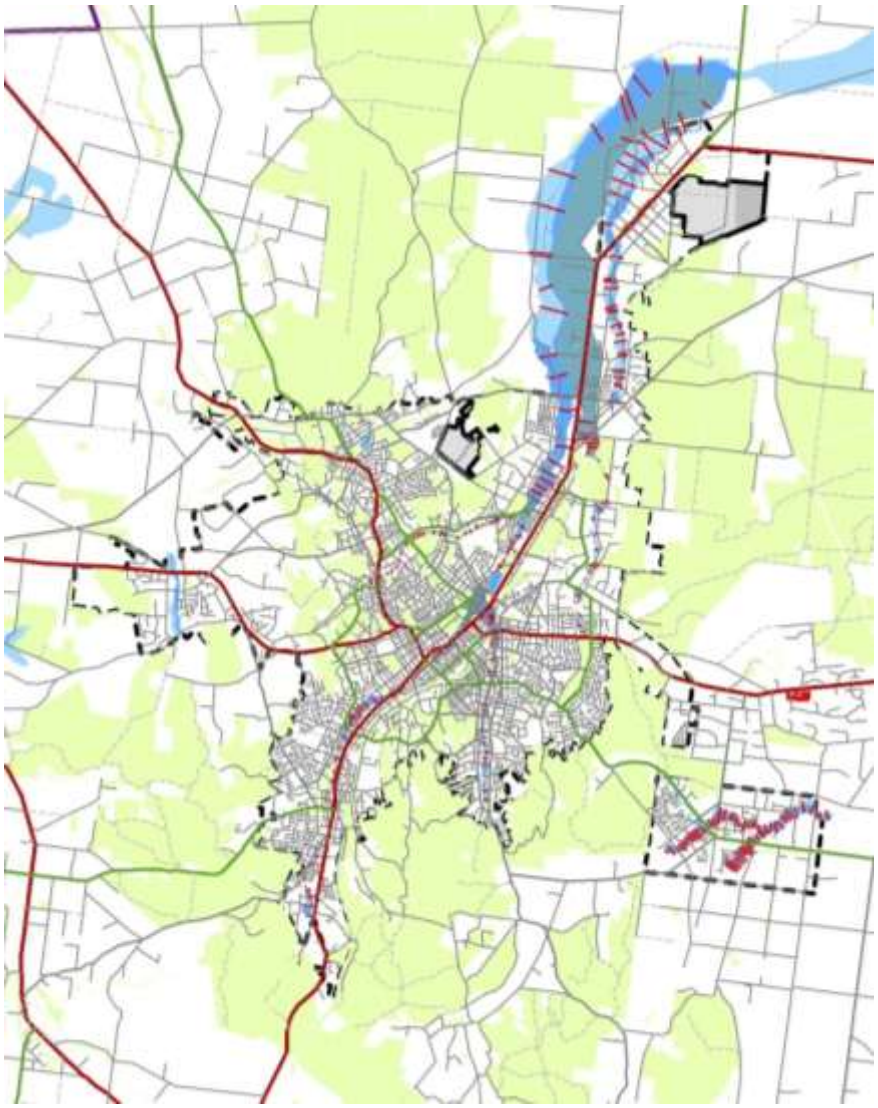


Figure 9 Flood prone areas in the surroundings of Bendigo

4.3 Bendigo charrette 1 - outcomes and maps

Over two days, the charrette process generated nineteen landscape plans. The first fifteen solutions were generated on AO-scale maps. These included:

- Five large regional scale maps for the City of Greater Bendigo (Figures 10-14)
- Six district scale maps for the northeast, southeast and western districts of Bendigo (Figures 15-16 North Eastern map 01-02, Figures 17-18 City of Greater Bendigo South-eastern district 01-02, Figures 19-20 City of Greater Bendigo Western precinct 01-02)
- Four 'town' scale maps of satellite areas in Huntly, Marong and Strathfieldsaye (Figures 21-24 Huntley Map 01, Marong Map 01-02, Strathfieldsaye map 01-02)

The mix of scales prompted participants to think about climate adaptation through different lenses. For example, the town scale encouraged participants to think about specific building features, whereas the regional scale prompted consideration of transport connections between the various satellite cities.

The final assignment of the two-day charrette required participants to develop four plasticine models, drawing on specific diverse themes that were arising from the charrette process. The themes were

16. Learning to live with fire…'the life saver region': This theme viewed fire a consistent threat and combines natural landscape and the built environment to mitigate the threat.

17. The golden centre…'the shining heart of the state': this theme viewed Bendigo's gold heritage as an asset that may continue be extractable in the future, so those benefits can be emphasised as part of the region's history but also its future.

18. 'The scarcer the water': This theme viewed water scarcity as the central threat to the region; the design group were challenged with the task of transforming the city with limited water.

19. 'If you can't stand the heat': this theme engaged with the increased likelihood of days above 40°C.

The concepts were labelled respectively as concept 16, 17, 18 and 19, following consecutively on from the fifteen preliminary design solutions generated in the charrette process (These initial fifteen concepts were not assessed in the appraisal) that were amalgamated into these final four concepts. The final four concepts are explained in more detail in the following appraisal sections.

