Critical Perspectives on Accounting (2000) **11,** 583–605
doi:10.1006/cpac.2000.0475
Available online at http://www.idealibrary.com on IDEAL®

ACCOUNTING FOR SUSTAINABLE DEVELOPMENT—A CASE STUDY OF CITY FARM

GEOFF LAMBERTON

Southern Cross University, Center for Accounting and Finance, Faculty of Business and Computing, New South Wales, Australia

An accounting model designed to evaluate performance in achieving the objectives of sustainable development is applied to an organisation striving for a mix of ecological, social, and economic goals. The accounting model uses environmental performance indicators and life cycle analysis to measure performance against ecologically efficient and sustainability targets, utilising both quantitative and qualitative data. It is found that the organisation's industrial design is consistent with some of the ecological goals of sustainable development, but ecological and financial constraints, together with priorities of the economic system within which the organisation functions, lead to specific aspects of the organisation's operations being ecologically unsustainable. The paper concludes that the accounting model enables an organisation's contribution to the multidimensional objectives of sustainable development to be evaluated, and the implications of this for accounting and the sustainable development agenda are discussed.

Introduction

Inextricably linked to the ecological crisis that confronts humankind are the activities of business organisations which result in the production of industrial waste and pollution and the consumption of a diminishing natural resource base (Holland and Petersen, 1995; Aplin *et al.*, 1995; Trainer, 1996). Concern about the severity and pervasiveness of ecological destruction has led to a search for a new form of economic development that is consistent with desired ecological and social goals. Emerging from this search is the concept of sustainable development which has the potential to provide business with an alternative set of values to divert decision making away from a singular focus on economic performance.

Attempts within the accounting discipline to absorb the sustainable development concept are in the exploratory stages and have led to a new form of accounting referred to as "accounting for sustainability", or alternatively "accounting for sustainable development". This form of accounting goes beyond conventional

Received 6 June 1999; revised 23 November 1999; accepted 31 December 1999

1045–2354/00/100583+23/$35.00/0

accounting, which focuses on financial objectives, by including environmental and social objectives in the accounting framework. This paper reports on the results of applying an "accounting for sustainable development" model to an organisation which is striving to achieve the ecological, social and economic goals contained within a multidimensional perspective of sustainable development.

Defining Sustainable Development

Considerable momentum toward developing the sustainable development concept at the global level is credited to the international fora resulting in the publication of *Our Common Future* (WCED, 1987) and Agenda 21 (United Nations, 1992). Given widespread support for sustainable development as an appropriate goal for humankind, the process of transformation to sustainability requires clarification of the precise meaning of the concept as well as the formulation and implementation of relevant policy. Clarifying the concept has proved difficult and no single definition of sustainable development has universal acceptance, although an evolving theme is the conception of sustainable development as a synthesis of ecological, social and economic goals (United Nations, 1992; Milne, 1996; van der Bergh, 1996; Westing, 1996; Frankel, 1998). Gudmundsson and Hojer (1996) define sustainable development as a multi-directional concept.

"Development represents increase in quality of life and social equity. Sustainability represents long-term survival of systems that provide foundations for development." (Gudmundsson and Hojer, 1996, p. 272).

This definition captures the multidimensionality of sustainable development linking the long term survival of ecological and social systems to development, which includes the consumption of economic goods as well as socially equitable distribution of both economic and natural resources.

There is also recognition that implementation of sustainable development policy is required at multiple levels (e.g. global, national, regional, municipal, organisational, individual), and, given the size and potential innovative capacity of the global business community, the organisational level is considered crucial to the process of transformation to sustainability (Shrivastava, 1995; Starik and Rands, 1995). As organisations shift their foci from an exclusively financially oriented perspective and respond to the challenge of sustainable development, accounting systems are needed to provide feedback on organisational performance towards the multidimensional objectives of sustainable development. The accounting for sustainable development model applied in this research provides an example of a possible form for this type of accounting.

Environmental Performance Indicators

The incidence of corporate environmental reporting is gathering momentum in both Australia (Deegan and Gordon, 1996) and overseas (Owen *et al.*, 1996). State-of-the-art environmental reports document environmental policies, describe environmental management systems, provide data on natural resource conservation initiatives and report on emission of pollutants (see for example WMC Environment Progress Report 1995–96), although opinion is mixed as to whether environmental reporting as currently practiced is anything more than a corporate public relations exercise (Beder, 1997; Frankel, 1998). Elkington (1993) provides a typology of the various stages of environmental accounting distinguishing environmental reporting at the lowest level from the most evolved form “accounting for sustainable development”, which links environmental, economic, and social aspects of corporate performance, supported by indicators of sustainability. The use of indicators to measure environmental performance has received considerable attention in the environmental management and ecological economics literatures. Research towards developing integrated ecological–economic indicators of performance is continuing (CICA, 1994; Ditz and Ranganathan, 1996), although much of this research is aimed at developing sustainability indicators at the macro level (Nilsson and Bergstrom, 1995; Azar *et al.*, 1996; Opschoor and Reijnders, 1991; van Pelt *et al.*, 1995). More recently the focus has shifted to the organisational level and has led to the development of international environmental standards such as ISO 14031, which provides a framework for the evaluation of environment performance and the selection of relevant environmental performance indicators (Hortensius and Barthel, 1997).

Performance indicators are used in management accounting where balanced scorecards provide a link between an organisation’s strategic objectives and key performance indicators (Kaplan and Norton, 1996; Partridge and Perren, 1997). Key performance indicators include not only measures of financial performance but also measures of operational efficiency, innovation, and customer satisfaction. Adding an environmental dimension to the balanced scorecard recognises society’s growing concern with the impact of industrial activity on the natural environment.

Sustainability indicators represent one specific type of environmental performance indicator, which attempt to measure the deviation between actual performance and sustainable performance (van Pelt *et al.*, 1995). The size of the gap between performance and the sustainability target represents the degree of unsustainability.

Desired attributes of environmental performance indicators have been identified, see for example State of the Environment Advisory Council (1996); OECD (1994), although Schaltegger *et al.* (1996) conclude that the four desired qualitative characteristics of financial accounting information apply to environmental performance indicators. These four characteristics require that environmental performance indicators are

- **understandable** by nonscientists
- **relevant** to an organisation’s environmental and social objectives as well as to the information needs of stakeholders
- **reliable** and free from material error
- **comparable** across entities and against relevant benchmarks.

