Environmental Management for Industrial Estates

Information and Training Resources

United Nations Environment Programme
Division of Technology, Industry and Economics

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Prepared for United Nations Environment Programme
Division of Technology, Industry and Economics

by

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Institute for the Communication and
Analysis of Science & Technology

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Environmental Management for Industrial Estates:
Information and Training Resources

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INTRODUCTION

In 1997 UNEP published a Technical Report (No. 39) on *The Environmental Management of Industrial Estates*. At that time, to consider not only the environmental problems but also their solution at the level of an industrial estate was a relatively novel approach. As the Preface to the report states:

> *"While some initiatives have already been taken, […], they have not yet resulted in a consensus about how best to tackle the problems. Simply leaving the environmental problem to be resolved by individual enterprises is not enough as they, and the estate as a whole, are locked into a relationship of management interdependence."*

The goal of the report was to help estate planners and operators "tackle these problems". The report describes possible environmental impacts of industrial estates and suggests approaches that can be used to address environmental aspects associated with the construction and operation of an estate. Guidelines for new and existing industrial estates are provided that can be used as practical tools by estate managers to set the process in motion.

In the three years since the publication of the report, the number of industrial estates around the world has continued to increase. While it is unclear how many industrial estates exist worldwide today, a recent report points to there being more than 2000 industrial estates in China alone. At the same time progress has been made in raising awareness of the environmental dimension of industrial estates. For example, Technical Report No. 39 has been used as the basis for a series of training workshops held in Thailand, Singapore, Vietnam and China, and targeted at industrial estate managers in the Asian region. In addition, numerous projects on Eco-Industrial Parks are currently being carried out throughout the world. And several industrial estates have obtained certification of their environmental management systems through ISO 14001.

This new Manual, *Environmental Management for Industrial Estates: Information & Training Resources*, builds on the groundwork laid by Technical Report No. 39 and takes into consideration changes that have taken place since 1997. It has been written to respond to two principal needs:

- As a Resource package of information on industrial estates, their possible environmental impacts and some approaches for addressing them, it targets environment and industrial development practitioners (consultants and experts) who require background information about the particular environmental dimension of an industrial estate in order to complement their own expertise. In this respect the Manual will also be of value to those involved directly with the planning, construction and running of industrial estates, as well as to local and government authorities who are promoting industrial estates as a development tool.
- The need to introduce as widely as possible within the industrial development community the ideas behind the UNEP approach to environmental management for industrial estates has resulted in the material in the Manual being designed to provide the basis for putting together seminars, training courses and workshops on the theme.

The format of the Information & Training Resources Manual has been chosen so that it can evolve with time. The Background Paper gives an overview of the situation as it stands at the end of the year 2000. In order to avoid overwhelming the reader of the Background Paper with information on environmental tools and strategies that he or she may not need, a series of Briefing Papers has been provided separately covering topics such as Environmental Management Systems or Environmental Impact Assessments.

Case studies have been chosen to cover different approaches to managing environmental problems by industrial estates throughout the world. Each case study points to successes, as well as difficulties that have been encountered in addressing the environmental impacts of an industrial estate or network. Since this Manual is not supposed to be the definitive textbook but an introduction to the subject, not all aspects are covered in detail. A comprehensive bibliography and references to additional sources of information are provided at the end of the Manual. Since one objective of the Manual is to help with the creation of seminars and training activities, overheads and a suggested *modus operandi* for presenting the material are included.

As issues and environmental tools change, each section of the Information & Training Resources Manual will be added to and updated on a regular basis. However, in order to make it into a “living document”, readers are encouraged to inform UNEP of their experiences with using the Manual. This will allow it to be improved in order to respond better in the future to the needs of the industrial estates, and will create the basis for a network of stakeholders to exchange information and concerns about the environmental dimension of industrial estates.

GUIDE FOR USERS

This *Information & Training Resources Manual* on *Environmental Management for Industrial Estates* has been written with different people in mind – i.e. people who have different activities but who all share an interest in the environmental dimension of industrial estates.

They include –

- Consultants and experts, who specialise in environment and industrial development issues.
- Industrial estate managers.
- Entrepreneurs and private property developers.
- Representatives of government, at both a local and central level.

With such a disperse audience, each group is likely to use this Manual in a different way and will want to pick out the elements that are most relevant to their situation. The following recommendations may help to support this selection.

Starting with ***consultants and experts***, they may be expected to find the Manual useful in two different ways –

i. As a source of information about possible environmental impacts of industrial estates and specific approaches to reducing the environmental aspects.

ii. As background material for creating seminars and training courses / workshops as part of their work with the different stakeholders in industrial estate development.

Sections 3, 4, 5, 8, and 9 are relevant in the first case. It is worthwhile mentioning at the outset that this Manual is not designed to be a reference book. This is why the factual material has been separated into a Background Paper (Section 3), Briefing Papers (Section 4) and Case Studies (Section 5). From the Background Paper the reader will obtain a general overview of industrial estates as an economic development tool, as well as the environmental management dimension **as it applies to industrial estates**. The Briefing Papers supplement this material with in-depth information on environmental strategies and tools as they may be applied more generally. Case studies then provide an opportunity to analyse how these strategies and tools are being applied and are (or are not!) working. Finally, additional information and resources, such as Internet sites and organisations working with industrial estates, are listed in Sections 8 and 9 respectively.

Sections 6 and 7 need to be studied in addition for the situation where seminars or training programmes are envisaged. The Overheads (Section 6) are supposed to act as a basic support to the process, a source of material and ideas. Depending on the situation – e.g. geographical region, type of industrial estate development, type of audience, they should be adapted to suit the particular circumstances. Each of us has his or her own way of making presentations or carrying out training programmes and there is no single "right way" of doing it. In Section 7 we have merely attempted to suggest elements that can be used within different training activities. These elements have been inspired from previous workshops for industrial estate managers that seem to have been successful.

Turning now to ***industrial estate managers***, they may find themselves initially on the receiving end of a seminar or training course, where they will be exposed mainly to the material in Sections 5 and 6. However, as they start to work with their tenant companies to put in place or improve the environmental management system for their estate, they will find themselves needing to run seminars and training courses and their needs will be similar to those in case (ii) above. The amount of detailed information from Sections 3 and 4 that they will need to digest will depend on whether they decide to carry out the training programme alone or to work in collaboration with an external expert. Training is an important component of a management system such as ISO 14000 and an industrial estate manager will need to target very carefully the programme at a level that will be motivating to all of the participants from the tenant companies. Section 7 should be useful to industrial estate managers at this point in the process.

Entrepreneurs and private property developers, and ***representatives of local and central government*** are increasingly being faced with new demands from Eco-Industrial Development with respect to policies, planning issues, and legislation relating both to new and existing industrial estates. For them, the Manual will be useful initially as a participant in a seminar or training workshop, where they will encounter Sections 5 and 6 (probably in the company of some estate managers). Subsequently, they may find Sections 3 and 9 helpful as a way to increase their knowledge about the importance of environmental factors in industrial estate development and to know whom to contact for further information.

As we mentioned in the previous Section, the format of the Manual has been chosen so that it can evolve. We hope that those who use the Manual will also provide information in return to UNEP about their experience with using the Manual, and about new Case Studies that they have developed for use with it. In this way we believe that the Information & Training Resources Manual will continuously improve over time and respond better to the future needs of all stakeholders in industrial estates.

If you are a ...	**... you should not miss**
Consultant or Expert	Complete manual
Manager of an industrial estate	Sections 3, 5, 7 and 9
Property developer or Entrepreneur	Sections 3, 5 and 9
Government representative	Sections 3, 5 and 9

ENVIRONMENTAL MANAGEMENT FOR INDUSTRIAL ESTATES -

A BACKGROUND PAPER ON THE UNEP-DTIE APPROACH.

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1. INTRODUCTION

The purpose of this Background Paper is to describe an approach to environmental management for industrial estates that is being advanced by the Division of Technology, Industry and Economics of UNEP. This paper builds on an earlier publication – Technical Report N° 39 - *The Environmental Management of Industrial Estates* - that was published by UNEP in 1997.

The paper initially provides the reader with an overview of the role of industrial estates as an instrument for economic development. It discusses the growth of industrial estates and the economic advantages that they bring to communities and the companies located there. The paper also describes environmental impacts that may result from the development and activities of an industrial estate. Although a first impression may be that the environmental issues associated with an industrial estate and their solutions are the same as for any large factory, we shall show later that this is not the case. The paper goes on to suggest strategies and tools that can be employed to reduce environmental impacts from industrial estates and how some of the traditional approaches must be adapted to the particular problems engendered by the structure of an estate.

> In thinking about sustainability, we must carefully balance our human desire to live as we please with an increasing set of political, economic, social, and environmental constraints.
>
> R. Frosch, *The Bridge*, 1999.

While the word "environment" has been used extensively so far, it is important to realise that the environmental impacts cannot be considered in isolation, and the reader will find that health and safety issues are woven into the discussion of environmental questions. In addition, a presentation of the environmental aspect of industrial estates would not be complete without a consideration of the social, economic and policy framework within which the estate operates.

As an integral part of the *Information & Training Resources Manual on Environmental Management for Industrial Estates*, the Background Paper is designed to provide the reader with a basic understanding of the issues and a selection of strategies and tools for tackling them. In order to keep the Background Paper focussed on the specific case of industrial estates, more detailed information on the tools is presented in the Briefing Papers in Section 4 of the Manual.

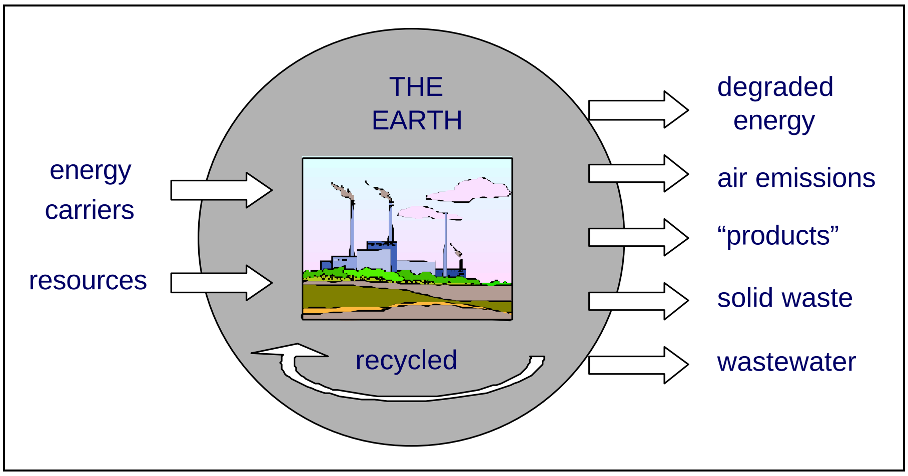
An important question to address now is why there is a need for an Information & Training Resources Manual on Environmental Management specifically targeted at industrial estates.

When industrial estates began to appear a little over 100 years ago in the industrialised countries, the objective was to promote, plan and manage industrial development in a systematic way. Since then the development of industrial estates has spread to most countries in the world, particularly in the second part of the 20th century, and an often-quoted estimate from 1996 puts the number of estates globally at more than 12,000 (UNEP, 1996a). Growth in the developing countries of Asia has been very rapid and recent estimates indicate that there may now be more than 20,000 industrial estates globally with 2,000 in China and over 500 estates in other parts of the region. The number of industrial estates is therefore clearly increasing worldwide with a particular interest in the industrialising countries.

> Relatively little attention has been paid to the environmental impact of industrial estates in most developing countries. Moving industry out of town all too often merely means shifting pollution away from existing residential areas, and where action is taken, this rarely extends beyond end-of-pipe treatment.
>
> UNIDO, 1997

Many of these industrial estates, however, are being planned, built and run with little concern for their impact on the environment and it is clear that significant environmental damage is occurring. It is important to understand that an industrial estate cannot be viewed in isolation from its surroundings (Figure 1). It receives its energy (typically in the form of coal, oil, or gas) and its material resources from the Earth. Its activities result in the creation of "products" and waste materials, and the release of degraded energy, i.e. heat.

Figure 1: The Industrial Estate viewed within its Surroundings.



These all return to the Earth – even the products at the end of their useful lives. Therefore, environmental damage results from the demand of the companies on the industrial estate for raw materials and energy, from the companies' activities in the estate, as well as from the products that they create. As we shall see later, environmental damage frequently results just from the existence of the industrial estate! Moreover, industrial estates are but one component of industrial development and what is true for the environmental impact of an industrial estate is also true for the whole of the industrial system – but on a different scale.

The Main Environmental Issues according to Agenda 21.

- ⇨ Protection of the atmosphere.
- ⇨ Sustainable management of land.
- ⇨ Combating deforestation.
- ⇨ Combating desertification and drought.
- ⇨ Sustainable mountain development.
- ⇨ Sustainable agriculture and rural development.
- ⇨ Conservation of biological diversity.
- ⇨ Management of biotechnology.
- ⇨ Protecting and managing the oceans.
- ⇨ Protecting and managing fresh water.
- ⇨ Safer use of toxic chemicals.
- ⇨ Managing hazardous wastes.
- ⇨ Managing solid wastes and sewage.
- ⇨ Managing radioactive wastes.

Some of the principal environmental issues today are shown in the Box above. An industrial estate manager may be forgiven for believing that the activities of an industrial estate are not relevant to many of these issues. At the same time, he or she will surely acknowledge the importance of hazardous and solid waste management and a responsible use of toxic chemicals within the estate.

However, IHDP (the International Human Dimensions Programme on Global Environmental Change) has pointed out (IHDP, 1999) that the so-called "global environmental issues" in reality can be divided into:

- ⇨ truly global environmental issues, such as climate change, ozone layer depletion, biodiversity loss or resource depletion,
- ⇨ universal practices that can lead to major environmental issues as a result of their cumulative effect, examples being water scarcity and water pollution (in particular the pollution of ground water), eutrophication, acidification, land degradation, and deforestation, and
- ⇨ regional environmental issues that may develop into global issues.

What may seem to be an appropriate practice on the scale of an individual industrial estate, therefore, may no longer be acceptable when it is carried out by an extremely large number of estates and the global dimension is considered. As a result an industrial estate manager needs to be concerned with a broad range of environmental issues associated with both the development and the operation of the estate.

Some examples of why these issues on the environmental agenda should be of concern to an industrial estate manager are presented in the Box on the following page. As can be seen, although it might be convenient to think about **local impacts** and **global impacts**, the two have an unfortunate tendency to become intertwined.

Of course such environmental impacts are not specific to industrial estates and may also result from the activities of any large factory. However, there are two main differences between the case of a single factory and an industrial estate:

1. An industrial estate combines large-scale and diversity in its industrial activities. It is unlikely that a single factory will cover as many different industry sectors, resulting in a wider range of environmental aspects and the possibility of synergies between effects.
2. The approaches available for addressing environmental issues are not the same in the two cases.

Let us tackle these two points in more detail. In a large company it is the factory manager, or the company CEO, who defines the environmental policy. The company possesses a unique corporate culture and usually establishes a Health, Safety & Environment structure with a responsibility to tackle such questions. As a result the company can function as a single entity to reduce its environmental impacts, for example by adopting

> "As far as I was concerned, CEO stood for chief environmental officer as well as chief executive officer."
>
> Edgar S. Woolard,
>
> *former chairman and CEO of Dupont*

Environmental Concerns for an Industrial Estate Manager.

- Protection of the atmosphere – in addition to more traditional problems of air pollution, the energy use pattern within the estate is directly related to emissions of carbon dioxide, while industrial activities within the estate can result in the release of other greenhouse gases or ozone-depleting substances.
- Sustainable management of land – this is associated with the choice of the location of the estate (e.g. is the estate built on high-quality agricultural land?).
- Combating deforestation - does the choice of location result directly or indirectly in deforestation? In addition, do the activities of the estate result in emissions to the air of pollutants that can lead to forest damage?
- Sustainable agriculture and rural development - the development of an industrial estate within a rural area may have a large impact on the local socio-economic framework.
- Conservation of biological diversity – the damage to ecosystems when an estate is built may result in loss of habitat and affect biodiversity in the region (e.g. the use of reclaimed wetlands or other sensitive areas). Releases into the environment around the estate of chemicals that are toxic, persistent and bio-accumulative can also have a negative effect on wildlife.
- Protecting and managing the oceans – releases of effluents from estates in coastal locations may lead to contamination of coastal waters and seas.
- Protecting and managing fresh water – the release of effluent into freshwater can lead to contamination rendering the water unusable for human consumption and leading to loss of aquatic species. In addition, an unsustainable use of freshwater for cooling purposes can lead to water scarcity for the surrounding areas.
- Safer use of toxic chemicals – accidental releases of chemicals can result in exposure in the workplace as well as putting the surrounding communities and environment at risk.
- Managing hazardous wastes – inappropriate treatment and/or storage of waste from an estate may lead to the accumulation of hazardous substances in the soil and in groundwater, resulting eventually in the transport of toxic substances into the food-chain. For an industrial estate manager the potential liability to the estate represents a serious problem to the estate's long-term economic viability.
- Managing solid wastes and sewage – improperly managed disposal of solid waste by landfill can result in leaching into the soil and groundwater. Landfill sites also have significant impacts on land-use and landscape since they require large amounts of land. Improperly treated wastewater and sewage from an estate can lead to water contamination and eutrophication and result in a scarcity of drinking water.
- Managing radioactive wastes – although it is highly unlikely that an estate will have highly radioactive wastes, industrial activities that result in low-level waste should not be overlooked.

preventive strategies such as Cleaner Production/Pollution Prevention, Eco-efficiency, and energy conservation. It may support this approach by making sure that its environmental management system works effectively, and is compatible with ISO 14001.

Many industrial estates are home to a large number of different companies that value, if not their independence, certainly their interdependence. This often results in there being a *cumulative* effect of the environmental aspects of the individual companies within the estate, but with each company tending to address its problems on an *individual* basis. However, this does not necessarily need to be the case - the proximity of the companies in an industrial estate can also be used profitably <u>if a way can be found to co-ordinate their activities</u>. A co-operative effort to address some of their, and hence the estate's, environmental problems by exploiting synergies between the companies can prove to be more effective and less costly than an individual approach.

Unfortunately, strategies and tools, such as those mentioned above, have been designed for the management structure in a single company and are difficult to apply directly to an industrial estate. The role of the manager of an industrial estate is very different to that of a company CEO in terms of how to introduce and implement environmental management, and he must find a way to balance the interests of the individual companies with those of the estate as a whole. As a result, he requires a new approach to environmental management that is specifically tailored to the needs of the industrial estates.

As was mentioned earlier, it is worthwhile to focus efforts on industrial estates because they are underpinning economic development strategies in many countries. As the authors of an article about industrial estates in the Asia-Pacific region have pointed out (US-AEP, 2000), industrial estates can provide leadership in the area of environmental performance to other sectors of industry and the economy.

⇨ Firstly, industrial estates provide a fertile ground for the introduction of better environmental practices because of their provision of common infrastructure, their close links with government (at least in many developing countries), and the location of a broad spectrum of companies, varying from (multi-)nationals to SME's.

⇨ Secondly, the position of an industrial estate in the global supply chain gives companies within the estate an opportunity to influence their local suppliers with respect to environmental performance, such as by requesting that they have ISO 14001 certification.

⇨ Thirdly, industrial estates bring together stakeholders from all parts of society, including manufacturing companies, local and national government, and local communities.

Therefore, when the important role of industrial estates within the modern economic development model is combined with their specificity in terms of the management of their environmental impacts, it is clear that they cannot be treated merely like any other "factory". Industrial estates require a different approach to environmental management that focuses on the community of companies in the estate rather than on the companies themselves.

2. A BRIEF INTRODUCTION TO INDUSTRIAL DEVELOPMENT

When we consider the beginning of industrial development, as we know it, we normally think back to the middle of the 1700's in Britain - to the start of the Industrial Revolution. One of the reasons why we consider this as a true "revolution" is that it brought about a fundamental change in the way that people manufactured goods (Jackson, 1996).

In the early part of the 18th century the British economy functioned mainly through local craftsmen working with relatively simple techniques and renewable resources. The population at the time lived in comparatively prosperous and well-organised villages or small towns that were linked in a form of network. In the woollen industry, for example, the wool was distributed by companies in the town to workers in the villages who spun it into the yarn that was then sent back to the company to be made into blankets and other goods. This phase of development is sometimes referred to as the "cottage industry" or the proto-industrial period.

As the century progressed one started to see in the woollen industry the gradual arrival of textile mills – the first factories – located near rivers and powered by water. The first real textile mill was constructed around 1720 and employed some 300 people (Clow, 1972).

However, starting around 1750 a major change in the economy occurred to one in which manufacturing became concentrated in factories using mainly mineral resources as raw materials. These factories were located where raw materials – such as coal, iron ore, or salt – were found naturally, or where transport was unproblematic.

The requirements of mechanisation meant that the workers needed to live near to the factory so that the workforce could be organised to take full advantage of the new machines. As a result, in a short period of time, industrial towns grew up around the factories.

Of course such an important change in the way that work was carried out had many major impacts, not least of which was the need for an efficient transport system to serve the needs of the factories and the new towns. This need was filled initially by canals and rivers, and later by railways. Another impact concerned the effect of these factory towns on the surrounding natural environment. We sometimes think that environmental concerns are a recent phenomenon. However, the first cited example in Britain of an enterprise being closed as a result of environmental pollution dates from the early 19th century (Clow, 1972)!

> Muspratt established an alkali works in Liverpool in the early 1820s [to manufacture sodium carbonate]. The process involved the treatment of common salt with sulphuric acid, which liberated large quantities of highly corrosive gaseous hydrogen chloride. Since initially there was no market for the hydrogen chloride – which later became a source of chlorine [for bleaching] – it was allowed to run to waste in the atmosphere. [The environmental impact] locally can be imagined.
>
> Even in the pollution-permissive society of the early 19th century this could not last and eventually Muspratt was told to leave.
>
> Clow, 1972 (page 73)

Although the trend to an industrial economy spread from Britain to many other countries in the subsequent century, the way in which industry operated changed little. An excellent overview of this period of industrial change is to be found in Chapter 2 of the book *Material Concerns* (Jackson, 1996) and in the article by Clow (Clow, 1972).

One consequence of the changes introduced during the Industrial Revolution was a form of regional development in which the influence of industry was locally very concentrated. We have only to think of the Black Country in Britain or the Rühr valley in Germany. However, towards the end of the 19th century a new concept for managing industrial development appeared in the shape of the ***industrial estate*** and the first estates were established early in the 20th century in the United Kingdom and the USA. A definition of an industrial estate, attributed to Peddle (UNEP, 1997), is given below.

> **Industrial Estate**
>
> " a large tract of land, sub-divided, and developed for the use of several firms simultaneously, distinguished by its shareable infrastructure and close proximity of firms."
>
> M.T. Peddle (UNEP, 1997)

One result of the introduction of industrial estates was that it pushed industries to relocate out of over-developed urban areas, essentially the factory towns, thereby reducing congestion (both of people and traffic) and pollution in those areas. It also helped to promote the start-up of industrial activity in the smaller towns or in rural areas; often the areas that had most suffered from the initial loss of work and then of people at the beginning of the Industrial Revolution.

After 1945 industrial estates began to become part of the economic development strategy in many countries and from the 1970's onwards the number of estates increased rapidly. According to a survey carried out by the International Development Research Council (UNEP, 1996a), there were more than 12,000 industrial estates in 90 countries in 1996, and this certainly represents a lower limit. The growth of industrial estates in the rapidly

> "[The] grimy grey landscapes of the 19th century industrial zones yielded to the pastoral, picturesque parks of the mid-20th century."
>
> Grant, 1997

industrialising countries of Asia has been particularly important, reflecting the fact that by industrialising at a later stage some countries have been able to leapfrog over the problematic phase of the "factory towns".

