This chapter will discuss environmentally induced ﬁnancial impacts on a company’s management accounting system.Management accounting ‘is the identiﬁcation,measurement,accumulation,analysis,preparation,interpretation,and communication of information that assists executives in fulﬁlling organisational objectives’ (Horngren and Foster 1987: 2). Management accounting ‘measures and reports ﬁnancial and nonﬁnancial information that helps managers make decisions to fulﬁl the goals of an organisation. Management accounting focuses on internal reporting’ (Horngren et al. 2000: 2). Synonyms for management accounting are ‘managerial accounting’ and ‘cost management’(Garrison and Noreen 2000;Hansen and Mowen 2000). The International Federation of Accountants (IFAC1998:paragraph 1) deﬁnes environmental management accounting as follows:

Environmental Management Accounting—the management of environmental and economic performance through the development and implementation of appropriate environment-related accounting systems and practices.While this may include reporting and auditing in some companies, environmental management accounting typically involves life-cycle costing, full-cost accounting, beneﬁts assessment, and strategic planning for environmental management.

From these deﬁnitions it can be seen that IFAC, following deﬁnitions of management accounting such as that of Horngren et al., makes no analytical distinction between ﬁnancial and non-ﬁnancial aspects of environmental management accounting. Bennett and James (1998a), in line with IFAC terminology, call these two aspects ‘environmentrelated management accounting’. However, in this book, environmental management accounting is deﬁned in a narrower sense to include only the environmentally induced ﬁnancial aspects of accounting that help managers to make decisions and be accountable for the outcome of their decisions. Information about non-ﬁnancial environmental impacts for decision-making and accountability are distinguished separately in an accounting system that is here called ‘internal ecological accounting’. Internal ecological accounting is examined in Chapter 11. Environmental management accounting and internal ecological accounting are brought together in discussions about eco-efﬁciency

Management accounting is one of the most important information tools used by managers.First,it supports strategic and operational planning,deﬁned as the delineation of goals, prediction of potential results under various scenarios and implementation of ways of achieving goals. For example, given the broad objective of moving towards an ecologically sustainable business,a number of scenarios are possible (e.g.environmental crises intensify or ease).An appropriate goal might be to improve corporate eco-efﬁciency. This could be implemented through the introduction of a system that enables measures of economic and environmental progress towards eco-efﬁciency. Second, management accounting provides the main basis for decisions about how to attain desired,or target,goals.If a goal is to reduce waste from raw material usage by 10% in a year,it is the management accounting system that provides information about targets, actual waste from raw material usage and a comparison of the two. Third,management accounting facilitates feedback about results and acts as a control device.When a gap has been calculated between a goal and the actual level of achievement,a management accounting system provides reports about this gap to people responsible for the gap.With such information people responsible for the gap can take action to try to ensure that goals and actual performance are closer together in the next planning and control cycle (see e.g.Garrison and Noreen 2000:5;Hansen and Mowen 2000:268; Horngren et al. 2000:4;Raiborn et al.1996).These people are held accountable for their actions. Through its essential function,management accounting provides relevant information to facilitate the most economic way of managing a company.As environmental issues begin to exercise increasing inﬂuence on corporate economic performance and,therefore,on corporate eco-efﬁciency,they need to be institutionalised in management accounting systems. Ideally, management accounting provides the foundation for all other accounting systems (e.g. ﬁnancial accounting), ﬁnancial management (e.g. the shareholder value concept) and communication with external stakeholders (e.g.ﬁnancial reporting).For this reason,it is logical for management accounting to be examined ﬁrst,followed by ﬁnancial accounting and a discussion of the shareholder value concept. The basic need for environmental issues to be incorporated in conventional management accounting is to ensure that there is an accounting for the ﬁnancial impacts of environmentally induced activities, such as environmental protection and investment in cleaner production processes. Management accounting information is used mainly to facilitate decision-making by and accountability of different types of company managers and support staff responsible for products,sites and divisions.Contrary to the regulated foundations of conventional ﬁnancial and ‘other’ accounting (Chapter 8), management accounting is largely a voluntary activity and is not undertaken to satisfy the requirements of external stakeholders. Only on the basis of relevant and reliable information management will managers and employees be able to: assess the actual and potential economic consequences of environmental issues,adapt technical and ﬁnancial performance to new environmental regulations and conduct a mutually beneﬁcial discussion of how to implement best practice in pollution prevention. Only when rules have to be established for cost reimbursement from customers can a required form of management accounting be institutionalised. For example, in the USA, cost accounting standards have been introduced for cost reimbursement when a private organisation provides unique services to government organisations on a cost reimbursement basis. Hence, there is a need to recognise that ‘other’ conventional accounting systems exist and are linked to management accounting. In an ideal world, all impacts, including those borne by society and the natural environment, would be included in a management accounting system. In practice, business managers are not appointed with the speciﬁc task of voluntarily incorporating the cost of negative externalities in the ﬁnancial management plans of their organisations. As only a small part of externalities are internalised,strategic decisions taken by managers will be based on incomplete information and this will be misleading and could lead to a misallocation of resources to activities that have been undercosted from a perspective based on social cost (Kreuze and Newell 1994). However, the difﬁculty is that it would be even more misleading for stakeholders if management internalised externalities in its accounting if they were not part of the actual ﬁnancial effects of a business. A mixture of external and internal ﬁnancial impacts (i.e. external and internal costs) in the same accounts would distort the ﬁnancial results so that stakeholders would no longer have the necessary information for making economic decisions about the accounting entity. The ﬁrst step for managers is to establish what environmentally induced (already internalised) ﬁnancial impacts it actually incurs (Ditz et al. 1995). Hence, initially, management accounting considers only internally relevant ﬁnancial effects that have an impact on the company as a separate legal entity.Whether a company then decides to internalise any further environmentally induced costs is a question related to its competitive strategy. Management accounting is not a uniform accounting system as it has to serve various management levels and functions that require different data.The information gathered in management accounting can be divided into accounting for products and product lines, sites, divisions and for the whole company. Product, site, divisional and top managers typically require different information from an accounting system (Fig.6.1). Product managers,for example,are interested in environmental product liabilities,site managers in issues such as site-speciﬁc clean-up costs and divisional and top-level managers in aggregated information about environmentally induced ﬁnancial impacts. Conﬂict may exist between the wishes of these different types of manager to include ﬁnancial impacts of environmental issues. For example, imposition of an environmental tax will lead to poorer ﬁnancial results.If these results are used as the basis for evaluating a product manager’s performance the imposition of such a tax will be resisted.In general, Stinson (1993) observes that product margins rarely rise at the same rate as imposed taxes, and as a result the performance of managers appears to worsen. In these circumstances, product managers have an incentive to ﬁght a direct allocation of environmental taxes to ‘dirty’products (Burritt 1998).However,the inclusion of environmental taxes within the general overhead cost category is not an acceptable solution to this problem from an ecoefﬁciency perspective.The true costs of the products would no longer be reﬂected by the accounting ﬁgures, leading to less than optimal management decisions (Kreuze and Newell 1994). All levels of management accounting have the following concerns in common: A The deﬁnition of environmental beneﬁts,costs and opportunity costs A Tracking and tracing of environmental costs A Allocation of costs to products and activities A Investment appraisal These concerns are equally as relevant for management accounting and ecological accounting (Part 3) although their importance varies depending on the level of management involved (product, site, division or whole company). Each concern is addressed below.

6.1 Consideration of benefits and costs with regard to sustainable developmentand eco-efficiency 6.1.1 Costand benefitlinks between sustainability dimensions Sustainable development has three dimensions—economic, environmental and social. These three dimensions of sustainable development may interact to produce positive impacts (beneﬁts) or negative impacts (costs), as shown in Figure 6.2. Hence, the following possible interrelationships may occur:

a Economic activities can cause social impacts (e.g. social integration at the workplace;isolation of workers).

b Social impacts can lead to economic beneﬁts and costs (e.g. good working morale improves economic performance; health costs and loss of jobs reduce economic performance).

c Social opportunities and problems can accompany environmental impacts (e.g. people develop an intrinsic motivation for nature conservation; deforestation occurs because of poverty).

d Environmental issues can induce social beneﬁts and costs (e.g. good environmental quality can cause migration;deforestation can cause migration).

e Economic activities can have environmental impacts (e.g. as a result of the development of technology to improve water quality; increases in air pollution from factory waste).

f Environmental impacts can result in economic impacts (e.g.natural attractiveness supports eco-tourism;toxic waste spills lead to clean-up costs).

In reality, environmental, economic and social dimensions are interrelated. Strong sustainable development is characterised by an improvement in all three dimensions (see also Part 1). However, this book focuses only on environmental issues from an environment–economy perspective.Arrows (e) and (f) in Figure 6.2 show eco-efﬁciency links. The best way to improve eco-efﬁciency is to reduce harmful environmental impacts while at the same time keeping constant or increasing proﬁtability (economically proﬁtable environmental protection), for example by developing and selling more environmentally benign technologies—a proactive approach to environmental management. An alternative approach with the same result but a different focus is to try to increase proﬁtability by using methods that also happen to reduce environmental impacts (environmentally beneﬁcial economic activity)—a reactive approach to environmental management.The latter may be seen as a part of normal commercial activities whereas the search for measures of environmental protection that also increase revenues and/or reduce costs is usually seen as part of corporate environmental management. Both approaches are central to the management of eco-efﬁciency-oriented knowledge and require managers to integrate the environmentally induced beneﬁts and costs of alternative business activities with normal commercial activities.

**6.1.2 Environmentally induced benefits**

Management accounting rarely includes classiﬁcation,recording and analysis of environmentally induced beneﬁts. Such beneﬁts include environmentally induced additional revenues (e.g. revenues from sale of recyclables, the higher contribution margins from ‘greener’products) and reduced costs (e.g.cost savings because less material is used).The relative size of these beneﬁts and the amount of beneﬁts compared with other investment projects provide a quantitative basis for management and shareholders to assess appropriate environmental measures and strategies for their organisation. In general, environmentally induced revenues can be divided into direct and indirect categories.Direct revenues,for example,include the gains from sales of recyclables (new markets), an increased volume of sales (quantity effects) and higher prices for the products sold (price effects). Indirect effects are less tangible and may, for example, include beneﬁts ﬂowing from an enhanced ‘green’image,increased customer satisfaction and employee morale, and the transfer of know-how.An example of direct and indirect classiﬁcation is provided by Baxter International Inc., a US-based diversiﬁed healthcare company. It discloses detailed costs and revenues related to environmentally induced impacts (Baxter International 1994–1998; Bennett and James 1998b). Between 1990 and 1997 over US$100 million was accumulated in savings and cost avoidance. Baxter International distinguishes 11categories of environmentally induced costs,grouping them into costs for proactive programmes as well as disposal costs and the costs of measures to remediate orphaned landﬁlls. Environmentally induced revenues are divided into cost savings and income and into cost avoidance, including cost savings caused by a reduced amount of material inputs and packaging,avoided disposal costs and revenues from sale of recyclables (Table 6.1). The total of all net savings equals about 1.5% of Baxter International’s income from continuing operations before taxes in 1997. The calculation and disclosure of such ﬁgures is only possible with use of an advanced management accounting system.The result of being able to measure and disclose this information is twofold. First, the success of Baxter’s advanced environmental strategy is measurable, targets can be established and actual performance can be compared with targets as part of environmental management. Second, the economic success of this approach can be communicated to internal and external stakeholders. In practice,environmentally induced costs and cost savings are central to environmental management accounting.For that reason,and to simplify this chapter,there is a focus on ‘costs’.However,expenses and assets will be discussed later (Section 7.2).

**6.1.3 Environmentally induced costs**

The term ‘cost’ is used in different contexts (and by different individuals) with different meanings. Even in economic literature and in accounting practice there are inconsistencies in the meaning given to the phrase ‘environmental costs’. Economists tend to be concerned with costs as prices and for pricing,whereas accountants tend to focus on costs and costing for income determination and asset measurement purposes. From a ‘deep green’ (or ecocentric) perspective, the natural environment is seen to possess a value independent of humans. A deep green perspective implies that impacts on the environment must be considered irrespective of whether human society is affected. Ideally,accounting should,therefore,reﬂect all direct and indirect outcomes for the natural environment.From an all-embracing systems viewpoint,companies are subsystems of the economy,the economy is a subsystem of society and society is a subsystem of the natural environment (see Fig. 6.3). From this perspective, environmental accounting would include all costs that can possibly exist—social,economic and company-level costs.Every use of the environment could be seen as a ‘consumption of goods and services’and could be expressed as an environmental cost.To attempt to do so,although,of course,an ideal situation,would in practice not be feasible.In this book the term ‘environmental costs’is therefore used in a more selective sense. The deﬁnition of environmental costs used here does not cover all costs for human beings and other species. Society faces costs that are not environmentally induced (e.g. because of social injustice). Environmental accounting, in the sense deﬁned in Part 1 of this book, does not fully capture issues of social development and injustice although it is concerned with accountability of companies for the activities they undertake.The focus of environmental accounting used here is rather on environmentally induced economic costs, or those monetary and non-monetary impacts on the natural environment that somehow affect society through the economy. Some external costs affect society in a very direct way.This is the case, for instance, if the noise level near a road increases because of an increase in the volume of trafﬁc.The costs of reducing these adverse effects (e.g. by building a soundproof wall) are usually borne by the government (i.e.taxpayers) even where outsourcing is used to construct new roads on behalf of government.If an anthropocentric approach is taken,the only part of environmental costs considered is the part that results in costs for human society now or in future.These are costs of degradation which have either a monetary or a non-monetary impact on the quality of life of at least one human being. In Figure 6.3 these costs are described as ‘social costs’(sometimes also described as ‘societal costs’). Negative external effects on the natural environment can also indirectly affect people. For example,a loss in biodiversity would result in few opportunities (options) for future generations to observe wildlife and they would also lose the satisfaction from knowing that species exist. Lost opportunities to gain psychic beneﬁts from nature also induces economic costs.These so-called ‘opportunity costs’, or costs of foregone opportunities, which will be considered fully later in this book (see Section 6.1.6),are not shown directly in Figure 6.3 as they form a subset of ‘economic costs’.Furthermore,economic costs are part of social costs.For example,as noted above,the extinction of species leads to social and economic costs because any reduction in the pool of genes results in a loss of potential beneﬁts from those genes (e.g.for the potential development of pharmaceuticals through bio-prospecting).This is the case even if nobody (or hardly anybody) has ever viewed these species.Biologists compare the loss of a gene to the burning down of a library before anyone has had the opportunity to read the books (Arber 1992). From a business perspective, the distinction between external and internal environmental costs is also crucial as external costs become economically relevant for a company only if and when they are internalised (Panayotou 1996).The distinction between these classes of cost is drawn below

**6.1.4 External costs**

For the past two decades, the concept of ‘external costs’ has shaped discussion of environmental costs.External costs (also called ‘negative externalities’) are costs borne by people other than those who cause the costs and receive the concomitant beneﬁts. Externalities can be divided into external costs and external beneﬁts.People who gain from external beneﬁts do not contribute to the costs of producing the beneﬁt.The expression ‘externality’usually designates external costs (see e.g.Baumol and Oates 1988;Frey et al. 1993; Pearce and Turner 1994). External costs are traditionally not reﬂected in the accounting systems of a company (Box 6.1). Exceptions are the studies compiled by BSOand Origin (1993) and Ontario Hydro (see EPA 1998a). These two companies calculated and reported the annual external costs caused by their operations (Box 6.2). No contemporary information about full-cost accounting is available for these two companies, however, because BSO and Origin have merged to become Origin,and full-cost accounting is being downplayed in their accounts, and Ontario Hydro has withdrawn from full-cost accounting in the lead-up to its