The use of environmental performance indicators is not without limitations. Most notably a varying level of precision due to the unavailability of required data leads to the widespread use of estimation and sampling techniques to plug information gaps, and the general lack of common definitions and industry standards reduce the comparability and possibilities for benchmarking EPI (CICA, 1994). However given a definition of sustainable development that goes beyond economic issues to include environmental and social objectives, accounting for sustainable development using predominantly financial units of measurement is not a feasible option. Indicators are required capable of measuring performance towards objectives such as ecological sustainability and as this case demonstrates this is best achieved using multiple units of measurement.

Accounting for Sustainable Development

Advances in accounting for sustainability at the conceptual level are mainly due to the work of Gray *et al.* (Gray, 1992, 1993; Bebbington and Gray, 1993; Gray, 1994). Gray identifies three possible methods of accounting for sustainability:

- accounting for natural inventories
- the calculation of sustainable cost
- input–output analysis

and exploratory research applying each method is beginning to emerge, see for example Jorgensen (1993); Jasch (1993); Jones (1996); Bebbington and Tan (1996, 1997). Underpinning Gray's suggested methods of accounting for sustainability are the concepts of eco-efficiency and eco-justice. Eco-efficiency links economic with ecological issues focusing on the production of more goods and services with less natural resource inputs (Stone, 1995; Schaltegger *et al.*, 1996), whereas eco-justice links social with ecological issues (Bebbington and Tan, 1996) focusing on the maintenance of natural resources for future generations (intergenerational equity) and the redistribution of wealth to alleviate poverty (intragenerational equity).

The accounting model used in this research provides a framework that subsumes the concepts of eco-efficiency and eco-justice into a three dimensional conception of sustainable development. The ecological, social, and economic dimensions of sustainable development are then decomposed into five measurable performance factors.

The five performance factors depicted as Figure 1 are used in this research to evaluate the performance of an organisation striving to achieve the objectives of sustainable development. Central to this accounting model is the concept of ecological sustainability, which goes beyond the concept of eco-efficiency which focuses on the *conservation* of natural resources (Milne, 1996), requiring the *preservation* of natural resources crucial to achieving humankind's intergenerational obligation to provide future generations with healthy and resilient ecosystems (van der Bergh, 1996). Intragenerational equity requires acceptance of the responsibility to provide all members of the present generation with a fair share of natural and humanmade wealth, the elimination of poverty and the restraining of actions which

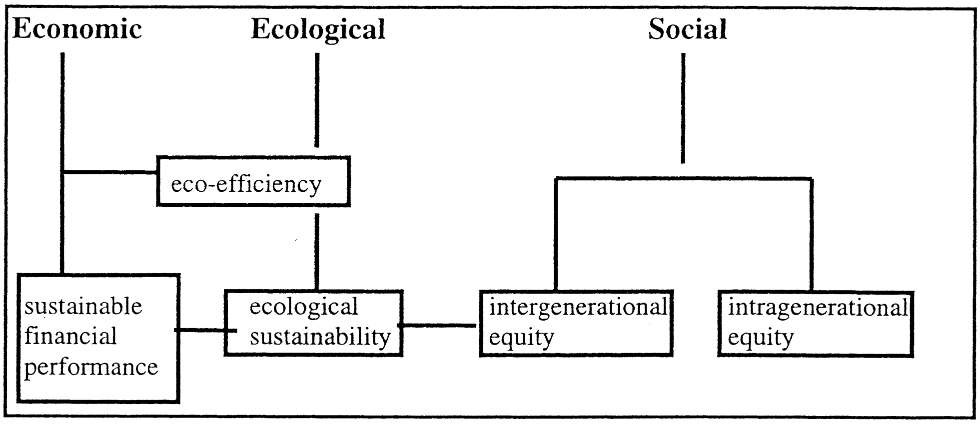

Figure 1. An accounting for sustainable development model.

may adversely affect other communities who share the global commons (Chiras, 1992).

Financial performance is not ecologically sustainable if the organisation's long term economic viability is threatened by a diminishing or degrading natural resource base. A prerequisite to achieving ecologically sustainable financial performance is achieving the objective of ecological sustainability (Lamberton, 1998). Stakeholders, particularly investors, need to be informed if an organisation's ecological life support system is being destroyed, threatening the economic viability of the organisation. Financial performance may not be sustainable for social, political or economic reasons, but such as analysis is beyond the scope of accounting for sustainability. Social and economic factors included in this accounting model are limited to those that are directly linked to ecological factors, such as providing resilient ecosystems for future generations or the economic implications of the management of environmental risks.

The objective of this research was to use the accounting model to evaluate an organisation's performance in achieving the objectives of sustainable development. This was achieved using a methodology that provides an enriched data set enabling a holistic perspective of organisational performance.

Research Methodology

The methodology used was predominantly field-based involving the collection of evidence from multiple sources concerning the case organisation. A single case design is relevant when the

- unit of analysis is being examined from a holistic perspective
- phenomenon being investigated has proved previously inaccessible to researchers (Yin, 1994)

- research represents a exploratory study of a contemporary phenomenon where existing theory is inadequate (Eisenhardt, 1989).

This research was a exploratory study applying the sustainable development concept at the micro level where existing theory is inadequate and in need of research (Owen *et al.*, 1996; Ditz and Ranganathan, 1996). A further reason for the single case design is the complexity and sheer size of the task of evaluating performance toward the objectives of sustainable development, requiring a deep and holistic understanding of a single setting as distinct from comparative insights, which are provided by multiple case designs (Gibb-Dyer and Wilkins, 1991). A case study is considered an ideal unit of analysis when multiple sources of evidence are required to provide the organisational context of the phenomenon examined (Smith *et al.*, 1988). In this research data was collected from

- consultant's reports
- financial statements
- correspondence with suppliers and council
- interviews with employees (formal and informal)
- direct measurement of primary data
- publications concerning the case organisation
- observation at management meetings
- observation at community meetings.

Throughout this research environmental performance was measured with reference to first-level environmental impacts (i.e. the case organisation's direct impacts on the environment) and second-level environmental impacts (i.e. impacts caused by suppliers of the case organisation's inputs). Third-level impacts (i.e. impacts incidental to the provision of inputs) are excluded as in Bebbington and Tan (1996). A considerable amount of the information needed to apply the accounting for sustainable development model required estimation: for example water consumption, energy consumption, and emissions were estimated using information provided by supplier, vehicle emissions were calculated using a model provided by the NRMA (O'Dwyer, 1998) and reuse rates were estimated by sampling randomly selected weeks throughout the period of observation. The accounting period for which environmental data was collected and reported in this paper is the year ended 30 June 1998.