We should not take away from this discussion, however, the idea that industrial estates currently represent the dominant arrangement for industrial development. In a 1997 UNIDO report (UNIDO, 1997) the comment is made that - "*In most countries only a small proportion of the industrial enterprises and of the labour force operate in industrial estates …*". For example, in Vietnam only 20% of national industrial output (14% of national exports) came from industrial estates in 1998 (UNIDO, 1999). However, this proportion is clearly growing, as can be seen in a recent report about industrial estates in China (Yang et alia, 2000). 32 national Economic and Technological Development Zones (ETDZ's) received approximately 10% of the foreign investment coming into the country in 1998.

Thus, industrial estates have emerged as an important part of recent industrial development, following on from the factory towns. We shall now describe in more detail what characterises an industrial estate and why industrial estates have become so popular as an instrument of economic development.

3. THE INDUSTRIAL ESTATE CONCEPT

3.1 THE CHARACTERISTICS OF AN INDUSTRIAL ESTATE.

In the UNEP Industry and Environment Review (UNEP, 1996a), an industrial estate is described as -

> A defined geographical area which contains businesses of an industrial nature.
>
> […] the essential element is that the estate is administered/managed by a single authority that has defined jurisdiction with respect to tenant companies.
>
> The authority makes provision for continuing management, enforcing restrictions on tenants and detailed planning with respect to lot sizes, access and utilities.
>
> UNEP Industry and Environment Review (UNEP, 1996a)

In two recent reports, UNEP (UNEP, 1997) and UNIDO (UNIDO, 1997) have described some of the characteristic features of industrial estates that allow us to distinguish them from other forms of industrial development, such as industrial zones or industrial areas. It is important to note, however, that there is some inconsistency in terminology in the literature (*see below*). Industrial estates are characterised by -

- Industrial estates cover a relatively large surface area - typically between 40 - 80 hectares. This is necessary if the cost of infrastructure per hectare is to be reduced to an acceptable level.
- All factories and buildings on the estate have access to utilities (such as water and electricity) as well as common services (for example central effluent treatment, waste collection or fire protection). The estate is responsible for providing roads, transport and telecommunications. Some estates also include housing for workers.
- Restrictions on companies within the estate may exist with respect to the type of construction that they can use and the size of individual sites. There is normally a detailed plan of performance standards and specifications for all aspects of the built environment.
- Industrial estates are normally developed according to some form of master plan that guides:
  - ⇨ the physical planning of the estate, and

- ⇨ the economic and social environment, depending on the role that the estate has been attributed within the regional or urban development plan.

- The estate functions through an administration that typically assumes the following roles -
  - A ***managerial*** role for enforcing restrictive covenants in leasing agreements, deciding on the entry of new companies into the estate, collecting rents and ensuring that taxes and charges are paid, and being responsible for maintenance and order on the estate.
  - A ***technical*** role that covers responsibility for common facilities as well as training or other technical services.
  - A ***financial*** role including overseeing loans to tenant companies on the estate or arranging bulk purchasing agreements for materials.

> ***Jurong Town Corporation (JTC) is the manager of Singapore's primary industrial estate:***
>
> **"***JTC has a tight regulatory grip on the companies operating under its auspices, allocating land to companies that may themselves build or that may occupy buildings established by JTC under a thirty-year lease. JTC has built all the required infrastructure – sewers, roads, substations, electrical and communication lines – in the industrial estate. Presently half of the 500 companies in the zone are small-and medium-sized enterprises.*
>
> US-AEP, 2000

Overall, the management team is responsible for promoting the long-term development of the estate and protecting the interests of the companies located there.

For comparison, the term *industrial zone* refers only to land reserved by municipal authorities for industrial development. An *industrial area* is land that has been prepared and sub-divided into plots that are then sold for industrial development - essentially a property promotion. The important difference between an industrial estate and an industrial area is that the former includes an administrative structure. However, not all authors adhere to this terminology and the term industrial zone is frequently employed when referring to an industrial estate.

Although it is possible to outline the general characteristic features of an industrial estate, there exists an extremely wide range of industrial estates depending on the stage of economic development of a country, the role of development planning and the availability of investment capital. Some estates are very small zones (~5 ha) located in rural areas – perhaps on the outskirts of a small town and managed by the municipal authorities. Others are extremely large industrial complexes, such as the Jebel Ali Free Zone in Dubai, which covers more than 100 km^2 and contains more than 1600 tenant companies.

In addition to the general type of industrial estate that allows most companies to locate in the estate provided that their activities are compatible with those of the other tenants, there are other industrial estates whose activities are focussed towards specific business sectors. Amongst these, one finds:

- ***Export Processing Zones*** (EPZ's) or Free Trade Zones are industrial estates that are focussed on export activities. Companies within an EPZ can import materials and equipment free of customs duties or government taxes if their activities include manufacturing, assembly, processing, or repackaging. If their products are subsequently exported no customs duties or taxes are paid at all. However, if the products are sold in the domestic market, duties and taxes must be paid on the finished item. For obvious reasons, EPZ's are enclosed estates that are monitored by the Customs Authorities. Industries within an EPZ traditionally fall into the following categories – assembly of electronics, light engineering, clothing production, and warehouse and distribution. However, software production and financial services are also increasingly being located in EPZ's (UNIDO, 1999; Venable, 1998).

- ***High Technology Zones*** (HTZ's) are estates that contain high technology industries and are often linked with universities or institutes of technology. Examples of such industries are electronics, medical / health care, aviation engineering and (increasingly) biotechnology.

- ***Integrated Industrial Zones*** (IIZ's) are estates developed according to an approved plan that integrates an industrial function, which may be an EPZ or an HTZ, a residential area and supporting commercial and amenity areas. An example of such an integrated industrial zone is the Dalian Economic and Technological Development Zone in China (Geng & Côté, 2001; and see the Case Study in Section 5). The complete IIZ covers 28 km^2 with 15 km^2 being designated as the industrial area. The industrial area has 1150 tenant companies, covering a wide range of activities from chemicals and pharmaceuticals to electronics or food processing, that have brought in more than US $10 billion in investment. The total population of the IIZ is over 200,000, of which the workforce of the industrial area represents close to 100,000.

3.2 INDUSTRIAL ESTATES AS A DEVELOPMENT TOOL.

The popularity of industrial estates stems from the fact that their introduction often brings a number of benefits to a country or a region. On the one hand industrial estates contribute to industrial and economic development and, in addition, they can be used as an important tool for the urban and regional planning policies of the country (UNIDO, 1997).

Among the industrial and economic advantages of industrial estates are that they -

- Promote industrialisation, and hence employment, by attracting new investment.
- Attain a more balanced distribution of production and employment within a region by spreading out industries to smaller towns in rural areas.
- Introduce diversification within the industrial base and at the same time improve quality and productivity.
- Encourage industrialists to establish their company in a particular area through lower capital investment costs and easier start-up of the plant.
- Achieve economies in investment in public infrastructure.
- May encourage a more efficient use of resources. An example is through the creation of large, highly diversified industrial estates located around a so-called anchor industry, such as a power plant, an oil refinery, a steel mill or a chemical plant. An alternative approach is co-location around a transportation centre, for example a port, an airport or a rail or road junction. The goal here is to exploit synergies between the companies on the estate.

Industrial estates can also serve as a catalyst for urban and regional planning policies. In this respect they may serve -

- To promote the decentralisation of industrial activity, thereby preventing too much growth in certain urban areas and reinforcing the economic base of smaller towns.
- To control both the influx of industry and its location so as to separate industrial and non-industrial areas in the situation where an industrial estate is to be located within an important urban area. The outcome is a more attractive and healthier urban environment.
- To maximise efficiency in the use of land and hence reduce the cost of land development.

3.3 COMPANY LOCATION IN AN INDUSTRIAL ESTATE.

Of course industrial estates must also provide advantages for the companies that install their activities there, otherwise they will go elsewhere! Some of the advantages that an industrial estate can offer a company are -

- As mentioned above, the companies benefit from fewer hurdles and lower costs to construct their plant since part of the set-up has already been carried out by the sponsors of the estate. In addition, in some countries, companies locating in an industrial estate are subject to fewer bureaucratic difficulties than those setting up elsewhere.
- Companies also have access to common facilities provided by the estate - such as water and electricity, effluent treatment, waste collection or fire protection.
- Estates may also provide housing and recreation areas for workers, as well as training programmes.
- For SME's (Small- and Medium-size Enterprises) collective access to such facilities can be very important since they may not have the financial strength to access them individually.
- In addition, the fact that many industries are located in close proximity may provide an opportunity for co-operation between them.

It is important to note that, for companies to benefit fully from these advantages, there must be a good management team that plays a dynamic role and does not merely limit itself to maintenance of the facilities.

We see that an industrial estate can offer a number of advantages to a company seeking to locate its activities in an area. However, when a company is choosing where it will locate, what are the factors that it considers to be important? The Association Orée, which is active in the establishment of an Environmental Charter for industrial zones in France (we shall discuss their work later), lists the points shown below (Orée, 2000).

This study indicates that the two main driving forces for a company in its choice of location are – (i) that there is an easy access to suppliers and markets, and (ii) that the environment and infrastructure available are of a high quality. Fiscal advantages are surprisingly low on the list. We can conclude, therefore, that an industrial estate that is well situated and can offer facilities to a company, such as help with its environmental management, is likely to be viewed favourably.

Responding to the needs of companies …

The factors determining a company's choice of location are, in decreasing order of importance:

- Ease of access
- Proximity to clients, potential markets and suppliers
- Cost of set-up (land, rent for buildings, charges)
- Geographical situation
- Quality of office space
- Proximity to other subsidiaries of the same company
- Distance to urban centres
- Opportunity costs
- Fiscal conditions (subsidies, professional taxes)
- Image of the region
- An existing industrial estate
- Qualification of the local work force

Source: Association Orée

3.4 THE STAKEHOLDERS IN AN INDUSTRIAL ESTATE.

Industrial estates require the participation of a number of stakeholders to be successful on all fronts - economic, social and environmental. These stakeholders come from four sectors of society:

a) Government:

Local and central governments may intervene at various stages of the development and operation of an estate. Firstly government may be the sponsor of the estate, initiating the project and providing the initial financing. This has been the predominant form of sponsorship in the past, although it is being superseded increasingly by private investment or "public-private initiatives". As the sponsor, government's goal is to attract business to locate in the estate so as to bring investment and employment to the region. In many industrialising countries, the additional objective is to attract foreign business that will bring foreign investment to the region.

However, government has a second role that may prove to be in contradiction with its desire to attract business and investment. This is its responsibility to the community to protect the environment by monitoring and enforcing environmental regulations. It must therefore ensure that its policies, planning and legislation are well-adapted to achieve a balance between the socio-economic role of an estate and environmental protection.

b) The Management of the Estate:

The management of the estate has three main roles, as we described in Chapter 3.1. These are - managing the operation of the estate, maintaining the technical services and arranging financing. In the case where the government has set up the estate, the estate management often retains a close relationship to government agencies.

c) Companies:

The tenant companies are present in the estate because they believe that this is where they can maximise their profits. Some of the advantages of industrial estates for companies have been listed in Chapter 3.3 above. However, they are obliged to comply with the laws of the country in areas such as health, working conditions, worker safety, and environmental impact. In this respect, companies are constrained to find the optimal solution to satisfy both sets of criteria.

d) Communities & Non-Governmental Organisations:

Local communities are important stakeholders in the industrial estate since they benefit economically through employment and increased economic activity for the region, but may well suffer from the environmental impacts arising from the development and activities of the estate. Communities, or NGO's representing them, are increasingly demanding to be informed about the activities of nearby industrial complexes, whether they are estates or factories.

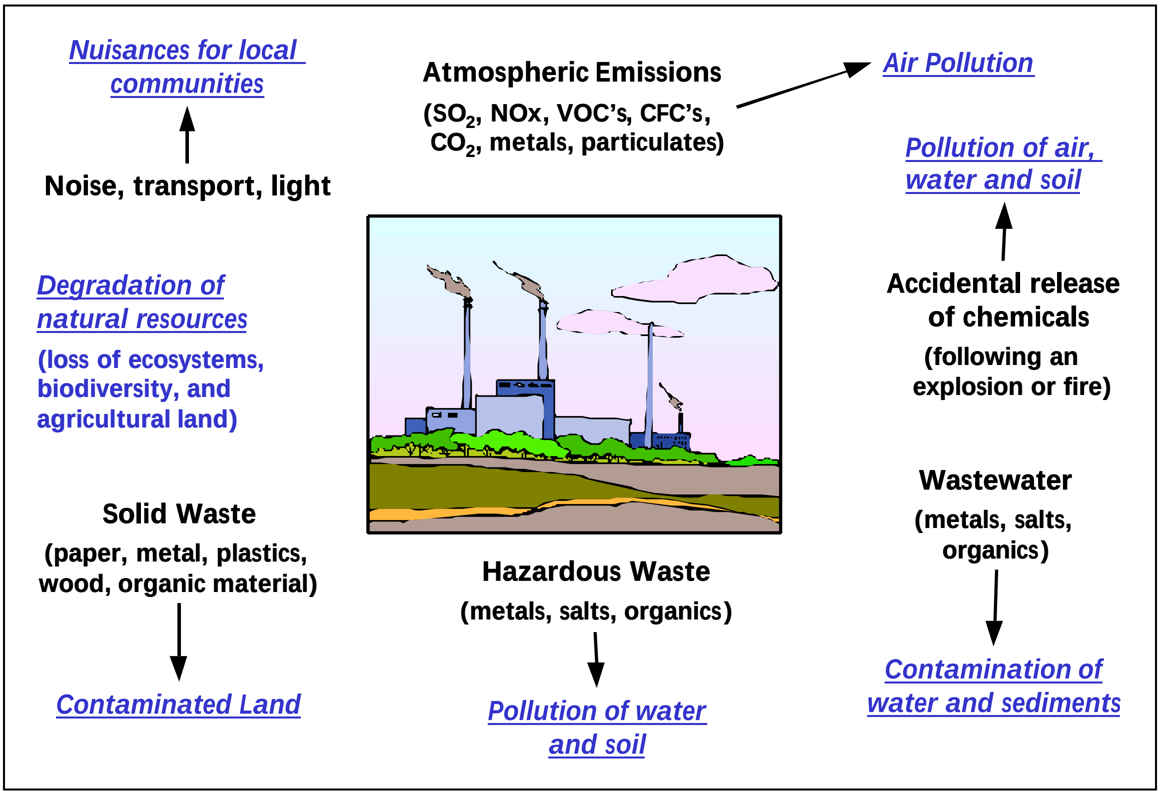
4. INDUSTRIAL ESTATES AND ENVIRONMENTAL MANAGEMENT

4.1 ENVIRONMENTAL IMPACTS OF INDUSTRIAL ESTATES.

Industrial estates can be an important cog in the wheel of industrial development for a country or a region. Unfortunately they do not only have their positive side. Probably the most important problem associated with the growth of industrial estates concerns their impact on the environment, and this is very often the area that has been the most overlooked in the past. A UNIDO study of industrial estates in developing countries led them to conclude that relatively little attention had been paid to environmental impacts so far, and what has been done is mainly limited to an end-of-pipe approach (UNIDO, 1997).

In the Introduction to this Background Paper we described the main concerns that are to be found on the present environmental agenda and showed how industrial estates may contribute to these issues. In the current Chapter we want to move our focus to the industrial estates and how their environmental aspects specifically lead to major impacts on the environment.

Figure 2: Environmental Aspects of Industrial Estates and Impacts.



Some of the possible environmental aspects and impacts associated with industrial estates are presented in Figure 2. The impacts can essentially be divided into two types:

1. Impacts that occur as a legacy from when the industrial estate was **planned**.
2. Impacts arising from the day-to-day **operations** of the industrial estate.

During the planning and development phase of an industrial estate a number of decisions are taken that have an extremely important effect on the subsequent environmental impact of the estate. Developers of industrial estates traditionally consider their project only from a marketing and engineering perspective and this often results in environmental impacts that come from a poor location for the estate. For example, flat agricultural land located near to urban centres is extremely attractive for developing an estate and the resulting loss of high-quality land for farming often does not enter into consideration, even in areas where such land is not plentiful.

The reclamation of valuable ecosystems such as wetlands for the construction of an industrial estate destroys areas that act as habitats for many animal and plant species. In addition, wetlands provide a natural water filtration and storm-water management system for the surrounding areas (see Box). The location of an industrial estate near to fragile ecosystems and animal habitats also means that any pollution resulting from the subsequent day-to-day operations of the estate will have a greater impact than if the estate were situated in an environment with a greater capacity to assimilate the pollutants. As a result, the choice of location for the industrial estate can lead to environmental impacts varying from the destruction of ecosystems to the loss of biodiversity and a scarcity of freshwater for local communities.

> Between the mid-1970s and the mid-1980s, approximately 3.3 million acres of inland freshwater wetlands were destroyed, and the amount of coastal wetlands decreased by 71,000 acres.
>
> Conversion to agricultural use was responsible for 54 % of the losses, drainage for urban development for 5 %, and development for 41 %.
>
> In addition to these losses, many other wetlands have suffered degradation of functions, although calculating the magnitude of the degradation is difficult.
>
> *America's Wetlands – Our Vital Link Between Land and Water*, US-EPA, 2000

Other environmental impacts are uniquely linked to the scale of an industrial estate. The effect of scale should not be neglected when we consider that industrial estates that cover 10 – 100 km^2 and that contain hundreds of companies are becoming commonplace. Examples are the JTC-managed estate in Singapore (> 500 companies), or the Jebel Ali Free Zone in Dubai and the Colón Free Zone in Panama (each with > 1600 companies). The impact of such estates on the surrounding environment, as well as on the socio-economic capacity of a region is of another dimension to that of a single factory.

For example the effect of a high demand for fresh water by the estate may create a problem in the supply of drinking water to local communities in areas where this is a scarce resource. A high demand for industrial water can result in the depletion of groundwater and the lowering of water tables, which in coastal areas will lead to contamination of the groundwater by salt water. Alternatively, the rejection by an estate of large quantities of warm water that has been used for cooling purposes will affect aquatic ecosystems downstream from the estate.

Large industrial estates also require an extensive transport infrastructure to bring in raw materials and take away finished products. With this scale of activity, the impact of the transport on the local communities, both in terms of risk as well as noise and air pollution, becomes non-negligible. As anybody who has passed a large industrial complex during the night can affirm, the amount of light and noise emitted by the installations is quite impressive.

> "The continued expansion of [Thailand's Map Ta Phut industrial estate] has resulted in a substantial increase in the population in the nearby area, which has begun encroaching into the green buffer zone surrounding the complex."
>
> Chumpol NaLamlieng, President of Siam Cement Public Co., *C&EN*, 1999.

Another phenomenon that is particularly relevant to developing countries is that large industrial estates require a large workforce. Since workers want to live near to their workplace this puts a tremendous strain on the infrastructure of the surrounding communities, in particular in terms of housing. If this factor is not included during the planning phase of the estate a problem may arise in which the residential area starts to encroach on the industrial area, leading to greatly increased risk for the local inhabitants.

Let us turn now to the day-to-day operations of the industrial estate. An estate manager can have some influence over the way that companies in the estate function from an environmental perspective. However, the simple fact that companies use energy and raw materials will lead to environmental impacts. These impacts arise principally from emissions of materials to air or water and the generation of solid waste materials, whether they be hazardous or not (Figure 2). Adding impacts that may result from releases of chemicals following an accident completes the picture of environmental issues that estate managers must consider with respect to their estates.

The release of different materials to the atmosphere leads to what is generally referred to as "air pollution" (Figure 2). However, this term masks a wide range of different impacts. For example, emissions of sulphur dioxide in the flue gas from a combustion process may lead to poor local air quality near to the estate. Further away the sulphur dioxide will eventually be deposited from the air leading to acidification of the soil or water. Acidification of the soil often results in damage to plants and forests and may lead to the release of heavy metals that are present in the soil. Acidification of lakes is known to result in the death of fish.

Direct release of process effluents to watercourses allows a number of synthetic organic chemicals, heavy metals, acids and salts to enter the environment with differing impacts. For example, the heavy metal mercury is still used in some parts of the chlor-alkali industry. Release of mercury to a river or sea results in the contamination of water and the build-up of mercury in the sediment. Its conversion by micro-organisms into an organic form of mercury (methylmercury) increases its rate of uptake by living species and renders it able to enter the foodchain. The case of Minamata in Japan, in which the consumption of methymercury-contaminated fish resulted in the death of more than 200 people and serious illness to many more, is a terrible example of what happens when mercury enters the foodchain.

The reduction of such environmental impacts at the level of an industrial estate depends on two factors – what the individual companies on the estate allow to enter their waste streams, and the type of treatment that the waste stream receives before it leaves the estate. As we have mentioned above, many industrial estates offer waste treatment as a service to the companies on the estate. This can be through a Common Wastewater Treatment Plant, an incinerator or through controlled landfill sites.

It is a regrettable fact however that decreasing air pollution (by the use of filters) or water pollution (through a common wastewater treatment plant) does not reduce the total amount of waste emitted. The pollutants may be retained by the air filters or in the sludge from the water treatment plant, but they must then be disposed of as hazardous solid waste. One way of treating the solid waste is via incineration. However, the flue gases from an incinerator will require air filters or water-scrubbers in order to remove any remaining pollutants and avoid air or water pollution. Which brings us back to the starting point!

Another approach is the storage of waste, whether it is hazardous waste or merely a "municipal" type of waste, in landfill sites. Landfill sites also lead to environmental impacts, particularly if they contain hazardous materials and insufficient care is taken to prevent leaching of materials into the soil and groundwater. Even if the waste is relatively innocuous, such as paper, plastics, wood or metal, the simple fact of creating the landfill may render the land unusable for other purposes during many years.

Although it is often easier to think in terms of local problems – such as the air and water quality or pollution of the soil in and around the industrial estate – the estate manager should not forget that many global environmental concerns can be traced back to local environmental issues and individual practices (IHDP, 1999). In other words, industrial estates are also responsible for environmental impacts that are not limited to the immediate vicinity of the estate.

For example, global warming is linked to the emission of the greenhouse gas carbon dioxide and is therefore directly related to the energy efficiency within the industrial estate. Volatile organic compounds or VOC's may often be used as raw materials or solvents by companies on an industrial estate. When the VOC's are released to the atmosphere they lead ultimately to the formation of photochemical smog. CFC's (chlorofluorocarbons) have been used for many years in industry as refrigerants, propellants, cleaning compounds and in the production of foam insulation. Following the realisation that CFC's were responsible for stratospheric ozone depletion, a phase-out of CFC's and other similar ozone-depleting substances was negotiated through the Montreal Protocol, signed in 1987. However, depending on the activities of the companies on an industrial estate, ozone-depleting substances may still be actively used. Finally, the industrial estate may contribute to the release of so-called persistent organic pollutants (POP's), such as the dioxins or PCB's. Dioxins may be formed through the incineration of chlorinated organic compounds, while PCB's have been used for many years in industry in electrical devices, as heat exchange fluids and as additives. POP's are of concern on a global scale because of their mobility (volatility or solubility), their ability to persist over relatively long periods of time, and their tendency to bio-accumulate in animals and humans.

While the environmental impacts described above can also be attributed to the day-to-day activities of individual companies, an important difference concerns the ***scale*** of an industrial estate and the ***diversity*** of these activities. A final comment about the environmental impact of an industrial estate concerns the case of an accidental release of chemicals resulting from an abnormal situation such as a fire or an explosion. The clustering of many different industries in a relatively small area may lead to a greater cumulative effect than would be predicted. For example, depending on how industries are co-located within an estate, the risk to workers or the surrounding communities arising from industrial accidents or spills of hazardous materials may be increased if the consequences of an accident or spill in one company cannot be localised easily.