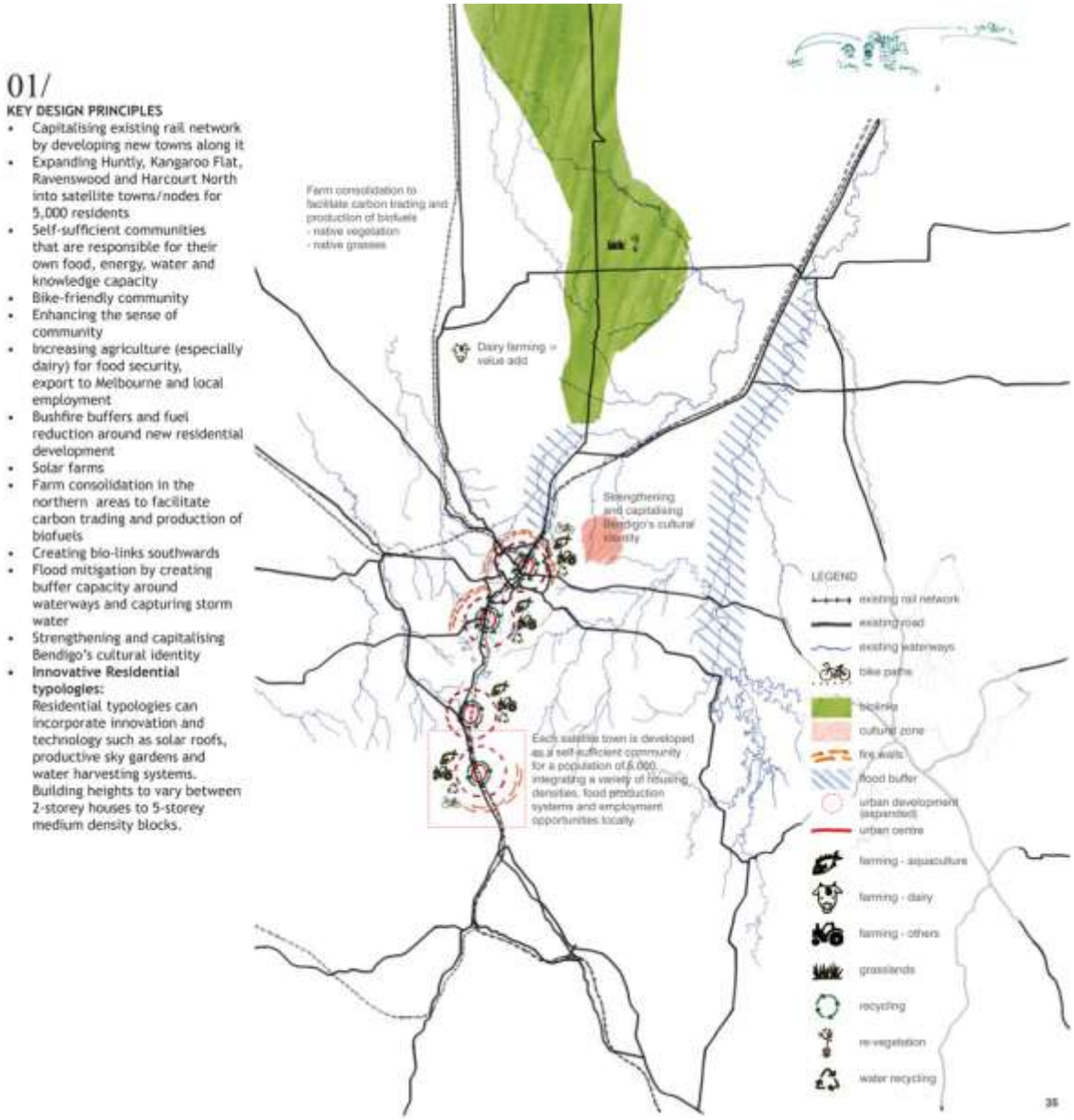


Figure 10 City of Greater Bendigo regional map 01

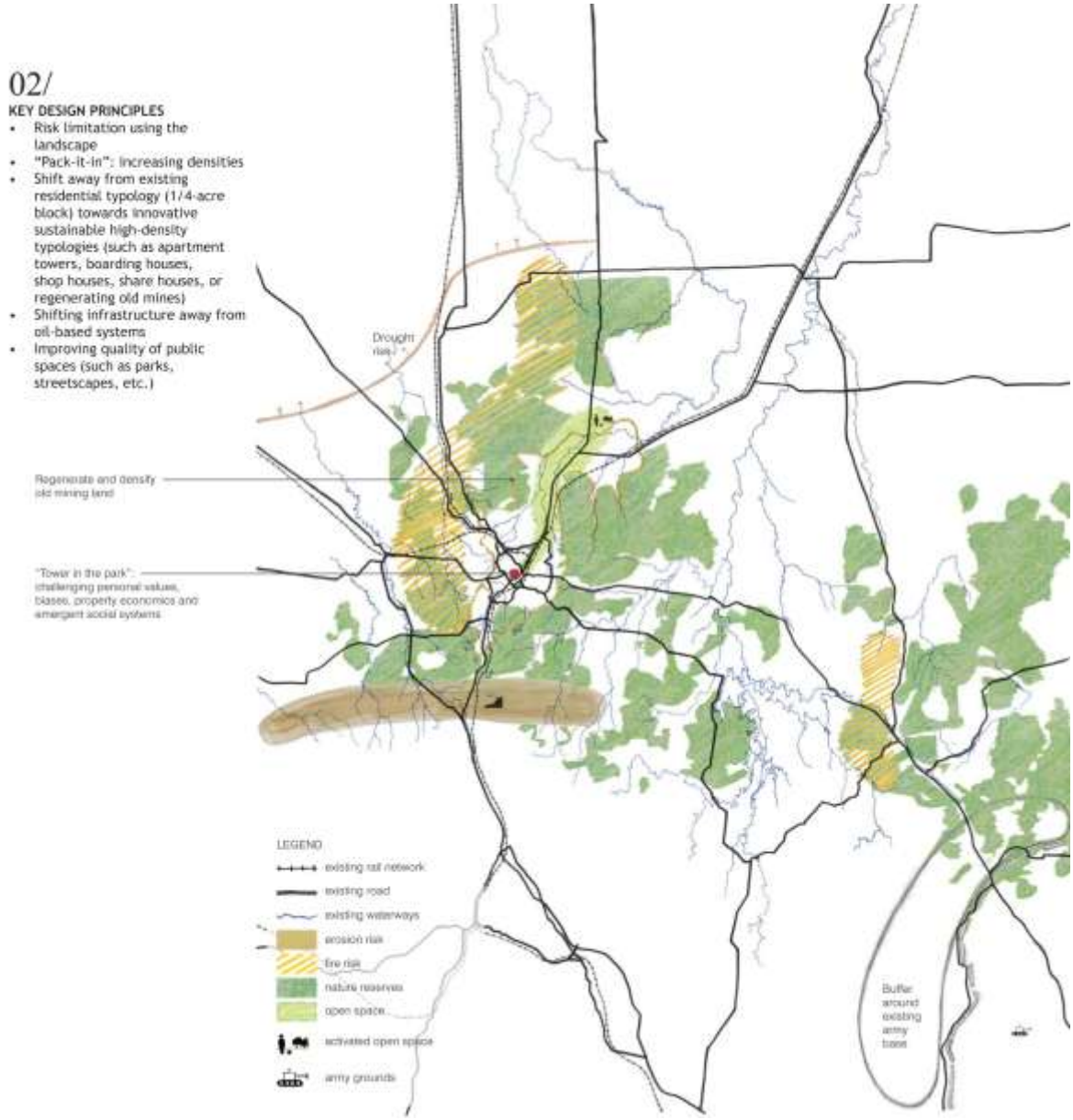


Figure 11 City of Greater Bendigo regional map 02

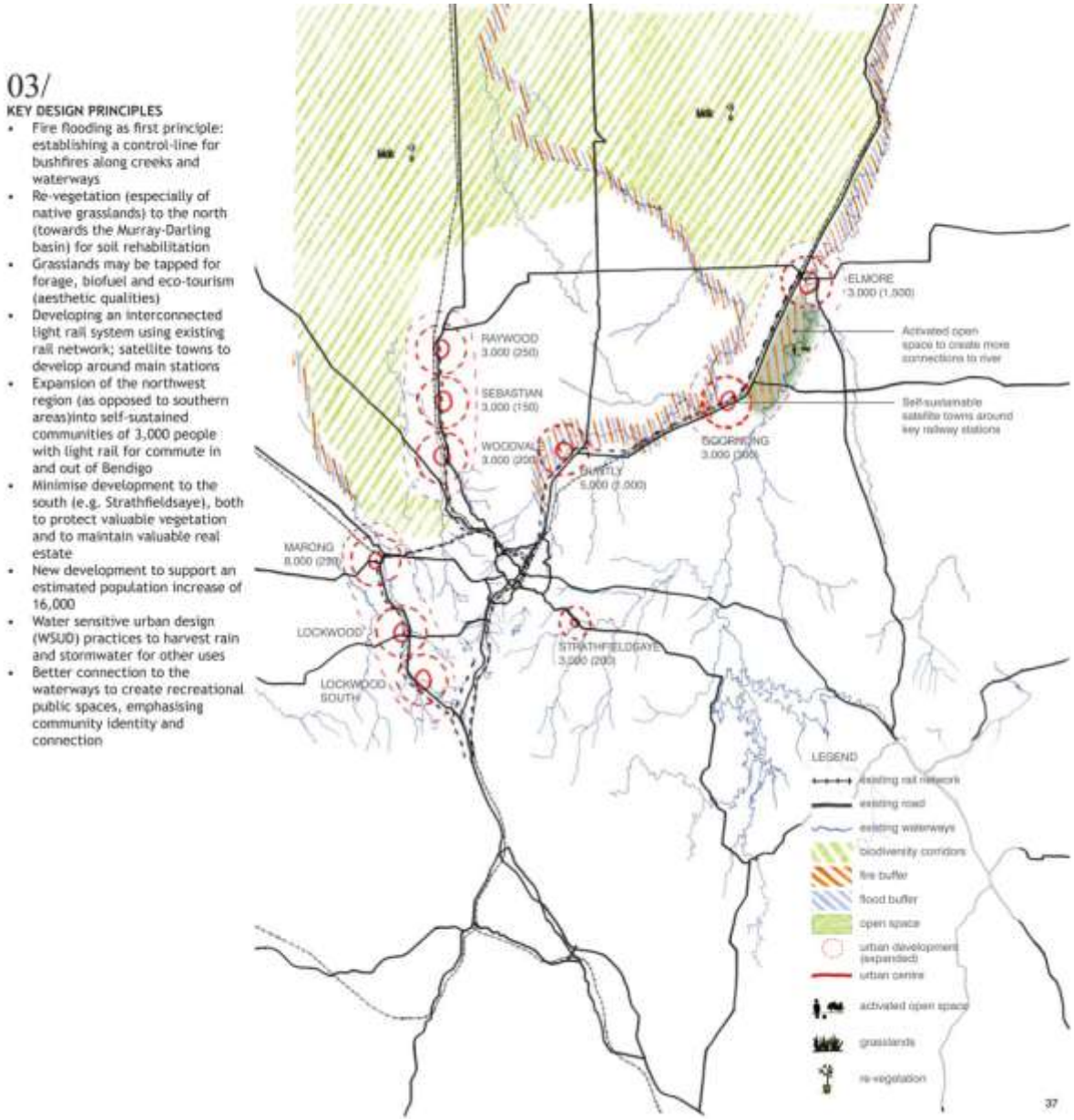


Figure 12 City of Greater Bendigo regional map 03

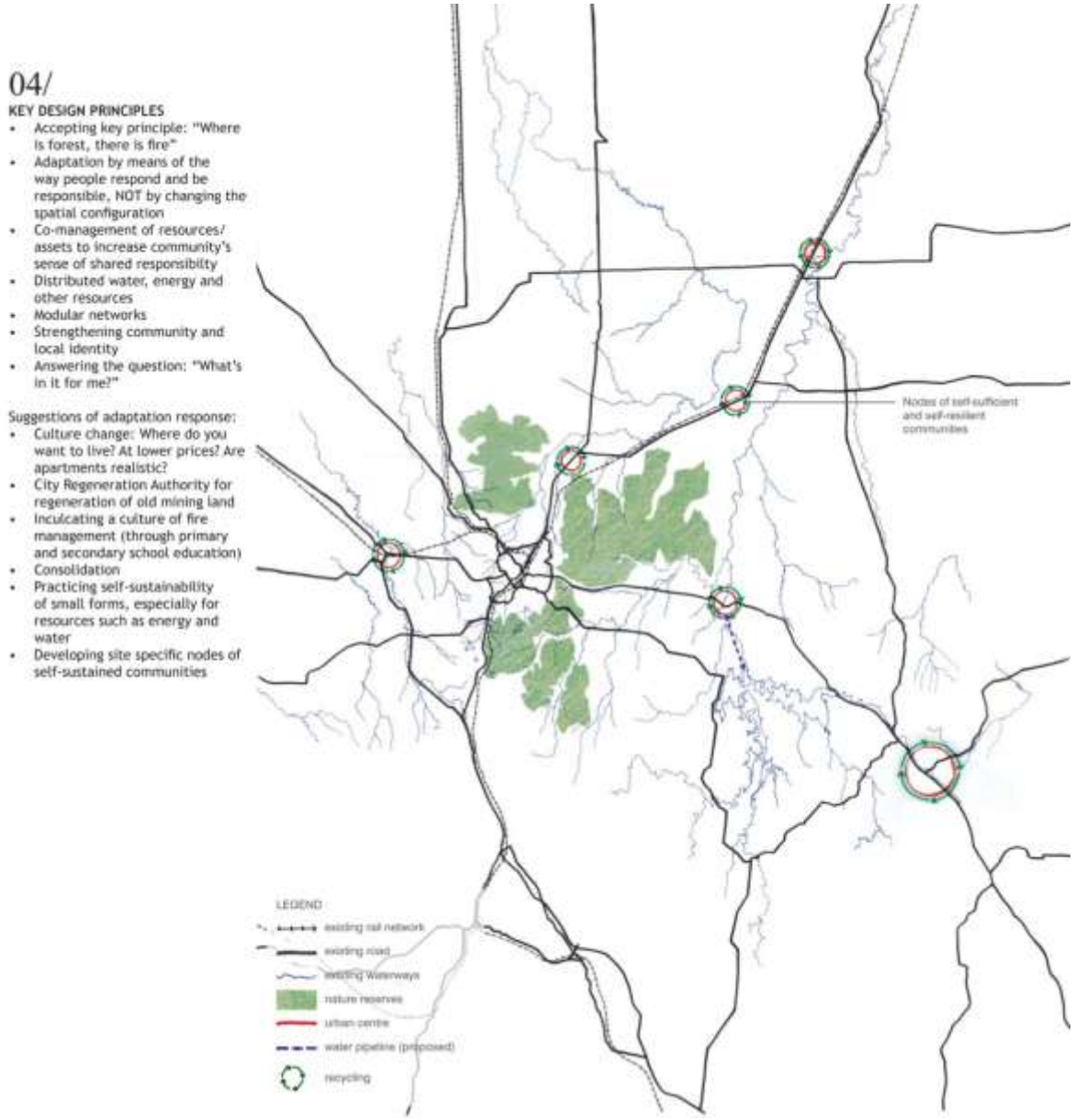


Figure 13 City of Greater Bendigo regional map 04

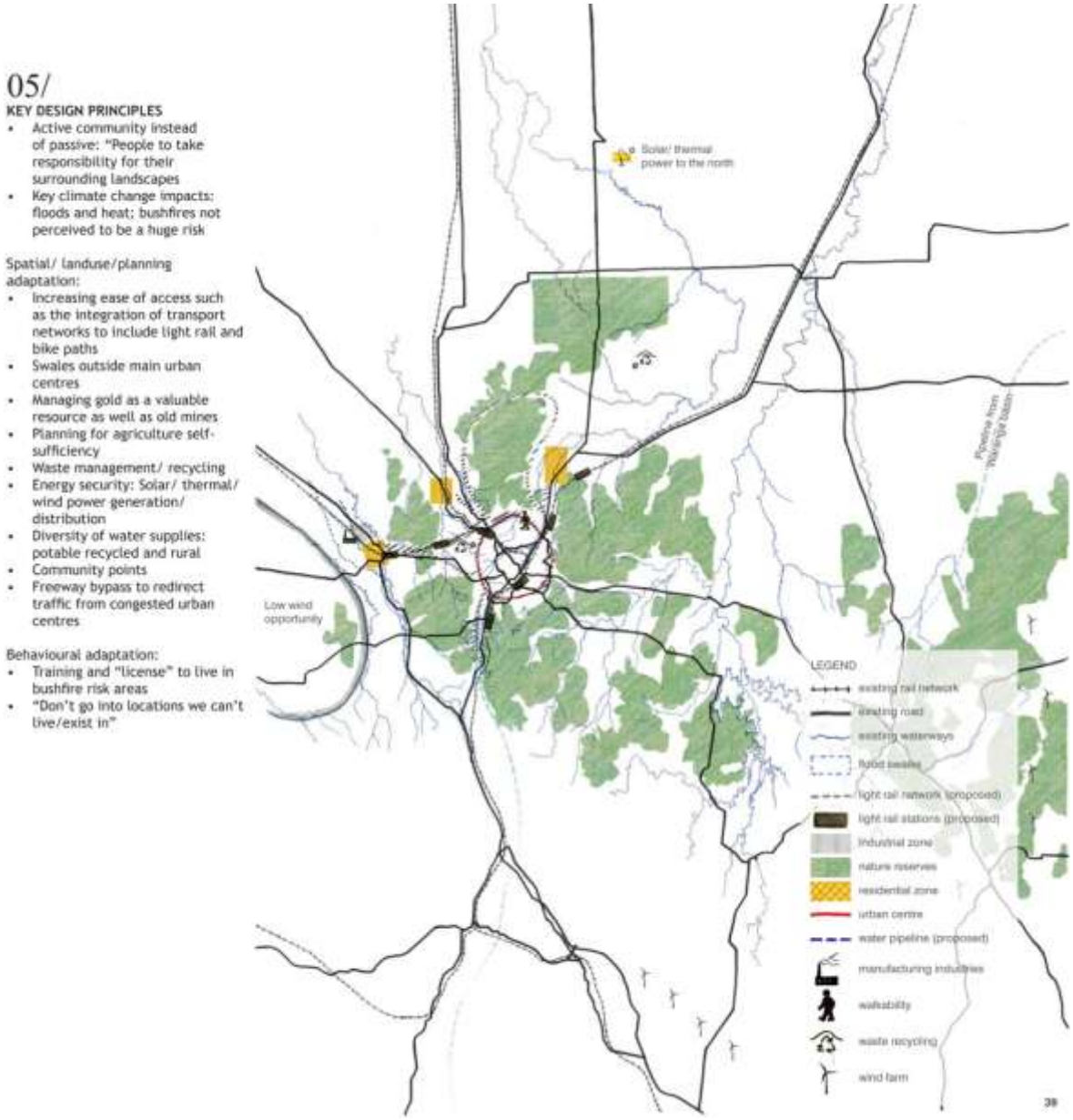


Figure 14 City of Greater Bendigo regional map 05

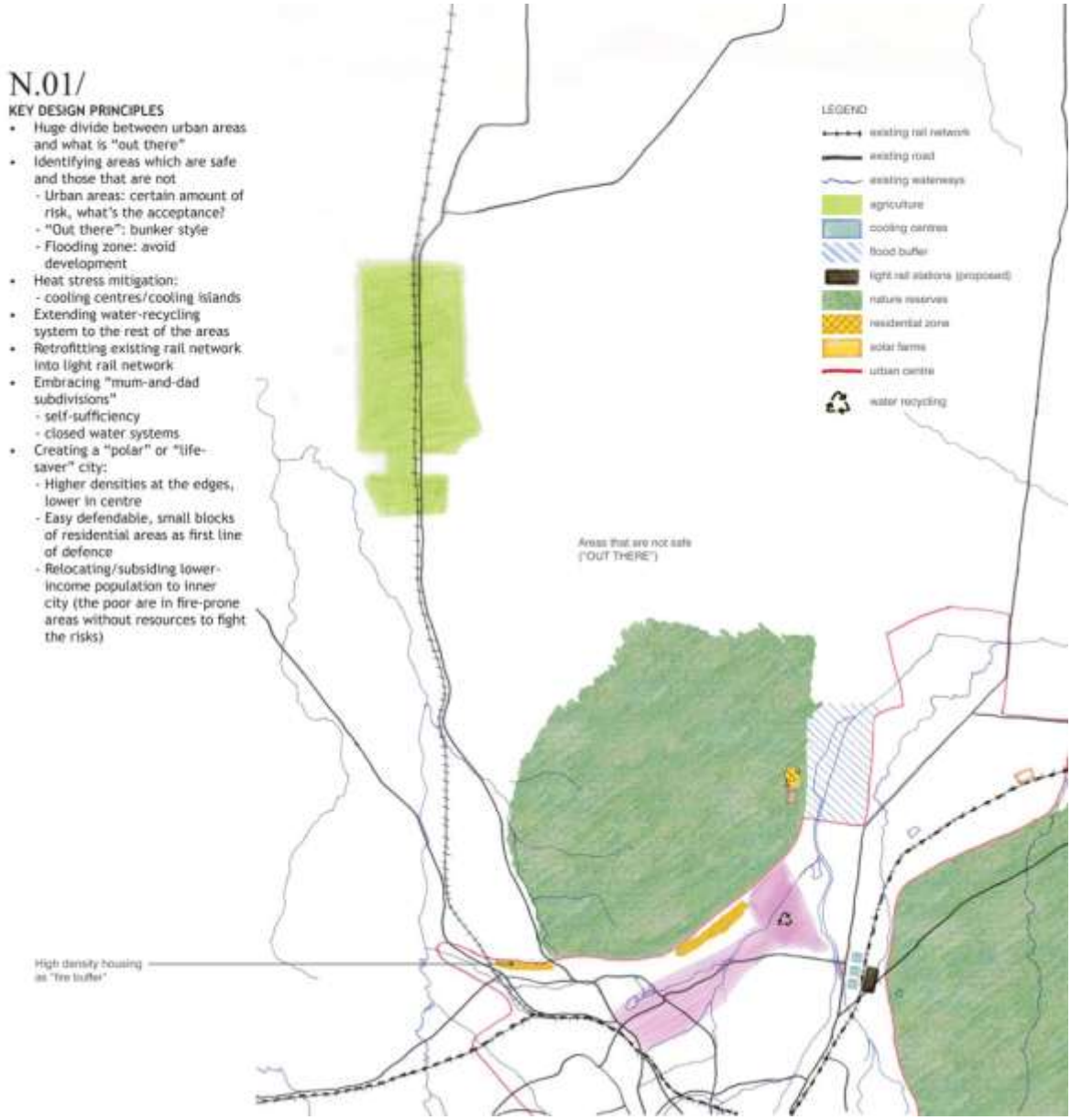


Figure 15 City of Greater Bendigo North Eastern map 01

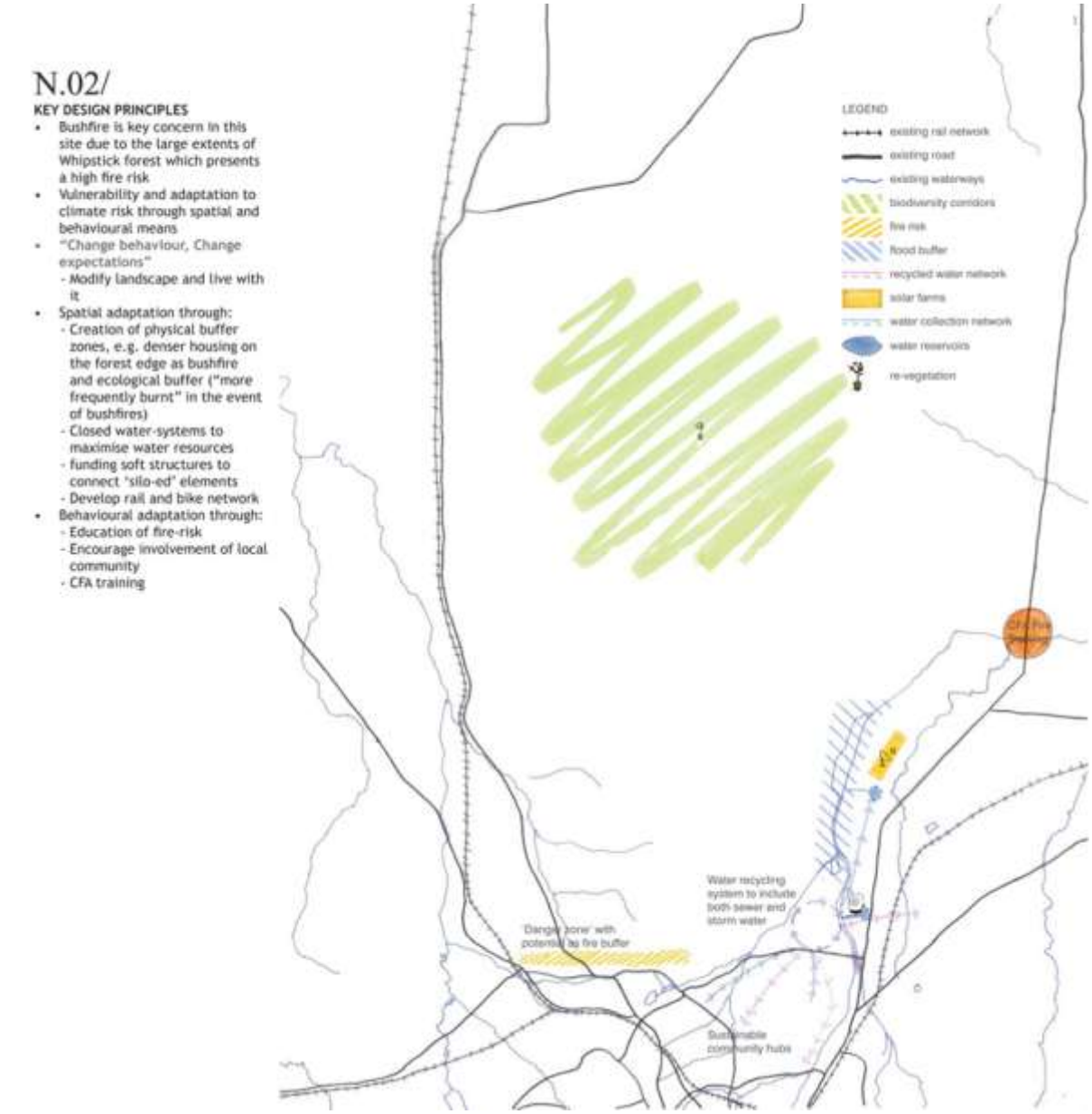


Figure 16 City of Greater Bendigo North-western district 02

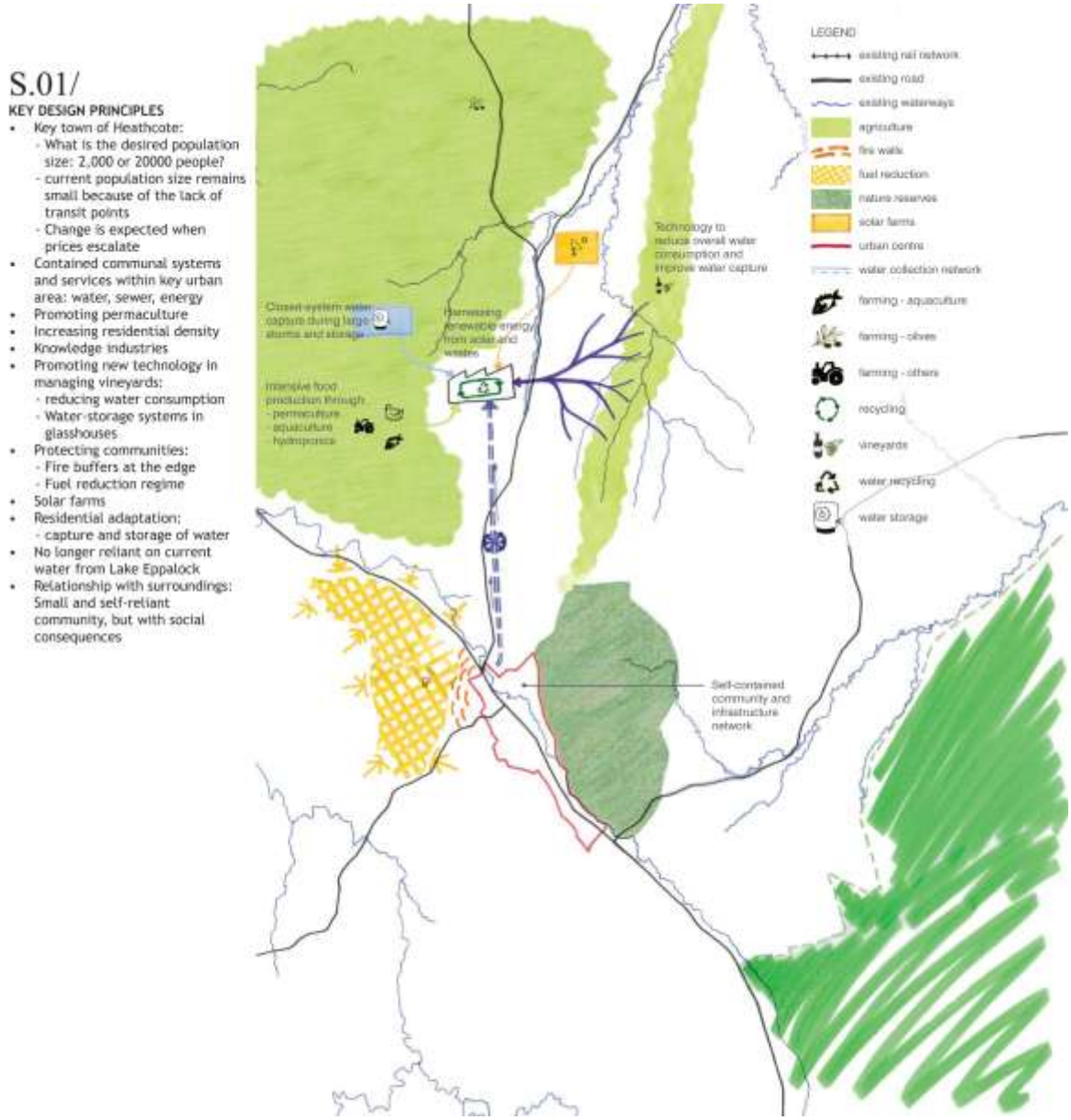


Figure 17 City of Greater Bendigo South-eastern district 01

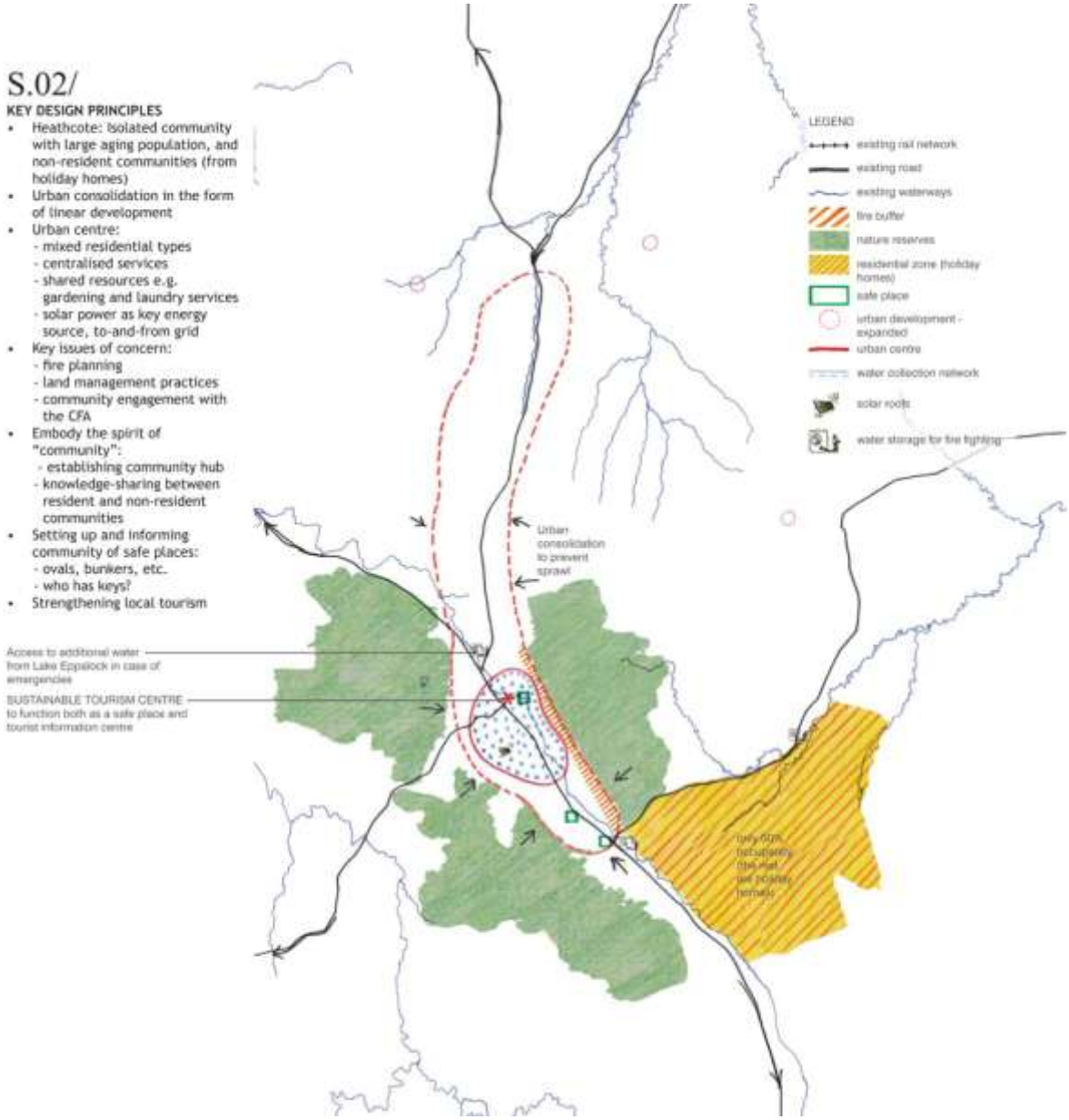


Figure 18 City of Greater Bendigo South-eastern district 02

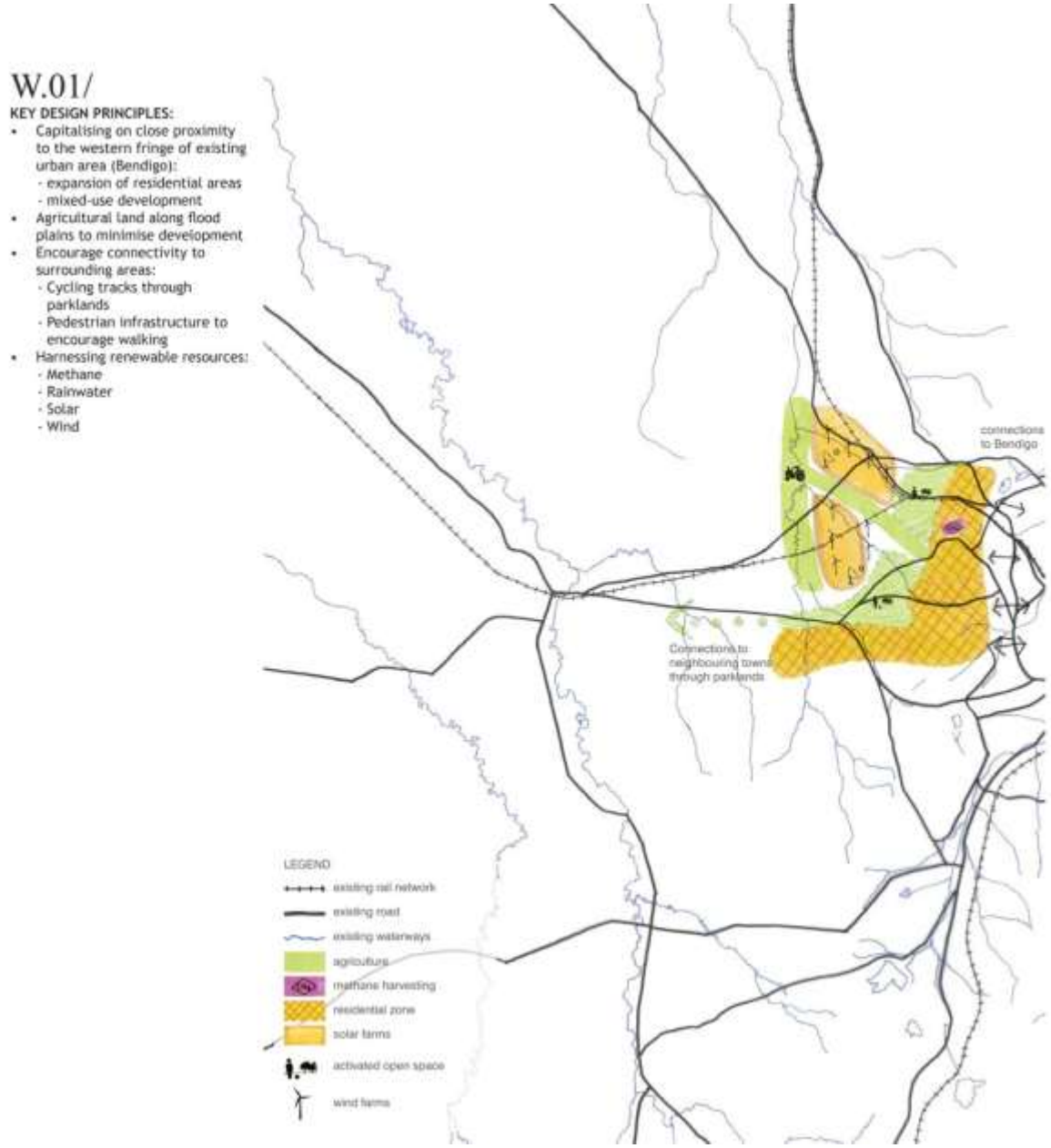


Figure 19 City of Greater Bendigo Western precinct 01

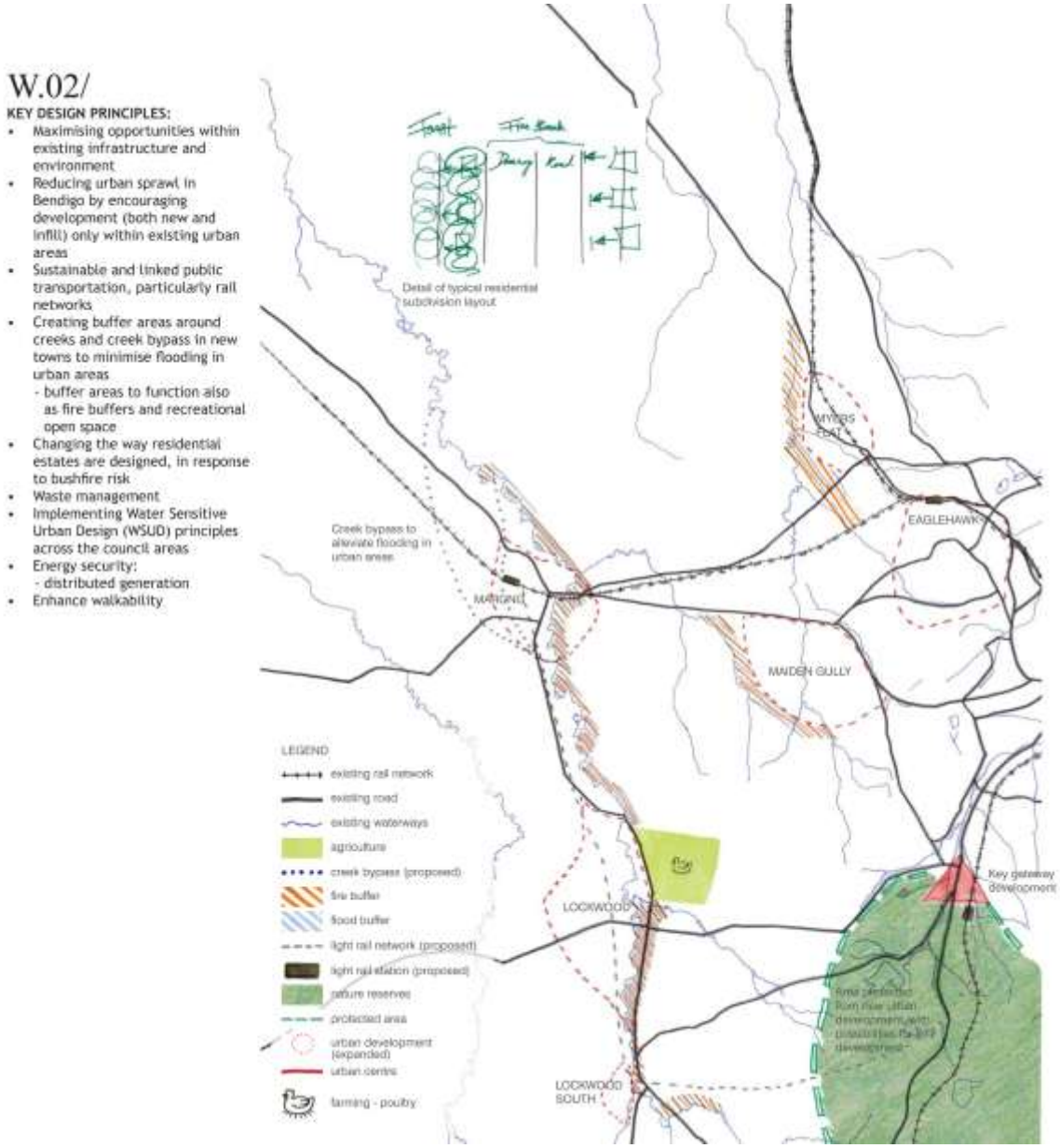


Figure 20 City of Greater Bendigo Western precinct 02

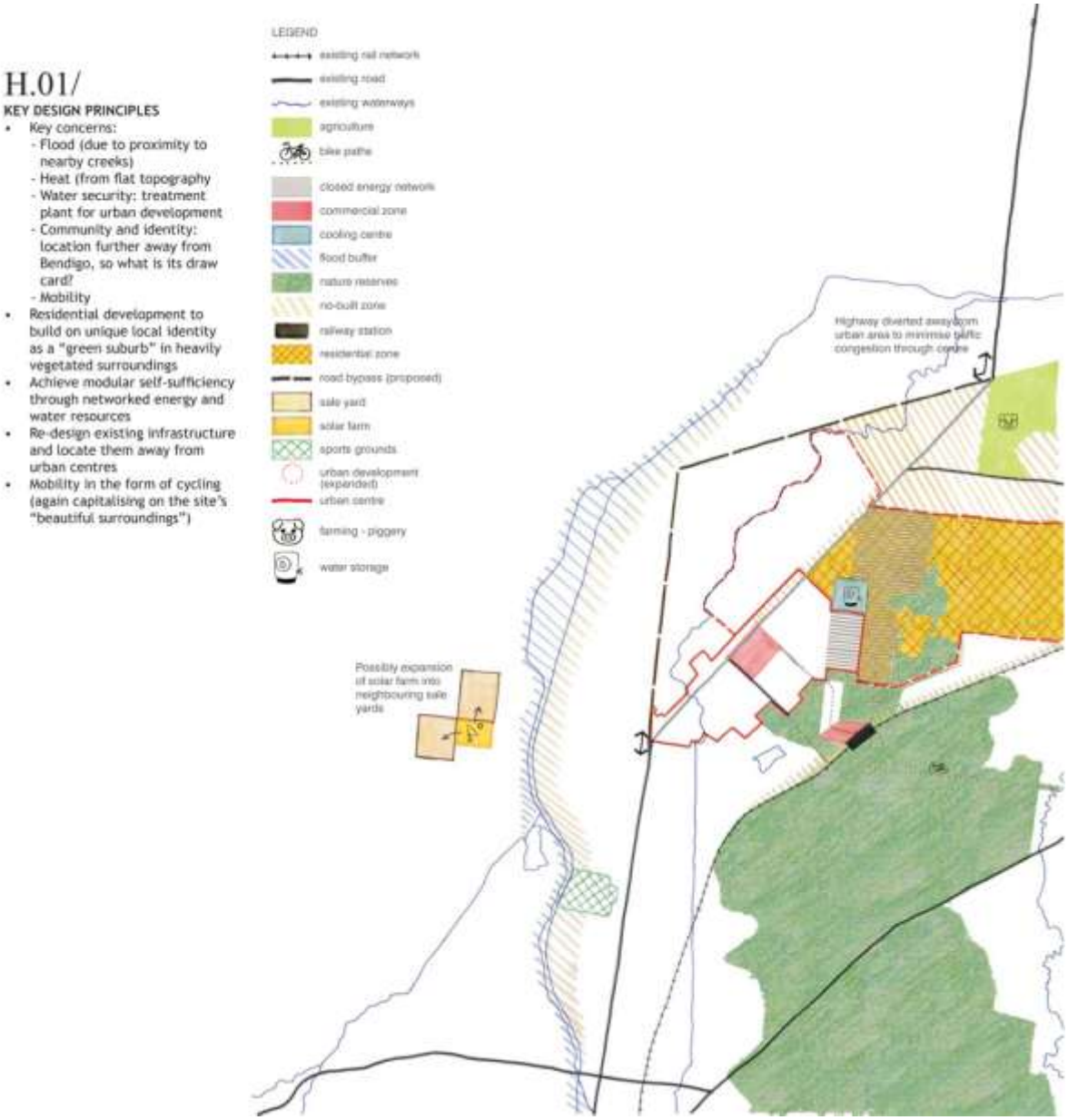
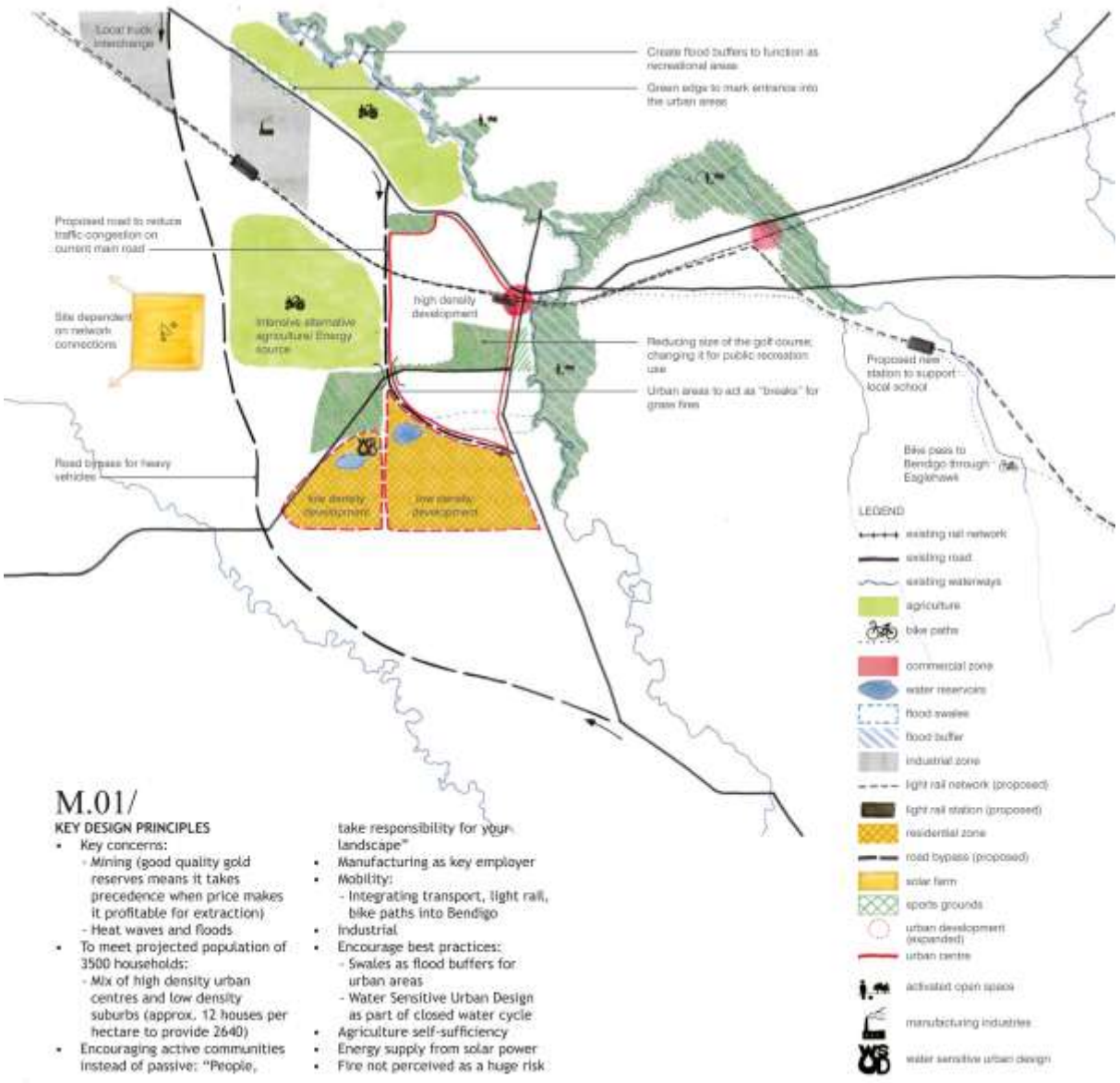


Figure 21 Huntley Map 01



M.01/

KEY DESIGN PRINCIPLES

- Key concerns:
  - Mining (good quality gold reserves means it takes precedence when price makes it profitable for extraction)
  - Heat waves and floods
- To meet projected population of 3500 households:
  - Mix of high density urban centres and low density suburbs (approx. 12 houses per hectare to provide 2640)
- Encouraging active communities instead of passive: "People, take responsibility for your landscape"
- Manufacturing as key employer
- Mobility:
  - Integrating transport, light rail, bike paths into Bendigo
- Industrial
- Encourage best practices:
  - Swales as flood buffers for urban areas
  - Water Sensitive Urban Design as part of closed water cycle
- Agriculture self-sufficiency
- Energy supply from solar power
- Fire not perceived as a huge risk

Figure 22 Marong Map 01

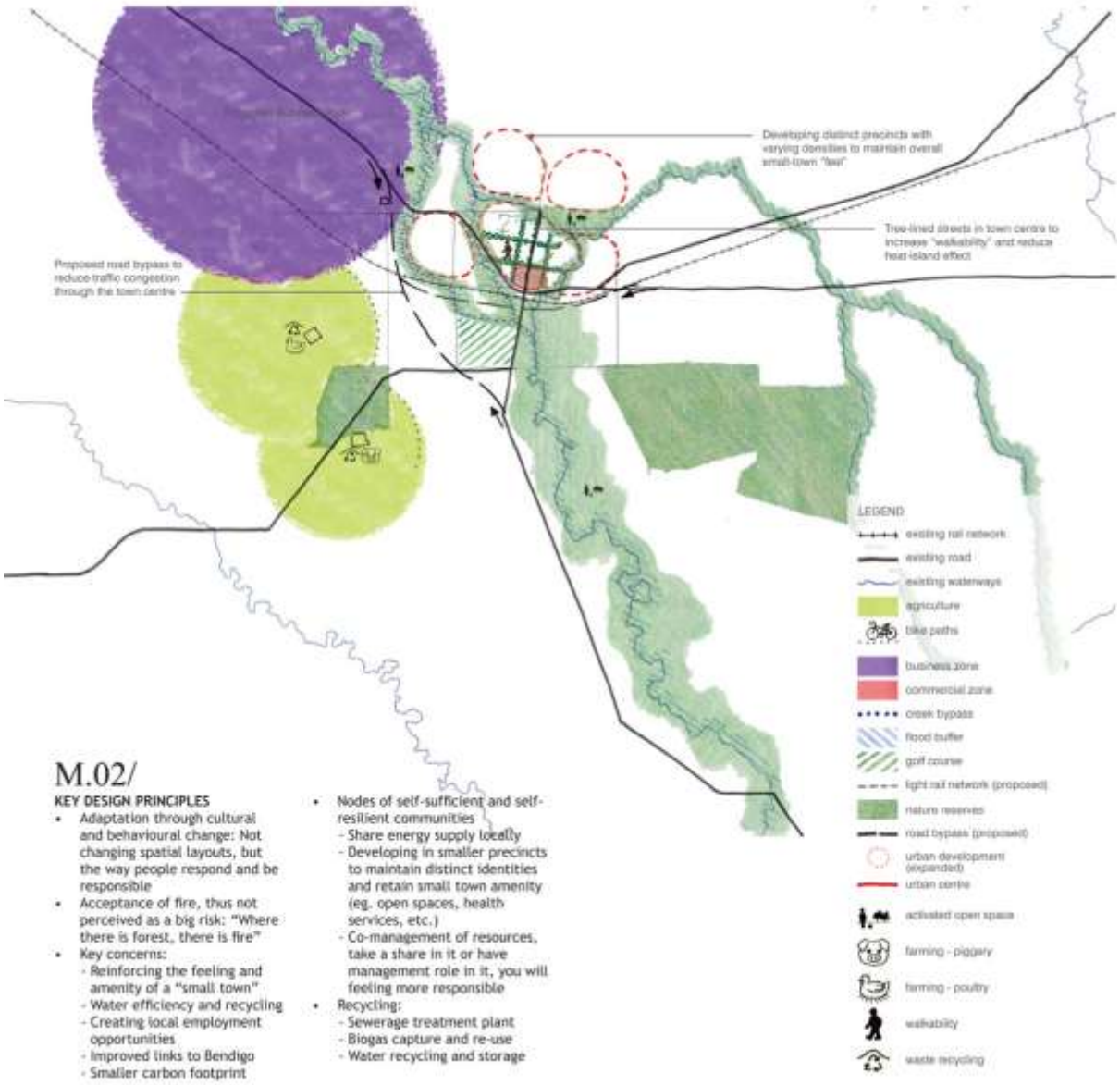


Figure 23 Marong Map 02

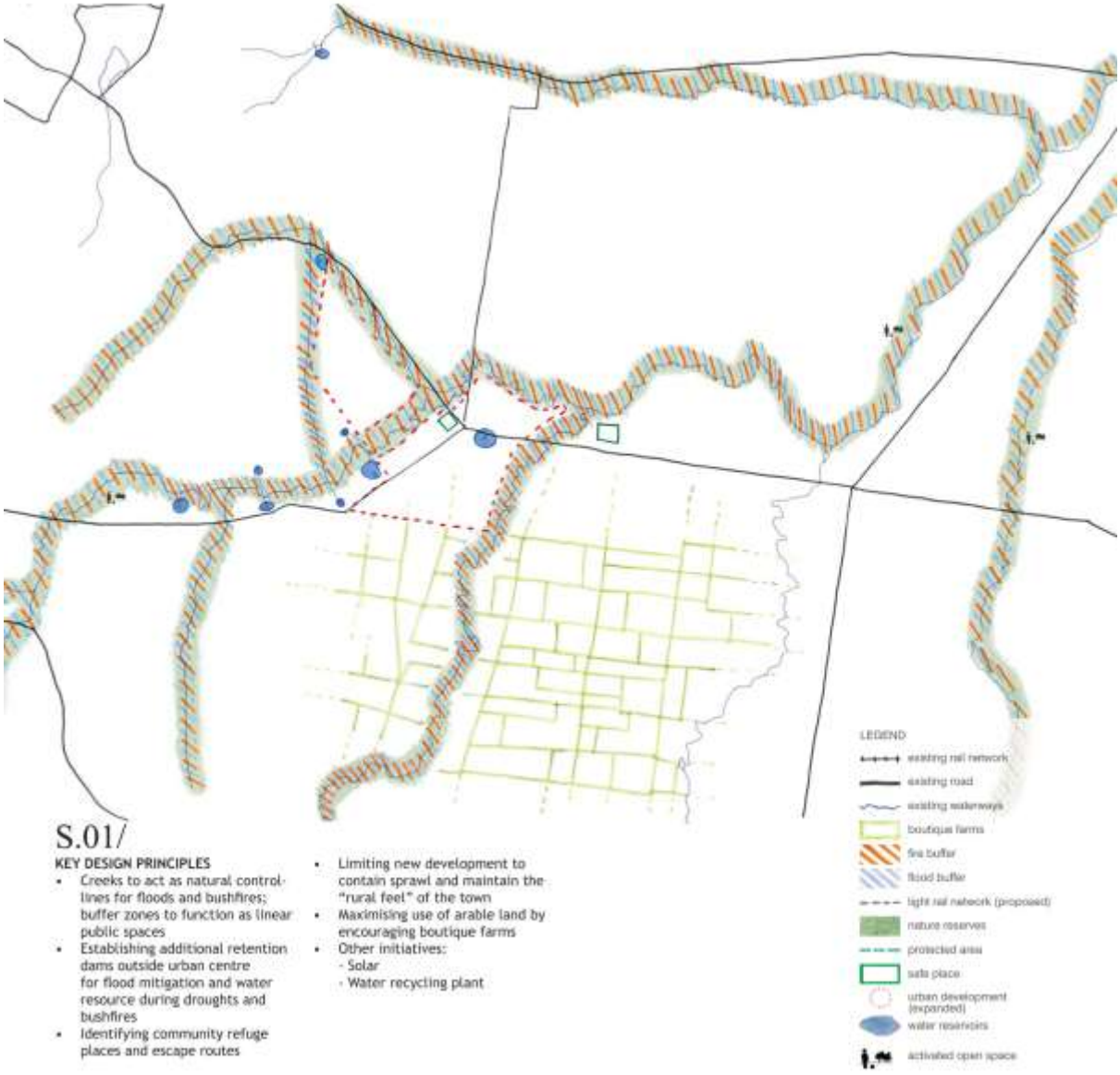


Figure 24 Strathfieldsaye Map 01

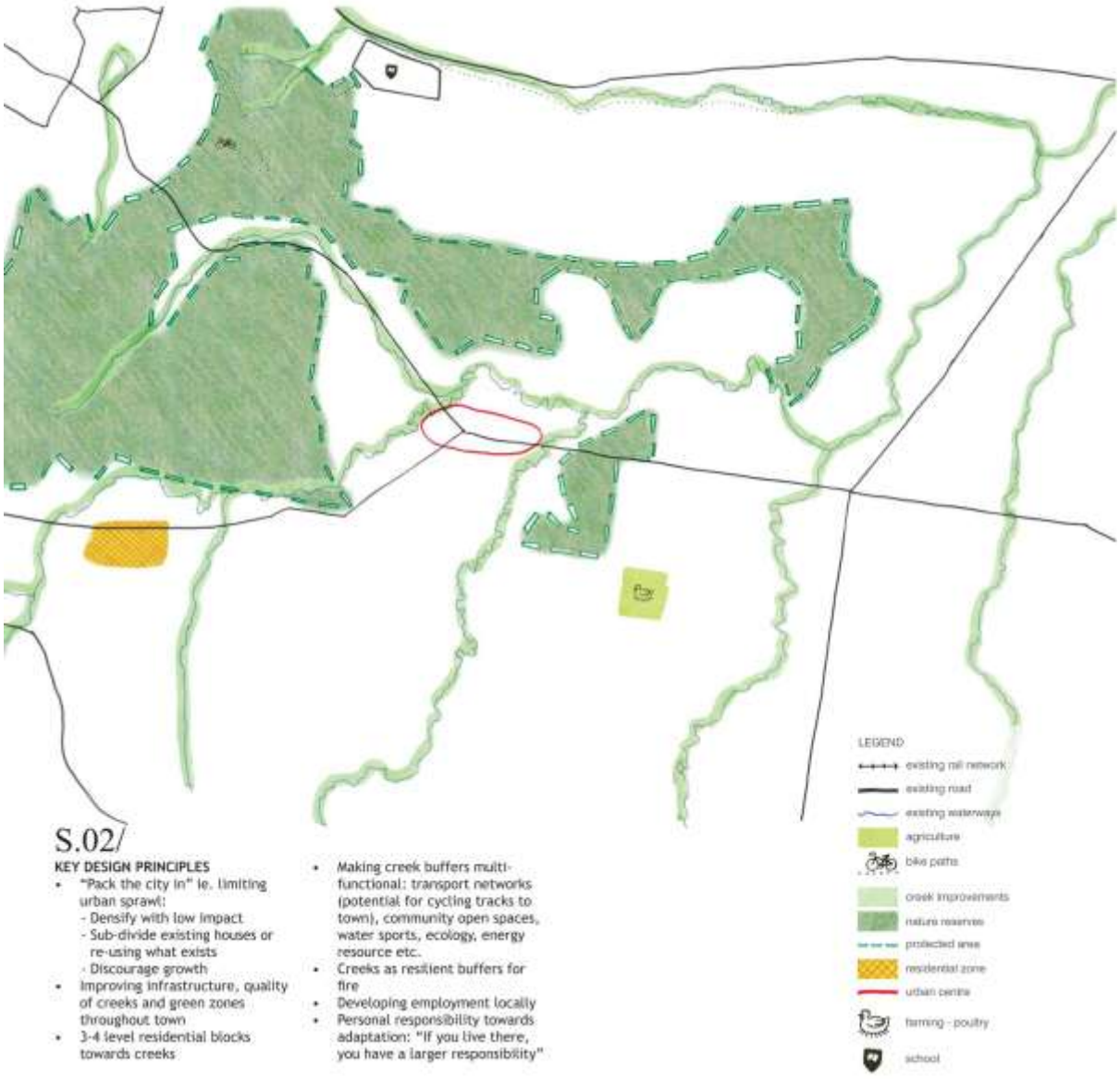
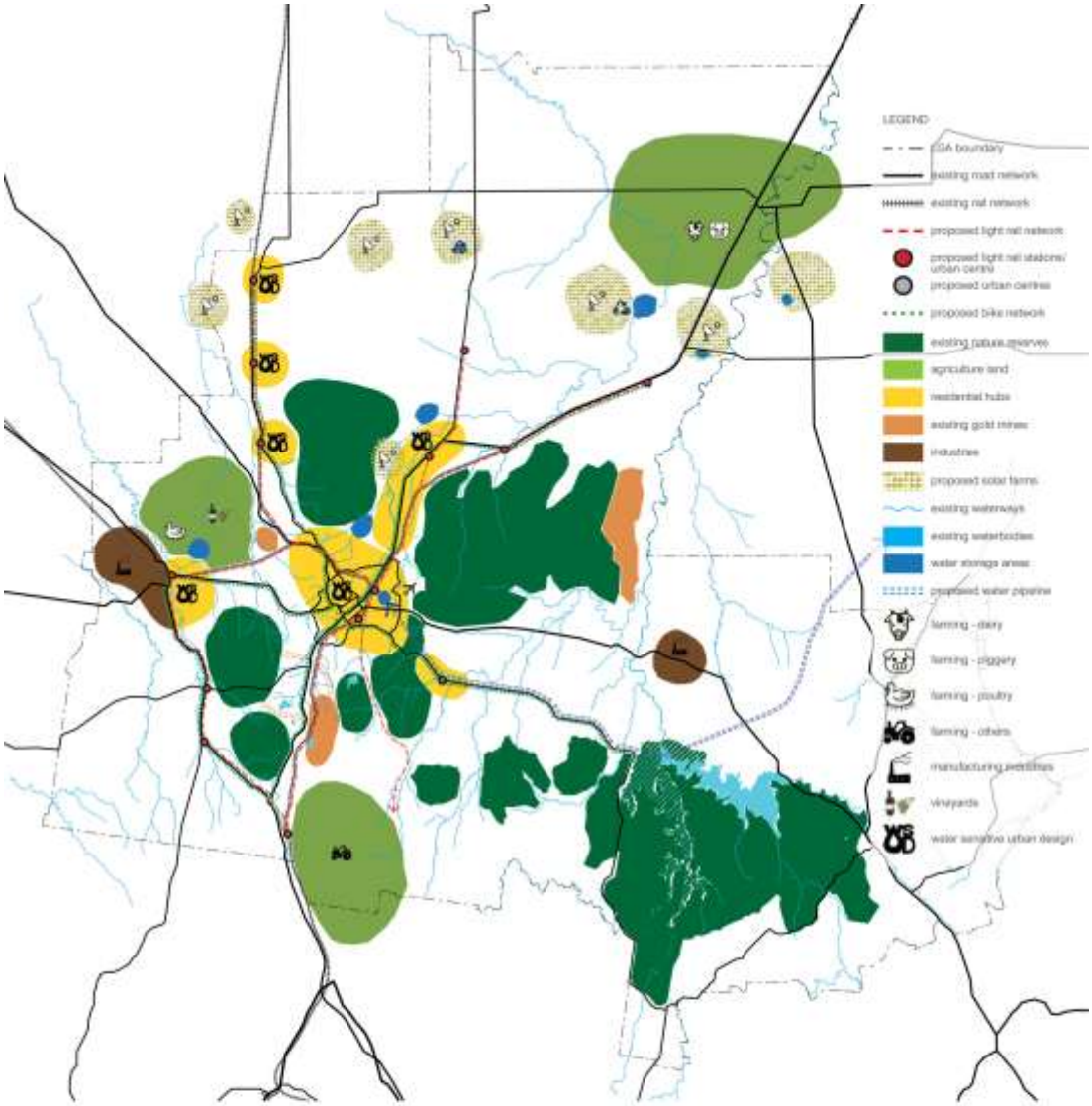