The Case Organisation

The case organisation selected was "City Farm", a small business committed to sustainable development striving for a synthesis of ecological, social, and economic goals. City Farm encompasses three interdependent business operations

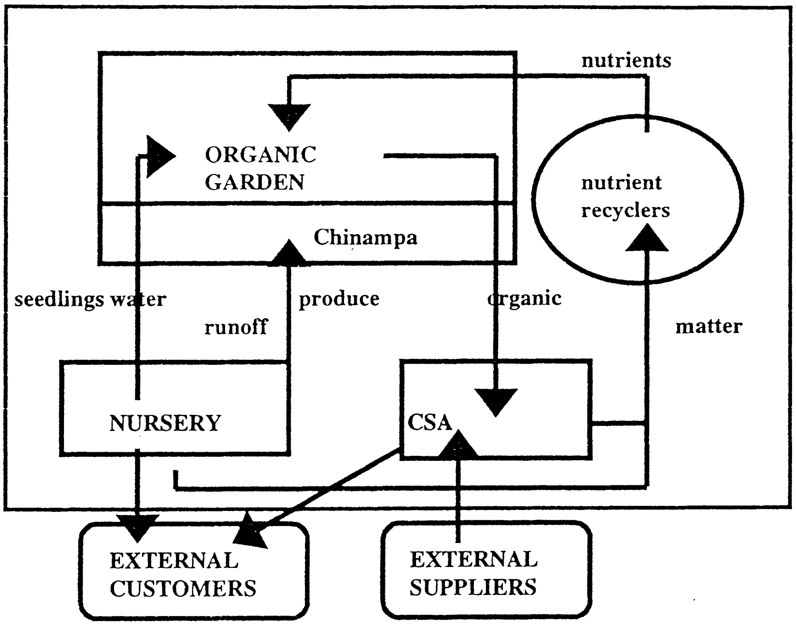

Figure 2. City Farm's operational design.

1. an organic seedling nursery
2. an organic fruit, vegetable, and herb garden
3. the CSA (community supported agriculture).

City Farm's Nursery and CSA operations are managed independently. The Nursery sells seedlings directly to the City Farm Organic Garden and to external customers. The CSA purchases organic produce from growers actively supporting sustainability by purchasing produce from local organic growers wherever possible. Produce is sorted, packed, and sold directly to customers. The Garden is managed using a permaculture strategy aimed at establishing an agricultural system which is biologically diverse and resilient (Mollison, 1988).

Evident in the site and operational design of City Farm is the concept of industrial ecology, where industrial systems are designed in the image of natural system. Within an industrial ecology waste products become raw materials for other industrial processes within a cyclical system which runs almost entirely on solar energy (Andrews *et al.*, 1994; Frosch, 1995; Graedel and Alleny, 1995).

The interdependence of City Farm's business operations is displayed in Figure 2.

City Farm's three operations are located on the same site, providing proximity of supplier with consumer and enabling waste products from one operation to be recycled into one of the two adjacent complimentary operations. As displayed in Figure 2 the Nursery supplies seedlings to the Garden and the Garden provides produce to the CSA, reducing transportation requirements and the economic and environmental cost of obtaining inputs. Solid waste from the Nursery and CSA are recycled as nutrients back into the Garden using compost heaps and worm farms. Waste water from the Nursery is recycled into the Garden's chinampa, which is a drainage system used to grow water based crops.

This site design promotes conservation of natural resources and reduces operating costs. The Nursery produces enough seedlings to supply the Garden; however the Garden at full production is capable of supplying approximately 15% of the CSA's normal produce requirement. This scale limitation leaves the Nursery dependent on external customers and the CSA dependent on external suppliers, which reduces City Farm's environmental performance as will become evident later in this paper.

The remaining sections of this paper provide an evaluation of City Farm's performance using each of the five performance factors depicted in Figure 1, followed by a discussion of the implications of this case for accounting and the sustainable development agenda.

Eco-efficiency

City Farm's eco-efficiency is evaluated using the environmental performance indicators listed in Table 1. These indicators enable actual performance to be compared with efficiency targets in each of seven performance categories. In future years trends in these indicators will provide evidence of changes in the level of eco-efficiency over time and enable actual efficiency to be compared to efficiency targets, which are usually expressed in terms of a required percentage improvement each year.

Environmental performance indicators are used to achieve improved levels of eco-efficiency over time. This is achieved by setting reduction targets for resource consumption and emission levels, monitoring performance over time using critical performance indicators and taking action appropriate to ensuring performance meets targets. The environmental performance indicators listed in Table 1 show the following.

- There is low return rate for cardboard boxes and plastic containers used to pack CSA produce (21% and 5% respectively). Customers may reuse these products, but the proportion reused and the proportion disposed of is unknown. City Farm responded to these low return rates by encouraging customers to return or reuse boxes and containers.
- 100% of City Farm's products are reusable or recyclable, although nursery punnets are normally disposed of after use.
- City Farm's operations contribute to air pollution levels, mostly from the reliance on conventional models of transport and the consumption of electricity generated from non-renewable sources. The emitted substance listed in Table 1 are all linked to known environmental problems (refer to Table 5).
- Solid waste is minimal (approximately 4 cubic litres per year). This low level of

Table 1 Environmental performance indicators for City Farm

Performance category	Performance indicator	Actual value	Efficiency targets	Sustainability target
Recycling	percentage materials returned for reuse		Reduce cost and usage of materials inputs	100% recycling of all outputs
	CSA			
	boxes	21%		
	plastic containers	5%		
	Nursery			
	trays	95%		
	inserts	95%		
	punnets	nil		
	percentage of reusable material available at end of product's lives	100%		
Waste management	emissions (kg per week)		Reduce cost of waste disposal Reduce volume of waste	Eliminate waste
	CO_2	701		
	HC	0.99		
	CO	15.8		
	NOx	1.97		
	HCFCs	0.019		
	solid waste produced (cubic litres per year)	4		
	cost of waste disposal	nil		
Water management	town water usage	712 litres per week	Reduce cost and usage of water	Sustainable use of own supply
	nursery contribution margin per litre of water consumed	$0.105		
Electricity management	total electricity usage per week		Reduce cost and usage of electricity	Switch to non-polluting renewable energy sources
	kW h	263		
	cost	$42		
	percentage of energy usage reliant on fossil fuels	100%		
	CSA contribution margin per kW h of electricity used	$1.30		
Transport management	petrol consumption per		Reduce cost and usage of transport services	Switch to non-polluting and renewable energy sources
	week	188.7 litres		
	$1 of revenue	0.14 litres		
	distance from suppliers to City Farm (km per week)	859		
	distance from City Farm to customers (km per week)	1 028		
	revenue earned per km travelled	$0.61		
Compliance	fines imposed	nil	Avoid fines	Beyond compliance
	percentage compliance	100%		

Table 1 —*continued*

Performance category	Performance indicator	Actual value	Efficiency targets	Sustainability target
Land management	land cleared at City Farm site	0.5 ha	Increase production per hectare	Maintain biodiversity
	cleared area required to produce one standard box per week for one year	0.02–0.04 ha		
	transformation of land	100%		
	native vegetation	minimal		
	area eroded	nil		
	land irrigated	100%		
	number of species planted	> 50		

solid waste is due to the recycling of all organic waste, the mulching of paper products and the reusability of most packaging materials.