❝external impacts may be caused by degradation (pollution,waste,etc. and their effects on people and other living things) or by the consumption of natural resources, renewable or non-renewable.In many such cases,itis notpossible to determine a price for that impactor the price may be distorted by,say,subsidies...External impacts may also be positive, for example,when an entity works on restoring the environment.Again,there may be currently no marketplace value or price recognition for such activities under normal accounting processes. Conventional financial and managementaccounting,being transactions-oriented and entitycentred,cannot provide these types of information.Some entities are,however,developing approaches and methodologies to measure and reportexternal costs.❞

“cfcs (chlorofluorocarbons) contribute to the depletion of the ozone layer.Since stratospheric ozone shields the earth from ultravioletradiation,depletion of the ozone layer allows increased levels of radiation to reach the earth’s surface.Evidence exists to suggestthatthis depletion results in increases in skin cancer rates and damage to crops and fisheries.Thus,use of CFCs has an impacton the production function of farmers and fishers. Furthermore,with higher health costs and mortality,substantial technological costs are borne by society. These costs are notshown in the traditional accounting systems of the CFC users.However, they reduce the overall efficiency of the world economy.They are partially reflected in the accounting systems of the farmers and fisheries (as decreases in revenues), hospitals (as increased turnover) and nations (as lower gross domestic product).”

privatisation (see EPA 1996a, 1998a: 310). However, their experimentation with full-cost accounting continues to be of interest,and further information is provided in Table 6.2. There are two types of externality: technological (physical, such as pollution) and pecuniary (such as the impact of a company’s input purchases on the prices other companies have to pay for these inputs).Technological externalities affecting the natural environment and society reduce the overall efﬁciency of an economy (for a distinction between pecuniary and technological externalities, see Baumol and Oates 1988: 29f.). However, externalities are sometimes ‘picked up’ in the accounting systems of other, uninvolved, companies if they alter their production costs.This can be illustrated by the example of CFC (chloroﬂuorocarbon) emissions (Box 6.2). Stakeholders who have to bear these external costs and who ﬁnd them reﬂected in their own accounts are likely to exert increasing pressure on politicians and companies to internalise external costs. In consequence, some environmental costs are internalised through governmental enforcement. Other external costs are internalised, in a voluntary way, for example, through negotiations with important stakeholders who bear external costs.The difﬁculty of internalising non-monetary externalities is that they somehow have to be assigned an induced price (e.g.through an environmental tax or liability) before they can be considered in conventional accounting. In spite of these difﬁculties, managers should anticipate a continuing movement towards internalisation of external costs through: A The assignment of property rights over the environments in question A Adjustment of prices and costs to cover the cost of pollution damage (a so-called ‘Pigouvian’tax) A Control of permitted quantities of polluting inputs,outputs or waste products A Control of production processes through prescription of ‘best available technology’ The pressure to internalise costs in these ways is increasing both through the gathering of scientiﬁc evidence and through the adoption of the precautionary principle by government.

**6.1.5 Internal environmental costs of a company**

Conventionally, internal company environmental costs (also called ‘private environmental costs’) have been deﬁned as costs of corporate environmental protection (sewers, waste-water treatment plants;see also Fichter et al.1997). These are costs of doing business and can be divided into ordinary and extraordinary costs (Box 6.3), into direct and indirect costs and into potential future costs (Fig. 6.4). Among the most obvious environmentally related costs are ordinary costs such as capital and operating costs for clean-up facilities. For example, environmental costs associated with the production of cars are ordinary costs for a car manufacturer (e.g. costs to treat the waste-water from production).An unexpected,exceptional accident,however,results in extraordinary costs (e.g. clean-up costs caused by the unexpected explosion at Esso’s Longford gas plant in Melbourne,Australia). Direct environmentally induced costs could be,for example,costs of scrubbers directly linked to the production of a speciﬁc type of car.Costs of joint clean-up facilities,such as a waste-water treatment plant, are indirect costs as they have to be speciﬁcally allocated to cost centres and cost objects. Potential future clean-up costs include costs of future remediation of landﬁlls.Table 6.3 provides some examples of external and internal costs. In contrast to the conventional perspective, environmental costs can be deﬁned as the sum of all costs that are directly and indirectly related to material and energy use and their resulting environmental impacts (see Fig. 6.4, see also Fichter et al. 1997). These environmentally induced costs include all costs that occur because material and energy ﬂows are not reduced, such as, for example, fees (ordinary costs), ﬁnes (extraordinary costs), materials purchase (direct costs) or administrative costs that are caused by environmental regulations (indirect costs such as reporting costs) and contingent environmental liabilities (potential future costs).The conventional and the material and energy ﬂow-based deﬁnitions of internal company environmental costs are reﬂected in conventional cost accounting (see Section 6.3). Internal company costs can,moreover,be distinguished according to their measurability and their consideration in accounting (Fig. 6.5). Conventional ordinary and extraordinary direct costs are mostly quantiﬁed and are included in management accounting. Indirect (‘hidden’) costs, however, are often not explicitly recognised in management accounting but rather are considered to be part of general overhead costs. Less tangible costs include negative effects on the goodwill of a company. Potential future (contingent) costs have to be estimated.They are sometimes included in accounts as provisions or charges on income.Large measurement problems can occur in the case of intangible costs (e.g. a loss of reputation) and in the case of external costs that are usually not directly reﬂected in accounts. Nevertheless, these costs can have an indirect effect on a company’s level of economic success. In the 1960s,the asbestos industry sold products that caused tremendous health damage in the 1980s and 1990s.Today,asbestos as a product has mostly been phased out and it is insurance companies that often have to foot the ﬁnancial bill. Financial liabilities for pollution,illnesses such as asbestosis,clean-up liabilities and related claims have all to be borne by the insurance industry and today’s payers of insurance premiums (see Box 5.1 on page 78).Insurance claims have been estimated at US$2trillion in the USAalone.Only US$11 billion of these are covered by reserves and provisions (Knight 1994:48f.). Typically, these costs have not been made transparent in the accounting systems of those responsible for them,although,years later,the negative ﬁnancial consequences are being internalised.

**6.1.6 Opportunity costs of pursuing or neglecting corporate environmental protection**

Reﬂections on how much voluntary expenditure a company should make on environmental protection measures are dominated by discussion of relevant direct internal costs. Compulsory spending on environmental protection (e.g.spending forced by regulations) is not taken into account here as there is no legal choice but to incur such costs. A comparison of the direct and indirect costs of corporate environmental protection with other commercial investments is,without doubt,economically highly relevant.However, from an economic point of view, a comparison based on opportunity costs (Box 6.4) is even more important (see e.g.Hirshleifer 1980:265;Wöhe 1990:790).Economists consider that the economic cost of undertaking any activity has to be interpreted as the cost of the best alternative opportunity forgone. Opportunity costs are the costs that arise from the best unrealised opportunity whenever an alternative is chosen. The reason for considering opportunity costs is that they show that no decision is without cost even if no direct internal or external costs arise.The opportunity cost of an investment in environmental protection is equal to the beneﬁt of the most attractive alternative investment foregone (e.g. the return that could have been earned in the ﬁnancial marketplace for the same level of risk). In turn, the environmentally relevant opportunity costs of non-environmental investments are the unrealised beneﬁts of the most beneﬁcial investment in pollution prevention.From this perspective,environmental costs include the costs of purchase and handling of material that becomes waste at a later stage in the production process. As a result,the decision as to whether a company should voluntarily spend more money on pollution prevention should be based on the choice that has the lowest opportunity cost.Other things being equal,investment will take place until the net present value of all implemented projects, including environmental protection projects, is equal to zero.To arrive at the correct investment decisions requires knowledge of the beneﬁts of voluntary corporate environmental protection.Yet many beneﬁts of a company’s environmental protection are,of course,not quantiﬁed,because they are intangible or external.Possible ways of including these beneﬁts in investment appraisal will be discussed in Section 6.5. Although the cost of environmental protection is both an internal cost and measurable within a conventional management accounting system, the possibility of reducing the opportunity cost of unrealised environmental protection is usually not considered by business. For example, omitted pollution prevention will cost business money if it could be undertaken with use of techniques that help proﬁts rise. Opportunity costs of unrealised environmental protection are the forgone proﬁts from environmental protection that cause internal costs for the company to be reﬂected in its accounts. The opportunity costs of unrealised environmental protection of a company are shown in Figure 6.6. The horizontal axis in Figure 6.6 shows the environmental impacts of a cost centre’s activities (e.g. a production process or site), of a cost object (e.g. a product or product group) or of a company.Costs are depicted on the vertical axis.In general,many internal costs of environmental impacts (CEI) increase more than proportionally the higher the number of environmental interventions (e.g.fees,ﬁnes,liabilities and administrative costs to comply with regulations). Some fees or regulations become relevant when particular amounts of hazardous waste or materials are used.Special administrative activities become mandatory, and education costs can arise or grow more than proportionally when staff need special education because a certain minimal amount of waste is exceeded. In contrast, the total costs of environmental protection (CREI) falls with a higher incidence of environmental impacts because the ﬁxed costs of environmental protection are spread out over many impacts because of a shared ﬁxed element of cost. Hence, the optimal level of environmental impacts of a company is where the total costs (Ctot = CEI + CREI) are minimised,that is at Q1,corresponding to total cost Ctot(Q1).This optimum is where the sum of CREI and CEI is at a minimum and is not related to the crossover of CREI and CEI as Figure 6.6 shows total cost ﬁgures. It is, however, the same place as the point where the marginal costs of pollution prevention equal the marginal costs of environmental impacts (see Fig. 2.2 on page 57). Unrealised environmental protection causes opportunity costs for a company whenever it exceeds Q1 (e.g. at Q0). These opportunity costs are shown by the difference between minimal total costs, Ctot(Q1), and actual costs, Ctot(Q0) of pollution—the area dCtot(Q0→ Q1). The question remains why a company would wish to take the opportunity cost of unrealised environmental protection into account. There are two main reasons. First, accounting systems have not adjusted.Second,in order to judge whether a company has incurred, an economic loss all investment opportunities have to be considered. The opportunity cost of unrealised environmental protection has to be compared with the net present value of the realised (or planned) alternative investments,as shown in Section 6.5. They are equal to the net present value of the most economic pollution prevention measure (the forgone alternative).The ﬁrst aspect, the emerging importance of the opportunity costs of unrealised environmental protection,is illustrated in Figure 6.7. Chapter 2 showed how the marginal costs of environmental impacts have been increasing for business in the past decade because of stricter regulations and stakeholder pressures.This has led to an upward shift of the total cost curve,so that the optimum point in Figure 6.7 has been sliding to the left of the ‘environmental impacts’ axis. However, because environmental costs have been unimportant historically,the increase of environmentally induced costs has not been adequately reﬂected in conventional information systems (i.e.it has not been separately accounted for). Figure 6.7 shows the development of opportunity costs of unrealised environmental protection based on the inclusion,in sequence,of indirect costs,intangible costs (e.g.loss of reputation) and newly internalised external costs. Cost curves CEI 0 and Ctot 0 illustrate the perceived cost situation if only the direct ﬁnancial consequences of the environmental impacts of a company are considered.As discussed later, in many companies environmentally induced indirect costs such as administrative costs,required to comply with regulations,are often treated as overhead costs and are thus not explicitly considered in decision-making (i.e. in investment appraisal of pollution prevention technology). If these indirect and internal costs are included, the total cost curve shifts upwards to the left (Ctot 1 ).The cost curve would shift even further to the upper left if liabilities arising from formerly externalised costs (e.g.from dumping of toxic waste) were internalised (Ctot 2 ). Both of these types of indirect cost have substantially increased in the past decade, thus shifting the optimal level of environmental impacts from Q0 to Q1 and Q2.Although economic analysis recognises their importance, few of these costs have been recognised in accounting systems.Exploration of the signiﬁcance of such costs and the ways that they can be reﬂected in management accounting have been explored (see Ditz et al. 1995; IFAC 1998;Parker 1999;Schroeder and Winter 1998). The above analysis shows the effects when little consideration is given to environmentally induced ﬁnancial impacts on a company.The ﬁrst effect is that the total costs of many proﬁt and cost centres (e.g. polluting production processes, equipment) and cost objects (e.g.environmentally harmful products) are underestimated,as Ctot 0 (Q0) instead of Ctot 2 (Q2) (Fig. 6.7). The second effect relates to the presence of opportunity costs because corporate environmental protection is not at its optimal level—area dCtot(Q0 → Q2) represents the opportunity cost of underinvestment in environmental protection from a social perspective). The third effect is that this leads to a lower level of environmental protection than would be economically optimal (Q0 instead of Q2). Evidence supporting the view that many economically beneﬁcial measures of environmental protection are not realised is provided in a large survey in the USState of Washington (WSDOE1992b,1992c,1993b).As a result, the less than optimal level of company eco-efﬁciency also means that eco-efﬁciency levels for the whole economy are too low. This section can be summarised as follows: opportunity costs relating to unrealised environmental protection have been neglected for too long by many companies. Public pressure and increasing government legislation is making managers consider strategies for internalising these opportunity costs before they are ‘forced’ to do so. Once these costs are identiﬁed and recognised, as illustrated in Figure 6.7, managers will tend towards higher levels of environmental protection. Once the opportunity cost of unrealised environmental protection is recognised by managers, they will focus on ways to reduce these opportunity costs by lowering environmental impacts in a cost-efﬁcient manner.In short,in anticipation of having opportunity costs of unrealised environmental protection forced on them,managers will implicitly adopt the concept of corporate efﬁciency where they look for a reduction in environmental impacts, while maintaining, or improving proﬁtability. In Section 6.5.3 an example is provided showing how the opportunity costs of unrealised environmental protection can be calculated as part of an investment project. Of course,it should be noted that an environmental management accounting system does not record opportunity costs on a regular basis as these are not costs that are actually incurred by an organisation.Instead,they relate to anticipated costs as part of a decision to select one course of action rather than another. One may ask two questions. A Why do businesses need to know opportunity cost? Answer:at the time they make a decision they need to know the best alternative course of action to make sure that it is not as good as the alternative they are taking. A When do they need to know opportunity cost? Answer:at the time they make a decision, not after a decision is made because the opportunity cost (the cost of the best alternative not taken) may change at a later date.

Given the potential effects of neglecting the opportunity cost of unrealised corporate environmental protection,in particular the resulting corporate losses associated with being told what to do by regulatory bodies rather than choosing the best course of action in the ordinary course of business and the growing stakeholder concerns over environmental impacts,it is hardly surprising that some stakeholders have exerted their inﬂuence to try to ensure that environmental issues receive better consideration from companies in their management accounting systems.