In conclusion, the environmental factors associated with industrial estates can be reduced to three points:

- ⇨ They require a large amount of land, often in a relatively remote region. This will have serious implications for land-use that may result in the degradation of natural resources, damage to habitats and loss of biodiversity.
- ⇨ The scale and diversity of the industrial activities means that the risk from pollution is actually concentrated within the estate. The cumulative effect of the environmental aspects will require extremely effective environmental management tools on an individual and estate level.
- ⇨ Although the industrial estate's activities may be relatively far from urban agglomerations, the environmental impacts of the industrial estate may reach far beyond the local level and have a regional or even global component. As a result, the attitude "out of sight, out of mind" must be avoided.

We shall now turn to the question of how to use the resources within an industrial estate to better manage its environmental impacts.

4.2 THE UNEP APPROACH TO ENVIRONMENTAL MANAGEMENT IN INDUSTRIAL ESTATES.

Since the middle of the 1990's UNEP-DTIE has become increasingly concerned by the question of how to lessen the environmental impact of industrial estates. Following two workshops in 1996, a Technical Report - *The Environmental Management of Industrial Estates* - was published by UNEP in 1997 (Technical Report N° 39 - UNEP, 1997). The report introduced what was at the time (and remains to some extent so) a rather novel approach. It considered not only the environmental problems, but also their solution, at the ***level of the industrial estate.*** In other words, the focus was put mainly on the community of companies in the estate rather than on the companies themselves.

What we shall refer to as the "UNEP approach to environmental management for industrial estates" takes as its starting point several issues that come out of Agenda 21 (Balkau, 2000):

i. Reducing the amount of wastes and emissions from industrial production and the users of the products, and managing safely and responsibly what cannot be eliminated.
ii. Protecting natural habitats and biodiversity.
iii. Protecting the seas and oceans, and in particular coastal zones.
iv. Reducing the release of greenhouse gases and ozone-depleting substances.
v. Conserving soil, water and energy.
vi. Managing safely the production and use of chemicals.
vii. Protecting landscape, human amenities and heritage sites.

It then asks the question –

⇨ In what ways do the activities of an industrial estate impact these issues?

In this way it therefore broadens the palette of environmental management beyond issues of materials and energy flows (even though they are still important). It is in effect grounded in the concept of ***industrial ecology*** (Balkau, 1997) and considers the interactions between the estate and the environment in terms of an ***industrial ecosystem*** interacting with a natural ecosystem. We shall discuss this methodology in more detail in a later chapter. *(Some basic information on Industrial Ecology is presented in a Briefing Paper in Section 4 of the Information & Training Resources Manual.)*

The environmental management strategy for an industrial estate can then be defined with the help of questions such as the following –

- ⇨ What aspects of the estate's activities result in these environmental impacts?
- ⇨ How can the activities be modified in order to reduce these aspects?
- ⇨ How can the different members of the industrial estate co-operate to modify their activities in the most effective way?

This last question is very important because, in considering the estate itself as a type of ecosystem, it requires the companies and the management of the industrial estate to work together in a **co-operative way** to look for solutions to the problems.

Considering that an industrial estate is a managed activity, there is great potential for promoting and implementing industrial ecology –

- In many estates there are enough companies to allow co-operative approaches, such as by-product synergies, to be applied.
- Managers of industrial estates have an essential role to play in the planning and operation of the activities of an estate and they can encourage co-operative approaches to environmental management to be adopted as well as promoting environmental management. This is particularly true when the estate is in public ownership, or is a joint venture, and is relatively tightly controlled by government environmental policies.
- Industrial estates may have a better chance to address issues, such as those raised by the sustainable development agenda, since they are often part of a longer term regional development strategy and can profit from an extended timetable for return on investment.

However, there are also factors that discourage the management of an industrial estate from taking a very active approach to environmental management. For example, in some countries there are too many estates and they are unable to attract enough companies, which results in industrial estates competing among themselves. They therefore look for commercial advantages over their competitors, and it is an unfortunate fact that "social and environmental factors are still often regarded as constraints rather than opportunities" (Balkau, 2000).

The challenge then is to convince the different stakeholders in industrial estates that an environmental management approach based on industrial ecology principles is a positive business factor rather than a cost burden. Technical Report N° 39 was therefore designed

> "Financial savings are also an invariable result of improved environmental management either through reduced costs for raw materials, utilities, waste disposal or being cynical, in reduced fines for non-compliance."
>
> S. Haile, *Green Chemistry*, 1999.

to provide just this type of information to a target audience of -

- people planning new industrial estates,
- managers of existing industrial estates,
- the financial sector involved in investment in industrial estates, and
- government representatives responsible for environmental regulations.

Subsequent workshops in Thailand (UNEP/IEAT, 1997), Singapore, Vietnam and China have provided an opportunity to promote this concept to industrial estate managers in particular. It is clearly important for each manager to recognise that, although the environmental impact of the estate may be mainly due to the activities of the tenant companies, it is a part of the manager's responsibility to work with them to resolve their problems. In fact, the successful resolution of such problems benefits not only the companies concerned but the estate itself.

Having introduced the thinking behind this UNEP approach to environmental management for industrial estates, we shall describe in more detail in the coming chapters the principles, strategies and tools that can be used to put the approach into practice.

5. ENVIRONMENTAL MANAGEMENT & THE INDUSTRIAL ECOLOGY APPROACH

Before we talk about the strategies and tools that make up the UNEP approach to environmental management in industrial estates, let us take a brief look at how environmental management has evolved over time.

5.1 "DOING NOTHING".

Environmental management has evolved significantly since the times described in the introductory chapters of this Background Paper. The earliest approaches to environmental management can be succinctly described as "doing nothing". As Odum has noted (Odum, 1975), nature treats, recycles or makes use of her pollutants; and for a long time mankind has counted on nature to treat his pollution as well. This has resulted in, what Jackson calls a *laissez-faire* philosophy towards the environment that "has allowed waste materials to flow more or less unhindered out of the economy into the atmosphere, into lakes, rivers and seas, and on to the land" (Jackson, 1996). This attitude has permeated the whole of the industrial economy, from companies to regulatory authorities and governments, and although it may have had some justification before the beginning of the industrial revolution, this is no longer the case.

We saw with the example of Muspratt (see page 9) how the uncontrolled release of hydrogen chloride led to massive local pollution and resulted in him being forced to close his company. What we did not say was that he merely moved to another location and continued his activities! This style of environmental management, what Jackson calls "foul and flee", has been quite common in the past.

5.2 THE END-OF-PIPE APPROACH.

This earliest type of environmental strategy, therefore, involved the *direct release* of pollutants to the environment. Jackson points out that this was based on the belief that it is possible to "dilute and disperse" pollutants within the air or water at a concentration that causes no harm. This relies on the environment being able to tolerate a certain level of pollutants without being affected – the idea of an *assimilative capacity* of the environment.

A closely linked idea is that if diluting and dispersing is not feasible, one can "concentrate and contain" pollutants. This approach has been employed for solid and liquid residues in the form of landfill sites, what is called *secure disposal*.

However, both approaches have been characterised by some notable past failures in which dispersal merely transferred the problem elsewhere (an example being that of acid rain), or where containment was found to be less secure than previously thought - witness the growing concern surrounding landfill sites in many countries, including the case of the so-called Superfund Sites in the USA.

The subsequent phase of environmental management was introduced on the basis of the two beliefs – dilute and disperse and concentrate and contain – and although its origins are to be found in the 1960's, it is a form of environmental management that is still very prevalent today. If there is an assimilative capacity of the environment for mankind's pollutants, the logic is that it should then be possible to find a technological solution that guarantees that the quantities of pollutants being emitted from industrial activities are always within the capacity of the environment to assimilate them. This technology is usually referred to as *end-of-pipe technology* and consists of wastewater treatment plants to reduce the concentration of contaminants in water, the use of filters or scrubbers to reduce emissions to the atmosphere, and incinerators to break down solid and liquid wastes to remove potential pollutants. The relative success of this strategy can be judged by the figure $300 billion – the sum spent annually by the OECD countries on end-of-pipe technologies (Erkman, 1998).

Although there is no doubt that end-of-pipe technology has achieved a lot in reducing pollution from individual factories or cities, there are several weaknesses to the approach:

- From the industrial point of view adding on equipment makes production processes more expensive and costs continue to rise with time.
- With respect to resource efficiency the quantity wasted does not in general diminish, unless material can be recovered (e.g. the production of gypsum from waste sulfur dioxide gas from flue gases).
- There is such a complex mixture of pollutants currently being generated that it is difficult to know what the assimilative capacity of the environment could be for the blend of all pollutants. In addition, simply because a pollutant has been put in a secure landfill does not mean that it will not eventually leach out into the environment. In other words, nothing is foolproof.

- Finally, pollution problems are increasingly arising from other non-point sources – for example global warming arising from emissions of greenhouse gases such as carbon dioxide.

We see that the weaknesses can be reduced to two factors – efficiency and uncertainty. Both are linked to the fact that we create a problem and then try to find a solution to it. As a result, another approach was sought to add to the list of environmental strategies – that of avoiding the problem in the first place.

5.3 POLLUTION PREVENTION.

This brings us to the next phase of environmental management – pollution prevention. In its simplest form pollution prevention seeks to *eliminate the production of waste* rather than the waste itself after it has been created. This idea of reducing waste *at the source* gradually came into favour during the 1980's and was a clear response to some of the weaknesses of the end-of-pipe approach. However pollution prevention was officially formalised by the Pollution Prevention Act of 1990 in the USA, which also established what is often referred to as a hierarchy for waste management (see for example Allen & Sinclair Rosselot, 1997):

Source reduction	>	In-process recycling	>	On-site recycling	>	Off-site recycling	>	Waste treatment	>	Secure disposal	>	Direct release

The US Environmental Protection Agency later defined pollution prevention as the modification of a process so as to produce less waste (*source reduction*) and the recycling of unused raw materials back into the same process (*in-process recycling*). This definition is considered by many to be too restrictive and it has been pointed out that in some circumstances *on-site* and *off-site recycling* should also be eligible for inclusion as pollution prevention measures (Allen & Sinclair Rosselot, 1997). Other authors consider the first three elements as making up pollution prevention. However, the definition is not so important – the ultimate goal is to avoid as much as possible the creation of pollutants.

What is interesting about this scale for waste management is that we find the earlier strategies included (with the exception of foul and flee!). This reflects the fact that in different parts of the industrial economy one encounters companies that are at different stages of "awareness" on the environmental management scale. More importantly, one encounters legislation that has been created to fulfil the needs of a particular environmental strategy. This point is particularly important for the manager of an industrial estate in his/ her role as a promoter of good environmental management within the estate.

By and large, pollution prevention measures are activities that a company carries out alone to prevent the creation in its processes of by-products that may become pollutants when released into the environment. Examples of such measures are the modification of the process, the upgrading of technology, the change of raw materials, or even the redesign of the product. Included in the scope of pollution prevention is the reduction of, what may be called, the *toxic dispersion* associated with the manufacture of products. By this we mean limiting the use of toxic raw materials, the production of toxic intermediates and the presence of toxic by-products in processes as a way to reduce the toxicity of emissions and wastes and thereby minimise the health and safety risk to workers and the general public.

However, an understanding has grown in the last ten years or so that focussing on process efficiency within specific industrial sectors does not address very well all of the environmental concerns that we now face. This is particularly true of global environmental issues such as climate change, ozone depletion, the loss of biodiversity, or water scarcity and water pollution. And yet it is the enormous expansion of the global industrial system that has contributed to the creation of just these environmental issues. This realisation leads us to the idea that an approach is needed that addresses the whole industrial system.

5.4 A SYSTEMS APPROACH: INDUSTRIAL ECOLOGY.

The environmental problem of ozone depletion in the upper atmosphere, described above, resulted from an inappropriate use of CFC's. And yet CFC's had been developed originally by the chemical industry to solve a pressing problem – the need for safer refrigerants. As Graedel & Allenby have pointed out (Graedel and Allenby, 1995), the case with CFC's is just one example of how industry, in responding to its customers' needs, has failed to identify the long-term consequences of its actions. They suggest that this failure can be attributed to the fact that industrial activities are perceived as being essentially unrelated to the wider world.

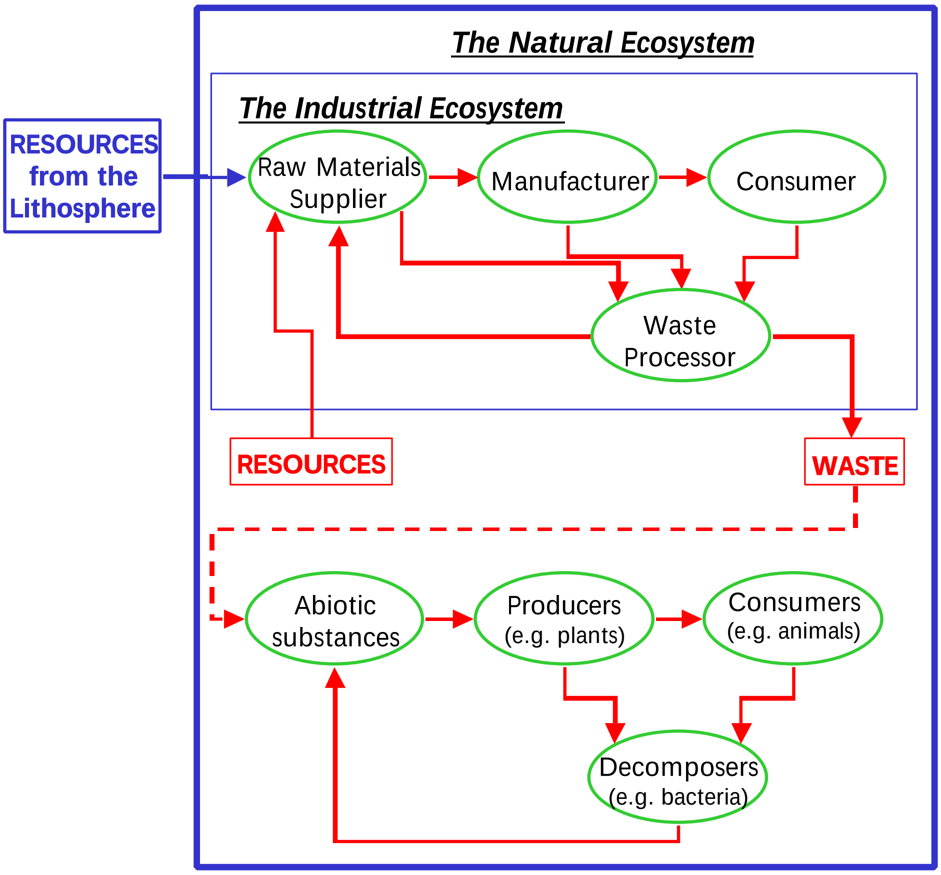
It is precisely this question that industrial ecology seeks to address. The basis of the industrial ecology approach to environmental management – as described by Frosch and Gallopoulos (Frosch & Gallopoulos, 1989) – is that our industrial activities should not be considered in isolation from the wider world but in terms of an *industrial ecosystem* functioning within the natural ecological system (see also Frosch, 1992). The concern of industrial ecology, therefore, is how to manage the industrial ecosystem so that it can coexist with the natural global ecosystem in a sustainable fashion. Although in industrial ecology there is a tendency to focus on material and energy flows, it is important to remember that the two ecosystems interface in many other ways, such as through land use, biodiversity and natural resource use.

> Industrial ecology involves the analysis of the flows of materials, energy, capital, labour, and information within production and consumption systems. It considers the impacts of these flows on the environment, as moderated by the influences of technological, economic, political, regulatory, and social factors.
>
> The objectives of industrial ecology are to better integrate environmental and social concerns in the design and management of industrial activities, and inform public policy decision making. While metrics and systems approaches such as industrial ecology are needed, we neither need perfect metrics, nor should we be paralysed by analysis.
>
> R. Frosch, The Bridge, 1999.

The underlying concept of industrial ecology is presented graphically in Figure 3, with the material flows making up each ecosystem. The natural global ecological system is shown with its characteristic four components – abiotic substances, producers, consumers and decomposers (Odum, 1975). The industrial ecosystem can also be conveniently described in terms of four components or *functions* – the supplier of raw materials (including extraction and refining); the manufacturer, who transforms the raw materials into products that can be used by the consumer; and the waste processor, who converts back into useful materials or "technological nutrients" unused materials from the supply of raw materials and the manufacturing processes, as well as the product at the end of its useful life. We refer to them as *functions* because they serve certain specific purposes and do not necessarily represent different companies or sectors of the economy.

From Figure 3 we can see that an analogy can be drawn between the way that natural ecological systems use materials and energy and the way that the industrial system functions. There is one major difference between the two ecosystems, however. In the natural ecosystem all materials are eventually returned to the level of simple substances or nutrients for use by the plants. Today's industrial ecosystem, in contrast, is nowhere near as effective at re-generating useful materials and, while some metals, such as lead or mercury, are actively recycled (see for example Allen & Behmanesh, 1994), the flow of many materials is essentially linear with resources being used, products being manufactured and waste being generated.

Figure 3: An Industrial Ecology Approach to Environmental Management.



The material flows in Figure 3 show that waste materials from the industrial ecosystem enter the natural ecosystem, either in the form of emissions to air or to water, or through storage as solid waste in landfills. The diagram also allows us to appreciate why the "dilute and disperse" form of environmental management has sometimes resulted in disastrous consequences (e.g. the previously described case of mercury poisoning in Minamata, Japan). Re-concentration of these materials can lead to bio-accumulation and contamination of the food chain, and in this respect it is useful to remember that mankind is also a "consumer" in the natural ecosystem!

This picture also allows us to understand that it is not only the classical toxic materials resulting from industrial activities that create problems at the interface between the two ecosystems. Other waste materials, although appearing initially to be inoffensive, can have major consequences when we consider the scale of industrial activities relative to the natural ecosystem. We have mentioned CFC's at the beginning of this section, but probably the most important example today of such a waste material is carbon dioxide. Its increased concentration in the atmosphere as a result of the burning of fossil fuels that have been extracted from the lithosphere (lying outside the natural ecosystem) is implicated in the most serious environmental concern of today – global warming.

If industrial ecology helps us to understand the impacts of our industrial activities on the natural global ecosystem, it also provides an approach to bring about change at the level of the complete industrial ecosystem by transposing some characteristics from the natural to the industrial ecosystem. Therefore, in an "ideal" industrial ecosystem the use of materials and resources would be similar to that in a natural ecosystem, with all materials flowing *cyclically* in a form of "closed loop". While this may be unattainable in practice (see Box), our goal must be to bring about change in this direction by reducing as much as possible the quantities of "waste" generated and hence "resources" used.

> *"An ideal industrial ecosystem may never be attained in practice, but both manufacturers and consumers must change their habits to approach it more closely if the industrialised world is to maintain its standard of living - and the developing nations are to raise theirs to a similar level - without adversely affecting the environment."*
>
> *Frosch & Gallopoulos*, 1989

The strategy to take us in the direction of an "ideal" industrial ecosystem, "eco-restructuring" (Erkman, 1998 and references therein), contains four main elements:

- ⇨ Making the maximum use of by-products in new production so as to reduce the need for virgin materials.
- ⇨ Closing material loops (recycling) and reducing inherently dissipative uses of materials, and in particular toxic materials.
- ⇨ The "dematerialisation" of products and economic activities by reducing the mass of material required for producing an object that fulfils a particular need, by extending the durability of an object, or by developing a new way to provide the same service.
- ⇨ "Decarbonising" the energy supply (and hence reducing carbon dioxide emissions) by a progressive shift to greater energy efficiency and sources of energy that are richer in hydrogen and poorer in carbon, e.g. coal ➔ oil ➔ natural gas ➔ (hydrogen?).

While our goal is to eco-restructure the overall industrial ecosystem, the four approaches described above can be applied at three different levels (Allen, 1994):

1. At the level of the complete industrial ecosystem, i.e. the *macroscale*, where the objective is to improve overall material and energy efficiency.

2. At the level of the production site, the *mesoscale*, through modifications to processes and products.

3. At the molecular level, or *microscale*, where synthetic routes for chemical production, combustion pathways or material fabrication procedures are redesigned to reduce impacts.

It is merely important to remember that the industrial ecosystem is an example of a complex system that is characterised by emergent behaviour (Allenby, 1999). In other words, when a change is made at one of the lower meso- or micro- levels, you cannot always be sure of the effect that it will have on the overall system.

> - Industrial ecology requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them.
> - It is a systems view in which one seeks to optimise the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal.
> - The factors to be optimised include resources, energy and capital.
>
> *Graedel & Allenby,* 1995

Let us finally come back to the definition of an industrial ecosystem. In their original presentation of the concept of industrial ecology, Frosch and Gallopoulos described an industrial ecosystem that covers the whole of the manufacturing industry. The diagram in Figure 3 describes such an industrial ecosystem and represents the flow of materials both within it and between it and the natural ecosystem. If we are to work with the concept in a practical way it is clear that we need to break this "global" industrial ecosystem down into smaller, more manageable parts. To use the terminology of Tibbs (1993), we need to design - *"industrial infrastructures as if they were a series of interlocking man-made ecosystems interfacing with the natural global ecosystem."*

How do we choose or define these interlocking ecosystems? One approach, described by Frosch and Gallopoulos (1989), is to use the material flows of a specific material - for example iron/steel, PVC or the platinum-group metals – to define the ecosystem. Another way is to consider whole industrial sectors - such as the chemical industry, the textile industry, or the automobile industry - as separate ecosystems. One can also base the description on geographical location, by considering a group of industries within a particular country (Resource Flows, 1997) or region (Schwarz & Steininger, 1997), or ... within an industrial estate (Côté & Hall, 1995).

6. THE INDUSTRIAL ESTATE AS AN (ECO-)SYSTEM

6.1 INTRODUCTION.

The UNEP approach to environmental management in industrial estates, introduced in Chapter 4.2, considers the overall interaction of the estate with the environment or natural ecosystem. It seeks to reduce the global impact of the estate by focussing on the community of companies, rather than on each individual company independently, and by addressing the following questions:

- ⇨ In what ways do the activities of an industrial estate impact on major environmental issues – such as resource efficiency and waste generation, chemical safety, water issues, protecting biodiversity and habitat, landscape protection, and global climate change?
- ⇨ What aspects of the estate's activities result in these environmental impacts?
- ⇨ How can the activities be modified in order to reduce these aspects?
- ⇨ How can the different members of the industrial estate *co-operate* to modify their activities in the most effective way?

The final question stresses the point that, by considering the estate from a *systems perspective*, changes can only be introduced if there is *co-operation,* both between individual companies and with the estate management.

As we have just seen in Chapter 5.4, starting from industrial ecology principles we arrive at a similar conclusion – that the best way to treat the environmental impacts of our industrial system is to consider it as being interfaced with the natural ecosystem. In the important study of Burnside Industrial Park, described in the report *Designing and Operating Industrial Parks as Ecosystems* (Côté et alia, 1994), the authors point out that an industrial estate is an excellent place to initiate industrial ecology concepts. By analysing material and energy flows within the estate, it is possible to find ways to encourage a more efficient use of resources, in particular because we can take advantage of economies of scale. But industrial ecology goes beyond resource efficiency and, as the authors comment – "the key is that energy, materials, species and populations interact in a sustainable manner … ". In Chapter 7 we shall see how this idea takes us in the direction of eco-industrial development and Eco-Industrial Parks (EIP's).