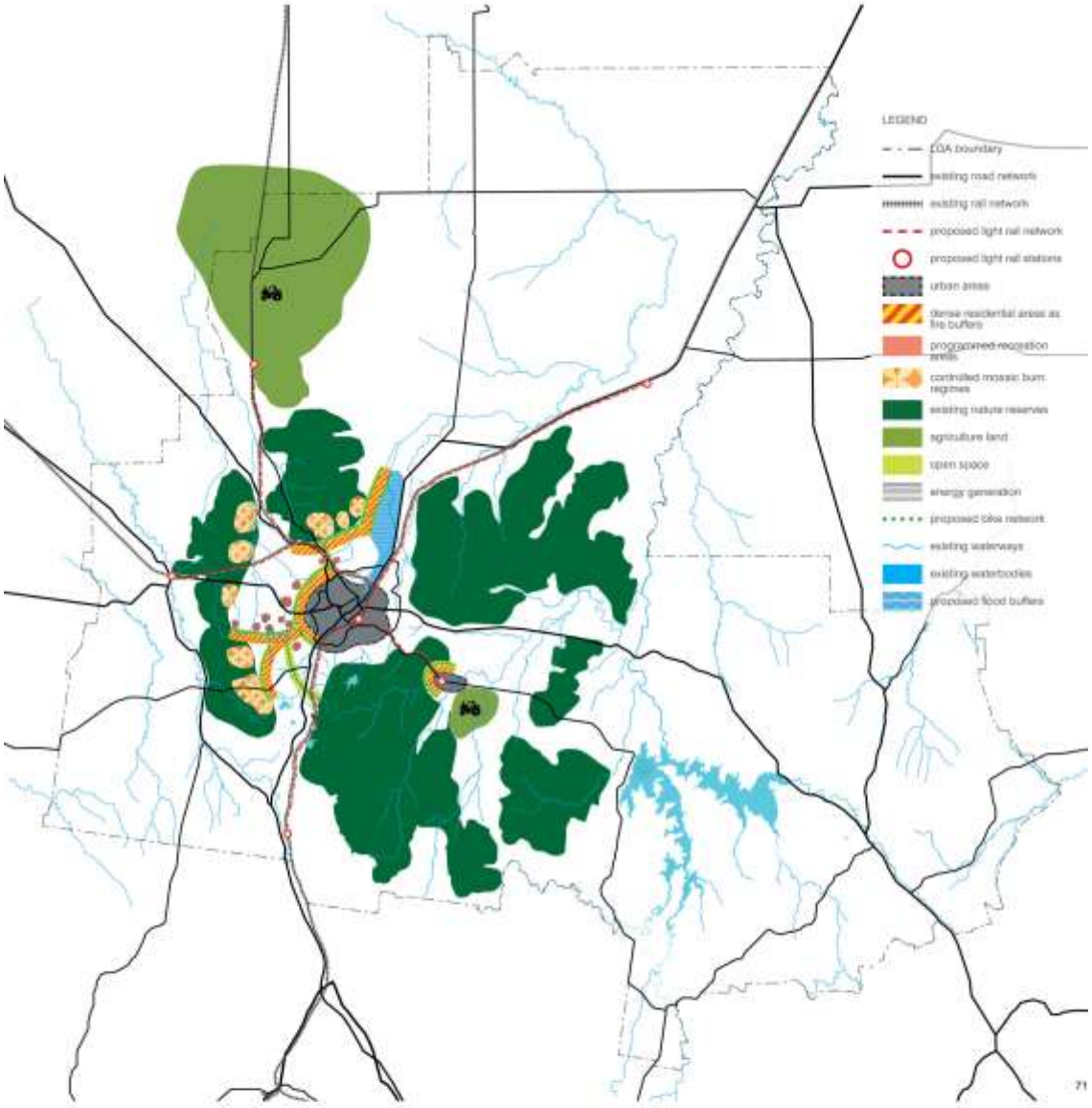
Figure 25 Strathfieldsaye Map 02



KEY DESIGN PRINCIPLES

- Sustained and effective management of Bendigo's key resources eg. gold
- Ensuring energy security through
  - promoting community responsibility
  - the use of renewable energy sources
- Use of solar as primary energy source:
  - modifying built-form to incorporate solar roof panels
  - establishing solar farms to the north
- Strenghtening Bendigo's identity through cultural resources and precincts
- Containing urban sprawl by creating secondary residential precincts away from urban centre (Bendigo), and developing supporting infrastructure:
  - Public transport line connected to-and-fro Bendigo through proposed light rail system
  - Establishing cycling networks
- Adapting residential typology to incorporate best building practices:
  - Solar roof panels
  - Water harvesting, storage and recycling within built-form
  - Passive cooling devices such as wind-towers
  - Exploring best layouts and building heights suitable for local climate (Refer to details in Design Development)
- Encouraging household connectedness by setting up integrated networks for re-distribution of energy and water sources
- Integrated management of resources e.g. solar farms and water harvesting plants
- Ensuring long-term water security:
  - Prolonged droughts could result in a smaller Lake Eppaloch (half its current size)
  - water-pipe infrastructure from Loddon catchment
  - water harvesting/recycling to maximise use of water resources through networks
- Better waste management
- Strengthening food production in the north
  - Localised production in smaller sub-areas to encourage self-sustained communities and minimise food miles
  - Harvesting agriculture waste for energy production

Figure 26 The shining heart of the state



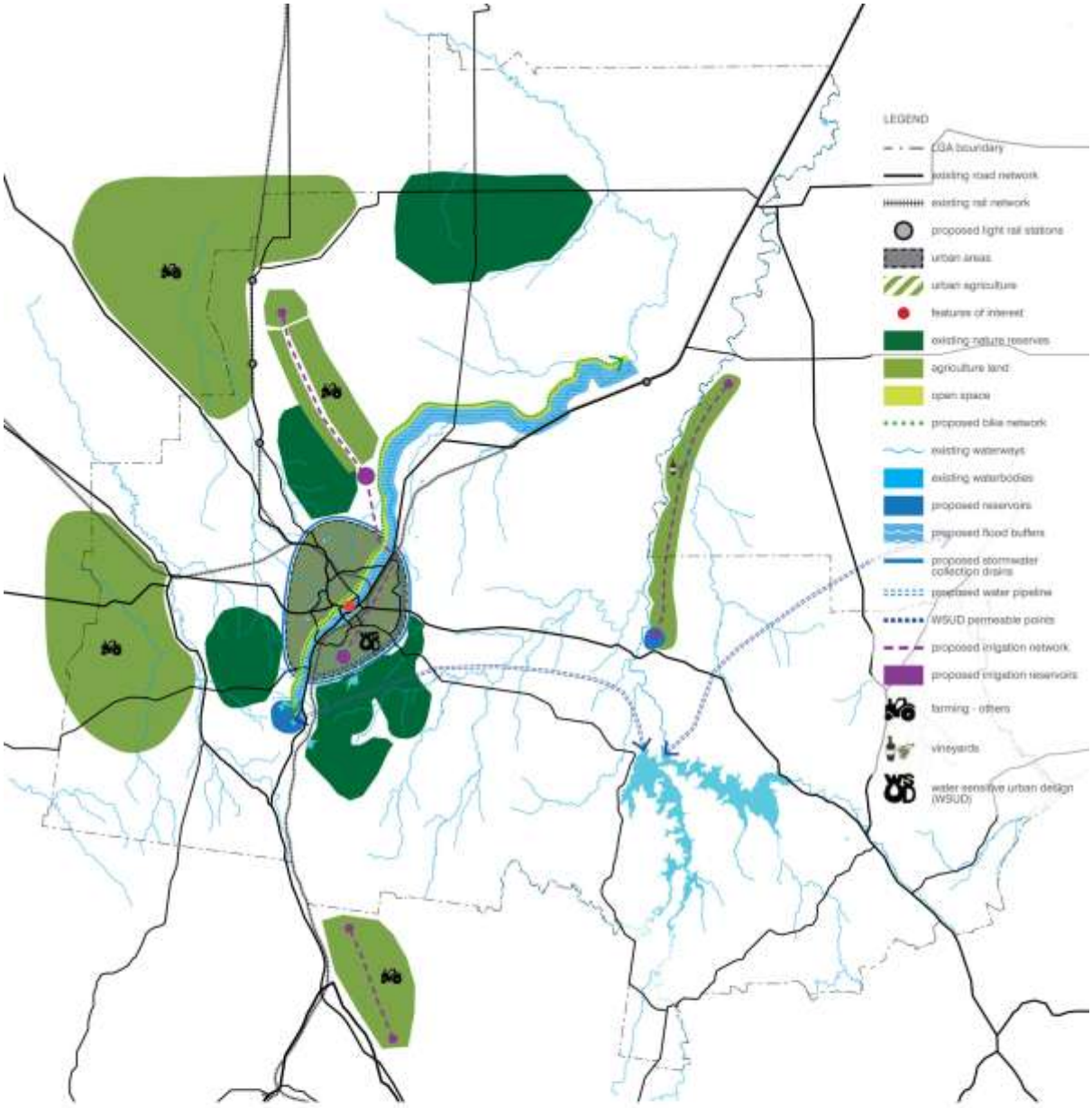
KEY DESIGN PRINCIPLES

- Almost a "fortress":
  - Build urban centres with protective high density housing on the outer edges and in the centres
- Developing a housing typology more resistant to bushfires:
  - "Eva-curate" strategy
  - High density housing on urban fringes become "lifesaver"
  - Typical cross-section of a high-density residential neighbourhood:

Integrated open space network and road corridors become natural fire buffers for housing units and fire-fighting zones during bushfires

- Controlled burns and planting for fire-management
- Energy self-sufficiency:
  - Combined corridors of open spaces and green infrastructure
- Improved public transport network by encouraging rail and light-rail systems
- Flood buffers outside urban areas to reduce flooding

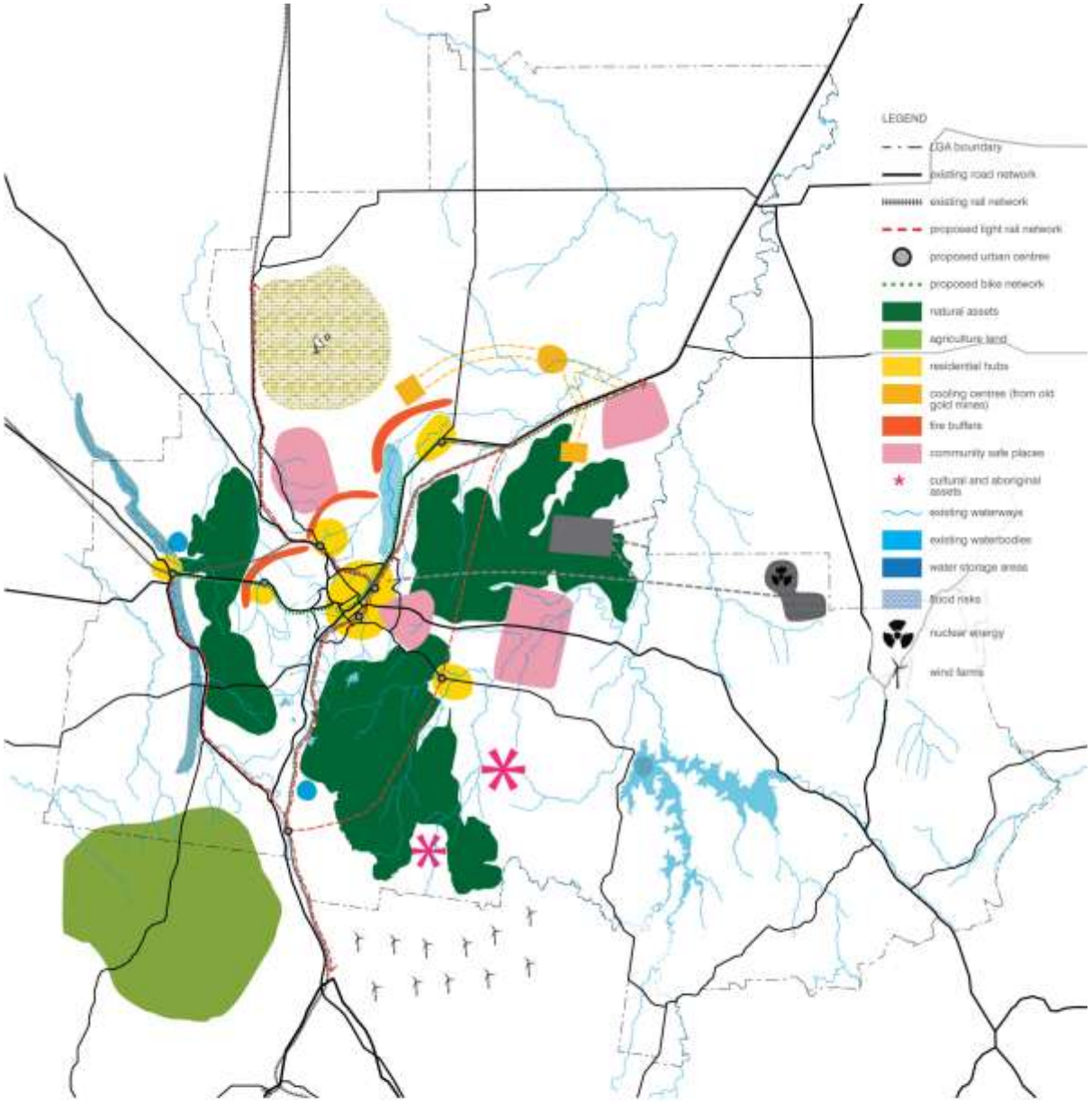
Figure 27 The Life Saver region



KEY DESIGN PRINCIPLES

- Vision: "Productive, Liveable, Sustainable, Happy Community"
- Focus on community engagement, encouraging responsibility of residents, and managing water efficiently through best practices of water capture and usage
- Community engagement through visible icons eg. clock tower water meter
- Protecting and enhancing natural waterways
- Capture stormwater before it reaches the creeks
  - a resource prior to entering creek as buying it back will be more expensive
- Opportunity in "fat" times:
  - saving as much water as possible in times of "rich" rainfall
- Flood mitigation as water opportunity ie. not letting floods go to waste
- Adaptive design/ WSUD
- Managing water seepages and evaporation (of agricultural channel)
- Zero discharge to streams from treatment plants
- Sustainable integrated agriculture to encourage self-sufficiency:
  - increase in food production in and around Bendigo
  - balance reduction of food miles with water sensitivity through urban agriculture eg. balcony gardens, rooftops, etc.
  - market gardens by the city
- Integrated land use:
  - linear infrastructure and bike paths
- Self-contained housing typology with integrated water collection and solar energy systems, and veggie garden
- Reduction in water use through technology such as water-saving appliances (ie. washing machines)
- Harnessing solar energy for growth and health

Figure 28 The scarcer the water



KEY DESIGN PRINCIPLES

- Acceptance of bushfires:
  - "Deal with heat, just gotta face this"
- Fire protection through establishing buffers
- Urban centre:
  - Mixture of residential densities
  - Highest density in the town centre ie. Bendigo Residential Tower
  - Light-rail system to connect urban centre
  - Bike networks
- Recycling can be much better
- Fruit bowl outside urban areas
- Refuge for hot days:
  - community safe places
  - re-using old gold mining shafts as cooling heads and cooling centres
- Energy sources:
  - Parabolic dish
  - Solar farm
  - Hydro power at Lake Eppalock
  - Nuclear plant
- Capitalising on assets:
  - Natural assets such as nature reserves
  - Aboriginal heritage

Figure 29 If you can't stand the heat

4.4 Bendigo charrette: Appraisal of emerging themes

The following five themes were identified from the outcomes of the design charrette in Bendigo:

1. Self Sufficiency
2. Responsible & Active citizens,
3. Innovation
4. 4. Identity
5. Density

Self sufficiency

For many of the proposed settlements, self-sufficiency and self-reliance were seen as key, but basic elements for living in this area (Figure 30). Self-sufficiency—the ability of community members to supply their own needs with locally produced food, energy and clean water—is necessary to contribute to climate change mitigation and, more generally, to contribute to sustainability. However, it can also foster greater community awareness of the vulnerability of the environment and of alternative ways of living. Community self-reliance and its capacity to respond and survive a potential hazard are increasingly important under the projected changes in Bendigo's climate. If hazards, such as bushfires, floods or extended heat waves, become more frequent and/or more intense, the State Emergency Services (SES) and other life-saving activities may experience greater demand on their resources and it therefore becomes more critical that individual people and communities are self-reliant.

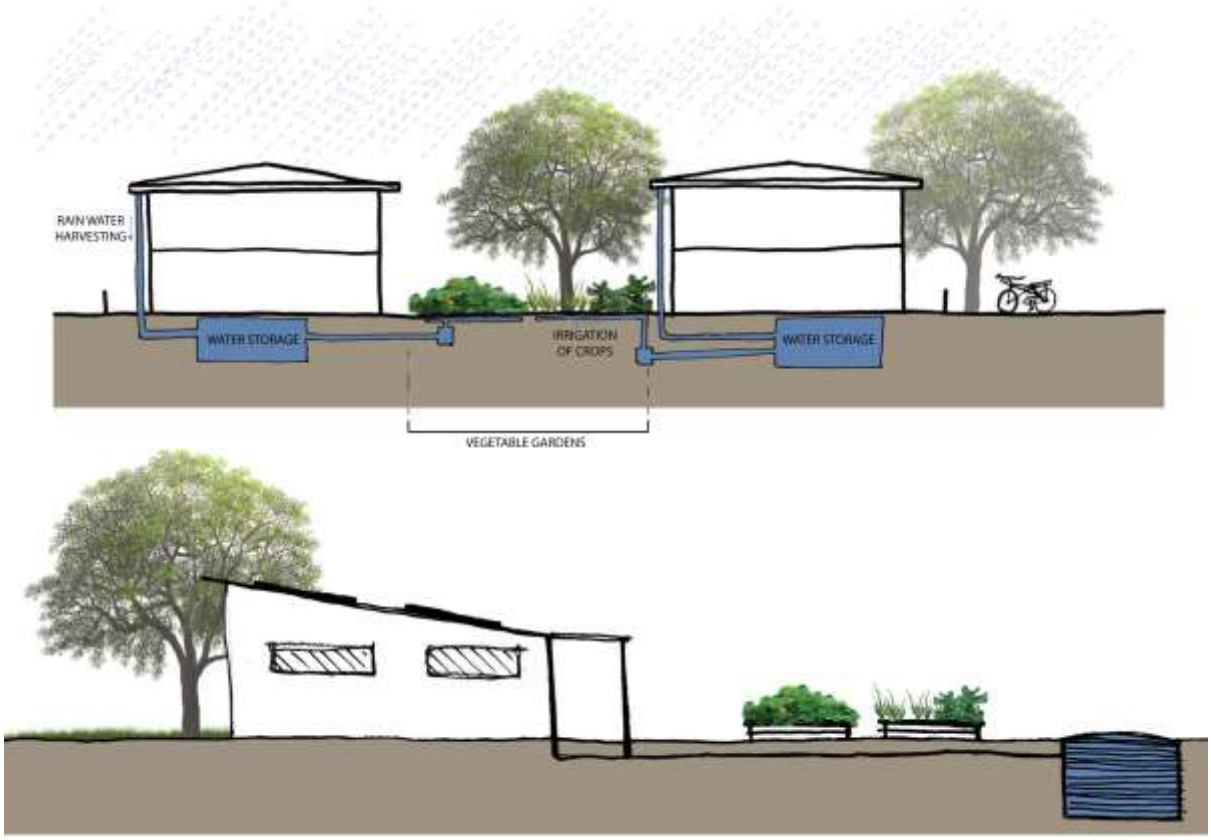


Figure 30 Self-sufficient residences from 'the shining heart of the state' and 'scarcer the water'

Responsible & active citizens

Local, state and federal government cannot guarantee the safety of Australian communities from all hazards and threats. Individuals and communities therefore need to be active in their own safety,

particularly in the context of projected changes in climate and extreme weather events. Mechanisms and strategies for community support, preparedness, and anticipation of future change and events provide opportunities for the sharing of knowledge, expertise and resources and thereby increase a community's resilience.

Innovation

Future living circumstances are likely to be fundamentally different from the present. Our lives used to function without access to abundant reserves of oil, coal and natural gas. Mobile phones, computers and the internet were not available 10-15 years ago and have significantly changed the way we live. Smart phones, iPads and notebooks are even more recent innovations. As these examples illustrate, innovation has been a constant part of mankind's history. Transformation towards a society less reliant on carbon resources and able to deal with the impacts of climate change is likely to be accompanied, by necessity, by a similar and even increasing pace of innovation. These innovations will be not only at the household level but will include urban development patterns, housing typologies/densities and the integration of green space (Figure 31).

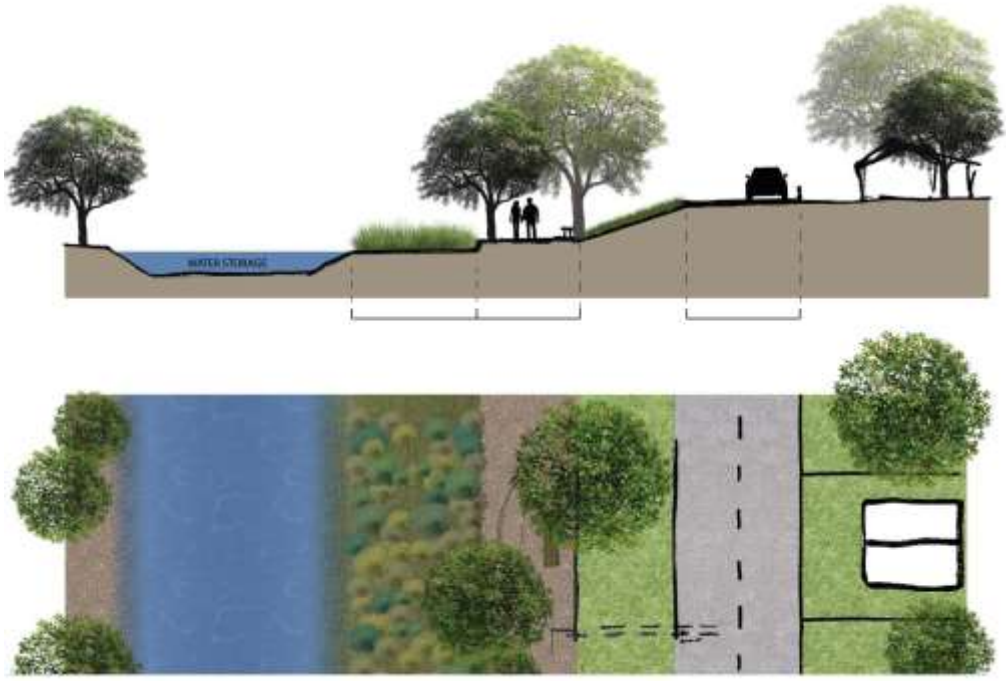


Figure 31 Multiple-use of creeks as open space, flood control, bushfire control and transport corridors

Identity

Bendigo has a strong and persistent identity based on its history as a gold-mining town surrounded by forests. Although a valuable trade-mark for the city, a new identity might give Bendigo a fresh perspective on remaining prosperous and unique. Possible identities that emerged from the charrette are: become the solar power centre; the safe and sustainable city; or the city that is always prepared for change. Figure 32 draws on Bendigo's past as a gold mining town and uses existing mineshafts as a cooling resource for the town.

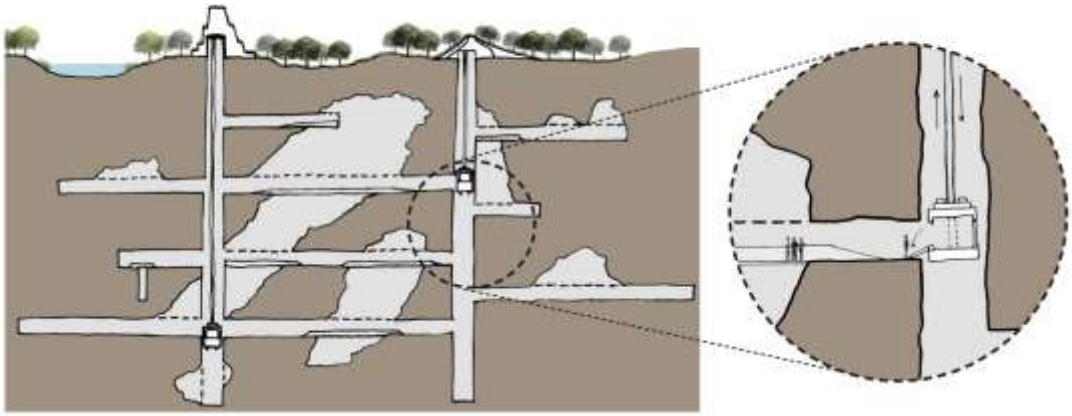


Figure 32 Re-using old mines as a cooling resource

Density

Growth of Australian cities and towns is characterised by an ongoing sprawl into surrounding landscapes. This has two main effects: 1) people increasingly live further away from the city centre, which requires them to drive longer distances to work or shopping, and 2) occupying the (sometimes very valuable) landscapes brings more people closer to higher risk areas in terms of flooding, bushfires etc.). Neither effect is sustainable, and increased building densities in Bendigo have been supported primarily to minimise their impact. One way to increase densities is to keep urban developments within current boundaries, while another is to reduce the existing boundary by a certain percentage and any new developments need to fit within this new boundary. The contour of Bendigo could also be shifted eastward creating a protection zone against bushfires in the west and keeping the total area for urban uses at the same level or less. 'Management of the boundary' requires innovative solutions for existing urban areas, retrofitting and new developments within existing neighbourhoods. The key is to design semi-urban dense concepts for residential living, which also allow people to live near the natural landscape (Figure 33).

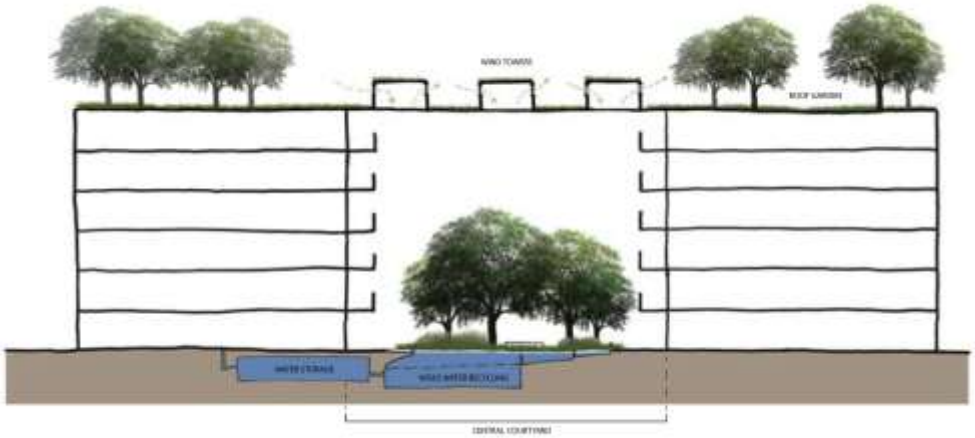


Figure 33 High density housing with roof top gardens

4.5 Bendigo charrette appraisal

This section presents the results of the four groups that worked together during the Bendigo charrette. The concepts appraised are the final outcomes of the first Bendigo charrette. The concepts are labelled respectively as concept 16, 17, 18 and 19, following consecutively from the fifteen preliminary design solutions generated in the charrette process that were amalgamated into these final four concepts. The initial fifteen concepts were not assessed.

Each of the four concepts was given an overarching theme by the charrette facilitator that was representative of the focus and outcomes of the amalgamated concept:

16. Shining heart of the state:
17. The life-saver region
18. Sacred the water
19. If you can't stand the heat

Each concept is explained in more detail in the following sections.

