Inquiry into a Sustainability Charter

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Acronyms used

ALCAS	Australian Lifecycle Assessment Society
AwwaRF	Awwa Research Foundation
CAD	Computer aided design
CRC	Cooperative Research Centre
ITS	Intelligent Transport systems
IUWS	Integrated Urban Water Systems
LCA	Life Cycle Analysis
LCI	Life Cycle Inventory
SoE	State of the Environment
WfHC	Water for a Healthy Country National Research Flagship

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Executive Summary

Australia's capital cities continue to act as economic engines and present challenges in planning for smart growth and redevelopment incorporating sustainability targets.

The development of a Sustainability Charter as recommended by the report from the Inquiry into Sustainable Cities 2025 provides an opportunity for Australia to make aspirational statements about sustainability as well as setting performance targets across scales in a number of sectors. This submission should be seen as a follow-on to CSIRO's response to that inquiry.

A shift in State of Environment (SoE) reporting from descriptive analysis to sustainability reporting provides a mechanism for monitoring progress against targets, but requires substantial underpinning knowledge platforms. For targets to be meaningful, an understanding of the interactions of different parts of the system is required, as are methods for predicting the flow on consequences of setting targets for one part of the system. Tools such as the Extended Urban Metabolism Model developed for SoE reporting (Appendix 1) provide a useful mechanism in this regard.

The importance of behavioural change in achieving sustainability cannot be underestimated in development of any targets or performance measures.

In the built environment, sustainability targets should take into account the importance of urban form in driving resource use, and the need to balance form against amenity in designing urban areas.

Tools are available in both design and selection of materials which allow for assessment against sustainability criteria. There is potential for Australia to improve on its current five star energy rating system for buildings and CSIRO would support such an improvement to bring Australia in line with international best practice.

Residential energy efficiency must begin at subdivision level. This would suggest that targets for energy efficiency need to go beyond individual structures and consider new subdivisions as a whole to be effective.

Lifecycle Inventory and Lifecycle Analysis tools allow for material selection to meet sustainability targets. CSIRO supports the development of a materials labelling system to aid in material selection.

Incentives for changed behaviour of occupants is critical to achieving sustainability in the built environment, given that behaviour outweighs design and materials in reducing consumption and emission.

Integrated Urban Water Systems (IUWS) require an understanding of total system performance, including the interactions between components, to achieve sustainability. Components include social, economic, legislative and operational issues that influence the performance of the system, as well as physical infrastructure.

Defining a 'sustainable urban water system' and suitable indicators is challenging and defining an absolute target for sustainable water management is not appropriate. Monitoring trends in comparison to baseline sustainability conditions is a preferable and more practical approach. Headline indicators that may be considered universal for monitoring urban water system trends could include:

- water use per capita;
- measures of the ecological health of urban waterways and groundwater systems;
- greenhouse emissions relating to water supply and use; and
- socio economic indicators relating to public health (drinking water quality), water service quality, cost and acceptability.

A number of tools can be brought to bear to quantify performance against targets, such as the urban metabolism model, national lifecycle inventory database, lifecycle analysis design tools and stocks and flows modelling.

In all cases it is important to remember that our current state of knowledge does not always allow for effective benchmarking measuring and

modelling and that human behaviour is as important as physical change in achieving sustainability.

Introduction

Preamble

CSIRO welcomes the Inquiry into a Sustainability Charter for Australia's urban communities. This submission should be seen as a follow-on from CSIRO's submission to the Inquiry into the Sustainable Cities 2025 and the subsequent Report's recommendations involving future directions and CSIRO's role.

There are several other key dimensions in addition to those that are represented in the Terms of Reference for this Inquiry that warrant attention in the context of a Sustainability Charter for Australia's Cities. These would include:

- Human Well-Being;
- Environmental Quality within Cities;
- Generation and Utilisation of Waste Streams; and
- Urban Form and Density.

CSIRO can supply information to the Inquiry on these topics as requested by the House of Representatives Standing Committee.

CSIRO's role and relevance

CSIRO has R&D capabilities in development of the built environment, issues of sustainability and land and water management. In the past these capabilities have been brought to bear in developing sustainability frameworks or charters such as:

- The Melbourne Principles for Sustainable Development , developed at an International Charette held in Melbourne between 3-5 April 2002;
- The Extended Urban Metabolism model, developed initially for Australian SoE reporting (Appendix 1);
- The Urban Resilience Framework; and
- The Capital Accounting model outlined in CSIRO's submission to 2003 Inquiry into Sustainable Cities 2025.

