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Positioning Paper

Affordability and sustainability outcomes of 'greenfield' suburban development and master planned communities – a case study approach using triple bottom line assessment

authored by

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AHURI POSITIONING PAPER SERIES

AHURI Positioning Papers is a refereed series presenting the preliminary findings of original research to a diverse readership of policy makers, researchers and practitioners.

LIST OF ABBREVIATIONS

AMCORD: Australian model code for residential development

CIP: Community indicator program

DCP: Development control plan

ESD: Ecologically sustainable development

GBTool: Green building tool

IPA: Integrated Planning Act

LGA: Local government authority

MPC: Master planned community

MFA: Material flow analysis

NSW: New South Wales

NatHERS: National home energy rating system

SA: South Australia

SFD: Single family dwelling

SOEs: State of the environment reports

TBL: Triple bottom line

TRS: Traditional regulatory subdivision

WSUD: Water sensitive urban design

GLOSSARY

Abatement costs: The term generally refers to corporate capital expenditures connected with environmental protection and damage. It includes the direct costs of rectifying damage by pollution; the increase in operating costs by type of media that might be attributed to hazardous and other forms of waste from industrial processes; the level of disposal and recycling costs; and a miscellany of pollution prevention and remediation costs associated with site cleanup, habitat protection, environmental monitoring and testing, administrative environmental programs, application for permits and related fees and any penalties and fines connected with compliance issues.

Carrying capacity: Carrying capacity refers to the number of individuals who can be supported in a given area within natural resource limits, and without degrading the natural social, cultural and economic environment for present and future generations. The carrying capacity for any given area is not fixed. It can be altered by improved technology, but mostly it is changed for the worse by pressures which accompany a population increase. As the environment is degraded, carrying capacity actually shrinks, leaving the environment no longer able to support even the number of people who could formerly have lived in the area on a sustainable basis. No population can live beyond the environment's carrying capacity for very long.

Contingent valuation: Contingent valuation is used to estimate economic values for all kinds of ecosystem and environmental services. It can be used to estimate both use and non-use values and it is the most widely used method for estimating non-use values. It is also the most controversial of the non-market valuation methods. The contingent valuation method involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services, either to give them up or to receive them. For example people may be asked for the amount of compensation they would be willing to accept if they were to live adjacent to a sewerage treatment plant. The compensation might be in the form of a discount on market price of a house in the vicinity. It is called “contingent” valuation, because people are asked to state their willingness to pay, *contingent* on a specific hypothetical scenario and description of the environmental service.

Material flow analysis: The term material flow analysis is used to denote the method employed to record, describe and interpret metabolic processes. This method is a scientific procedure used to quantify the turnover of materials for a defined area over a specified period of time as the system boundaries. This method can be applied in the same way to energy turnover. The terms "material flow (or flux) analysis" (MFA) and "substance flow analysis" (SFA) are found in international literature.

Precautionary principle: The precautionary principle is about living with uncertainty and risk. It suggests that if we are unsure about future limits the prudent course is to temper our activities until proven that they do not pose a problem for current or future generations.

Release areas: The term “release area” means areas that are not zoned for residential use but which are specifically designated by Planning NSW in conjunction with the relevant local government agency to be serviced with necessary infrastructure and made available for residential and other forms of urban development.

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EXECUTIVE SUMMARY

Introduction

Urban development, including housing, has significant environmental impacts such as resource consumption, over-extraction from aquifers, the pollution of water, the atmosphere and land, and the elimination of habitat and consequent destruction of flora and fauna. As a result, there is a growing desire to provide housing which offers a comfortable standard of l iving, reduces environmental impacts and which simultaneously achieves a degree of affordability. To this end, governments at federal, state and local levels are beginning to incorporate principles of environmental sustainability into urban development, es pecially new housing, and both policy and regulations are beginning to reflect the need to become more environmentally sensitive.

The primary aim of the research is to assess the extent to which housing can be affordable whilst simultaneously being sustain able. The research will examine the economic, environmental and social characteristics of two broad development types and the relationships between these three domains of the sustainability model (Hodge 1996). The two broad development types are the tradit ional regulatory subdivision (TRS) and the master planned community (MPC) and they act as a vehicle for the research using a case study approach. The two land development forms are defined in the research as providing “mainstream” housing, that is single family detached dwellings in middle -income neighbourhoods and two case studies in each of NSW, South Australia and Queensland will be examined. Sustainability in this research project applies firstly, in an economic sense, for example, the financial costs associated with the two development forms. Secondly, it applies to the environmental arena, for example reducing impacts by incorporating features that will encourage water and energy conservation or through improved stormwater management. Thirdly, sustaina bility also applies in a social sense so that neighbourliness or feelings of community may vary depending on the nature and form of the development.

This Positioning Paper introduces the conceptual framework for the study. It defines the term sustainability as used in this research project, reviews the literature connected with its measurement, examines the national policy context related to sustainability, especially in connection with land development for housing purposes, and discusses triple bottom lin e analysis and its application to the research problem. The paper elaborates on the research methods used in the project and comments briefly on methodological issues and problems grappled with to date. Subsequent reports will present the findings of the project.

The Research Process

Since its conception in 1972 (Meadows 1972), sustainable development has been defined in literally thousands of ways, none of which materially help to operationalise the concept or to reduce the complexity of its measurement. T he context for the research is the Bruntland Report’s all -embracing philosophical definition (WCED 1987), elaborated into principles and practices as evidenced from the literature and policy reviews. The research process is illustrated in Figure 1 on page 2. A number of detailed sustainability assessment methods have been canvassed. Each possesses a methodological framework designed to assess the impact of development in either economic terms (for example, its financial capital); in environmental terms (its physical capital - the quality of natural resources, including water, air, soil and biodiversity); or in social terms, that is its socio -cultural capital, including quality of life, and cultural heritage (Mercer 2000; Hodge 1996).

Aspects of some of the a ssessment tools examined are rudimentary for the evaluation of complete communities. The only methodology with a direct and practical application to the type of integrated performance assessment required for the study of sustainability involved the use of indicators which cover the three sustainability domains and their inter -relationships. Most methods emphasize the physical and most lacked a robust framework that encompassed all three sectors, in particular an acknowledgement of their interacting nature. The researchers concluded from the sustainability assessment literature that a suite of indicators based on the tenets of sustainability would provide the most appropriate approach for the performance evaluation. The research will use a 'triple bottom line ' (TBL) process for the comparative

evaluation. The TBL tool will consist of a series of indicators reflecting key aspects of the economic, social and environmental domains. The suite of TBL indicators were derived from a wide variety of sources in the cur rent sustainability literature and also from operational indicator programs, chiefly in Australia and the United States (for example North Sydney City Council 2000; Willoughby City Council 2000; City of Santa Monica 2000; City of Olympia 2001).

Local gove rnment's planning and development powers are positioned to have significant influence on the private housing market in Australia. However, councils have generally not been proactive in shaping housing outcomes (Gurran 2002; Paris 1990). Environmental poli cies in existence when the proposed case studies were being developed were rudimentary and mainly limited to basic infrastructure services to provide clean water and sewage treatment (Liverpool City Council 1991). Application of sophisticated environmental policy is a recent phenomenon in Australia for all levels of government. The policy review covers a number of overlapping areas which have relevance to residential urban development, for example biodiversity, emissions (in relation to energy use), water quality and supply, storm water management, and waste management. It is clear from the review that a more proscriptive regulation in regard to the environmental performance of urban development is developing, especially in the housing area. For example, the rating system, NatHERS, developed by the Commonwealth Scientific, Industrial and Research Organization is gaining widespread application in Australia a tool used to predict the energy loads in new residential buildings. In the states of New South Wales, Queensland and South Australia, the strategic planning agencies of PlanningNSW (2001), the Department of Local Government and Planning (1997) and PlanningSA (2002) respectively, have adopted sustainability principles which act as a policy and regulatory fra mework for local Councils in their exercise of the planning and development function. Ensuing legislation and other initiatives identified in the policy review help to highlight the critical issues inherent in sustainability and have contributed to the dev elopment of the TBL assessment methodology. In Queensland the Integrated Planning Act (IPA) became law in 1997 with the express purpose of achieving 'ecological sustainability' by, firstly, coordination and integrating planning at the local regional and State levels and, secondly, by carefully managing the development process. Some local councils have introduced sustainability criteria at the design approval stage. For example Brisbane City council through its City Plan 2000 requires buildings to meet perfo rmance or prescriptive standards for energy.

Research outcomes will be based on four methodological paths. The first is the literature review, chiefly focussed on sustainability assessment. The second is the policy review which is where the link with sust ainability ought to occur in practice. Thirdly, the literature and policy reviews combine to yield a suite of TBL indicators reflecting the three domains of the sustainability triad. Lastly, the TBL indicators are applied to case studies and make a critica l contribution to the research findings.

The TBL assessment will be based on a suite of 37 indicators that will be applied to the case studies selected in the three States. The case studies will address varying climatic, economic, and policy environments and will provide national relevance to the research. The TBL evaluation will involve an economic assessment, for example the relative subdivision costs of the two land planning types. Attention to the social aspects of each community will come through a su rvey which will assess sense of community as well as residents' satisfaction with their neighbourhood. Lastly, there will be an environmental appraisal of the different land development types looking at energy consumption and emissions and other environmen tal impacts involving for example biodiversity, stormwater and water sensitive urban design and the destination of the waste stream.

1 ACHIEVING HOUSING AFFORDABILITY AND SUSTAINABILITY SIMULTANEOUSLY

1.1 Introduction

This Positioning Paper reports on a researc h project being carried out by the UNSW/UWS Research Centre of the Australian Housing and Urban Research Institute. The research examines the application of economic, social and environmental variables to a sustainability performance assessment of two prin cipal development models, namely traditional regulatory subdivision (TRS) and master planned community (MPC) in Australia. The two land development forms are defined later in paragraph 1.2.

The paper is the first of a number of outputs from this AHURI proj ect. The aim of the Positioning Paper is to provide an overview of environmental policy in NSW, SA and Queensland related to sustainability, to provide a review of the literature related to the operationalisation of sustainability and its measurement and t o detail the research methods used in the project. Further outputs from this project will present the findings of the project, and will include a Work in Progress Report and a Final Report. The project will be completed by 30 May 2003.

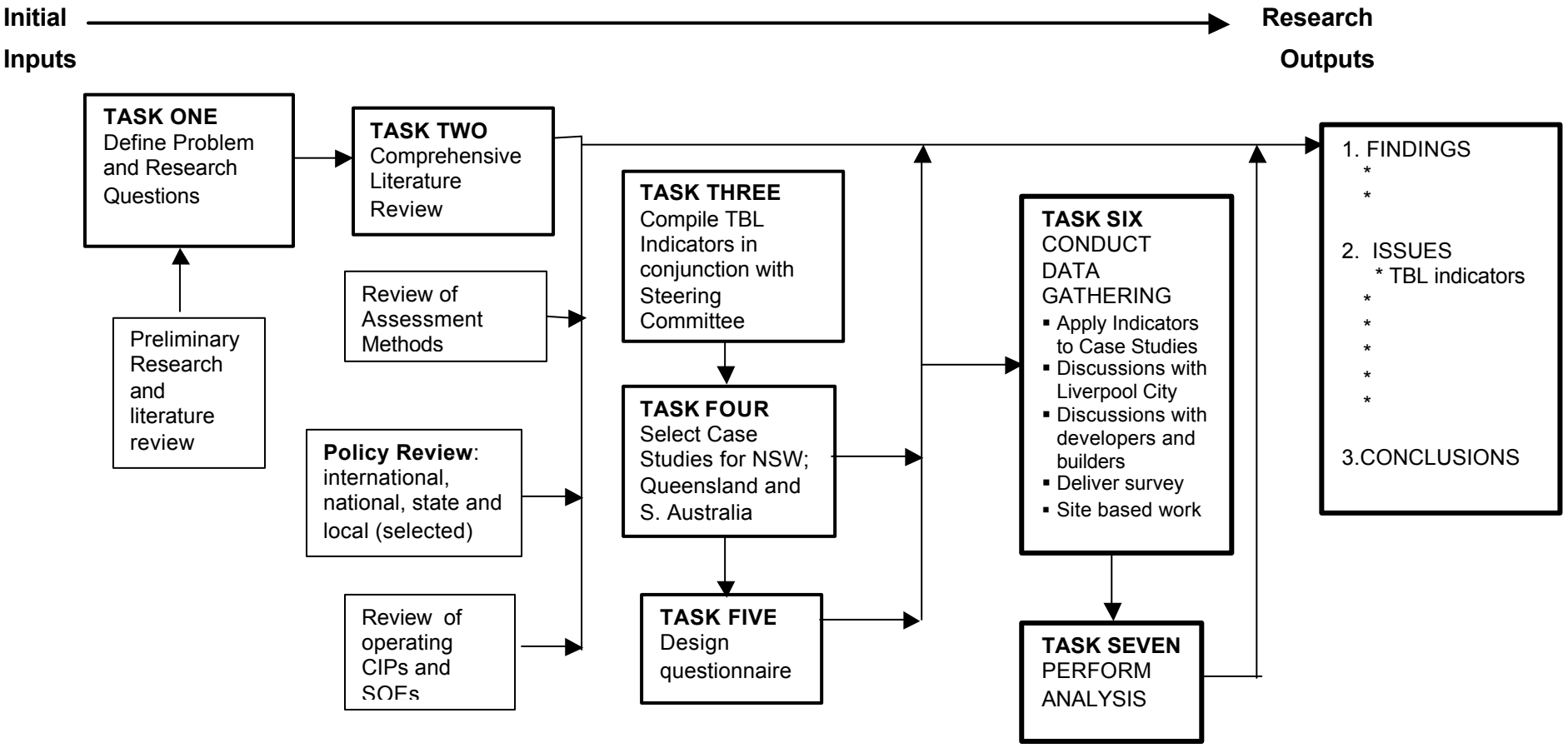
1.2 Background

Site planning, subdivision and building design and construction methods related to the provision of housing in Australia (including affordable housing), has a number of economic, environmental and social impacts. As a result there is a growing desire to incorporate the principles of 'sustainability' within urban development, seeking an integration of existing economic and social priorities with emerging environmental ones.