- City Farm incurs no waste disposal costs due to low waste levels and a co-operative arrangement with a neighbouring business.
- Water is pumped from the dam located on the City Farm site to the Organic Garden. The dam supplemented by rainfall supplies all of the Garden's needs but holds insufficient water to supply the Nursery, which draws all its water from the town water supply.
- $0.105 contribution margin is earned by the Nursery per litre of water consumed.
- The CSA's refrigeration unit is responsible for most of City Farm's electricity consumption. Electricity is supplied by the regional power authority and generated from non-renewable sources.
- $1.30 contribution margin is earned by the CSA per kW hr of electricity consumed.
- Nursery and CSA produce needs to be transported an average of 1 887 km per week from suppliers' to customers' residences. Revenue earned is approximately $0.61 per km travelled.
- There were no fines imposed on City Farm and no known breaches of the following environmental legislation:

  Local Government Act 1993
  Noxious Weeds Act 1993
  Environmental and Assessment Act 1979
  Noise Control Act 1975
  Clean Air Act 1961
  Ozone Protection Act 1989
  Clean Waters Act 1970
  Pollution Control Act 1970.

- The City Farm site occupies 0.5 hectares of cleared land, planted with minimal native vegetation and a diverse mix of food bearing plants. It is estimated that between 0.02 and 0.04 hectares of land must be cleared to enable one CSA box to be supplied each week for a year. City Farm has more than 50 different plant species growing in the Organic Garden.

This analysis of eco-efficiency shows that for improvement to occur City Farm needs to reduce airborne emission, water and electricity consumption, and distances travelled to deliver supplies to City Farm and finished products to consumers. Recycling and reuse rates need to be increased to reduce materials costs.

The environmental performance indicators listed in Table 1 together with life cycle analysis are used in the next section to evaluate the ecological sustainability of City Farm.

Ecological Sustainability

The performance factor of ecological sustainability is central to the accounting model depicted in Figure 1 as it is prerequisite for both intergenerational equity and ecologically sustainable financial performance. In this section three techniques are used to evaluate the ecological sustainability of City Farm.

1. A comparison of actual performance measured by the environmental performance indicators in Table 1 with sustainability targets.
2. An ecological sustainability checklist listing incidents of compliance and non-compliance.
3. Life cycle analysis of City Farm's major products.

Actual Performance Compared to Sustainability Targets

The gap between actual performance measured by environmental performance indicators and the relevant sustainability target is an indicator of the degree of ecological unsustainability (van Pelt *et al.*, 1995). Sustainability targets are set with reference to the five rules of ecological sustainability (Daly, 1990; Costanza and Daly, 1992) which are listed in Table 3. Environmental legislation is not necessarily based on achievement of ecological sustainability, so a sustainability target for the compliance category of environmental performance indicators has not been calculated.

Table 2 provides a comparison in narrative form of City Farm's actual performance as measured by the environmental performance listed in Table 1 and the relevant sustainability target listed in the fifth column of Table 1.

The narrative provided in Table 2 demonstrates that City Farm's performance falls short of the relevant sustainability target in all indicator categories. Sustainable performance is feasible in the recycling/reuse category but currently appears to be a remote possibility in the other five categories.

Table 2 Comparison of actual performance with sustainability targets

Category	Comparison	Comment
Recycling	Actual return and reuse rates were below the sustainability target of 100%	A new design of nursery punnet could make 100% reuse or recycling of all outputs feasible.
Waste management	Emission levels below sustainability target of zero waste	Zero emission, energy, transport and refrigeration options are required.
Water management	Reliance on town water supply results in failure to achieve target of sustainable use of own supply	City Farm's Nursery operation is dependent on the town water supply. Usage of town water by Nursery beyond City Farm's catchment capabilities. Reliance on external supply necessary given scale of Nursery operation.
Electricity management	Performance below sustainability target due to 100% reliance on electricity generated from non-renewable sources	Option to switch to electricity generated from renewable source is available from regional supplier. It is not known whether this source of electricity is ecologically sustainable. Possibility of generating own electricity has not been investigated.
Transport management	100% reliance on conventional transport methods results in performance being below the sustainability target	City Farm needs to reduce reliance on ecologically unsustainable modes of transport. Options available include • exploring alternative fuel sources • using local suppliers and customers • purchasing a low impact vehicle for transporting inputs and outputs.
Land management	Land cleared for food production resulting in loss of biodiversity and hence failure to meet the sustainability target	A small proportion of the products sold by City Farm are produced using permaculture techniques which utilise biologically diverse farming systems for food production. Organic farming methods are used to produce the remainder.

An Ecological Sustainability Checklist

Table 3 provides an assessment of the ecological sustainability of City Farm in the context of the five rules of ecological sustainability defined by Daly (1990) and Costanza and Daly (1992). These rules define boundaries for natural resource usage, discharge rates and the scale of human activity which are consistent with the objective of ecological sustainability at the macro level. Table 3 identifies outcomes of City Farm's activities that represent incidents of compliance or non-compliance with each of the five rules facilitating an evaluation of City Farm's contribution to the objective of ecological sustainability.

The third and fifth rules listed in Table 3 are difficult to apply given the inherent difficulty in estimating both the rate of creation of renewable substitutes for non-renewable resources (Victor, 1991) and carrying capacities of ecosystems. A clear ramification of rule three is that individual organisations need to reduce their reliance on energy generated from non-renewable resources by switching to renewable energy sources. One hundred per cent reliance on energy generated from non-renewable resources cannot be considered to be ecologically sustainable.

Rule five requires the scale of human activity to be limited to the earth's carrying capacity. Milne (1996) suggests that issues of scale be resolved by collecting data at a regional level over the long term concerning an ecosystem's ability to support economic activity. An alternative approach is to evaluate the overall impact of the organisation on the stock of natural capital. If natural capital is being eroded this implies a fall in potential carrying capacity, reducing productive capability and options available to future generations. Furthermore, if an organisation is breaching any of the first four rules of ecological sustainability, this implies that the scale of operation is beyond a capacity that an ecosystem can sustain at current levels of resource consumption and emissions.