4.5.1 Concept 16: Shining heart of the state

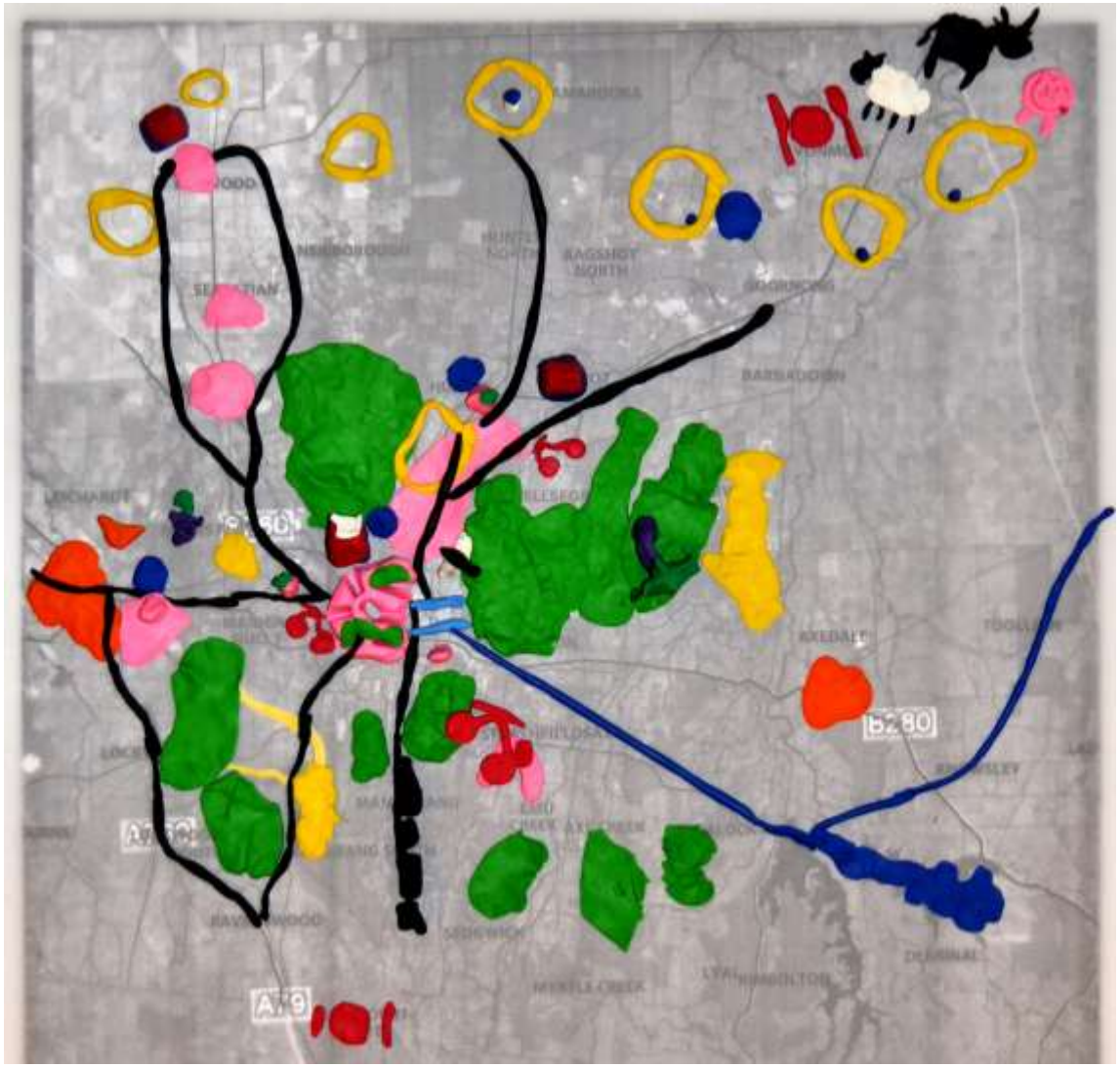


Figure 34 Concept 16: shining heart of the state

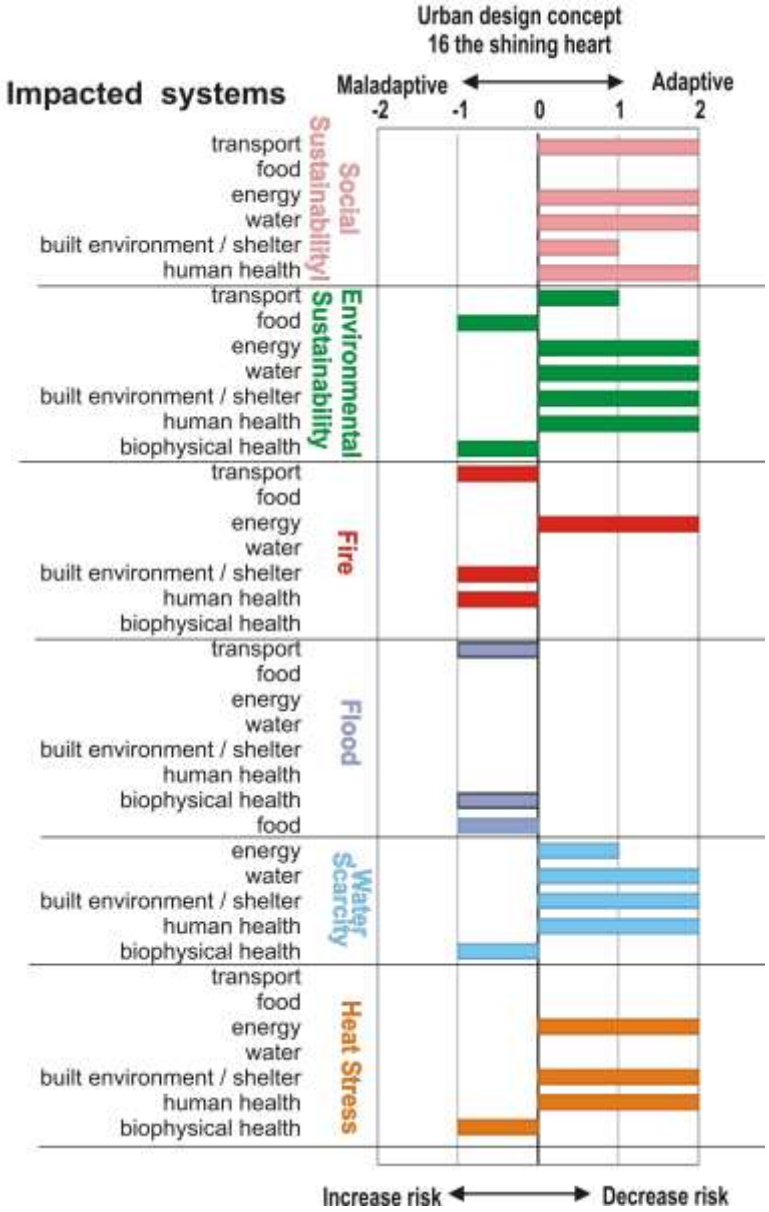


Figure 35 Concept scoring appraisal 'shining heart'

Concept 16: Shining heart of the state

Concept 16: the 'Shining heart of the state' focuses largely on creating an identity for Bendigo that is not based on it being a satellite city of Melbourne. Community and household 'connectedness' are emphasized in this scenario through several features of housing provision, and decentralized energy and water supplies. Identity hubs through Bendigo form cultural precincts, with arts of all varieties present. The precincts include sustainable buildings, transport, energy and water considerations. The cultural precincts assist in forming a strong identity for Bendigo as its own place – separate from Melbourne. This is viewed as a resilient concept for the future livelihood of Bendigo. Gold has helped form an identity for Bendigo, and is still highly valued as a resource to the community. Further exploration and extraction of gold within the scenario is expected.

Solar energy is the primary source of energy (thermal or PV) within this concept. Buildings are passively designed with integrated cooling towers, which were seen by charrette participants as a positive design element imported from warmer climates to assist in reducing heat stress.

Within this future scenario the community manages a large quantity of water, and Lake Epiloch has halved in size. Water is piped to the city centre and stored in bladders under buildings. The bladders are for storage of rain and piped water. Exporting and importing water is possible—similar to the concept of peak demand management. The appraisal of the design with consideration of water scarcity is its most positive element, as the decentralised system harvests a great amount of water. Decentralized and co-managed energy systems have been shown to reduce the consumption of household energy (Strengers 2010). The impact of increased storage on environmental water flows needs to be further considered for its potential to be maladaptive.

The 'Shining heart of the state' concept protected agricultural land for a 'food bowl' (illustrated by cattle, sheep and pigs). On one hand this increases resilience with respect to food security; on the other, depending on practices, protecting traditional farming practices may impact adversely on biodiversity, including a potential high opportunity cost, and increase $CO_{2\text{-eq}}$ emissions.

This scenario lacked the resolution to fully assess the risks of fire and heat stress.

Design challenges:

- Explore potential of water bladders to store water for multiple uses, and impacts on stream health.
- Integrate 'community connectedness' into the landscape architecture.
- Consider the risk of existing energy systems sparking when temperatures are above 45^{o} Celsius.

4.5.2 Concept 17: the Life-saver region

Figure 36 Concept 17: The Life Saver Region

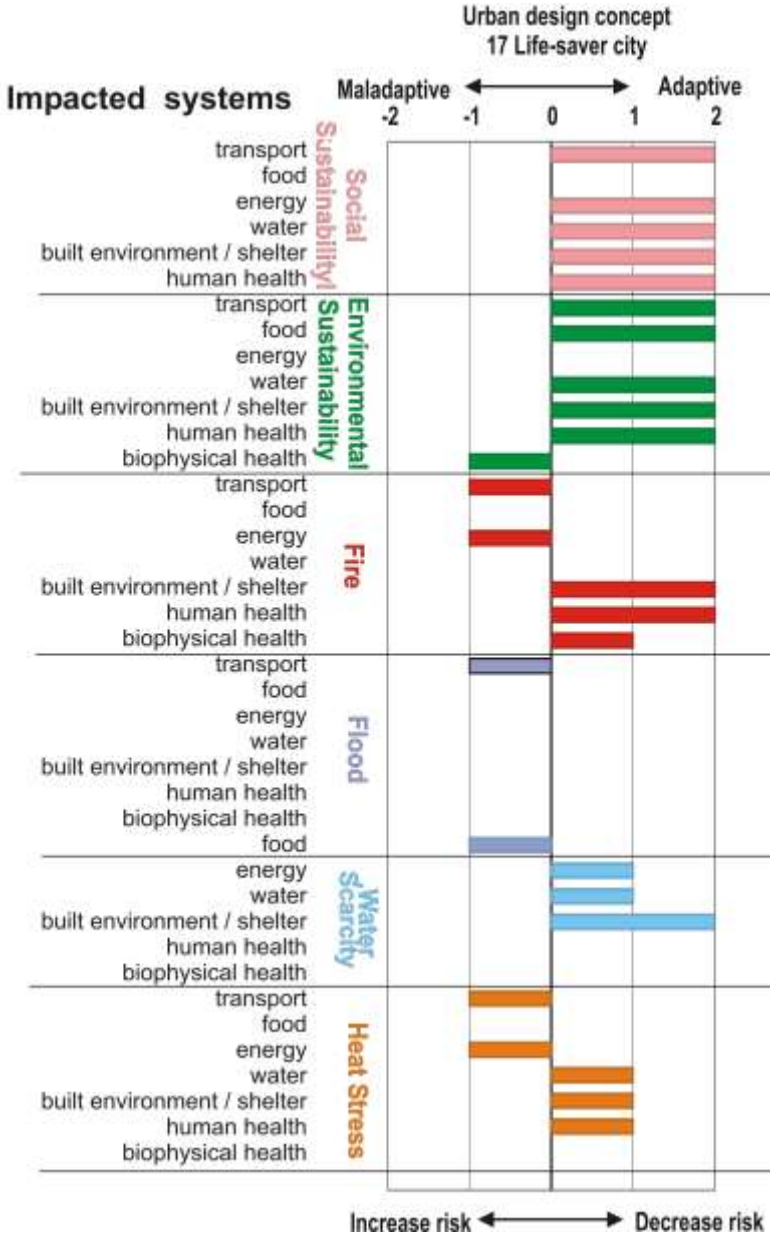


Figure 37 Concept appraisal 'life saver'

Concept 17: The life-saver region

Concept 17: the 'Life-saver city' features higher density development on the outskirts of town that doubles as the fire defence on the urban boundary. The design features a very risk adverse approach to fire. The housing design provides shelter for firefighting, while also storing water for this purpose within the integrated sprinkler systems. Fire defence is emphasized within the defined cities boundaries. In the advent of a fire, the strategy for the local community was to evacuate the immediate premises to designated centres. The 'Life-saver city' makes a clear distinction between the city and bushland in the form of an urban boundary. The city takes control of risk within the boundary for fire defence, while outside the city greater responsibility is placed on landowners.

Residents currently living outside of the town, perhaps because of housing affordability, may be offered incentives to move within the city boundary. The underlying philosophy of the design suggests; 'Increasing density in outer areas will lead to better transport and better facilities for residents'. The community challenged the notion of higher development as it may 'risk losing the living in the bush experience' and the 'impact of high density near the forest (environmental impact)' (participants' appraisal).

Housing within the city is also designed to be self-sufficient in terms of energy and water. Between the housing development and forest is mixed use open space 'integrating open space and recreational opportunities with stream infrastructure where possible' (Charrette participants 2011) which acts as a buffer zone for fire protection.

The appraisal of the design is weighted towards the built environment, energy and fire risk as there was limited resolution provided for other elements of the concept.

Design challenges

- Design the urban environment with higher density while also taking advantage of the natural features of the 'bush'.
- Soften the strategy via design as the current form is viewed as 'harsh' from the participant appraisal.
- Consider the pre-existing risk of current energy systems sparking when temperatures are above 45^{o}C.
- Consider the design of bike paths to reduce heat stress.

4.5.3 Concept 18: Scarcer the water

Figure 38 Concept 18: Scarcer the water

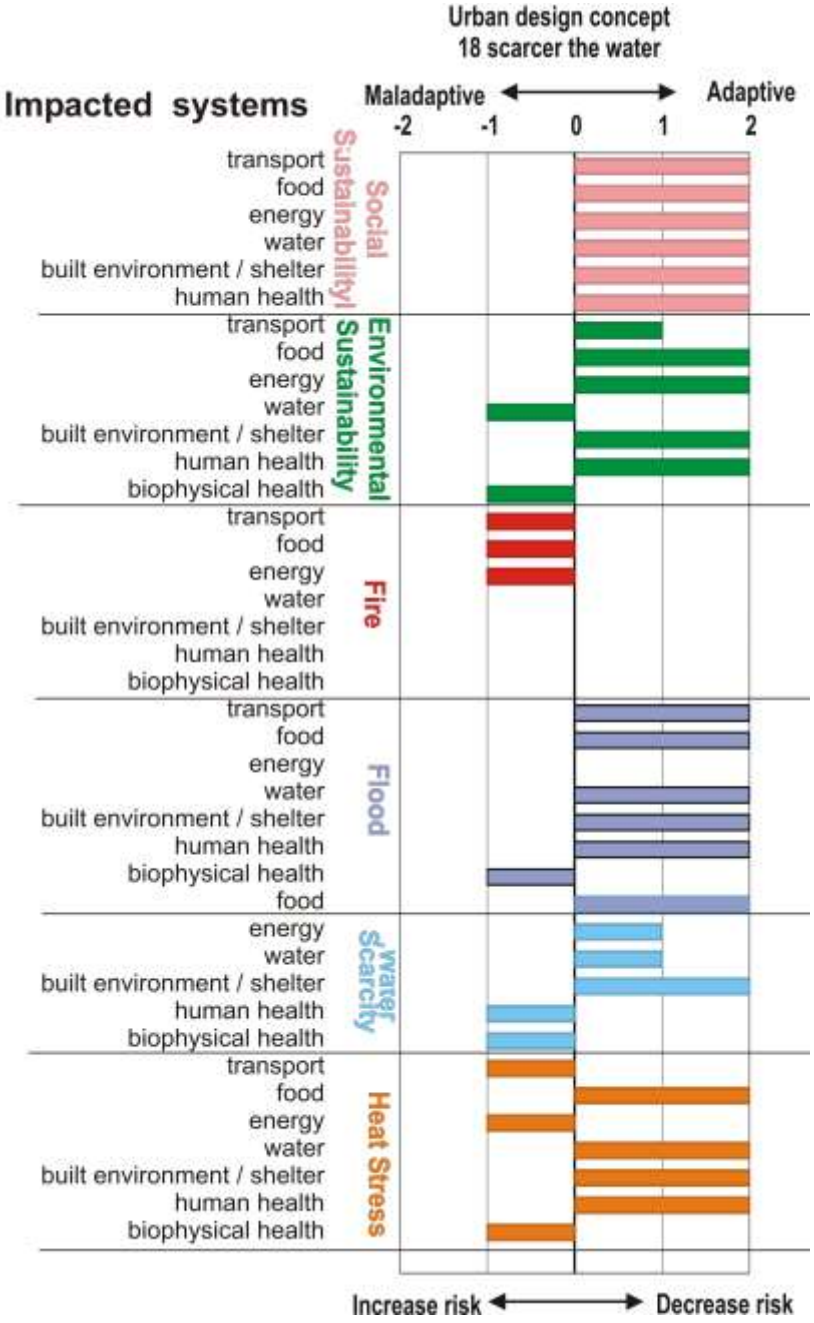


Figure 39 Concept 18: Scarcer the water

Concept 18: Scarcer the water

Concept 18: the 'Scarcer the water' scenario aimed for Bendigo to become more self-sufficient in areas such as water capture, water use, and food production. 'Water Sensitive Urban Design' assumes best practice in designing landscapes for minimal water use, stormwater capture and storage, and natural stormwater treatment. The increased vegetation and permeable pavements in the design assist to reduce heat stress on days above 40^{o}C. Bike paths could be maladaptive with increased days above 40^{o}C unless designed appropriately (i.e. including shade and non-reflective surfaces).

A co-management approach is adopted within the scenario where the community takes responsibility for the capture, storage and efficient use of water. Features such as the community clock assist as an interface to communicate water levels. Co-management of resources can lead to reduced demand and increase household/community resilience (Strengers 2010, Centre for Design, 2011) and as such, is considered a positive resilient approach.

The 'better integration of water sensitive strategies at multiple scales (household, neighbourhood, [community] suburbs and city council)' was viewed as positive in the participants' appraisal. However feedback also stated that 'without extra storm water flow, maintaining river health [would be] more difficult' (participant appraisal). This scenario could prove challenging as it is attempting to achieve the best of both worlds, that is, capturing storm water runoff prior to it entering the waterways, and managing waterway health through appropriate flow. This may be presented as a design challenge requiring greater detail to realise the proposed scenario.

Solutions relating to fire risk were absent from this scenario. Investigation into why we are using so much water is required—demand reduction is through the use of more efficient technologies as opposed to changing practices.

Design challenges

- Refine the tension between capturing additional storm water *and* maintaining river health.
- Consider the pre-existing risk of current energy systems sparking when temperatures are above 45^{o}C.
- Consider bike path designs to reduce heat stress

4.5.4 Concept 19: If you can’t stand the heat

Figure 40 Concept 19: If you can't stand the heat

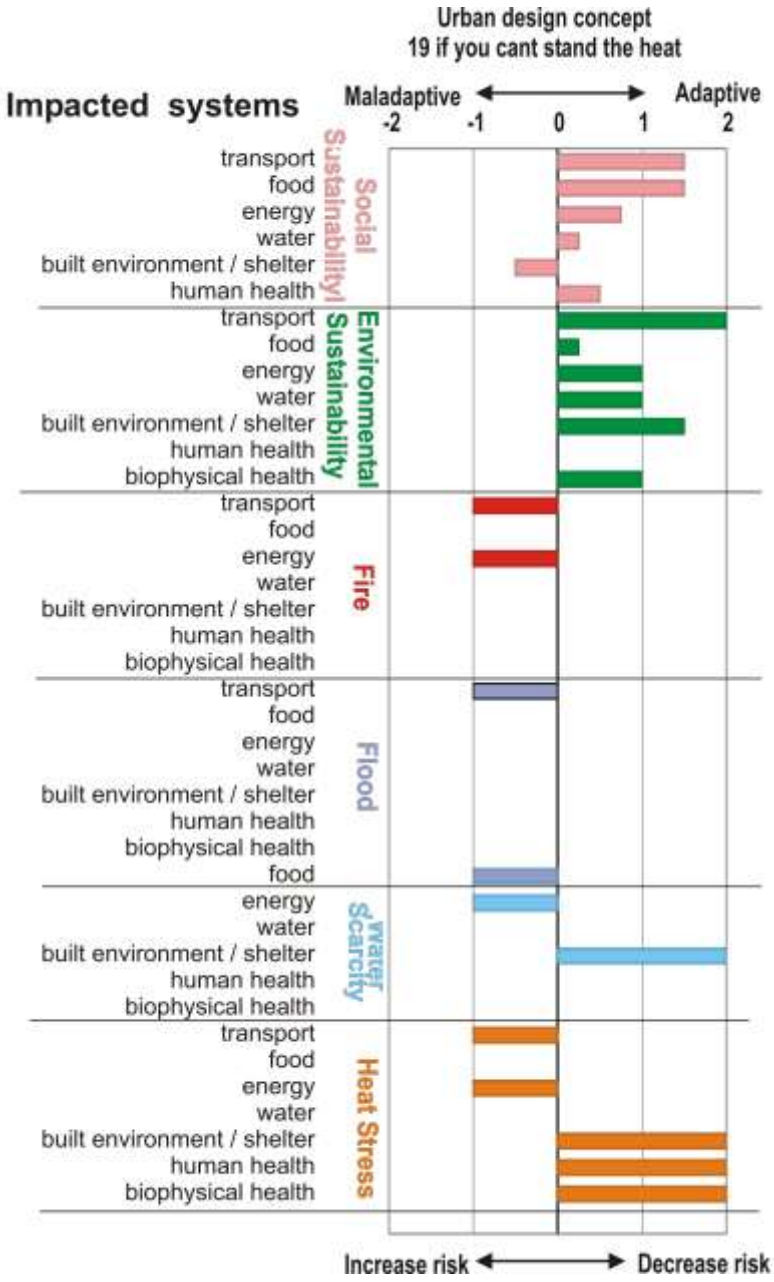


Figure 41 Concept scoring appraisal 'heat'

Concept 19: If you can't stand the heat

Concept 19: 'If you can't stand the heat' responded to the design brief through a hazard reduction approach that presented progressive solutions. The design contains three unique features which were mentioned in the participants' appraisal by the majority of participants. These were: 1. using the underground mines as a cooling resource for the town; 2. a high rise residential tower; and 3. nuclear power (albeit in the neighbouring municipality). Each element was appraised individually prior to combining the results, as they significantly alter the appraisal outcomes.

The cooling tower and multiple cool rooms around the city have the following advantages: protecting vulnerable populations on extreme heat days; creating a meeting place with a unique identity; ensuring equity in access by having multiple towers; potentially providing passive food storage; and reducing electricity costs for cooling. From an environmental perspective, the cooling tower has the potential to provide an efficient cooling resource with a small environmental impact, and is worth exploring further.

The residential tower offers a higher level of density allowing for good access to public transport, food, water and energy. A reduction in spatial footprint is viewed as positive for habitat and biodiversity, as land is freed – although the land may be developed for the 'food bowl' of agricultural industries. Higher densities would allow cost effective delivery of infrastructure. The potential threats posed by the residential tower—increase in the urban heat island effect leading to increased heat stress, and increased risk to a large number of people in the event of an emergency—are largely dependent on how it is designed. Nuclear power as a design solution was rejected by the charrette participants in the appraisal session at the conclusion of the event. One community appraisal read: 'nuclear (we have great renewable resources) – do not need to introduce a new waste stream to region, lots of renewable options that don't have by product'. Nuclear energy introduces new 'stand-alone' risks to the design scenario outside of those assessed.

Design Challenges

- Make high density residential living attractive within the Bendigo shire while capturing country living.
- Consider bike path designs to reduce heat stress.
- Consider pre-existing risk of current energy systems sparking above 45^{o}C.
- Develop cooling tower concept using mines as storage and cooling resource.

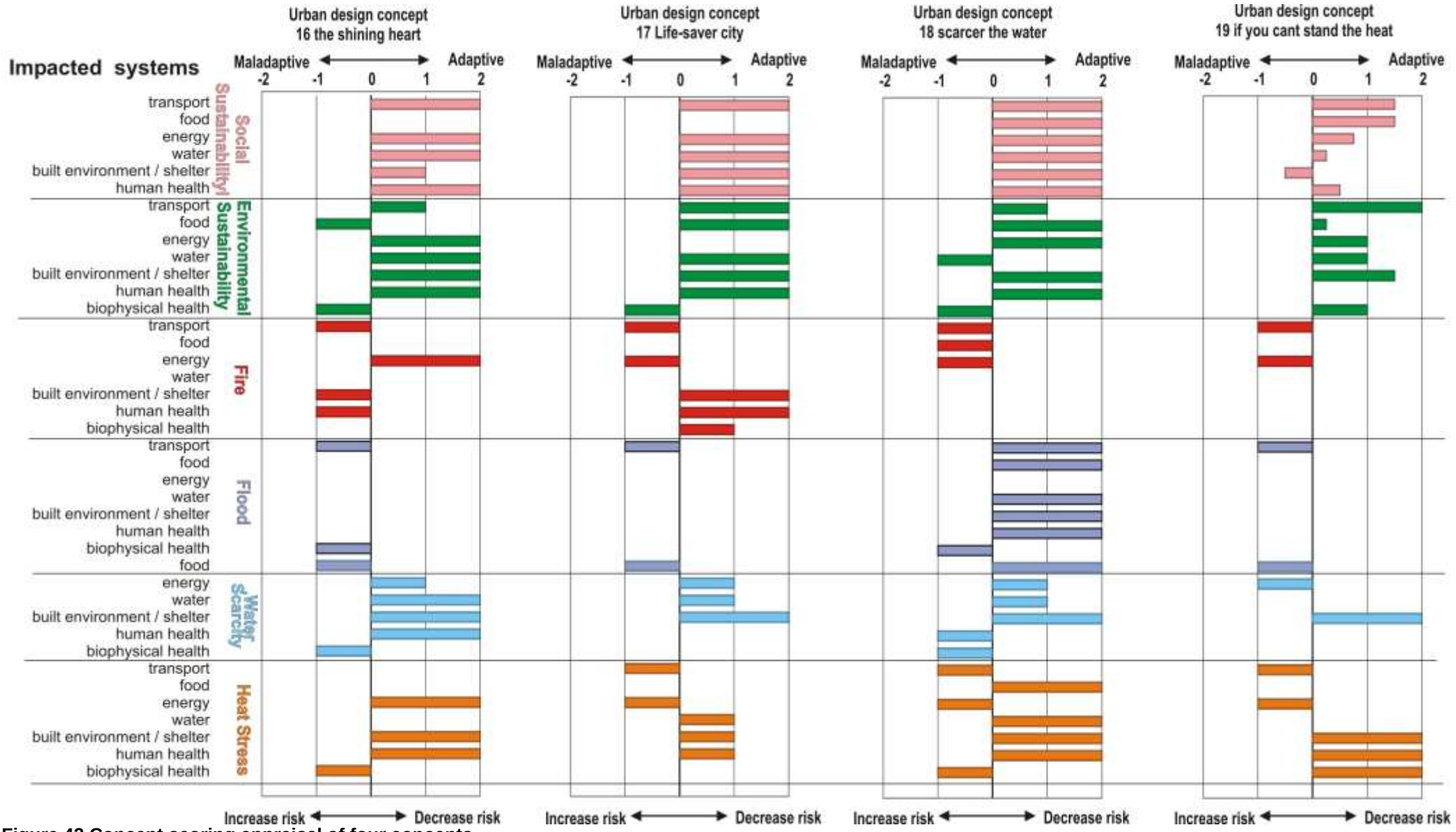


Figure 42 Concept scoring appraisal of four concepts.

4.6 Appraisal results: Bendigo charrette 1

The solutions generated through the Bendigo charrette process display considerably differences in their respective focus points—most likely due to both the themes presented by the project team within the charrette, and the approach and experience of the participants. This led to some solutions focusing more thoroughly than others on specific hazards and systems. The appraisal identified the differences between the solutions with regards to social and environmental sustainability, adaptation, and maladaptation. The appraisal indicates that the majority of concepts from a social and environmental perspective are sustainable. Common sustainable themes that arose from the appraisal of the four designs are:

- **Density is good**—the protection of the urban boundary for Bendigo was common in all designs.
- Design features that strengthen Bendigo's **independent identity** appeared across all designs.
- **Renewable energy** and the **passive design** of buildings are viewed as positive and desirable in all design concepts.

The appraisal also indicates whether the climatic impacts of fire, flood, water scarcity and heat stress reduce or increase risks on particular systems such as transport, food or energy. Reducing risk is seen as adaptive. It is clear from the appraisal that not all concepts explicitly address all potential threats. Figure 11 illustrates the results of the concept scoring of the four final concepts, highlighting that:

- Concept 18 'Scarcer the water' reduces the hazards associated with flooding as a key focus, while the hazards associated with fire are not explicitly addressed.
- Concept 17 'Life-saver city' focuses predominately on a risk averse residential design on the urban boundary to defend fire, while flood and water scarcity are not explicitly addressed.
- Concept 16 'Shining heart of the state' sees community connectedness as a resilient social solution. Similarly, concept 18 'Scarcer the water' uses water sensitive urban design for local food production.

Locating the concept scoring appraisal at this 'reflection in action' phase of the design process enables the potential synthesis (or merging) of multiple design elements into future designs. Promising design concepts from the appraisal that could be explored further include:

- Developing cooling towers using mines as storage and cooling resource.
- Increasing the density of residential living while capturing/retaining the essence of country living.
- Designing bike paths to cope with an increase in the number of days above 40^{o}C.
- Increasing the water storage capacity of the town while maintaining/increasing stream health.
- Combining concept 17 and concept 18 to reduce fire and flood risks.

Common risks identified through all conceptual design solutions were the impacts on transport from flood and fire. The existing power lines were identified within the Bendigo Design Brief as the cause of the previous black Saturday bushfires, and again the design solutions/concepts did not explicitly reduce the risk of power lines, although concept 16 'the Shining heart' stipulated 100% decentralised renewables which the appraisal team assumed to use a different grid. The risks associated with renewables in severe heat, flood and fire were raised in the participants' feedback, and as these risks affect all design solutions, it may be a future challenge to design such systems to be risk averse to these hazards.

This appraisal method allows design solutions to be appraised for their adaptive capacity. However, the appraisal also identified gaps in the charrette approach in terms of what is not included in conceptual designs. The conceptual design concepts promoted technical solutions that lead to the creation of new 'things' for Bendigo, and largely overlook what will happen to existing buildings. The brief was to house an extra 50,000 new residents in approximately 23,000 new residences. However the design concepts focus predominately on new buildings, while urban infill and retrofitting of existing

homes receive less emphasis in the final presentations[2]. Also absent in the charrette outcomes is a critique of our everyday practices, such as those that might shape the capture and storage of as much water as possible.

4.7 Bendigo charrette 2

Bendigo Charrette 2 aimed to concentrate the results of charrette I into the proposed development of Marong Business Park (MBP). Although planning documentation for the MBP has been developed, detailed site design is yet to be finalised and no tenants have been confirmed for the site. Therefore, there is perceived to be some degree of flexibility to incorporate the results of charrette I. While risk assessments have been completed, a holistic plan for climate adaptation for the site has also not been developed and the outcomes of Charrette 2 provide an opportunity for CoGB in this respect. It is estimated that a five-year timeframe exists prior to the opening of the southern end of MBP for business.

The second design charrette serves as an opportunity to compare the results of the appraisal, and to identify adaptive solutions to develop further or maladaptive features to amend. Based on the appraisal report, this charrette aimed to:

- Compare appraisal results from charrette I to identify adaptive solutions to develop further, or maladaptive features to amend;
- Develop specific Design Criteria for the Marong Business Park based on the appraisal of charrette I and facilitated discussion;
- Collate and incorporate the results into the Marong Business Park Plan; and
- Consider the implications of the conceptual design solutions in future planning

Participants were directed to work in collaborative teams towards what they commonly believed to be good spatial pathways into the future. This charrette also aimed to deliver an implementation strategy including catalyst projects. In addition to the appraisal report, this charrette was re-informed and guided by the overarching understanding for this project that good adaptation is (1) adaptive; (2) sustainable; and (3) avoids maladaptation.

Marong Business Park (MBP) is a proposed 242ha business park on the outskirts of Marong (Figure 12). The vision for MBP is for a 'contemporary business park with high standards of building design and public realm and innovative and integrated site planning' (CoGB 2012). At present the site is predominately agricultural farmland divided by a small green wedge of native vegetation. According to CoGB, the type of Industry that may be located in the park includes:

- Manufacturing 42%
- Freight 30%
- Services 19%
- Utilities 9%

The development of the MBP Plan by the City of Greater Bendigo (CoGB) has been ongoing for a substantial period of time. The site has several potential risks relating to fire, flood and shoestring sands. CoGB has progressed planning documentation to the identification of risks and making recommendations for the MBP site development with respect to these risks. Transport and ecological assessments of the site have also been completed.

[2] Discussion on retrofitting did occur in earlier design concepts.