In this Chapter, we shall develop the UNEP approach in more detail by presenting the strategies and tools that can be used within the industrial estate to manage the environmental aspects of the estate as a whole. As we shall find later, the approach includes –

⇨ activities that need to be implemented at the level of the estate, and

⇨ activities that are best carried out at the level of individual companies.

It requires the estate management to assess all factors involved with both the **construction** and the **operation** of the industrial estate - including land use, the impact on biodiversity, the use of natural resources and energy, or the generation of emissions and waste (Yang et alia, 2000).

We shall therefore consider creation of a clear environmental concept for the industrial estate throughout the three phases of its existence:

1. The planning and construction phase, where the environmental concept will be moulded as a function of the type of estate that is envisaged (e.g. heavy industry, technology- or science-based industry, or service industry), the choice of site and how industries will be located within it.
2. At the stage where companies are negotiating to come into the estate, the environmental criteria used by the estate management will be crucial in setting the scene for the type of company that will eventually locate there and what kind of environmental footprint the estate will have.
3. The operating phase, or day-to-day running of the estate, which will require the creation of a coherent environmental programme, such as through the use of an *environmental management system* or EMS.

Before addressing the strategies and tools, it is important to stress that there is an underlying principle that forms the basis of the UNEP approach to environmental management – the Precautionary Principle (see for example, O'Riordan, 1994). Based on this principle, a company in an industrial estate would be required to take corrective action if there is reasonable evidence that irreversible damage may result from one of its activities. The Precautionary Principle, therefore, does not require *scientific proof* that there is an impact either on the environment or the health of its workers or the community. As Jackson comments – "it is too late to worry about a causal link *after* irreversible environmental damage has taken place." (Jackson, 1996). Examples of such activities are

> "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."
>
> (*Principle 15* of the Rio Declaration, 1992)

the use of raw materials or the production of waste materials that are potentially hazardous. By potentially hazardous materials we mean not only substances such as Persistent Organic Pollutants (POP's), that are susceptible to bio-accumulate, but also a substance such as carbon dioxide that is linked to global warming.

> A comment about the importance of the Precautionary Principle comes from Sir John Browne of BP-Amoco who, referring to the question of Climate Change, said:
>
> "In the real world we have to act on the balance of the available evidence, and everyone has to do what is in his or her power to confront the issue. *[...]* even those who disagree should recognise that in a world where knowledge is openly available, the scope to carry on denying a widely perceived problem is very limited."
>
> (Browne, 2000)

Although some companies are sceptical about the Precautionary Principle, it should represent an integral part of any environmental management plan since it requires the company to act voluntarily in a preventive way without necessarily being obliged to do so by law. As UNEP notes – "A precautionary approach will ensure that the [industrial] estate and its constituent companies are better equipped for the environmental and economic challenges of the future by reducing the possibility of surprises." (UNEP, 1997)

6.2 THE PLANNING AND CONSTRUCTION PHASE.

We shall not present here a very detailed discussion of the different environmental issues that must be considered during the planning and construction phase of a new industrial estate. This subject is covered in some depth in the chapter on *Environmental Guidelines for New Industrial Estates* in the UNEP Technical Report N° 39 (UNEP, 1997). We refer the reader to this publication [included as Section 10 of the *Information & Training Resources Manual*] for additional information on the topic. Other factors to be taken into consideration during the preliminary stages of the development of an industrial estate are to be found in the UNIDO publication *Industrial Estates: Principles and Practice* (UNIDO, 1997). This chapter draws on these two publications for much of the information.

When a decision is taken to develop a new industrial estate in a particular area, the impetus may come from several different directions. It may be –

- a privately-sponsored initiative,
- a government-driven effort as part of a regional development plan, or
- a privately-developed and managed project carried out on behalf of a government body, such as an industrial estate authority.

However, whether the origin of the project lies in the private or public sector, a similar process will be associated with the planning and construction phase of the new industrial estate. And there will be environmental considerations arising from each individual step in the process.

The first step in the planning process for a new industrial estate is to *define the potential clients*, or tenant companies. The decision as to the type of estate that is to be developed – for example, heavy industry, high-technology/science park, light manufacturing, service sector, or even a general purpose estate – will determine the type of environmental issues that may be anticipated. For example, whether tenant companies will be large users of water or energy, or large producers of waste materials. It also influences other factors, such as the type of transport infrastructure and public utilities that will be needed, and property issues related to the provision of ready-built work-places or allowing tenants to build their own premises. These factors, in turn, introduce issues that will affect the overall environmental impact of the estate.

The next step is to *select a site* for the industrial estate. At this early stage in the planning process it is important that a project team be created that includes –

- The ownership group / estate manager.

- The financial sector, including economists.
- The site planner / engineer.
- Marketing experts.
- Environmental specialists.

Some *economic* factors that will be considered in the choice of the site for the estate are –

1. The size of the site relative to the expected future demand for space. Since industrial estates are developed in phases over many years, the planning team will need to choose a site where land is available nearby for future expansion.
2. The specifications of the site. A light-manufacturing type of estate for example would ideally require:
   - Suitable land conditions (gently sloping ground for drainage, good ground conditions for building foundations).
   - Good access to cities, ports and airports.
   - Adequate water supplies.
   - Reliable electricity supply and telecommunication facilities.
   - The possibility to install wastewater treatment facilities and solid waste disposal (UNIDO, 1997).

Some useful *environmental* guidelines when choosing the site are –

- Select sites where, with good planning and site management, environmental impacts can be minimised.
- Avoid selecting a site that will result in damage to areas that are environmentally fragile. For example, coastal wetlands were considered of little value in the past and were often reclaimed for development. Recently, their value has been recognised as part of the natural water filtration and storm management system, as well as a rich habitat for plants and animals. The site selection team should also look at the region in which the estate will be implanted to assess if the development can be supported by the natural ecosystem.
- Agricultural land is often chosen for industrial estates because it is flat and can be easily developed. The economic advantages to the developers from the use of such land are counter-balanced, however, by the loss of useful farming land to the community.
- If disused sites, sometimes called "brownfields", are available these should be favoured. In this way one avoids increasing needlessly the amount of land that has been developed for industry, and existing infrastructure (transport, utilities) can be utilised. A cautionary note, however, is that some sites that have been used previously for

industrial purposes may be contaminated, such as through pollution of the soil. An effective "due diligence" study is therefore necessary to avoid future liabilities for the new owners.

Difficulties may arise because economic and environmental factors may lead to conflicting conclusions at the site selection stage. Therefore, it is important to look at the *potential environmental impacts* of the industrial estate at this early stage. This will of necessity be speculative because the exact nature of the individual companies in the future estate will not be known.

The most useful tool at this stage is an Environmental Impact Assessment (EIA) based on the projected structure of the estate. The goal of the EIA is to try to predict the potential impact of the estate on the environment and to suggest ways to reduce unacceptable impacts. Examples of questions to be answered during an EIA are given in the Box below. A particular difficulty with such an assessment for an industrial estate is that we cannot consider only the impacts arising from individual tenant companies but must also look at cumulative impacts resulting from the presence of so many different companies (Walker & Johnston, 1999).

Questions to be asked during an Environmental Impact Assessment.

- Can the industrial estate operate safely, without serious risk of dangerous accidents or long-term health effects?
- Can the local environment cope with the additional waste and pollution it will produce?
- Will the estate's proposed location conflict with nearby land uses, or preclude later developments in the surrounding area?
- How will the presence of the estate and its activities affect local fisheries, farms or industry?
- Is there sufficient infrastructure, such as roads and sewers, to support the estate?
- How much water, energy and other resources will the estate consume, and are these in adequate supply?
- What human resources will be required, and what will be the social effects on the local communities?
- What damage may be caused inadvertently to national assets such as forests or other valuable ecosystems, tourism areas, or historical and cultural sites?

Adapted from North, 1992

It is also important to evaluate the *potential socio-economic impacts* of an industrial estate in a particular area. The influx of workers into a region to find employment may put local infrastructure – such as housing, transport, hospitals or schools – under great pressure. If government is not directly involved in the project (i.e. it is not a public sector initiative), the inclusion of representatives from local authorities at an early stage in the planning process is clearly critical to the success of the project. It is very important to assess whether an increased future demand for housing and services can be met and, if not, how the local authorities propose to act. The example of the Map Ta Phut Industrial Estate in Thailand is a good example of the types of problems that a development can face.

> "The continued expansion of [Thailand's Map Ta Phut industrial estate] has resulted in a substantial increase in the population in the nearby area, which has begun encroaching into the green buffer zone surrounding the complex."
>
> Chumpol NaLamlieng, President of Siam Cement Public Co., *C&EN*, 1999.

Unless there are strict zoning laws to prevent the establishment of unplanned residential areas too close to the industrial estate, resulting from insufficient housing infrastructure, there will be the possibility of surrounding communities being put at risk in the case of an accident. The gravity of the accident at Bhopal in India (see Box on page 87) can be attributed in part to this situation.

Once the site has been designated the next step is to *design the site*. Although in the traditional literature one will find phrases such as "industrial estates should be designed to suit the requirements of industry", the value of an industrial estate will be enhanced if other factors are considered as well. For example, working with the site so as to develop the industrial estate in a way that limits environmental impacts to a minimum, or to optimise health and safety protection for the workers and surrounding communities, will lead to long-term enhanced value.

UNEP suggests the following six principles as contributing to an ecologically-sensitive design of the site (UNEP, 1997):

1. Define the carrying capacity of the site.
2. Maintain natural areas and indigenous vegetation as much as possible.
3. Retain natural drainage systems.
4. Increase the density of development.
5. Design sites with energy efficiency in mind.

6. Create the potential for synergies by co-locating companies so as to achieve easier opportunities for industrial symbiosis.

Guidelines for the environmental design of industrial estates are also given in Côté et alia, 1994. An extremely good example of the application of ecologically-sensitive site planning to an individual factory is provided by the example of DuPont in Asturias, Spain, presented in the Box below.

DuPont's Complex in Asturias, Spain.

DuPont has worked with local communities over the past 6 years to develop an environmentally-conscious site plan for its new site in Asturias, Spain.

1. Habitat restoration – imported eucalyptus trees have been removed and replaced by indigenous plants and trees in the buffer zone around the factory. Wetlands and peat bogs have been restored.
2. Visual impact – the excavated earth and rocks from the construction work has been used to create small artificial hills around the buildings. Combined with the reintroduction of local vegetation, this minimises the visual impact of the site from the outside in what is a predominantly rural area.
3. Maintenance – the presence of local breeds of cattle, horses, sheep and donkeys looks after the green areas located immediately outside the plant.

Source: Layman, 1999

In addition to the type of approaches used by DuPont in the environmental management of their site in Asturias, which allow the site to impact as little as possible on the natural ecosystem, the design of a new industrial estate provides an opportunity to build-in energy-efficiency. Some ideas from Côté et alia, 1994 are –

- Position buildings and streets so as to optimise passive solar use for lighting and heating.
- Utilise natural vegetation and land forms to cool the site in summer and protect from the wind in the winter.
- Investigate the feasibility of using alternative energy sources, such as active solar, wind or geothermal energy.

The density of the development is an important factor when designing the site. Clustering some businesses close together will tend to favour exchanges of materials or energy, and the sharing of other resources. However, in order to avoid a sensation of overcrowding in the estate it is useful to increase development density in some areas while allowing for relatively large, contiguous natural areas to be left unused. If the estate contains industries that produce a lot of noise or light, or operate higher risk activities, it is advisable not to locate them on the perimeter of the estate, where the impact on the surrounding communities is greatest.

Moving from the planning phase to the construction phase, there are a number of environmental management possibilities available to achieve an *environmentally-sensitive construction* process. These include reducing the disruption of natural areas, limiting the generation of waste during the construction of the estate, and landscaping in order to reduce energy and water requirements.

An area of the planning and construction process where the environmental aspect must be considered very carefully is in establishing the type of *infrastructure* that will be put in place. As we have already mentioned, estates offer many services to tenant companies. Possibilities for designing environmentally appropriate infrastructure within an industrial estate occur in areas such as (UNEP, 1997):

1. Transportation – by planning the transportation needs of the estate carefully, it is possible to reduce the environmental impact. Some ideas are –
   - Location near to existing railways, ports or airports to reduce the need for road transport of materials.
   - If the estate uses a large workforce, the development of mass transit systems (buses, regional trains) to bring workers to and from the estate. Within the estate the provision of opportunities for workers to walk or cycle to their place of work, or use a bus service.
   - The use of environmentally friendly materials for road construction within the estate to avoid excessive water run-off.
2. Energy – energy efficiency within the estate can be increased by –
   - Optimising energy use through energy cascading and co-generation, and reducing energy losses through the construction of energy-efficient buildings.
   - Maximising the use of renewable energy in non-essential (i.e. non-process related) applications, including an optimal use of natural lighting in buildings.
3. Water – water efficiency can be improved if the estate operates a “private” water utility because it can influence water usage through its cost structure. Examples of ways to reduce water consumption at the estate level include –
   - Conservation and an efficient use of water.

- Re-using water through a water management programme that matches the right quality of water with the need.

4. Wastewater treatment – creating an integrated approach to the management of wastewater can be an efficient and effective way to reduce environmental impacts arising from the generation of contaminated water as well as water use –
   - The construction of a common wastewater treatment plant for the estate can result in a more cost- and environmentally- effective form of treatment. By combining activities for the estate with wastewater treatment for a neighbouring community, the water treatment plant can often be maintained at a higher level of activity.
   - Water leaving a treatment plant need not be sent to the river or drain. It is often of a suitable quality for re-use in the estate, even if only for irrigation.
   - In some areas, artificial wetlands can serve the purpose of treating certain types of wastewater, while natural wetlands provide an effective and cost-effective form of stormwater management.
5. Materials management – the estate management may consider providing a service to companies to handle wastes, by-products or unused materials –
   - Creation of a recycling centre for the estate is one possible initiative that will reduce environmental impacts.
   - Development of a treatment facility can provide an effective way to address the problem of hazardous wastes on larger estates.
   - Construction of an incinerator or the operation of a controlled landfill for the estate.

   The latter two options at first appear to be environmentally “unfriendly” if we think about pollution prevention as a strategy for the estate. The environmental advantage of centralising these environmental services derives from the possibility to better control at an estate-level the companies’ activities with respect to waste disposal.
6. Buildings - opportunities to create more environmentally-compatible buildings exist as a result of recent innovations in sustainable architecture. Industrial estates can promote such building approaches through the codes, covenants and restrictions that are used to guarantee that buildings on estates meet official standards.

Although many of the environmental management tools that we have described above will be implemented during the operating phase of the estate, and we shall come back to them in Chapter 6.4, they require the infrastructure to be put in place during the initial construction phase of the estate.

6.3 THE IMPLANTATION OF NEW COMPANIES.

Once the industrial estate has been finalised as a concept and companies start to show interest in locating in the estate, the question will arise of what environmental criteria are to be used in the admissions policy for the estate. Traditionally the factors influencing admission were (UNIDO, 1997):

- Whether the new company is compatible with existing or prospective businesses in the estate.
- The level of technology utilised within the company.
- The employment it will generate.
- The use that it will make of local resources.

To these factors we may now add the potential environmental impact of the company if it were to locate in the estate. In order to address this question, the Jebel Ali Free Zone in Dubai requires that an Environmental Impact Assessment (EIA) be carried out for each new company (UNEP, 1997). However, this is not uniformly the case for all industrial estates.

It is worthwhile mentioning the European Union Directive 97/11/EC on the use of EIA's. This directive lists industrial estate development projects only under Annex 2 (projects that require a case-by-case examination as to whether an EIA needs to be carried out) and this only applies to the infrastructure project itself. The Annex 1 projects (those automatically requiring an EIA) refer to very large projects or integrated chemical installations and is unlikely to be applicable to companies interested in locating in the majority of industrial estates. Indeed, the types of companies that would typically be found in an industrial estate are also to be found in Annex 2. Logically speaking, this is a very surprising situation since the large number of different activities being carried out in an industrial estate means that the cumulated impacts of the estate might well be as important as an Annex 1 project.

Therefore, an estate that requires an EIA before admitting a new tenant company would probably be viewed as very strict at the moment. Nevertheless, prospective companies can be requested to provide information on the environmental aspects of their activities so as to evaluate the load that they would put on waste treatment plants in the estate, for example. Some of the activities that need to be considered are listed in the box below. The estate may then ask the company, as a requirement for admission to the estate, that it set up some form of in-house, preliminary treatment for its waste before the estate service will accept it in the common treatment plant.

Identifying Potential Environmental Impacts of a New Locator Company.

The following activities may give rise to environmental impacts:

- ⇨ Operation of production or other processes.
- ⇨ Supply of materials, power, water.
- ⇨ Combustion of fuels.
- ⇨ Storage, handling or transport of hazardous materials.
- ⇨ Release of residues to air, water, soils, sewerage system.
- ⇨ Release of light, heat, noise, vibration, other radiation.
- ⇨ Generation and disposal of wastes - process wastes, surplus materials, hazardous wastes.
- ⇨ Use of hazardous materials.
- ⇨ Accidents - explosions, releases, spills, fire, *etc.*
- ⇨ Vehicle movements on and off site.
- ⇨ Housing and facilities for the workforce.

Source: European Commission, 1996.

This stage of the admission procedure therefore can be very beneficial to the estate manager because knowing the companies' environmental problems is in fact the first step towards the creation of an environmentally responsible management of the estate itself. Knowledge of the environmental aspects of a company's activities allows the estate manager to identify opportunities to optimise resource efficiency through the creation of by-product synergies between companies or through some form of energy efficiency programme.

Whether an estate manager demands an EIA from a prospective company or merely requests information on the environmental aspects of the company's activities, the outcome is that the estate manager is then fully aware of the activities of the tenant companies. As a result, this avoids the situation where an estate manager can claim that problems with air or water pollution arising from the activities of tenant companies are not part of the manager's responsibility.

It is important to mention here a programmatic Environmental Impact Assessment approach that has been developed by the PRIME Project Team with the PNOC Petrochemical Development Corporation for an industrial estate in the Philippines (PRIME, 2001). The project team first carried out a baseline study of the environmental impact of the industrial estate including –

- a study of the carrying capacity of the receiving environment (air , soil and water) and the actual discharges to it,
- an environmental risk assessment, and
- an environmental health impact assessment.

In collaboration with the Department of the Environment and Natural Resources, a single Environmental Compliance Certificate (ECC) was developed for the whole estate. As a result, when a new company wishes to locate in the estate, the management group can assess whether the environmental impact of the company's activities is compatible with the ECC of the estate. For example, since the estate management knows the carrying capacity of the area with respect to air pollutants such as SO_2 or NOx and the amount of these pollutants currently being emitted, they can then decide what emissions profile for the new company will allow the estate to remain within the carrying capacity limit.

Although this means that the company must provide detailed information on its environmental aspects, the advantage for the company is that it does not need to obtain its own ECC. This can result in the time for it to carry out its project development and start operations being reduced by 6 months to 1 year.

This is a very interesting approach and is part of a larger effort towards creating an eco-industrial park (see Chapter 7) that also includes a synchronised introduction of environmental management systems by the estate management and the locator companies.

6.4 THE OPERATING PHASE.

During the day-to-day operation of an industrial estate, the tenant companies (the locators) and the estate management need to work together to reduce environmental impacts. This requires the use of a range of different strategies and tools. Some strategies, such as Cleaner Production and Eco-efficiency, are best addressed at the level of individual companies. Other activities are better implemented at the level of the whole industrial estate if the maximum benefit is to be obtained. Examples are by-product synergy projects, integrated waste management, or emergency response measures.

The role of the manager of the industrial estate is very important in seeking ways to combine the activities of the individual companies and those of the estate management into a coherent environmental programme. The estate manager's role can be broken down into two parts:

⇨ promoting an environmental programme to the management of the individual companies through various strategies and tools, and

⇨ co-ordinating companies' activities with those being carried out at the estate-level.

We shall initially present some ideas of what the manager of the industrial estate can do to promote an environmental programme within the estate.

6.4.1 PROMOTING AN ENVIRONMENTAL PROGRAMME.

The manager of an industrial estate must endeavour to establish an environmental policy for the estate that will give a sense of direction to an environmental programme. Key issues that an environmental policy needs to address are - (i) the estate's vision with regard to the environment, (ii) the estate's commitment to adhere to principles such as continual improvement and pollution prevention, (iii) a willingness to comply (at the minimum) with environmental laws and regulations, and (iv) the desire to maintain an open communication with all key stakeholders and interested parties.

The manager must also promote the idea that the introduction of an environmental programme is an important benefit for both the tenant companies as well as for the estate. What arguments does the manager have?

1. For the tenant companies the environmental programme will help them to locate wastage and inefficiency in their operations, thereby resulting in cost savings. While it is sometimes said that developing and implementing an EMS is time-consuming and

costly at the beginning, the resulting efficiency and operational improvements clearly lead to long-term cost savings.

2. Many companies, whose activities are focussed on high quality products for export markets, have realised that a total quality management system, including an environmental component such as ISO 14001 (ISO, 1998), is very important for the image of their company and hence the success of their sales. For example, many industries in the high-technology industrial estates in Malaysia, particularly in the electronics sector, have sought ISO 14001 acceptance of their EMS. By 1998, 32 companies (mostly multinationals) had been successful (US-AEP, 2000).

Some of the benefits to an industrial estate of introducing an effective environmental programme are -

1. It enhances the image of the estate, and through this the image of the tenant companies.
2. The estate therefore becomes more attractive when recruiting prospective tenants and the value of being located in the estate increases. In addition, if investors are satisfied then access to capital is usually improved.
3. The fact that the estate as a whole demonstrates reasonable care, by giving priority to prevention over remediation, helps to improve relations with government and local communities. The estate and its tenants are perceived to be willing to go beyond mere compliance with environmental regulations. One result of this improvement may be in facilitating the approval of permits;

The manager, therefore, should have good reasons to want to introduce an EMS, and be able to convince the tenant companies of its value. The alternative may be a situation similar to that described in the Box below.

From "Environmental Mess in Taiwan", by J-F. Tremblay, *C&EN*, 1999, May 31st, p. 19.

The combination of wealth and excessive pollution leads groups of Taiwanese to oppose most industrial projects…

Last year, protesters succeeded in their efforts to kill a project to build a toluene diisocyanate plant in Taichung, where the firm concerned had promised to implement its cleanest and most advanced technologies.

a) ***ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS's).***

One way of establishing an environmental policy and then creating a coherent environmental management programme within an estate is through an environmental management system, or EMS. The best known examples are ISO 14001 and EMAS (the Eco Management and Audit Scheme of the European Union), although many companies have their own "generic" versions. These EMS's have been developed for individual companies and they are well suited to this type of management structure. In contrast they need to be adapted to the situation in an industrial estate.

In the following discussion we shall present only a brief overview of environmental management systems from an industrial estate perspective. A more complete picture of EMS's can be found in the publication *Environmental Management System Training Resource Kit*, prepared by UNEP, ICC and FIDIC in 1997 (UNEP/ICC/FIDIC, 1997) and in Section 4 of this *Information & Training Resources Manual*.

Côté & Balkau (1999) have identified four different options for introducing an EMS within an industrial estate:

- ⇨ The enterprise option,
- ⇨ The infrastructure option,
- ⇨ The comprehensive option, and
- ⇨ The environmental charter option.

These are explained in more detail in the Box on the following page.

If we look at industrial estates around the world, what is the current status with respect to these four options? Focussing initially on the enterprise option, of the nearly 15,000 ISO 14001 certificates that have been granted so far (Purcell, 2000), it is difficult to assess how many of these relate to companies located within industrial estates. The one assumption that we can make, however, is that the majority of certifications in the developing countries probably come from estate-based enterprises.