Based on the information available it appears that non-compliance with four of the five rules has occurred.

Table 3 shows the following.

- Critical natural capital is being destroyed by ozone depleting HCFCs and biodiversity is reduced by land cultivation required to produce food.
- City Farm appears to be consuming renewable resources at sustainable rates due to low materials usage and recycling strategies.
- All of City Farm's energy consumption is generated from non-renewable fossil fuels. Conventional motor vehicles provide an ecologically unsustainable form of transportation (Gudmundsson and Hojer, 1996).
- City Farm's operations result in the emission of substances which contribute to air pollution levels and are linked to major environmental problems such as the enhanced greenhouse effect, ozone depletion and human health risks (Aplin *et al.*, 1995).
- City Farm is breaching the first, third, and fourth rules of ecological sustainability thus eroding natural capital and potential carrying capacity. Furthermore, at current levels of resource consumption and emission levels City Farm's scale of operation is above an ecologically sustainable level.

The evidence presented so far has demonstrated that City Farm's operation is not ecologically sustainable and this perspective is supported by the life cycle analysis (LCA) which was performed on City Farm's major product line.

Life Cycle Analysis

City Farm's major product line is a standard box of organic produce sold by the CSA. One standard box is designed to supply two adults with fresh produce for one week. Produce is obtained from organic growers and when available from the Organic Garden. The goal of performing LCA on City Farm's major product is to

Table 3 An ecological sustainability compliance checklist for City Farm

Five rules of ecological sustainability	Natural capital component or service	Compliance or non-compliance?	Incidents of compliance/non-compliance
Maintain critical natural capital	Ozone layer Biodiversity	Non-compliance	Ozone layer depleted by release of HCFCs from refrigeration. Biodiversity reduced by land cultivation required to grow produce.
Limit usage of renewable resources to natural rate of renewal	Forests Soil	Compliance	Low usage of paper and cardboard products due to minimum packaging policy. Heavy mulching and composing of garden has helped maintain the volume and fertility of soil.
Limit usage of non-renewable resources to rate of creation of renewable substitutes	Fossil fuels Fossil fuels	Non-compliance	Reliance on fossil fuel based transport system to move materials inputs and deliver finished product to customers. Reliance on electricity generated from non-renewable sources.
Limit discharge of waste to rate of assimilation	Air quality Assimilation of waste Ozone layer	Non-compliance	Reduction in air quality from release of CO, HC, NOx, and lead from vehicle emissions. Solid plastic waste from nursery sent to landfill. HCFCs released from refrigeration.
Limit scale of human activity to carrying capacity	Carrying capacity	Non-compliance	Non-compliance with rules 1, 3 and 4. Reduction in potential carrying capacity due to erosion in natural capital stocks.

- calculate a series of life cycle performance indicators that measure the environmental impact of providing this product and
- identify environmental problems that are linked to the provision of this product.

The boundaries of this LCA have been drawn to exclude the environmental impact of growing produce, as this is considered to warrant an extensive and separate LCA.

This LCA consists of a life cycle flow chart (Figure 3), a collection of life cycle performance indicators (Table 4) and a summary of environmental impacts (Table 5).

Figure 3 presents the flow of resources from delivery to disposal of the finished product.

Figure 3 decomposes the supply and disposal of a CSA standard box of organic produce into four separate stages.

1. Delivery of produce from the supplier in bulk packs resulting in the consumption of vehicle fuel and airborne emissions, except where the supplier is the City Farm Organic Garden, which requires no vehicle transport and no packing prior to delivery.

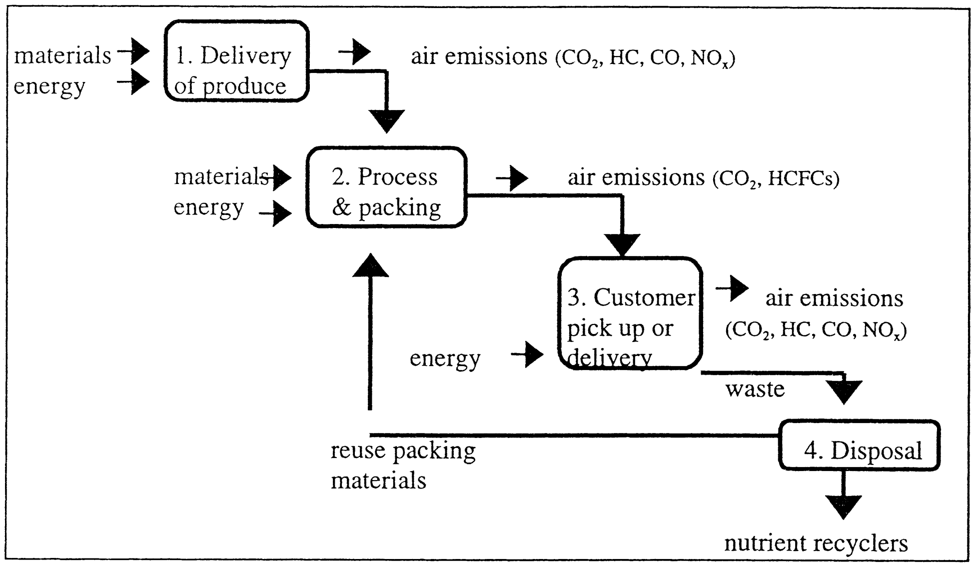

Figure 3. Life cycle flow chart for a standard CSA box

2. Processing and packing produce into cardboard boxes. Energy is required to operate the coolroom, resulting in airborne emissions from coal generated electricity and HCFC leakage from the refrigeration unit.

3. Product delivered to or collected by customer resulting in the consumption of vehicle fuel and airborne emissions.

4. Product is disposed of by customer. All packing materials are reusable and organic waste is recyclable.

Figure 3 shows that each of the first three stages of the life cycle of this product require management strategies to minimise energy consumption and air emission. Raw material inputs occur at the first and second stages and can be minimised by reuse strategies. Sustainable disposal and reuse options are available for the product and its packaging components and City Farm provides information to customers concerning these options in their newsletter.

Table 4 presents a series of life cycle indicators that measure the environmental impact of providing one standard box of organic produce each week for one year.

Life cycle indicators can be used to improve eco-efficiency by reducing the consumption of energy and emissions over the product life cycle. Sustainability targets for environmental performance indicators were provided in Table 1. The impact of City Farm's major product falls short of the sustainability target in all except the recycle/reuse category. Consistent with the finding that City Farm's operations are not ecologically sustainable is the conclusion that provision of the major product is also ecologically unsustainable. Provision of this product can be linked to major environmental problems, which together with their causes are displayed in Table 5.