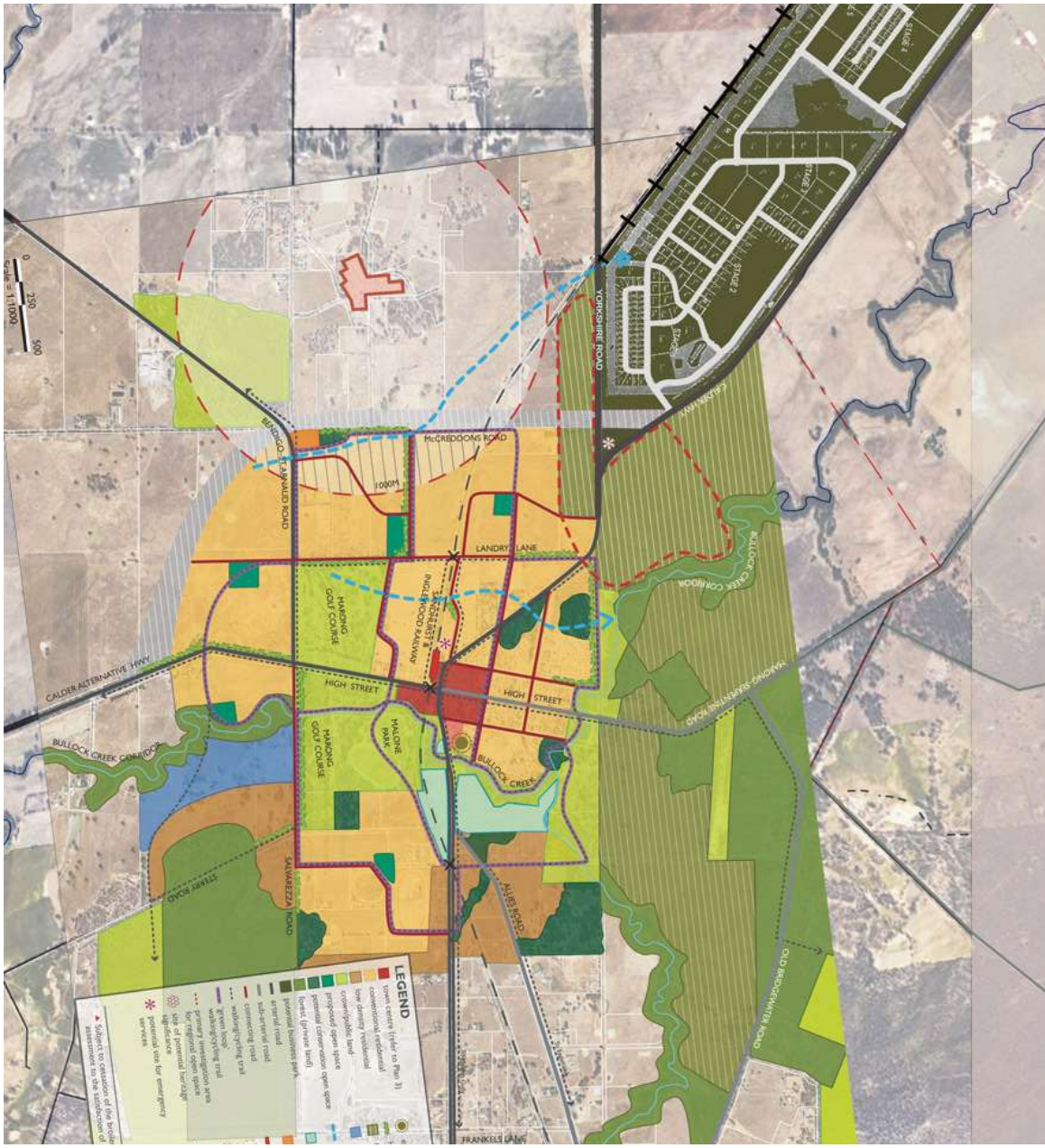


Figure 43 Marong Business Park plan 2011

Charrette 2 design criteria

The site-specific design criteria for MBP that emerged from Charrette 2 are presented in Table 6. These criteria in many ways replicate the appraisal criteria used in charrette I in a site specific context. Reaffirming the criteria through a participatory process provides criteria that CoGB can confidently use in future planning processes. The charrette I appraisal identified demand side management for reducing heat stress and energy consumption were neglected, which became a key focus charrette 2.

Table 6 Development criteria for Marong Business Park from charrette 2

Must have's	Nice-to-have's	Maladaptive – to be avoided
ENERGY: Integrated energy system on-site; Energy security of supply (secure	**FLOODING:** Flood prone tendency becomes an advantage;	**WIND:** Avoid wind tunnels in hot south westerlies.

for 24/7 operation if grid fails); Demand Side Management.	Site provides a buffer before the next town for water filtration.	
TRANSPORT CONNECTIVITY: Transport and logistics centre; Walking and bike path, light rail, electric bus; MULTIPLE CONNECTIONS TO Marong and Maiden Gully residents,	**DESIGN INTEGRATION:** Landscape system to support industrial system; Multifunctional landscape features e.g. wetlands, may assist to treat stormwater.	**RISK MANAGEMENT**: Failure of engineered system in severe climate events, e.g. water inundation, drought and or severe heat waves.
WATER SENSITIVE URBAN DESIGN; Hydrology zoned and contained; Resilient storage capacity.	**WASTE/ENERGY/WATER:** Waste management and integration on site; Self-sufficient in energy, water, 24/7.	**POST-PEAK OIL AND MITIGATION:** Reliance on fossil fuels for transport; Avoid GHG intensive uses/design.
	INNOVATIVE INTERNAL COHESION: Flexibility and adaptability of plot uses, and integration with industry cycles; Maximise benefits of co-location; Industrial Ecology for value added businesses.	
	REGIONAL CONNECTIVITY: A focus for regional industries.	

Design solutions Marong business park

The above design criteria were applied to produce two regional level plans, and two final site specific plans. The ideation session carried over several adaptive solutions from charrette I (Roggema et al. 2011) into the MBP, these included:

- Transport corridors combining swales, bike paths and biodiversity;
- Improved public transport network with light rail on existing train tracks;
- Using landscape architecture to create features for the development:
    - Wetlands as storm water treatment and to retain flood water
    - Flood mitigation as water opportunity i.e. not letting floods go to waste
    - Plantings as windbreaks
    - Water bio links and swales
    - Protecting and enhancing natural waterways
- On-site renewable energy production, energy self-sufficiency;
- On-site capture, retention and treatment of water; and
- Green wedges as a buffer between town and MBP for flood and fire.

All conceptual design solutions generated in Charrette 2 did not radically depart from CoGB brief for a new industrial zone on the outskirts of Marong. The internal layout of the site, and use of landscape features to reduce fire, flood and heat stress risks, and create visual spaces were significantly different to the original plan presented by CoGB. The two final site plans are discussed and appraised in the following sections.

Concept A: Marong business park

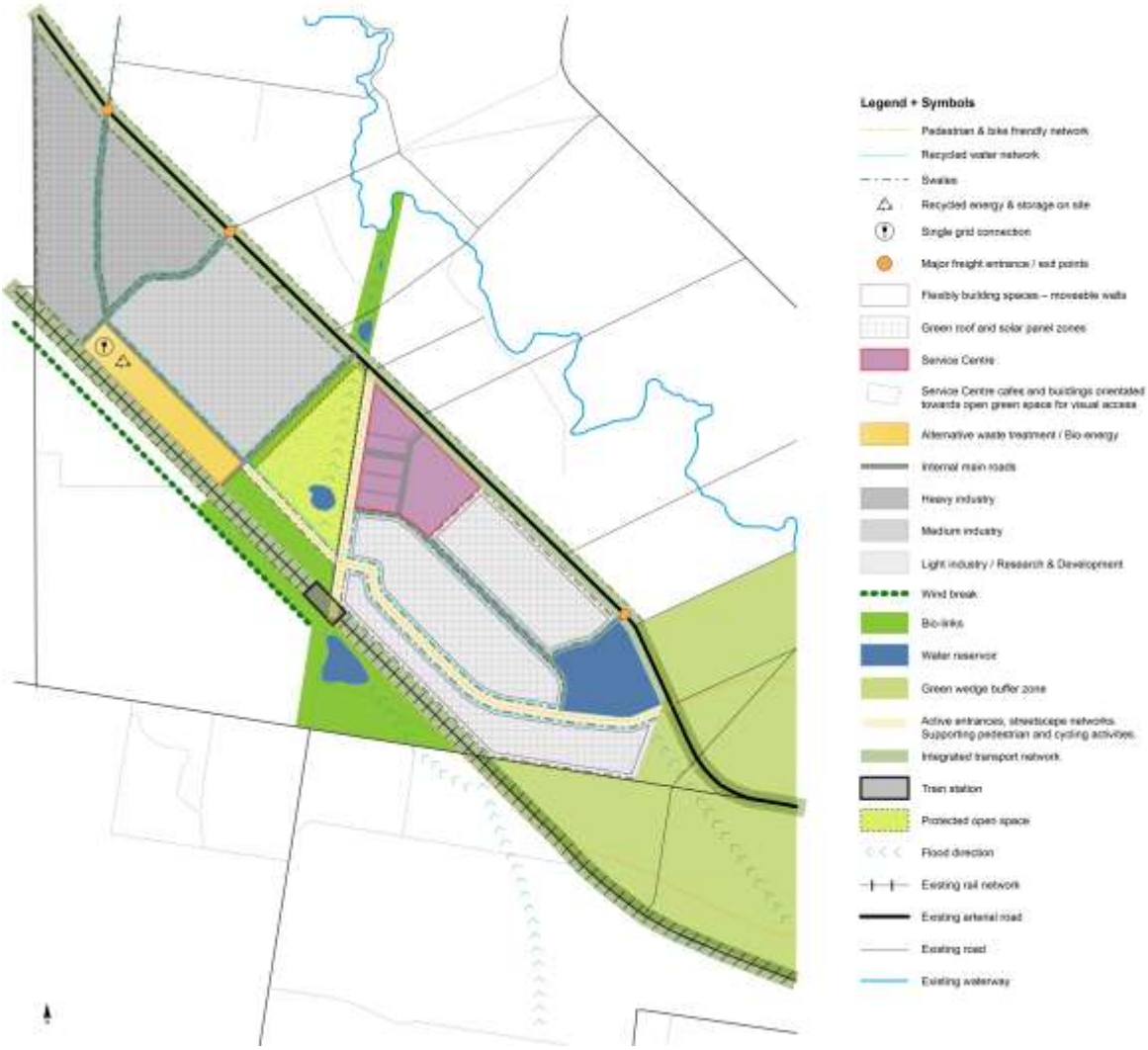


Figure 44 Concept A: Marong business park

Concept A includes a diverse range of features for the MBP, as described below.

Design Integration

- Increased biodiversity through windbreaks and planting along railway lines.
- Water bio links and swales.
- Street greening and shading.
- Layout restructured to take advantage of landscaped areas, for example the service centre and cafés would overlook the central wetland (Figure 45).

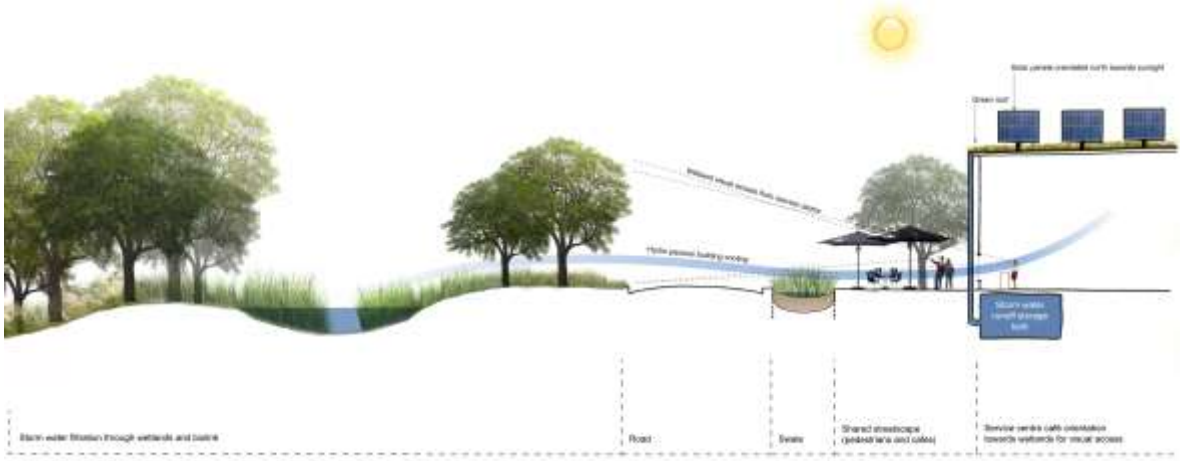


Figure 45 Layout restructured to take advantage of landscaped areas

Water

- On site collection and reticulation of all water.
- Water bio links and swales.
- Redirecting water flow to the south and centre of the MBP.

Energy

- Integrated energy on-site, including energy sharing between businesses.
- Internal electricity grid with storage capacity.
- Co-generation where appropriate, possibly through alternative waste treatment plant.
- Energy efficient buildings through insulation, orientation, green roofs and thermal mass.
- Passive cooling through overland water flow and evaporation.

Transport connectivity

- Multiple modes in light rail service. Active transport in walking and cycling paths to Marong and Maiden Gully and Bendigo.

Risk management

- Redirecting water flow to the south and centre of the MBP.

Concept B: Marong business park

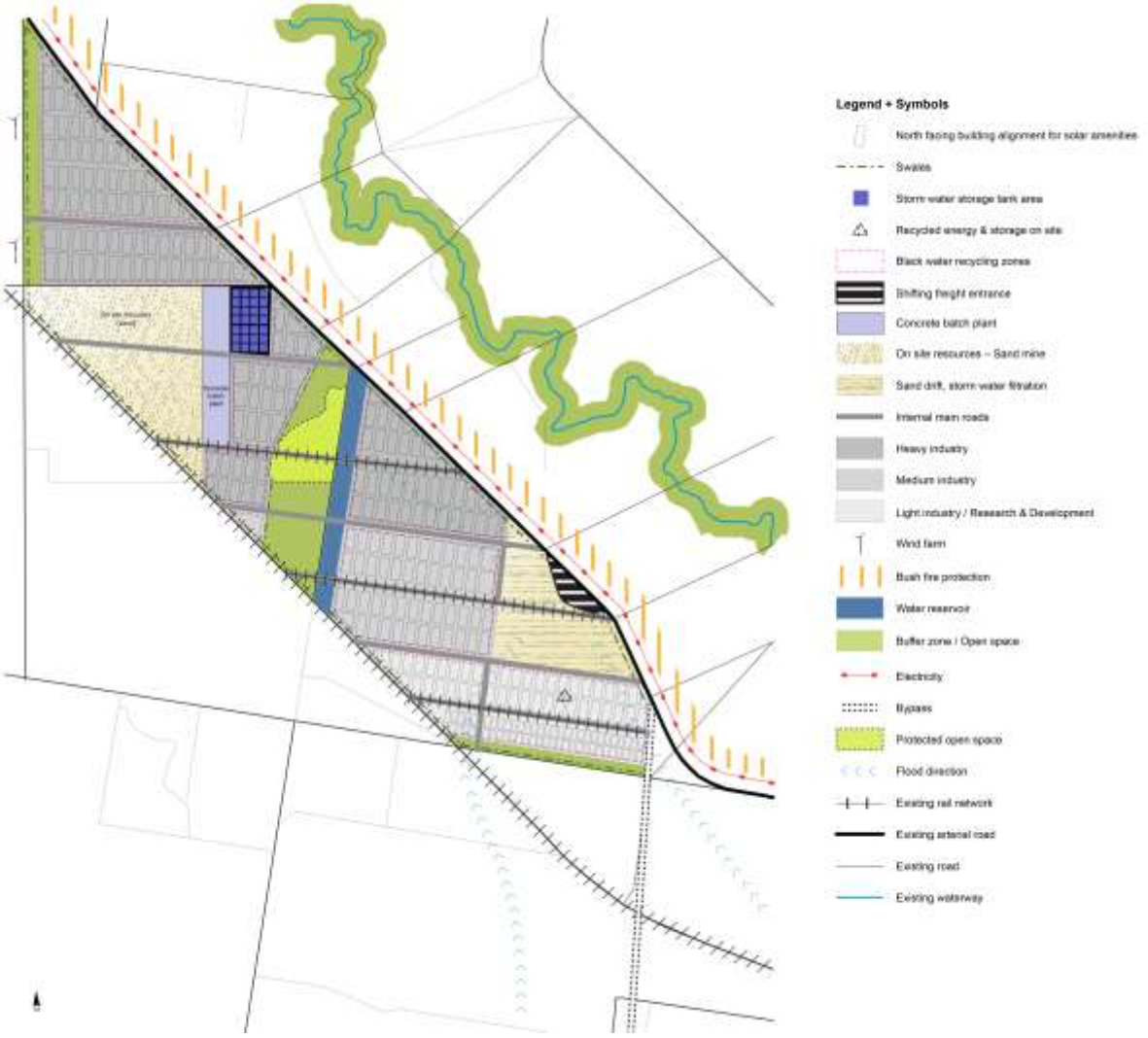


Figure 46 Concept B: Marong business park

Similar to Concept A, Concept B worked with the existing natural landscape to create features for the development. The major contrast between Concept A and B is with respect to building orientation, and transport. Concept B's design features include:

Design integration

- Buildings orientated to take advantage of solar radiation alters the existing proposal for site development.
- Take advantage of the natural landscape features that the site may provide in sun, water and sand.
- Sand utilised by concrete batch plant.
- Bioswales used as buffer for urban growth boundary.

Water

- Swales, service roads and power lines combined.
- Swales and wetlands that bring water across the surface of the site.
- Tank water storage on industrial sites.
- Black water recycling on site.
- Storm water filtered through sand drifts.

Energy

- Solar on roofs and wind farms of site.
- Economic plan that develops the site to progress key initiatives.

Transport connectivity

- Cycle paths connecting to Marong and Bendigo.
- Cars and trucks run on alternative energy.
- Rail road reclaimed for internal use as it was viewed as unlikely that rail would be utilised for freight or public transport on the aligning rail line. This could enable dispatch and incomings to be centralised on the site.

Risk management

- Fire: bush-fire protection through landscaping along high voltage power lines, including swales providing a fire break for south part of the park.
- Floods redirected around site and utilised as a resource for water storage.

4.8 Appraisal results of concepts A and B Bendigo charrette 2

A simple traffic light indicator has been applied as an appraisal against the development criteria developed by charrette 2. Green indicates that the criterion has been positively addressed; orange indicates that the criterion has been addressed but not completely resolved, and red indicates that the criterion has not been specifically addressed.

Table 7 Development criteria and appraisal for Marong Business Park concept A and B from charrette 2

Must have's	Nice-to-have's	Maladaptive – to be avoided
ENERGY: Integrated energy system on-site; Energy security of supply (secure for 24/7 operation if grid fails); Demand Side Management	**FLOODING:** Flood prone tendency becomes an advantage. Site provides a buffer before the next town for water filtration.	**WIND:** Avoid wind tunnels in hot south westerlies
TRANSPORT CONNECTIVITY: Transport and logistics centre; Walking and bike path, light rail, electric bus; MULTIPLE CONNECTIONS TO Marong and Maiden Gully residents	**DESIGN INTEGRATION:** Landscape system to support industrial system. Multifunctional landscape features i.e. wetlands may assist to treat stormwater).	**RISK MANAGEMENT**: Failure of engineered system in severe climate events; e.g. water inundation, drought and or severe heat waves
WATER: WSUD; Hydrology zoned and contained resilient storage capacity.	**WASTE/ENERGY/WATER:** Waste management and integration on site; Self-sufficient in energy, water, 24/7	**POST-PEAK OIL AND MITIGATION:** Reliance on fossil fuels for transport, Avoid GHG intensive uses/design
	INNOVATIVE INTERNAL COHESION: Flexibility and adaptability of plot uses, and integration with industry cycles; Maximise benefits of co-location; Industrial Ecology for value added businesses.	
	REGIONAL CONNECTIVITY, a focus for regional industries	

Positive adaptation

Against the criteria of: design integration, energy, and water, both conceptual design solutions fair exceptionally well when viewed within the MBP site boundary, as both proposals integrate a range of sustainable features.

On-site, integrated energy systems were proposed, with an internal grid and substantial back up securing supply 24/7 if the grid fails. The site may produce more energy than it draws while still being grid connected.

Demand Side Management strategies to reduce energy production were proposed. It was possible to improve detailing of site design, e.g. improve site layout for solar orientation, passively cool buildings and be self-sufficient in water and energy. These adaptation solutions also double as climate mitigation measures, potentially providing significant reductions in CO2-eq emissions in comparison to a business usual scenario of brown coal.

A demand side focus was less in evidence, with a focus for industries to capture and store an enormous amount of water without an explicit rationale as to why such a quantum of water would be required for the industries located on the site.

A key strength of the proposals was the design integration of natural landscape features. The proposals have the capacity to increase biodiversity on site and use the landscape features for multiple purposes. For example, green roofs and permeable surfaces may reduce stormwater management costs.

Areas for further resolution to be adaptive

'Risk management' with regards to flooding and 'Innovative internal cohesion' were addressed in part. Risk Management and Flooding Concept B propose an alternate means of treating sand drift.

A desire existed to have symbiotic relationships (industrial ecology) between businesses. For example, the waste product of one industry may provide the feedstock for another. However, this was considered in principle only. The design to achieve such a strategy relies on explicit detail that can only be created when the context is clear. The MPD site has as yet no secure tenants or prospective industries and so the context of which industries may be co-dependent on another cannot be resolved. Industrial ecology can only be suggested as a principle for the site when there is greater clarity regarding site occupants.

The transport system proposed using the existing rail network with incoming and dispatch areas. This provides opportunities for fuel and space efficiencies and enables unique building designs and site plots to be proposed that do not have to conform to traditional road radiuses for heavy vehicles.

Potentially maladaptive

'Transport connectivity' and 'post peak oil and mitigation' are unresolved concepts. In Concept B, the site remains car dependent in the immediate future and faith is placed on finding an alternative to fossil fuel use. Employees of the site would have a high probability of being car dependent in order to access their worksite. The lack of alternative transport in rail may make the site vulnerable post peak oil. The response to peak oil relies on a shift in technology (shifting modes to electric or hybrids). The location of the MBP with respect to transport may have irreconcilable challenges for climate adaptation (decreased density) that may not be resolvable through landscape architecture within the context of the site boundaries. Charrette I identified a desire to increase the density of Bendigo and this proposal may be counter to this desire.

Concept A's proposed use of the existing rail line for light rail in transport and heavy rail for freight may ameliorate this risk to some degree.

The appraisal from Charrette 2 is seen to be directionally relevant for CoGB to focus on particular elements of the MBP plan that require further consideration prior to implementation. These include:

- **Transport Connectivity:** Transport dependency remains closely aligned to cars and trucks run on alternative energy. The rail road was reclaimed for internal use only as it was viewed as unlikely that rail would be used for freight or public transport on the aligning rail line.
- **Risk Management:** Using floods as a means to control sand drifts, and the impacts of flooding on the revised layouts.

5 Case study 2: Sea Lake charrette

The town of Sea Lake, halfway between Bendigo and Mildura and close to the salt lake of Lake Tyrell, is in the middle of one of the most important grain producing regions in Victoria. The charrettes were hosted by 'Advance Sea Lake Inc', a community group that represents the interests of the Sea Lake community, both within the local government area of Buloke Shire and beyond.

5.1 Background

The Shire of Buloke is a predominantly rural area located in north-eastern Victoria, on the eastern edge of the Wimmera plains and southern Mallee. It is approximately 300km from Melbourne, and covers an area of 8,003 square kilometres. Prior to European settlement, the Boorong people were the main inhabitants of this area. There are now ten key towns in the shire, five of the largest being Birchip, Charlton, Donald, Sea Lake and Wycheproof. Characterised by a dry climate and dry land agriculture, the region forms part of Australia's wheat belt, At present, agriculture constitutes the largest economic and employment sector, with most of the land use taken up by grain production (wheat, oats and barley) and sheep grazing. Other significant economic sectors include education, retail, light industries and community services.

Based on 2006 Census data, local demographic features for the Shire of Buloke are as follows:

- median age: 44 (youngest of the five major towns)
- 7.3% of the population is aged 0-4 years of age
- 6.2 % of the population is aged 15-19 years of age
- 3.8% of the population is aged 20-24 years of age
- 55.7% of the population is aged 25-64 years of age
- 27% of the population is aged over 65 years of age
- 16% of people live alone
- the median individual weekly income is $315
- the median household weekly income is $568
- 0.8% of the population identify themselves as being of Aboriginal or Torres Strait Island descent.

The Shire of Buloke accommodates just 7,331 people in an area approximately the same size as greater Melbourne. The region's population is decreasing further, showing a steady decline in population over the last decade. . On the basis of this demographic profile two problems can be identified:

1. Ageing of the population. Only 17.3% of the population is under 24 years old and 27% is above 65 years old. This will likely lead to greater social burdens to be carried by a smaller workforce and a lack of sufficient workers as elderly workers retire.
2. Decline in total population. This may cause problems for local businesses and services. The number of potential customers decline and it may become unprofitable to continue operating. The potential lack of suitable employees may also drive up wages. Services are relatively more expensive to maintain in areas with a small population.

The recent history of the region is dominated by a combination of challenging agricultural conditions (principally droughts) and global factors related to wheat and other agricultural commodity prices. 30 years ago, in 1982 the economy was strongly influenced by an extreme drought, the worst since the 1940's. This precluded the Mallee Crisis, which in 1985/1986 led to large numbers of farms becoming unviable and subsequent farm exits. People were unprepared as the extremely dry year of 1982 was followed by a very productive year, which lulled producers into an invincible mindset.

Seal Lake's population before 1983 was higher than now, with many farms, workers and shearers, and more services and products available. At the time, farms had a low debt ratio and sheep had a high value. In addition to the hospital, there were two doctor surgeries, as well as two viable hotels, clothes shops, butchers, slaughter yards and a TAB. Three or four banks were located in town, along with a bakery, three car-dealers and four mechanical farm machinery dealers and services. The new

Carinya Community Centre opened in 1981, a new Shire office opened, and a regional Department of Primary Industries (DPI) office was located in town. The SEC and water commission held residence in Sea Lake. Green Lake was a popular campsite over summer and functioned as the primary campsite for all primary schools. A film society was also active in the community.

After 1983, many things changed and the extreme drought is generally seen as the cause. Population declined, interest rates increased to 15-18% and household debt grew. There was hardly any financial support from government, leaving the responsibility of financial support to families, the church and rural finance. Overdrafts were introduced and pushed to extremes as banks were generally unsupportive. People were forced to shop locally and it was possible (and necessary) to put things on account ('over the counter banking'). In cafes, only fruit and vegetables were available. Many women were retrained to return to work, whether voluntarily or out of necessity.

5.2 Climate change and Sea Lake

Already, the town of Sea Lake suffers from frequent droughts and hot summers, and occasional failing harvests. Other major problems in Sea Lake include:

- climate/weather related issues, mainly drought, heat and heavy rainfall
- low capacity of the landscape and agriculture to deal with excess rainfall, droughts and soil erosion
- the effects of heat waves, including heat exhaustion and heat stroke, on the young, elderly, and sick.

Kerang is the closest high quality weather data site. The average maximum temperature during the period 1962 to 2001 was 22.7 degrees Celsius. During the last decade the average maximum temperature was 23.6 degrees Celsius. The moving average shows an increasing temperature trend. This last decade was 0.9 degrees warmer than the 30 year average beginning in 1960. From 1995, there has been a significant increase in annual average temperatures. Although there have been periods of hot weather previous to 1995, such as between1978 and 1982, hot weather has become more common and consistent since 1995. CSIRO data (2012) indicates an increase in temperatures for the whole of Victoria under both low and high climate change scenarios. The low impact scenario is a best case scenario and represents the lower boundary of future climate change. The high scenario is a worst case scenario and represents the upper limits of climate change as simulated by the models used.

The range that these models indicate is 1.1 degree Celsius for the lower boundary and 4.7 degrees Celsius for the upper boundary. The highest increase for the lower boundary will occur in summer, when temperatures will be on average 1.5 degrees warmer. Currently, the average summer temperature for Sea Lake is 31.3 degrees Celsius. In 2100, the average summer temperature under the high scenario will be 36 degrees.

It must be noted that these figures are for the State of Victoria as a whole and there might be significant local or regional variations. Moreover, these numbers represent a limited range of models and scenarios. Therefore, the figures represent a plausible scenario for the full range of possible future climate changes for the region.

The majority of Sea Lake's rain falls during the growing season—May to October. During this period, average rainfall is 32 mm per month. Average seasonal rainfall is as follows:

Season	**mm**
Summer	23.6
Autumn	24.9
Winter	31.4
Spring	30.8

Sea Lake is generally dry with an average annual rainfall of 330 mm. Over the last two decades, the 30-year average has frequently fallen below the long term average. An exception was 2010 with 600 mm of rain. Predictions for Sea Lake in 2100 indicate up to 195 mm of annual rainfall, or a 60%

decrease on present figures. For Victoria as a whole, predictions show a decrease in annual rainfall by 2100. Under the best case scenario, the decrease is less than 10 mm and the worst case scenario shows a decrease of almost 250 mm. Most of this decrease occurs during winter and spring while summer shows a small increase. Climate models and theories suggest that rainfall patterns will result in more frequent, high intensity rainfall.

The potential evapotranspiration of the region is also predicted to increase due primarily to higher temperatures, and since rainfall is also predicted to decrease, the region's moisture deficit will increase leading to dryer soil conditions.

Sea Lake is in a similar climatic zone to Bendigo, and has experienced broadly similar climate and weather patterns. Drought has accompanied hotter and drier conditions in the region. Research indicating less storm generation over southern Australia suggests that dry conditions will, on average, continue. Heavy daily rainfall has already decreased by more than 25 mm since the 1970s. Wet conditions earlier this year (2012) were exceptional and were associated with a negative Indian Ocean Dipole and La Nina. Eleven such events in northern Victoria since 1900 have caused moderate to major flooding. A simple model based on IOD-ENSO indices suggests that this recent event was much wetter than would otherwise have been anticipated. Therefore drier conditions are expected to lead to fewer very wet events but such extreme events will be more intense, i.e. wetter.

Sea Lake has experienced periods of frequent hot weather in the past, particularly during the 1980s. However, the frequency of hot days (above 35 °C) and particularly very hot days (above 40 °C) have been more common in the last decade than ever before—a 16% increase overall, compared with the period 1961 to 2001, and a 40% increase for days of 40°C or above (from 6.7 days to 9.4 days).

There is a relatively low risk of bushfires across the Shire of Buloke. However, the Loddon Mallee Regional Strategic Fire Management Plan has identified a concentration of valuable "relict and fragmented landscapes" in the region that may be at risk during fire events or fire management activities.

There is a relatively low risk of flooding in the Shire of Buloke except in the areas immediately adjacent to Tyrell Creek.

5.3 Sea Lake Charrette I

Within Sea Lake Charrette I, the first exercise was a reflective task in which participants described the economy, climate, technology and people in 1982, 2012 and 2042. This participatory exercise assists to identify additional assessment criteria for local climate adaptation. By discussing the past, present and future, a story of the regions is created, and desirable qualities that stakeholders may wish to retain, or amplify, and qualities that they may want to reorientate are identified.

Sea Lake in 1982

Considering the wet years of 1981 and 1983 when big rains occurred in late March and April, 1982 stood out as an exceptionally dry year. However, considering the early to mid-80's, the drought becomes dominant and 1981 and 1983 are exceptionally wet years. It was experienced as a shock to be confronted with several dry years in succession, which hadn't occurred since the 1940's. In 1982, many dams were without water. January 1982 had a small amount of rainfall, and there was nothing for the rest of the year. Extreme winter frost killed many trees and crops and one of the greatest dust storms in memory led to a significant loss of top soil. The drought and lower humidity changed garden practices and people are said to have become more stressed. The drought had broader community impacts as young people left the town, the population declined, businesses closed and schools were forced to merge. However, because of the wet years pre- and post-1982, Green Lake was full and functioned as a vibrant social hub. It was noted as a good year for mushroom picking.

1982 is also seen as a watershed year for changes in farming practices. At the time, climate change was not considered and the drought was viewed as a normal cycle of the weather, it brought about indirect benefits as a result of the search for innovations and new solutions. Research was initiated into farming practices to deal with the stressful circumstances, such as no-till, crop genetics, tree

planting to mitigate erosion, and salinity solutions.

In 1982, farm machinery was much smaller than now and used CB Radio as opposed to GPS technology. Sowing and harvesting therefore took much longer. Most of the machinery, such as 24/28 row combines, 10 tonne tray trucks and PTO headers and tractors, was individually and locally owned. More (casual) labour, recruited from the surrounding region, was required on farm. It was the era of mechanical diesel motors, 2WD-utes, 2WD-tractors and basic fire trucks. Hydraulic presses were a recent introduction and the price of fuel would have been under 40 cents per litre.

Rail was the main transportation means for moving grain in 1982. All silos were in use and grain was delivered to bulk handling facilities spread along the railway lines making it less segregated. All land was cultivated and paddocks were rested every four years. There were no generic fertilisers or pesticides available and production processes used fewer chemicals, which were also more expensive. Soil-conservation was locally executed local agricultural officers, based in the Department of Agriculture and Walpeup Research Field Station, organised days for farming information.

The weather was mostly predicted by looking at the sky. There was no air-conditioning either in the machinery or in housing. Cooling was provided mostly through ceiling fans. The telephone was a landline, operated through manual exchanges. There were no computers in schools, no photocopiers, digital photo-cameras or Eftpos. Orders, often placed by telephone, needed to be paid cash or using cheques. Shops made use of adding machines, kept manual customer 'shoe box' accounts. Bank statements were typed on type writers. There were just a few radio (AM Radio, 3SH, with Harold Pratt) and TV (ABC, Bendigo, BCTV6, BTV8) channels, and TV transmission finished at 11 pm. The common mode of local transport was the bike: bike racks in school were full. Windmills and gravity fed energy systems were introduced.