Urban development, including housing, often has significant environmental impacts such as waste from resource consumption, pollution of surface water and aquifers, over -extraction of water supplies, the destruction of habitat and the loss of flora and fauna. Consequently, there is a realization that society needs to achieve multiple housing object ives simultaneously by building homes that are affordable, safe, provide a good standard of physical comfort, and at the same time minimise the kind of environmental impacts noted above.

Allied with these environmental impacts, urban development can also h ave a range of social impacts. Urban character, heritage, streetscape, open space, density, dwelling scale, and privacy all have a bearing on the attractiveness of neighbourhood for its inhabitants. However, the economic aspect of housing – its affordability - is critical for shelter carries important social and political ramifications. In some locations there is now a dearth of affordable housing for people on low to even moderate incomes (Donald et al 2001) with the number of people experiencing housing-related poverty, and inappropriate housing increasing (NCOSS, 1998). Closely related to this phenomenon, there appears to be a shift away from providing affordable housing as a function of government towards its provision by the private sector through marke t mechanisms (Caulfield 2001).

Fig. 1. The Research Process



Nevertheless, local government's planning and development powers endow LGAs with significant influence on the private housing market in Australia. As noted in the Executive Summary, Gurran has commented that local government in Australia has not generally been proactive in shaping housing outcomes (Gurran 2002; Paris 1990) especially in the environmental arena. Environmental policies in existence in Liverpool City when the proposed case studies were being developed in the 1980s and 1990s were rudimentary and mainly limited to basic infrastructure services to provide clean water and sewage treatment (Liverpool Ci ty Council 1991). Application of sophisticated environmental policy is a relatively recent phenomenon in Australia for all levels of government. From an affordability viewpoint, there is already concern about the wide range of development and building cost s and how they impinge on price and therefore affordability. Adding to these pressures, there are perceptions that introducing environmental features into housing will inflate costs and penalize affordability even more . Priemus (1998) has commented on the conflicts between the spatial objectives of environmental planning and housing policies that tend to emphasize social needs. However, the NSW Local Government and Shires Association is an example of the growing awareness of the need to consider the environ mental impacts of residential development (LGSA 2001) as well as social policy objectives (Commonwealth of Australia 2002; UN Habitat 2002; Brugman1996) . It is possible that one way of achieving this is through the application of sustainability principles rather than by avoiding them. Viewing the ownership and occupation of property as a total lifespan cost as opposed to an initial capital cost may be a tactic which can help restore the affordability component to housing and simultaneously gain a degree of environmental responsibility.

In Australia there is a wide range of land subdivision and development forms but the two main ones are:

- • Traditional Regulatory Subdivisions (TRSs)
- • Master Planned Communities (MPCs)

Traditional regulatory subdivisions are typically characterised as meeting all relevant regulations like zoning ordinances and building codes, with lots sold individually and generally without additional controls on building design. This form of development occurs widely throughout the Sydney Region in fringe, middle and inner urban areas as well as in the Brisbane and Adelaide metropolitan areas. The main development elements typically tackled include lot sizes and layout, open space, infrastructure provision including roads, stormwater, sewage, and utilities, and street lighting. There are rarely additional requirements and virtually no flexibility for developers or builders to apply innovative solutions to issues of affordability, aesthetics or environmental sensitivity.

On the other hand MPCs consider many additional elements such as solar access, overshadowing, privacy, community facilities, landscaping, pedestrian and vehicular traffic, and the nature and form of buildings. The planning and design of MPCs often considers such issues simultaneously in an integrated and significantly more comprehensive way. There may, for example, be stringent controls on lot development and building design such as building envelope shape, orientation, setbacks, and internal planning and shading to ensure proper solar access, as well as construction and building materials requirements, minimum appliance rating requirements, and even water and energy conservation requirements achieved through advisory guidelines, zoning ordinances or through the use encumbrances a ttached to lot titles. Socio - economic matters such as the affordability of the housing stock, strategies for safety and crime prevention, design to favour pedestrian movement and maintenance issues may also be contemplated. This form of development typical ly occurs in fringe areas but occasionally as infill projects in middle and inner urban areas. Both MPCs and TRSs appear as a continuum of the land development forms illustrated in Figure 2 (page 7). The MPC case study used in the NSW research – Wattle Grove - is noted in the diagram. It is less than a perfect case for study because other MPCs in the Sydney Region that are candidates for study from an environmental viewpoint have not been in existence for long enough to allow a sense of community to be gene rated. Sense of community makes an important contribution to sustainability but cannot be reliably measured in communities that are less than three to five years old (Preiser et al, 1988).

It is often argued that MPCs can provide more sustainable outcomes in subdivision and housing development because they have the potential to integrate a number of economic, environmental and social variables simultaneously. Drawing on the subdivision guidelines in the Australian Model Code on Residential Development (Commonwealth of Australia 1995) a range of planning and design issues concerning streets, lot layout and orientation, lot size and the inclusion of retail, commercial, public open space and other neighbourhood amenities are being associated with MPCs. They are promoted as providing a strong sense of community identity and personal, traffic and property safety. They are able to conserve non-renewable energy sources and reduce high levels of vehicular movement (Commonwealth of Australia 1995). MPCs also tend to be attractive to developers, their generally smaller lots providing a more cost-effective approach to subdivision. MPCs use infrastructure and available land more efficiently and their increased densities lead to resource and transport efficiencies, the net result bringing a greater potential for housing affordability.

1.3 Aims of the Research

Measuring sustainability involves assessing the two main land development forms in terms of their relative economic, environmental and social merits. The research will use a triple bottom line (TBL) approach. Case studies from three States will be employed, namely NSW, Queensland and South Australia, correlating to high, moderate, and lower housing cost environments, and will be used to highlight compatibilities and conflicts between the triple bottom line variables. The results will be used as a basis for informing policy options.

Specific project aims are to:

a) Examine the issue of housing affordability in relation to sustainability.

b) Conduct a comprehensive literature review to examine the current methods for the assessment of sustainability in relation to the provision of affordable housing.

c) Develop a clear methodology for the assessment of sustainability in its three economic, environmental and social dimensions relevant to the provision of affordable housing in Australia.

d) In consultation with User Group stakeholders, assess the policy implications of merging sustainability and affordability in housing in relation to the specified site development models.

The research questions that flow from these aims are encapsulated in Table 1, below. The methods that will be employed are matched against each question.

Table 1: Research Questions

Research Questions	Methodology
1. What are the current alternative methods for assessin g the sustainability of differing land development types? How are they used and how effective are they?	Internationally based literature review focusing on sustainability measurement encompassing affordability
2. What government sustainability initiative s are there in Australia and what are the social, economic and environmental implications for affordability in housing?	National review of government sustainability policies, targeting TBL implications for the provision of affordable housing
3. What social, economic, and environmental indicators are needed to yield a useful picture of the degree of sustainability obtained for differing development types, especially in relation to affordable housing? How are these parameters integrated?	The specialized lite rature on indicators of sustainability; expert opinion of the steering committee. See TBL suite, Appendix 2
4. Do 'master planned' communities provide more sustainable outcomes than traditional regulatory subdivision? What are the conflicts and synergie s between economic, environmental and social priorities?	Using selected model or indicator suite, carry out TBL comparative assessment of the two main forms of subdivision development in the three participating States See TBL suite, Appendix 2
5. What ar e the best policies and land development practices for achieving sustainability goals in light of the proposed triple bottom line assessment model?	Analysis and conclusions of the policy and literature reviews and the case study assessment results

1.4 The Research Process

Research outcomes will be based on four chief approaches shown as a task listing in Figure 1. The first is the comprehensive international literature review. The second is the policy overview which reflects current practice on how society is attempting to operationalise sustainability. Thirdly, the literature and policy reviews combine to yield a suite of TBL indicators reflecting the three domains of sustainability. Fourthly, the indicator suite is applied against case studies to assess the performance of the two development modes. In a sense, the TBL suite itself is also under scrutiny for the appropriateness of the method.

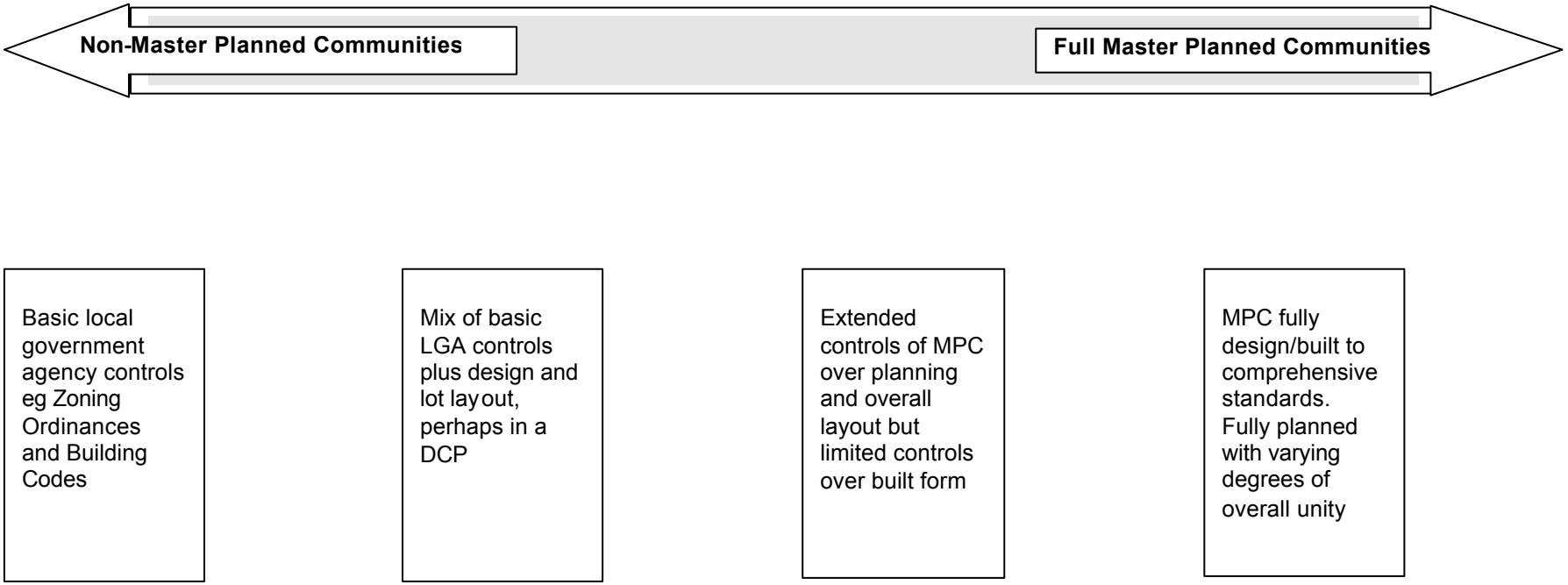
The TBL assessment is based on a suite of 37 indicators that are applied to the case studies selected in the three States. Case studies of the two nominated land development types in NSW, Queensland and South Australia address varying climatic, economic, and policy environments in Australia, providing a national relevance to the research. The TBL evaluation will involve an economic assessment, for example, the relative subdivision costs of the two land planning types. Attention to community issues comes through a survey which develops a questionnaire emphasizing social indicators. The survey will be distributed to household s in the study areas. It will assess sense of community as well as residents satisfaction with their neighbourhood. Lastly, there is an environmental appraisal of the different land development types looking at energy consumption and emissions and other environmental impacts involving for example biodiversity, stormwater and water sensitive urban design and the destination of the waste stream. Proposed data sources for the study are discussed in Methodology, Section 4 of the paper.

2 SUSTAINABILITY POLICY IN GOVERNMENT

The research to date has examined and identified government policy pertaining to environmental sustainability developed at the international, Federal, State and local levels. Environmental policy applying in the 1980s (the TRS case study) wa s rudimentary and policy applying in the mid - 1990s (to the MPC case study) lacked specificity beyond general frameworks and recommendations. Housing and urban development policy has had a restricted social and economic focus and the increasing sophisticati on of current environmental policy is a recent initiative for all levels of government.