CSIRO continues to undertake a significant and focused program of research related to the sustainability of Australia's urban environments.

Addressing the Terms of Reference

Key elements of a sustainability charter

There are many "charters" that have been established which embody high level aspirational sustainability principles designed to guide future urban and industrial development processes.

It typically follows from such that a group of high level objectives emerge. Headline indicators, such as those developed for national SoE Reporting, can be further developed and nested – and so the process continues.

To date most reporting (such as SoE) has been descriptive in nature, describing the current situation and trends. A shift to sustainability reporting, where the challenges are several orders of magnitude greater, requires substantial underpinning knowledge platforms and a greater understanding of system dynamics. For targets to be meaningful, an understanding of the interactions of different parts of the system is required, as are methods for predicting the flow on consequences of setting targets for one part of the system.

Innovation will constitute an important driver of sustainability in the urban context. However, as one moves from a prescriptive to a performance-based platform for urban planning and design, there is a requirement for scientifically validated assessment tools capable of quantifying performance against benchmarks or targets. The Extended Urban Metabolism Model developed for SoE reporting (Appendix 1) provides a means of examining the key pressure points on Australia's urban systems and preferred performance trajectories for future urban development.

To address sustainability it is necessary to set performance *targets* at all *scales* ranging from material elements, to whole buildings, to blocks or neighbourhoods and to entire urban systems. Crossing scale boundaries also allows for reporting at different levels of enterprise and government.

It is also necessary to assemble information relevant for decisions on target-setting that include:

- best Australian performance;
- best (relevant) international performance currently in practice; and
- best prospective Australian performance,

as this information is not currently readily available in a consolidated form.

Best prospective performance will depend on certain planning, design, materials, behaviour and innovations being implemented.

There are a growing number of key urban transitions that need to be initiated now in order to gain sustainability benefits across the urban domains specified in this Inquiry. Many of these relate to behavioural change as much as physical change and this needs to be taken into account in development of a sustainability charter.

The Built Environment

There is evidence that urban form influences environmental performance and that higher levels of residential density in cities can achieve a number of environmental objectives. Such higher densities need to be assessed against other benefits such as neighbourhood character and amenity.

The key drivers of sustainability of buildings and infrastructure *"as built"* are (1) design and (2) the materials selected.

Some parts of Australia are already employing building energy performance standards for design and construction of housing and there have been proposals to expand these standards Australia-wide. However, international comparisons suggest that Australia's proposed five star standard is below international levels of performance which provides scope for improving the energy performance of the housing shell for existing and new houses in Australia. (Horne et al 2005). Even at the five star energy rating level behaviour of the occupants could outweigh building performance.

In relation to *Materials* performance, CSIRO is leading a National Life Cycle Inventory (LCI) initiative, working with the Australian Lifecycle Assessment Society (ALCAS), industry and government to develop a consistent high quality National LCI database for use in Australia, similar to that which was established and is being maintained by the National Renewable Energy Laboratory in the US[1] and the Eco-Invent database in Europe[2]. This proposal has great potential to forward ALCAS' aim to have consistent national LCI data available for public use in assessing the sustainability of building materials.

In Recommendation 19 of the *Sustainable Cities* report the committee recommends that the Australian Government, in consultation with the Housing Industry of Australia, CSIRO and other industry and scientific bodies, investigate the establishment of a 'sustainable building material' labelling system. CSIRO would welcome broader government and industry support for this initiative.

Life Cycle Analysis Design tools such as CRC Construction Innovation's LCADesign are capable of automated eco-efficiency assessment of "as designed" and "as built" buildings or infrastructure. By augmenting these tools with checklist systems such as Green Star targets, the sustainability of proposed and existing structures can be assessed against targets.

The other key dimension for sustainability assessment is *"as-operated"*. This introduces the challenge of demand management. Hence, in assessing the sustainability of the built environment it is necessary to look at the behaviour of occupants as a key driver of resource consumption in the context of sustainability.

Water

It is generally recognised that the traditional linear approach to urban water management is increasingly unsustainable, especially in water-stressed countries such as Australia. The continuing growth of our cities, together with reduced water availability due to climate change is influencing urban water managers to introduce integrated water cycle management solutions, including initiatives to improve the efficiency of water use and supplying additional water from

[1] http://www.nrel.gov/lci/about.html

[2] http://www.ecoinvnet.ch/en/index.htm

diverse sources such as wastewater or stormwater, in order to increase sustainability.