**6.1.7 External stakeholder influence on managementaccounting**

Management accounting is designed for internal decision-making and accountability, which means,in principle,that managers cannot be forced to account for environmental impacts in a speciﬁc way. However, management accounting does not operate in a vacuum. Financial reporting standards have been accused of exerting a strong inﬂuence on management accounting (Kaplan 1984), at the same time reducing the relevance of information provided by the management accounting system.When internal accounting systems inﬂuence external returns, for example by ignoring environmental impacts of company activities, investors need to be mindful of the need for improvement and may even try to inﬂuence internal changes.Although ﬁnancial accounting standards are slowly changing (see Chapter 7),some additional environmentally oriented stakeholders,although having no effective power to tell managers how to organise their internal accounts, have substantially inﬂuenced management accounting practices so that environmental issues are now considered in greater depth. For example, in the USA, two of the most active stakeholders are the United States Environmental Protection Agency (EPA) and the Washington State Department of Ecology (WSDOE) (see WSDOE 1992a, 1993a; see also Spitzer 1992). US EPA is a major player concerned with the ‘greening’ of management accounting practices (Box 6.5). It has issued guidelines on costing techniques and capital budgeting (EPA 1995c) to help educate managers on what environmental accounting is, what environmental accounting techniques are available to managers and how managers can carry out investment appraisals of alternative pollution prevention plans.In addition, US EPA provides information on techniques for determining the monetary value of potential environmental liabilities as well as on new approaches to environmental accounting, on case studies where environmental accounting has been successfully implemented and on software packages that can be used to promote environmental management accounting (Boyd 1998;Spitzer 1992; EPA 1995b). WSDOE has established a regulation associated with the 1990 Hazardous Waste Reduction Act which requires companies either to carry out investment appraisals for pollution prevention plans or,since 1997,to adopt an alternative environmental management system. A guideline for investment appraisal for pollution prevention has been published (WSDOE 1992a, 1993a). The results of this regulation and its guidelines are quite impressive (see e.g. WSDOE 1992a, 1993a). Data collected for 1994, and adjusted for changing economic conditions, show a 34% reduction in hazardous waste generation compared with 1992. For 1997, the decrease is 44% compared with 1992. The initial target was a 50% reduction by 1995. Facilities are encouraged to establish reachable goals for reduction, recycling and treatment and to report their progress annually.Many economically favourable pollution prevention plans have been developed and implemented with use of these enforced investment appraisals. The regulation had to force information about the economic consequences of pollution prevention plans on management.Obviously,information costs as well as lack of interest prevented management from seeking such information for itself earlier.One result of the legislation was that more pollution prevention activities were implemented as soon as ﬁnancial information became available through the plans and as soon as the costs of information were made compulsory for management to bear. Most information costs related to the ﬁxed costs of adapting existing cost accounting methods and computer programmes,and to education costs. Referring to the discussion of Figure 2.2 in Section 2.4 (page 37), this result is not a surprise.According to this analysis,marginal costs of environmental impacts have grown unnoticed over many years as a result of the introduction of increasingly tighter regulations.As a result,the beneﬁts of increased pollution prevention were not considered even though the marginal cost of obtaining information about cost-effective pollution prevention plans had fallen. Some pollution prevention measures may not have been economically beneﬁcial to start with because of high information costs. However, as companies were forced by regulators to collect the information, management may have considered information costs to be sunk costs and thus may not have taken them into account when calculating the proﬁtability of pollution prevention devices. In this context, being forced to collect information about pollution prevention plans as a requirement for continuing business operations can either improve or decrease a company’s economic performance, depending on how high the information costs are compared with the (formerly unknown) economic beneﬁts of pollution prevention. In this instance, the WSDOE has forced transparency and accountability in pollution prevention planning on managers through their capital budgeting procedures. Other stakeholders are also beginning to bring pressure on managers to take environmental concerns into account.For example,recently the German Bundesumweltministerium (BMU) and Umweltbundesamt (UBA) have started to emphasise the importance of environmental cost accounting in companies (BMU/UBA 1996b). Likewise, professional accounting associations are now parading the advantages of environmental management accounting systems before their members (ASCPA 1999). Moreover,introduction of new economic instruments,such as environmental taxes and tradable emission permits,would simplify management accounting by making future and external environmental costs of a ﬁrm an explicit part of decisions to trade in the market and by assigning them a monetary value. External ﬁnancial costs would then be visible, internalised and would have to be considered in decision-making because ignorance about these costs would be removed by the introduction of ‘ofﬁcial’or ‘market-based’valuations and because the allocation of internal company environmental costs to cost centres and cost objects would be simpliﬁed. Thus, both the introduction of regulations and the establishment of market-based policy tools can help reduce the cost of obtaining information about corporate environmental impacts and their ﬁnancial repercussions. The next section presents an overview of the state of the art of different approaches to environmental management accounting.

**6.2 Currentmethods of environmental costaccounting**

**6.2.1 Overview**

Environmental cost accounting is described by IFAC (1998) as part of the core of environmental management accounting (see also Hummel and Männel 1993).The current methods of environmental cost accounting can be distinguished according to the deﬁnition used for ‘environmental costs’(see Fig.6.4on page 100) and the cost accounting method proposed.Table 6.4 provides an overview of current methods of environmental cost accounting. The particular cost analysis varies depending on the deﬁnition of the subject matter,as different costs are required for different purposes (Clark 1923). As discussed above, environmental costs can be viewed either as (1) costs of environmental protection or as (2) costs related to material and energy ﬂows that could be reduced through an increased level of environmental protection.Opportunity costs of unrealised environmental protection occur if the net present value of pollution prevention measures is positive.Thus,view (2) focuses on costs of unrealised pollution prevention. On the one hand, approaches dealing with the costs of environmental protection consider past and present costs, or future costs;whereas,on the other hand,approaches focusing on the costs of material and energy ﬂows appear to be based only on past results (see Table 6.4). To date,four methods have been used to deal with environmental costs.Some methods have been designed to produce separate calculations, not integrated into established company management accounting systems (Section 6.2.2).The other methods proposed include full-cost accounting (Section 6.2.2), direct costing (Section 6.2.3) and process costing (Section 6.2.4; for a general overview of cost accounting approaches, see Coenenberg 1993;Freidank 1991;Garrison and Noreen 2000;Hansen and Mowen 2000; Horngren et al.2000;Kosiol 1979;Parker 1999;Ulrich et al.1989).In Section 6.2.5 a new approach considering future environmental costs—‘material-ﬂow-oriented and energyﬂow-oriented activity-based budgeting’—will be discussed.Box 6.6provides an overview of the main terms used to classify or categorise costs in different environmental cost accounting systems.

6.2.2 Separate environmental costing of pollution abatement and environmental full-costaccounting The ﬁrst authors to deal with environmental cost accounting were Fleischmann and Paudke (1977) and the Verein Deutscher Ingenieure (VDI 1979). Their approaches calculated the costs of end-of-pipe measures of pollution prevention incurred and reﬂected knowledge about environmental protection existing at that time.Environmental protection was seen only as a cause of additional costs to business.Whereas VDIproposed a separate procedure for calculating environmental costs, others attempted to integrate the measurement of pollution prevention costs into established management accounting systems either through full-cost accounting (CICA 1997; Fleischmann and Paudke 1977; Haasis 1992; Popoff and Buzzelli 1993; Stölzle 1990;Wicke 1992), direct costing (Kloock 1990,1993,1995;Roth 1992;Schreiner 1988,1991) or,more recently,activity-based costing (Ditz et al. 1995). Environmental full-cost accounting and environmental activity-based costing have been applied in some companies, whereas no company-level examples of a practical application of direct costing to environmental costs are known (Fichter et al. 1997: 35), although direct (marginal) environmental costing is applied to electricity generation in the USA by economists by means of direct ‘environmental adders’(or addons) at the industry level (Navrud and Pruckner 1997). Full-cost accounting is the conventional method of cost accounting and traces direct costs and allocates indirect costs to a product, product line, process, service or activity (see e.g. White and Becker 1992). IFAC (1998: paragraphs 22 and 25) views full-cost accounting and environmental cost accounting as the same thing: ‘the identiﬁcation, evaluation, and allocation of conventional costs, environmental costs, and social costs to processes, products, activities or budgets’. A key element of this deﬁnition is the recognition that, to obtain full costs of an object, costs must be allocated to that object because they cannot be directly traced. The term ‘full-cost pricing’ is also sometimes used as a synonym for ‘full-cost accounting’, but there are differences between the two as the provision of full-cost accounting information for decision-making does not require a company to adopt fullcost pricing (EPA 1996a,1998a).Full-cost accounting is merely a necessary means to the introduction of full-cost pricing.Total cost accounting is another ‘term sometimes [ . . . ] used as a synonym for “full-cost accounting”’(EPA1995a:6).Not everyone uses the term ‘full-cost accounting’ in the same way. Some applications include only the internal costs of a company (i.e.those costs that affect the company’s ﬁnancial bottom line [White and Becker 1992]) whereas others (EPA1996a,1998a) include the full range of costs throughout the life-cycle of the product, from raw material extraction to product disposal. Some of these full costs do not show up directly or even indirectly in the ‘bottom line’ of the company (Spitzer et al. 1993:5; EPA 1993a).Hence,the term ‘full-cost accounting’can be misleading and has to be used with caution as it may or may not be seen to include environmental externalities (external costs).In this chapter,only internal company costs will be considered. Different cost accounting approaches have, of course, various strengths and weaknesses, which are dealt with in depth elsewhere (see e.g. Burritt and Luckett 1982; Coenenberg 1993;Freidank 1991;Garrison and Noreen 2000;Hansen and Mowen 2000; Horngren et al. 2000; Kilger 1992, 1993; Kosiol 1979). Therefore, discussion of these approaches is kept rather brief (see also Fichter et al.1997). One of the advantages of calculating the costs of end-of-pipe devices separately is that it entails no change to the existing management accounting system (Fichter et al. 1997). For example,this costing approach is in line with requirements of the German federal law on protection against emissions (Bundesimmissionsschutzgesetz,BImSchG).It provides a direct comparison of the costs of various end-of-pipe technologies in different industries. However, as the approach also has its problems because it does not take into account integrated technologies (e.g. new, less waste-creating, production systems) or the costs incurred when environmental protection is neglected.In addition,the approach is reactive, as it focuses only on additional costs caused by environmental regulations.Although costs of end-of-pipe devices can be allocated to cost centres and cost objects, environmental protection is not integrated into management accounting and no clear indication is provided about how to treat such integrated technologies. Traditionally, full-cost accounting is the dominant approach of cost accounting in general;for example,in Australia direct costing is not permitted for ﬁnancial accounting purposes,thereby putting pressure on management accountants to ignore the approach. The advantages of applying full-cost accounting to environmentally induced costs includes the possibility of allocating these costs on the basis of the activities that cause the costs—their cost drivers. Central to cost allocation is the management process of establishing what the cost objects and cost centres are in an organisation and who is responsible (accountable) for them. As a result, environmental protection is seen as part of daily business,a spur to the search for potential savings,a market opportunity. Among the ﬂaws of the full-cost accounting approach are that environmental protection is generally regarded as a cost to business rather than an opportunity and the emphasis is mostly on end-of-pipe devices.Information on the pollution abatement costs of speciﬁc production processes and products is often not seen as being useful because end-of-pipe technologies largely cause ﬁxed costs independent of the level of production so that the costs of end-of-pipe technology per product unit strongly ﬂuctuate depending on capacity utilisation.Allocation of ﬁxed costs to units of product is a much-frowned-upon procedure in management accounting.When environmental costs are treated as general overhead costs to be allocated,this will reduce the transparency of environmental costs so necessary for environmental cost management.It will also result in distorted costs for decision-making if no speciﬁc mechanism for the linking of environmental costs to products is deﬁned.Viewing environmental protection as a cost-adding factor may,moreover,lead to a negative attitude towards pollution prevention. Furthermore, the opportunity costs incurred through the neglect of corporate environmental protection are not taken into account either. Hence, on grounds of faulty decision-making and poor accountability, full-cost accounting can be criticised if it does not try to identify costs that are speciﬁcally related to cost objects. The main advantage of environmental direct costing is the emphasis placed on the possibility of tracing environmental costs to products based on economically plausible causal relationships (Burritt and Luckett 1982).Moreover,direct costing allows ﬁxed and variable costs to be considered separately and, therefore, for a distinction to be made between information relevant to the short and the long run.Schreiner’s (1988,1991) multistage direct costing proposal suggests identiﬁcation of environmental cost centres that can be used to pinpoint the localisation of potential savings from environmental protection. Schreiner also raises the issue that the costs of material and energy ﬂows will have to be considered too.The practical problem with the direct costing approach is the necessity to separate environmental from other costs and the fact that no authors have provided clear criteria to help managers with this process.It thus remains unclear,for example,how the costs of integrated technologies should be tracked and traced. Apart from Schreiner’s approach,the methods proposed do not take costs of neglected pollution prevention into account. One of the main advantages of using activity-based costing to assess environmental costs—apart from the advantages that have been mentioned concerning environmental full-cost accounting—is the integration of environmental cost accounting into the strategic management process and its linking to management objectives and activities. However, as the experience gained in US companies shows (Ditz et al. 1995), the introduction of activity-based costing (process-based costing) can be quite expensive for most companies. In addition,as with all other approaches discussed so far, future environmental costs are not taken into account. However, an accounting system, such as activity-based costing, that encourages managers to try to trace environmental costs to products responsible for those costs is to be encouraged.

6.2.3 Environmental budgeting and the assessmentof potential environmental costs From the general deﬁnition of environmental costs as costs intended to protect the environment, some authors propose that potential or future costs (second column of Table 6.4) be assessed too.Wagner and Janzen (1991) designed a separate costing system along these lines. Integration of future costs of environmental protection using full-cost accounting has been discussed by Neumann-Szyska (1994).In principle,the assessment of future costs,especially when related to environmental issues,is very important indeed. Conventional accounting has been criticised for being far too oriented towards the past instead of towards present and future activities (see e.g.Johnson and Kaplan 1987a,1987b). Also,direct costing,another popular conventional management accounting approach (see Horngren et al. 2000), is less decision-oriented than is activity-based costing because it concentrates on calculating the costs of speciﬁc business activities with use of volume as a cost driver rather than the richer set of cost drivers used in activity-based costing. An important use of management accounting information is to assist planning for the future.Extending these approaches to include budgeting is,therefore,another advantage of the full-cost, direct-cost and activity-based approaches because the future consequences for the environment are required to be taken into account if managers use these methods.However,none of the approaches (Freese and Kloock 1989;Kloock 1993,1995; Roth 1992;) has,at the time of writing,been implemented. Apart from the pros and cons mentioned above, anyone attempting to undertake a consideration of future costs faces quite substantial problems when trying to estimate those costs. Estimation of the future costs of pollution prevention and environmental liabilities is particularly difﬁcult as neither future technologies nor future demands of stakeholder groups are known. Furthermore, the explicit assumption in environmental budgeting that environmental protection is always related to a single case or project (Wagner and Janzen 1991:124) does not always reﬂect reality.Parker (1999:64),following an empirical survey of environmental costing in Australia, recommends change through adaptation of existing budgetary control systems,such adaptation to be governed by: A The environmental management processes that are considered to be signiﬁcant activities for the organisation involved A The operational decision and control needs of the management team A The degree of management’s familiarity and comfort with environmental input– output statistics and costs A The rate of change in accounting system innovation deemed appropriate to the organisation involved

Practice suggests that the need is to focus on key operational strategies with which managers may be familiar and comfortable—such as setting budgetary targets for land remediation projects, pollution control systems, waste management and recycling activities. If management accounting can help to create purpose-oriented knowledge,the methods discussed so far need to be assessed within the context of the management objective of improving corporate eco-efﬁciency. The methods listed in the ﬁrst two columns in Table 6.4 focus on the costs of end-ofpipe environmental protection technologies and occasionally on integrated technologies (production processes 1 and 2 in Fig. 6.8). This perspective is based on the implicit rationale that increased environmental protection leads to higher costs—in this case,costs of end-of-pipe incineration of waste. However,this perspective is irritating for managers wishing to enhance corporate ecoefﬁciency. The implied link between environmental and economic performance is in contrast to attempts to improve the company’s economic record by improving the environmental record in a proactive way.This is why cost accounting methods that focus on the costs of environmental protection without highlighting the environmental gains are unlikely to create eco-efﬁciency-oriented knowledge. Information provided by these methods contradicts somewhat the management aim of enhancing corporate ecoefﬁciency.