The community of Sea Lake in 1982 was much more traditional and mono-cultural. Many women stayed at home and did not work. Farms were smaller, but could sustain more people, and families were larger. This led to more family-oriented activities. More people were actively religious and supported a number of churches. People were financially comfortable such that they could weather the downturn of1982. There were schools in all the surrounding towns (Colgoa, Berri, Nandaly and Sea Lake) and a separate primary and high school in Sea Lake. The high school population in 1981 was 245. Each surrounding town had its own football club and there were cubs, scouts and guides. The Corinya complex was built and a weekly cabaret with a band travelled around the towns. There was a small theatrical group. Several service clubs were in operation, including CWA, Apex, Young Lions, and there was a local hospital and small aged care unit. The three banks, four churches, and three petrol stations attracted more professionals, such as bank managers, church leaders and others who became members of local committees. As a result, the socio-economic range (SEIFA) was higher. In 1982, this situation changed. The drought forced young people off the farms to Melbourne and Bendigo where they could earn comparable wages. Family sizes reduced further as a result, leading to a 'missing' generation. A lack of employment led to mums being forced to stay at home even if they wanted to enter the work force. The decline in population, especially of young people, had consequences for the number of schools, football- and other sporting clubs. Some disappeared, while others were forced to amalgamate, such as the cricket and netball clubs. In this period, the first signals of council amalgamation became apparent with the pre-council amalgamation of Wicheproof. A potent indication of the hardship of these times, and the unfavourable forecasts, is the high rate of suicide.

It should be noted that the charrette process assisted the Sea Lake community to identify precedents of adaptive and resilient initiatives. For example, the response to drought in 1982 changed farming practices and introduced no till cropping after the region's topsoil 'flew to Melbourne'; The Birchip Cropping Group conducted ten-year research trials on donated lands to identify best practice farm management; Tyrell College's hands-on approach to agriculture has attracted students to the town plus $500,000 in funding. Another local resilience response includes the purchase of the local supermarket by 50 local residents after closure was imminent. Past precedents should be celebrated and provide a means to imagine future adaptation.

Sea Lake in 2012

Sea Lake today has a compact business district and the town is a walkable size beneficial for health

and transport. Some problems relating to the town centre include: the old school site is seen as a waste of a prime real estate and the quality of existing, ageing housing stock is seen as poor. There is a lack of quality housing for professionals and the sports oval is too far from the town centre. The main (Calder) highway bypasses the main commercial district, which leads to a loss of potential tourism and retail business. The main road is accessible for trucks and a bypass is desirable here. The quality of the pavements and roads could be improved, particularly given the heavy truck use. The town is well serviced by public transport (bus). The health precinct is good and could be emphasised, for instance through expanding space for aged care units as the aging population is currently not well catered for through independent living space. The number of cycling and walking tracks as well as facilities for skaters and netballers could be improved. Generally, the number of bio-links needs to be increased to support native vegetation. The area for nature reserves could also be increased. There are opportunities for biodiversity corridors around Lake Tyrrell, along boundary fences (mechanised), and along the railway and creeks. The actual natural watercourses are broken and incomplete. The water does not flow easily, even after heavy rain. To maintain waterways and creeks, culverts need to be reinstated, for instance in the Dunmunkle creek between Birchip and Sea Lake. The unused salt extraction area has not yet been given a reserve status, which could improve biodiversity. In other parts of the salt extraction area, salt harvesting could continue and provide business opportunities. The potential of Lake Tyrrell is underused. It could play a significant role in tourism development. To preserve good farming conditions, salt incursion onto farmland must be minimised through planting salt tolerant plants and both salinity and rabbits must be controlled.

Sea Lake in 2042 – positive imaginaries

The primary attractions of Sea Lake in 2042 are the natural environment and its tourism potential. The unique, star-filled skies above the salty Lake Tyrrell offer tourist opportunities for astronomy, art and health (Tyrrell salt scrubs), mountain biking, farm, and flora and fauna tours. Tourism can be diversified and developed as a thriving industry with an excellent supply of water.

Sea Lake becomes the heart and hub of Australian excellence in agricultural education. It includes an agricultural school program for residential students and international school exchanges. There are strong connections with the broader region, metropolitan centres and the rest of the world. Fast Internet and train connections (fast trains, bullet trains) will be essential elements in this scenario. Farming continues to be important for Sea Lake and its surroundings. It has the potential to feed the world. Therefore, it is necessary to develop a trusted food chain and supply local markets where local vegetables can be purchased by the community. In this manner, food miles can be reduced. At the same time, it is important to diversify the economy to become less dependent on crop farming. Further exploitation of Lake Tyrell, whilst conserving the salt, is an option. Innovative opportunities, such as the production of batteries from salt for the new trains, need to be further explored.

The beauty of the natural environment can be used to create a very attractive residential area, where houses and a retirement village can be built on the water of Sea Lake. As older people are more financially secure, these developments can be capitalised. Besides these more exclusive houses, affordable and accessible housing for people of different age groups and situations contribute to the identity of Sea Lake as a preferred residential location. A good hospital and residential aged care, and a diversity of housing stock, for example smaller units with no backyards, contribute to this idea.

Economic development, including online industries, requires all kinds of facilitative measures. The appearance of the town from the Calder highway is important, as is the establishment of a community bank as a foundation for local business owners, a bakery opposite travellers rest, and excellent technology for professionals to work in Sea Lake and link to anywhere else in the world. In 2042, the majority of people working in Sea Lake will enjoy a three day work week.

Through combining the touristic, educational and agricultural strongholds with new ways of living, health care, and excellent high speed physical and virtual connections, by 2042, Sea Lake has become the central service centre and economic hub for the Mallee ward.

Meanwhile, the climate of Sea Lake in 2042 is expected to be more variable and include more extreme events. More frequent and intense rainfall events will cause periodically severe water problems in terms of capture and storage, flooding, and quality.

Adaptation measures for this future climate could include renewable energy technologies to enable householders and communities to be self-sufficient whilst reducing carbon emissions and contributing to economic development. An innovative approach to periodic flooding of the lakes might involve building adaptive housing, similar to the floating villages of Culgoa Point in Noosa. Capturing and storing carbon in soil is another adaptive as well as mitigative option (e.g. biochar), which simultaneously improves soil condition and increases productivity. Farmers will need to become more adaptive to variable weather conditions through innovative practices for storing summer rainfall, adjusting the diversity of crops, cropping cycles and methods, introducing drought tolerant wheat strains, sowing opportunity crops (e.g. corn, sorghum, sunflowers) and decreasing dependence on monocultures. Marginal land is allocated to alternative uses such as livestock grazing, kangaroo or emu. Larger farms will are able to be more flexible to cope with uncertainty, and will no longer use practices that negatively impact the environment, such as burning and spreading fertiliser.

There are opportunities for research and tourism around astronomy. A telescope and observatory could be located at or near Lake Tyrrell with links to astronomical research in Victoria and across the country. New technology may assist in solving the 'Green Lake leak' problem and thereby open up further tourist opportunities. The second natural advantage is the potential to generate secure food and energy supplies within the region of Sea Lake. The area already has excellent farming and food production facilities and its location offers good potential for wind and/or solar energy production to provide the energy needs of the town and beyond. In the future, virtual, wireless and fast broadband technologies will be widespread changing the ways in which systems and activities of education, recreation, work and other elements of life are organised and delivered. . Fewer people will work in the traditional 'brick and mortar' sectors and more will operate at a global level via virtual technologies. Primary and secondary schools will have opportunities to enrich their curriculums through exchange programs with international communities, and learning becomes a lifelong opportunity supported by new and renewing technologies. In health care, virtual technologies introduce opportunities for remote care services, while an increased reliance on air services for specialist services. High quality housing stock will become important for attracting health care and other professionals to the region, supported by an improved Sea Lake website providing a virtual tour, and access to job opportunities and housing options.

Farming changes might include a shift in focus from the local or regional to the global, virtually connected and competitive market. Technology will allow farm sizes to increase, with many practices now automated and providing remote control options informed by accurate and accessible local climate information. A greater range of drought tolerant crops and variable rate technology for sowing will lead to higher yields. Improved rail/freight technology and integrated logistics will make it possible to transport lager amounts of grain, allowing farm operations to upscale. The farmer essentially becomes a technology manager and employs professional expertise as required. This provides opportunities for more vertical integration of products with farms now owning or participating in several parts of the production, distribution and supply chain, including marketing, machinery, seed banking and distribution.

There are benefits for a larger population of Sea Lake with a balanced demographic profile. Given the current gaps, attracting young people is a priority through the development of appropriate social infrastructure beyond sports, including scouting facilities, apex, crabs, theatre, skate- and bike-park, and gopher and bike tracks through the town and surrounding areas. A master plan to create a community hub encompassing the existing recreation reserve, the old courthouse, pool and old croquet club needs to be developed. Other aims for the community in 2042 include the dismantling the divide between town and farm and re-involving disengaged Sea Lakers.

A more demographically balanced population will need an increased diversity of flexible, innovative and high quality housing stock which, along with employment opportunities, education, health and community services, will attract and retain retirees and professionals to the area. 'Centres of excellence' in agricultural and aged care provide additional educational opportunities and contribute to shaping the identity and attraction of the town.

New agricultural programs can strengthen the connection between school, young people and farming helping to attract and retain people in the area through apprenticeships and local employment. The Birchip Cropping Group model, which comprises a network of farms sharing and developing knowledge and resources could be applied here.

5.4 Sea Lake charrette 1 outcomes

The charrette process generated a total of eight landscape plans, including two town level plans, two regional level plans and four models detailing a combination of town and regional scale initiatives. Only the four models are presented here as they effectively combine the ideas generated in the town and regional plans. The four concepts are:

1. Development through diversity
2. Salt, sun, skies and stars
3. Community hub
4. Centre of the Mallee

Each is described in more detail in the following sections.

1. Development through diversity

The 'Development through diversity' concept emphasises the range of investments and activities that need to be integrated to create a sustainable and climate proof future. The first focus area is Lake Tyrrell, which is currently underdeveloped but for tourism but presents potential commercial in this regard. Although, at present, salt extraction operations continue, an environmental zone is proposed around the Lake, with a dual bio-ecological and tourist function. Through such development the lake would become more accessible with attractions created along the shorelines, including an observatory at the north-western shore, which is accessible by road and also by flat bottom boat that is able to cross the lake even in low water levels. Several places around the lake have been identified as potential locations for opera under the stars, which could develop into a summer festival event. Additional bio-links are proposed along the Tyrrell and Dunkmunkle creeks to connect with the environmental zone. Ample space has also been identified in the environmental zone for the generation of solar and wind energy, especially on the eastern side of Lake Tyrrell.

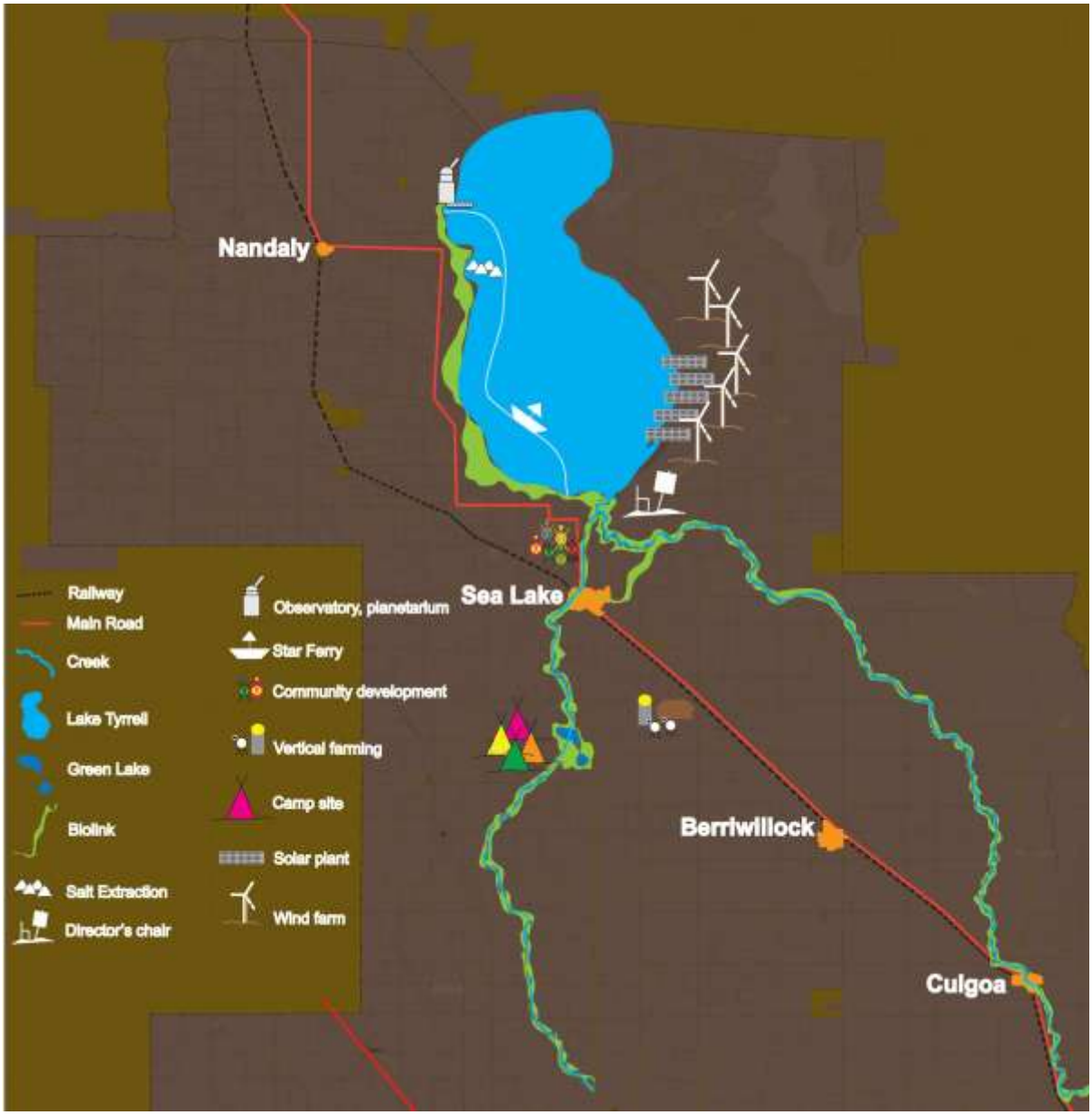


Figure 47 Sea Lake, development through diversity

The balance between biodiversity goals and farming in the region can be preserved through a focus on the efficiency of farms and the integration biodiversity corridors. Regulations that support farm outcomes and protect the environment are required. Greater integrated knowledge that includes local knowledge and leadership is needed to respond to extreme weather events such as long droughts, sudden floods and locusts. Farming becomes a more holistic activity. It twins the goals of plain efficient agricultural production with activities that go beyond agricultural production activities. This vertical integration of activities, in which a range of industries, such as broadacre and intensive production, value adding, marketing, R+D, virtual and direct sales, along with other new industries associated with tourism and ecological protection activities, all requires a critical mass of engaged people.

A strategic response is required to manage wood infestations. It is proposed to focus on research that approaches this issue from a regional perspective. Extensive research is needed to respond to the outcomes of no-till practice through local institutions such as BCG and the government. In order to support farmers in temporary difficult times an innovation centre is proposed that develops appropriate governance arrangements to provide labour and/or capital on ad-hoc basis.

The potential of Green Lake is realised under the plan. The water problem will be addressed and a new, state of the art, campsite is projected. A cultural response to labour expertise from Asian countries is developed and stimulates the arrival of Asian families. It is seen as important to provide appropriate cultural support, such as language classes and education for children. A multicultural community, in which locals also learn Asian languages is developed and improves understanding and coherence amongst all inhabitants of Sea Lake.

In order to connect all projects and ideas, to dedicate labour to project and to liaise between the local community and the (higher) governments and other funding bodies, the position of town-manager is proposed.

2. Salt, sky and sun

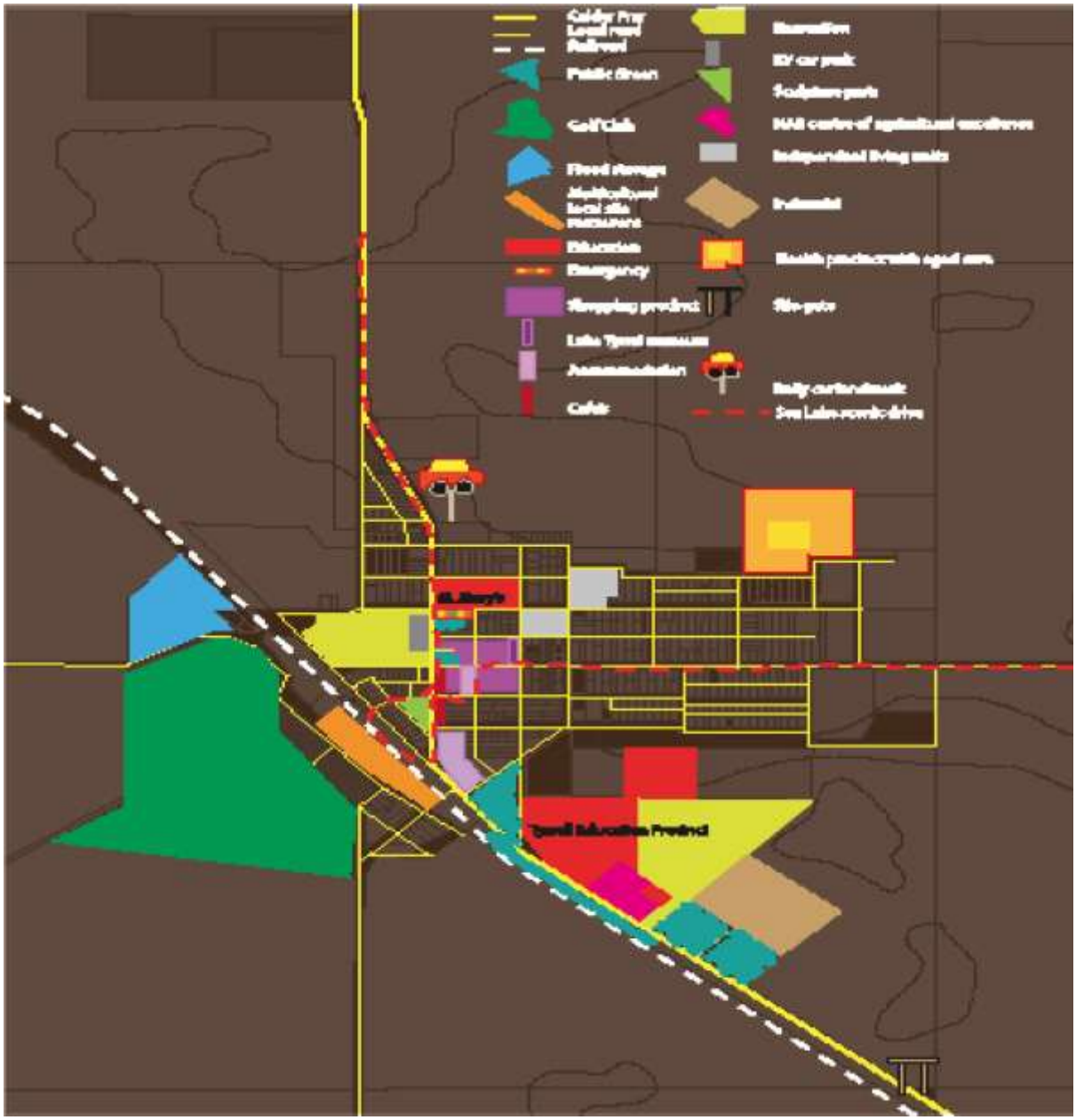
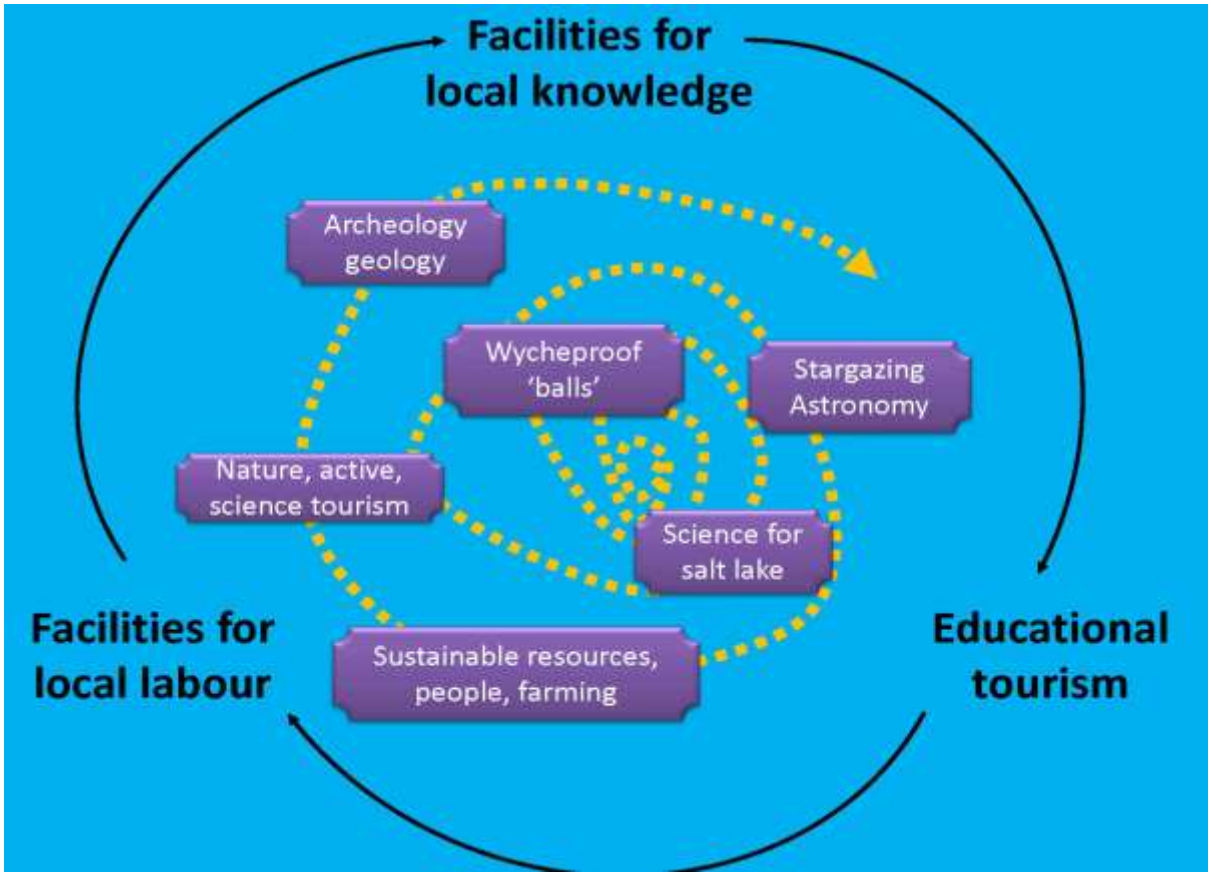


Figure 48 Sea Lake, centre of the Mallee

The 'Salt, Sky, Sun and Stars' design makes optimal use of the natural qualities of Sea Lake and around. The specific qualities of Lake Tyrrell are taken as the starting point for the proposal to

develop the area for sustainable tourism. Apart from the general aim to make the area more sustainable, the focus lies on the crisp and clear skies, archaeology, indigenous heritage and art. The skies offer the opportunity to develop astronomical science and stargazing activities. The dunes and salt lakes, and facts such as the shoreline that used to be at Swan Hill, are used to develop interest in archaeological finds. In the area many cultural heritages of aboriginal origin can be discovered. Several ideas related to art are launched. The development of an artists and/or writers retreat near the lake is one of these. The other, more specific idea is to create an art exhibition in Lake Tyrrell. What if overnight the large balls, made by an artist in Wycheproof appear suddenly in the lake? They would have the same impact as the grain circles do in remote areas in the US. Further it is suggested to paint buildings with artwork, organise more exhibitions and create art in the landscape. These developments all require accommodation and facilities. This design proposes to realise those as part of the farm experience and in a sustainable way. Moreover, the idea is to link these proposals to educational tourism: (young) people come to Sea Lake to learn about culture, art and astronomy. This would generate a broader scientific interest for the salt lake.



In Lake Tyrrell, students, academics and interested local people could jointly research and be brought together. Linking this idea with Tyrrel College educational programs, school camps and agricultural learning establishes a connection between local assets and the wider world. A sustainable relationship can be developed between nature, science and activities, such as cycling (bike races) and hiking along or around the Lake.

In the long term, sustainability is seen as an integrated approach in which the quality of the environment and care for natural resources such as water and energy is connected with demographic and economic prosperity, which provides work locally, and in turn increases facilities and the number of people, visiting or living in Sea Lake. Specific points that enhance sustainability include the attention to local flora and fauna, a sustainably filled Green Lake with a kitchen and other facilities and the development of more drought tolerant crops.

The focus on the assets Lake Tyrrel brings to the region, and exploiting those, in combination with an adaptive sustainability strategy gives Sea Lake a position as the HUB to other towns and regions in north-western Victoria, such as Little desert, Big desert and Sunset National Parks.

3. Community hub

In community hub it is proposed to integrate many goals of different kinds. Historical aims in the form of a museum are combined with aged care, education and arts and culture. The town then develops into a hub through concentrating and building of these different facilities in close vicinity. In order to facilitate these functions to be developed available land is proposed to be used. Land currently underused, such as the old primary school site and oval, the railway precincts and station and the recreation reserve are potential options. These centrally located areas are suitable for functions that fit in a town centre, such as hotels or motels, conference facilities, a memorial hall, a theatre or an outlet for online ordering. In order to create an attractive centre, where passing visitors, tourists or students stop by, the shop fronts along the Calder freeway need to be updated and placemaking projects undertaken to improve amenity.

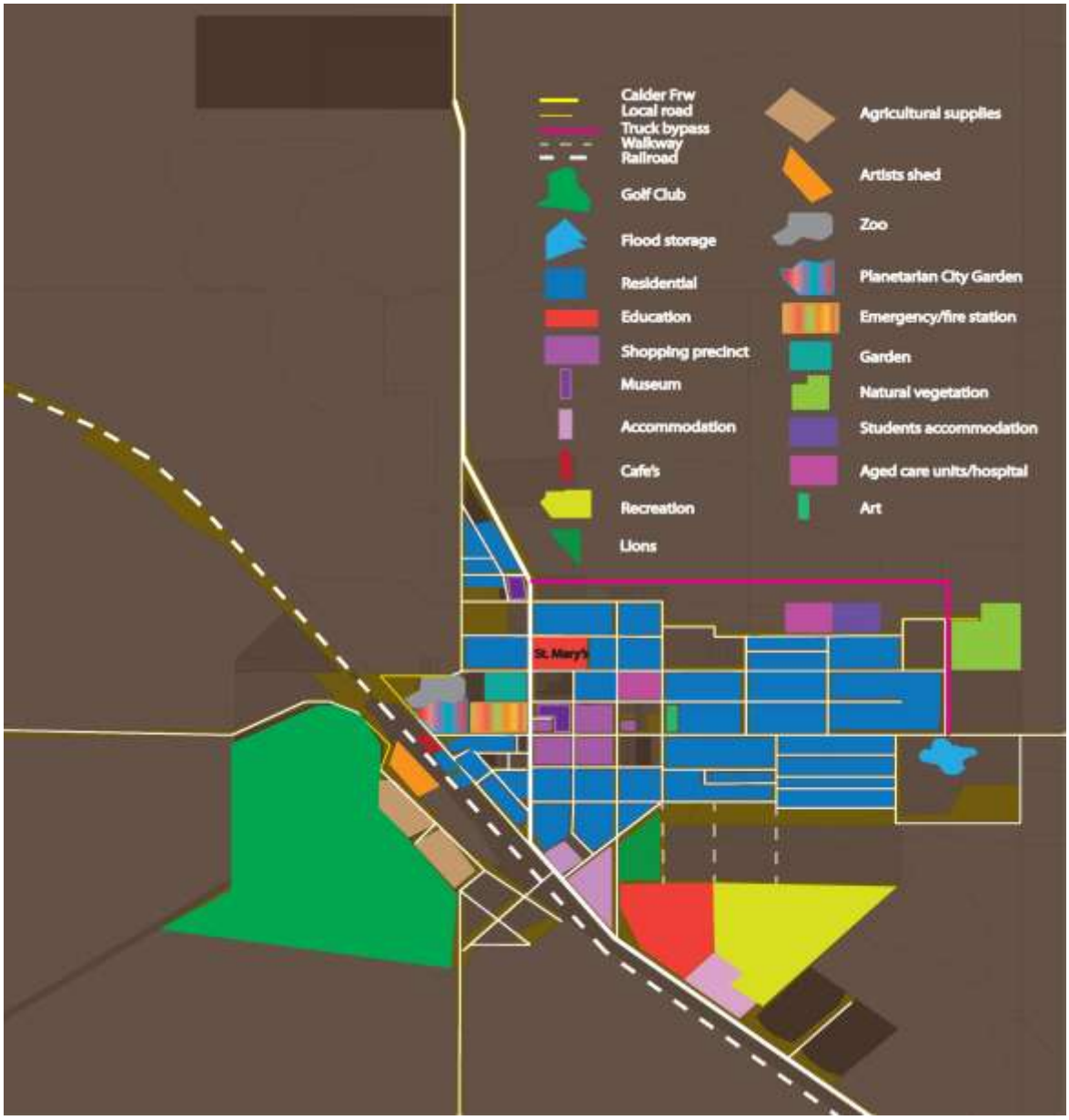


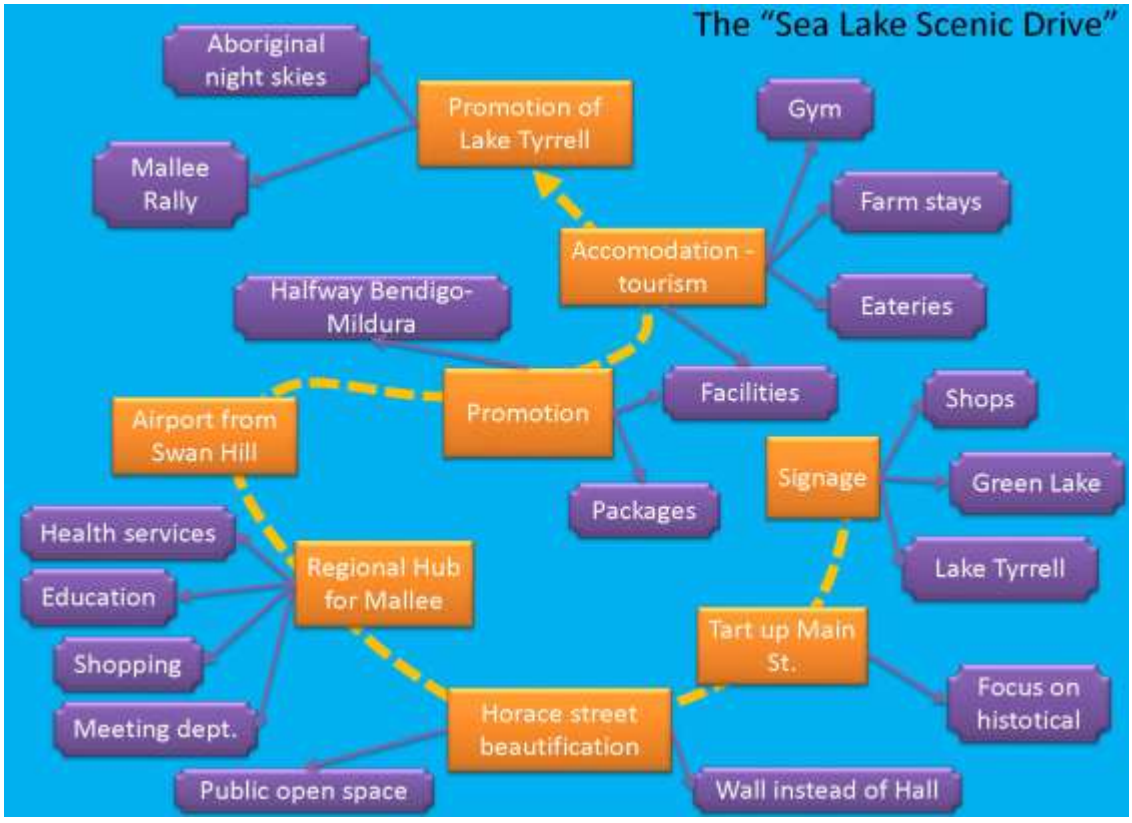
Figure 49 Sea Lake, community hub

Another site that can be developed is the health services complex, in which the hospital, the ambulance function, police, pharmacy and doctor services are combined with office uses such as for DPI-landcare and where BCG can be united. Independent housing for aged can be attached to this cluster.

Social Infrastructure in the form of facilities (as well as jobs) is key to making Sea Lake more attractive to families. This includes in this plan integrated facilities for primary school children, TAFE and higher education. Part of the community hub is also to arrange a sustainable town. Therefore it is proposed to provide solar energy for every building/house and realise a solar farm for the entire town. Rainwater is collected and preserved to water the city gardens and natural vegetation. The city garden and/or the old croquet club are seen as an ideal location to develop a planetarium.

In order to provide future funds to realise these ideas 'community hub' proposes a community bank, which develops capital flows to invest in local projects. A town manager is seen as essential to consolidate all project ideas and stimulate realisation.