Table 4 Life cycle indicators

Life cycle indicator per box per annum	Value
CO_2 emission	672 kg
Electricity consumed	268 kW h
Distance travelled	1757 km
Petrol consumed	176 litres
Ozone depleting substance released	17.1 g of HCFCs
Product reusability	100%

Table 5 Environmental problems contributed to by CSA box

Environmental problem	Cause being emission from:
Air pollution	
sulphur dioxide (SO_2)	coal combustion to produce electricity
oxides of nitrogen (No_x)	motor vehicles
lead	use of leaded petrol
carbon monoxide (CO)	motor vehicles
hydrocarbon (HC)	motor vehicles
Ozone depletion	
HCFCs	refrigeration
Enhance greenhouse effect	
carbon dioxide (CO_2)	burning fossil fuels
nitrous oxide (N_2O)	forest clearance
HCFCs	refrigeration
methane (CH_4)	burning fossil fuels and rotting vegetation

The provision of City Farm's major product can be linked to the three major environmental problems of air pollution, ozone depletion and the enhanced greenhouse effect, as well as the additional problem of loss of biodiversity from land cultivation required to grow food. This latter problem is excluded from Table 5 as this LCA specifically excludes the environmental impact of growing produce. The goal for City Farm is to remove the causes of these problems. Options for doing this were provided in Table 2 and are discussed further in the next section of this paper.

The Sustainability of Financial Performance From an Ecological Perspective

The finding that City Farm's operations are not ecologically sustainable has significant implication for the sustainability of its financial performance. Figure 1 links the sustainability of financial performance to ecological sustainability. Failure to achieve the objective of ecological sustainability implies that all or part of the organisation's revenue streams are earned from ecologically unsustainable sources.

Table 6 links revenue streams to specific activities that are ecologically unsustainable. An examination of City Farm's revenue streams shows that 100 per cent of revenue earned is dependent on one or more of the following ecologically unsustainable activities:

- reliance on conventional methods of transport, resulting in air pollution and the consumption of non-renewable resources
- refrigeration of produce resulting in emissions of HCFCs
- electricity generated from non-renewable sources
- reduction in biodiversity from land clearing for agricultural use.

Table 6 Sustainability of revenue streams

Source of revenue	Actual/potential revenue stream	Dependent on the consumption of critical natural capital due to	Dependent on the consumption of non-renewable natural capital due to
CSA	$4 200 per month (actual)	reduction in biodiversity from land clearing reduction in ozone layer from release of HCFCs from refrigeration unit	100% reliance on fossil fuels for vehicle use and electricity generation
Nursery	$640 per month(actual)	minimal impact	100% reliance on fossil fuels for vehicle use
Garden	$1000 per month(potential)	minimal impact	100% reliance on fossil fuels for vehicle use

City Farm has the potential to earn revenue from ecologically sustainable sources if it fully exploits its design as an industrial ecology and restructures and rescales its operation. A fully operational Organic Garden has the potential to yield revenue of approximately $1 000 per month. All garden inputs can be obtained from the City Farm site and customers could obtain produce directly from the garden, eliminating the need for refrigeration. Alternately, City Farm could deliver produce directly to local residents using low impact transport, reducing or eliminating the reliance on unsustainable modes of transport. This would significantly reduce emissions and the consumption of non-renewable energy resources.

This type of smaller scale, entirely localised approach is operationally feasible and should enable City Farm to meet most of its ecological goals, but is not considered economically viable. Over 90 per cent of City Farm's customers live outside a 2 km radius of City Farm. These customers would be lost unless a low impact form of transport is found to deliver produce over longer distances. Thus an impediment to achieving an ecologically sustainable form of economic development is the prioritisation of shorter term economic goals over longer term ecological goals.

An examination of City Farm's financial position reveals that it has no environmental contingent liabilities and no history of environmental hazards or accidents. The most significant environment risk to City Farm is its location on a flood plain where the risk of flooding is significant (Colquhoun, 1996). In the case of flood, damage would occur to the Organic Garden, resulting in the loss of crop income. Design features within the Organic Garden including plant selection, raised garden beds, drainage, and soil cover would serve to minimise this damage.

Intergenerational Equity

Failure to achieve ecological sustainability implies the intergenerational goal of preserving the stock of natural capital for future generations has not been achieved. Under the axiom of strong sustainability, future generations will inherit an eroded stock of natural capital due to City Farm's consumption of

- critical natural capital (ozone layer and biodiversity)
- non-renewable resources (total reliance on energy resource stocks)
- waste assimilation capacity (air pollution).

City Farm's impact on natural and humanmade capital is summarised in Table 7. Although the stock of natural capital has been clearly eroded, City Farm has managed to maintain its financial investment and stock of real assets. It has also contributed to intellectual capital through its educational activities, training staff, volunteers, and customers in sustainable food systems.

Table 7 City Farm's impact on capital

Category of capital	Impact on stock of capital
Natural	
• critical	Reduced
• non-renewable	Reduced
• renewable	Reduced
Humanmade	
• physical	Maintained
• intellectual	Increased
• financial	Maintained

To achieve the goal of intergenerational equity City Farm needs to redesign and rescale its operations to be ecologically sustainable so that it contributes to the goal of providing biologically diverse and resilient ecosystems to future generations.

Intragenerational Equity

The goal of intragenerational equity is normally linked to alleviating poverty throughout the world through a fairer distribution of both natural and humanmade wealth.

City Farm's operations have very minimal impact on economies or ecosystems outside Australia. The LCA identified that two minor packaging components of City Farm's major product are imported from Asia. These transactions are not material in an economic or social context.

City Farm has a positive social impact from the following:

- Endeavours to educate and train people in permaculture and sustainable food systems by employing staff and training volunteers who work in the Organic Garden. Organised tours of the Garden earn revenue as well as disseminating information concerning permaculture and sustainable food systems.
- Employment of disabled persons. Two persons were employed during 1997 and were supervised and trained by City Farm staff.
- Promotion of health through the provision of organic produce.

These examples provide an indication of City Farm's social Impact, which is almost entirely confined to the local community in which it operates. In the next section of this paper the implication of this case for accounting and the sustainable agenda are discussed.

Implications of the Case Study

The accounting profession has been criticised for the singular focus of accounting information on economic performance and thereby ignoring social and environmental impacts. Accounting for sustainable development is a response to this criticism attempting to provide a more balanced account of organisational performance. Given that the definition of sustainable development is evolving to include a mix of environmental, social, and economic objectives, an underlying assumption of this research is the relevance of accounting to the sustainable development concept. Accountants need to be involved in this form of reporting given their expertise in the measurement of the economic performance of micro-entities, and the potential of their contribution to measures of sustainable development that integrate economic with environmental and/or social elements.