Improved efficiencies can be achieved if all components of the system are considered together – potable, storm and waste water, together with technical, social, economic, operational and governance issues. Such systems are commonly referred to as Integrated Urban Water Systems (IUWS). A good understanding of total system performance, including the interactions between components, is essential if the influence of individual components on achieving sustainability is to be recognised. Components include social, economic, legislative and operational issues that influence the performance of the system, as well as physical infrastructure.

Defining a 'sustainable urban water system' and suitable indicators is challenging as it requires consideration of social, environmental and economic factors that change over time and vary from location to location. Therefore defining an absolute target for sustainable water management is not appropriate, monitoring trends in comparison to baseline sustainability conditions is a preferable and more practical approach. Headline indicators that may be considered universal for monitoring urban water system trends could include:

- water use per capita;
- measures of the ecological health of urban waterways and groundwater systems;
- greenhouse emissions relating to water supply and use; and
- socio economic indicators relating to public health (drinking water quality), water service quality, cost and acceptability.

Subsets of these indicators could include more detail on the efficiency of water use in different sectors, sources of water, energy use across the water system, and the performance of new water service options (eg demand management, recycling, stormwater harvesting) in contributing to achieving more sustainable urban water management. Detailed performance indicators are generally limited to those for which calculation methods and data exist; the performance of the system can then be calculated and compared to a predetermined criterion, or to existing practice.

CSIRO's Water for a Healthy Country National Research Flagship is undertaking research to analyse urban water system sustainability, both in the long and the short term. Major initiatives include evaluation of alternative IUWS at scales ranging from household to city- and catchment-wide, including evaluating the impacts of the effects of climate change on IUWS performance. The current research portfolio includes development of methodologies, risk assessments and decision support but these projects are not yet at reporting phase.

CSIRO has developed network theory to model the requirements for integrated resource management in urban streams and is currently working with the Swan River Trust to examine the drivers and obstacles to behaviour change and the sustainable management of urban stream water quality, again recognising that behavioural change is as important as physical change in achieving sustainability.

Energy

Energy use is a major economic and environmental issue for Australia.

Electricity generation is a leading consumer of energy in Australia, with a continuing high growth in electricity demand and a widening gap between electricity demand and supply. There is clear scope for greater energy efficiencies in relation to energy conversion, as well as a transition to a more environmentally sound energy platform for the nation (Productivity Commission 2005) given that the current centralised fossil-fuel-based electricity generation industry is also the leading contributor of greenhouse gases. Here CSIRO's research on Distributed Generation and the Intelligent Grid presents opportunities for meeting higher (prospective) performance targets that government may consider setting linked to more eco-efficient energy systems of the future.

CSIRO has developed design and analysis tools for architects to quantify the energy-efficiency of residential and commercial buildings. Much of the information included in our comments about the built environment is also relevant to this section.

CSIRO research, undertaken for the CRC for Construction Innovation, has demonstrated that residential energy efficiency must begin at subdivision level – ensuring configuration of allotments provide best opportunity for energy efficiency of buildings as a result of solar access and ventilation, in context of orientation and proposed building density. This would suggest that targets for energy efficiency need to go beyond individual structures and consider new subdivisions as a whole to be effective.

There are considerable opportunities to drive more sustainable energy behaviours and this suggests that suitable targets should be set with behavioural change in mind. As outlined in CSIRO's submission to the inquiry into Sustainable Cities 2025, opportunities include:

- implementation of best practices to minimise consumption without prejudice to quality of life;
- investment in new and developing technologies; and
- appropriate policy settings.

Transport

Transport is one of the key components of any urban centre in that it is fundamental to providing inhabitants with access to goods and services and can have large negative impacts on liveability. As outlined in CSIRO's submission to the Inquiry into Sustainable Cities, an opportunity exists to minimise traffic stresses while providing better access to goods and services by:

- Undertaking integrated land use/transport planning of multi-centred cities to increase accessibility and limit travel demand.
- 'Right moding' public transport to centres and between centres, walking or cycling for short trips; efficient car travel outside centres.
- Reducing energy use and pollution using Intelligent Transport Systems (ITS) and low energy vehicles.
- Utilising ITS for logistics and for safety and security.
- Setting pricing regimes to improve the urban transport "Triple Bottom Line".

Ecological Footprint

The Ecological Footprint is gaining increasing acceptance internationally as one of a small number of high level sustainability metrics related primarily to the issue of resource consumption/depletion.

Currently CSIRO is undertaking research capable of assigning an ecological footprint metric at both macro and micro scales.