Often environmental policy in Australia has its origins and priorities based on international treaties such as the Convention of Biological Diversity (UNEP 1992), the Vienna Convention for the Protection of the Ozone Layer (UNEP 2001), and the United Nations Framework Convention on Climate Change (UNFCCC 2002). They are embodied at a Federal level, but often implemented at a State or more commonly, local government leve l. Policy which influences residential development covers matters like visual and social amenity, biodiversity/flora & fauna and site and building controls that reduce resource consumption, especially of energy and water, and lower pollution. Less tangible issues of concern to the research like safe development and community cohesion enter the policy realm through AMCORD (1995) and the promotion of master planned communities.

Figure 2: Key Greenfield Development Models



The main areas of policy studied relevant to residential development are listed as follows. Each is discussed in subsequent pages of this section of the paper.

- Sustainability and Urban Design
- Flora, Fauna, Biodiversity
- Emissions – Ozone Depletion
- Emissions – Greenhouse Gas (energy use)
- Water Quality
- Storm water management
- Water Supply Management
- Waste Management

2.1 Sustainability and Urban Design

Responding to international priorities such as Agenda 21 (UNCED 1993) there are a number of national programs which seek to stimulate the development of environmentally sustainable urban forms. These include the Better Cities program (Commonwealth Department of Housing and Regional Development 1994) which promotes integrated urban development, and the Australian Urban and Regional Development Review (AURDR 1995). In addition the Federal government has developed AMCORD (Commonwealth of Australia, 1995) encouraging the adoption of performance based planning in Australia's States and Territories. The code suggests sustainability may be implemented by attention to urban form, density, transport, site planning, access, building design, stormwater and integrated catchment management, all for social and environmental benefit. AMCORD was released in phases over the late 1980's to 1995 and remains an important influence on more recent attempts to articulate the physical focus of ESD. NSW state government has also developed state-based legislation through PlanningNSW (SEPP 53 – Metropolitan Residential Development) and a development control plan (DCP) framework to encourage local councils in NSW to prepare consistent performance based codes based on AMCORD.

AMCORD is an important prelude to the increasing sophistication and complexity of urban management. Best management practices for stormwater management remain in recent policy, for example, but are joined by an interest in water sensitive urban design (WSUD) for all forms of development, not merely housing. The emphasis in stormwater management has broadened from safe disposal of water and avoiding flood damage to a more general sensitivity to water. WSUD (Hunter Region Organisation of Councils 2002; Local Government Focus 2001) is closely related to stormwater management but encapsulates water quality concerns and resource consciousness in a water conservation sense, too (Booth and Reinelt 1994; Schueler 1994). WSUD may advocate green fences and roofs to help absorb storm precipitation from impermeable surfaces and water conservation may stress dual plumbing, low flow water fittings, and drip irrigation, all of which contributes to ecologically sustainable urban development. Urban ESD is a sub-set of broader sustainability philosophy which may involve partial on-site waste disposal, alternative forms of transportation, mixed use development (Morris and Kauffman 1996) and "green" building, all of relevance to the research project.

In South Australia, all housing developments are managed by PlanningSA, which is responsible for administering the planning and development of South Australia. PlanningSA is the State Government's principal adviser on planning and development strategies, proposals and policy issues. PlanningSA administers the Development Act, 1993, which is the base for the Development Plans in every council. PlanningSA produces *Good Residential Design SA – a resource for planning, designing and developing neighbourhoods and homes,* which applies guidelines set up in AMCORD (PlanningSA 2001). It also produces a companion document, the *Residential Policy Planning Bulletin,* which will assist local government to more effectively implement the provisions of the State Planning Strategy.

Traditional land use and urban planning has long had a regulatory focus and a rather narrow emphasis on zoning. Pursuing principles of ecologically sustainable development (ESD) will enhance the role that planning can play in bringing more sensitive development. ESD declares that the resources needed to maintain quality of life for people today should not be at the expense of future generations. ESD principles grew out of the Rio Earth summit in 1992 and the sustainability declaration associated with Agenda 21 (UNCED 1993). The declaration was adopted by many nations around the world during the 1990s (for example Environment Australia 2002). In South Australia, the City of Marion has been a frontrunner in their commitment to Local Agenda 21 by including the principles of sustainability within the City of Marion's Community Plan and Council's Corporate Plan (City of Marion 2003). The City of Onkaparinga Development Plan (2002) has also incorporated a significant number of LGA-wide development control statements about sustainability and urban design. For example there are a number of objectives and principles associated with conservation (environmental and cultural), ESD, significant trees, water management, social inclusion, land division and transport.

The regulatory process for urban design in Queensland comes under the remit of The Queensland Department of Local Government and Planning (1997). The Government is advancing housing through its Smart State Initiative. The Queensland Ministry of Housing (Undated) elaborated on this initiative with its “Smart Housing” concept. There are numerous benefits to the concept. First, it is affordable and cost-efficient over time because operating cost features are incorporated into the initial design and construction. Extra initial costs can be quite minor compared to the savings that they will generate over time. Smart Housing recognises that affordability is not just the initial design and construction costs, but the cost-benefit achieved over the life of the home.

Second, Smart Housing features energy efficient design, reducing energy costs and improving living comfort. Passive solar design features such as house orientation, ventilation, insulation, adequate eave overhangs and shading improve energy efficiency in the long-term. Third, it is universally designed, which makes the home comfortable for people at different stages in their lives. For instance, wider hallways makes moving furniture easier, stepless entries help to get a stroller or the shopping cart into the house and hobless showers assist people with restricted mobility. As well as making the house more welcoming to occupants and visitors, it reduces the costs involved in modifying rooms to meet future needs. Altering an existing home to accommodate special needs or changing lifestyles can cost up to three times more than including these same features during the initial design-and-build stage. Finally, Smart Housing is safe and secure, incorporating features to improve security against crime and reduce the occurrences of common accidents in the home. The focus is also on the location and aspect of the house, ultimately resulting in better-planned, safer, more affordable and more environmentally responsible communities – the triple bottom line of the three domain model of sustainability.

2.2 Flora, Fauna, Biodiversity

Responding to the international Convention on Biological Diversity (1992) the Federal government has developed the Environment Protection and Biodiversity Conservation Act (1999) setting up bilateral agreements between the Commonwealth and States or Territory governments. At least six NSW statutes are connected with urban bushland and biodiversity matters, for example the Environmental Planning and Assessment Act 1979 (EP&A Act), Threatened Species Conservation Act (1995), National Parks and Wildlife Act (1974), and the Local Government Act (1993. NSW’s State Environmental Planning Policy (SEPP) 19, made under the EP&A Act 1979, also requires local government agencies (LGAs) to protect bushland. One of the TBL indicators is concerned with urban bushland and its protection and the research will take the policies enshrined in these statutes and regulations into account.

In South Australia, the statutes include the Development Act (1993), Native Vegetation Act (1991), National Parks and Wildlife Act (1972), and Heritage Act (1993). These statutes protect significant urban trees, control the clearance of native vegetation in defined areas, and protect trees of state significance.

2.3 Emissions – Ozone Depletion

Australia has made an international commitment to control the consumption and production of ozone depleting substan ces. The Vienna Convention for the Protection of the Ozone Layer (UNEP 2001) states that the parties (to the convention) must take appropriate measures to protect human health and the environment against adverse effects likely to result from human activities which are likely to modify the ozone layer. The Montreal Protocol on Substances that Deplete the Ozone Layer (UNEP 1987) builds upon the Vienna Convention and stipulates that the production and consumption of ozone -depleting compounds --chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform --were to be phased out by 2000 (2005 for methyl chloroform).

In Australia responsibility for implementing this control is shared between the Commonwealth, State and Territory Governments, for example with the Environment Protection Act (1993) in South Australia). Such legislation primarily affects industry and controls the use of any of these substances in the manufacture of products including household appliances and products. To this extent, ozone depleters are modestly related to the type of residential development being appraised in this research.

2.4 Emissions – Greenhouse Gas and Energy Use

Mandated at a Federal level, national greenhouse strategy initiatives (Commonwealth of Australia, 1998) related to housing are generally State driven (for example Energy Smart Homes Policy in NSW) and enforced at LGA level (in NSW). NSW legislation contains minimum House Energy Rating (HER) standards for new house construction and water heating appliances, affecting end energy use. Neither NSW case study is recent enough to be influenced by the HER standards. The Building Code of Australia (Australian Building Codes Board, 1996), proposed for adoption 2003, will include minimum energy performance requirement s but its influence on housing development will not be felt for some time.

The BCA energy-efficiency provision 2003 was adopted in South Australia on January 1 st, 2003. All new houses are now required to achieve high levels of energy performance equivalen t to a four star energy efficiency rating. The state government also applies the energy rating labels and minimum energy performance standards for domestic appliances and industrial and commercial equipment, which was developed by the National Appliance a nd Equipment Energy Efficiency Program (NAEEEP).

2.5 Water Management

The Commonwealth, State and Territory Governments have developed a National Water Quality Management Strategy for Australia which adopts an integrated approach to groundwater management. Thi s means that groundwater issues must be considered in relation to surface water management and land use decisions. Decisions should consider interactions between groundwater quality, quantity and dependent ecosystems as well as the possible impacts of using groundwater on soils and vegetation and surface water systems.

In NSW the Water Management Act 2000 (NSW, 2000) is a whole-of-government program which involves the Department of Land and Water Conservation, the Environment Protection Authority, NSW Natio nal Parks and Wildlife Service, NSW Fisheries and NSW Agriculture. Land use planning legislation and instruments are used, administered by the Department of Urban Affairs and Planning (DUAP), in co -operation with local government authorities under the EP&A Act, 1979.

Aspects of water management have generally been applied by local and state governments to the development process and AMCORD (Commonwealth of Australia 1995 and its catchment management guidelines would have had some influence especially with the more recently constructed case studies. However, integrated water management principles were not in existence when the case studies were developed in NSW and it is doubtful that they would have underlain development that took place in the 1980s to mid 1990s.

In South Australia, The Water Resources Act (1997) provides a comprehensive framework for the planning, use and management of the State's water resources, similar to the more recent NSW legislation. The Act provides for a system of water plans whic h establish policies for controlling a range of activities that affect water resources, including the allocation and transfer of rights to consume water. It is important to note that water management plans and controls instituted by the Water Resources Act , 1997 are closely integrated with the policies and assessment processes under the Development Act 1993. Both acts have some influence on the Adelaide case studies selected for evaluation.

2.6 Storm water management

In NSW the Environmental Protection Authorit y has a multi-phased Urban Stormwater Program which includes principles of water sensitive urban design, noted earlier in paragraph 2.1. The authority for urban stormwater management plans is Section 12 of the Protection of the Environment Administration Act 1991. The main responsibility for storm water management rests with LGAs. State adoption of ESD principles is the context for LGAs in relation to WSUD initiatives. In new subdivision, lot design must be closely integrated with storm water management in mind, for example limiting or avoiding completely discharge off -site or off - subdivision. Formal WSUD provisions are too recent to have influenced the NSW case studies but AMCORD water management principles may have had some effect.

In South Australia The Stormwater Infrastructure Planning package (PlanningSA 2002) has been prepared to promote an integrated approach to catchment management. The focus of the package is on improving the development policy framework, promoting the better coordination of existing expenditure and equitably sharing costs. The package includes the Stormwater in Urban Areas Plan Amendment Report, Guidelines for Urban Stormwater Management, and the Urban Stormwater Infrastructure Planning Bulletin. The guidelines encompass the objec tives for urban stormwater management as expressed in the Water Resources Act 1997, the Local Government Act 1999 and the Environment Protection Act, 1993. These guidelines provide a methodology for managing urban stormwater, "that is ecologically sustainable, provides for the restoration and enhancement of the environment, assigns the management of stormwater resources to suitable decision makers, and establishes a system for use and management of the water resources of the state" (PlanningSA 2002: p 1).

Given the recency of this policy material it is unlikely to influence the two Adelaide case study sites directly though some elements of the policy may have been carried through from earlier initiatives.

2.7 Water Supply Management

In NSW the Departmen t of Lands and Water Conservation and the Sydney Water Corporation are responsible for the Water Management Act 2000 (NSW, 2000). The act provides for the integrated and sustainable management of the State's waters. The act was driven by the need to secure a sustainable basis for water management since the Sydney Region is now at the limits of its available water resources. Sydney Water's operating licence requires that daily per capita water consumption be reduced from 506 litres in 1991 to 364 litres in June 2005 and 329 litres in June 2010. Sydney Water's targets are to be met through a suite of strategies to promote more efficient water use and increase the use of recycled water. Conservation strategies being marketed include subsidized low flow showerhe ads, dual flush toilets and outdoor drip irrigation. All are relevant to the design of new homes and the retrofit of existing ones to help make the goal of sustainability in residential areas an achievable aim.

2.8 Waste Management

In NSW, the Waste Avoidanc e and Resource Recovery Act 2001 (WARR), operated by Resource NSW, has expanded aims compared to the act it replaced (Waste Minimisation and Management Act 1995). It introduces Extended Producer Responsibility for industry and amends the waste hierarchy to reflect resource management and ESD principles more strongly. It stresses avoiding unnecessary resource consumption, recovering resources (including re -use, reprocessing, recycling and energy recovery) and suggests disposal only as a last resort.