A further issue is the relevance of the sustainable development concept at the organisational level. There is an inherent difficulty in applying the objective of ecological sustainability to individual organisations, due to the absence of clear definitions of resource use and emission targets. Nevertheless one outcome of this case study is the provision of unequivocal evidence of ecological unsustainability as well as specific direction of City Farm on how to improve its environmental performance.

However, significantly, the goal of ecological sustainability appears out of reach of individual business organisations at least in the medium term. Given that organisations operate within an ecologically unsustainable industrial system, competing with business that prioritises short term cost reduction opportunities over longer term environmental goals, continuing improvement towards ecological sustainability appears a more realistic target to measure performance against. This places the emphasis in the performance evaluation phase on incremental improvements towards sustainability targets over time.

Measurement controversies are commonplace in accounting. If incremental changes in performance are to be detected, information reported by the accounting system must be measured precisely. A general lack of precision in the measurement of environmental performance indicators is a critical problem given the scientific uncertainty of some environmental impacts and the difficulty of accurately tracing these impacts to individual organisations. A further complication is the necessary use of multiple units of measurement given that the objectives of sustainable development include social and environmental, as well as economic, elements. Financial units of measurement were used in this case where relevant. For example some environmental performance indicators capture both an economic and an environmental dimension. This provides a broader picture of performance than would be the case using financial data alone (Ditz and Ranganathan, 1996).

Due to the complexity of the task of measuring performance towards sustainable development, accountants need to form multidisciplinary teams together with professionals from the environmental and social disciplines, with the goal of evolving and interpreting the information set that provides relevant measures of sustainable development. Working effectively in such teams requires a continuing transdisciplinary dialogue and the development of a common language to facilitate this dialogue.

Further research into the measurement issue is required, although at this stage the focus of accounting for sustainable development is on exploring *what* should be measured, leaving the issue of *how* the precision of measurement can be improved to future research.

Not surprisingly, this case study further demonstrates that not all business–environment conflicts can be resolved with win–win solutions! In this case environmental performance was compromised by the need to remain economically viable. As the sustainable development agenda develops, the inevitable conflicts between business and environmental objectives need to be debated in the public arena, as it is not the role of corporate management to exclusively decide such issues. If the community is to engage meaningfully in this debate there is role for environmental accounting to provide information concerning the social and environmental impacts of business (Lehman, 1996).

The challenge that sustainable development represents to society cannot be underestimated. There is some skepticism as to whether change can be implemented at the corporate level (Lehman, 1999). This would be unfortunate if correct, but given the importance of the sustainable development debate, and the significance of the contribution that could be made at the organisational level (Shrivastava, 1995), continued exploration into the application of sustainable development at multiple levels should continue.

Conclusion

The aim of this research was to evaluate the performance of an organisation in achieving the objectives of sustainable development. An accounting model was designed specifically for this purpose and tested on a single organisation, leading to the conclusion that City Farm has not achieved the objectives of sustainable development due to its impact on critical and non- renewable stocks of capital, as well as it contribution to air pollution. Contributions to four significant environmental problems were linked to the operation of City Farm—ozone depletion, the enhanced greenhouse effect, air pollution and loss of biodiversity. Alternatives for reducing City Farm's impact were identified, but are not necessarily economically viable.

Another finding of this research is that the environmental accounting model used provides clear evidence of ecological unsustainability and its causes. Whether this information will initiate change within an organisation is problematic given that most business are operating within an industrial system that prioritises economic wealth over ecological preservation, and are forced to be competitive with organisations that do not consistently pursue ecological and social goals.

Furthermore the implications of using a broad definition of sustainable development are that accountants need to be involved in the process of evaluating organisational performance and this would be best achieved through co-operation between accounting, environmental and social professionals to design and utilise integrated performance measures.

Information unavailable to this study that would increase the confidence in the conclusions drawn includes estimates of carrying capacity and technological advancement in resource substitution, resource use and emissions defined at the organisational level and natural inventory accounts enabling the degree of the reduction in natural capital stocks to be measured.

References

Andrews, C., Berkhout, F. & Thomas, V., "The Industrial Ecology Agenda", in Socolow, Andrews, Berkhout, Thomas (eds) *Industrial Ecology and Global Change* (Cambridge: Cambridge University Press, 1994).

Aplin, G., Mitchell, P., Cleugh, H., Pitman, A. & Rich, D., *Global Environmental Crises: An Australian Perspective* (Melbourne: Oxford University Press, 1995).

Azar, C., Holmberg, J. & Lindgren, K., "Socio-ecological Indicators for Sustainability", *Ecological Economics*, Vol. 18, 1996, pp. 89–112.

Bebbington, J. & Gray, R., "Corporate Accountability and the Physical Environment: Social Responsibility and Accounting Beyond Profit", *Business Strategy and the Environment*, Vol. 2, No. 2, 1993, pp. 1–12.

Bebbington, J. & Tan, J., "Accounting for Sustainability", *Chartered Accountants Journal*, July, 1996, pp. 75–76.

Bebbington, J. & Tan, J., "Accounting for Sustainability", *Chartered Accountants Journal*, February, 1997, pp. 37–40.

Beder, S., *Global Spin: The Corporate Assault on Environmentalism* (Melbourne: Scribe, 1997).

Chiras, D., *Lesson from Nature: Learning to Live Sustainably on the Earth* (Washington, DC: Island, 1992).

CICA., *Reporting on Environmental Performance* (Toronto: Canadian Institute of Chartered Accountants, 1994).

Colquhoun, J., *The Viability of Community Supported City Farms for Sustainable Agriculture*, Honours Southern Cross University, 1996.

Costanza, R. & Daly, H., “Natural Capital and Sustainable Development”, *Conservation Biology*, Vol. 1, March, 1992, pp. 37–46.

Daly, H., “Toward Some Operational Principles of Sustainable Development”, *Ecological Economics*, Vol. 2, 1990, pp. 2–6.

Deegan, C. & Gordon, B., “A Study of the Environmental Disclosure Practices of Australian Corporations”, *Accounting and Business Research*, Vol. 26, No. 3, 1996, pp. 187–199.

Ditz, D. & Ranganathan, J., Corporate Environmental Performance Indicators: Bridging Internal and External Information Needs. Paper presented at the Fenner Conference on the Environment, UNSW.