An increasing number of estates are choosing the infrastructure option. Some examples of industrial estates that have obtained ISO 14001 certification are –

- in Indonesia, the Batamindo Industrial Estate (Balkau, 2000);
- in France, the Plaine de l'Ain and Landacres industrial estates and the Vesoul Technologia park (Orée, 2000);
- and in China, the industrial estates at Suzhou and Dalian (Yang et alia, 2000).

Introducing an EMS within an Industrial Estate.

1. The enterprise option:

In this approach the estate manager may encourage companies within the estate to adopt an EMS, while allowing them to resolve their environmental problems on a company by company basis, i.e. without any overall co-ordination. The encouragement may take the form of - financial incentives, assistance by providing seminars, training or technical assistance. Although this option is relatively simple to implement it does not necessarily facilitate the building of synergies between companies or address cumulative environmental impacts pertaining to the estate as a whole.

2. The infrastructure option:

An estate can implement an EMS for its own activities and services. This approach then sets an example to companies in the estate and might even be a useful step towards the creation of a **comprehensive** EMS for the whole estate. The infrastructure option, however, is only of importance if the estate management is responsible for major services such as drainage, waste incinerators, common effluent treatment plants, solid waste collection and disposal facilities and perhaps recycling plants. In most cases the activities for which the estate management is responsible do not constitute the major environmental impact of the estate.

3. The comprehensive option:

If the estate has direct influence over the pollution activities of its tenants through permits or other contractual agreements, the estate manager can envisage developing a comprehensive EMS, such as ISO 14001, with the estate viewed **as a total interacting system**. Such an EMS would ideally be developed with the tenants as primary stakeholders.

4. The environmental charter option:

This model has been promoted in France by the Association Orée. The approach requires different stakeholders in an estate to prepare and sign a contractual charter that specifies the environmental responsibilities of each partner. Although it is not formally an EMS, it does encompass many elements of an EMS and can either be adopted in conjunction with one of the three other options or developed as an independent arrangement. A number of industrial estates or regions have developed such a charter. We can mention Les Grands Champs de Roissy-en-Brie or La Chaussée-Puiseux à Cergy Pontoise (Orée, 2000).

Côté & Balkau, 1999

IEAT, the Industrial Estate Authority of Thailand has announced plans to have all of the estates under its control certified to ISO 14001, while a few private estates in Thailand have already started the certification process (Balkau, 2000).

To our knowledge no estate as yet has obtained ISO 14001 certification as a complete entity. The one example that comes closest to this approach is the Philippine National Oil Company (PNOC) Petrochemical Industrial Estate in Bataan, the Philippines. All of the locator companies and the management group are working to obtain ISO 14001 certification. Although each entity will be certified independently, the fact that they are all going through the process at the same time and (presumably) sharing resources will lead to a more coherent and effective environmental policy for the estate (PRIME, 2001).

Finally, there are examples in France of estates that have adopted an environmental charter (as described in the Box), and proposals have been made recently to introduce a certification process for industrial estates in Thailand through IEAT (E. Lowe, personal communication).

In summary, we can conclude that two cases predominate at the moment in industrial estates –

i. Estates in which companies have implemented independently a formal EMS, and

ii. Estates where the estate management has implemented an EMS for its own activities.

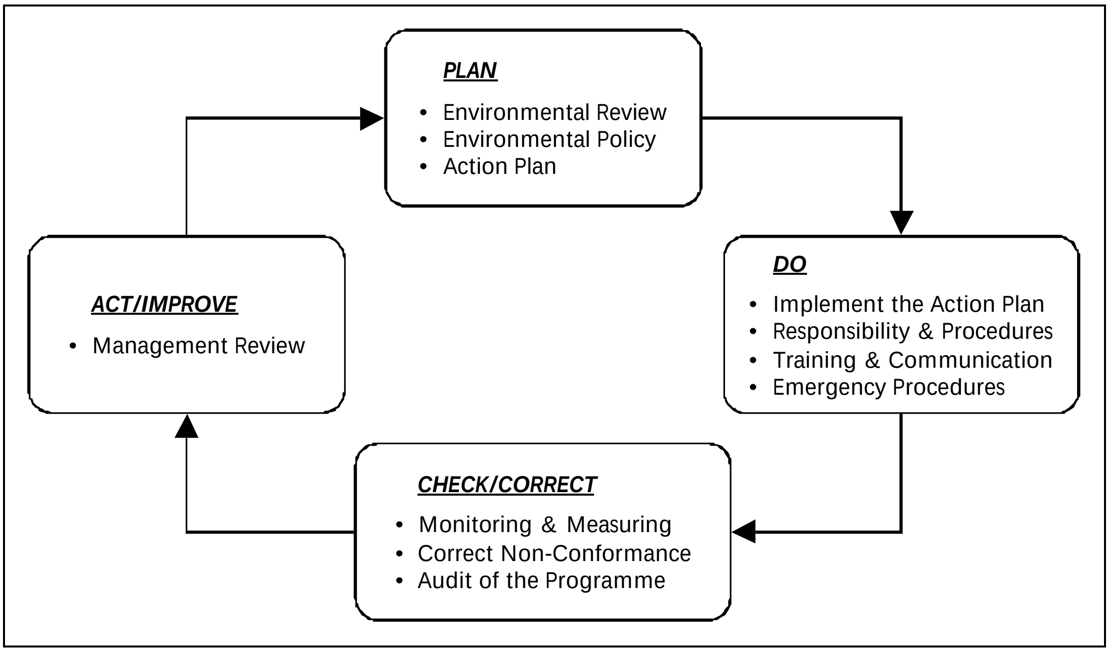
Although this is already a positive step, such estates miss the synergies that accrue when one can create an estate-wide environmental programme. The goal therefore must be to take a combination of Côté and Balkau's *enterprise* and *infrastructure* options and to turn them into a *comprehensive* approach and this **requires the industrial estate manager to play a key role in advancing the process**.

Where the estate manager does not have an EMS in place, the first step is to correct this situation. In the context of industrial estates in France, the Association Orée (Orée, 2000) proposes that an EMS for the estate management should cover the estate management office, the estate infrastructure and the services provided. For the EMS to be relevant the estate manager must, as a minimum requirement:

1. Be responsible for activities that have a significant environmental impact, such as solid waste treatment or wastewater treatment.
2. Be able to control and influence the outputs of the tenant companies.
3. Be in a position to provide training for tenant companies on EMS.

Figure 4 presents the different steps in the implementation of an EMS for a company (for more details see Section 4 of the *Information & Training Resources Manual*). We shall use this diagram in order to show the key points when putting an EMS in place in an industrial estate. In the case of an industrial estate the choice of project team to implement the EMS is very important. The Association Orée proposes that all stakeholders should be represented in the team, including government and local authorities as well as the estate manager and the tenant companies. This is relatively easy to achieve when the estate development and management are linked to the public sector.

Figure 4: Elements of an Environmental Management System (ISO 14001).



The first step is to carry out a complete audit or Environmental Review in order to identify where the actual activities of the estate may have an impact on the environment. The environmental review requires a large amount of information to be collected on material flows and mass balances, safety issues and waste handling. The structure of the team is very important for the success of this step because the environmental aspects of the estate are linked to the operations of the tenant companies and their involvement is required to establish what contribution they will make towards reducing the environmental impacts of the estate.

As a function of the results of the environmental review, the estate must then decide what objectives it will set itself and agree on the Action Plan or Environmental Programme. At this point a paper should be written, based on the objectives and actions to be undertaken, that describes the Environmental Policy of the estate. This is sometimes also called the Environmental Quality Charter (Orée, 2000).

We see now why the active participation of the tenant companies is so important to the success of the EMS for the estate since they must also agree with these objectives. This participation can be fostered in two ways: (i) Through the estate providing information to the companies on joint actions in environmental management that can be carried out, and (ii) By introducing an obligation in the contract of the tenant companies when they decide to locate on the estate. We shall come back to the more voluntary approach of the two in the next section.

The subsequent phase of the environmental programme is the implementation of the Action Plan and the monitoring of the results. The actions are then corrected if the desired results are not obtained. In view of the large number of stakeholders involved in an industrial estate, communication is an important issue during this phase. It is important to distinguish between two types of communication –

- Internal communication is aimed at informing and motivating the internal stakeholders, for example employees and owners of other tenant companies. They will undoubtedly be affected by the implementation of the programme.
- External communication is targeted at presenting the environmental performance of the estate to external stakeholders, such as the general public, regulatory authorities, or financing institutions. It is often said that the environmental report makes an important contribution to maintaining the "license to operate" of an enterprise or organisation.

Some suggestions for other ways that the management of the industrial estate can contribute in the area of communication are as follows:

- publishing on a regular basis information sheets or a newspaper,
- holding seminars and conferences,
- opening the estate to the public on certain days,
- the use of posters to describe progress being made within the estate on environmental matters,
- the creation of contact groups or advisory groups, to inform the general public about the estate's activities.

The Association Orée points out that for many small estates, the environmental programme will remain formalised through the Environmental Charter. However, for large estates this is only an intermediate step and the structure of the environmental programme will be reviewed and modified if it is found to be lacking in some areas. After a period of time, varying from 1 – 2 years, during which the management system is fine-tuned the estate will then seek ISO 14001 certification.

A questionnaire completed by 8 industrial estate managers from Thailand, Indonesia and China, during a UNEP Training Workshop, gave the following picture of environmental management in their estates:

1. The three most important environmental concerns for the estates are:

   wastewater, solid waste, air pollution.

2. Out of 8 industrial estates:

   6 have an environmental programme and a formal EMS,
   5 have tenant companies with their own EMS,
   2 have an EIA.

3. Out of the 6 industrial estates with an EMS:

   6 have monitoring of environmental quality and main sources of pollution,
   5 report and investigate environmental incidents,
   5 have a communication on environmental performance,
   4 have defined environmental responsibilities for the personnel,
   3 have a written management commitment to environmental goals.

4. In 2 estates companies work in some form of synergy.

UNEP/IEAT, 1997

Only now can the estate manager and his team really contribute to the promotion of an EMS throughout the companies in the estate. It is at this stage that the estate manager adopts a role that can be referred to as "promoting an environmental programme" for the whole estate. Referring back to Figure 4, one way that the estate manager can encourage environmental management is by providing a small team of qualified people who can work with a tenant company to help them to put in place an EMS. Small companies may not have sufficient resources (human or otherwise) to do this alone and this can represent a significant service to be offered by the estate to the company.

Alternatively, the estate manager may contribute in the area of training. Within each company everybody must know what he or she is responsible for, whom they report to and who reports to them. For this to occur all employees must be brought to a suitable level of understanding of the environmental issues associated with their work and how their actions affect the environmental performance of their enterprise.

The estate management can offer training on a wide range of environmental issues to the tenant enterprises or help to develop common training programmes. The goals of these programmes might be: improving general environmental awareness of all staff, creating specialist skills needed to implement the environmental programme such as an understanding of environmental laws and regulations, or management training to help with implementation of the system. The *Environmental Management System Training Resource Kit*, prepared by UNEP, ICC and FIDIC, can provide the groundwork for building such training programmes.

The estate provides a number of environmental services to the tenant companies and these activities are covered by the EMS of the estate manager. However, the estate may offer other services to companies that help them in the implementation of their own EMS (see for example the Box below). Examples of such services are in integrated environmental management, resource efficiency, environmental legislation and permitting, and emergency response to accidents. Since the estate manager will have an overview of the different activities on the estate, this will allow collective solutions to problems to be discovered. We shall discuss some of these topics in more detail later in the chapter.

Environmental Services.

The Estate Management can provide many environmental services to their tenants as an integral part of the overall offer of services and activities–

- Supply of water,
- Centralised supply of heating and/or energy,
- Waste recovery and valorisation (by-product synergies),
- Collection and treatment of wastewater,
- Collection, treatment and disposal of hazardous waste,
- Collection and disposal of solid waste,
- Training on environmental issues,
- An information service on environmental issues (environmental regulations, new technologies, new waste minimisation concepts etc),
- Environmental monitoring,
- Environmental auditing,
- Provision of services and advice for emergency situations, such as accidents.

adapted from Yang et alia, 2000

Finally, the estate manager must already monitor the environmental parameters of the estate as part of the estate's EMS. Examples of areas where such monitoring is necessary in an industrial estate are shown below (UNEP, 1997):

- ambient environmental quality,
- emissions to water and air,
- solid waste generation (including hazardous waste),
- storage of hazardous goods on site,
- accidents and spillages, and

- procedures for the control of safety and pollution.

The manager can also provide a service to companies to monitor their in-house emissions and waste as part of the EMS of the companies. This approach therefore provides a collective solution to environmental monitoring that will allow small and medium companies on the estate to share the costs of implementing their environmental policy.

While this does not correspond to the comprehensive approach of Côté and Balkau (1999), which requires one EMS to be established for the whole estate, an industrial estate in which the estate manager and all of the tenants are ISO 14001 certified represents a significant advance on the path to reducing environmental impacts. The one area in which this approach may fail is where environmental aspects do not appear to be important on a company-level although they are very important when the overall activities of the estate are considered. An example might be in water or energy consumption, or greenhouse gas emissions. This requires the estate manager and the tenant companies to work together through their individual EMS's to address these collective objectives. It comes down to a question of communication in the end.

In this respect, perhaps the most important feature of being able to introduce EMS's within an industrial estate is that it allows everybody, both tenant companies and the estate management, to speak the same environmental language and to work towards similar goals for the estate. Each company will achieve its goals in its own way – its workers are undoubtedly the most knowledgeable about its processes and how to address the environmental aspects of them. However, this will hopefully open up the possibility of collaboration to solve environmental problems, as we see with the case of Kalundborg. As Peck has noted (Peck, 1997):

"… *opportunities for such linkages will improve as the application of Environmental Management Systems and Life Cycle Management practices becomes more widely accepted as an important business tool*."

b) *VOLUNTARY INITIATIVES.*

Probably the most difficult problem facing the manager of an industrial estate is how to create a coherent environmental policy and programme for the estate, bearing in mind the diverse nature of the companies. We mentioned earlier that the participation of the tenant companies in the process could be made obligatory when they locate on the estate. However, in older industrial estates this participation must be fostered by the estate manager and this can be difficult. Fortunately, some other sectors of industry have already faced such problems and their responses can serve as an important guide to the estate manager.

Responsible Care.

The Responsible Care initiative of the chemical industry provides some very interesting pointers to approaches that can be used in an industrial estate. In both cases – (i) there is an administrative group that oversees the activities of a diverse group of members, and (ii) the administrative group has relatively few legal means to oblige its members to adopt better business practices, in particular in the environmental area. The chemical industry has been relatively successful in persuading its members of the value of adhering **voluntarily** to the Responsible Care programme. The manager of an industrial estate might well be inspired therefore to look at a voluntary approach such as Responsible Care when seeking ideas for implementing an environmental management programme for the estate.

The chemical industry launched its Responsible Care programme in the 1980's in response to public concern about the safety of chemical manufacturing after accidents such as the one in Bhopal, India in 1984. This voluntary programme now covers between 85 – 90% of world-wide chemical production (ILO, 1998).

The Responsible Care Programme provides a structure by which a national chemical association can co-ordinate the efforts of its member companies to improve their performance in the areas of health, safety and environment. There are a number of fundamental features of the Responsible Care Programme (see Figure 5), the first being that all members must adhere to a set of Guiding Principles. The Guiding Principles of the Canadian Chemical Producers' Association for example include – a responsible attitude to manufacturing activities, providing information on hazards and associated risks of activities and products, laws and regulations relating to manufacturing, and interactions with communities and governments (UNEP, 1998). The programme is evolving, however, and

Figure 5: The Fundamental Features of Responsible Care.

1.	A formal commitment to a set of Guiding Principles by each participating company.
2.	A series of Codes, Guidance Notes or Checklists to assist companies to implement the Responsible Care commitment.
3.	The progressive development of indicators against which improvements and performance can be measured.
4.	An ongoing chemical association and member company process of communication on environmental health and safety matters with interested parties outside the industry.
5.	Provision of forums in which company CEO's and Responsible Care co-ordinators can share views and exchange experiences on implementation of the commitment.
6.	Systematic procedures to externally verify the implementation of the various elements of Responsible Care by the member companies.
7.	Consideration of how best to encourage all association member companies to commit and participate in Responsible Care.
8.	Adoption of a title and logo which clearly identifies national programmes as being consistent with and part of the concept of Responsible Care.
9.	The Responsible Care fundamental features are intended to insure global consistency of the initiative for the chemical industry and for its stakeholders.

Source: D. Roczniak, *American Chemistry Council* [OECD, 1997]

the guidelines in the United Kingdom have recently been updated to include resource conservation (Stevenson, 1999).

The programme also provides support to companies through Codes of Management Practice to help them to put into effect their commitments. The codes at present cover six areas – pollution prevention, process safety, employee health and safety, community awareness and emergency response, distribution (transport, handling), and product stewardship. An excerpt from a Code of Practice for Pollution Prevention is shown in the Box on the next page, and we see that there are clear statements about what the chemical company is expected to do in the area of Pollution Prevention.

Also although the programme was initially voluntary and administered within the chemical industry, there is increasing interest in opening it to independent verification. At the present a compulsory verification programme exists in Canada while the USA and the UK have introduced voluntary independent verification programmes (Reisch, 2000).

Each member company shall have a Pollution Prevention Program that shall include:

1. A clear commitment by senior management through policy, communications, and resources, to ongoing reductions at each of the company's facilities, in releases to the air, water, and land and in the generation of wastes.
2. A quantitative inventory at each facility of wastes generated and releases to the air, water, and land, measured or estimated at the point of generation or release.
3. Evaluation, … , of the potential impact of releases on the environment and the health and safety of employees and the public.
4. Education of, and dialogue with, employees and members of the public about the inventory, impact evaluation, and risks to the community.
5. Establishment of priorities, goals and plans for waste and release reduction, …
6. Ongoing reduction of wastes and releases, giving preference first to source reduction, second to recycle/reuse, and third to treatment …
7. Measurement of progress at each facility in reducing the generation of wastes and in reducing releases to the air, water, and land, by updating the quantitative inventory at least annually.
8. Ongoing dialogue with employees and members of the public regarding waste and release information, progress in achieving reductions, and future plans …
9. Periodic evaluation of waste management practices … taking into account community concerns and health, safety, and environmental impacts and implementation of ongoing improvements.
10. Implementation of engineering and operating controls at each member company facility to improve prevention of and early detection of releases that may contaminate groundwater.

…

excerpts from the Codes of Practice, American Chemistry Council

The Relevance to Industrial Estates.

In the context of an industrial estate the dual concept of Guiding Principles and Management Codes of Practice appears to be particularly promising when setting up an environmental management programme. Cohen-Rosenthal and the group at the Cornell Centre for the Environment have recently published a *Handbook on Codes, Covenants, Conditions, and Restrictions for Eco-Industrial Parks* (Cohen-Rosenthal, 2000) that discusses codes of practice for eco-industrial development. Covenants, Conditions, and Restrictions (CC&R's) are used routinely by developers of industrial parks or estates to "promote the long-term viability of the park in the marketplace" by setting standards for some activities and listing other activities that are prohibited within the estate (Cohen-Rosenthal, 2000). In broadening the scope of the traditional CC&R's, Cohen-Rosenthal lists six areas that should be considered:

1. Design of the estate – including the use of materials, the site plan, landscaping and construction.
2. Resource use – how to minimise energy consumption, raw material use (including water), and the generation of waste.
3. Transportation and infrastructure – the type of transportation system to use for people and goods outside and inside the estate.
4. Emissions and pollution – balancing pollution prevention activities with the need for infrastructure for waste treatment, as well as efforts to provide environmental support services.
5. Social and community issues – such as the type of work environment and employment, as well as the interaction between the estate and the local communities.
6. Management – what type of management structure is best adapted to the needs of an eco-industrial development project.

The Eco-Business Programme – Burnside Industrial Park.

A concrete example of how voluntary initiatives can be applied within an industrial estate is provided by an Eco-Business Programme that has been started by the Eco-Efficiency Centre of the Burnside Industrial Park in Dartmouth, Nova Scotia in Canada.

The mission of the Eco-Efficiency Centre is to work with companies to support "financial efficiency and ecological effectiveness". The goals are to demonstrate that carefully considered choices can have positive financial and environmental impacts, and to help companies to locate the right solution for their problems.

How is this put in practice? The Eco-Efficiency Centre works with tenants to convince them that active membership in the Eco-Business Programme will bring about cost savings and help to improve the image of the Burnside Park within the local communities. A Code of Eco-Efficiency and Environmental Excellence has been created (see Figure 6) and companies can either decide to adopt it or register their own environmental policy as a surrogate for it. We find many of the elements of a Management Code of Practice, described earlier, in this document. Since it is non-binding, it provides an initial access to the companies within the park without imposing too many conditions on them.

The Eco-Business Programme is designed to introduce the small businesses in the park to the ideas of an environmental management system in a more "informal" and manageable way. Thus the Code of Eco-Efficiency and Environmental Excellence is in many respects equivalent to an Environmental Policy (see Figure 4). The company is called upon to identify its environmental aspects (the Environmental Review) and to set objectives and targets (so as to create an Action Plan). The Eco-Efficiency Centre provides assistance to the companies during the implementation phase if they require it. The companies are then eligible for an Eco-Efficiency Centre Award of Environmental Excellence. The evaluation for this award serves a similar purpose to the Management Review in a formal EMS in that it verifies that the environmental management programme is functioning correctly. It is to be hoped that once the companies are in the programme, they will use this as just the first step to a more concrete environmental management plan through a formal EMS. Further information can be found on the Burnside website – www.dal.ca/eco-burnside.

In this first section we have discussed how an environmental policy and programme can be introduced within an industrial estate through the use of environmental management systems and how voluntary initiatives can help to promote such an approach. While these two tools create the organisational structure for environmental management, we must now turn to the strategies and tools that companies and the estate can actually use to improve their environmental and business performance.

Figure 6: The Code of Eco-Efficiency and Environmental Excellence for Burnside Businesses.

[Eco-Efficiency Centre in Burnside, Canada]

1. We are committed to reducing the environmental risks associated with the manufacture, distribution or sale of our products and services.
2. We will educate our employees and customers on relevant environmental issues. We will encourage our suppliers, employees and customers to strive for environmental excellence.
3. We will periodically review our operational procedures and use appropriate opportunities to improve our environmental performance.

Where practicable and applicable, we will:

- Manage our affairs in ways that reduce the generation of solid waste. We will separate and divert materials from landfills;
- Reduce discharges of liquid wastes into sewers and minimise the discharge of toxic and corrosive materials;
- Promote efficiency and the conservation of energy and water, by educating our staff and applying innovative technologies and conservation practices;
- Reduce the generation of greenhouse gases associated with manufacturing, distributing and transporting our supplies and products;
- Re-use and recycle products and materials; and
- Use recyclable, reusable, and/or returnable packaging.

6.4.2 <u>CLEANER PRODUCTION</u>.

a) THE STRATEGY.

"ISO 14001 provides a series of organisational elements for environmental management with which organisations can do whatever they feel is appropriate. A detailed knowledge of Clean[er] Production is required to make the ISO organisational elements into functions that result in improved environmental and business performance." This is how Heinke et alia (1997) present the link between an EMS and Cleaner Production.

Cleaner Production is a concept for reducing environmental impacts that was initially introduced by UNEP in 1989. Over the years the concept has evolved and a recent definition of Cleaner Production is given in the Box below. In an industrial estate a Cleaner Production programme is likely to be adopted at the level of individual companies. The role of the manager of the industrial estate, therefore, is to *promote Cleaner Production as a strategy within the tenant companies.*

An important part of adopting a Cleaner Production strategy within a manufacturing context is for the company concerned to carry out a Cleaner Production Assessment. If Cleaner Production is a strategy for a company, the Cleaner Production Assessment is the primary tool that is used to follow that strategy.