To ensure that councils adopt efficient waste management practices, LGAs must comply with the WARR Act 2001, the Local Government Acts 1993 and 1997 and the Protection of the Environment Operations Act 1991. While there are variations in the nature of waste management in the Sydney Region between LGAs, both case studies are in the same LGA so there is unlikely to be a marked difference in the response to waste and recycling is sues. It is an issue which will be tested through the TBL indicators as well as two questions on the survey instrument.

In South Australia waste management and resource recovery is an intergovernmental issue and actions are coordinated over a number of s tate and local governments including the Office of Sustainability, Environmental Protection Authority (EPA) and LGAs as stated in the Minister's Local Government Forum (PlanningSA 2002). The strategic policy advice and direction to Government and stakehold ers is provided by "Waste to Resources Committee" under the auspices of the EPA. The Environment Protection (Waste to Resources) Policy is currently being proposed, its general purpose being to establish important waste management principles such as the "waste hierarchy" and to establish strategic, as well as specific, waste management practices that give clear direction to the community on how waste should be managed. Given the recency of this policy material it is unlikely to influence the two Adelaide si tes directly though some elements of the policy may have carried through from earlier initiatives.

3 SUSTAINABILITY AND ITS MEASUREMENT

3.1 Defining Sustainability

Sustainability acts as the framework for the research and the nature of the concept needs to be discussed. The term sustainability is derived from the Latin *sustinere,* meaning to maintain or keep going, the implication being that there may be constraints or limits ahead (Meadowcroft 1997). Use of the concept in connection with the resources of the pla net has a surprisingly long pedigree, being mooted by eminent people like Thomas Jefferson in 1795 and J. S. Mill in 1858. One of the earliest uses of the term sustainability came in the controversial publication *Limits to Growth* (Meadows et al 1972). The authors, in warning about exponential growth trends, suggested that it was possible to alter those trends and to "establish ….ecological and economic stability that is sustainable far into the future" (1972: 24). Subsequently, the document *Our Common Future* (WCED 1987) also known as "The Brundtland Report" popularized the concept through a much quoted definition which was perhaps the first widely accepted at an international level:

> Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED 1987: 43)

Since the Bruntland report there has been a plethora of publications on sustainability, its meaning, and the ramifications for society in relation to global growth paths and local conditions. Subsequent work on sustainability stems from action under the 1992 United Nations (UN) Conference on Environment and Development, specifically Agenda 21. More recent definitions and explanations of the concept now refer specifically to the finiteness of the world's resources and advance the notion of carrying capacity (for example Pronk and ul Haq 1992; IUCN 1991; and Hodge 1997). The term carrying capacity refers to the number of individuals who can be supported in a given area within natural resource limits, and without degrading the natural social, cultural and economic environment for present and future generations (see glossary).

Some definitions of sustainability have been developed as conceptual models (Hodge 1997). One of these appears in the form of a Venn diagram. A second is the Pressure -State-Response (PSR) model (OECD 1991). The former is a model which encapsulates the inter -relatedness of the social, economic, and environmental domains. It implies a sta te of balance as well as the need for holistic treatment of problems and issues. In terms of current practice the economic domain is dominant, provoking tension between social and economic goals and environmental quality. Ecologists see human systems as su b-sets of the natural realm and declare that environmental needs must be favoured if sustainability is to be a realistic goal (Pronk and ul Haq 1992; Hodge 1997).

There are several conceptual levels inherent in the attempts to articulate sustainability. The mission statement from the Bruntland Commission represents a philosophically encompassing statement while a second tier articulates the conceptual models described by Hodge (1997) and the OECD (1991). Establishing a third level is essential, that of t ransforming the concept to an operational scale. The pathway for achieving that is far from obvious though several researchers claim that reaching sustainability is a political and cultural challenge rather than technical issue. For example changing the e mphasis in transportation from private to public requires behavioural change and political fortitude, not technological innovation, *per se* (for example Scully 2000; Michalos 1997; Orr 1994). Similarly, introducing the kind of WSUD techniques noted earlier are politico-cultural obstacles to be overcome rather than technical problems *per se.*

The paradigm of sustainability is intuitively appealing for it appears to offer a way out of the growth versus environment dichotomy. It allows society to consider the possibility that adopting certain patterns of economic and social development could simultaneously protect life support systems, permit development and current standards of living, and not compromise the welfare of future generations (Meadowcroft 1997). Wh ile it is difficult to know whether the planet has reached its limits, "we clearly dare not escape the question" (Friend 1996, p.1866) and interpretations of the complex notion of sustainability can be diametrically opposing depending on one's world view (De Kruijf and Van Vuuren 1998). The interpretations can lead to different

criteria for evaluating sustainability performance, an issue which is relevant to the research and which is raised again in the methodology section.

A key argument about sustainability is how strictly current trends need to be modified. Discussion of intensity has given rise to the notion of a scale of response ranging at the extremes from technocentrism (cornucopian sub-set) to the deep ecology sub-set of ecocentrism (Reid 1995; Moll 1991; Daly and Cobb 1989; and Orr 1994). The former is essentially business as usual. It denies the finiteness of the planet's sinks (its ability to absorb waste without detrimental effect) and its resources and assumes that humankind will solve current and future problems through technological progress and substitution of materials. Ecocentrism sees the natural world as the dominant paradigm and in the deep ecology sub-set, humans as subservient to it. Neither technocentrism nor ecocentrism are tenable concepts, the former because there are too many segments of government and the business sector preaching caution. At the other extremity, ecocentrism is politically unrealistic for it implies limits to population and economic growth, frugality, de-materialism, and widespread unemployment in the short term.

A strong thread in sustainability is the conservation theme. It holds the notion that capital stock must not be depleted if human welfare is to be maintained for future generations (Friend 1996). However, capital stock includes human-made capital as well as the natural capital of the environment (Ekins and Jacobs 1998). Thus arises the related concepts of *weak* and *strong* sustainability relating respectively to technocentrism and ecocentrism. Weak sustainability is defined as allowing complete substitution between human and natural capital but is indifferent to the form in which it is passed on. For example, there is no special place for the environment so soil erosion is of no consequence if hydroponics can be used for agricultural production instead (Victor et al 1998). Nevertheless, weak sustainability would still require technological investment to provide substitutes for resources that are finite (Pearce 1993). Optimists like AtKisson (1999); Lovins et al. (1999); and Weisacker et al. (1997) suggest that there is enormous potential in this paradigm for investing in efficiency and the promise of vastly diminished waste and pollution and our call on virgin resources.

Strong sustainability denies that complete interchangeability between human and natural capital is possible and it implies that reaching sustainability and maintaining growth cannot occur simultaneously. Strong sustainability views ecological capital as vital to human well-being and perhaps survival in the long term (Pearce 1993; Reed 1995). The construct is not as extreme as ecocentrism but it hints at a distinct slowing of material throughput in the economy, perhaps near-zero economic growth and static living standards in western countries. If the intense efficiency initiatives proved successful over the long term, it might moderate some of the concerns demonstrated by proponents of strong sustainability.

The varied concepts within the sustainability paradigm do not rest on a well-developed theoretical or evidentiary base. The Scientific Committee on Problems of the Environment (SCOPE) concluded that there was no scientific consensus on the nature of the links between the environmental, social, and economic domains (SCOPE 1996). The National Research Council (NRC) (1999) observes that the effect of implementing goals in any one of the three domains may have quite unpredictable effects on goals and achievement in other domains. Both organizations suggest that filling this research vacuum is a key challenge for the scientific community if the transition to sustainability is to succeed.

The absence of consensus over the meaning and operationalisation of sustainability fifteen years after Brundland (1987) is due to the paradigm's breadth and generality. It is at once a strength and a weakness (Schiller 2001). As a strength, the entire spectrum of society can find some goals that speak to them. Therein lies the weakness, that is, the concept's function as a "man for all seasons"1. It is a hindrance to gaining a consensus on a discrete set of normative aims and

1 Said of Sir Thomas More in *Vulgaria,* by Robert Whittington, 1520.

taking a prudential position, that is applying the precautionary principle, [2] (United Nations 1992) does not have widespread acceptance.

The absence of a strong conceptual framework for sustainability has brought assessment systems that are still embryonic for they lack a holistic and integrated element that is important in assessing entire communities. Indicator suites that appear in state of the environment reports (SOEs) throughout the western world (for example North Sydney Council 2000; Willoughby City Council 2000) focus mainly on the natural environment. Those that appear in TBL community oriented indicator programs are more comprehensive in that all three sustainability domains are usually covered but, to quote the NRC (1999): "Indicators used to report on a transition toward sustainability are likely to be biased, incorrect, inadequate, and indispensable. Getting the indicators right is likely to be impossible in the short term. But not trying to get the indicators right will surely compound the difficulty of enabling people to navigate through a transition to sustainability" (NRC 1999: 265). The indicator suite compiled as part of this research project is a step in that direction.

The following section of the paper describes potential assessment methods that are relevant to the assessment of sustainability. With a large variation in both scope and process the limitations and appropriateness of these assessment methods are discussed, including a critique of their relevance to the performance assessment of the two land development models. A tabulated comparative summary of their advantages and disadvantages is in Appendix 1.

3.2 Methods for Measuring Sustainability

The main methods of sustainability assessment appropriate to the appraisal of land development that were found in the review of the literature are:

a) Economic assessments,

b) Material and energy accounting,

c) Building assessment tools,

d) Indicators - Economic, Social, and Environmental Indicator Sets and Frameworks

e) Triple Bottom Line Assessments

3.2.1 Economic assessments

The economic cost of housing is an important issue for a wide range of stakeholders including financiers, developers, governments and the public. Overall development costs, influenced by lot sizes, infrastructure run lengths and costs, development approval costs and building costs greatly impact affordability and saleability according to AMCORD (Commonwealth of Australia,1995). In discussions with developers for example it was made clear that such financially related concerns are paramount and are carefully considered in the design of housing developments (Mcnamara and Ilias, 2002) with single economic measures such as unit price and profit commonly used in assessment.

The other commonly used tool for economic assessment is cost-benefit analysis (CBA). This assessment method has been used for many years to examine the impacts and benefits of proposed policies or developments. This method attempts to place dollar values on all economic, and some environmental and social impacts, usually expressed in terms of cost savings, abatement costs and contingent valuation (Dodd and Lesser, 1994). The term "abatement costs" generally refers to corporate expenditures connected with environmental protection and rectifying environmental damage. Accurate estimates of pollution abatement costs are crucial to any effort to set or evaluate environmental policies. Contingent valuation also known as "willingness to pay" involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services, either to give them up or to receive them. Both terms are explained in the glossary.

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2 The precautionary principle is about living with uncertainty and risk. It suggests that if we are unsure about future limits the prudent course is to temper our activities until proven that they do not pose a problem for current or future generations (Reid 1995).

CBA was not chosen for the post-occupancy evaluation of the two neighbourhoods. CBA is not a valid measure of sustainability at this point largely because of the number of assumptions needed, both in terms of determining the scope of study, and the conversion of non-economic costs and benefits into monetary terms (Mazurek 1998). A study prepared for the OECD (Barde and Pearce, 1991) also points out that CBA is often time-consuming and expensive; that data on surrogate values are difficult to obtain and are unreliable at present; that the monetary values accorded phenomena often underestimate environmental benefits, with some observers suggesting that they defy economic measurement; and that while the technique appears to be objective, CBA is often value-laden. The researchers accepted that these were strong grounds for avoiding a technique which had not progressed sufficiently to allow its application successfully across the social, economic and environmental domains of the residential case studies.

3.2.2 Material and Energy Accounting

Material accounting techniques are defined as primarily seeking to quantify and represent flows of material and energy used in a production or development process as indicative of the level of environmental impact (Moore and Brunner, 1996). Bringezu (1993) has suggested that it should be possible to assess sustainability performance using such techniques. However, they would need to be extended to embrace additional economic and environmental issues. Linkage with other information concerning critical input and output thresholds that maintain natural balances would also be needed if realistic evaluation of sustainability to take place.

The main material accounting tools that will be discussed are Life Cycle Analysis (LCA), Material Flux Analysis (MFA) and Ecological Footprint (EF).

Life Cycle Analysis (LCA) is probably the most developed and widely used material accounting technique. LCA is generally used at a product or process level, accounting for all material, energy and related impacts (including ecological, human health, resource depletion, and social and aesthetic issues) due to material extraction and processing, manufacture, transportation, product use, maintenance, disposal and/or reuse or recycling i.e. "from cradle to grave" (Moore and Brunner, 1996).

The LCA framework is not a fixed methodology but it has been standardised through the introduction of International Organisation for Standardisation (ISO) standards. LCA does have the particular strength of not focusing on one single effect, but of creating an overview of the total complexity of interactions between different processes in industrial society, within ecosystems and over extended timescales (Moore, 1996). However, LCA is trenchantly criticised for a combination of relying on inadequate scientific knowledge, its huge data research requirements, a somewhat arbitrary method for setting study scope, and the way environmental impacts are weighted for their significance (Guinee et al. 1993). Also a critical shortcoming is that LCA does not comprehensively assess social and economic issues, and parallel analyses would be needed. On this basis alone, LCA is of limited use for assessing land development models.