6.2.4 Costs of material and energy flows Recently,the traditional deﬁnition of environmental costs has been challenged (see Fichter et al. 1997). The next few sections will show that the focus of attention, accounting information and in-company incentives,change quite substantially if environmental costs are deﬁned as all costs caused by material and energy ﬂows that have an impact on the environment.Judged from this point of view,environmental costs are caused by any kind of material purchased and processed and the associated waste ‘produced’. Environmental costs are seen to include the costs of purchasing and handling materials that cause environmental impacts (costs number 4 in Fig.6.8 show the material that has ‘been bought only to become waste’).If waste were not produced,the material would not have had to be purchased. Purchasing and handling costs are therefore material-ﬂowrelated environmental costs. This also ‘automatically’ includes (i.e. without having to distinguish between normal production costs and costs of integrated environmental technologies) the costs of treating input materials by end-of-pipe (costs number 1 in Fig. 6.8) and integrated technologies (costs number 2 in Fig.6.8) as well as the environmentally related internal company costs of the products sold (such as liabilities relating to products dumped in a landﬁll;costs number 2 in Fig.6.8). Thus, environmental costs can be lowered by reducing material ﬂows as these cause environmental impacts.This way of thinking is in line with the plea of the Wuppertal Institute for Energy and the Environment to reduce material ﬂows in order to tackle environmental problems (see Schmidt-Bleek 1994).As a result,environmental protection includes all activities that reduce material and energy ﬂows. Furthermore, costs of scrubbers and efﬂuent treatment plants are not regarded as costs of environmental protection but rather as environmental costs.The costs of environmental protection (i.e. reducing material ﬂows) can then be regarded as the ‘costs incurred to reduce environmental costs’. Opportunity costs of environmental protection occur if the difference between environmental costs and the costs of environmental protection is positive. Such a perspective ﬁts in with a managerial objective of improving corporate eco-efﬁciency because the reduction of environmental costs is related to less, or less crucial, environmental impacts. The ﬁrst method,which focused on environmental costs as costs related to material and energy ﬂows, applied the method of full-cost accounting (Fischer and Blasius 1995; BMU/UBA 1996b), whereas others have taken a process costing view (Fichter et al. 1997; Kunert et al. 1995). Only slightly different is the approach whereby costs are allocated based on material ﬂows to internal company activities such as, for example, various production activities (Schaltegger and Müller 1998). One of the main advantages of full-cost accounting of material and energy ﬂows is that any reduction of throughput and related environmental impacts is recognised as a reduction of environmental costs. This way of thinking spurs advanced corporate environmental management to renewed efforts (i.e. prevention instead of a mere abatement of pollution). The information provided is decision-oriented with a focus on improving corporate eco-efﬁciency.The search for potential cost savings by means of environmental protection is encouraged as the costs of neglected pollution prevention are calculated and made transparent within the company. In addition, it is much easier to distinguish between costs related to material and energy ﬂows than between costs of integrated environmental technologies and normal production technologies. Integration of this method with cost accounting is facilitated if the identiﬁed material ﬂows are related to cost centres,cost objects and associated activities. One problem of this approach is that all material and energy ﬂows of a particular company have to be known.Moreover,the implementation of a material-ﬂow and energyﬂow accounting system is expensive. This is partially because of the fact that the establishment of a satellite ecological accounting system is necessary (see Part 3) and this requires the introduction of a general account of all material ﬂows,an allocation of related overhead costs to the material ﬂows (e.g. the administrative costs to deal with permits related to material ﬂows) and the deﬁnition of allocation keys.Allocation keys are bases used to link environment-driven costs to cost objects.A new kind of knowledge to promote ecological accounting (i.e.accounting for the amount of materials and energy used) is also required (on ecological accounting,see Chapter 4 and Part 3). The following sections will discuss the process of accounting for materials-based and energy-based environmental costs.The main emphasis will be on environmental costs related to material ﬂows as this approach is seen to provide the best example for understanding the information needed to improve corporate eco-efﬁciency. This discussion includes the costs of end-of-pipe technologies. The costs of pollution abatement are included with the environmental costs related to material ﬂows. Pollution abatement measures are always taken to reduce the amount or change the composition of material and energy ﬂows.When calculating the costs of managing speciﬁc material and energy ﬂows,the pollution abatement measures involved have to be considered.

6.2.5 Material flow-oriented and energy flow-oriented activity-based budgeting The overview of the existing approaches to environmental cost accounting (Table 6.4) shows that no cost accounting approaches considering potential future costs of material and energy ﬂows have yet been proposed in the literature.This is surprising given the potential cost savings that can be discovered by taking a material ﬂow-oriented and energy ﬂow-oriented view of current production processes. It is to be expected that a futureoriented costing approach that considers the potential environmental costs related to material ﬂows from investments, production processes and business operations would show even greater potential for cost savings compared with analysis based on past and current operations. The main reason why a proactive approach may uncover greater potential for cost savings is that measures to reduce material and energy ﬂows are often much cheaper than measures for changing existing processes or installations. Thus, proactive environmental management may be best reﬂected through a material ﬂoworiented and energy ﬂow-oriented activity-based budgeting approach. The focus of this approach is budgeting for the potential future costs of all material and energy ﬂows. For example, this includes budgeting for all materials that are expected to be purchased in the next period,the cost of logistics for these materials,the wages of the staff who deal with these materials and the expected costs of waste treatment. Conceptually,this approach is the same as activity-based material-ﬂow accounting but its ﬁgures represent expected future costs.Thus, this budgeting approach is based on assumptions made about the future material and energy ﬂows calculated by means of trend extrapolations.However,given the prospective character of budgeting,this assumption can be altered to demonstrate what costs would be under different scenarios with growing or declining material and energy ﬂows based on the expected sales and production systems in place. The next section explores the identiﬁcation (i.e. the tracking and tracing) of environmentally induced ﬁnancial impacts on companies.Tracking and tracing is a precondition for correct tracing and allocation to cost objects (e.g. products) and cost centres (e.g. speciﬁc sites and production processes).

6.3 The tracking and tracing of environmental costs 6.3.1 Issues of tracking and tracing Most companies employ accounting systems that were designed before anyone was able to anticipate the business costs associated with environmental impacts and regulatory compliance.Until recently,costs of environmental impacts and compliance were thought to be of marginal signiﬁcance for many manufacturing companies.At the same time,the cost of tracking and tracing environmentally induced costs has been very high (see Haveman and Foecke 1998).Therefore, many companies simply included all environmental protection costs and many of the costs related to material ﬂows in their general overhead costs, along with the president’s salary, janitorial costs and other expenses that were not traced back to individual manufacturing processes and ﬁnal products.A limited search of the Canadian Financial Database,which contained the annual reports from 1983 to 1989 of more than 500 public Canadian companies, revealed that very few companies separately disclosed environmentally related costs (Hawkshaw 1991: 24).This result is supported by the more recent surveys of Bennett and James (1996),Gray et al.(1998) and Parker (1999:32). In the past decade, this lack of attention to the need for separate identiﬁcation of environmental costs has been reversed as new incentives, stricter environmental regula

118 tions and greater awareness of environmental issues by key stakeholders have changed management perceptions. In many countries, capital investments and expenditure on environmental protection activities beneﬁt from subsidies, tax exemptions and other advantages, whereas external costs of pollution are increasingly being internalised as polluters are being made to ‘pay’ for any environmental damage they cause.The most obvious way to internalise environmental costs is through the introduction of taxes,ﬁnes and fees.Such taxes,ﬁnes and fees have a very direct impact on management accounting. For example, customers may require a detailed calculation of a company’s product prices once they have been increased because of new environmental taxes or charges. However, management accounting is usually not in a position to identify or disclose this information as the information system is often not designed to separate manufacturing costs from manufacturer’s taxes,fees and ﬁnes. Management is also reluctant to disclose the contribution margins associated with important products. As environmental costs grow in importance management accounting systems need to track charges, ﬁnes, fees and taxes because they have to be considered as part of the product costs.Because environmental costs related to material ﬂows have become higher and continue to increase for many companies, and the costs of tracing environmentally related costs have become relatively lower compared with the costs of not tracing them at all (see Fig. 2.2 on page 37), the net beneﬁts from tracking costs have grown. In consequence,the tracking and tracing of environmental costs have become more important to the process of correctly calculating the proﬁtability of products, production sites and companies. In spite of these needs and changed circumstances,many companies still do not attempt to calculate their environmentally induced costs. Most managers of such companies simply do not know whether the marginal costs of collecting environmental information and reducing environmental impacts are smaller than the marginal costs of environmentally induced fees,ﬁnes and image problems. However,a growing body of examples has demonstrated that companies beneﬁt ﬁnancially from decisions made to trace, track and allocate environmentally induced costs, thereby improving the relevance of available information for decision-making (Box 6.7; see also White and Zinkl 1997). The most important task of tracking and tracing is to determine which costs should be classiﬁed as ‘environmental’ compared with other costs. Generally, only those costs that are speciﬁcally related to environmental issues caused by material and energy ﬂows and which are identiﬁable should be included, not those that relate to, or are part of, normal business activities. The most important issues in tracking and tracing environmentally induced costs (and revenues) include: A End-of-pipe technologies and integrated technologies (Section 6.3.2) A Research and development (R&D) costs (Section 6.3.3) A Costs of past and future production (Section 6.3.4) A Life-cycle costing (Section 6.3.5) A Environmentally induced assets and expenses (Section 6.3.6) Revenues can be considered in a similar way to costs and therefore are not discussed separately.

6.3.2 Environmental technologies Identiﬁcation of internal environmental costs presents no problems if they are deﬁned as costs of end-of-pipe technologies.End-of-pipe technologies are clean-up devices, which are mainly installed for cleaning purposes at the end of the core production process. Scrubbers and waste-water treatment plants are typical examples of end-of-pipe technologies. They can help to concentrate toxic substances and/or reduce toxic impacts. However, end-of-pipe technologies do not usually solve environmental problems at source,rather they ‘catch emissions’before they are released uncontrolled into the natural environment.Another characteristic of technologies of this kind is that they shift emissions from one environmental medium to another (e.g.a scrubber shifts emissions from the air to the water and/or to the soil). End-of-pipe technologies have been encouraged in the past by regulatory authorities in order to control speciﬁc,identiﬁable sources of pollution. These regulatory authorities often specify the technology that must be used by a company in order to reduce pollution to an acceptable level. Figure 6.9 shows a manufacturer with three production steps which all produce waste. The costs of ‘environmental cost centres’that provide joint services to all or a number of production centres, such as incinerators and waste-water treatment plants, need to be identiﬁed separately from other overhead costs if they are to be controlled.In the example provided, the entire waste from production is treated in a jointly used incinerator on the production site.The costs of incinerating the waste from current production amount to $800. The remaining overhead costs for general administration and salaries of top management amount to $9,000.This example will be extended later in this chapter. The identiﬁcation and measurement of environmentally related costs is much more difﬁcult with ‘integrated technologies’(also called ‘clean technologies’;e.g.the integration of coal-based electricity generation with gasiﬁcation combined-cycle technology designed to improve the acceptability of coal-based power production).Integrated technologies are more efﬁcient production technologies which reduce material and energy ﬂows at the source,or before pollution occurs (e.g.a new device uses 50% less energy and creates 20% less toxic efﬂuents than the old one).Environmental issues were already integrated when the technology was developed. Because of this integration of environmental protection into the production plant,the following question arises:What part of the production plant (the ﬁxed asset) and of any associated maintenance expenditures are environmentally induced? To answer this question in practice, a rule of thumb has to be developed (EPA 1995c). The main information needed is the cost difference in relation to the less favourable environmental solution. For example, 20% of the capital costs may be classiﬁed as environmental if the integrated technology has caused 20% extra costs compared with a comparable,non-integrated technology.In addition,if the integrated technology were to be installed two years earlier than could be justiﬁed solely on economic grounds, simply to comply with environmental regulations, the difference between depreciation costs of the old technology over two years and the depreciation of the new integrated technology may be considered as an environmentally induced cost. However, costs should not be considered as environmentally induced if the integrated technology represents only present technological knowledge and if it has been installed for no other reason than the regular replacement of an old device—a purely commercial decision.

6.3.3 Research and developmentintangible costs In the case of R&D costs, the tracking and tracing of environmentally related costs also presents difﬁculties. Which R&D costs are incurred to reduce material ﬂows and to improve the environmental performance of a company, its products and its production processes? Again,a rule of thumb is required. Today,in developed countries where legislation is effected,most R&Dprojects consider environmental issues.However,environmental considerations are sometimes only minor in relation to other considerations, and the actual beneﬁt for the natural environment is often a ‘spillover’ from the main ongoing effort to improve productivity and costeffectiveness. The problem of tracking and tracing R&Dcosts to speciﬁc cost categories is neither new nor speciﬁcally related to environmental questions. Practices vary very much not only between industries but also among companies in the same industry (Box 6.8). For example,some companies consider the costs of applications as R&D costs whereas others do not.Although the discretion is left to each company,sometimes guidance is provided by professional accounting organisations to show companies which costs are normally to be considered as R&D and which are not. Therefore,the general classiﬁcation criterion needs to be interpreted on a case-by-case basis by management, to the effect that only those costs that are speciﬁcally related to environmental issues, and which are identiﬁable, should be included and not those that relate to or are part of normal business activities. This is a matter of management judgement.