Eisenhardt, K., “Building Theories from Case Study Research”, *Academy of Management Review*, Vol. 14, No. 4, 1989, pp. 532–550.

Elkington, J., “Coming Clean: The Rise and Rise of the Corporate Environmental Report”, *Business Strategy and the Environment*, Vol. 2, No. 2, 1993, pp. 42–44.

Frankel, C., *Earth’s Company: Business Environment and the Challenge of Sustainability* (Gabriola Island: New Society, 1998).

Frosch, R., “The Industrial Ecology of the 21st Century”, *Scientific American*, September, 1995, pp. 178–181.

Gibb-Dyer, W. & Wilkins, A., “Better Stories, not Better Constructs, to Generate Better Theory: A Rejoinder to Eisenhardt”, *Academy of Management Review*, Vol. 16, No. 3, 1991, pp. 613–619.

Graedel, T. & Allenby, B., *Industrial Ecology* (Englewood Cliffs, NJ: Prentice-Hall, 1995).

Gray, R., “Accounting and Environmentalism: An Exploration of the Challenge of Gently Accounting for Accountability, Transparency and Sustainability”, *Accounting, Organisations and Society*, Vol. 17, No. 5, 1992, pp. 399–425.

Gray, R., *Accounting for the Environment* (London: Chapman, 1993).

Gray, R., “Corporate Reporting for Sustainable Development: Accounting in Sustainability in 2000 AD”, *Environmental Values*, 1994, pp. 17–45.

Gudmundsson, H. & Hojer, M., “Sustainable Development Principles and Their Implications for Transport”, *Ecological Economics*, Vol. 19, 1996, pp. 269–282.

Holland, H. & Petersen, U., *Living Dangerously* (Princeton, NJ: Princeton University Press, 1995).

Hortensius, D. & Barthel, M., “An Introduction to the ISO 14000 Series”, in C. Sheldon (ed.) *ISO 14001 and Beyond* (Sheffield: Greenleaf, 1997).

Jasch, C., “Environmental Information Systems in Austria”, *Social and Environmental Accounting*, Vol. 13, No. 2, 1993, pp. 7–9.

Jones, M., “Accounting for Biodiversity: A Pilot Study”, *British Accounting Review*, Vol. 28, 1996, pp. 281–303.

Jorgensen, H., “The “Green Account” of the Danish Steel Works Ltd”, *Social and Environmental Accounting*, Vol. 13, No. 1, 1993, pp. 2–5.

Kaplan, R. & Norton, D., “Using the Balanced Scorecard as a Strategic Management System”, *Harvard Business Review*, Jan–Feb, 1996, pp. 75–85.

Lamberton, G., “Exploring the Accounting Needs of an Ecologically Sustainable Organisation”, *Accounting Forum*, Vol. 22, No. 2, 1998, pp. 186–209.

Lehman, G., “Environmental Accounting: Pollution Permits of Selling the Environment”, *Critical Perspectives on Accounting*, Vol. 7, 1996, pp. 667–676.

Lehman, G., “Disclosing New Worlds: A Role for Social and Environmental Accounting and Auditing”, *Accounting, Organisations and Society*, Vol. 24, No. 3, 1999, pp. 217–214.

Milne, M., “On Sustainability: The Environment and Management Accounting”, *Management Accounting Research*, Vol. 7, 1996, pp. 135–161.

Mollison, B., *Permaculture: A Designers Manual* (Tyalgum: Tagari, 1988).

Nilsson, J. & Bergstrom, S., “Indicators for the Assessment of Ecological and Economic Consequences of Municipal Policies for Resource Use”, *Ecological Economics*, Vol. 14, 1995, pp. 175–184.

O’Dwyer, B., *Clean Air 2000 Vehicle Emissions Model: National Roads and Motorist Authority*, 1998.

OECD, *OECD Environmental Indicators* (Paris: Organisation for Economic Co-operation and Development, 1994).

Opschoor, H. & Reijnders, L., “Towards Sustainable Development Indicators”, in O. Kuik, H. Verbruggen (eds) *In Search of Indicators of Sustainable Development* (Dordrecht: Kluwer, 1991).

Owen, D., Gray, R. & Adams, R., “Corporate Environmental Disclosure: Slow but Steady Progress”, *Certified Accountant*, March, 1996, pp. 18–22.

Partridge, M. & Perren, L., “Winning Ways with a Balanced Scorecard”, *Accountancy*, Aug 1997, pp. 50–51.

Schaltegger, S., Muller, K. & Hindrichsen, H., *Corporate Environmental Accounting* (Chichester: Wiley, 1996).

Shrivastava, P., “The Role of Corporations in Achieving Ecological Sustainability”, *Academy of Management Review*, Vol. 20, No. 4, 1995, pp. 936–960.

Smith, C., Whipp, R. & Willmott, H., “Case-Study Research in Accounting: Methodological Breakthrough or Ideological Weapon?”, *Advances in Public Interest Accounting*, Vol. 2, 1988, pp. 95–120.

Starik, M. & Rands, G., “Weaving an Integrated Web: Multilevel and Multisystem Perspectives of Ecologically Sustainable Organisations”, *Academy of Management Review*, Vol. 20, No. 4, 1995, pp. 908–935.

State of the Environment Advisory Council, *State of the Environment Australia* (Melbourne: CSIRO, 1996).

Stone, D., “No Longer at the End of the Pipe, but Still a Long Way from Sustainability: A Look at Management Accounting for the Environment and Sustainable Development in the United States”, *Accounting Forum*, Vol. 19, No. 2/3, 1995, pp. 95–110.

Trainer, T., *Towards a Sustainable Economy, The Need for Fundamental Change* (Sydney: Envirobooks, 1996).

United Nations, Agenda 21 Rio de Janeiro 1992.

van der Bergh, J., *Ecological Economics and Sustainable Development* (Cheltenham: Elgar, 1996).

van Pelt, M., Kuyvenhoven, A. & Nijkamp, P., “Environmental Sustainability: Issue of Definition and Measurement”, *International Journal of Environment and Pollution*, Vol. 5, No. 2/3, 1995, pp. 204–223.

Victor, P., “Indicators of Sustainable Development: Some Lessons from Capital Theory”, *Ecological Economics*, Vol. 4, 1991, pp. 191–213.

WCED, Our Common Future Oxford University Press, 1987.

Westing, A., “Core Values of Sustainable Development”, *Environmental Conservation*, Vol. 23, No. 3, 1996, pp. 218–225.

WMC, Environment Progress Report 1996.

Yin, R., *Case Study Research Design and Methods*, 2nd edn (Thousand Oaks, CA: Sage, 1994).