Material Flux Analysis (MFA) is another large scale and resource intensive assessment tool. Generally used in modelling for large scale regional studies, MFA quantifies the flows of specified materials through a nominated region or industrial process and maps the principal material, energy, and waste systems, including key linkages, over a given period. Flows and concentrations of materials allow the transfer coefficients for specific processes to be determined (Baccini & Brunner 1991). The output typically uses a flux diagram, showing the quantity of a material flow which is used as a surrogate for potential environmental impact.

While useful for evaluating and comparing single or simple materials and processes this technique is like the preceding LCA tool and is too limited for assessing communities. The technique is complex, is very much a tool for application to the physical environment and is still being developed for use in ecosystem accounting. Its intense data needs also precludes its use for land development assessment.

Ecological Footprint (EF) can be defined as the area of ecologically productive land and water systems that is required to prov ide all energy and material resources used in maintaining, and to assimilate any wastes discharged by, a defined population (Wackernagel and Rees 1996). It is an emerging tool, still in search of a common methodology yet it has been adopted by organisations like the World Wildlife Foundation (WWF) and for use in the development strategies of regional authorities in the United Kingdom.

The major strength of EF is that it takes into account principles of economics and the carrying capacity of our eco -system at the same time (Rees 2000). It acknowledges a close interdependence between urban development, urban economy and urban ecology (Rees 1992). It is not only conceptually related to the embodied energy analyses of Howard Odum (Hall 95, quoted in Rees 2000) and the environmental space concept of the Sustainable Europe Campaign (Carley and Spapens, 1998, quoted in Rees 2000) but also corresponds closely to Ehrlich's and Holdren's well known definition of human impact on the environment *I=PAT.* In this equation I=impact, P is population, A is affluence and T is Technology. The population ecological footprint corresponds to impact (I) in the Ehrlich -Holdren formulation and is a function of population size and consumption, converted to land area. Since consumption is a function of income and state of technology, EF is an area based analogue of PAT.

EF *"firmly reconnects people to the land"* (Rees 2000 p 371). In other words it partially succeeds in "combining material resource use, energy use and land use (Ecotec 20 01 p 8). It is a tool that presents a simple and intuitive means of demonstrating the magnitude of human impacts in terms of land use and scarcity . It is an excellent communication tool —easily understood by the individual, professionals and politicians (Ec otec 2001 p 8; Prosus 2001; Deutsch et al 2000; Costanza 2000) and can be used to raise public awareness (van Kooten et al 2001). It does not require extensive data since its calculations are based on a small group of indicators. One of its additional advantages is that it considers the export of pollution and import of ecosystem services in its calculation (UN, 1994). It may fulfill the role of a sustainable development indicator which not only reflects demand but also indicates the direction towards whic h we should be moving (Prosus 2001;Simmons and Lewis 2000).

Criticisms of the EF model include its specialized aggregation function, covering only a few major resource categories (subsumed within land types) and consumption activities. Only major categories of consumption can be included and spatial implications of waste discharges other than CO_2 are yet to be analysed (Rees 2000). EF lacks scope for identifying flows between specific goods and processes, and cradle -to-grave impacts are only measured in a highly-aggregated manner (Ayres, 2001; van den Bergh and Verbruggen, 1999). Similarly, EF is limited in its measurement of recycling, stock changes, and output from the human economy, and hidden flows around the periphery of "economic" activity. Additiona l concerns include the neglect of the multifunctional nature of land, unconvincing comparisons of sustainability based on consumption and availability of resources within artificial political boundaries, the use of global ecological productivity averages, the assumed static nature of resource productivity, and the incomplete array of ecological services covered (Daniels, and Moore, 2002). None of this lends credibility to the accuracy to the results, one of the major points of contention for the scientists working in this field, and it was deemed unwise to use EF in the case study assessment.

3.2.3 Building assessment tools

Buildings are the source of significant environmental impact and have been a focus for environmental and environmental/economic assessment too l development. The majority of the many available tools (generally computer based) have concentrated on issues such as fabric performance and operational energy efficiency, but further tools have been developed to look at the broader sustainability agenda including the assessment of a greater range of environmental issues and some level of social assessment. The main tools discussed fall under the headings of Building Decision Support and Whole Building Assessment.

Building Decision Support Tools: A large range of predictive and measurement techniques exist to evaluate building performance. Typically data-oriented tools, they provide predominantly environmental and economic related parameters (Athena 2000). Such tools tend to predict specific aspects of per formance either singly or in combination such as operational energy use,

embodied energy, illuminance, daylighting, and ventilation, all with environmental (and comfort) implications. Examples are DOE2, natHERS and ATHENA.

Primarily these tools are used t o inform the building design process. Often based on significant research, field validation, and on formal standards of assessment (Athena 2000) they do provide a reasonably accurate level of environmental assessment for buildings. Their application to assessments at the neighbourhood scale would be extremely resource intensive and given their focus on the physical or environmental domain, are unsuitable for the case study performance assessment.

Whole Building Assessment Systems such as BREEM, GBTool, and LEED, provide a broader coverage of environmental, social and economic issues deemed to be relevant to sustainability. Using a mix of objective and subjective data, obtained mainly through a process of weighting and aggregation, they distill information to provide useful indices of sustainability. Most whole building assessment tools claim to be life cycle assessment tools although they often do not meet the full ISO criteria (Athena 2000).

GBTool is an example of a set of environmental criteria used to an alyze the environmental performance and impact of buildings. While focusing mainly on environmental impact it has scope for both economic and social analysis. Quantitative needs include detailed data on the predicted consumption of energy, water, land use, materials, as well as emissions, waste and sewage and the measurable aspects of indoor environmental conditions. Some contextual factors like the environmental loading on neighbouring or adjacent properties may also be included. Qualitative data may inclu de aspects of indoor environment, health issues, design issues related to longevity, design and construction processes, building operations planning and management issues. The system provides a series of weighted indices in the various categories, as well as providing one single overall index (University of British Colombia 2001; Larsson and Cole 2001).

Whole Building Assessment Systems have been primarily developed for investigating individual buildings and while there is potential for providing a more broad based sustainability assessment, expert opinion suggests that their use would be prohibitively resource intensive. Significant levels of data collection and input are required and each dwelling would need to be assessed separately and then aggregated for the suburb. These tools are not sufficiently capable in their current form of assessing development at a subdivision level (Cooper 1999) or the multi -domain nature of established communities.

3.2.4 Indicators

Indicators and their underlying data at some poin t support all the assessment tools described above. In this section they are used in a more formal sense, usually as sites to evaluate performance of communities, from the neighbourhood scale to the global level. I

Indicators had their origins in a diverse range of fields covering the environmental social and economic disciplines. Indicators are primarily descriptive, quantitative units of information on the state or condition of phenomena which are intended to quantify, simplify, and monitor performance in a system (Spreng & Wills, 1996). More recently suites of indicators which attempt to comprehensively measure sustainability have been developed by national governments and international organisations including the United Nations and the World Bank, and a re seen as having potential for informing decision-making on sustainability issues (United Nations, 1992).

Concerns about environmental impacts, commonly related to air and water pollution and ecosystem health, led to attempts to develop ‘indicator’ or rep resentative species that are sensitive to broader changes in the environment (Bell & Morse, 1999). Representativeness in a monitoring or evaluation programme is an attractive proposition in any sector or domain. Sustainability seeks a greater understanding of the ramifications of one action on other spheres and a representative suite of indicators offers that potential. However, to be truly representative an indicator must be sensitive to the underlying condition of interest and be very specific if accuracy is to be obtained. The indicator must also be couched in terms that reflect a deep knowledge of the relationships within the sub -system being measured. There are significant doubts that society possesses that degree of knowledge at present, an issue which is explored further in the concept of multi-dimensionality of indicators, below (Murtaugh 1996).

With increasing concern for natural systems many governments have attempted to internalise environmental impacts, moving to techniques like environmental au diting as well as indicators to monitor the impact of humans on natural systems. There has also been a move within corporate reporting to measure and present environmental information on emission levels of particular substances and environmental incidents. Details of environmental policies, environmental management systems, environmental awards, stakeholder engagement, performance against best-practice guidelines, environmental risks and impacts, energy and water usage, and a degree of life -cycle analysis a re now being reported by the more environmentally conscious companies (Deegan, 1999).

Social indicators are another precursor to indicators sets of sustainability. Originally defined by R. Bauer, who was looking at the social side effects of space travel, he concluded that there was a lack of adequate data and the methodology for social science research (Spreng and Wils, 1996). The social indicator movement developed during the 1970s when the OECD and the Social and Economic Council of the United Nations be gan to develop social and demographic statistics, intended for improved monitoring and reporting of social conditions and processes. In this period the concept of "quality of life" was also developed as an alternative to economic measures of progress. As a result, a variety of indicators such as personal income, health, the quality and quantity of work and leisure, environmental quality, and personal and social security have appeared , most of which remain today.

Economic indicators are a common part of eve ryday life. Examples of national level indicators are gross domestic product (GDP), gross national product (GNP), and labourforce information, including unemployment data, all of which are used to monitor economic condition and trends. Other economic measu res with direct social ramifications and relevant to the nature of this research project are connected with issues like the affordability of housing, house prices and housing costs.

The use of indicators for assessing sustainability can be related to the 1992 United Nations Conference for Environment and Development, which called for countries to develop Sustainable Development Indicators (SDI's) concluding that commonly used indicators like GNP or GDP do not provide adequate indications of sustainability (United Nations, 1992). Sustainability indicators build upon the early social, economic and environmental indicators. Sustainability is a call for integrated consideration of ecological, economic, and social matters (Meadows 1998; Gilbert 1996). The City of San Francisco (1999) is a rare example of a city reaching out for fundamental change – not only to reduce negative impacts on the environment but also to conserve resources; achieve economic vitality on a more sustainable model; and to spread civic goods more equitably among the community. Thus sustainability indicators have to be more than an extension of traditional indicators. They need to be more strategic in nature (Nijkamp 1994) and be integrative, that is, forge links at least between sectors and p referably between the three domains of the sustainability triad (De Kruijf and Van Vuuren 1998; Hancock et al. 2000) since sustainability is a holistic concept.

Attempts have been made to deal with the issue of holism in sustainability by constructing complex indicators. Quality of life indicators, for instance, are less about linkage and more about single-dimensional counts or viewpoints. Elementary measures like these are useful but tend to ignore the complexity behind the phenomena being monitored and th e existence of relationships in a system. For example, simply knowing the number of gallons of water consumed does not reveal if the aquifer is being depleted or replenished (Klein 1997). Similarly, measuring median income is one -dimensional. It is a state ment about economic, not social condition because it ignores the distribution of that income. A more searching indicator linking the social and economic legs of the triad would be the percent of the median income needed to pay for the basic needs of a per son in the community. The more sophisticated or analytic the individual indicators are, the more they are likely to contribute to sustainability.

There is much agreement (for example Bean 2000; Parker 1995; Cobb 2000a) on the value of building sophisticate d indicators that can speak about patterns and connections. At the same time, other observers recognize that indicators may not be able to play such a role (for example (Hodge 1996; Cobb 2000a; Moxey et al. 1998). Indeed, some researchers (eg Cobb 2000b) h ave pointed out that finding causal relationships is a troublesome task. Indicators are based on

observed phenomena and root causes can only be identified through inferential modelling. Also relevant is the idea of indivisibility, expressed in the Santiago Declaration of the Montreal Process (in Lowe 1995, p. 347). It is that "no single criterion or indicator is alone an indicator of sustainability. Rather, individual criteria and indicators should be considered in the context of other criteria and indicators." Hodge (1998) has stated much the same opinion.

An alternative to the complex indicator is to cluster several measures around the same issue. However, this tactic cannot guarantee that all linkages between phenomena will be revealed, let alone causal relationships. In any event, the point can be made that the multi-dimensional indicator does not invalidate or make superfluous the simpler measure. An alternative way of gaining "linkage" across and within each leg of the domain triad may be to activate several measures for the same theme and then gauge the relationships intuitively. Traditional indicators may be useful as long as they are numerous enough to derive weight.

Indicators are flexible tools since the suites can be adjusted to reflect the diversity of economic, environmental and social circumstances and the peculiarities of a specific system. They are very useful for identifying, synthesizing, and communicating states and trends. They are well regarded for sustainability assessment and widely used (Meadows 1998). However given the open format of indicator frameworks their selection and definition has proved problematic with many criticizing their choice, accuracy and validity. The United Nations reporting on their own indicators of sustainability, on which they spent considerable development time, concluded that no set of indicators can be final and definitive, but must be developed and adjusted over time to fit country-specific conditions, priorities and capabilities (United Nations, 2000).