Stocks and flows modeling allows macro-scale targets to be examined using the technique of back-casting—searching for those inputs that result in the scenario target being achieved. This tool allows users to inject different value judgments without these being hard-wired into the framework.

This area of research (and its associated models and metrics) relates to Recommendation 18 of Sustainable Cities report. CSIRO continues to lead the strategic research in this area and would welcome the opportunity to apply this technique more widely across Australia.

At the micro-scale, LCADesign is a model developed by CRC Construction Innovation and CSIRO that automatically calculates the environmental impact (resource use, environmental degradation, human health) of a building or infrastructure at the design stage from a 3 dimensional CAD model of a building. It provides a basis for deriving an ecological "fingerprint" for individual buildings and infrastructures - indeed all built assets.

A whole of life assessment tool would be a necessary basis for performance assessment of built environment sustainability. LCADesign has the capacity for being developed into such an assessment tool.

Conclusions

The development of a sustainability charter for Australia's cities provides an opportunity to express aspirational sustainability principles for the nation and set targets at a range of scales across a number of sectors.

In developing such a charter and setting targets urban environments should be considered as complex systems incorporating biophysical, social and economic elements, which interact and feedback into each other.

Shifting SoE reporting from descriptive analysis to true sustainability reporting would provide an effective mechanism for monitoring progress against target, but requires substantial effort in understanding, benchmarking, measuring and monitoring current and prospective performance.

A number of tools can be brought to bear to quantify performance against targets, such as the urban metabolism model, national lifecycle inventory database, lifecycle analysis design tools and stocks and flows modelling.

In all cases it is important to remember that:

1. Our current state of knowledge does not always allow for effective benchmarking measuring and modelling and
2. Human behaviour is as important as physical change in achieving sustainability.

References

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Appendix 1:

A Model Framework for SoE Reporting

The extended urban metabolism model of human settlements (Figure 1) enables a representation and assessment of the built environment in terms of:

1. **resources produced and consumed** – whether renewable or non-renewable, and consequent impact on draw-down on stocks and natural endowments (including both human capital as well as natural capital).

2. **urban systems and processes** – the 'engine' of human settlements which includes as its constituent 'parts', governance systems, legal frameworks, organisation practices, technological sophistication, as well as a range of industrial processes and products across all sectors in the economy that vary in their level of efficiency and environmental performance (eg inter-modal transport networks; office design; electricity generation and distribution, etc).

   It is in this domain where *sustainability* has emerged over the past decade as a new and powerful driving force that is engaging government, industry and community in a new way of thinking that recognises that we are all living on a closed system called earth that would be incapable of supporting the planet's current population at a level of consumption representative of countries such as Australia and USA.

   To advance our efforts in sustainable urban development, we need to progress on at least three fronts. First, we need a better understanding of our natural and built environment systems as complex, inter-connected systems. Our knowledge base and way of thinking is currently too fragmented. Second, we need to develop new policies and instruments (eg ISO 14000 standards, eco-labelling, green building, etc) that will engender change and some re-ordering of consumption and production drivers. Third, we need new technologies (products and processes) that embody *eco-efficiency* principles. The shift required here is from the currently dominant paradigm of productivity (more output with lower costs, fewer people) to one of *eco-efficiency* (more output with fewer people and less resource consumption and environmental impact) – the *Factor 4* principle articulated by Weizsacker et al, (1998).

3. **environmental quality of the natural resource systems** within and adjacent to the urban system in question, including such aspects as catchment management, quality of rivers and receiving waters, biodiversity, air quality, environmental noise.

4. **human well-being** of the resident and visitor populations (as measured by a wide range of factors now common in quality of life and social indicator studies; both quantitative -eg related to housing, employment, health, income etc; (ABS, *Australian Social Trends* 2000, Cat. No. 4102.0) and qualitative (Eckersley, 1998) in nature).

5. **waste and emissions and their level of recycling and re-use** embodies another paradigm shift in thinking which redefines waste streams as potential resource streams (eg stormwater, wastewater, construction and demolition waste, obsolescent appliances, motor vehicles, tyres, etc) as well as the longer established initiatives seeking to minimise the generation of waste across the full spectrum of production and consumption activities.

   The value of such a model from a BDP (short for Building Design Professionals) viewpoint is that it is normative: it prescribes a desired direction for change – reduced resource use (ecological footprint: see Wackérnagel and Rees, 1996); reduced waste; improved physical environment; enhanced human well-being and quality of life; and more eco-efficient built environment processes and products – that should be a feature of every development project (refer to Figure 1).