4. Centre of the Mallee



In 'Centre of the Mallee' Sea Lake is seen as the central hub of the region. The town has a function for the entire region as a housing centre, for amenities and facilities. Sea Lake has excellent aged care and the housing that is required for that. Care facilities are also attractive for older people from out of town, which brings ancillary jobs and services. The housing offerings are diverse. There are 'try before you buy' houses, which you can occupy for a certain period in order to experience the quality; especially for retirees attractive. There are appropriate houses for families in the form of units and many other different typologies. In town there are a lot of activities for children, not only sports, but also technology, art and music. In order to create a safe and quiet town the main truck route, currently crossing town is bypassed away from Best St. Sea Lake will have frequent and good quality bus transport with surrounding towns as well as with Bendigo and Mildura.

Horace St. is beautified and operates as a high quality public open space with nicely painted walls. Then there is the Mallee centre, where facilities, such as health, education, shopping, meeting and government are concentrated and function as a regional hub. Thirdly the town as place to stay midway Bendigo and Mildura is advertised and Lake Tyrrell is promoted as the ultimate experience for quiet night skies and aboriginal art and history as well as the less quiet uniqueness of the Mallee Rally. Sea Lake offers a range of accommodation, from farm stays, family hostels and luxury sleep-inns to a range of locally supplied eateries. Main St. is improved with placemaking projects and thanks to its historic buildings, shining and blinking again. All points of interest are well signed and easily connected.

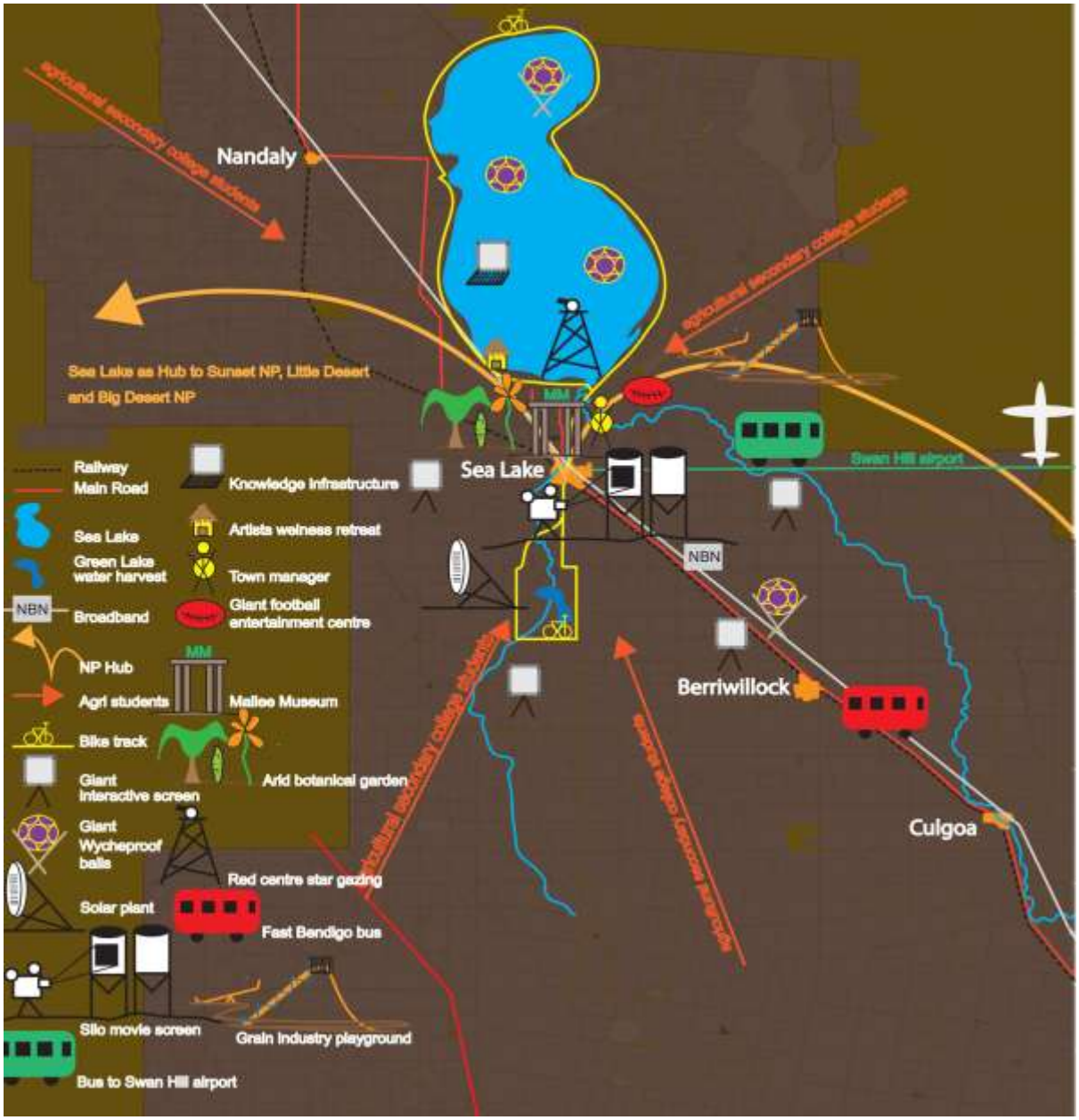


Figure 50 Sea Lake, salt, sun, skies and stars

5.5 Appraisal Sea Lake charrette 1

The charrette process generated eight landscape plans detailing two town level plans, two regional level plans and four final models detailing a combination of town and regional scale. The concepts from the landscape plans were thematically analysed to identify six major themes presented through the Sea Lake charrette. The six themes are:

- 1 Land use and agriculture
- 2 Lake Tyrell and tourism
- 3 Renewed town centre and community garden
- 4 Silo and railway station redevelopment including art precinct
- 5 Aged care accommodation and services
- 6 Education development and accommodation.

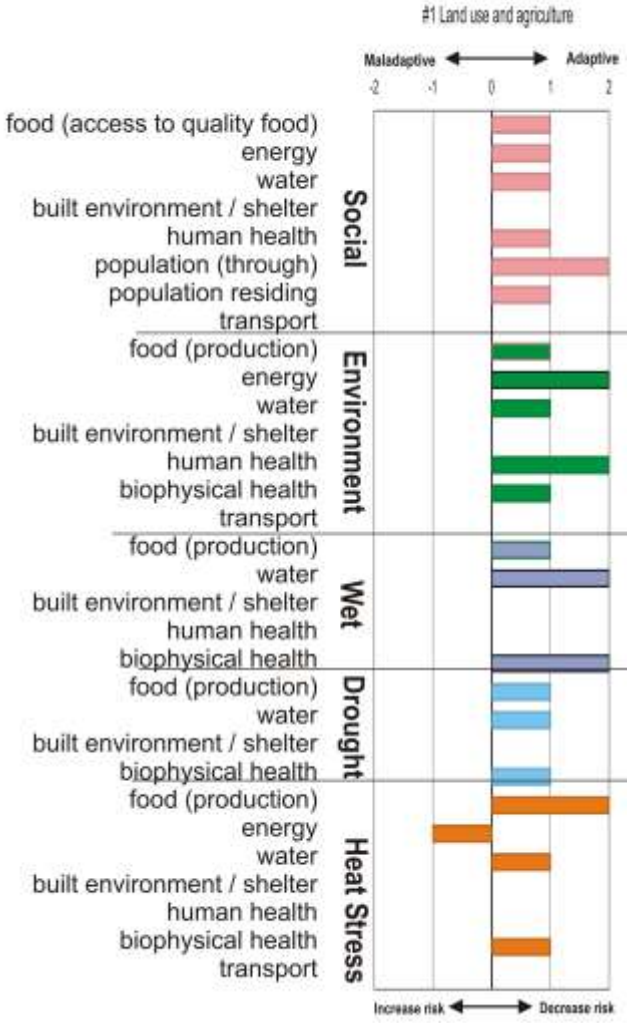
This following section presents the results of the Sea Lake charrette in the form of a thematic compilation of the conceptual design solutions, followed by their appraisal. A major difference between the Sea Lake and Bendigo charrette was that the final solutions were extremely similar due to a convergence of ideas that is the ideas differed marginally between the landscape level plans. Therefore, rather than appraising the final four conceptual scenarios, the major themes from all of the scenarios from this charrette were presented for appraisal.

Thematic 1: Land use and agriculture

Figure 51 **Thematic 1: land use and agriculture**

Conceptual design solutions:

- Developed better corridors for vegetation
- Expands Dunkmunkle Creek bio link
- Diversified farming: Kangaroos, flowers (perennial)
- Farm stays for Lake Tyrell visitors
- Vertical integration of products via:
- bakery,
- pigs, or
- chickens,
- Carbon farming
- Connected to agriculture advice for rapid response to localized issues
- Solar thermal and wind



agriculture

Thematic 1: Land use and agriculture

Climate Adaptation Design Goals

- Exploit whilst conserving the natural environment
- Integrate carbon capture technologies
- Increase bio links on farms
- Diversify what is farmed with less monoculture reliance
- Advanced research into crops, planting and land management practices for erosion, salinity and drought.
- Regional and local perspectives on management of land issues e.g. resilient weeds (Bircher Cropping Group - good precedence)
- Quick communication and response times to agricultural issues like locust and floods
- Revitalizing land care (local support)
- Vertical integration of products within regions, value adding to wheat

A strong theme running through the two-day charrette was the contribution of agriculture within the region. What is farmed, and how, has a significant impact on the region's biodiversity and the ability of the land to retain moisture, address salinity and increase the organic matter and carbon content of the soil. The bullet points above present articulate goals for agriculture and land use. Use of adaptation measures in the past to address climate changes through agriculture were also evident such as no till farming to limit soil erosion in response to dust storms of the early 80's, and the diversification from wheat to lentils.

Two strategies can be broadly presented to respond to the above goals in: (1) Conservation of unfarmed land, and (2) improved and diversified farm practices. Conservation and restoration of land of natural significance (e.g. salt lakes), and land that is not suitable for farming were suggested via corridors for vegetation such as the Dunkmunkle Creek bio link and fence lines. Restoring land and increasing biodiversity were viewed as positive initiatives from an environmental perspective. A challenging suggestion would be to not farm suitable land and reclaiming instead to increase biodiversity.

Farm management practices that improve the land via alternate farming techniques and diversification of land use were widely suggested. Land management techniques saw localised research and quick communication of results being central to success. Carbon capture and carbon farming could also be included under land management techniques.

Suggestions for diversification included: wind and solar thermal energy farms that could provide alternate income streams and reduce CO2-eq emissions; farm stays as accommodation for tourists visiting the salt lakes (centralised through town manager or air B&B); and farm trials of kangaroos with lower associated CO2eq emissions than sheep and perennial flowers.

The desire to vertically integrate industries through Sea Lake was attempted and proved a challenge in terms of identifying industries that would add value to local produce, provide employment and not degenerate the environment. Suggestions included a local bakery, pig farms and chicken farms. Pig and chicken farms may, however, be maladaptive through the increased energy and water use, particularly to keep cool. Future farm practices will largely determine if the appraisal for adaptation is positive with regards to CO2eq emissions, water use and energy use.

Thematic 2: Lake Tyrell and tourism

Figure 53 **Thematic 2: Lake Tyrell and tourism**

Conceptual Design Solutions:

- Eco lodge for Tyrell or Green lake; Site seeing air tours; Co-ordinated Farm stays for visitors promoting Lake Tyrell's heritage
- Promote Aboriginal heritage (30,000 year evidence of aboriginal population); astronomy: Aboriginal night skies (first documented aboriginal astronomy in 1857 at Lake Tyrell from Boorong people); opera under the stars; planetarium and/or observatory
- Vegetation protected
- Cycle tracks to and around Lake Tyrell and Green Lake; Cyclo-cross (mountain bike) event like Mallee Rally
- Sculpture park connecting Sea Lake to lakes, with an exhibition of statues and art through Sea Lake and Tyrell (residencies for artists)
- Lake Tyrell salt works employment
- Public transport to Sea Lake on weekends, using school bus on weekends

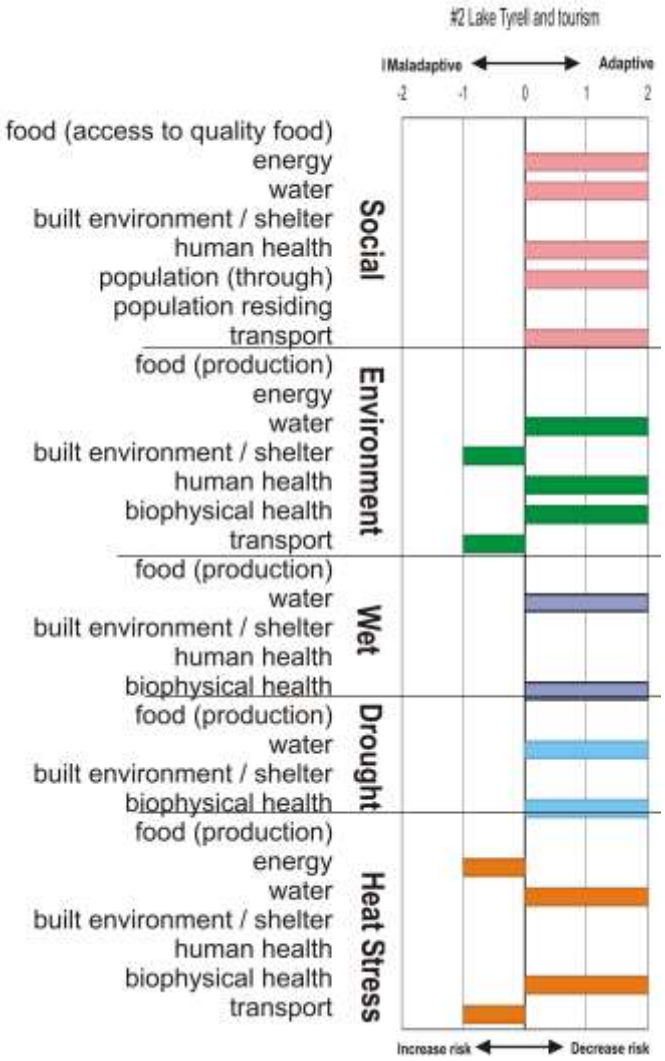


Figure 54 Appraisal thematic 2: Lake Tyrell and Tourism

Thematic 2: Lake Tyrell and tourism

Climate Adaptation Design Goals

- Tourism: potential for attractions, photography, agricultural tourism, recreation, science and heritage.
- Educational tourism, astronomy, science tourism, schools and camps, educational support material to connect Sea Lake science, stories and education.
- Attract visitors to nature with cultural and environmental outcomes

Sea Lake is fortunate to have one of Victoria's most scenic features only a 10 minute drive away. Lake Tyrell was the focus for the majority of suggestions for tourism, followed by Green Lake. Lake Tyrell Salt Works was acknowledged as a significant employer in the region. Tourism for (1) science, (2) recreation, and (3) the arts, was suggested for Sea Lake. Vegetation around the lakes was protected in all the design solutions.

Aboriginal heritage, science and astronomy were identified as themes that could sustain science tours for education, with varying degrees of sophistication. If education support material is provided it could be possible for schools to visit the region, with the community hall expanded as an education centre. A substantial amount of this material already exists, such as scientific papers on Aboriginal heritage (30,000 year evidence of aboriginal population at Tyrell), astronomy, and the Aboriginal night skies (first documented aboriginal astronomy in 1857 at Lake Tyrell from Boorong people). A planetarium and or observatory at Tyrell (or in the town) would strengthen the science tourism potential of Sea Lake.

Recreation and site seeing suggestions included an eco-lodge for Tyrell or Green Lake, co-ordinated farm stays for visitors, and site seeing air tours. Cycle tracks to and around Lake Tyrell and Green Lake, and cyclo-cross (mountain bike) paths for an event like the Mallee Rally could attract cyclists to the district. A mix of soft and hard infrastructure would be required for each suggestion.

With regards to the arts, several groups proposed sculpture parks to connect Sea Lake to Lake Tyrell and Green Lake, with the exhibition of sculptures enhancing the natural features of Lake Tyrell and surrounding area. For example, an arc frames the silos from the Calder highway approaching Sea Lake. This may be supported by residencies for artists proposed in Thematic 3.

All of the above solutions have the potential to attract visitors to Sea Lake, with differing investment outlays. Farm stays, site seeing tours and promotion of the aboriginal night skies could occur with limited investment, whereas a planetarium, expansion of the community centre, cycle tracks and art installations require more significant investment. Thematic 4 'Silo and Railway Development' on the following pages are seen to compliment the vision for tourism.

The preservation of Lake Tyrell, and cycle tours are positive with respect to climate mitigation. The attraction of tourists may increase transport related emissions; however, public transport to Sea Lake could be increased to offset this. Cycle tours in summer could be problematic with regard to heat stress. These were perceived as the only limitations to the overall positive appraisal of increasing tourism at Sea Lake by amplifying the natural features of the region. The fragility of the environment was acknowledged in the charrette, and that it would need to be protected (and managed) under an increase in visitors.

Thematic 3 Renewed building stock and land use reused

Figure 55 Thematic 3 Renewed building stock and land use reused

Conceptual design solutions:

- Rain water collection at opposite end of town
- Hostel for the aged transformed into something else
- Appropriate housing ¼ acre blocks and gardens for families; ('try before you buy') for staff and home type accommodation
- Student accommodation in vacant buildings
- Accommodating people in community housing (education and exchange students) for expanded College
- Art precinct and residence
- Easy access to Community gardens
- Access from town to school via direct path

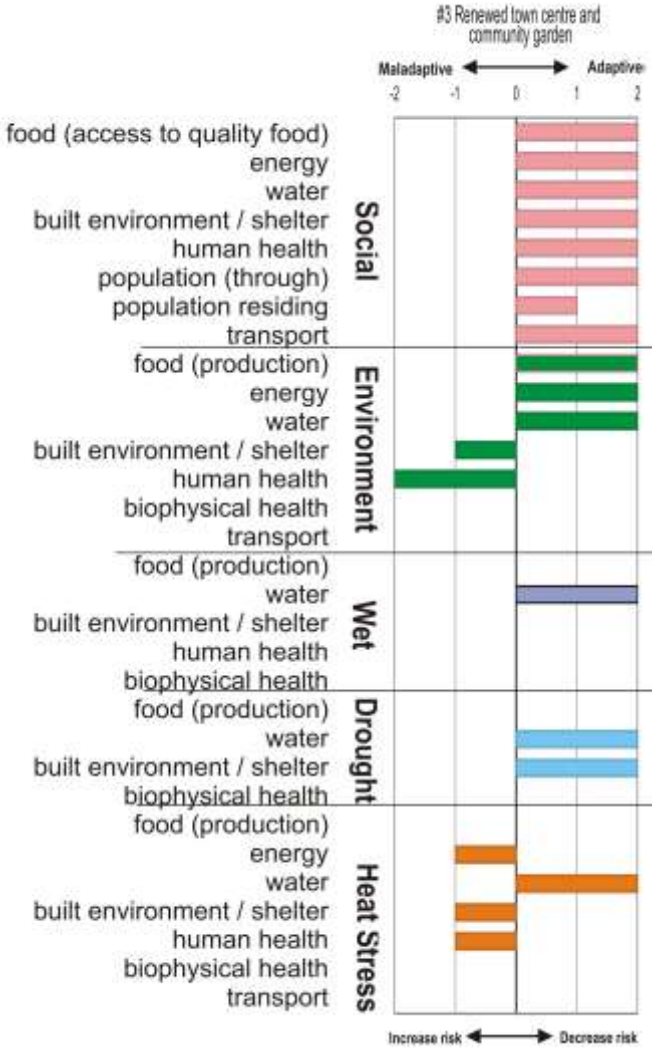


Figure 56 Appraisal thematic 3: Renewed building stock

Thematic 3 Renewed building stock and land use reused

Climate Adaptation Design Goals

- Diversity of housing stock (less vacant areas, more diverse housing options)

The charrette identified that Sea Lake has an ageing building stock, much of which is vacant at present and could be used for a variety of purposes. The 'use what exists' approach was central to this thematic. This included better use of vacant land within the town boundary, such as the old school and croquet club. Upgrading the building stock in town and providing a diversity of housing stock for a range of people were also desired. The conceptualised design solutions from the charrette attempt to occupy vacant buildings in town under the following scenario:

- The hostel for the aged transformed into something else, possibly student accommodation for expanded Tyrell College
- New appropriate community housing constructed (education and exchange students)
- Vacant ¼ acre blocks, with gardens for families; a 'try before you buy' scheme to attract tree change sector to Sea Lake
- Aged care, independent living units and easy access to community gardens
- Art precinct and residence
- Beautification of town and better signage
- Walking tracks that cross creeks to make walking a more attractive option
- New warehouse distribution centre co-ordinating online purchases, stocking one range of appliances to enable serviceability within the town
- Heavy vehicles to bypass town

The vision included rooftop solar throughout the town and better water management and capture through one end of town. One aspect of the plan not covered was design for extended days above 40° Celsius and managing heat stress within the town. This may have a multiplier effect on increasing energy consumption in summer for air conditioning, which best practice passive design may ameliorate. Landscape design to combat heat stress could also be applied through appropriate planting of trees.

How to mobilise the plan is the next logical question for the Sea Lake community. The charrette identified that Sea Lake at present lacks building trades capable of performing the above retrofit. A large part of the discussion within the charrette focused on expanding agricultural excellence within the town. The 'hands on approach' of Tyrell's agriculture program was viewed as highly successful and a similar approach may be applied for carpentry, building performance or renewable energies. The alternative approach may entail prefabrication or transportable houses, or bulk buys through the warehouse. If the warehouse specialises in efficient products then energy consumption in town could be further reduced. A plethora of suggestions could be made to respond to the above issue of 'how' which may be a question for subsequent charrettes, framed in terms of how to develop social capacity.

How the plan would be realised through building design and material selection largely determines the environmental impact of the renewed building stock. At present, environmental considerations for the building stock have not been made explicit. From a social sustainability perspective, a more vibrant community could be realised through an increase in population. Having heavy vehicles bypass the town was critiqued in the community appraisal as it may bypass revenue for the town centre.

Thematic 4: Silo and Railway station redevelopment including art precinct

Figure 57 Thematic 4: Silo and Railway station redevelopment including art precinct

Conceptual design solutions:

- Railways developed as an art precinct with restaurant and museum
- Silos used as cinema walls
- Silos as heritage area
- Museum for Mallee Rally and off road racing (home of off road racing)
- 100 mile restaurant with a view and weather station on top of the silo
- Café in old station
- Old sheds attached to artists residency
- Planetarium (in silo)
- Climbing wall on silo
- Old push rail cart on unused railway tracks

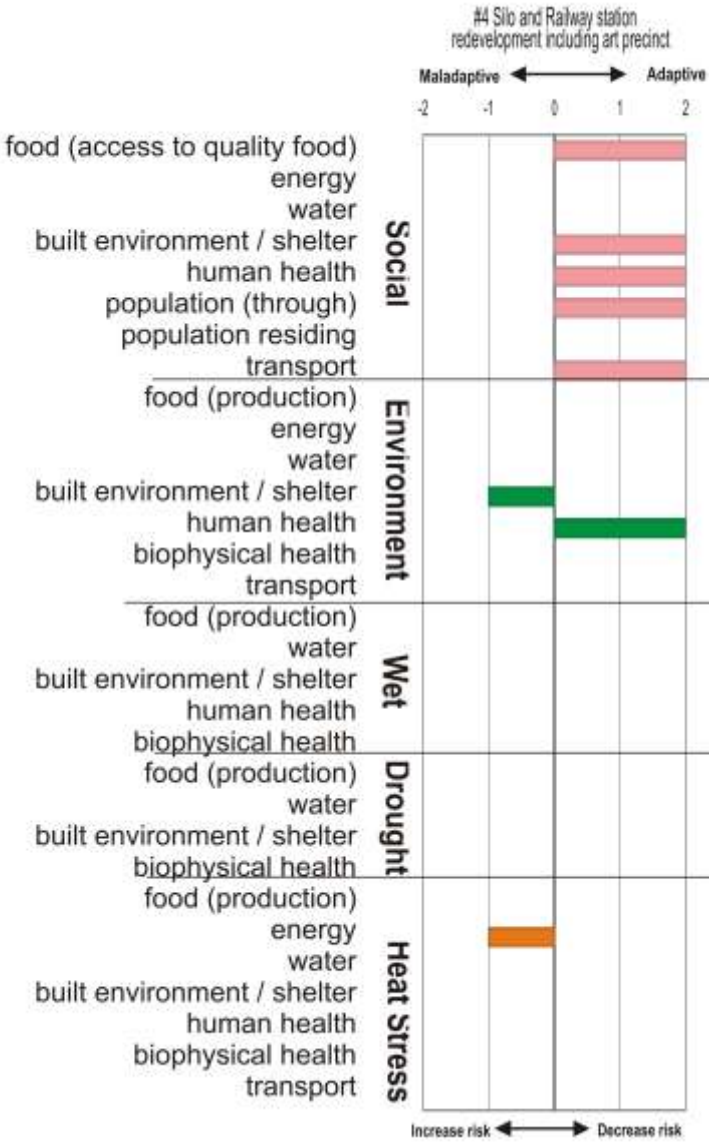


Figure 58 Appraisal thematic 4: Silo and Railway redevelopment

Thematic 4: Silo and Railway station redevelopment including art precinct

Climate Adaptation Design Goals

- Tourism: potential for attractions, photography, agricultural tourism, recreation, science and heritage.

The railway station and silo in town were identified by several groups within the charrette as a potential landmark in the town that could be developed into an interesting precinct for the arts, housing cultural heritage and science (planetarium). A large number of initiatives suggested in the charrette could be housed in this precinct. The suggested design solutions included:

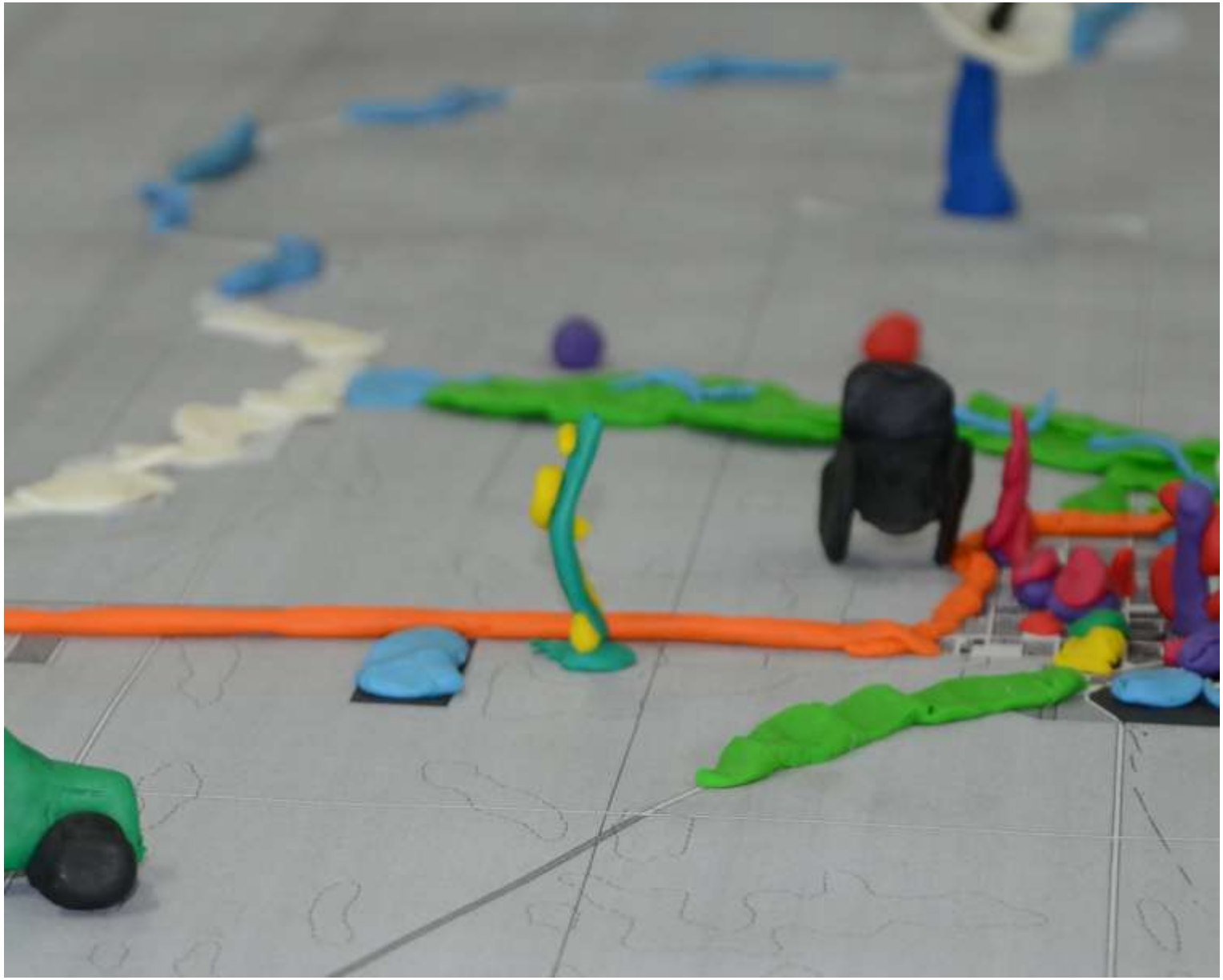
- Silos walls used as outdoor cinema (drive in or not), silos used for lighting installations
- Silos as heritage area; museum for mallee rally and off road racing (home of off road racing)
- 100 mile restaurant with a view and weather station
- Café in old station
- Bakery
- Artists residency attached to old sheds
- Planetarium (in silo being large dark and round)
- Recreational area; climbing wall and abseiling on silo; old push rail cart (kalamazoo) on unused railway tracks
- Skate park
- Novel accommodation (like lighthouse stays)

No shortage of possibilities exists for redevelopment of the silos and railway station if they were available, limited only by the creativity of the town. Green grove organics developments in the Corowa Whiskey and Chocolate Factory (www.corowawhisky.com), and Junee Liquorice and Chocolate factory (www.greengroveorganics.com.au) are interesting case studies of redevelopment in small towns.

If the development was on the south west side, the silos would provide substantial summer shade, and may provide a cool place in town if accompanied by appropriate landscaping, enabling the site to operate as a haven on hot days. Again, the building envelope was not addressed, yet has a high impact on the ability to reduce demand for air conditioning and manage heat stress.

The development could provide a reason for passing traffic to stop, and draw visitors to the region. The 100-mile restaurant or bakery may be one means to vertically integrate produce from the local area in the town. The range of solutions proposed vary significantly in investment costs: an outdoor movie cinema could be as simple as a projector and speaker; residents for artists could be achieved through making space available in town; while a planetarium and rooftop restaurant would have higher costs.

Thematic 5: Aged care accommodation and services



Conceptual design solutions:

- Maintaining hospitals and care facilities with residential accommodation
- Communal housing for elderly people
- Semi-detached independent living units
- Community garden
- Gopher tracks

Figure 59 Thematic 5: Aged Care accommodation and services

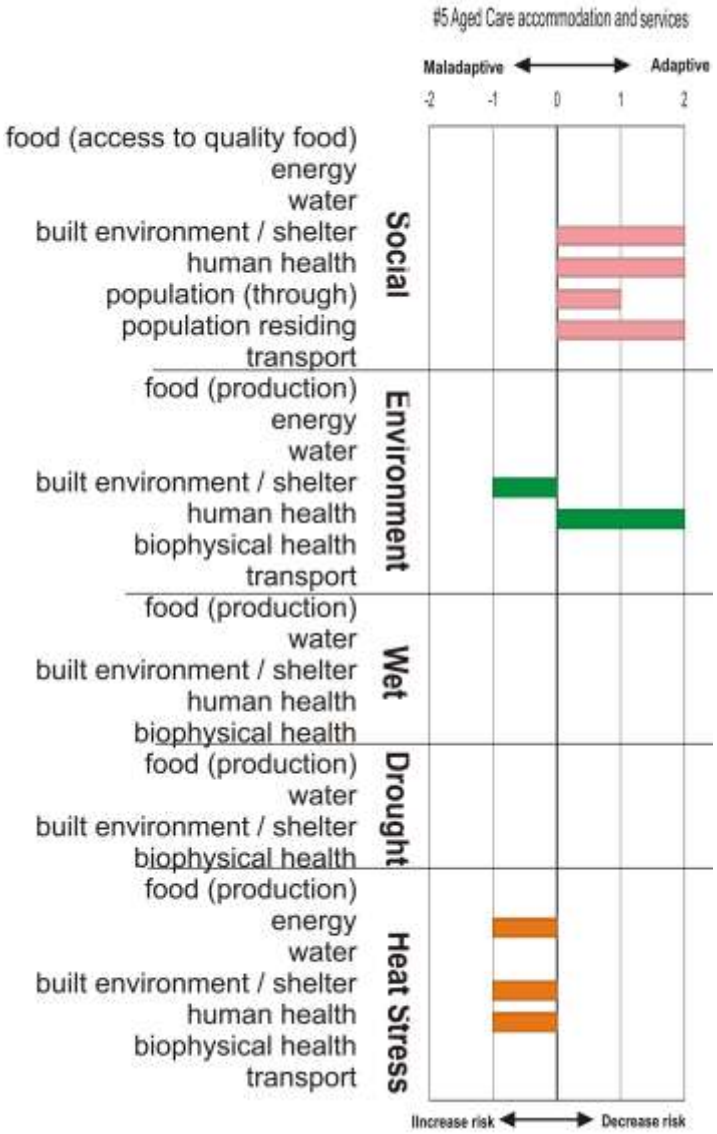


Figure 60 Appraisal Thematic 5: Aged Care accommodation and services

Thematic 5: Aged care accommodation and services

Climate adaptation design goals

- Attracting the wealth of Australia's aged
- Maintain hospitals and care facilities

Down-sizing and a tree change (or sea change) to Sea Lake! The future scenario of day one identified that attracting the wealth of Australia's aged population in 2042 could be a viable means of economic growth for Sea Lake if it could maintain and increase the service offerings for aged care and retirement living. This may include communal housing for elderly people, smaller semi-detached housing, access to community gardens, and gopher (scooter) friendly paths. The lower cost of living in Sea Lake could be used as an attraction to the town for new residence, enabling retirement in comfort (both physically and financially).