Meadows (1998) also noted that "indicators are abstractions, based on sets of assumptions about how the world works and what should be measured, describing a large number of complex component systems, with a myriad of connections. At their best they provide good abstractions of parts of a system and provide useful information indicative of the impact that development is having. At worst, indicators may be irrelevant, time consuming and even misleading, criticisms which are echoed by several observers (eg Bossel l 1999, Hendricks and Harding 1996, and Moldan and Billharz 1997). The choice of indicator may be partly invalid, for example, GDP. This measure has an emphasis on economic and financial matters and is often chosen to measure national condition. However, GDP measures the quantity of money in circulation, not whether real progress is being made. Thus, "If an indicator of the state of the system is poorly chosen, inaccurately measured, delayed, noisy, or biased, decisions based on it cannot be effective" (Meadows 1998, p3).

Another specific criticism of relevance to the research is that much of the effort directed to sustainability indicators has been carried out at the level of the nation, region or city. Only limited progress has been made in applying such indicators at the neighbourhood scale to test sustainability performance (but see National Neighbourhood Indicators Partnership 1996).

A number of authorities have prepared lists of desirable criteria for indicators (e.g. Innes and Booher 1999; Meadows 1998; Hart 1999; Adriaanse 1995; Redefining Progress 1995; and Sustainable Seattle 1995). Successful indicators are:

- Representative of important concerns. A systematic approach must also look at the interaction of systems and use as few indicators as possible, given their data needs;
- Relevant to policy issues and regional concerns and are able to guide policies and decisions at all levels of society and government in relation to sustainability;
- Clearly defined and reproducible. They must use accurate data, which is technically feasible to collect, and be developed using theoretically valid and transparent methods;
- Unambiguous, understandable and practical, and reflect the interests and views of different stakeholders. There is much literature relating to the need for the process of developing an indicator set to be participatory to ensure that the set encompasses the visions and values of the community or region for which it is developed; and
- Where possible presented as time-based graphs rather than as single numbers.

3.2.5 Triple Bottom Line Assessments

Triple bottom line (TBL) is a term that originated in the corporate sector in connection with socially responsible investing. The term TBL is chiefly used by business firms but the twin concepts of TBL and sustainability are occasionally used interchangeably by other organizations (eg Manaaki Whenua Landcare Research 2002; Christchurch City Council 2002; Price, Waterhouse, Coopers 2002).

Until recently, business's bottom line has been an economic one, limited to finance and profitability. The corporate financial bottom line ignores externalities, environmental, economic and social. TBL analysis concerns all aspects of an organisation's performance and aims to demonstrate its accountability to society so **TBL is both an assessment tool and a framework for assessing a corporation's performance in non-traditional areas.** (Elkington 1998; Maroochy Shire Council 2002; Christchurch City Council 2002).

The flexibility and pointedness of indicators that can be used in TBL analysis and reporting is a major benefit. TBL analysis an appealing concept but there are, nevertheless, difficulties in operationalising the technique. Primarily there is no agreed methodology at present for measuring environmental and social costs. Even in the more tangible financial area, the accounting method chosen can affect the economic/financial bottom line significantly. Drawbacks like these tend to affect all reporting and assessment systems however. Many organisations around the world are working on performance indicators for all three domains but it is likely to be some time before there is a degree of consensus on how to measure social and environmental costs and how to ensure that the inter-connections between the three domains are adequately covered (**Ecosteps 2002;** Elkington 1998**)**.

3.3 Conclusions

The review of assessment methods clearly points towards the use of indicators for evaluating the performance of the case study communities. Indicator suites possess several advantages. There is an overall flexibility since specific indicators can be abandoned or introduced depending on circumstances like data reliability or data availability. They are useful in organizing data, their contribution to problem solving is valuable and they are applicable to virtually any spatial scale of enquiry. Indicator suites are pointed, that is they can be focussed readily on particular issues. Finally, they can be constructed in a single dimension or elaborated as multi-dimensional measures. These advantages are all highly supportive of the TBL approach and the research has adopted the term "triple bottom line" for the assessment in an acknowledgement that the concept aims to embrace all three domains of sustainability.

The suite of indicators selected from practice and the literature reflect critical aspects of each domain and the interactions between them. The suite of indicators originated from an international literature review, a review of policy as applied by government agencies in Australia and from operating monitoring systems such as state of the environment reports (SOEs) and community indicator programs (CIPs). Both SOEs and CIPs are used in OECD countries to assess the performance of small groups of dwellings, neighbourhoods, cities and even regions. They have a strong connection with the TBL model.

Sources for the economy and community/society indicators are partly founded on the work of Randolph and Judd (2000), Bruckner (1988) and Big Cities (2001). Contributions also come from the multi-domain community indicator programs in the United States such as those for King County (1999), the City of Olympia (1999), and the City of Tucson (2001). Sources for the environmental indicators are predominantly the City of Tucson (2001), King County (1999), City of Olympia (1999), City of Santa Monica (2001), King et al 2000 and NSW State of the Environment reports (for example North Sydney City Council 2000 and Willoughby City Council 2000).

4 PROPOSED METHODOLOGY

4.1 Summary

The methodological approach was developed in response to the research questions presented in the first part of the Positioning Paper. A suite of indicators has been prepared from a number of sources, especially the literature and policy reviews. In addition, the core research team and the externally-based project steering committee helped distil a long list of 80 indicators into the final suite. There are 37 indicators representing the three domains of TBL analysis – economy, society and environment. They directly underpin the third and fourth research questio ns presented in Table 1 (Part 1) of this Positioning Paper and they are applied to two case studies in each of the three participating states. The suite of indicators is attached in Appendix 2. Four specific lines of investigation are being used to activat e the indicators with data. Some of the lines will help corroborate data sourced by other means. Examples where this occurs are given in the following paragraphs. One line of enquiry will use a questionnaire in the selected MPC and TRS case studies respectively. There is a social focus to the questionnaire but the instrument also asks a number of questions designed to throw light on use of natural resources, including energy. The second and third lines of research involve, respectively, extensive discussion s with council and the developers of each community. In the fourth line of research, the project team will conduct a number of separate investigations, partly on -site in the case study neighbourhoods, but also using 2001 census data from the Australian Bureau of Statistics (ABS 2001).

4.2 Case Study Selection Criteria

Choice of case study greatly affects the results of the research so using criteria that are neutral is important. It would not be wise to use a sustainability criterion that resulted in a neig hbourhood which reflected advanced sustainability applications, for example. Criteria are also needed to ensure a degree of uniformity across the tri -state research project. Thus the criteria below were adopted to act as guidelines for case study selection:-

a) Both case studies (MPC and TRS) should have relatively similar socio -economic characteristics.

b) The case studies should both be reasonably representative of mainstream housing, that is, predominantly single-family dwellings in the mid to outer suburbs.

c) Both case study sites should be in the same LGA to control for differences in local government planning and zoning policies.

d) Both should be reasonably mature, that is completed and occupied for a minimum of 3 -5 years to allow at least the potential for sense of community and neighbourliness to develop.

e) Both communities should have been constructed in approximately the same era (a 10 year gap, for example, would not be appropriate).

f) Since a minimum of 100 questionnaire responses is needed from each case st udy site to ensure statistical validity (Zehner 2002), the subdivisions should be a minimum of 500 lots in size for questionnaire drop and mail reminder survey techniques to be effective.

4.3 Developing the TBL Indicators

The indicators for the evaluation proc ess use the tri -domain model as a framework. The model represents society, economy, and environment and is similar to the form of community indicator programs used to measure the condition of some towns and cities in the United States (City of Santa Monica 1999; City of Olympia 1998; City of Tucson 1999) and increasingly in other OECD countries such as Australia (eg Western Sydney Regional Organization of Councils and the University of Western Sydney 2002). The suite of indicators comprising the program for this sustainability appraisal are termed in this research as the TBL model. Sub -categories within the model contain the indicators used for evaluating the two case study neighbourhoods. The sub - categories are issue and subject based with an emphasis on me asuring outcomes as would be expected in a post -development evaluation. The TBL indicator set was developed initially through the literature and policy reviews with additional input from specialized literature on indicators and operating programs. The premises underlying indicator selection are that:-

a) The indicators are **not** being used to evaluate how well the developments' objectives have been achieved. The evaluation is a comparative assessment and snapshot of two development types though it will be difficult to avoid inferences springing from case studies which are largely sequential in time, as is the situation in NSW.

b) The research is purely comparative and the two case studies will not be compared with a "best practice" or benchmark standard.

c) Individual objectives have not been prepared for each indicator, the general aims of the project being adequate to form a context for the assessment. In addition, indicators are not value-free and there are implicit societal objectives in the criteria which reflect quality of life concerns in all three domains of the TBL model.

Data for two of the indicators in the TBL suite (Indicators 16 and 17, sense of community and perceptions of the neighbourhood respectively) can only be compiled by summing several subsidiary measures. They appear on the survey instrument as nine subsidiary questions in the case of Indicator 16 and eight in the case of Indicator 17.

In paragraph 3.1 above, there was mention of weak and strong sustainability and how the concepts could influence the nature of indicators chosen for performance evaluation. It would have been possible to design stringent indicators for the TBL suite, perhaps containing standards (where available) for energy emissions, including greenhouse gases, for example, or through benchmarks for waste management and recycling activity. However, the research is a comparative performance assessment of two development forms. It is not measuring progress towards specific goals or targets but looking for evidence of movement towards greater environmental and social sensitivity. Consequently, the indicators are neutral in tone and they generally avoid targets and standards with the exception of the indicators which are related to housing affordability, that is, the proportion of income devoted to rent or mortgage payments for housing.

4.4 Developing The Questionnaire

The questionnaire has been constructed using the TBL indicators as the basic guide for the instrument. Ten of the performance indicators are addressed directly through the survey instrument. The instrument has 31 primary questions, many with sub-questions and there are three parts to it. Part 1 asks eight questions connected with neighbourhood satisfaction. Part 2 asks nine questions designed to establish how strong a sense of community is felt by residents. Neighbourhood satisfaction and sense of community are two of the TBL indicators that rely heavily on resident input through the questionnaire to gauge the success of the two development forms. Part 3 consists of 14 questions seeking environmental data on energy, water and other resource matters.

The survey will be delivered to 1260 homes in the NSW component of the survey. Some 1000 homes are being surveyed in Adelaide and 1200 in the case study communities in Brisbane. In all three states, each of the two case studies will receive approximately half of the survey forms. They will be distributed by hand in all three states and be self-administered. Reminder letters and duplicate questionnaires will be dropped off into residents' mail boxes 12-14 days later if the response rate does not reach the desired minimum.

The research activities that involve human subjects need the approval of UNSW's Human Resources and Ethics Committee (HREC). The application was submitted to HREC on November 29, 2002. The questionnaire is a vital part of the submission. HREC approved the research application on December 17, 2002.

4.5 Interviews and Discussions with Developers and Council

This component of the research involves discussions with the planners at Liverpool City Council in NSW and the City of Onkaparinga Council in South Australia; discussions with the planners at PlanningSA in Adelaide; discussions with community leaders and organizations in all relevant LGAs and separate talks with the land developers and builders of both developments. In the last case a series of themes and some specific questions were prepared prior to the discussions to give focus to the interview. Examining NSW documents like the DCP and master plan for Wattle

Grove and the zoning and planning regulations in operation for the Chipping Norton development will also be important. Similar work has been conducted in South Australia by examining relevant documents to for the Seaford Rise and Woodcroft developments, the two cas e studies in South Australia. This aspect of the research has started. No difficulties are expected with this aspect of the research other than the general one of availability of detailed data, discussed below.

Although the questionnaire addresses neighb ourhood and sense of community issues, the research team will also endeavour to gain additional information through discussions with appropriate council staff. The data will again help to corroborate (or refute) information gathered from the survey, for example Indicators 13 – 17 come into this category.

4.6 Field Work and Other Direct Research

Some of the TBL indicators can only be assessed by on -site observation. For example the core research team will assess Indicators 15 and 22 (Number of pedestrians and cyclists) and Indicator 18 (Number of public gathering spaces and people using them). On-site observation will permit triangulation techniques to be applied to check responses to some of the data obtainable from Council or from developers. An example is orientation of housing for passive solar purposes (Indicators 29 and 30) and the nature and location of commercial and other facilities provided in the two case studies (primarily Indicator 23). Data for some of the affordability indicators (Indicators 1 – 6 inclusive) are available from the Australian Bureau of statistics either as current data from the 2001 census or from special tabulations. Data for other affordability indicators are largely with Council or the developers of the case studies as noted above in paragraph 4.5.

We do not anticipate any difficulties with this aspect of the research other than questions that surround the possibility of conducting a design -oriented safety assessment using the CPTED process noted below.

4.7 Methodological Issues

Several methodological issues arose moving the research forward. Not all were anticipated in the research proposal.

4.7.1 Case Study Selection NSW (Sydney)

Master Planned Communities

Case study selection was unexpectedly difficult for the NSW (Sydney) situation. An extensive search was mounted which represented three forms of inquiry. The first was informal discussions within the core research team and the steering group. The second consisted of discussions with development managers in Landcom (two separate repres entatives) and Lend Lease (the developer of several MPCs) and with the town planners of Liverpool, Fairfield, Blacktown and Baulkham Hills. The third line of enquiry was a series of site inspections in the Cities of Liverpool, Fairfield and Blacktown and the Shire of Baulkham Hills.