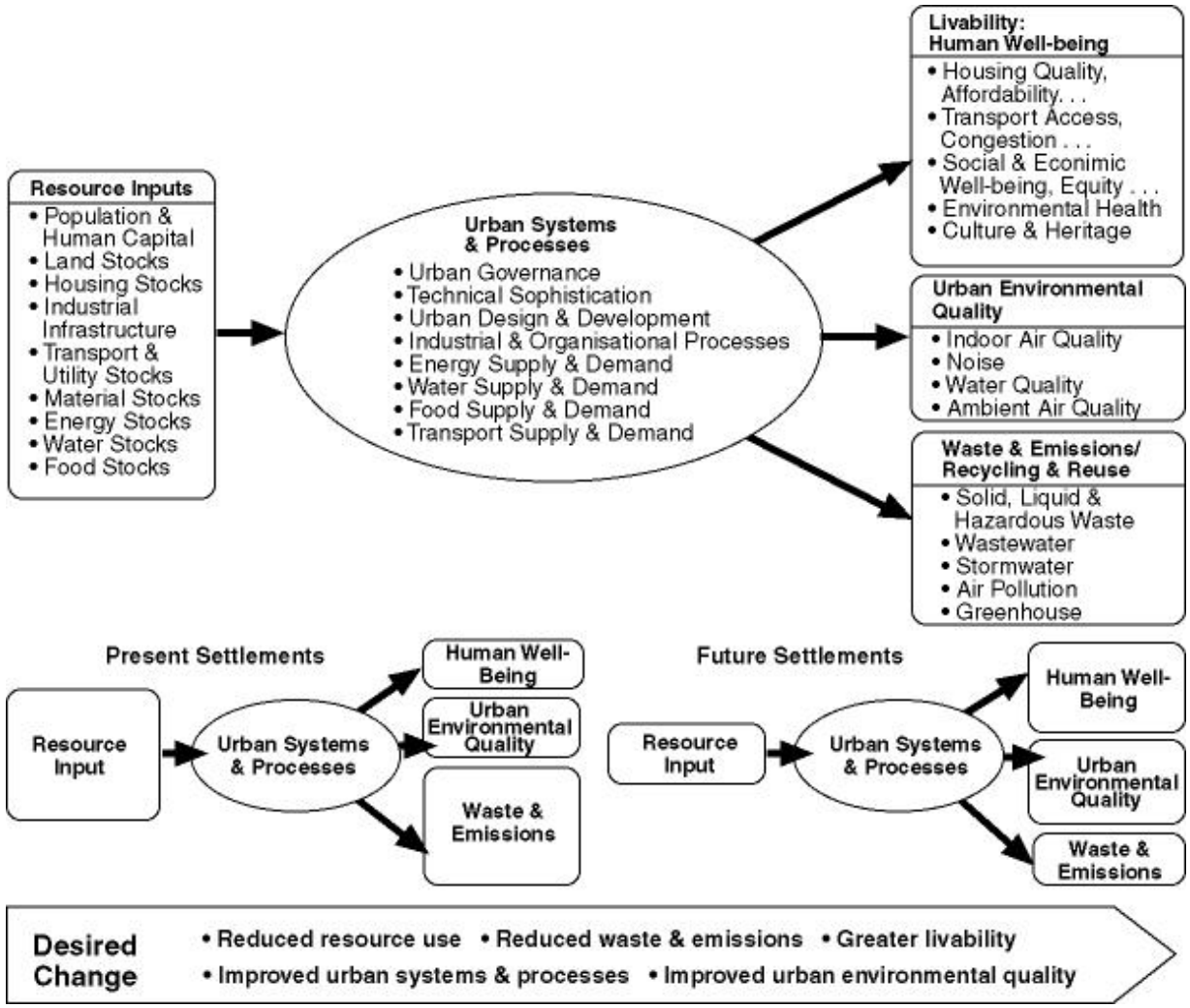

Figure 1. Extended Urban Metabolism of Human Settlements.

Source: Newton, P.W., Baum, S., Bhatia, K., Brown, S.K., Cameron, A.S., Foran, B., Grant, T., Mak, S.L., Memmott, P.C., Mitchell, V.G., Neate, K.L., Pears, A., Smith, N.. Stimson, R.J., Tucker, S.N. & Yencken, D. 2001, *Human Settlements, Australia State of the Environment Report 2001* (Theme Report) CSIRO Publishing on behalf of the Department of Environment and Heritage, Canberra.