6.3.4 The costs of pastand future production The tracking and tracing of costs incurred because of environmental considerations is further complicated by long-term effects which are more important when considering environmental rather than other issues. Present costs can relate to past, present or future production activities. Examples of current costs of past production are today’s clean-up, waste disposal and incineration costs.The current costs of future production include present capital costs (e.g. interest payments for environmental protection investments that will reduce material ﬂows in the future; see e.g. Raftelis 1991).As part of accrual-based accounting, accurate matching of costs and revenues will reduce the amount of expenditure related to future beneﬁts but charged in the present period. Instead, such future costs will be capitalised in an asset value. Present production can be linked to past,present and future costs.Past costs of present production include, for example, the capital costs of past accounting periods that are written down through a depreciation charge. Future costs of current production are mainly liabilities and contingent liabilities. A correct accrual-accounting-based tracking, tracing and recognition of (environmentally induced) costs requires that all (past,present and future) costs be treated in the accounting period in which they accrue and not necessarily when they have to be paid (see Table 6.5; on the accrual basis, see IASC 1995: 47, IAS F22). In other words: past, current and future costs of present production should be recognised and disclosed in the present accounting period.The situation is similar to the downward revaluation of assets— past costs of past production recognised in the present period should be counted as a loss in the present accounting period in accordance with the guidelines for re-valuing assets because of unexpected technological or market developments (see IASC 1995). Taking future costs into consideration is problematical because their estimated amounts are mostly unknown, especially in the case of environmental issues such as contingent liabilities. One possibility is to insure against environmentally induced economic risks. In this way, the cost of an insurance premium facilitates recognition in the present. However, it is not possible to insure against a number of environmental risks. Comparisons with similar risks in the past or similar risks faced by other companies can be made in order to estimate probable liabilities. In the past decade, contingent environmental liabilities have become an important issue in ﬁnancial accounting (see Chapter 7). The main problem is that disclosure of contingent liabilities might attract the attention of certain stakeholders and thus have unwelcome legal and economic consequences. However,greater transparency can also act as a defence for managers. Unexpected current costs related to past and future production should be accounted for separately in the period in which they occur (or when they are realised) so as not to distort the calculation of current proﬁtability from operations.Also,present costs resulting from past production should be identiﬁed as losses (extraordinary costs) to prevent the distortion of the correct calculation of operational proﬁtability from present production. Apart from considering past and future costs, the boundaries of accounting can also be extended to include the entire life-cycle of a product.The next section will examine life-cycle costing,a costing approach that is often promoted by environmentalists.

6.3.5 Life-cycle costing The basic idea behind life-cycle costing is to identify,track and account for costs relating to the whole life-cycle of a product. Life-cycle costing (or ‘cradle-to-grave’ product costing) involves examining the costs of a product at R&D,design,production,marketing, distribution and disposal stages. Logistics behind value chains have provided an insight to the various stages in product life-cycles and this is why groups such as the Society of Logistics Engineers (SOLE) have developed life-cycle costing with the idea of taking all internal and external monetary costs of a product into account. Indeed, in some organisations the concept of ‘cradle-to-cradle’, where components of a product are recycled or re-used as an input to the next cycle of manufacturing,views the costing cycle as a closed-loop system. All costs for the economic actors in a product life-cycle are identiﬁed with the product throughout its whole lifetime. The costs should preferably be measured in quantiﬁed terms, though, if this should not prove possible, qualitative judgements may be added (Spitzer et al. 1993: 6). Life-cycle costing encourages expansion of the accounting boundaries of the company to include suppliers and consumers as well as extending the time-horizon of accounting into the distant future. Thus, in principle, the focus on a narrow entity is discarded and a broader view adopted to allow inclusion of the whole lifecycle of a product.Yet, in practice, deriving monetary values for all life-cycle costs is somewhat unrealistic because of the ‘inﬁnite regress’ problems associated with the need to deﬁne boundaries for any life-cycle. Hence, many organisations choose to focus on narrower aims,such as the US EPADesign for Environment programme,with its emphasis on environmental improvement and cost reduction at the design stage of any life-cycle. The method of life-cycle costing should not be confused with the much more popular concept of life-cycle assessment (LCA), which focuses on the physical environmental impacts of a product life-cycle (see Chapter 10). Although discussed in academic circles, life-cycle costing has not received much attention by the corporate sector to date.First,in a competitive market the price mechanism should already include the internalised environmental costs of suppliers if the products are priced correctly (through correct identiﬁcation and allocation).In addition, because of uncertainty, external costs can be estimated only very roughly and so their information value may be very low. Second, the concept of life-cycle costing suffers from major problems in practical applications.The collection of necessary information from economic actors outside the company (suppliers,customers and disposal costs) usually results in: A Low-quality data A Data of inconsistent quality A High costs for data collection To initiate life-cycle costing,management must deﬁne the boundaries of the life-cycle system under consideration.In doing so,management has considerable latitude in setting the boundaries of the system investigated.So far,no generally accepted criteria exist and this makes comparisons between alternatives difﬁcult. In most cases, the collection of information from outside a company results in poorquality data. Unless a very powerful company can insist on obtaining and can verify the data from, for example, suppliers, employees in other companies have little incentive to concern themselves about the quality of information provided. For a supplier, some information might be of strategic importance or related to processes that are conﬁdential or competitively sensitive.In addition,most companies have different information system conﬁgurations and these provide different details, classes and qualities of data. When ecological accounting is examined (Part 3),it will be seen that life-cycle assessment faces similar problems. Despite its substantial deﬁciencies, the basic idea of systematically examining all the environmental costs of a product life-cycle can be useful as a general way of thinking to help in strategic management,especially for the early identiﬁcation of contingent liabilities or of environmentally weak and strong points in an industry’s value-added chain.

6.3.6 Environmentally induced assets and expenses When tracking and tracing environmentally induced costs (e.g.to reduce material ﬂows) a company is,sooner or later,faced with the question whether the costs should be deﬁned as expenses or capitalised in asset values.In principle,and in accordance with accounting convention, an expense is deﬁned as a cost that has provided a beneﬁt that has now expired, whereas unexpired costs that can lead to future beneﬁts are classiﬁed as assets (see also Section 7.2,Box 7.2). The decision as to whether an environmentally induced cost item is identiﬁed as an asset or as an expense has a major impact on management decision-making.As illustrated in Box 6.9,the distinction between assets and expenses is often not clear-cut in practice.To answer this question the following distinction between two types of environmental costs may be useful: A The preventative costs of reducing the material and energy ﬂows of a company A The reactive costs of pollution abatement and those of environmental impacts caused by existing material ﬂows (ﬁnes,fees and scrubbers)

The ﬁrst covers costs incurred through the reduction of material and energy ﬂows with the aim of conserving natural resources and reducing emissions or any kind of environmental damage. The costs of pollution abatement (e.g.costs of purchasing and maintaining scrubbers) are incurred because some (excess) material and energy ﬂows were not reduced. Expenditure for environmental impacts caused includes any extraordinary costs of noncompliance such as ﬁnes and the costs of litigation,as well as the ordinary operational costs related to unrealised environmental protection such as the fees paid for waste disposal and environmental taxes. Generally, the costs of treating the environmental impacts of existing material and energy ﬂows,as well as pollution caused,are the result of omissions or uncertainties and therefore tend to be treated as period expenses.On the other hand,any costs incurred in order to improve the future environmental record by reducing a company’s material and energy ﬂows tend to be recognised more easily as assets. Unfortunately,standards,regulations and guidelines established for ﬁnancial accounting and reporting have a major impact on how this issue is treated in management accounting (Kaplan 1984). As a result, less emphasis is placed on relevant data for decision-making and accountability and more emphasis is given to compliance with external accounting standards.If,for example,an outlay has to be counted as an asset in ﬁnancial accounting, it will, for reasons of consistency, generally be treated in the same way in management accounting. The question whether to expense or to capitalise an environmentally induced outlay is therefore dealt with in greater depth in Chapter 7, on ﬁnancial accounting. Nevertheless,ﬁnancial accounting guidelines leave management accountants with some discretion.Management should account for environmental costs in the most appropriate way for decision-making.Two contradictory effects are worth considering: A Environmentally induced outlays that are recognised as assets increase the net assets and hence the net worth of a company.These assets will be depreciated (the costs expire) over several accounting periods as they are used up.Thus, capitalisation spreads costs over several accounting periods. As a result, ratios of proﬁtability to earnings per share will also be affected over a long period. A If the outlay is regarded as an expense in an accounting period, proﬁts, proﬁtability and earnings per share will be affected for a short period only (the accounting period) although to a greater extent than if the outlay had been treated as an asset.

Once environmentally related ﬁnancial impacts are tracked,traced and recognised,they are allocated to cost centres and cost objects.

6.4 Allocation of environmentally induced costs 6.4.1 The conventional approach For many companies,where environmentally induced costs are signiﬁcant,it makes sense to consider tracking and tracing such costs to help determine how much the company is affected ﬁnancially by environmental issues.In addition,it is often argued that,to calculate accurate contribution margins,economic value added or proﬁt margins,environmentally related costs should be allocated to products. Direct costs are taken to mean those costs that can be traced to cost objects,whereas indirect costs cannot be traced to cost objects; they can be allocated only by using a predetermined allocation base or key.Indirect costs are usually referred to as overhead costs.Where direct tracing of costs is not possible the main concern is to provide relevant information for those who need or can use it. In practice there is an inevitable grey zone where ‘correct’ information is not possible to obtain (e.g. how much of the chief executive ofﬁcer’s time is related to dealing with environmental issues?) and cost allocations have to be made.To help practitioners,US EPA (1995c:12) suggests three approaches that can be considered when trying to link costs with cost objects (e.g.a product) in these circumstances: A Allow the cost item to be treated as environmental for one purpose but not for another A Treat part of the cost of an activity or item as environmental A Treat costs as environmental for accounting purposes when managers agree that a cost is more than 50% environmental The conventional approach to cost accounting is absorption cost accounting.Internal environmental costs are assumed by most organisations to be negligible(perhaps because historically they were negligible) and thus treated as general overhead costs to be divided between all cost objects by using a predetermined cost allocation base.Figure 6.10provides an example.It illustrates a common situation where the costs of treating product B’s toxic waste are included in general overhead costs which are then allocated to all products (both A and B) on the basis of an accepted cost allocation base. However, ‘dirty’ products cause additional emissions and require additional clean-up facilities relative to ‘clean’ products.An equal allocation of those costs, therefore, would subsidise relatively less environmentally benign products.Cleaner products,on the other hand,are ‘punished’by this allocation rule as they have to cover costs they did not cause in the ﬁrst place.In this case product A bears half the cost (assuming an equal allocation) of toxic waste caused by product B—a cost that can be traced to product B in its entirety. Product A is the cleaner product,but the cost allocation mechanism penalises it by making it look more expensive to produce than it really is. A simple example in Table 6.6 provides another illustration of how equal allocation between products that have different environmental impacts can lead to sub-optimal management decisions.Two production processes are compared:process A is ‘clean’and does not cause any environmentally induced costs for the company, whereas process B causes $50of extra costs because it is environmentally harmful.If these costs are assigned to general overhead and allocated equally,both processes seem to create a proﬁt of $75(if $50 is allocated to overhead,$25 will implicitly be allocated to each process.This leads to a proﬁt of $75 [$200 – $100 – $25]).In reality,however,process A has created a proﬁt of $100, whereas process B has contributed only $50 to the company proﬁt.This example illustrates how opportunity costs of unrealised environmental protection,as theoretically discussed in Section 6.5, can emerge. A proﬁtable investment to improve the environmental record of process B may be considered unattractive, and the total costs may be underestimated as a consequence of distorted information. Such inaccurate information may lead to a sub-optimal management decision whereby cost-based prices of products produced by the two processes are overstated or understated. Cross-subsidised ‘dirty’ products are sold too cheaply whereas environmentally benign products can be sold at too high a price.As a result,a market share can be lost in the most sustainable ﬁelds of activity and, at the same time, the company’s position is enhanced in ﬁelds where environmental risk is underpriced and there is the possibility of a reduced or no commercial future. Whenever possible,environmentally induced costs should,therefore,be directly tracked and traced to the respective cost centres and cost objects (especially products). Consequently, the costs of treating, for example, the toxic waste of product B in our example should directly and exclusively be traced to that very same product (Fig. 6.11) (see also Kreuze and Newell 1994). As discussed at the beginning of this chapter, the focus of this section is on activitybased costing (ABC) and its link with material ﬂows.ABCfocuses on identifying the direct costs of activities and then allocating these activity costs to products. In this sense, ABC is similar to conventional cost accounting in that it relies on cost allocation to obtain cost information about products. Within this conventional framework, in order to operationalise the relevant factors affecting corporate eco-efﬁciency and accountability of divisional managers, the allocation of overhead costs should focus on identiﬁcation of activities causing the environmental impacts of material ﬂows and the person or group within the organisation responsible for such impacts.This is the main purpose of material ﬂow-oriented activity-based costing,described in the next section. 6.4.2 Material flow-oriented activity-based costing Many terms and methods are used to describe and guide allocation procedures. In this book, an ‘activity-based costing’ approach is adopted. The term ‘environmentally enlightened cost accounting’has also been used to refer to this costing process (Todd 1992: 12f.).Activity-based costing (ABC)represents a method of cost allocation that ﬁrst traces costs to activities undertaken by cost centres in an organisation and, second, traces or allocates these costs to units of output or other cost objects (see e.g. Gunn 1992: 104f.; Hansen and Mowen 2000: 674; Spitzer 1992; Spitzer et al. 1994: 6; EPA 1995c). Cost centres and cost objects are deﬁned on the basis of production and other organisational activities that are established in order to facilitate co-ordination and responsibility. Activity-based costs are calculated by adding the indirect joint ﬁxed and the joint variable costs to the direct production costs of each product. The main strength of ABC is that it enhances the understanding of the business processes and activities associated with each product.It reveals the activities where value is added and where it is destroyed and, as a result, facilitates activity-based management (Morrow 1992). In relation to the need to improve corporate eco-efﬁciency, costs are calculated on the basis of the material ﬂows associated with activities. To simplify the following illustrative examples,energy ﬂows are ignored,even though they can be treated in a similar way. In relation to a desire to improve accountability, ABC allows a clearer linkage to be drawn between responsibility centres and the environmental costs of those centres. Not all environmental costs can be linked to cost centres. Although, where environmental costs are signiﬁcant,it is inappropriate to continue to include all environmentally related costs under the heading of ‘general overhead’,some environmentally induced costs will remain part of general overhead.The type of costs that cannot be directly traced or allocated to units of output include, for example: costs for new insulation of head-ofﬁce buildings; costs of past production that are clearly related to strategic management decisions of the whole company (e.g. environmental liability costs of products that have already been phased out). Figure 6.12 (Schaltegger and Müller 1998) illustrates the main steps in material ﬂoworiented activity-based cost allocation. It shows a two-step allocation process: ﬁrst, from joint environmental cost centres (e.g. an incinerator providing common environmental services) to the ‘responsible’cost centres (e.g.production centres 1,2and 3);and,second, from the responsible cost centres to ﬁnal cost objects (e.g.units of products C and D).After tracking and tracing, the costs of joint environmental cost centres, such as incinerators and sewerage plants,have to be allocated to the ‘responsible’cost centres and cost objects. Total input to production is 1,000 kg of material,200 kg of which are treated as waste in the incinerator. Total incineration costs amount to $800. Given these ﬁgures, if we assume,for simplicity,that every unit of waste causes the same costs,the treatment of one kilogram of waste will cost $4 ($800/200 kg = $4/kg).This relationship we will call the cost allocation key (or base). As a ﬁrst allocation step, costs of the incinerator have to be allocated to the three cost centres (allocation 1) based on the cost allocation key: $400 to cost centre 1 ($4/kg × 100 kg of waste) and $200 to cost centres 2 and 3 ($4/kg× 50 kg each).The cost key reﬂects the amount of waste produced by each cost centre. As a second step (allocation 2),cost-centre costs have to be allocated to the cost objects (e.g. products C and D). A second cost allocation key needs to be chosen for this allocation,one that reﬂects the separate costs of waste incineration that have been caused by each product within each cost centre (e.g.100% for the ‘dirty’product,product C,and 0% for the ‘clean’,or ‘green’,product,product D). At present,even in some ‘advanced’management accounting systems,many companies allocate the costs traceable to environmental cost (service) centres (e.g. an incinerator) ﬁrst to production cost centres and, second, to products. However, additional environmentally induced costs,associated with the ﬂow of raw materials and the waste emanating from production processes rather than a joint environmental cost centre (the incinerator in this case), are ignored. Yet some of these costs of waste could be saved and the proﬁtability of products increased substantially if less waste were created in the ﬁrst place. Waste uses manufacturing capacities, labour and increased administration. If no waste were produced, depreciation would be lower and the total salary bill would be reduced. Such greater efﬁciency in resource usage and productivity would lead to less waste and an improved ﬁnancial bottom line.Furthermore,as illustrated above,improved resource productivity has the potential to reduce labour cost and thereby increase labour productivity. The question to be answered concerns what activities (e.g.purchasing,production and incineration) are related to the generation of waste. For instance, in the example shown in Figure 6.12, 200 kg of the 1,000 kg input were purchased only to be emitted from the production process as waste, without creating any value. In this case, waste has caused a 25%—[(1,000 – 800)/800] × 100—increase in purchasing cost, higher costs of machinery depreciation and extra administration costs. Neglecting to track and trace these costs results in underestimation of the total costs of cost centres and cost objects (see Section 6.3) because such costs are assumed in the general corpus of ‘period’ costs, not being linked with environmental cost centres, production processes or products.Therefore, in conventional management accounting procedures,a third step whereby indirect costs are allocated to the cost centres and to cost objects is needed. Figure 6.13 illustrates this third step of allocation on the basis of the above example illustrated in Figure 6.12. Recall that 1,000 kg of raw material inputs were purchased to create 800 kg of products.Of the 200 kg of waste,100 kg are caused in step 1,and 50each in steps 2 and 3. The ﬁrst and second allocation steps traced, tracked and allocated the costs of the environmental cost centre ($800 for incineration) to cost centres and objects. However, some environmentally induced costs have been excluded.The inputs that were purchased ‘just to be thrown away’,without creating any value,have an associated opportunity cost. As waste is not inevitable, or can be reduced, the inputs could have been used to create economic value. The value forgone, measured in terms of economic value added, contribution margin or proﬁtability,represents the opportunity cost.Therefore,management should also track,label and account for these other environmentally induced costs, such as increased depreciation and higher costs for staff—costs that are not directly traceable to joint environmental cost centres but costs, nevertheless, that vary with the amount of production activity.Figure 6.13 takes these environmentally induced costs into consideration and illustrates that a third allocation step is necessary. In the case presented it is assumed that the environmentally induced overhead costs of $9,000are all variable,that the volume of waste in kilograms is the agreed basis for linking costs to cost centres and that the overhead costs per kilogram of all three cost centres are the same. A total of 1,000 kg of material are processed in cost centre 1; 900 kg in cost centre 2; and 850 kg in cost centre 3 (see Table 6.7).If the total amount of processed material (e.g. 1,000 kg of 2,750 kg for cost centre 1) is taken as the allocation key,allocation rates for total environmentally induced overhead costs are: cost centre 1, 36.36%; cost centre 2, 32.73%; cost centre 3, 30.91%.Thus, the total overhead costs ($9,000) per cost centre are: cost centre 1,$ 3,273;cost centre 2,$2,946;cost centre 3,$2,782. In this case the environmentally induced indirect (overhead) costs are calculated as follows.In cost centre 1,100 kg of waste from the 1,000 kg processed is directly related to production in cost centre 1. Economically, however, the waste that later shows up in cost centres 2and 3causes additional costs in cost centre 1because good input is spoilt.In total, 200 kg (100 kg + 50 kg + 50 kg) of the 1,000 kg of inputs purchased (20% of inputs) cause indirect costs in cost centre 1.Hence,in this case,the additional,environmentally induced indirect costs at cost centre 1 amount to $654.6 (20% [200 kg of 1,000 kg] of $3,273). In cost centre 2, 900 kg of material enter cost centre 2 (the 1,000 kg of initial inputs minus the 100 kg lost as waste at cost centre 1), but only 800 kg will ﬁnally leave the company as good products.Thus, 100 kg of the 900 kg (11.11%) of inputs that enter cost centre 2 cause waste.The total overhead costs allocated to cost centre 2 are $2,946.The indirect waste costs amount to $327.3 (11.11% [100 kg of 900 kg] of $2,946). The costs in cost centre 3 amount to $163.6 (5.88% [50 kg of 850 kg] of $2,782). In summary, as calculated, recognising environmental costs as activity-based costs to be traced or allocated to cost centres,the total of all environmentally induced indirect costs amounts to $1,145.3 ($654.6 + $327.3 + $163.6). The total direct costs of the environmental cost centre (the incinerator) amount to $800 whereas the total of all indirect environmental costs amount to $1,145.5.The total of all environmentally induced costs is shown in Figure 6.13 for each cost centre as well as for the whole company.The cost total for cost centres to absorb has increased from the $800 cost of the incinerator to $1,945.5because of the recognition of additional variable indirect environmental costs. As the above example shows, the three-step allocation of environmentally induced indirect costs can provide motivation for management to reduce material ﬂows thereby realising large efﬁciency gains as well as improving the company’s environmental record (see also Burritt 1998). In other words, when environmentally induced indirect costs are allocated on the basis of material ﬂows, information provided to cost-centre managers encourages them to improve the eco-efﬁciency of the company as well as to support environmentally benign methods of production. An empirical example from the German metal industry is provided in Table 6.8.Other empirical studies demonstrate that savings of a factor of between 6 and 10 times are available for realisation and are highlighted if investment decisions for corporate environ mental protection are based on information using comprehensive allocation rules (see e.g. Fischer et al.1997;von Weizsäcker et al. 1997). Up to this point,the volume of waste has been taken as the allocation key,or allocation base,for environmentally induced costs.However,as shown in the next section,this might not be the most appropriate ﬁgure in all cases.