Two problems arose which prevented an ideal MPC case study from being identified. First, MPCs in the Sydney Region which have an environmental agenda are extremely recent. ESD principles have only been applied seriously in the last three years at LGA level (Flynn 2002). Most developments are either high end, upper income developments (eg Stockland's development "The Outlook" in Baulkham Hills on Old Windsor Road and A.V. Jennings' development immediately adjacent); are still under construction (eg Stage 1 of Stanhope Gardens, Blacktown); or are special projects, small in scale and unrepresentative of mainstream housing (eg the infill, higher density niche market sustainable developments of Hunterford Rd., on Pennant Hills Road, Baulkham Hills; or Stringybark Creek in Lane Cove). Other MPCs that satisfy housing form and middle income criteria are too recent for sense of community to develop.

Second, there are many examples of MPCs (eg several Landcom developments) that are old enough to have generated a sense of community but none have more than rudimentary design elements of environmental sustainability. The Kingsbay, Five Dock development (Landcom) is also too recent to be a good case study and is also medium density and targeted at upper-middle income people.

Traditional Regulatory Subdivision

There are dozens of examples of traditional regulatory subdivision in Liverpool LGA. An acceptable case study at Chipping Norton has been identified though a slightly more recent development would have been preferable. However, Chipping Norton is the last of the genre of TRSs in Liverpool. Subsequent developments are release area projects like Cecil Hills, Green Valley, Hinchinbrook, Hoxton Park, Carnes Hill and Horningsea Park. They are all partial master planned communities and Council's documentation is poor which could inhibit our research process (Flynn 2002). These partial MPCs date from the mid to late 1980s and are an environmental notch above the calibre of the Chipping Norton development. Each area was developed by many small scale developers and builders, only loosely coordinated by Council DCPs with few sustainability features other than drainage swales and detention basins, for example. The Wattle Grove development was a further improvement over the release area subdivisions in being a fully master planned community with unifying design standards, abundant landscaping and more modest and compact development (Flynn 2002).

Summary

Wattle Grove, a master planned community (MPC) and *Chipping Norton*, a traditional regulatory subdivision (TRS) are the communities selected for study. They satisfy the criteria in the following way:-

a) Both are middle-income communities with similar socio-economic profiles – Criterion 1 (checked through the 2001 census).

b) Both sites are largely developed with single-family dwellings (SFDs), about 3000 homes in Wattle Grove and 2000 in Chipping Norton, both in the same LGA (Criteria 2, 3 and 6).

c) Wattle Grove was completed in the late 1990s (about 1997) within the context of AMCORD criteria which recommended sustainability or ESD principles. Chipping Norton represents the last of the traditional regulatory subdivisions in Liverpool and was completed in the late 1980s, shortly before the Wattle Grove development started. Some degree of overlap would have been preferable but they are completely sequential developments (Criteria 4 and 5).

With elements of environmental sensitivity in the design of the community, Wattle Grove represents the best available compromise between age of subdivision and potential for sense of community and presence of ESD principles. Both communities have been established for long enough to allow sense of community to form and be measurable.

4.7.2 Case Study Selection, South Australia (Adelaide)

South Australia has also had some difficulties in selecting case studies. First, there are very few MPCs and TRSs built in the same era and located in the same LGA. Those that do exist have a very different socio-economic background. Second, where this does occur the MPC is usually small, less than 500 dwellings in size and often smaller than this. After looking at a number of possibilities as suggested by PlanningSA and visiting the developments, the researchers decided to use *Seaford Rise* (MPC) and *Woodcroft* (TRS) as the case studies.

Master Planned Communities

Two master planned communities with overt environmental agenda were suggested by PlanningSA, *Mawson Lakes* and *Seaford Rise.* In neither case does the Master Plan address specific issues on building design although there are cumbrances suggested on building set back, orientation, building materials and colours, and overlooking. The master plans do address some elements of environmental planning and design for the entire site, for example planning, landscaping, footpaths and bicycle tracks, facilities for community gatherings, and water and waste management matters.

The problem with Mawson Lakes, however, is that there is no TRS "pair" with a similar socio-economic background in the same LGA. From observation, it also appears to be a development for the middle to upper income society. Seaford Rise also has a stronger affordability agenda. Also, there are a number of TRSs in the same LGA that can be used as the comparison study. Seaford Rise is an early 1990s development which was often cited as an example of an

environmentally responsible urban design, promoting *Green Street* principles. The Green Street program aims to encourage and promote the development of efficient and sustainable urban environments which provides a range of housing choices (Housing and Regional Development 1994). Further, Green Street encourages the development of better, more affordable housing which utilises good design and planning principles as outlined in the Australian Mode l Code for Residential Development.

Until 2000 the Seaford Rise development benefited from the application of "environment-friendly" principles. However, due to a change in the State Government Policy, the environmental agenda is now only partially presen t. Seaford Rise was a joint venture of the South Australian Urban Land Trust, South Australian Housing Trust, Kinsmen Pty Ltd, Jennings Group Pty Ltd and State Bank of South Australia but the joint venture was terminated in 2000 under the policy of the South Australian State Government. There is now much less control over the application and maintenance of the Seaford Rise Master Plan and although the new development at the site still follows site planning guidelines as set in the Master Plan. the sustainab ility outcomes of this development may not be quite as expected 3 to 10 years ago.

Traditional Regulatory Subdivision

The *Woodcroft* community was selected amongst a number of other TRSs suggested by the City of Onkaparinga Council as it shows a similar s ocio-economic background to Seaford Rise and was developed during the same period of time. It was initially built as a demonstration subdivision by the city Council, with some involvement of the Urban Land Trust. A small part of Woodcroft was developed as a demonstration of the application of AMCORD, and the survey will include this part of the development. In general, however, each area has been developed by many developers and builders with some limited controls by the Council through the City of Onkaparinga development plans. It should be noted that Woodcroft was designed and built before the amalgamation of a number of councils to become the City of Onkaparinga, which now has much stronger environmental agenda in its development plans.

Summary

Seaford Rise, a master planned community (MPC) and Woodcroft, a traditional regulatory subdivision (TRS) are the communities selected for study. They satisfy the criteria in the following way:-

a) Both are middle -income communities with similar socio -economic profil es – Criterion 1 (checked through the 2001 census).

b) Both sites are largely developed with single -family dwellings (SFDs) with more than 1000 homes, both in the same LGA (Criteria 2, 3 and 6).

c) Both were first developed in the early 1990s within the context of AMCORD criteria (for all developments in Seaford Rise and partly in Woodcroft). Some parts of both communities are still being developed but both represent the best available compromise between age of subdivision and potential for sense of community to form and be measurable(Criteria 4 and 5).

4.7.3 Case Study Selection, Queensland (Brisbane)

An extensive search was mounted in the Brisbane metropolitan area which represented three lines of inquiry. The first was a review of sustainable development in Brisbane (Dobins 2002). The second involved discussions with developers and design professionals as well as local government agencies. A set of candidate communities was established for investigation and the third element of the selection process consisted of a se ries of inspections with the Project Coordinator of the candidate communities. The Master Planned Community was selected first and a complementary TRS chosen that matched in terms of socio -economic background, checked by using Snapshot data from the ABS web site.

Both the Queensland case studies examined as part of the research are located in the western suburbs of the City of Brisbane. These fully meet the criteria established for case study selection and are indicative of the type of development found in metropolitan Brisbane. ABS Snapshot data

were used to check the Wards in which the candidate communities are located and compared to Snapshot Data for the City of Brisbane, too.

Master Planned Communities

The master planned community selected is Forest Lake. Building started in the early 1990's and is in the last of three stages of development. Originally this development was criticised for its poor transport infrastructure but development of the Centenary highway and Logan Motorway makes it convenient for north/south east/west vehicular connections in the Brisbane metro area. Work is underway to assess the transport issues concerned with this development. About 32 percent of energy consumption in a household is from transport, so for a community to be sustainable it must reduce transport cost/energy for example by raising public transport use and increasing the number of local jobs. Part of the master planning of Forest Lake was to provide a local industry network and facility and it will be interesting to establish to which extent this objective has been met.

Forest Lake is a Delfin Land lease project which appears to place an 'iconic' emphasis on 'nature,' rather than a sustainable emphasis on biodiversity. The use of a 'common' area of 'man made' natural beauty gives a sense of centrality to the development both in a visual and social manner. Developed in three phases over a period of approximately 10 years, it has seen the hand of change applied to it so that the earliest buildings have very different development characteristics as compared to later houses.

Traditional Regulatory Subdivision

The TRS of Sinnoman Park also dates from the early 1990s but is completed. The community contains approximately 1000 houses and was developed by AV Jennings. The estate is located adjacent to the 'Centenary Suburbs' of Mount Ommaney which were developed as part of a Master Planned Community by LJ Hooker in the 1960's. The Council formed an alliance with Hooker to develop the community in exchange for a road bridge and other infrastructure like sewerage treatment work. The major highway that now connects the Centenary suburbs with the City of Brisbane provides the road transport link. Whilst Sinnamon Park meets the criteria for a traditional regulatory subdivision it seems to be connected to and dependent on the adjacent master planned community of the Centenary Suburbs. This raises issues of permeability between subdivisions, that is one subdivision might be able to access services and facilities of adjacent areas.

4.7.4 Pilot Study

The research proposal envisaged an initial pilot study of a single development in NSW to enable the proposed triple bottom line (TBL) assessment model to be tested and refined. A pilot study was not done for several reasons:-

a) Considerable care was devoted to preparing the initial set of performance measures. They were derived from the literature and policy reviews and from operational indicator programs.

b) The initial set of assessment criteria for the model was thoroughly discussed within the core research group and with the principal investigators at UNSW. The draft suite of 80 TBL indicators was considered by the advisory team and refined into a working draft of 31 indicators. The draft was circulated to the two companion universities in Queensland and South Australia which brought several rounds of comment and modifications and further discussions with the principle investigators to produce a final suite of 37 TBL indicators. The final suite was the result of extensive cooperation and the consensus that developed between the four main parties suggested that piloting the TBL model was not necessary.

c) Many of the TBL indicators for this research project come from operating indicator programs and are tested, to a degree, through those programs. In addition, none of the indicators are so innovative that piloting would be *de rigeur.*

d) Piloting the TBL model implies a similar exercise for the questionnaire which accommodates about 30 percent of the TBL suite of indicators. The consensus obtained between the four main research parties over questionnaire content and, in particular, obtaining the advice of a UNSW expert in survey design and delivery suggests that a pilot study would not have been a meaningful exercise.

4.7.5 Data Availability and Data Sources

The Australian Bureau of Statistics census data (ABS 2001) is an important source for economic information, especially that concerning affordability. Additional sources of data for priming the indicators are the developers for each case study neighbourhood; p rivate energy companies servicing the case study communities; and the LGAs within which the neighbourhoods are located; and government agencies responsible for water management, like Sydney Water. Most of the data assembled in the data bank will be seconda ry material. However, the researchers will contribute some primary data (in addition to the community survey) using direct observation techniques, for example use of pedestrian and bicycle paths. A special survey of the extent to which neighbourhood design improves safety using the Crime Prevention Through Environmental Design (CPTED) assessment process may also be conducted.

Some of the indicators that emerged from the selection process became part of the final assessment model without the researchers know ing whether there were data available to underpin the measure. While the triple bottom line indicators are valid in themselves, acquiring data for some of them may not be straight forward:-

a) Economic data: Discussions with Delphin-Lend Lease (the develo pers of Wattle Grove MPC) suggest that economic data for individual indicators covering the costs of land development and other non-house construction will not be available. There will be some economic data but it is likely to be in aggregated form as whol e-of-subdivision costs. Economic data for the TRS of Chipping Norton is also likely to be difficult to obtain because of record keeping issues and the multiplicity of developers. In this case acceptable data may be derived from a limited number of developers that were involved in representative building types in the neighbourhood and that are still in operation. Fine-grained and dis-aggregated data may not be forthcoming in either case study, however. The same comments apply to both Queensland and South Aus tralia.

Regarding housing affordability data – rent and mortgage repayments in relation to income – we will not attempt to collect this form of data via the questionnaire. The team's social scientist advises that people resist divulging very personal info rmation and respondents might even be deterred from completing the survey form if faced with very personal questions. The data we seek may be indirectly available from the 2001 census but if special tabulations by the Australian Bureau of Statistics are needed to reveal these relationships, the budget should allow that.

b) Environmental data: The research proposal indicated that an environmental appraisal would be carried out on the two land development types "using a combination of established models for environmental assessment, such as GB Tool (whole building assessment) and LC AID (life cycle costing)". It would enable the project to calculate "Environmental impacts such as overall energy budget, greenhouse gas emissions, air and waterborne emissions , resource use……". In the initial stakeholder meetings held to discuss the TBL indictor suite, it was considered that not all these proposed impact areas would provide useful information and the steering committee recommended focusing environmental apprai sal on energy and greenhouse gas related indicators.