> "Cleaner Production is the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase eco-efficiency and reduce risks for humans and the environment. It applies to:
>
> - *production processes* - by conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and the toxicity of all emissions and wastes
> - *products* - for which it seeks to reduce negative impacts throughout the life-cycle of the product, and
> - *services* - where it is concerned with taking environmental criteria into consideration when services are designed or delivered."
>
> UNEP/WBCSD, 1996

The Cleaner Production Assessment is used to identify sources of environmental concern - the environmental aspects associated with a company's activities. A central part of the assessment is an analysis of the material and energy flows associated with the company's processes. This allows the company to pinpoint the source and the cause of inefficiency in its operations. Looking at resource efficiency, for any production process there are five factors that can influence the type and the quantity of a waste stream – the choice of raw materials, the type of technology that is being used, how the process is carried out, the desired product, and the nature of the waste.

The company decides where opportunities exist to modify any of these parameters in order to reduce waste or emissions. A modification of any of the first four parameters represents an example of *source reduction*. Opportunities for modifying the fifth parameter come from the use of waste materials or residues back in the same process (*in-process recycling*) or in other processes (*on-site recycling*). The company then analyses the feasibility of each option from a technical, economical, organisational and environmental point of view before deciding what action to take based on its knowledge of the key environmental, health and quality issues. Further information on carrying out this type of assessment is to be found in van Berkel et alia (1997) and in UNEP (1995).

A comparison of the Cleaner Production Assessment with the different steps for implementing ISO 14001 (Figure 4) shows that the assessment covers similar ground to the Environmental Review and the creation of the Action Plan. In fact a complete Cleaner Production programme covers the implementation of the Action Plan, as well as the monitoring and evaluation of the results. Cleaner Production therefore can be considered as putting some "meat on the bones of ISO 14001" (Heinke et alia, 1997).

b) PROMOTING CLEANER PRODUCTION.

An extremely important task for the manager of an industrial estate is to promote Cleaner Production within the estate. There are essentially three arguments that can be used to motivate a tenant company (UNEP, 1995) –

1. *economic benefits*, such as reductions in production costs due to improved process efficiency, reduced costs for end-of-pipe treatment, and lower insurance costs due to reduced liability.
2. *environmental* benefits, including improved air and water quality for the surrounding communities due to reduced emissions.
3. the demonstration of a *responsible behaviour* by reducing the risk to workers and the community, as well as by managing resources and energy in a careful way.

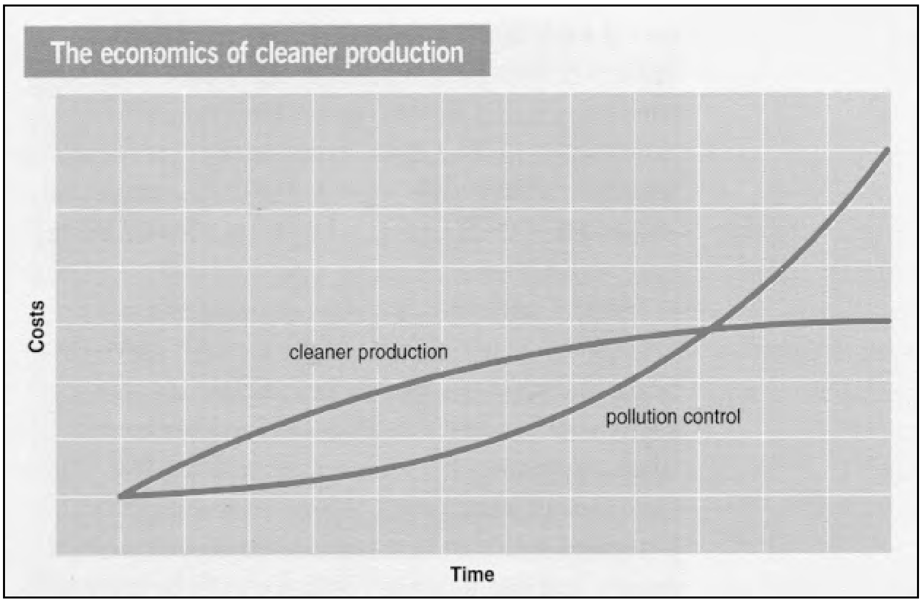
Examples of environmental and economic benefits that have been discovered by companies as a result of carrying out Cleaner Production assessments can be found in the different publications by UNEP-DTIE (for example UNEP - 1993, 1994a, 1996a). In 1998, UNEP launched an International Declaration on Cleaner Production in order to increase awareness and understanding about the concept of Cleaner Production. The text and background to the declaration can be found on the UNEP-DTIE website (UNEP-DTIE, 1998).

However, some companies still remain sceptical about the advantages of introducing a programme like Cleaner Production. Nearly 50% of UK companies surveyed in the mid-1990's had no plans to introduce a programme to reduce the amount of waste and moreover did not even monitor the cost of the waste that they were generating (Jackson, 1996)! This attitude is difficult to understand at first. A study of the impact of waste reduction at source programmes in the US chemical industry has shown that more than three-quarters of the projects resulted in money being saved overall, while payback times of less than 6 months were attained in two-thirds of the reported cases (Huisingh, 1986).

> The UK Environment Council has estimated that the adoption of simple resource-saving measures could save industry £70 per employee.

The fact that there may be initial costs associated with introducing Cleaner Production options is certainly responsible in part for this "scepticism". However, when these costs are compared (Figure 7) with those for the alternative - end-of-pipe technology - we see that Cleaner Production works out to be more economical in the long term (UNEP, 1999). Some other barriers to the introduction of Cleaner Production, that have been drawn principally from the Asia Pacific region, are shown in the Box on the following page.

Figure 7: The Economics of Cleaner Production (reproduced from UNEP, 1999).



Some Barriers to Cleaner Production in the Asia-Pacific Region.

Legislation –

In some countries Cleaner Production is not considered as an environmental management option. Pollution control is favoured over Cleaner Production through the provision of soft loans to companies investing in end-of-pipe technology.

Policy –

If the pricing of water and energy does not reflect the true cost, then there is little economic incentive to conserve resources. Similarly, if there are no taxes on the discharge of wastewater, for example, there is little encouragement to minimise waste.

Knowledge –

Many professionals in companies and in governments have little knowledge or experience of Cleaner Production. Training in Cleaner Production has not always reached people who are in a position to promote Cleaner Production (such as those in the financial sector, regulators and policy makers, or industry experts).

Values –

Some companies believe that the environment is not a priority issue and resist making Cleaner Production changes to their normal way of operating. If environmental standards are poor in the region, there is little pressure to improve.

Technical Obstacles –

The need to modify installations, processes, and even raw materials and products as part of a Cleaner Production programme frequently reveals technical problems.

Source: UNEP, 1994b, 1998

Examples of concrete initiatives that the manager can introduce to help to promote Cleaner Production are –

1. If the industrial estate carries out waste treatment for the tenant companies, such as effluent treatment or hazardous waste disposal, then it must create the right financial incentives to favour companies who introduce waste reduction measures.
2. Energy conservation should also be rewarded financially.
3. Information on Cleaner Production techniques and methodologies is often lacking in smaller companies. The first step for an industrial estate then should be the creation of a small team of people who can (i) inform the companies about opportunities associated with Cleaner Production, and (ii) present demonstration projects from other estates as an example of what is possible. An example of this approach is the Eco-efficiency Centre in Burnside Industrial Park (see page 61). The estate manager may even provide training to tenant companies in Cleaner Production if there is sufficient need.

4. Small- and medium-size companies often lack the resources to introduce programmes such as a Cleaner Production programme. The industrial estate can consider offering an environmental service to help with conducting Cleaner Production Assessments.
5. Companies may also lack financial resources for implementing Cleaner Production options, and the estate manager may be helpful in arranging loans for them.
6. On-site recycling is a part of the Cleaner Production approach, and the estate manager can help with finding synergies within the estate. We shall describe this in more detail later.
7. Publicising successful results within the estate is a good way to promote the programme.
8. As we shall discuss later, regulations or policies that date from the command-and-control period of environmental protection often hinder preventive approaches to environmental issues. If the management of the estate is linked to the government (i.e. a government managed estate or joint-venture), the estate manager can bring these problems to the attention of the authorities as a way of helping to create a more supportive atmosphere for preventive measures.

We see therefore that Cleaner Production in an industrial estate is very much a company-level activity. On the other hand, promotion of Cleaner Production is clearly a task for the estate manager. We have focussed here on the process-related aspect of Cleaner Production. However, once companies have been introduced to these concepts, they may well decide to look also at the product-related aspect through Life Cycle Analysis.

6.4.3 **ECO-EFFICIENCY**.

Having spoken about Cleaner Production, we shall also mention a closely related strategy – Eco-efficiency. UNEP and the World Business Council for Sustainable Development (WBCSD) have considered the similarities between the two approaches in two booklets (UNEP/WBCSD, 1996; UNEP/WBCSD, 1998). They comment that - “Eco-efficiency starts from issues of economic efficiency which have positive environmental benefits, while Cleaner Production starts from issues of environmental efficiency which have positive economic benefits.” (UNEP/WBCSD, 1996)

WBCSD points to the following factors as contributing towards Eco-efficiency within a company (WBCSD, 1996) –

> Eco-efficiency and Cleaner Production have much in common. They both help companies in their quest for continuous improvement in minimising their consumption of resources, reducing environmental burdens and limiting concomitant risks and liabilities.
>
> UNEP/WBCSD, 1998

- reducing the material and energy intensities of goods and services,
- reducing the dispersion of toxic materials,
- enhancing the recyclability of materials,
- maximising the sustainable use of renewable resources,
- increasing the useful lifetime of materials, and
- increasing the service intensity of goods and services.

Eco-efficiency can be introduced at different stages of a company’s activities by –

- ⇨ Developing eco-efficient or optimised processes that result in resource savings and the minimisation of risk.
- ⇨ Revalorising by-products, waste materials and energy, including through co-operation between companies.
- ⇨ Creating new and better products that follow eco-design principles.
- ⇨ Promoting more sustainable markets by the search for products and services that allow the closing of material loops and a more efficient use of industry [for further information see the WBCSD Internet site (WBCSD, 2000)].

In the context of an environmental management programme for an industrial estate, the estate manager can promote the *strategy* of Eco-efficiency, in a similar way to Cleaner Production, by focussing on the economic advantages to the tenant companies of more eco-efficient processes and the revalorisation of materials and energy. In this respect, the use of *eco- efficiency indicators* (WBCSD, 2000), either by individual companies or at the

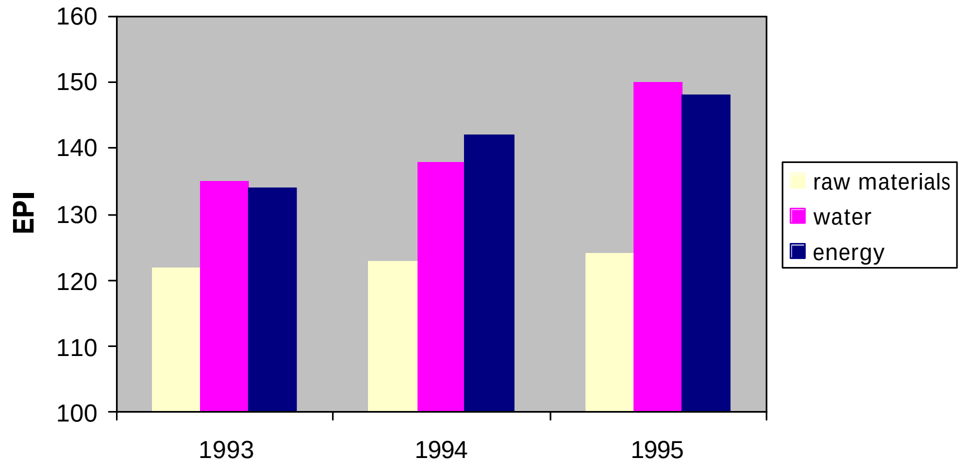
Novo Nordisk.

Novo Nordisk, one of the partners in the Kalundborg Industrial Symbiosis, has developed an eco-efficiency indicator - what they call an Eco-productivity Index or EPI - to monitor resource utilisation in their production processes (WBCSD, 2000).

The EPI indicator relates turnover (the *product value*) to the *resource consumption* for raw materials, water and energy, with 1990 taken as the base year (= 100):

$$EPI = \frac{\text{indexed turnover}}{\text{indexed resource consumption}} \times 100$$

By comparing EPI values from one year to the next, Novo Nordisk is therefore able to assess their environmental performance. The larger the EPI, the more efficient they are with using that particular resource (Novo Nordisk, 1995).



level of the estate, represents an extremely useful *tool* with which to follow progress in resource efficiency.

A typical way of representing eco-efficiency is via the equation given below:

$$\text{Eco-efficiency} = \frac{\text{product or service value}}{\text{environmental influence}}$$

where the *quantity* or the *sales value* of the product is an example of product or service value, and the environmental influence can be measured in terms of the *consumption of energy, raw materials or water, or the quantity of emissions*. By tracking the evolution of the eco-efficiency over time, one then obtains an *indicator* of how the environmental performance of the company or organisation is really evolving. An example of how eco-efficiency indicators can be useful to a company is given in the Box above.

A second type of eco-efficiency indicator, the *eco-compass*, was developed by DOW Chemical in Europe and considers the environmental impact of a product throughout its lifecycle (Fussler, 1996). It assesses the product in terms of six parameters – resource conservation, the potential risk to health and the environment, energy intensity, mass intensity, opportunities for revalorisation (e.g. remanufacturing, re-use and recycling), and service extension or durability. It is possible to restrict the use of the eco-compass to a part of the product lifecycle, such as the manufacturing sector, and use it to monitor the eco-efficiency of processes. In this case mass intensity refers to the amount of new raw materials needed, revalorisation corresponds to the recovery of by-products or waste as useful materials for other processes, and resource conservation relates to the use of resources such as water. Service extension is not relevant in this case.

An example of the use of the eco-compass as an indicator of eco-efficiency during the production phase is given in the Box *overleaf*. This case study, described in Fussler's book (Fussler, 1996), derives from work carried out by UNEP-DTIE as part of a project towards a Cleaner Production strategy in China (UNEP, 1996b).

The two points of particular interest with the eco-compass are that – (i) it allows one to see a complete picture of the eco-efficiency of the production phase relative to a previous situation in a single diagram, and (ii) the economic factor is only introduced indirectly. The eco-compass is not unique and we should also mention BASF's Ecoefficiency Analysis, which uses an "ecological fingerprint" of a process that is based on – materials and energy consumption, emissions, hazard potential and toxicity (BASF, 1999).

In summary, eco-efficiency indicators are designed to help management –

- evaluate performance,
- set environmental objectives, and also
- initiate actions for improvement.

In an industrial estate, eco-efficiency indicators are therefore extremely useful at the **company level** to monitor progress in reducing environmental impacts. But they are also valuable tools at the **level of the industrial estate** for monitoring the environmental performance at the estate level over time. It is important to remember that if continuous improvement in environmental performance is to be a goal of the industrial estate, suitable and meaningful indicators need to be used to check on the improvement … or otherwise.

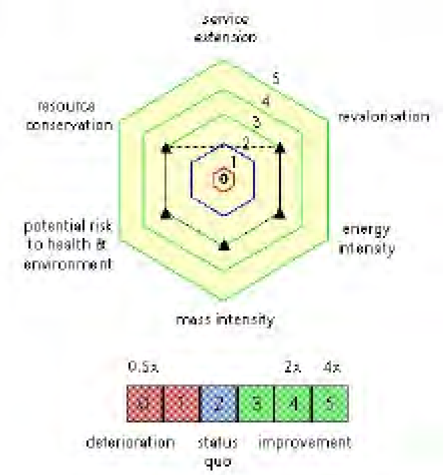
The Beijing Chemical Factory N° 3 carried out a Cleaner Production assessment in 1993, in order to reduce its pollution of a local river system by organic wastes. A mass balance study of the plant revealed how much waste was being generated by different sectors of the factory and showed that nearly half of the waste was coming from the production of a single chemical - penta-erythritol. Focussing on this part of the plant, the Cleaner Production team set itself the objective to reduce the amount of waste discharged by at least 50%. They discovered the reasons why the waste was being created and identified a number of options that could be introduced to achieve the objective. Amongst the options were -

- better process control, improved maintenance and better training, and
- on-site recovery of a by-product as a raw material.

They then tackled another sector of the plant, the production of butyl acetate, that was also creating appreciable water pollution. The Cleaner Production assessment revealed options for reducing the consumption of raw materials, energy and water as well as for cutting water pollution.

The eco-compass for this case is shown below. The situation at the time of the Cleaner Production assessment is, by definition, given a value of 2 for each relevant parameter (in this case service extension is not included). Improvements are rated from 3 - 5 depending on their importance, and a deterioration is indicated by a score of 0 - 1.

The **black triangles** indicate the situation after completion of the improvements. We see that the improvements at the Beijing Chemical Factory rate a value of 3 on average, indicating that they are significant but not yet equal to a Factor 2 or 4 in magnitude. For example, although the waste discharges to the river system have been greatly reduced, they are not yet down to 50% of the original values, which would warrant a value of 4.



6.4.4 BY-PRODUCT SYNERGIES.

We have seen how, at the company level, knowledge of the flow of materials is essential for carrying out a Cleaner Production assessment. From the quantities of the inputs (raw materials, solvents and energy) and outputs (products, residues and emissions) the material and energy losses can be identified, and opportunities found for preventing pollution and reducing costs.

One way that a company can assess a process is via the Material Efficiency Ratio, which is defined as follows (CIEPM, 1999):

$$\text{Material Efficiency Ratio} = \frac{\text{Product Sold}}{\text{All Material Purchases}}$$

In this equation the term "Product Sold" refers to all products, including the use of by-products as raw materials for other processes. The term "All Material Purchases" also takes into consideration the recycling of solvents or unused raw materials but, and this is very important, it includes all other materials that are factored into the cost structure of the product - including for example water that is purchased for use in the process.

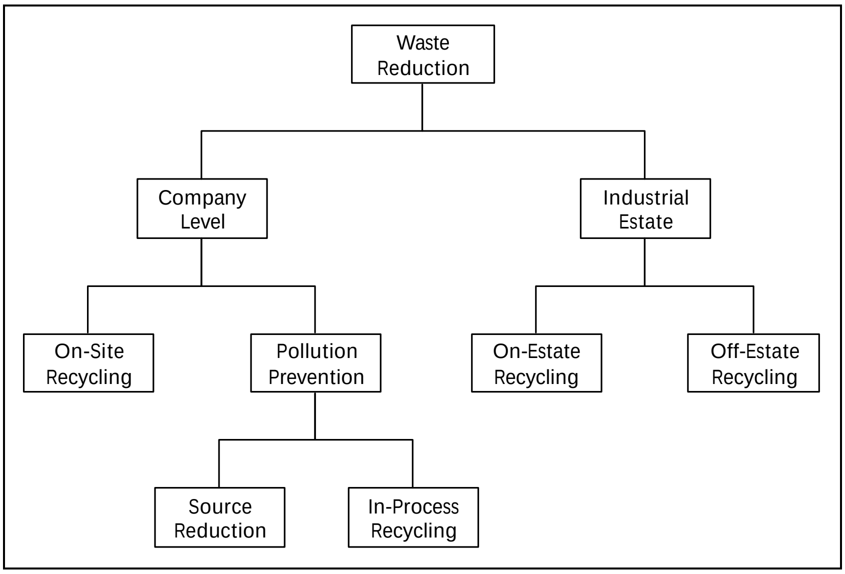
Within individual companies, the preferred activities to manage and minimise waste are (Allen & Sinclair Rosselot, 1997):

- reduction of waste at the source and in-process recycling (sometimes referred to as Pollution Prevention), and
- on-site recycling.

Off-site recycling is less preferable because – (i) it is relatively easy to lose track of the waste once it has left the site, and (ii) increased transport and handling of the waste may increase the risk to workers and the environment.

As we see from Figure 8, there is an additional way to minimise waste in an acceptable manner in the case of an industrial estate – what we have called On-Estate Recycling. This is an example of what is better known as a By-product Synergy approach. This is where by-products from one company, which would normally merely be classed as "waste", find a useful application in another company. When both companies are located within the same industrial estate many of the concerns about Off-Site recycling are alleviated. The fact that industrial estates contain many companies increases significantly the probability that useful synergies will be found within the same estate.

Figure 8: Waste Management Hierarchy in an Industrial Estate.



Since a By-product Synergy programme is an estate-level activity, the role of the manager of the estate is clearly important in providing the impulsion for the creation of the programme. But, what is needed to favour the creation of By-Product Synergies between companies in an estate?

The first requirement is a good knowledge of the material flows occurring within the estate. Robert Ayres has coined the term *industrial metabolism* to describe the sum of material and energy flows within an industrial system (Ayres, 1994 and Ayres & Simonis, 1994) and he has identified a number of levels at which the metabolism of industrial activities can be described. The system can be a country or region, an industrial sector or a manufacturing company, and the concept applies particularly well to a group of companies located in an industrial estate.

How can the manager carry out a study of the industrial metabolism of the industrial estate? A number of authors have described approaches that can prove helpful in mapping the material and energy flows. We shall mention only a few examples. In a report from the Triangle J Council of Governments (Kincaid, 1999), J. Kincaid describes how partners were brought together in the context of a regional approach to resource recovery in the USA. The information was assembled using a combination of a survey booklet and personal interviews and then entered into a database. Since it was a study at a regional level, a GIS mapping was employed. What is particularly interesting about this study was that about 75% of the companies contacted initially were interested in the programme. Although only half of those initially contacted actually took part in the programme, close to 50% of those found some possible synergies - either in water, energy or materials. This report is a very valuable source of information for the management of an industrial estate that is interested in learning how it might fulfil such a role.

Côté and coworkers have used a different approach to establish a By-product Synergy programme in the Burnside Industrial Park (Côté et alia, 1994; Côté, 2000). They have created a centre, what is called the Eco-efficiency Centre (for more details see page 61), that works with companies to carry out waste assessments. By combining the results from different companies they are able to put together an idea of the metabolism of the park and look for synergies.

Industrial Economics Inc. have developed a computer-based set of tools for the US Environmental Protection Agency that facilitate the task of identifying potential material and energy exchanges (Industrial Economics, 1999). Three tools are provided –

- FaST (Facility Synergy Tool) – this is a database of profiles for different industries with typical inputs and outputs,
- DIET (Designing Industrial Ecosystems Tool) – this is an optimisation tool to aid in identifying suitable configurations of industrial facilities and assess the viability of the different options in terms of environmental performance, employment and economic performance,
- REaLiTy✓ (Regulatory, Economic and Logistics Tool) – this tool is under development to provide guidance on regulatory, economic and logistical questions surrounding material and energy flows in an industrial estate.

The second requirement is a willingness of the companies to share information and to be willing to work in an interdependent way. As A. Mangan has commented (BCSD-GM, 1997) – *"By-product synergy is successful not because of the technology, but because of the psychology."* The approach described by the BCSD-GM is to form joint teams with representatives from the different companies to identify the factors that impact on the feasibility of the project (see Box on the following page). Following an analysis of such factors, preliminary feasibility studies can be carried out and projects prioritised. The Primer prepared by the BCSD

> "Proponents focus on *green* aspects rather than on economic incentives. There is a pervasive *field of dreams* attitude that anything this good just *has to happen*. Some have a misconception that a complex materials exchange web can evolve in the absence of a detailed vision of the overall make-up of the system."
>
> D. Cobb, *Bechtel Technology and Consulting Services*

Factors affecting the Feasibility of By-product Synergies.