6.4.3 Allocation keys The choice of an appropriate allocation key (or base) is crucial in order to obtain comprehensive information for environmentally adjusted management accounting.The advantages and pitfalls of different allocation keys have already been extensively discussed in the accounting literature (see e.g. Burritt 1998;Young 1985).This section is therefore kept rather brief. Allocation keys have been described as arbitrary and ‘incorrigible’ (Thomas 1974), because no theoretical justiﬁcation can be provided for any particular key.Allocation keys are a matter of management and accounting judgement, based on knowledge of a particular business and the situation it faces.Under conventional accounting practices,it is important that any allocation key chosen is closely linked to actual environmentally related costs.In practice,the following four groups of allocation keys are widely discussed in relation to environmental issues: A The volume of throughput (materials,emissions and waste treated) A The toxicity of emissions and waste treated A The environmental impact added (volume multiplied by the impact per unit of volume of the emissions treated) A The induced costs associated with treating different kinds of throughput (materials and emissions treated)

One possibility is to allocate environmentally induced costs based on the volume of hazardous waste caused by each activity or cost object (e.g.volume treated per hour,waste per kilogram of output and emissions per working-hour of a machine).This key may be inappropriate in cases where the capital costs (interest plus depreciation of construction costs) as well as variable operating costs are not related to the total volume treated.Owing to higher safety and technological requirements, construction costs and variable costs often increase exponentially the higher the degree of toxicity of the waste treated.In many cases, these additional costs are caused by only a small percentage of the overall waste. Thus,the costs of a waste treatment or prevention facility are often not clearly related to the overall volume of waste treated but rather to the relative amount of cleaning required, depending on the type of waste. Another possible key is to allocate environmental costs according to the potential adverse environmental impact that would have been added by the treated emissions.The environmental impact added is calculated by multiplying the volume of waste by the toxicity of the emissions. However, this allocation key may also be inappropriate as the costs of treatment are not always related to the environmental impact added. Hence,following conventional practice,the choice of an allocation key has to be based on each speciﬁc situation. Allocation keys should be chosen on the basis of the speciﬁc costs caused by the different kinds of emissions treated.Sometimes a volume-related key best reﬂects the costs caused,whereas in other cases a key based on environmental impact is more appropriate.The appropriate allocation key depends on the variety and the kind of materials and emissions treated or prevented. Also, the time of occurrence may be relevant (past, current or future costs) because necessary data may for example not be available (e.g.the environmental impact created).

6.4.4 Conclusions Companies have faced substantial increases in environmentally related costs over the past decade.As a result,there is more to be gained in ﬁnancial terms from corporate environmental protection. However, many ﬁrms are still not aware of the potential savings they could achieve through the introduction of environmental protection measures. Four reasons account for this gap between potential and realised gains,as follows. A Management often underestimates the actual amount of environmentally induced costs because most management accounting systems still do not isolate environmentally induced costs in the accounts. From a management perspec tive it makes sense to track and trace environmentally related costs to help determine how much the company is affected ﬁnancially by environmental issues. A The need for compliance with environmental protection regulations and measures is regarded as the sole cause of environmentally induced costs.This view has its origin in the fact that environmental costs are often thought of as the costs of installing and operating end-of pipe devices and other pollution abatement technologies. But there is a need for managers to expand the deﬁnition of environmental costs to include the costs of ‘wasted’ materials and energy. Associated with this expanded deﬁnition,which adds eco-efﬁciency issues to the need for compliance with standards, is the need for managers to consider environmental issues as a way of reducing overall costs, at the same time as reducing environmental impacts of corporate activity. Consequently, environmental protection includes all measures to reduce use of material and energy resources as well as end-of-pipe compliance technologies that lead to costs because of the need to treat ‘excess’material (or waste). A Environmentally related costs are considered to be general overhead costs. However, under conventional management accounting, in order to calculate product contribution margins more accurately, there is a need for environmentally related costs to be comprehensively tracked and allocated in the ﬁrst place. A Indirect costs of material and energy ﬂows causing environmental impacts are neglected. In many cases, investment appraisal of environmental protection projects compares the direct (capital investment) and operating costs (labour and maintenance) of environmental protection with only the direct costs of waste and sewerage.Overhead cost savings,related to the environmental impacts of reduced material and energy ﬂows,are often ignored altogether.

As a consequence, management accountants have four responsibilities with respect to environmentally induced costs. First, any environmentally induced costs have to be adequately deﬁned,tracked and traced. Second,only those costs that relate to the same production period should be treated as period costs (i.e.all past,current and future costs that relate to current production should be considered together). Third, environmentally and economically responsible and accountable management needs to allocate environmentally induced costs to ‘responsible’ cost centres and cost objects.Indeed,as Burritt (1998) argues,companies seeking sustainable outcomes can give a corporate commitment to the introduction of an internal environmental cost allocation system designed to reduce environmental impacts by penalising poor environmental performance and risk-taking by ‘responsible’cost centres.Activity-based costing helps to deﬁne the cost centres and objects related to production and management activities. Fourth, there is no general rule for the ideal allocation key, but there are a number of reasons why allocation takes place, and these help determine the keys chosen (Zimmer man 1979).The suitability of an environmental cost allocation key depends on the variety and kinds of material ﬂows and emissions prevented or treated.However,as far as possible, the allocation key should reﬂect the costs actually caused by an activity. The implementation of these steps does not require a revolution in conventional management accounting but, from a business perspective, it is necessary. By inference, implementation of these steps implies the need for material ﬂow-oriented and energy ﬂoworiented ecological accounting to be introduced. Such a change may meet with opposition, but it makes sense.This broader deﬁnition of environmental costs and changes in the way cost allocation is used to discourage activities with highly unfavourable environmental impacts can lead to a redistribution of power towards sustainable outcomes for any company.Without commitment,understanding and a desire for suitable change and learning, line managers with currently proﬁtable products will tend to object to the introduction of allocation rules whenever they expect losses from those rules to affect their welfare.Also,in comparison,the ‘internal company lobby’for cleaner activities,processes and products may be neither well established nor large enough to carry weight in decisionmaking. Environmental management accounting helps to recognise and address these issues (United Nations 1999). Environmental impacts of company activities frequently have a long-term impact. Capital budgeting and associated investment appraisal techniques are speciﬁcally designed to take long-term ﬁnancial aspects of investments into account. Clearly, it is important that long-term environmental outcomes are considered in long-term project appraisal. Therefore, the next section examines investment appraisal as a tool for managerial decision support and contemplates how environmental considerations should be addressed.

6.5 Consideration of environmentally induced financial effects in investmentappraisal 6.5.1 General considerations Investment appraisal (the ﬁnancial measurement phase in capital budgeting) is one of the most important managerial activities. Other terms used in this context are ‘economic feasibility analysis’, ‘total cost assessment’ and, in an environment-speciﬁc sense, ‘cost– beneﬁt analysis’(Spitzer et al.1993:7).The basic notion behind investment appraisal is to provide ﬁnancial information that facilitates a comparison between different investment alternatives. It is not the intention here to review the various methods of investment appraisal (see e.g. Götze and Bloech 1993; Horngren et al. 2000) but to discuss how environmental issues are best included in investment appraisal. Gray (1993: 153) suggested there is no best way, because each method needs to take environmental considerations into account:‘Just as there is no single method of evaluating investment opportunities, there can be no single way of incorporating environmental considerations into investment decisions’. Nevertheless, the task of investment appraisal has been complicated by the increasing importance and uncertainty of environmentally induced future costs (Box 6.10; see also Epstein and Roy 1998).Although not discussed here, a similar argument holds true for ﬁnancial investments (see e.g. Knörzer 1995; Schaltegger and Figge 1997, 1999). An outline of the shortcomings of methods such as the payback period, annuity method or the internal rate of return can be found in any textbook on corporate ﬁnance (see e.g.Brealey and Myers 1991). The basic goal of investment appraisal is to calculate the net effect of the beneﬁts and costs of different investment alternatives. Any determination of eco-efﬁciency is one necessary step towards sustainable development, which requires that environmentally induced costs and beneﬁts be considered.This section will therefore focus on environmental costs including quantiﬁable economic beneﬁts caused by cost savings. However, this is not meant to imply that environmentally related beneﬁts such as higher sales or a better company image are not relevant. The following approach to investment appraisal is related to total cost assessment, a method that has been advocated by the US EPA to evaluate capital investments.Total cost assessment attempts to describe a long-term,comprehensive ﬁnancial analysis of the full range of internal (i.e.private) costs and savings of an investment (White and Becker 1992; Spitzer 1992:7;Spitzer et al.1994).The following steps towards inclusion of environmental considerations in investment appraisal can be identiﬁed: A Expansion of the cost inventory A A comprehensive allocation of costs A Extension of the time-horizon and the use of long-term ﬁnancial indicators (net present value and option value)

An expanded cost inventory considers four categories of costs: A Direct costs (capital expenditures,operations,maintenance,expenses,revenues, waste disposal and energy) A Indirect costs (administrative costs,regulatory compliance costs,training,monitoring,insurance,deterioration and depreciation) A Potential liabilities (contingent liabilities,potential fees,ﬁnes and taxes) A Less tangible costs (costs saved by not polluting and by having a better product image and better employee relationships)