Through preliminary investigations into sources of data for energy use (and greenhouse gas emissions), it was clear that none of the case studies selected in the three states would have energy rating da ta available through the development approval process. All six case studies predate home energy rating schemes. In addition, energy use figures are unlikely to be available from the developers or builders as energy simulations for the building fabric were rarely carried out in the mid-to-late 1990s. Energy consumption data will be sought through questions in the survey instrument. Social survey experts (for example Zehner 2002) warn that householders may find this type of question difficult to answer. Few h ouseholders file bills for the whole preceding year and may only be able to locate a current energy bill . The researchers have taken considerable care over how the energy -related questions are presented in the survey and

reminder letters may motivate house holders to provide data that can be used in the TBL assessment. In the absence of data from the survey instrument the researchers will explore the possibility of accessing energy data through a company that conducts meter readings for the energy companies, or through the energy companies themselves.

c) Social Data: One particular indicator in the TBL suite refers to a design -oriented safety assessment using the CPTED process. Such an evaluation of the two case study locations is normally a major undertakin g and was not anticipated as part of the research proposal. The researchers in NSW hope to carry out an attenuated assessment using a set of eleven CPTED criteria.

4.7.6 Data Reliability

Data is only reliable if its source is dependable. The researchers will o nly use the best available data from the most reliable sources. Where conclusions are drawn from the research which are based on data of debateable reliability, attention will be drawn to the deficiency.

5 CONCLUSIONS

The policy and literature reviews have been instructive in helping to inform the choice of assessment tool and the development of a suite of indicators for the performance task. Current sustainability policy addresses areas like water sensitive urban design, encouraging local solutions to glob al problems by focusing on issues such as fossil fuel energy consumption and urban water cycle management. Clearly articulated and strong sustainability policy initiatives are recent, dating from the very late 1990s and their application generally post-dates the case studies in this research, unlike the relatively weaker expressions of sustainability in AMCORD. Nevertheless, being aware of recent policy initiatives is important because they can help to identify indicator themes that might be introduced into the TBL performance assessment suite, especially a model suite. Moreover, a sub-set of the policy investigation notes the widespread existence of indicator programs, notably CIPs and SOEs. They are collectively the monitoring arm of the policy process. So me of these indicator programs are leaders in the monitoring field and could be deemed “best practice”. Examples are the City of Santa Monica’s CIP (1999) and Willoughby City Council’s SOE (2001).

Regarding the literature review, several assessment tools were examined that are appropriate to appraising land development within a sustainability context. The only tool with a direct application to the type of integrated performance assessment required for the study of sustainability involves the use of indicators. The indicators cover the three sustainability domains of the economy, the environment and community and their inter-relationships. Other assessment techniques canvassed lacked a framework that encompassed all three sectors, focussing primarily on the physical environment and therefore unable to acknowledge the interacting nature of the three domains. The research team concluded from the literature that a suite of indicators based on the tenets of sustainability would provide the most appropriate appro ach for performance evaluation of the two development forms. The research terms this approach the triple bottom line or TBL model. A number of paths will be taken to supply the data for the comparative analyses of the three pairs of case studies. Data will come from a field survey of each pair of communities; from discussions with developers and council; from development files held by council as part of its application procedures; and finally from personal observation in the field involving mini-studies and examining development and master plans.

The next stage of the research is multi-pronged. Questionnaire development is complete and the survey will be distributed following the December-January school holidays, an optimum time for delivery. All three stat es will hand deliver the questionnaire in February in two stages, first as an initial delivery and secondly, in the form of a reminder 12 days later. Analysis will take place in early to mid-March. Data for the remaining TBL indicators will be developed du ring March and April 2003. The research will include the use of triangulation (or data corroboration) techniques in several areas, for example for energy and water consumption information and for data regarding cost of development and housing.

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APPENDICES

Appendix 1. Summary of advantages and disadvantages of assessment methods

Assessment Method	Advantages	Disadvantages
Cost Benefit Analysis	• Can be applied to any spatial scale (suitable for development scale) • Able to assess economic impacts adequately but monetizing environmental and social impacts is questionable • Credible methodological framework • Capable of quantifying direct, indirect, trans-boundary, cumulative impacts if identified in study boundaries. • Useful tool for comparing alternative projects.	• While appearing objective, valuing impacts is a matter of judgment and is thus subjective. • Money values often underestimate environmental benefits. Some say they defy economic measurement • Data for values are often difficult to obtain • CBA is often resource intensive (time-consuming and expensive) • Precautionary principle hard to quantify using CBA
Life Cycle Analysis (LCA)	• Framework partly standardised through ISO standards • Looks at impacts over the entire life of the product or development. • Assessment methodology encourages accounting for complexity of all process interactions and their impacts. • Useful tool for comparing specific products. • LCA software available specifically for assessments at the building level.	• Primarily focuses on ecological impacts. Tracks and quantifies process inputs and outputs, and related ecological damage. • Very resource intensive and generally used at a product or process level • Despite some standardisation, open framework has left the technique exposed to subjective bias especially in relation to significance and quantification of environmental impacts • Data requirements mean it is impractical to evaluate large scale developments
Material Flux Analysis (MFA)	• Useful method for focused study identifying ecological impacts related to a specific material in an identified region.	• Generally used to track impacts only related to a single material in a region. • Primarily focuses on ecological impacts from process inputs and outputs. • Assessment method over set time period (usually 1 year). • Data intensive needs.

Material Intens ity Per unit Services (MIPS)	• Useful method involving fairly comprehensive identification and quantification of material and energy flows over the entire life span of product.	• Primarily focuses on physical/ecological impacts from process related material and energy flows • Characterized as preliminary and crude screening -level LCAs.
Ecological Footprint (EF)	• Can be applied to any spatial scale (suitable for national through to individual building scale). • Methodology of impact quantification and aggregation of impacts has a degree of standardization and robustness. • Simple and intuitive means of communicating the scale of ecological impacts • Good for comparison purposes.	• Primarily focuses on physical/ecological impacts from process related material and energy flows. • Lack of scope for identifying flows between specific goods and processes • Life cycle impacts are only measured in a highly - aggregated manner • Data intensive.
Sustainable Process Index (SPI)	• Aggregated indicator of environmental pressure for specific processes to provide a service or product. Like EF it calculates land area required to provide resources and assimilate wastes.	• Suited to product scale, while EF can be used for larger scale studies such as regions.
Building Decision Support Tools, eg DOE2, natHERS, ATHENA.	• Generally provide objective assessments based on standardised validated methodologies typically focusing on specific aspects of performance such as operational energy use, embodied energy, illuminance, daylighting, and ventilation, mo stly with environmental and building related performance impacts.	• Narrow focus. Typically looks at individual buildings and their environmental impacts.
Whole Building Assessment Tools, eg BREEM, GBTool, and LEED	• Provide a broad coverage of primarily en vironmental related assessments.	• Data intensive. • Economic and social assessments possible but embryonic at this stage. • Aggregation of impact results criticised.

Indicators	• Can be applied to any spatial scale, global to specific building. • Able to assess ec onomic, environmental, and social impacts • Especially suited to post-development evaluation as opposed to design/planning stage. • Useful method for identifying, synthesizing, and communicating assessment-related information • Capable of quantifying direct, indirect, trans - boundary, impacts if identified in study boundaries. • Capable of quantifying cumulative impacts if measured over longer time frames. • Flexible in that mix of indicators can change to match specific circumstances.	• Choice, accuracy and validity are often criticized. • Methodological framework for indicator design especially at the project level underdeveloped. To date most work on indicator sets have been applied at a national or city level. • Indicator design can make implementation very resource intensive • Indicators are generally anthropocentric
Triple Bottom Line	• Framework able to encompass environmental, social, economic conditions and impacts. • Potential to develop indicators that encompass combinations of these sectors (eg socio -economic socio-environmental etc). • Applied to various spatial scales from the individual building to the national and regional but especially suited to communities, large and small.	• Primarily indicator based • No agreed methodology for development of indicator frameworks • Weakest on measurement of social and environmental costs

APPENDIX 2: THE TRIPLE BOTTOM LINE INDICATORS

Affordability and sustainability: assessment indicators

AFFORDABILITY				
1	Median house prices (per bedroom or per sq. metre)		ABS 2001 census; Real Estate Institute?	
2	Median household income		ABS 2001 census; Real Estate Institute?	
3	Housing costs (renters and owners) as % of average household income		Speak to B Judd about source. Use H'hold Survey?	
4	Percent home prices in case study n'hoods below the LGA median			
5	Proportion of households paying more than 30% of income on housing		ABS 2001 census (C-Data)	
6	Rent assistance for occupants of privately rented housing		Dept. of Housing	
AFFORDABILITY AND HOUSING/DEVELOPMENT COSTS				
7	Development costs – subdivision (in 7 dimensions, cost per lot)[1]		Council, Sydney Water; Energy Authorities; case study developers; possibly Council	
8	Development costs – housing (per m^2)			
9	Development costs (per m^2) of green homes v. conventional homes		May be impossible to gain this kind of data unless subdivision is design -build. In theory the data is derived from Indicator 6 (and perhaps 5)	
10	Maintenance costs of public domain (in 4 dimensions)[2]		Council	

11	Nature and degree of public subsidy [3]		Council and or developers; D of Housing	
12	Return on investment (average for the n'hood)		Developers; Data could be for either the housing or the development or a total for the neighbourhood	

1. Defined as roads, parks, landscaping, trunk water supply and sewer, stormwater, utilities undergrounding

2. Defined as roads, parks, footpaths, public plazas

3. Subsidy for any of the elements of development costs (see footnote 1) or the housing itself

Note: indicators 3A and 3B are derivative indicators assuming household income and housing expenditure data is available

NEIGHBOURHOOD COHESION				
13	Neighbourhood newsletters and n° of local meetings, projects and events		Check with local school and PCA; library; clubs; council; bush regeneration groups; national tre e day	
14	Participation in community meetings, projects and events		Check with local school and PCA; library; clubs; council; bush regeneration groups; national tree day Alternatively, use the social survey	
15	Number of public gathering spaces and people using them		Observation survey eg (7 -9am; 3-5pm; night 7-9pm. How long for and at what points in the neighbourhood? Establish after case study selection and trial visit	
16	Psychological sense of community		The indicator will be derived from a series of questions in the household survey. It will yield a single scalar figure	
17	Satisfaction with neighbourhood		The indicator will be derived from a series of questions in the household survey. It will yield a single scalar figure	

NEIGHBOURHOOD SAFETY				
18	No of pedestrians and cyclists		Data from field observation	
19	Design-oriented safety assessment		Expert walkthrough, possibly using the CPTED [pronounced SEPTED] technique (Crime Prevention Through Environmental Design). Check if there is a "List of Safe Places" or neighbourhood watches in existence	
TRANSPORTATION				
20	Availability of alternative (non -auto) transport: forms and frequency		Data from Sydney Buses and/or SRA; plus private operators On-site observation and data from state agencies	
21	Length of pedestrian and bike paths per dwelling (in kms).		Development plans or aerial photos Measurements from plans and photos	
22	N^{o} riding bikes or walking and leaving the neighbourhood		Data from field observation Perhaps use the household survey?	
SERVICES				
23	Percent homes within 400 metres walk of selected facilities[4]		Data from development plans and developers.	
ENVIRONMENT - BIO-DIVERSITY				
24	Area and proportion of site retained as native bushland		Data from Council and/or NPWS and by measu rement from development plans	

25	N^{o} and depth of management strategies and habitat conservation plans (rate with Likert scale, superficial to profound)		Data from Council and/or NPWS	
ENVIRONMENT – ENERGY				
26	Energy use (by fuel type per capita and pe r dwelling)		Use NatHERS if rating available. Otherwise try energy authorities; also developers or possibly from household survey	
27	Amount of renewable v non -renew energy		From energy authorities or possibly from household survey	
28	GHG emissions/cap ita and total in Dwellings		Use conversion of average energy use to carbon quantities (eg 1kWhr = 0.92 kg carbon)	
29	Application of energy efficient design principles (site)		Observation on site; estimation from development plans (review aspects eg orien tation and envelope); discussions with developers and architects	
30	Application of energy efficient design principles (buildings)		Observation on site; estimation from development plans (review aspects eg orientation and envelope); discussions with developers and architects	

4. Defined as: community facility (tennis courts, children's playgrounds, swimming pool, community hall and library); primary school; local health services; public open space; mini-market

ENVIRONMENT - OTHER FORMS OF RESOURCE CONSCIOUSNESS				
31	Extent of materials used with lower embodied energy		Discussions with developers and architects	
32	Dwelling density, gross and net residential density			

33	Range of dwelling size and average (sq ^{m})			
ENVIRONMENT - WASTEWATER AND STORMWATER				
34	Wastewater treatment (on-site v. conventional engineered infrastructure)		Simple yes/no answer from Council, developers/engineers	
35	Water sensitive urban design for stormwater – number of best practices applied		Simple yes/no answer from Council plans developers/engineers or calculate an impermeable cover figure by aerial photo.	
ENVIRONMENT - WATER SUPPLY AND WATER QUALITY				
36	Water consumption per capita		Sydney Water. Compare v. regional average (427 litres per capita per day and against Sydney Water's targets)	
37	Use of best practice water conservation techniques[5]		Discussions with Council; developers and architects	

5. Defined as for example dual plumbing; low flow water fittings, outdoor drip irrigation, drought tolerant landscaping

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