Technical	⇨ Is the conversion of the by-product to a resource technically feasible?
Economic	⇨ Is the conversion economically feasible?
Geographical	⇨ Can the by-product be safely and economically transported from the producer to the consumer?
Regulatory	⇨ Is transportation of the by-product regulated?
	⇨ Will use of the by-product as a resource result in additional regulations, such as through the presence of trace impurities?
Legal	⇨ Could use of the by-product as a resource lead to increased liability for the consumer?
	⇨ Is transport or use of the by-product prohibited?
Business	⇨ Are partners willing to make a commitment to the project?
	⇨ Is funding available for the project?
	⇨ Will the market accept products made from by-products?
Social	⇨ Will the public refuse to purchase products made from by-products?
	⇨ What is the state of public trust in the organisations involved in the projects?
Time	⇨ Is by-product synergy a high- or low-priority for the organisation?
Information	⇨ Is information about the matching of by-product and resource streams available?
	⇨ Is information about potential partners available?
	⇨ Is information about technology available?

[*Source:* BCSD-GM, 1997]

gives a good overview of this process (BCSD-GM, 1997). In the context of an industrial estate, the estate manager therefore must be willing to adopt the role of a "broker" between companies to help them through this stage, while realising that the technical know-how resides at the company level.

The theory sounds very nice. However, what is the practical outcome? One of the best known examples of such a By-product Synergy is the Industrial Symbiosis in Kalundborg. This is described in detail in one of the Case Studies and so we shall refrain from saying too much here. However, it is worthwhile showing the extent of the exchanges that are taking place (shown in Figure 9) and the annual environmental benefits that can result (Table 1).

Figure 9: Material Flows in the Kalundborg Industrial Ecosystem [Christensen, 1999].

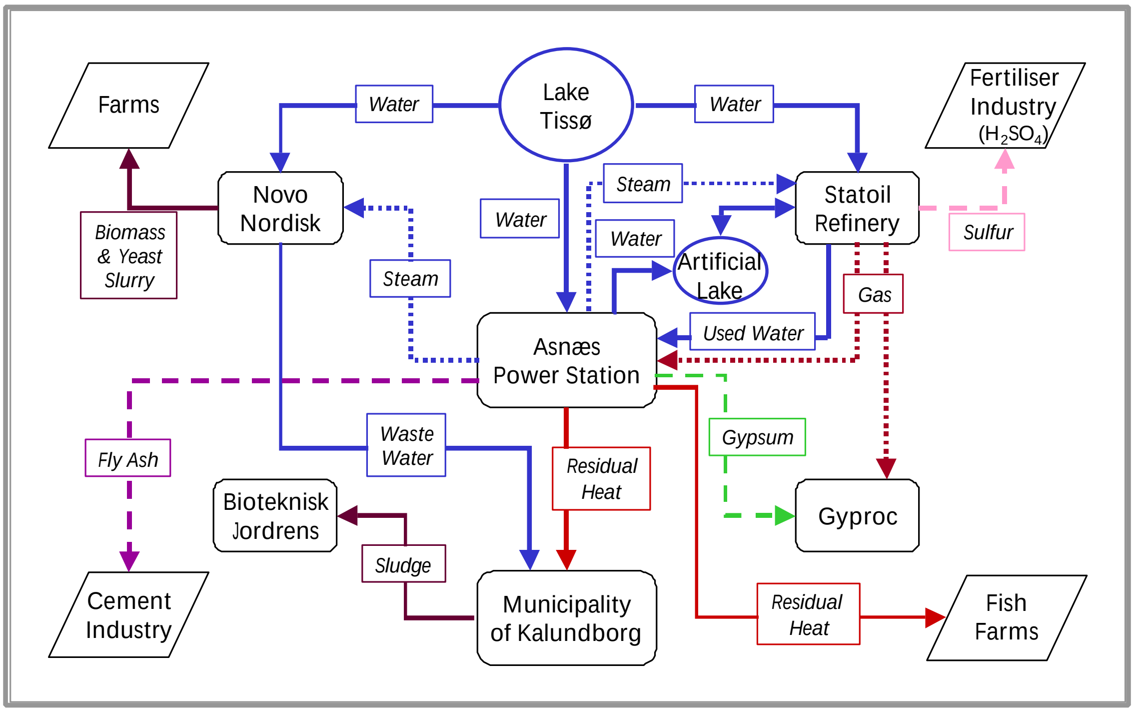


Table 1: Environmental Aspects of the Symbiosis [Erkman, 1998].

Reduction in consumption of resources	
oil	45,000 tons/year
coal	15,000 tons/year
water	600,000 m^3/year
Reduction in waste emissions	
carbon dioxide	175,000 tons/year
sulfur dioxide	10,200 tons/year
Valorisation of "wastes"	
sulfur	4,500 tons/year
calcium sulfate (gypsum)	90,000 tons/year
fly ash (for cement etc)	130,000 tons/year

A final role that the estate manager can play is to try to "change attitudes" of the companies within the estate. What do we mean by this?

In a By-product Synergy approach the real objective is to maximise the Material Efficiency Ratio, in other words to maximise the quantity of raw material that ends up in a useful product. Stated in this way, a process developer in each company looks at a process from the upstream side and asks the question "How do I organise my production so that as much of the raw material as possible ends up in products that I can sell profitably?" By-product Synergy therefore becomes a strategy to increase the possibilities for maximising resource-use through collaboration with other companies.

Let us compare this with the view of By-product Synergy commonly held by many companies today. This can be summarised as "My process gives me a good yield of the product that I want to sell profitably. However, some by-products are also formed. Can I find a use for these waste materials as raw materials by collaborating with other companies?" This is a downstream analysis.

The estate manager therefore has an extremely important role to play by working with the companies within the estate so that they consider the symbiotic nature of their activities when they design their processes. In this way the manager promotes By-product Synergy in a pro-active way. The two most important factors necessary for this to be successful are – (i) that the companies have built up trust between themselves and with the estate manager, and (ii) that there is a good understanding of the "metabolism" of the industrial estate. In this way, By-product Synergy becomes less of a waste management approach and more of a resource efficiency philosophy.

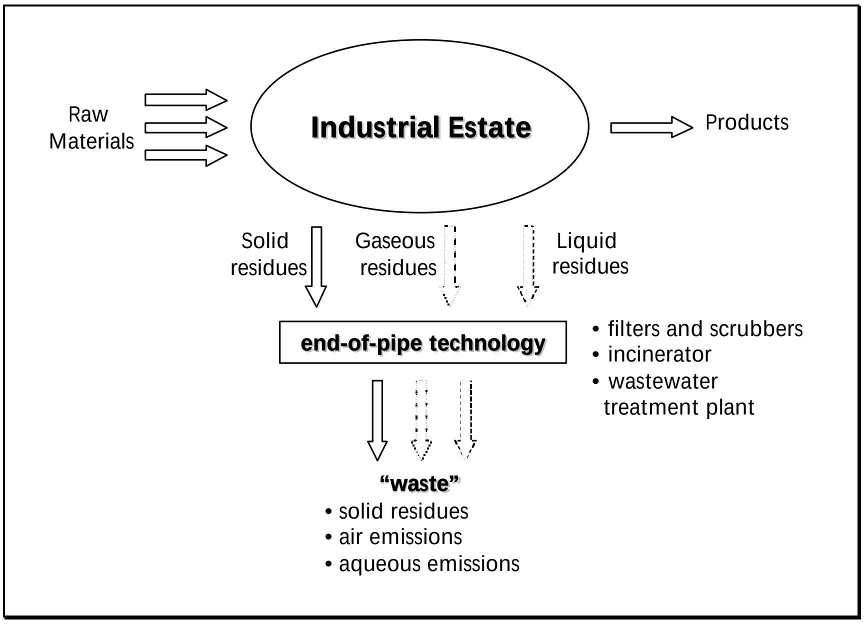
6.4.5 INTEGRATED POLLUTION PREVENTION AND CONTROL.

The strategies that we have described up to now – Cleaner Production, Eco-efficiency, By-product Synergies – and tools such as eco-efficiency indicators and material flow analysis, help companies in an industrial estate to generate less waste and contribute to reducing the overall environmental impact of the estate. However, as Odum has remarked (Odum, 1975), there is no way to avoid pollution entirely since we cannot circumvent the Second Law of Thermodynamics. Therefore, despite all efforts to reduce waste at source and recycle waste materials as raw materials, some unusable materials will always be left over. This brings us to the important question of how to deal responsibly with this waste and the need for an integrated approach to pollution control.

As we mentioned earlier, many industrial estates offer a range of environmental services. For example [see the Box overleaf], the Industrial Estate Authority of Thailand (IEAT), who are responsible for the administration of many estates in Thailand, provides services varying from wastewater treatment to overseeing environmental monitoring.

We can represent the activities occurring within an industrial estate as in Figure 10. Energy is also required to carry out these material transformations (although it is not shown here) and, if it is generated on-site, will contribute to the formation of different "residues".

Figure 10: Pollution Control in an Industrial Estate.



Industrial Estates in Thailand.

Establishment of the industrial estate begins with site selection and an environmental impact study. IEAT (the Industrial Estate Authority of Thailand) has to submit an environmental impact assessment for governmental approval before any infrastructure is constructed.

The infrastructure of the estate is then developed. This includes roads, water supply system, electricity, central wastewater treatment facilities, sewer system, storm water drainage system, an incinerator and a landfill site.

For all industrial estates IEAT sets up pollution control measures for air, water and hazardous waste management. This includes general environmental quality as well as the monitoring of specific facilities in the estates. Examples are – ambient air, noise level, water quality (ground- and surface water), and emissions from incinerator chimneys.

Homchean, 1996

From Figure 10 we see that losses occur in the form of solid, liquid or gaseous residues. The environmental services provided by the estate – such as wastewater treatment or incineration – are designed to reduce the concentration of hazardous materials in the different waste streams either by removing them from the streams or by converting them into more (environmentally) acceptable materials. A simple mass balance on the activities of the industrial estate, shown in Figure 10, is sufficient to convince us that the end-of-pipe approach reduces emissions to one medium but at the cost of an increase in the emissions to another medium. For example, tin present in an aqueous waste stream is precipitated during passage through a wastewater treatment plant and retained by the activated sludge. The water leaving the plant is then free of the metal. However, if the sludge is incinerated, the metal will be present in the ash from the incinerator, and the method for disposal of the ash will then need to be chosen as a consequence.

This means that, when an estate offers such environmental services to its tenants, a cross-media approach must be used that considers the best overall option for pollution control. Of course, the only way to reduce emissions to all media is to “prevent pollution”, as we have already seen, by changing the activities occurring within the estate. In this respect, in an industrial estate it is important to integrate pollution prevention and pollution control at an early planning stage.

In Figure 7 we saw how the cost of pollution control always increases with time, unlike the cost of pollution prevention (cleaner production) that tends to stabilise after a certain period of time. Therefore, pollution prevention will always eventually become cost effective relative to pollution control. As companies within the estate recognise this and find ways to

The European Union adopted a **Directive on Integrated Pollution Prevention & Control** in 1996. *Article 3* states that a company is obliged to make sure that:

a) All appropriate preventive measures are taken against pollution …

b) No significant pollution is caused.

c) Waste production is avoided … [and] where waste is produced, it is recovered or, where that is technically and economically impossible, it is disposed of while avoiding or reducing any impact on the environment.

d) …

minimise waste and reduce their emissions at the source, their demand for end-of-pipe treatment will decrease. Since waste treatment is usually charged to the user on a unit cost basis, it also allows them to reduce their environmental costs. On the other hand, the revenues to the estate management from waste treatment also decrease. This is where a problem arises because the estate management must recover the running costs of the end-of-pipe technology as well as its original investment. To put it another way – end-of-pipe technology must be paid for whether it is used or not.

By integrating pollution prevention and control during the planning phase, the estate management can avoid finding itself in a difficult financial situation due to a drop in the demand for end-of-pipe treatment. An example of how to integrate pollution prevention and control at an early stage would be to build small modular installations for water treatment, for example, and work with companies to help them with pollution prevention approaches. At the stage where a new module is required, the calculation will probably show that it is cheaper for the tenants to invest in pollution prevention rather than pay more for pollution control.

In summary, the estate management in many industrial estates is increasingly taking responsibility for providing environmental services, including pollution control activities. Such a situation has a number of advantages for the industrial estate and its industries:

- It is more efficient than to oblige each industry on the estate to act independently.
- It may provide an extra financial incentive to new companies wishing to establish themselves in the estate since they can use the existing environmental services.
- The estate management has a good view of the estate's overall environmental footprint.

However, an estate management should be careful when considering important investments in end-of-pipe technology. It may be more judicious to adopt an integrated pollution prevention and control approach so as to avoid future problems for the financial viability of the estate.

6.4.6 ENERGY CONSERVATION.

The manager of an industrial estate should find it relatively easy to convince tenant companies of the value of energy conservation if only through the cost advantages. Lowe et alia (1998) have estimated that many industrial estates could feasibly reduce energy consumption by as much as 50%. If the estate produces its own electricity and heat for the tenant companies, such a reduction would result in appreciable decreases in atmospheric emissions, such as carbon dioxide, from the estate.

Energy conservation can be carried out at the level of individual companies by the use of heat exchange networks in which process streams that must have their temperature increased are heated by process streams that need to be cooled. This reduces the need for fuel and decreases emissions arising from the combustion process (Allen & Sinclair Rosselot, 1997). The use of effective insulation of buildings and energy-efficient lighting are other ways for companies to reduce their consumption of energy.

At the estate level, important opportunities exist to conserve energy. For example, co-generation allows an estate to generate electricity and recover the waste heat energy from the generation process as steam. The steam can then be used for process energy within tenant companies. Cascading of energy can also be linked into this process. Cascading refers for example to the situation where high pressure steam is used to heat a process, and the unused energy from the process is recovered for use in another application that requires a lower temperature. Cascading can be achieved within companies or between different companies.

Energy Efficiency ...

Zeneca, formerly part of ICI, was spending about £3 million per year on gas and electricity at its Grangemouth site.

They created a full-time energy manager and carried out a simple energy audit of the site. Between £25,000 – 30,000 in savings were identified in each plant on the site – simply from basic housekeeping measures.

In order to guarantee that these housekeeping measures would be implemented, Zeneca appointed shift managers (who knew the processes extremely well) to be resource co-ordinators or energy wardens.

Source: Martin, 1998.

Referring back to the case of Kalundborg, shown in Figure 9, we see examples of several of these strategies being put into practice. The use of co-generation at Asnaes Power Station allows them to supply process steam to two companies, Novo Nordisk and Statoil, and low temperature heat to the municipality for the district heating system.

These initiatives do require investment in infrastructure. If steam for process heating is required by a lot of companies in the estate, this may well be an estate-based initiative, i.e. a service provided by the estate. However, for energy cascading between companies, the pipelines can be built on a co-operative basis.

6.4.7 WATER CONSERVATION.

Industrial estates can be very large consumers of water, when infrastructure activities and tenant companies' activities are considered together. As a result, the environmental impact of this large water consumption can be quite important. For example, excessive use of ground water can lead to the lowering of water tables while the release of warm water from cooling towers into watercourses can affect aquatic ecosystems.

Water can be reused in many applications if sufficient thought is given to the question. Lowe et alia (1998) point out that managing the water cycle in an industrial estate is linked to using water of different quality for different purposes. In the same way that energy cascading leads to energy conservation, water cascading can reduce water consumption. For example, filtered river water may be suitable for use as process water, while wastewater can often be used for irrigation. Relatively few industrial applications require drinking water standards!

As with energy conservation measures, water conservation ideally requires pipelines to be designed into the estate from the beginning. If such measures can be thought about at the planning stage of the industrial estate, then there is the possibility to influence the location of companies within the estate so that they can share these resources in an efficient way. The greater distance there is between potential partners, the less likely it is that synergies in water and energy use will be exploited.

However, as we mentioned earlier, if the pricing of water and energy do not reflect the true cost, then there will be little economic incentive to conserve resources and little will be done. Therefore it is important that estate managers in government-owned or joint-venture estates influence policy-makers in this respect.

> Following a Cleaner Production assessment in a chemical company that produces polyester fibre in Indonesia -
>
> It was realised that water generated as a co-product in a chemical reaction could be re-used after treatment as industrial water in the process. This led to a significant reduction (approximately 2500 litres/minute) in the amount of fresh water required by the plant with a similar reduction in costs.
>
> UNEP, 1994a

6.4.8 **INDUSTRIAL HEALTH & SAFETY.**

An environmental management programme in an industrial estate must also include health and safety. It is possible that, in focussing on the environmental side of the question, we forget the health and safety of workers within the estate as well as communities outside the estate. It is worthwhile remembering that in an industrial estate containing a large number of different companies, important health and safety risks may result from exposure to a complex mixture of hazardous materials. The risk may be associated with "normal" operating conditions within the companies or arise from industrial accidents.

> Unsafe situations and technological accidents are due mostly to poor co-operation between different units, poor inspection, unclear instructions and responsibilities, lack of trained employees etc. The company must identify the major hazard risks, determine how they can be controlled and establish emergency plans to prepare employees to deal with accidents which could be dangerous for themselves, the surrounding population and the environment.
>
> *Source:* UNEP/UNIDO/IFA, 1998

Ashford has pointed out (Ashford, 1997) that by focusing too strongly on the "environmental aspect" in an industrial ecology approach we may miss opportunities to improve the health and safety issues associated with production processes. The use of strategies such as by-product synergies may put workers at higher risk as a result of increased handling of waste materials. By substituting materials that are (environmentally) less hazardous for older materials, we may also create an increased health or safety risk.

An example of this last situation would be the replacement of CFC's by HCFC's in dry-cleaning processes. The complexity of the problem is demonstrated by the fact that, while CFC's are not toxic, their elimination is considered essential to combat ozone-depletion, one of the consequences of which is an increase in the incidence of skin cancer. Unfortunately, the first generation of replacement materials, the HCFC's, are suspected to be carcinogenic, therefore putting workers in the dry-cleaning industry at greater risk. These very legitimate concerns show that the creation of a more efficient industrial ecosystem requires that a truly integrated approach be applied to reduce risks to humans as well as to the environment. Of course a true reading of the concept of industrial ecology (see Chapter 5.4) should be enough to convince us that safety and health issues are an integral part of the *interface between the industrial and natural ecosystems*.

In an industrial estate, responsibility for the safety and health of workers within the individual companies rests with the companies themselves. The companies must make sure that materials that are dangerous to the health of their workers are carefully controlled so as to minimise health risks. This requires workers to be informed about the properties of the materials they are using – by the use of safety data sheets or the labelling of containers. It also requires training of the workers to be carried out so that they know how to work with the materials in a safe way. And finally they must have the necessary equipment so that they can work in a safe manner. The International Labour Office (ILO) has published a code of practice on *Safety in the Use of Chemicals at Work* (ILO, 1993) that covers many of these topics.

The hazards associated with the operations of a company must also be identified, and measures taken to reduce not only the probability that a hazard will occur but also the gravity of the consequences if it does. Therefore, each company on the estate will work internally to fulfil its obligations concerning the health and safety of its workers.

However, although in an industrial estate the safety and health of workers is affected primarily by the activities of their own company, at a secondary level it is also influenced by the activities of neighbouring companies. Thus while the activities of individual companies may not appear to be particularly hazardous, their clustering together on an industrial estate can result in a *combined risk* that is appreciably greater. It is at this point that the role of the estate manager becomes important in the safety and health sphere, because the estate manager alone has an overview of the activities of the estate.

One part of the estate manager's role, therefore, is to carry out a systematic study of the hazards associated with the estate's activities viewed as an *ensemble.* An example of such a study is a Hazard and Operability (or HAZOP) Study. This will allow synergies between different companies' activities to be evaluated. Such a study will also help the manager to establish the emergency response plan for the estate (see next section). As a result of such an analysis, the estate manager will need to work with the companies to minimise the risk associated with these synergistic effects. This may be better achieved if the estate also offers some common services in the health and safety area. These services might include –

1. Training for workers of all companies on the estate in:
   - Awareness of hazards in the workplace.
   - Health and safety routines and procedures.
   - Emergency procedures.
   - First-aid.
   - Reporting of incidents.
   - Accident prevention and safe conduct (UNEP/UNIDO/IFA, 1998).
2. An Information Centre for chemical hazards, including a library of Safety Data Sheets for materials and processes and links to other sources of information on safety and health

issues, such as the International Register of Potentially Toxic Chemicals (IRPTC) of UNEP Chemicals. Another area of interest for such a centre could be in so-called intrinsically safe processes (Kletz, 1999) or in integrated safety management systems.

3. Provision of some form of Health Care Service, either a first-aid centre or small medical centre that can intervene in the case of minor accidents on the estate.
4. Provision of a fire-service with specific experience in industry-related problems – such as how to intervene in the event of chemical spills.

The provision of these services by the estate is a considerable benefit to small companies, both in terms of human and financial resources, and fosters a collective approach to safety and health within the estate.

6.4.9 EMERGENCY RESPONSE AND APELL.

Turning now to the question of industrial accidents on an industrial estate, the most important approach is to prevent them occurring. However, since *zero risk* is difficult to attain, it is crucial to draw up emergency plans to minimise the effects of a major accident. This is particularly relevant in the case of an industrial estate where the high density of operations results in it being a relatively high-risk area. UNEP has published a Training Resource Package on the *Management of Industrial Accident Prevention and Preparedness* (UNEP, 1996c) that will be of interest to the reader in this context.

In 1982 the European Community issued a Directive 82/501/EEC, often referred to as the "Seveso" Directive after the accident in 1976 in Seveso, Italy. This directive seeks to prevent major accidents arising from industrial activities, and to limit the consequences should they occur. It requires risks to the workforce and the surrounding population to be identified, precautions to be taken and major incidents to be reported to the authorities. For sites where there are large quantities of dangerous substances, it requires the preparation of *on-site* and *off-site* emergency plans as well as the provision for surrounding communities to be informed about the hazards, safety measures and action to take in the event of an accident.

In our discussion here we shall distinguish between these two cases – (i) emergency plans to deal with *on-site* effects of an accident, normally drawn up by the site operator, and (ii) emergency plans to address off-site effects of an accident, which are usually the responsibility of the local authority.

In an industrial estate it is the role of the estate manager to establish the framework for the on-site emergency plan as part of the emergency services that the estate offers to the tenant companies. The main purpose of the plan is to control and contain the accident and prevent it from spreading to neighbouring companies in the estate, or beyond the estate. The International Labour Office (ILO) has published a code of practice on the *Prevention of Major Industrial Accidents* (ILO, 1991) as well as a manual on *Major Hazard Control* (ILO, 1988) that can serve as a reference when setting up an emergency response programme for an industrial estate.

The development of the plan is an estate-level activity and must be a collaborative effort between the estate manager and the tenant companies so as to profit from their detailed knowledge about the risks that exist within each company. However, it is the estate manager who then has an overview of the risks at the level of the estate and can see potential synergies between hazards in companies that may lead to increased risk. The emergency plan must take into consideration the possibility of an accident in one company leading to a problem in a nearby company.

The estate should have an emergency control centre that can direct operations in the event of an accident at one of the companies on the estate. For example, if the estate has its own fire protection service, the emergency control centre will direct their intervention on the scene of the accident, as well as co-ordinating with public services in the case where this is needed. The centre should have detailed information about the layout of the buildings within each of the companies on the site, and the hazards that exist. In particular, information about all hazardous materials should be maintained centrally to facilitate the work of cleaning up spills. The task of the estate manager will be helped if each tenant company has an “incident controller” who can work with the estate team during an intervention following an accident.