The calculation of direct costs forms a necessary part of any method of investment appraisal.However,environmentally related costs are sometimes hidden in general overhead costs and therefore are not considered separately. In particular, indirect costs, potential liabilities and less tangible costs are often difﬁcult or impossible to identify, measure and allocate. Nevertheless, these costs can very much affect the cost structure and thus the proﬁtability of an investment. Hence, in many cases, it may actually be worthwhile to put some effort into identifying these costs. It can be concluded that,depending on the deﬁnition used for environmental costs,as well as on the rules of allocation applied, environmentally related costs can substantially affect investment decisions and can determine which investments will be perceived as economically favourable. Many economically proﬁtable investments, especially for environmental protection, would not be accepted if management were to rely on traditional allocation rules that consider only the direct costs of environmental cost centres (e.g. incinerator costs).As discussed above, three steps of a comprehensive allocation system can be distinguished: A The allocation of costs of joint environmental cost centres (e.g.incinerators) to production cost centres and activities A The allocation of costs of production cost centres to cost objects A The allocation of environmentally induced indirect costs of excess material used to production cost centres and cost objects A further step on the path to incorporate environmental considerations into investment appraisal is to extend the time-horizon and use long-term ﬁnancial indicators. Environmental investments often have longer payback periods than other investments because the relevant beneﬁts and losses often accrue many years in the future. However, this is not always true, as investment examples with very short payback periods in the Australian confectionery industry show (Box 6.11). Use of payback,as illustrated in Box 6.11,emphasises the need for an investment to pay back within the shortest time possible. Once the payback time has been reached, future cash ﬂows are ignored. Other investment appraisal techniques consider all cash ﬂows associated with an investment.Hence,the use of ﬁnancial indicators with a focus on longterm outcomes is essential, especially for assessing potentially high contingent liabilities and expected high future beneﬁts beyond the payback period. A second point is that managers need to be aware of possible long-term environmentally induced ﬁnancial impacts.For example,new regulations that require the internalisation of previous external costs can be introduced at very short notice and so keeping an eye on potential environmental liabilities through long-term ﬁnancial indicators is a necessary characteristic of good management. The USA ‘Superfund’ legislation—the Comprehensive Environmental Response,Compensation and Liability Act (CERCLA) of 1980—provides a well-known example as it shows the enormous, unexpected ﬁnancial impacts that may be caused by long-running environmental issues that suddenly catch the regulatory eye (see Section 7.5). Calculation of long-term ﬁnancial indicators will help managers to consider future environmentally induced ﬁnancial impacts in advance. In particular, two long-term ﬁnancial indicators have been discussed within the context of environmental accounting: A Net present value (NPV) A Option value The NPV is calculated by using equation [6.1]: n FtNPV = Σ [6.1] t = 0 (1 + r)n where Ft is the net cash ﬂow (cash inﬂow minus cash outﬂow) in time-period t r is the discount rate (the opportunity cost of capital) n is the number of periods

The opportunity cost of capital,or the costs of a non-realised alternate investment activity, is taken into account by discounting the net cash ﬂows in each period.The sum of all discounted net cash ﬂows determines the overall value of a project.Projects with a positive NPVshould be accepted unless non-ﬁnancial factors suggest otherwise.Likewise,projects with a negative NPV should be rejected. When environmental considerations are taken into account,it could be argued that the concept of discounting is fundamentally unethical because a lower value is assigned to the needs of future generations, as represented by the discounting of future cash ﬂows.This is in sharp contrast to the need to conserve assets for future generations because they have a high—rather than a discounted—future value. Economists argue that discounting is a necessary assumption for the discounted cash ﬂow method to function,but,acknowledging its ﬂaws, they propose the use of a lower social discount rate for environmentally related investments (e.g.Wicke 1998).Such environmental projects,designed to deal with problems that it is thought will become progressively more serious over time,then appear to be more attractive.Thus, with a lower discount rate, future costs appear to be more important and company investments need a longer time-horizon to pay off. However, suggestions for the omission of discounting and the manipulation of the discount rate are problematic,as the calculated results do not reﬂect the actual economic situation. Many of the long-term environmental problems that give rise to these complaints against the NPV investment appraisal criterion relate to events which,if they were to occur, might be very far-reaching, or catastrophic, in their effects. Consequently, the problem could be seen as undervaluation of the absolute beneﬁts to be derived from environmental services rather than any need to adjust the discount rate (Ahmad 1983). Any investment appraisal should indicate the full economic values of alternative investment opportunities. Other, non-economic, aspects might be considered separately but should not distort the economic analysis. In addition to the above environmental cost–beneﬁt considerations, the NPV method also has some problems from the point of view of economics (Box 6.12).First,it does not explicitly consider non-quantiﬁed and non-quantiﬁable effects. This is a weakness, especially for strategic management,where the potential for success has usually also to be evaluated with use of qualitative information.Second,as with any other method involving trying to evaluate future effects, much of the data used when calculating the NPV are uncertain. In other words: calculation of the opportunity cost of unrealised gains from environmental protection could conceivably be underestimated. To a certain extent,decision-makers can address these problems by considering the use of option value.The net present value (NPV) rule—invest if the present value of expected cash ﬂows is greater than the investment outlay or investment benchmark—implicitly assumes that a decision to invest is made immediately.It neglects the possibility of waiting to implement the decision until more information has come to light (the precautionary principle of sustainable development) and until some uncertainty about the future has been resolved. Real options valuation is a way of taking account of this possibility. Real options are ﬂexible approaches allowing managers to postpone, expand or contract investment projects over time (see e.g.Loderer 1996;Mostowﬁ 1997). An option represents a right,but not an obligation,to acquire expected future cash ﬂows by paying the investment outlay and can thus also be deﬁned as the right not to undertake a follow-on investment.The option value takes the NPV as well as the strategic value of investments into account (see Brealey and Myers 1991;Dixit and Pindyck 1993,1995). Strict application of the NPV method very often ignores the value of creating or exercising options or the costs of impeding future options,because the NPV method was conceived for the valuation of bonds that have constant,known future cash streams over a determinate future period.To choose a project with a positive NPV over one with a negative NPV might remove the possibility of a follow-on project with a positive NPV.For example, a follow-on project from the initial, positive-NPV, project may become too expensive or may lose feasibility because of environmental degradation arising from the initial project (degradation that may not have occurred under the alternative, negativeNPV,project ﬁrst proposed;Box 6.13). Some investments create a special value within the context of other company investments. Sometimes, an investment that appears uneconomic on its own might be crucial if, in fact, it creates an option that enables a company to undertake other proﬁtable investments in the future.A negative NPV today only shows that the project in isolation from other company activities will not pay.However,the project could be very important within the context of any future projects a company may envisage.This effect is called the ‘strategic value’of a project and can be expressed as a call option. Because of emerging scientiﬁc evidence about environmental problems,new issues with large impacts on an industry come to the fore very quickly. Many crucial environmental projects (e.g. the launch of a ‘green’ product line or the introduction of an integrated environmental management programme within a company) are strategic in nature because of their long time-horizon as well as their effect on public perception (e.g. the signals they send out to the general public and to customers).The ability to be able to adapt quickly to new circumstances also clearly represents an option value. Information about ability to adapt is important for strategic management. As with ﬁnancial options in ﬁnancial markets, the value of a strategic option increases with the variability of a project’s cash ﬂows (the risk of the project).With stricter legislation and increasing risk,investments to prevent environmental liabilities or to introduce ‘green’ product lines in order to create new markets have an option value.They entail the option to be more competitive in the future. The strategic value of going further than merely complying with current regulations increases with the probability of future tightening of environmental laws.An option value can, therefore, be greater than the NPV of pollution prevention equipment (Dixit and Pindyck 1995;Koechlin and Müller 1992). It has been shown above that using NPV as the main investment appraisal technique may lead to incorrect strategic decisions because the value of future options are ignored. Another issue is that cash ﬂows in the distant future also tend to be underestimated if the option value is not also considered. Future free cash ﬂows are addressed in the next section. 6.5.2 Total environmentally induced costs:an example The following example shows how consideration of environmentally induced indirect costs of material and energy ﬂows can substantially inﬂuence the result of an investment appraisal when compared with the allocation method most frequently employed.Calculations are based on the example used earlier (see Section 6.4.2 and Fig.6.13 on page 133). The total amount of environmentally induced costs is $1,945.40,$800 of which are direct costs of the environmental cost centre (i.e.the incinerator) and $1,145.50are indirect environmental costs. As shown in Table 6.9,when neglecting the indirect environmental costs related to raw material ﬂow,a waste-reduction investment costing $1,700to reduce a quarter of the waste is considered to be very unattractive (not proﬁtable). The direct cost savings are calculated at $200 per annum (a quarter of the direct incineration cost of $800). Assuming the waste-reduction investment is totally ﬁnanced by credit (e.g. at an 8% interest rate), no change in ﬁnancial risk structure and a depreciation period of ﬁve years, the sum of discounted net reductions of costs and the NPV would amount to $399 and –$1,301, respectively. The proﬁtability index of the investment is negative (–76.51%) and, based on NPV or the index, the investment is therefore not worth accepting. The result of the investment appraisal changes when the environmentally induced indirect costs of cost centre 3 ($163.60) are taken into account.The proﬁtability index of the waste-prevention measure remains negative (–38%), as seen in Table 6.10. Nevertheless, only if we take into account the indirect costs of cost centre 3, as in Table 6.10, can we illustrate the underestimation of actual, total environmentally induced costs.Wastereduction investments in cost centre 3 are attractive as they also stop costs related to material ﬂows (i.e. waste) in earlier cost centres. By preventing 50 kg of waste in production step 3, costs can also be reduced in cost centre 2 (50 kg instead of 100 kg of processed waste) and cost centre 1 (150 kg instead of 200 kg of processed waste).Thus, the prevention of 50 kg of waste in cost centre 3 would reduce costs by $690.80 ($363.60 in cost centre 3 plus $163.60 [50% of indirect waste costs in cost centre 2] plus $163.60 in cost centre 1). The total reduction of all environmentally induced direct and indirect costs of the waste-reduction investment amounts to more than a quarter of the total environmentally induced costs ([$1,945.50]/4 = $486.38). However, the sum of $690.80 could be an overestimation of the costs that can actually be reduced by the material-ﬂow reduction (i.e. waste prevention) investment if some of the environmentally related indirect costs were ﬁxed costs (e.g. cost of administration to comply with regulations) and if they did not decrease in line with the partial reduction in waste emitted. For simplicity, a cost reduction of $600 per annum is assumed in Table 6.11.The sum of discounted net reductions of costs is now $1,996 and the NPV is $296.This results in an acceptable proﬁtability index of 17.43%.In these circumstances,with cash ﬂows deﬁned correctly,the NPV criterion indicates that the correct decision is to accept the investment.

6.5.3 Opportunity costof unrealised environmental protection: an example As discussed at the beginning of this chapter,consideration of opportunity costs can show management whether it has neglected (or would neglect) potential gains in economic efﬁciency because of unrealised material-ﬂow avoidance and pollution prevention. Opportunity costs of unrealised environmental protection occur if, for example, an omitted waste-prevention project would have reduced the total costs assigned to a cost centre or a cost object.In Figure 6.14these opportunity costs are determined on the basis of the same theoretical example used throughout this chapter. The function of perceived total costs, Ctot, in Figure 6.14 represents the perceived environmentally relevant costs without consideration of the environmentally induced indirect cost of the material ﬂow.The perceived total costs are the sum of the costs of environmental impacts (CEI) and the costs of environmental protection measures (CREI). The company will, therefore, choose the optimal point on this curve, Ctot 0 (Q0), at environmental impact Q0. Sliding to the left on this curve, an additional investment in environmental protection which would reduce environmental impacts to Q2 is perceived to have a negative NPV of $1,301,as in the example shown in Table 6.9. However, taking the environmentally induced indirect costs into account, the actual total cost curve in Figure 6.14 is C0real tot. Opportunity costs of environmental protection can be a result of not recognising future environmental costs, insufﬁcient differentiation of environmentally induced costs and inappropriate cost allocation. At environmental impact Q0, the actual total costs,Creal tot(Q0),are not minimised so that opportunity costs of unrealised environmental protection occur for the company. Opportunity costs of unrealised environmental protection are determined by the difference between the minimal total costs, Creal tot(Q2), and the actual costs borne, Creal tot(Q0).These opportunity costs can be reduced by increased investment in environmental protection,thereby reducing the level of environmental impacts to Q2.Once all environmentally relevant costs are included,the waste-prevention investment has a positive NPV of $296 (see Table 6.11) which is equal to the opportunity cost of environmental protection at point Q0 compared with point Q2. 6.5.4 The economic attractiveness of corporate environmental protection:an example It may seem surprising that cost savings and positive NPVs related to the reduction of throughput have often not been realised.However,the collection and analysis of relevant information comes at a cost.In the past,costs of environmental accounting systems were considered to be higher than the beneﬁts from being better informed. Establishment of an environmental information management system leads to ﬁxed costs that can only be borne if sufﬁcient economically relevant environmental information is provided. As discussed in Section 6.1,this is increasingly becoming the case. There may be an additional economic reason why managers refrain from considering speciﬁc environmental projects even though these projects show a positive NPV—capital rationing. As management capacities and capital are scarce, managers cannot possibly invest in all alternative proﬁtable projects at the same time. Only the most proﬁtable investments are pursued.Selection of the most proﬁtable investments requires a comparison to be made between them.In theory,the NPVof each marginal project decreases with every additional investment accepted,until the ﬁnal project has only a very small NPV(for reasons of simplicity a static view is taken,neglecting synergetic effects between different investment opportunities).Internal capital rationing guides managers to accept only those projects with the highest absolute NPVs. In Figure 6.15 it is assumed that internal environmental projects (e.g. waste reduction) generally have a lower NPV than do nonenvironmental projects (e.g. investments in production machinery) with the difference reducing the higher the number of investments made (the curve of the environmental projects is lower than that of non-environmental projects). On these assumptions,environmental projects become economically attractive once an NPV of NPV0 is reached.When the highest NPV the company can reach is NPV1 the optimal amount of environmental investments is PE 1 and of non-environmental investments PNE 1 . To determine the economic priorities of investing, the opportunity costs, or the NPV, of different possible investment projects should be compared. Depending on whether investment appraisal is undertaken in advance or whether the calculations are made to assess the investment afterwards (ex post audit),the most proﬁtable realised investment, or the most favourable planned alternative investment, will be used as a basis for comparison.In practice,management will often simplify the decision-making procedure by adopting a proﬁtability benchmark (e.g.15% in Table 6.12) for comparison. Based on the earlier example, the forgone waste-reduction investment is compared in Table 6.12 with the realised investment on the basis of an assumed internal, corporate proﬁtability benchmark of 15%. The NPV of the realised investment now amounts to $255 (15% of the invested sum of $1,700),which is $41 lower than the forgone cost reduction (i.e.the opportunity cost) of unrealised environmental protection ($296).The difference determines the inefﬁciency of the decision or the forgone NPV. In our example, the waste-prevention investment would have had a 2.43% higher proﬁtability index than the alternative project. In fact, corporate eco-efﬁciency could have been substantially improved by realising the wastereduction investment (see also Sections 6.1 and 6.2).