The risk of heat stress for an elderly population is of concern. Appropriate building design and landscaping to reduce temperatures via passive design are seen as critical.

The majority of groups discussed aged care a means to retain an ageing population, with the community garden and gopher tracks being design features that could appeal to an elderly demographic. Some design features such as a skate park may conflict with the desires of an ageing population.

Thematic 6: Education development and accommodation

Conceptual design solutions:

- Agricultural centre of excellence
- Tyrell College expanded and agricultural program to expand at local school bringing external people in
- Birchip cropping group (BCG) support Agricultural program
- Education and exchange students' accommodation in vacant buildings
- Connected to the world, Virtual Centre for education that is connected to the rest of the world (prefab or mobile classrooms)
- Educational tourism, astronomy, science tourism, schools and camps
- Educational support material, facilities to connect sea lake science, stories and education.

Figure 61 Thematic 6: Education development and accommodation

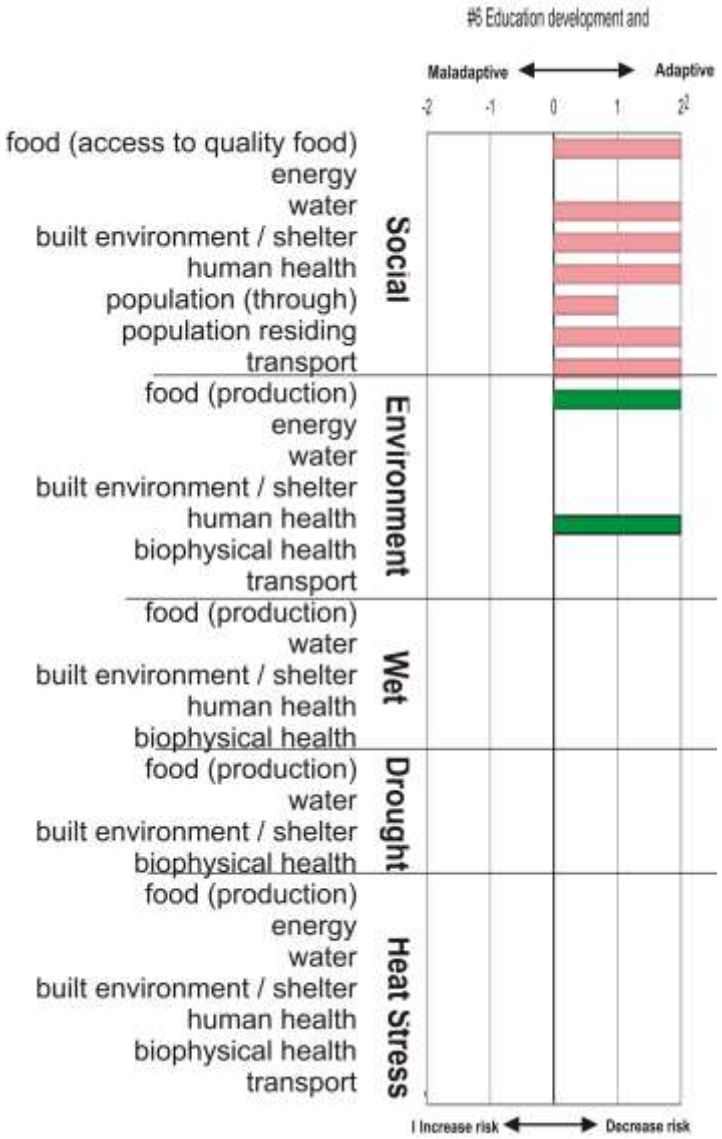


Figure 62 Appraisal Thematic 6: Education development and accommodation

Thematic 6: Education development and accommodation

Climate adaptation design goals

- Virtual classrooms retain students within school.
- Lifelong learning and tech aids to keep up to date.
- Leading education hub for research and development.
- Retain students in town after graduation.

Lake Tyrell's agricultural program was viewed within the charrette as a neat example of an adaptive community. Their work could be further expanded to an Agricultural Centre of excellence. An expanded agricultural program at the local school was seen as a way to bring external people in. Suggestions were made that the BGC group support agricultural program. Exchange students, and accommodation in vacant buildings in town for travelling students, would increase the town's population during school times. Connecting paths between the existing Lake Tyrell site and the town centre were also desired.

Aside from the agricultural program, it was desired for the school to be connected to the world, through a 'Virtual Centre for Education' that is connected to the rest of the world. This might be achieved through retrofitting existing school buildings, or prefabricated or mobile classrooms that could be brought into Sea Lake.

The educational tourism for astronomy, science tourism, schools and camps also requires a physical presence within Sea Lake with an expansion of the community centre, the silo development or an observatory/planetarium at Lake Tyrell as suggested locations. The Renewed Town Centre in Thematic 3 included student accommodation in various forms. If science tourism for schools were to succeed, 'school camp' style accommodation could also be desirable.

The goal of lifelong learning was not addressed in a spatial means within the charrette; however, communication between farmers and government departments in response to issues such as pest plagues, problematic weeds or severe wet was desired to assist in progressing agricultural practices.

The charrette participants stated a desired goal to diversify Sea Lake from being a predominantly agricultural town to one containing arts, tourism and aged care as well as a renewed town centre. The role of education within Sea Lake could progress such ideas through a hands-on approach similar to the agricultural program. A practical approach to adaptation with respect to heat stress, wet and drought could also prepare future generations of Sea Lake and contribute to creating a resilient community.

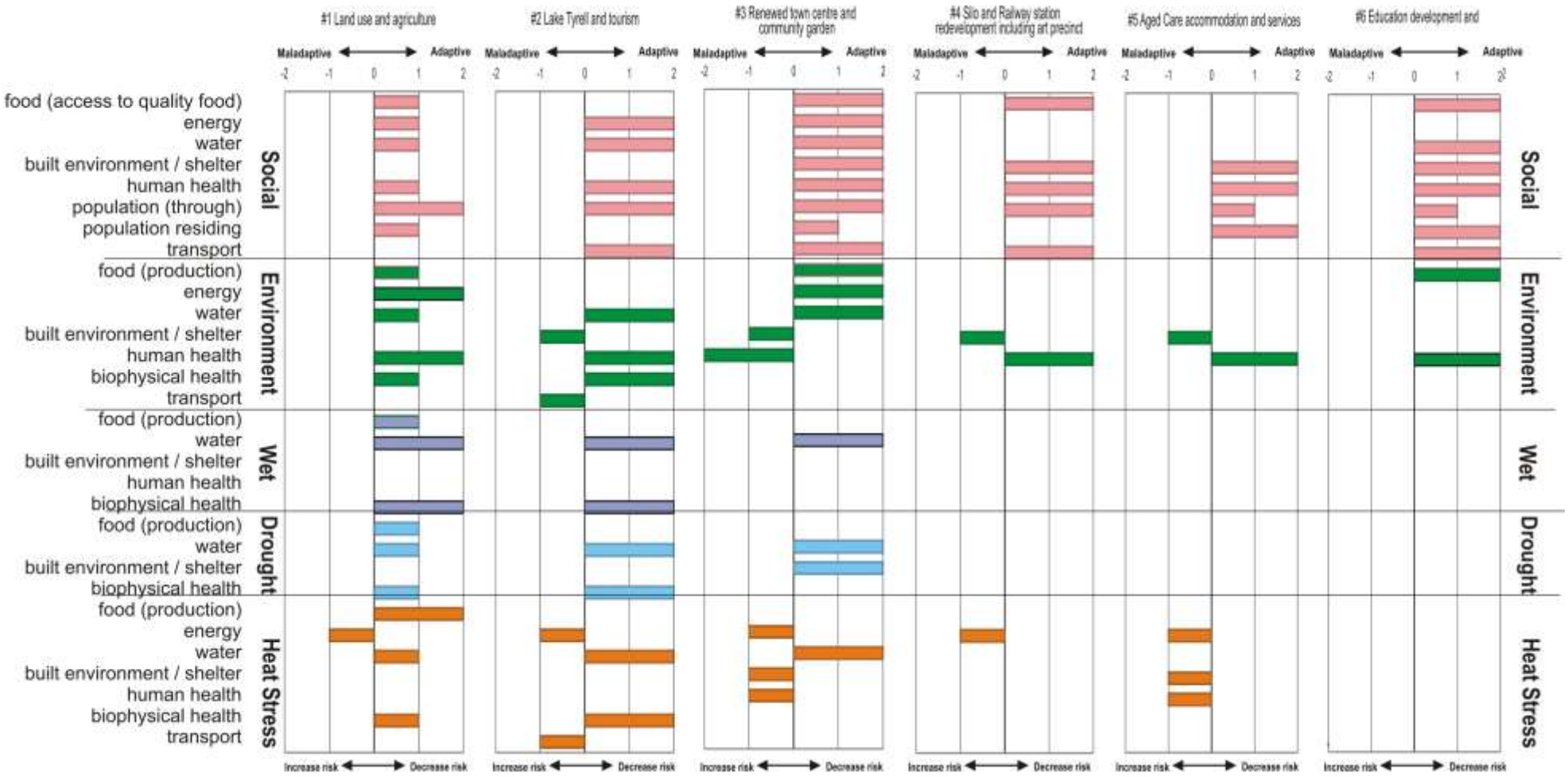


Figure 63 'concept scoring' appraisal of four concepts.

The appraisal identified differences between the thematics, each indicating different potential risks and elements of adaptation or maladaptation. Locating the concept scoring appraisal at this 'reflection in action' phase of the design process enables the potential incorporation of multiple design elements into future designs. It should be noted that no single thematic addresses all appraisal criteria, however, a combination of thematics could provide an adaptive strategy for Sea Lake with positive appraisal outcomes for each criterion achieved.

Population and the maintenance of community are at the heart of Sea Lake's future. Reversing the decline in population requires key services to be delivered, which may attract people to the area. Various conceptual design scenarios have the potential to achieve seasonal and permanent increases in population including tourists, retirees and students.

Adaptive solutions identified for tourism, education and aged care all have a range of associated costs. These can be classified as no cost, low cost or high cost by the community. For example low costs solutions include: air B&B farm stays require no capital aside from time and connection to the internet. The aboriginal night skies have existing educational material prepared via Museum Victoria (Museum Victoria 2012), journal papers (Morieson 1999) and the first recorded aboriginal constellation in *On the Astronomy and Mythology of the Aborigines of Victoria* (Stanbridge 1857). The Box Gully archaeological site on Lake Tyrrell has remains of a small hunting camp that has been radiocarbon dated as between 26,600 and 32,000 years old (Richards et al. 2007). Coordinating the existing educational material could assist in the promotion of Lake Tyrell at minimal expense, while cyclo-cross tracks around Lake Tyrell could use parts of the Mallee Rally track.

At the high cost end of the spectrum, a planetarium or observatory would require higher investment, although the conversion of existing buildings could be achieved for a more modest budget. In this vein, there are a number of worthwhile ideas that would require further refinement and matching against multiple business plans.

The appraisal has also identified gaps in the charrette approach relating to what the conceptual designs did not include. At present these are viewed as potentially maladaptive, and could be adaptive if attended to. These include:

- Farming practices are significant in determining future environmental impacts in the region. Environmental metrics should be considered in future farming practices.
- Heat stress and energy efficiency were not explicitly addressed and should be included in future development – achieved by both landscaping and building design. Energy generation was a feature, with various renewables proposed.

5.6 Appraisal results: Sea Lake charrette 2

Charrette 2 aimed to identify and prioritise specific initiatives from Charrette 1 that Advance Sea Lake Inc. may have the capacity in mobilising, and identify the first steps towards their implementation. This was achieved through facilitated discussion with the Advance Sea Lake Inc. committee focusing on three areas:

- Identifying themes/initiatives that would **not** be in the interest of Advance Sea Lake Inc.
- Revisiting areas that the charrette appraisal viewed to be 'maladaptive' and identifying how the existing designs may be modified to become more 'adaptive'
- Categorising concepts from each theme with respect to costs (low, medium or high) and timeframes (short, medium and long) to identify potential initiatives that could be developed further by the Advance Sea Lake community.

An overview of charrette 2 outcomes is provided in Table 8, and discussed in the following pages. The process used in Sea Lake charrette 2 differs to that used for Bendigo due to the context of the solutions and intended outcomes. CoGB were looking to develop a new industrial zone, while Advance Sea Lake Inc. were aiming to progress a community strategy.

Table 8 Community review of climate adaption strategies

Strategy	Status	Overview of Community Review 19th October 2012
#1 Land use and agriculture	Priority area outside direct influence of Advance Sea Lake Inc.	Initiative already advanced, and envisioned to continue through combined efforts of local farmers, regional groups and state departments. Advance Sea Lake may not be the best platform to progress agricultural initiatives.
#2 Lake Tyrell, Green Lake and Tourism	Priority, with a range of near, medium and longer term strategies.	Large potential for Green Lake and lake Tyrell: existing proposals for additional hydrological work called for by Green Lake committee is an existing near term strategy. Developing an iphone app to communicate significant and accessible areas of the region (particularly Lake Tyrell) a key new near term strategy to progress. Internal Strategy for tourism needs to start within the town and local education (medium term). Lake Tyrell has a key barrier in access to the salt lake due to: security of the salt works, and cultural reasons that would need to be negotiated in the longer term for Lake Tyrell to thrive as a tourist destination.
#3 Renewed Town Centre and Community Garden	Medium term strategy that requires income and population to advance. Themes #5 and #6 viewed as enablers of theme #3.	Desirable outcome of bringing additional people to town, investing in town. The strategy requires finance to assist. Strategies #5 & #6 could provide a mechanism to produce an influx of funds. The strategy would be responsible for upgrading the building stock and landscaping to reduce heat stress, and improve energy efficiency.
#4 Silo and Railway Station Redevelopment including Art Precinct	Low priority	Good idea, however a low priority for Advance Sea Lake Inc. Location from town is viewed to be distant. Requires more significant capital.
#5 Aged Care Accommodation and Services	Priority: near term strategy, with medium and long term visions	Engage with existing service providers to suggest that Advance Sea Lake Inc. see increasing service offerings for retirees as a viable strategy for the town's future. This would eventually contribute to upgrading the building stock in theme #3.
#6 Education Development and Accommodation	Priority: near term strategy, with medium and long term visions	Engage with Tyrell college with the proposition that short term boarders could stay within the town. Longer term vision would be retrofitting purpose built boarder accommodation into the town.

The Advance Sea Lake Inc. group identified three of the six themes as priority areas that could potentially grow and progress climate adaptation within Sea Lake. These are described below:

Theme #5 Aged care accommodation and services

A long term vision for population growth in Sea Lake is via attracting Australia's future retirees to the town on the premise of affordable retirement. By downsizing and making a tree change, retirees move from being asset rich and cash poor within major cities to cash positive. Sea Lake could be a base for the grey nomads.

Central to this theme is the continuation and expansion of care services in the town. The initial step for Advance Sea Lake Inc. is engaging with the existing care services within the town on the future vision. A near term strategy identified was to make Sea Lake attractive for care industry trainees in the field by providing boarding facilities within the town. An influx of trainees would increase population and the economy.

The longer term vision includes additional development of independent living units on the old primary school site, with community gardens and best practice sustainable development.

Theme #6 Education development and accommodation

The agriculture program at Tyrell College (local high school) that is exceptionally strong was viewed to have the potential to attract students from regional Victoria and overseas. The initial step identified is to engage existing education services to propose the Advance Sea Lake Plan, which includes possible co-housing of boarders for week long intensive agricultural courses. The longer term strategy includes retrofitting existing houses for school boarders, and expanding the student population of Tyrell College.

Theme #2 Lake Tyrell, Green Lake and tourism

Tourism is viewed as a means to encourage economic growth for Sea Lake through developing Green Lake, and using Lake Tyrell as a regional draw card. The Green Lake committee master plan, which aims to restore the lake bed is a present initiative aligned to the outcomes of charrette I. When the lake is full, the proposed accommodation and camping sites provide year round revenue from camp fees.

Lake Tyrell was viewed in charrette I to be an untapped potential resource for tourism; however, Advance Sea Lake Inc. identified that while desirable, access to the Lake is problematic for two reasons: 1) Security issues in relation to the Salt Work and, 2) Cultural heritage limiting access to the lake. The group identified that the area is only accessible one weekend every two years for the Mallee Rally. A longer term strategy for tourism requires activism and engagement with relevant bodies to negotiate more frequent, well-managed access.

A starting point to progress tourism under limited access to Lake Tyrell is the development of a phone App that embeds the existing knowledge of the various significant sites in the region, locating existing viewing platforms around Lake Tyrell that are accessible at present (Figure 64). This would enable limited self-guided tours of Lake Tyrell that may explain:

- aboriginal night skies constellations
- flora
- fauna
- the Box Gully archaeological site on Lake Tyrrell
- salt works

Additional features for the app could extend to the Sea Lake region to include:

- air B&B stays
- working of silo’s
- green lake
- places to eat.

Additional strategies and initiatives could be fast tracked through the co-ordinated efforts of a broader range of stakeholders. Dedicated funding and human resources to co-ordinate the various stakeholders from all spheres of governance and industry were identified by the Sea Lake community as necessary to enable a broader range of initiatives to be implemented.

Figure 64 Artistic impression of proposed Advance Sea Lake smart phone application

Table 9 Theme #2 Lake Tyrell and Green Lake tourism from the Sea Lake charrette

Theme	Proposed initiatives	Relevant Stakeholder	Timing
#2 Lake Tyrell, Green Lake and Tourism	Eco lodge for Tyrell or Green lake, Site seeing air tours, Co-ordinated Farm stays for visitors promoting Lake Tyrell's heritage	Developers and entrepreneurs, Buloke Shire Council, Tourism Victoria, DBI Tourism & Aviation, Air B&B, Advance Sea Lake inc, & Green lake committee.	potential near term and medium term
	Restoration of green lake	Green lake committee & Buloke Shire Council.	Progression on current initiatives, Near term
	Promote Aboriginal heritage (30,000 year evidence of aboriginal population). Astronomy: Aboriginal night skies (first documented aboriginal astronomy in 1857 at Lake Tyrell from Boorong people), opera under the stars; planetarium and or observatory	Advance Sea Lake inc, Toursim Victoria, DPCD (aboriginal affairs), Victorian Aboriginal Heritage Council, local elders and indigenous people, Tyrell College, Buloke Shire Council, Sea Lake Tourist information centre, potential developers.	Progression on current initiatives, near, medium and long term
	Vegetation protected, bio links expanded and biodiversity increased.	Sea Lake Landcare/VFF, local landowners, DPI, DCEE (CFI), DSE, BCG	Progression on current initiatives,
	Cycle tracks to and around Lake Tyrell and Green Lake, Cyclo-cross (mountain bike) event like Mallee Rally	Toursim Victoria, Advance Sea lake Inc, Mallee Rally Committee, DoT, DSE, Buloke Shire Council, cycling Victoria, sporting clubs	Near - medium term
	Sculpture park connecting sea lake to lakes, with an exhibition of statues and art through sea; lake and Tyrell, (residencies for artists),	Toursim Victoria, Arts Victoria, Culture Victoria, Advance Sea Lake inc, community groups, Sea Lake beautification committee. DSE	Near - medium term
	Lake Tyrell salt works employment	Cheetham Salt Works, DPI, Buloke Shire Council	Progression on current initiatives,
	Public transport to Sea Lake on weekends, using school bus on weekends	DoT, V/line, private bus company, Buloke Shire Council	Medium term
	Educational tourism, astronomy, science tourism, schools and camps, Educational support material, smart phone application collating sea lake science, stories and education.	Advance Sea Lake, Toursim Victoria, Sea Lake Tourist information, DPCD (aboriginal affairs), Victorian Aboriginal Heritage Council, local elders and indigenous people, Tyrell College, Buloke Shire Council, centre, Australian Centre for Astrobiology, Macquarie University, DEECD, DPI	Mix of near and medium term initiatives

6 Design-led decision support process and engagement

Following the experience of the Charrettes (Sections 4 and 5), Section 6 is drawn from an additional work package 3.3 “Design-led decision support process and engagement”. This presents proposed principles for undertaking design led decision support exercises, drawn from the experiences of the research for this project. The principles are drawn from the research experience and are intended to guide the application of the design-led approach to adaptation planning.

6.1 Synchronising with existing planning processes

Synchronisation of the design charrette within existing planning processes can most effectively engage councils by identifying where the charrette can address a gap or provide an answer to a specific question in the regular planning process. Clear connections and integration of the charrette with existing planning processes, rather than viewing it as a stand-alone exercise, increases the likelihood of successful engagement and the generation of ongoing commitment and enthusiasm,

Since planning combines plan cycles with ongoing strategic processes, the challenge for a design-led adaptation planning exercise is to both engage with these existing processes and activities, and offer a radical set of alternative possibilities and ways of thinking about the future. Charrettes have shown to be ideal for this, with the caution that they are best set within the strategic medium-long term arenas of regular planning processes.

6.2 Engaging local government commitment

There are two important considerations in securing local government commitment. These are partly drawn from the project experience where three of five councils engaged in the process withdrew at a later stage. The first is to ensure there is a single design champion within the Local Government at a senior level. This is preferably the CEO, or has direct access to the CEO. A design-led charrette engages local government staff and the community in a process of learning which discusses planning futures at both neighbourhood and regional scales. As such, many interesting and challenging topics are likely to be raised. It is important that the Council CEO is aware and supportive of the scope of the charrette and is able to brief councillors and staff accordingly and with appropriate lead time. Ideally, the CEO would attend the charrette and encourage relevant staff and stakeholders to participate thereby maximising opportunities for new and innovative ideas to come forward in relation to climate adaptation planning for the community.

The second is that commitments should be multiple and demonstrative rather than single and verbal in nature. Financial commitments from participating councils are desirable. In this Project, regional charrettes were delivered to the participating council free of charge, with in-kind commitment from the participating councils in staff time for attendance. The research project was by the State Government funding through VCCCAR and implied the design charrette be delivered free of charge for councils. Seeking a financial commitment for future charrettes could raise the validity of the process and outcomes for the participating councils. Asking local governments to participate in a design led-Charrette requires them to make resource allocation decisions related to the participation of staff. This in itself is a cost to the Council which must be recognised. We also believe that contributing to the costs associated with conducting a charrette adds value to the process, costs such as accommodation for facilitators (funded by the State Government), venue hire and meals for all participating. A financial contribution may form the basis for a stronger commitment with councils.

6.3 Engaging other government departments and agencies

It is important to ensure representation from relevant state government departments and agencies. Climate change adaptation requires planning and coordination at both state and local government levels. Appropriate state government officers can bring considerable professional expertise and understanding to a design-led charrette as well as awareness of state government public policy relevant to the development and implementation of adaptation strategies at the local level. Historically, the impacts of climate related events in Victoria have been addressed through collaborative efforts by both state and local governments.

6.4 Engaging the right mix of stakeholders

The VCCCAR design led charrettes invited participants from multiple backgrounds and levels of governance. Participants invited held diverse skilled sets including academics from landscape designers, creatives and climate scientists, local council participants from a diverse range of planning areas, community organisations and industry, and State Government officers from DSE together with DPCD and DPI. Identification of appropriate stakeholders is not only critical for the successful outcome of the charrette; it is also valuable in creating momentum for the delivery of the charrette.

6.5 Making space for tacit knowledge

The charrette should recognise the value of tacit knowledge within the community. One of the key reasons why participants reportedly enjoy the charter process is that it asks them to call on their tacit, or 'taken for granted' knowledge, of the neighbourhood, community and region in which they live. It is often surprising just how much knowledge and awareness people have about their locality and the impact of weather and climatic events in the area. A well-facilitated charrette moves from asking individuals to broadly reflect on possible adaptation options to small, focused group discussion about the details and implications of these options. Through this process of individual reflection to group discussion, participants typically share information that they may not have previously regarded as relevant. It is important to acknowledge this tacit knowledge from multiple perspectives throughout the process as it constitutes one of the key elements of a successful charrette.

A well facilitated charrette moves from asking individuals to reflect on possible adaptation options to small group discussion about these options. Tacit knowledge is the basis for the success of the charrette and must be acknowledged throughout the process. This tacit knowledge is located amongst planning and coordination at both State and local government level. State government officers bring considerable expertise and understanding bringing awareness of State Government public policy relevant to the development and implementation of adaptation strategies at the local level, warranting their inclusion.

6.6 Setting timing and expectations

A traditional design charrette takes between four and seven days (Lennertz and Lutzenhiser 2006; Condon 2008) with intermediate public involvement. In the context of The VCCCAR design led charrettes, excellent results were also found to be possible while using shorter time periods of 1.5-2 days. The charrettes for this project were well and consistently attended, but occasionally individuals did drop out, with immediate impacts on the design process and outcome. Therefore, it is important that all participants are well briefed with documents and material a week or two prior, and that they commit to attending all of the sessions, leaving phones outside, etc., rather than viewing the charrette as an optional matter.

6.7 Undertaking and resourcing communications

The Design charrette involves a diverse number of participants, and a much wider range of stakeholders who need to be informed about the event and its outcomes. A well-developed communication plan to engage all participants and stakeholders prior to and after the charrette is therefore essential, along with sufficient resources to enable its implementation.

7 Conclusion and recommendations for policy

This Project has adopted a Charrette-based design-led approach and in so doing provided new perspectives for climate adaptation. The main areas within which outcomes of the research are found are two-fold. First, the in outcomes of the Charrette exercises, and second, in findings regarding 'how to' undertake design-led adaptation planning process.

Regarding the first set of outcomes, the Charrette process is unpredictable and therein lies a strength, in that it allows thinking of the unthinkable, with checks and balances along the way (criteria). Sections 4 and 5 document the two sets of Charrettes and associated design exercises, for Bendigo and Sea Lake, respectively.

The futuring exercise describing the past present and future in the Sea Lake Charrette provided a platform for the community to reflect on what a desirable or undesirable future community may be. Within the Bendigo Charrette I, high density living and nuclear power were clearly rejected by the participants, whereas a suite of other alternatives appeared to gain the support of the participants as 'good climate adaptation'.

The appraisal between Charrette I and 2 was essential in refining the development of appropriate responses to climate adaptation, and highlighting potentially maladaptive features. Charrette 2 in Bendigo integrated multiple features from Charrette I into the Marong Business Park, and enabled a clearer focus on potentially maladaptive solutions (for example a specific focus on demand management). With respect to informing a decision support framework, the appraisal is directional as opposed to definitive in assisting to validate preferred futures. The appraisal methodology may be valid across smaller and larger geographic scales, and at the level of projects or programs. When applied in the two case studies the process was effective at highlighting strengths and weakness of proposed scenarios.

The 'Project Manual' in Section 3 provides a 'how to' guide for undertaking charrette-based design-led decision support for climate adaptation planning and the principles for Design-led decision support process and engagement. This is based upon previous Charrette-based design approaches as documented in the literature and the experience of this Project team. In addition, the 'process and engagement' Section 6 documents principles to guide the organisation of future design-led adaptation planning projects based upon the experiences of this Project.

7.1 Recommendations for policy

To date there has been no effective way to produce and test designs for 'good adaptation', defined as adaptation that:

- decreases climate risks, hazards and community vulnerability while increasing resilience; within the region,
- is sustainable from a triple bottom line perspective, and
- avoids maladaptation (where a particular response to an actual or predicted disturbance weakens the system's overall resilience, for example, by decreasing the effectiveness of mitigation strategies).

In testing a design-led process for adaptation planning, this Project provides the following recommendations for policy:

1. Reframe climate adaptation from risks to opportunity.

Reframing climate adaptation from risks to opportunities can be combined with conducting positive design-led exercises in a participatory manner, through the combination of Charrettes and appraisal applied in this Project. While the risks and consequences of climate change cannot be downplayed, the novelty of the Design charrette as a planning approach lies in its ability to reframe climate

adaptation as a potential opportunity as opposed to a risk. Designing spatial plans based on the natural features of the landscape can increase communities' resilience and their capacity to adapt to climate related events.

2. Provide an inclusive environment for co-design.

The inclusion of policy makers and other stakeholders in design exercises provides new yet practical adaptation responses to climate change in different Victorian contexts. The design-led process identified "no regret solutions" that would be of benefit to the community irrespective of a climate changed future, such as the recreational zones on the edge of town that provide both open space and a bushfire buffer zone. Proposals for Marong Business Park emerged that have the capacity to increase biodiversity on site, and utilise the landscape features for multiple purposes.

3. The key is process and engagement rather than prescriptive solutions.

The importance of process is instructive; the Project approach provides for context specific-solutions and criteria for climate change adaptation at a regional and/or local level. This involves use of participatory processes involving key stakeholders and the community to identify climate adaptive criteria within the regions that are adapting. The Charrettes were all successful in producing positive, adaptive plans which multiple stakeholders and perspectives contributed to. The spatial and temporal complexity of climate change mean that the adaptations considered to be successful by one group might be judged by others in different places and times to be unsuccessful (Adger et al. 2005). The goals of adaptation for Bendigo and Sea Lake differed, as did the type of conceptual design solutions generated.

This highlights the requirement for context when discussing climate adaptation, who is adapting (which community) and to what (climatic stressors). The Bendigo charrette was concerned with increasing density within the town and restricting urban sprawl as low density urban fringe development is often considered to be inefficient for infrastructure provision (Trubka et al. 2010) and is linked to poor health and social outcomes (Ewing et al. 2003; Giles-Corti et al. 2005; Trubka et al. 2010). The charrette process provides a process to not only ideate ideas for climate adaptation, but to also identify the appraisal criteria for what 'good adaptation' for the region would be.

4. Appraisal adds to the value of the design-led exercise.

To appraise 'good adaptation' a concept scoring approach common in design was utilised. The methodology for appraising designs for adaptation involved the following stages:

1. Develop the appraisal criteria in a participatory process.
2. Appraisal of the design outcomes in a participatory process.
3. Measurement of the design outcomes against 'good adaptation' appraisal criteria.
4. Comparison of the results to identify solutions.

The findings from applying the appraisal method suggest that most value is obtained when the appraisal occurs within the concept generation phase, occurring within the design planning process to improve design outcomes for climate adaptation. This process is also most successful if participatory—where the adapting community contributes to developing the criteria for 'good adaptation', as well as appraising the adaptive capacity of the design concepts. The community could be one of their best resources in terms of local and specific understanding of problems that are well known to be 'wicked' and complex.

The project demonstrates that the use of appraisal between Charrettes I and 2 is a useful means to inform the planning phase. For example, in the Bendigo Charrettes, the Residential Strategy was the subject of review at the timing of Charrette I, so the results could be used in the further development of the strategy. Charrette 2 focused upon applying the results of Charrette I to the proposed Marong Business Park. In this exercise, the appraisal results of Charrette I were directly influential upon the Charrette 2 exercise, process and outcomes, indicating the value of appraisal as part of the design process.

5. Adaptation and mitigation efforts should be complementary.

Charrettes can generate multiple climate adaptation design concepts and solutions. To increase their relevance and applicability for future implementation, our findings indicate that many adaptation solutions doubled as mitigation measures from both Charrettes. For example, renewable and distributed energy may provide a more resilient power supply for Marong Business Park (Bendigo Charrette) in the medium-long term, while also reducing CO2-eq emissions. Passive design and landscaping to reduce the heat island effect may reduce the perceived need for air conditioning, which also reduces energy use and CO2-eq emissions.

A significant constraint to the implementation of adaptation initiatives from the Sea Lake Charrettes is apparently a lack of capital. Incentives to finance local initiatives that reduce CO2-eq emissions could progress adaptation to climate change when mitigation and adaptation appear complimentary. Equally important is identifying mechanisms that may reduce the development of maladaptive initiatives, which may be inherent in 'Business as Usual' scenarios for the community.

6. Ongoing coordination and financing is required.

Ongoing coordination and financing across multiple levels of government and timeframes is required to ensure resilient futures. Initiatives for climate adaptation are not 'fit and forget' solutions. The scenarios developed by the local councils in all Charrettes involved various timescales and would require input from various levels of government if they are to be realised. For example, the Sea Lake charrette identified short, near and long term goals that would require a committed, multi-level strategy and funding over time in order to realise. The Sea Lake community specifically requested a local 'planner' to co-ordinate the multiple initiatives and stakeholders that could advance the town. The realisation of climate adaptation designs and plans requires support.

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