6.5.5 Option value Investments that lead to high sunk costs can determine a certain path for the company,at least for a few years. For example, if a pulp and paper manufacturer refrained from an investment in the prevention of toxic waste emissions it could steer the company towards very high path-changing costs in the future (for a discussion of the economic and environmental aspects of path dependency, see Goodstein 1995). History shows that environmental issues often emerge very quickly and that they can substantially alter the business environment, making it necessary to change from a less to a more eco-efﬁcient path. This rapid pace of change is why environmental projects often tend to be of particular strategic relevance for many companies (e.g.BHP’s Ok Tedi mining project;see Chapter 7). The investment appraisal approach discussed so far does not explicitly consider all potential and strategically relevant aspects of an investment. Opportunity costs of unrealised environmental protection have been deﬁned as the forgone beneﬁts of environmental protection which lead to internal costs and are reﬂected in the accounts. However, an environmental investment can produce additional, intangible, difﬁcult-tomeasure and future,strategically relevant,beneﬁts that exceed the beneﬁts from reducing environmentally related internal company costs. For example, the omission of a wasteprevention investment could cause high costs in the future if toxic waste were to become an issue of high social relevance. In an extreme scenario, the survival of the organisation could be threatened. One general way to consider such beneﬁts is to take option values into account (see e.g. Dixit and Pindyck 1995).The price of an option is determined by the NPV of a project, the exercise price for any follow-on investment, the time to maturity (the date when the decision has to be made), the risk of the project and the risk-free interest rate.The last three factors inﬂuence the discount rate to be used. One major difﬁculty with the calculation of real option values is the need for management to determine the exercise price for the follow-on investment in advance when,usually,there is no observable market price for the underlying asset of real options, when real options are often shared with competitors and when frequently there may be several real options with the same underlying asset (Crasselt and Tomaszewski 1998). In this context, methods of early diagnosis of company-relevant environmental issues can be of use (see e.g.Liebl 1996;Steger and Winter 1996).Not undertaking a project even with a negative NPV today might result in a follow-on project becoming either too expensive or not feasible (see Box 6.13).According to the theoretical analysis in Sections 2.3and 6.1.6and the illustration used throughout this chapter,potential company-relevant ﬁnancial effects of environmental impacts have often been underestimated in the past. Consideration of real option value where it can be calculated and included in analysis may well inﬂuence the outcome of an investment decision.However,the problem remains that option value is very difﬁcult to estimate.

6.6 The balanced scorecard

The success of managers can only be assessed in terms of progress made towards a given set of objectives (Kaplan 1995; Solomons 1965: 277). Hence, from period to period managers need to establish whether the goals established for their organisation,its business sub-units (e.g.divisions or departments) and for themselves have been achieved.Internal reports are drawn up to assist with this process.Information contained in internal reports can be used to identify whether performance is improving over time as well as whether performance is in line with strategic expectations. Reported information about performance also provides a basis for rewarding or penalising managers who are responsible for speciﬁed processes,activities or outcomes. Conventional management accounting provides feedback about the present and past performance of managers and segments of a company (e.g.divisions).Some accounting tools also provide information about expected future developments for management decision-making and planning (e.g. NPV, real option value analysis and operations budgeting).However,in general,internal reporting about strategic performance is not well developed within conventional management accounting,although the notion of strategic management accounting has received attention in the 1990s (see e.g. Ratnatunga 1999; Smith 1995). One tool of analysis that has been designed to provide information about performance at a strategic level has recently become popular under the name of the ‘balanced scorecard’ (Kaplan and Norton 1996).As the name implies,a balanced scorecard provides a selected set of performance measures that,when taken together,show whether a company,its subunits and its individual managers have improved their (past) performance across a range of activities and outcomes (see also Bennett and James 1999for a discussion of sustainable measures of performance). Two important questions are raised by the idea of a balanced scorecard: A Should relative (e.g.ratios) or absolute measures of performance be used? A What types of performance can be measured and integrated? Chambers (1966:87) provides a good explanation of the reason why ratio scales,such as eco-efﬁciency measures,provide the most useful basis for performance measurement. He recognises that measurements can be classiﬁed into nominal,ordinal,interval and ratio scales.Nominal scales categorise data by deﬁnition (e.g.emissions of gas 1,carbon dioxide [CO2],and gas 2,nitrous oxide [NOx]),but with nominal measures there is no way to rank these two properties simultaneously, as they are independent of each other. Ordinal measures take a single property,say CO2 emissions,and rank performance by position in a series;for example,company 1 has 10 sites emitting CO2 gas whereas company 2 has 8 sites,and so on. Interval scales provide a greater degree of measurement precision by using equidistant points on a scale to represent equal differences in the property being measured; for example, site 1 emitted 20,000 tons of CO2 this month, 25,000 tons of CO2 last month, and 30,000 tons the month before that. Provided that equal distances (e.g. an increment of 1 ton of emissions between 20,000–25,000 tons is the same as an increment of one ton between 25,000–30,000 tons) represent equal differences in the property being measured then interval scales will have a precise meaning. Finally, ratio scales have the characteristic that, with the base value taken as zero, the ratio of any series of measurements in the scale remains constant for any change in the deﬁned magnitude of the unit (Chambers 1966: 94). For example, the measurements of two weights bear the same relationship to one another whether those weights are expressed in ton or pounds,and the measurement of two ﬁnancial magnitudes should bear the same relationship to one another, whether expressed in terms of sales revenue or assets at different points of time.The advantage of using a ratio scale is that for the purpose of classifying performance measurement every object can be classiﬁed uniquely by the number assigned to it on the scale. One key consideration of the concept of the balanced scorecard is whether these different performance measures can be compared in any meaningful way. The balanced scorecard represents a management system that relates four basic modules to each other in order to support the implementation of the vision and strategy of the management (Fig. 6.16). A balanced scorecard has a number of characteristics.It: A Measures a set of key performance indicators (e.g.ﬁnancial and environmental) A Speciﬁes goals and measures goal achievement in similar terms (e.g.in terms of environmental impacts and economic value added) A Removes the focus on a single short-term measure of ﬁnancial results such as return on capital employed,residual income or economic value added A Provides physical as well as ﬁnancial measures of performance Furthermore,the balanced scorecard provides a strategic action process with the following four steps (Table 6.13): A Formulation and implementation of vision and strategy A Communicating and linking A Business planning A Strategic feedback and learning From an environmental perspective,one advantage of balanced scorecards is that they have an emphasis on long-term strategic performance as well as on short-run measures of performance.A balanced scorecard supplements traditional short-run ﬁnancial performance measures with lead and lag criteria that measure performance from the perspective of long-term corporate strategy (Box 6.14).Conventional performance measurement systems emphasise lag indicators that monitor what has happened in the past within an organisation (Corrigan 1998: 30). An increasing focus on value-adding has shifted performance measurement principles towards lead reporting—the monitoring of what is happening now and possible links between lead indicators and potential future consequences for a company. The need to use more than one measure of performance has long been recognised as being essential to achieving business success. Solomons (1965: 277ff.) identiﬁed seven areas of performance requiring measurement as a basis for maintaining control of divisionalised companies: A Financial A Productivity A Marketing effectiveness A Product leadership A Personnel development A Employee attitudes A Public responsibility His aim was the development of an integrated set of measures designed to assess the many facets of business performance. Kaplan and Norton’s balanced scorecard extends Solomons’s analysis to include corporate strategy. For Kaplan and Norton, a balanced scorecard puts strategy and vision, not management control, at the centre of analysis. It establishes goals but assumes that people will adopt whatever behaviour and actions are necessary to arrive at those goals rather than have their behaviour tightly controlled. Instead of tight control,with a balanced scorecard measures of performance are designed to pull people towards an overall corporate vision (Kaplan and Norton 1996). A balanced scorecard is a useful tool for promoting awareness both of the ﬁnancially induced and of the physical aspects of environmental management. It provides the opportunity to measure ﬁnancial aspects of corporate environmental performance and, once a top management commitment has been made to integrate the environment into decision-making, planning and control, a balanced scorecard forces managers to decide about the relative weighting to apply to ﬁnancial and environmental performance. Each company has to decide whether environmental performance should receive a high or a low weighting. Environmentally sensitive industries, such as mining, petroleum and chemicals, might be expected to include aspects of the environment in their ‘balanced’ performance measures. Kaplan refers to one petroleum company that ties 60% of its executives’bonuses to a weighted average of four ﬁnancial indicators—return on capital, proﬁtability, cash ﬂow and operating cost. It bases the remaining 40% of bonuses on indicators of environmental responsibility, customer satisfaction, dealer satisfaction and employee satisfaction (Kaplan 1992). At this point, no agreement exists on the appropriate set of environmentally induced ﬁnancial measures and related environmental performance indicators to include in a balanced scorecard.It might be expected that similar industries would tend to use similar measures.However,in practice,diverse measures are being used by similar organisations. Recent attempts have been made to encourage a degree of standardisation in ﬁnancial measurement of environmental performance. For example, the recommendations of the Sustainability Reporting Guidelines, an initiative of the Coalition for Environmentally Responsible Economies (CERES) (GRI 1999) are shown in Table 6.14. The guidelines do provide two useful speciﬁc links between ﬁnancial and other types of performance information.First,organisations are encouraged to report normalised data with use of appropriate normalising factors taken from the ‘Proﬁle of the reporting entity’ (GRI 1999:9).Second,in line with the argument above,reporting of information in ratio form (e.g.eco-efﬁciency indicators) is suggested as a useful,concise method to adopt.These foundations will assist transparency and accountability processes within organisations. When implementing the balanced scorecard some rules may be helpful to secure its usefulness (Box 6.15). Given a desire to integrate environmental strategy with other business strategies, it is important to translate environmental strategy into measures of performance that reﬂect a desire to reduce the use of materials and energy, to lower the proportion of waste (or residues) and to encourage environmentally benign process and product design. A balanced scorecard will facilitate this integrated approach to internal responsibility structures and accountability for management performance.

6.7 Summary

Rapid emergence of environmental issues has prevented many managers from being adequately informed about potential and actual environmentally induced costs and beneﬁts.In addition,most management incentive systems have not been adapted to reﬂect this new situation. Given the growing importance of environmentally induced costs and the decreasing marginal cost of providing information, it has been argued that the opportunity costs of unrealised environmental protection may be very signiﬁcant for many companies.Furthermore,potential cost savings from unrealised pollution prevention has not occurred because environmental protection has previously been deﬁned too narrowly in terms of end-of-pipe compliance-based technologies which merely cause additional costs for business. A change in this perspective is long overdue. Environmental protection should focus on the reduction of material and energy ﬂows and the related environmental impacts and economic advantages. Eco-efﬁciency provides a means of promoting this change in perspective.The argument that opportunity costs of unrealised environmental protection are relevant in practice has been supported empirically through a large survey of companies in Washington State (WSDOE 1992b, 1992c, 1993b). Acknowledgement, consideration and reduction of these opportunity costs of unrealised environmental protection is an imperative if corporate eco-efﬁciency is to be improved and the results communicated within the management structure in order to provide appropriate motivation and rewards for managers. Accounting practices, especially environmental accounting practices, are extremely important in providing support for the new perspective because they strongly inﬂuence management actions.An appropriate accounting for environmentally induced costs and revenues enhances future proﬁtability and reduces environmental impacts,ﬁrst,because relevant costs and revenues are actually reﬂected in the accounting system, and, second, because only relevant information allows the most proﬁtable management decisions to be taken. Every level of management is interested in slightly different information.Product managers require different information from that required by site,division or top management. Management accounting should provide relevant information for all levels of management. In addition, data should be related to the activities that inﬂuence corporate ecoefﬁciency and internal accountability most directly. It has been shown that many economically favourable investments are neglected if traditional rules of allocation and traditional methods of investment appraisal are applied without taking environmental issues into account.To improve corporate eco-efﬁciency the opportunity costs of environmental protection should be considered and compared with the opportunity costs of alternative investments. Also, strategic option value should be included in investment appraisal because in a growing number of companies environmental issues are,or are becoming,important for strategic management to be successful. How might such success be measured and reported internally? It has already been suggested (see Section 3.4) that a link between economic value added and environmental impact added would facilitate greater internal transparency about ﬁnancially viable environmental strategies. In this chapter the power of using ratio analysis (e.g. through eco-efﬁciency) for measurement and internal reporting has been conﬁrmed, and the growing interest in balanced scorecards that combine environmental and ﬁnancial indicators has been noted.The question now is to consider whether there have been any parallel developments in external ﬁnancial accounting. 1. ‘Conventional management accounting systems provide the foundation for all other accounting systems.’What are the main differences and links between conventional management accounting and environmental management accounting?

2. Baxter International Inc. (USA) established the following environmental goals in 1997 for 2005: global targets to cut packaging, energy consumption, toxic emissions to the air and the generation of hazardous and non-hazardous wastes. Relevant estimates are provided in Table 6.15. a What are the total estimated annual savings and cost avoidance for Baxter International from environmental improvements in 2005? b Are these savings driven by commercial or environmental management considerations? Discuss.

3. Use of the term ‘economic cost’ may be contrasted with use of the term ‘accounting cost’.The term ‘cost’is used in different contexts (and by different individuals) with different meanings. It is therefore useful to distinguish the accountant’s use of the term from the economist’s use. Accountants are concerned primarily with the proper recording and measuring of historical costs based on a uniform set of rules.They have developed a comprehensive system of recording and reporting data about costs, which is used by managers, investors, regulators and economists in carrying out their respective jobs.The data recorded in the books and records of a ﬁrm are referred to as ‘accounting’or ‘embedded’costs.Accountants have also developed various internal cost accounting rules concerning how costs should be allocated to various categories. Economists, on the other hand, have developed a comprehensive set of theories concerning cost, which they use to describe, explain and predict the behaviour of ﬁrms and individuals (e.g.consumers).The ﬁeld of economics thus provides the underlying theory of costs whereas accounting generally supplies most of the data that allow this theory to be applied in practice. Whereas embedded costs—the accountant’s measure of cost—are quite practical,readily available and fairly consistent from ﬁrm to ﬁrm,the economist’s idea of cost is more useful in analysing the critical decisions made by management and government. (Source: based heavily on text from Ben Johnson and Associates Inc. economic research and analysis;www.microeconomics.com/essays/cost\_def/cost\_def.htm) a What is the difference between an accountant’s cost and an economist’s cost? b How do ﬁnancial accounting costs and management accounting costs differ? c Do accountants and economists have different views of environmental cost?

4. How do full-cost accounting and full-cost pricing differ? Are they related? 5. External and internal costs: a How do external and internal environmental costs differ? Provide three examples of an external,and four examples of an internal,environmental cost. In your examples of internal environmental costs include examples of one direct, one indirect, one contingent and one intangible environmental cost. b Are the following contingent costs internal or external: natural resource damages;personal injury damages;economic loss damages?

6. What are opportunity costs? Why are they important to managers? What is the opportunity cost of not investing in environmental protection? Provide an example to support your answer.

7. Compare and contrast the following two statements. Are they concerned with achieving eco-efﬁciency,eco-effectiveness or both? A Businesses should sack the unproductive kilowatt-hours,tonnes and litres rather than their workforce.This would happen much faster if we taxed labour less and resource use correspondingly more. A The purpose of management accounting information is not accuracy for its own sake but to inﬂuence managers towards an organisation’s goals.By using cost allocation schemes to penalise poor environmental practices an organisation can encourage environmentally benign behaviour