An important role of the estate manager is to co-ordinate the whole emergency response programme on-site. One aspect of this programme should be training for employees of tenant companies. An emergency plan that has been regularly tested is likely to be effective in minimising the damage from an accident. If all workers on the estate have benefited from rehearsals or emergency procedures “drills” then they will recognise the warning alarm signals, will know how the emergency plan functions and what their duties are. The opportunity to share resources within an industrial estate in this area represents an important saving in resources and cost for a tenant company. It is interesting to mention that Peck has described how participants in an industrial *network* in Sarnia, Canada have also decided to pool their resources for emergency intervention in case of industrial accidents on any of their production sites (Peck, 1997).

Many incidents occurring within an industrial estate can be contained within the boundary of the estate and we have already seen the *on-site* measures that can be taken. If this is not possible and the effects of the incident spread *off-site* then it is probable that local communities will also be affected. The case of Bhopal in India is an example of what can happen to these communities when an incident in a chemical plant cannot be contained (see Box).

Bhopal, India - December 2nd 1984.

During routine maintenance, water entered a 60 tonne storage tank containing methyl isocyanate at the Union Carbide Plant in Bhopal, India. The safety systems were not working and the resulting runaway reaction led to an increase in temperature and pressure that presumably ruptured the storage tank. A cloud of gas containing methyl isocyanate, hydrogen cyanide and methylamine was carried by winds in the direction of the surrounding communities where about 1 million people were living.

Officially, more than 500,000 people were exposed to the poisonous gas of which 3,000 people died from the effects. Approximately 50,000 survivors were left partially or totally disabled. It is estimated that over 8,000 people have since died from latent effects of their exposure to the gas.

After more than seven years of legal action, an out-of-court settlement resulted in Union Carbide paying $470 million in compensation.

Source: Allen, 2000

In order to minimise the consequences of such situations, local communities must plan how they will react to any emergency that might result from industrial operations in their neighbourhood. To help the process of preparing emergency response at a community level, UNEP has created the APELL Network [**A**wareness and **P**reparedness for **E**mergencies at **L**ocal **L**evel] in co-operation with the United States Chemical Manufacturers Association (now the American Chemistry Council) and the European Chemical Industry Council (CEFIC) (see APELL, 1988).

Although the APELL programme was not created specifically with industrial estates in mind, it has already been implemented for some industrial estates in India and Thailand (APELL, 1998).

APELL consists of three parts –

- Community Awareness – the provision of information to the community.
- Emergency Response – the formulation of a plan to protect the public.
- Training.

The community should be aware of the hazards associated with the activities of an industrial estate and the steps taken by the industries and the estate manager to protect the community through estate-level emergency plans. On the basis of this information, emergency response plans for the community should then be developed to address the situation when an emergency endangers the safety of the community. Finally the residents should be trained in how to react in the case of an emergency.

In the APELL programme a 10-point approach has been developed for preparing an emergency response plan –

1. Identify participants and establish their roles, resources and concerns.
2. Evaluate the risks and hazards.
3. Review existing emergency plans from each participant to assess how they will fit into a co-ordinated response.
4. Identify the required tasks not covered by existing plans.
5. Match these tasks to the available resources.
6. Make any necessary changes.
7. Prepare a complete documentation.
8. Educate participating groups about the integrated plan and carry out training if necessary.
9. Establish procedures for testing, review and updating.
10. Educate the wider community about the integrated plan.

Source: APELL, 1988

The partners in establishing the community emergency plan are drawn from the representatives of the industrial estate, the local authorities and local community or interest groups. APELL requires a technical-level co-ordinating group to be set up with representatives from the industrial estate, local government, police and fire departments, rescue teams and local institutions, such as schools.

In the case of a large factory located within a community, the industry representative in the co-ordinating group is clearly defined and is a person who is totally familiar with the hazards associated with that company's operations. With an industrial estate that contains a large number of different companies – and we have seen frequent examples of estates with as many as 500 to 1000 tenants – the role of the estate manager becomes critically important for emergency preparedness and response. The estate manager must be able to work within the co-ordinating group to provide the bridge between the local government and the on-site emergency programme so that the local communities are also able to respond correctly if they are put at risk by a major accident in the industrial estate.

The activities of an industrial estate do not stop at the perimeter of the estate and we must remember that goods produced by companies on an industrial estate normally have to be transported to their customers. If the goods are hazardous, an accident occurring during transportation may have a serious impact on outside communities. A special programme – TransAPELL – has been created by UNEP to respond to this situation, and is described in a Technical Report from UNEP-DTIE (TransAPELL, 2000).

7. ECO-INDUSTRIAL PARKS

In the previous chapter we described an approach to environmental management for industrial estates in which different strategies and tools are applied to address the environmental aspect of the industrial estate. From an industrial ecology perspective the objective is that a more efficient industrial ecosystem will emerge from the combined efforts of the tenant companies in collaboration with the management of the estate.

Another approach is to "design" an industrial estate that functions like an industrial ecosystem (Côté et alia, 1994), in essence an Eco-Industrial Park (EIP). As Côté and Cohen-Rosenthal (1998) have commented, the "designed-systems" approach and the emergent or "self-organising" approach do not represent opposing views but two points along a continuum of views on how to apply industrial ecology principles to an industrial estate.

Several definitions exist in the literature of what an EIP should be (see for example Côté and Cohen-Rosenthal, 1998). It is useful to compare one definition (shown in the Box) with that on page 9 for a traditional industrial estate. What is striking about the definition of an EIP is the emphasis on the interdependence of the companies within the industrial estate. The success of the estate is linked closely to the economic and environmental success of the companies. In contrast, the definition of a traditional estate focuses on providing for the needs of the companies while allowing them to function more or less independently.

> **Eco-Industrial Parks (EIP's) ...**
>
> *"An EIP is a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water and materials.*
>
> *By working together, the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realise if it optimised its individual performance only."*
>
> *Source:* Lowe et alia (1998)

The concept of eco-industrial parks began to appear at the beginning of the 1990's, particularly in the USA and Canada. In the USA the Eco-efficiency Task Force set up by the President's Council on Sustainable Development in 1993 considered initially four EIP projects within its mandate – Baltimore, Maryland; Cape Charles, Virginia; Brownsville, Texas; and Chattanooga, Tennessee. Since then the number of projects in the USA has increased (PCSD, 1997) and an extensive literature has grown up relating to the EIP concept. In Canada, the best known EIP project is Burnside Industrial Park in Dartmouth, Nova Scotia (see Section 5 of the *Information & Training Resources Manual*; Côté et alia, 1994, and Côté & Smolenaars, 1997).

A valuable starting point for information about the development of EIP's is the Internet site of Cornell University's Work & Environment Initiative (Cornell, 2000), which provides links to many of the different parks. Additional information can be found in two guidebooks: *Eco-Industrial Parks - A Handbook for Local Development Teams*, by Lowe, Moran and Holmes (Lowe et alia, 1998) and *Designing and Operating Industrial Parks as Ecosystems*, by Côté et alia (Côté et alia, 1995). An excellent booklet has been published recently by the PRIME Project Team in the Philippines that describes how to develop an EIP using in particular the By-product Exchange approach. The booklet is called *Adopting Industrial Ecology Tools for Industrial Estates* (PRIME, 2001).

A report by Peck & Associates (Peck, 1997) provides a useful inventory of known EIP developments around the world at the time that the report was written. This inventory shows that the main effort has so far been in the USA and Canada with interest increasing in the rest of the world.

Six Strategies for Designing an Eco-Industrial Park.

1. Maximise energy efficiency when designing the EIP through
   - ⇨ co-generation and energy cascading within and between firms, and
   - ⇨ extensive use of renewable sources.
2. Master material flows and waste management for the whole EIP site by
   - ⇨ emphasising Pollution Prevention, in particular with respect to toxic materials,
   - ⇨ maximising re-use and recycling of materials between firms in the EIP,
   - ⇨ reducing risk from toxic waste materials by integrated waste management within the EIP, and
   - ⇨ creating links between firms in the EIP and the surrounding region for exchanges of resources and recycling networks.
3. Conserve water resources and reduce possibilities of water pollution.
4. Entrust the management of the EIP with the following tasks in addition to the traditional functions (maintenance, recruitment)
   - ⇨ maintaining the range of companies required to allow the by-product synergies to function efficiently
   - ⇨ supporting improvements in environmental performance within companies as well as for the EIP as a whole
   - ⇨ supporting efficient communication between companies, informing members of local environmental conditions and providing feedback on the EIP performance.
5. Follow best environmental practices in the selection of materials and building technology when carrying out new construction or rehabilitation of existing buildings.
6. Integrate the EIP into natural ecosystems by-
   - ⇨ incorporating the EIP into the local landscape and ecosystems, for example the hydrological cycle, so as to minimise local environmental impacts
   - ⇨ considering the global environmental impact of the activities of the EIP, such as the production of greenhouse gases.

Source: Lowe et alia (1998)

How does one go about designing an industrial ecosystem? In their handbook, Lowe and co-workers (Lowe et alia 1998) suggest six strategies for designing an eco-industrial park (see Box above).

Although the Technical Report, *The Environmental Management of Industrial Estates* (UNEP, 1997) is not a guide for creating an EIP, many useful elements are to be found there.

When creating a new industrial estate a certain degree of freedom exists in the way that the site is selected, the estate is designed and construction is carried out. Industrial ecology principles therefore can be introduced throughout the development phase of the project in order to eliminate or reduce potential environmental impacts and provide the basis for an EIP.

In the same way that we have described industrial estates that are focussed towards specific business sectors, such as export processing zones or high technology parks, an EIP also targets a certain type of client – one that seeks to maintain its position as an environmentally- and socially- responsible company. Therefore the EIP fills a niche where the green image of the park benefits its tenants while also helping them to be economically competitive.

Various authors have pointed to different approaches that can respond to these requirements for an EIP. Lowe has described the use of resource exchange activities (Lowe, 1997) and pointed out that there is little difference between a resource exchange that focuses on so-called *wastes* and the traditional location of companies to be near customers or suppliers, which is a *product*-focussed approach. The co-location of businesses associated with the automobile industry is a good example of this latter case. In order to foster resource exchanges, the recruiting of companies to an EIP should take into consideration how they can contribute to this exchange. The use of an anchor tenant that will attract other companies because it can also supply resources - such as energy, water or by-products - is one option. Planning the structure of the EIP so as to maximise exchanges with the broader regional economy is a different way to address the question of recruiting companies to an EIP. Côté has pinpointed the need for the decomposer function (or scavenger) of the industrial ecosystem to be strengthened in the context of developing a resource exchange in an EIP (Côté et alia, 1994). Examples of such companies are those who are involved with remanufacturing and recovery/recycling/reuse. In this regard, Côté draws on the need for effective "food chains" of materials if the industrial ecosystem of the EIP is to function well.

An additional feature of the EIP concept that is sometimes overlooked is the identification of "ways in which the total impact [of the EIP] on the local ecosystem [can be] reduced." (Côté & Cohen-Rosenthal, 1998). This involves taking the region in which the EIP is located and looking for approaches that will allow the EIP to contribute economically to the region, while at the same time helping to reduce the overall environmental impact on that region. This requires a community-focussed planning approach to the development of a new EIP.

While it is relatively straightforward to establish a strategy for creating an EIP, putting that strategy into practice is proving to be an important challenge. Some key areas where the challenge is greatest are (PCSD, 1997):

- *Finance* – obtaining private financing for new EIP developments is difficult at the present because the traditional financial institutions are not aware of the potential for EIP's to lower risk and increase rates of return.
- *Regulations* - some environmental regulations act as barriers to EIP development by restricting the possible exchange of waste materials and preventing the EIP to be treated as a single facility with respect to emissions. This latter point limits solutions to reduce emissions from the EIP as a whole through collaboration between companies.
- *Profitability* – although the EIP concept should lead to increased profitability for the companies from improved environmental performance (by-product synergies, economies of scale and reduction in risk and liability), firm evidence is lacking because the concept is still at an early stage of development.
- *Recruiting* – attracting tenants, in sufficient number as well as the "right ones", is crucial for the early success of an EIP. Finding anchor companies that can attract others to the estate so as to create the nucleus of an industrial ecosystem is very important.

As Lowe has recently noted (E. Lowe, personal communication), by the middle of the year 2000, at least 40 eco-industrial development projects had started in the USA, with another 50 similar projects elsewhere in the world. While not all of these initiatives are EIP's, this rapid growth in interest during the eight years or so since the concept first appeared is very promising. It is important to stress, however, that eco-industrial development, as exemplified by EIP's, is still a relatively recent phenomenon and only time will tell whether designing an industrial ecosystem is feasible.

8. CONCLUSIONS

In this Background Paper we have presented the approach to environmental management for industrial estates that is being promoted actively by UNEP-DTIE. The distinguishing feature of this approach is that it views the industrial estate as a complete entity – or "(eco-)system" – and then looks for ways to reduce the impacts on the environment from the entire estate. In this way it considers not only the individual impacts of companies within the estate but also the cumulative impacts resulting from the community of companies and the infrastructure of the estate.

By focussing on the interface between the industrial estate and the natural environment, the UNEP approach broadens the scope of environmental management beyond questions of resource efficiency and waste generation/ minimisation. In this regard it mirrors the concept of industrial ecology with its emphasis on the interaction between the industrial ecosystem and the natural global ecosystem.

This strategy for reducing the environmental impact of an industrial estate calls for some activities to be carried out at the level of the industrial estate while others are best implemented at the level of individual companies. However its success relies on a collective form of environmental management existing within the estate and points to the important role that the estate manager must play. This starts during the planning of the estate, so that a higher level of environmental performance can be reached, and continues through to the operational phase, where activities by the individual companies to improve their own performance must also be facilitated at the estate-level.

We have presented in this Background Paper a palette of strategies and tools that can be employed either at the level of the estate or in the plant as part of an environmental management approach to reduce the environmental impact of the estate during the operational phase. We have also tried to bring out the role of the estate manager in promoting these approaches. However, one feature of environmental management in industrial estates is that the classical environmental management systems, or EMS's, are not well adapted to the organisation within an estate. Increasing numbers of estates are seeking ISO 14001 certification of the management system for the infrastructure activities of the estate and the popularity of ISO 14001 with individual companies has not yet waned. Nevertheless, we are still lacking any way of formally organising environmental management for an entire industrial estate. This paper suggests some possible solutions based on voluntary arrangements between the estate and the tenants.

As we have seen in this paper, there exists a broad spectrum of activities that can be used within an environmental programme designed to reduce the environmental impacts of an industrial estate. It varies from activities aimed at preventing pollution and increasing resource efficiency through to industrial safety and health and emergency response in the case of accidents. And there exists an even greater wealth of different terms. So much so that there is a danger of getting lost in what Baas refers to as the "tangled web of terminology" (Baas, 1998). The principle to keep in mind is that –

"This confusion of terminology requires people to look beyond the words and analyse the actions." (UNEP, 1993).

And indeed it is useful to ask ourselves at this point what actions are being undertaken towards a collective approach to environmental management in industrial estates today. The answer is unfortunately not very positive with the majority of estates still going no further than common waste treatment and disposal services that are offered to companies so as to allow them to comply with the local pollution standards.

Progress is being made, as we have seen with the spectacular increase in the number of eco-industrial development initiatives that have been launched in the past 10 years. Approximately 100 projects worldwide, however, is still a rather small number compared with the more than 20,000 industrial estates estimated to exist today. In order to try to improve this situation, UNEP has been active in the past 2 – 3 years in bringing together managers of industrial estates to share experiences, and is now planning a number of pilot studies in several industrial estates in China. A workshop, held in February 2001 at Dow Europe's ValuePark development in Shkopau (Germany), centred on the creation of a network of people in Europe that are interested in advancing the practice of environmental management in industrial estates. And finally, a conference and workshop to be held in Manila, the Philippines in April 2001 represents a major impetus to bring together industrial estate managers and other members of both the public and private sectors. The objective of this meeting is to raise awareness of the need for better environmental management in industrial estates, based on an eco-industrial networking approach, to present the current status of the field and to initiate a network of practitioners in the Asian region who will be able to advance the process.

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Environmental Management Systems

Introduction

The goal of this Briefing Paper is to present a short overview of the subject of Environmental Management Systems (EMS's). For those readers requiring a more complete presentation of how an EMS is developed and implemented, a useful and informative publication is the *Environmental Management System Training Resource Kit*, prepared by UNEP, ICC and FIDIC (UNEP/ICC/FIDIC, 1997).

Environmental management systems were originally developed for individual enterprises, the purpose being to introduce a rational approach to environmental care by -

- Identifying and controlling significant environmental aspects and impacts.
- Identifying significant environmental opportunities.
- Identifying relevant environmental regulatory requirements.
- Establishing a sound environmental policy and basis for environmental management.
- Establishing priorities, determining objectives and working towards their achievement.
- Monitoring performance and evaluating the effectiveness of the system, including the promotion of improvements and adaptation to meet new and changing conditions and demands (UNEP/ICC/FIDIC, 1997).

> An Environmental Management System [...] includes the organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for implementing and maintaining environmental management [within the enterprise].
>
> (UNEP/ICC/FIDIC, 1997)

Background

When interest in environmental management systems first arose, individual companies developed their own systems, often focussing not only on environment but also on health and safety. Subsequently an effort was made to harmonise procedures, such as through the British standard (BS 7750) or the Eco Management and Audit Scheme (EMAS) of the European Union. However, an international standard for the EMS approach was felt to be necessary and ISO (the International Organisation for Standardisation) introduced its ISO 14001 standard in 1996. An important feature of ISO 14001 is that it is consistent with ISO 9000 and the two standards share a number of common elements. In fact ISO 14001 can be considered as providing a form of "quality assurance" of environmental management performance. It is important to remember that ISO 14001 is only one of a “family” of environmental standards – the ISO 14000 family – which includes more than 20 standards at different stages of completion (ISO, 1998).

Use of a Standard Approach – ISO 14001

In the following discussion we shall focus on the ISO 14001 standard. This is principally due to it being accepted as an international standard throughout the world. The EMAS system, while possessing many good qualities – such as the requirement to publish an environmental report or the obligation to undergo an audit every three years – is only valid within the European Union.

EMAS 1836/93/EEC

Art. 1

The eco-management and audit scheme and its objectives.

1. A Community scheme allowing voluntary participation by companies performing industrial activities, hereinafter referred to as the “Community eco-management and audit scheme” or “the scheme”, is hereby established for the evaluation and improvement of the environmental performance of industrial activities and the provision of the relevant information to the public.

2. The objective of the scheme shall be to promote continuous improvements in the environmental performance of industrial activities by:
(a) the establishment and implementation of environmental policies, programmes and management systems by companies, in relation to their sites;
(b) the systematic, objective and periodic evaluation of the performance of such elements;
(c) the provision of information of environmental performance to the public;
...

An EMS, such as ISO 14001, cannot be introduced in a haphazard way. There is a (chrono-)logical sequence of five steps to carry out, often referred to as a process of continuous improvement. They are:

1. The definition of an **Environmental Policy**, covering the commitment of the enterprise to, for example, continuous improvement, pollution prevention, compliance with legislation, and that is openly communicated to the personnel of the company and the general public.

2. The **Planning** phase of the programme of continuous improvement of the enterprise based on an initial study of the environmental aspects of all of the activities and products.

3. The **Implementation and Operation** of the environmental management system under normal and emergency situations.

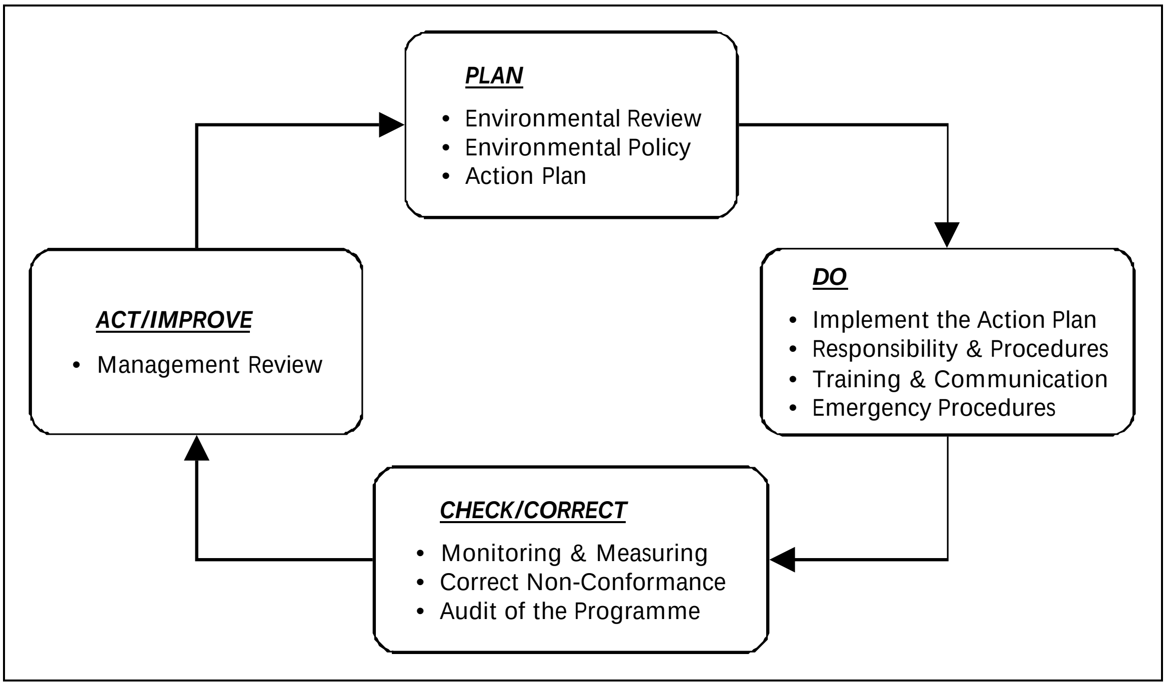
4. The **Monitoring** of the programme **and Correction** if there is non-conformance. This includes internal auditing of the EMS.

5. A **Review** by the **Management** in which the results are analysed and new objectives are proposed in order to achieve further improvements.

One framework for presenting this sequence of steps is via an adaptation of the Deming Model for Quality Management, which was originally devised for ISO 9000. Such a framework for ISO 14001 is shown in Figure 1. This diagram, which has been modified from UNEP/ICC/FIDIC (1997), contains four steps that are called - PLAN, DO, CHECK/CORRECT, and ACT/IMPROVE. This corresponds to each of the five steps above, but with the definition of the Environmental Policy included as a part of the Planning phase.

What does not appear in Figure 1 is that, once the environmental management system is in place, the company can apply to have its system certified as responding to the criteria defined in ISO 14001. For this step an external audit by an approved organisation is required.

Figure 1: Elements of an Environmental Management System (ISO 14001).



The Planning Phase

Looking initially at the planning phase, in order to put an EMS in place it is indispensable to know what the current environmental status is. The first step is therefore to carry out a complete **Environmental Review** in order to identify the current "environmental aspects", i.e. where the actual activities may have an impact on the environment. If environmental impact assessments have already been prepared, it will provide a useful starting point for the environmental review.

The environmental review requires a large amount of information to be collected on processes, material flows and mass balances, safety issues and waste handling. Visits to individual sites and interviews with staff are also necessary. The review should address four main areas:

- potential environmental issues relating to current activities,
- existing environmental management procedures,
- previous environmental incidents (e.g. accidents, fines, corrective measures put in place), and
- the status or compliance of operations with respect to legal requirements.

Based on the environmental review, the management establishes an **Environmental Policy** that is designed to give an overall sense of direction for action and ensures that subsequent actions are co-ordinated and effective. Key considerations in setting environmental policy are -

- clarifying the company's vision or values with respect to the environment;
- incorporating principles such as continual improvement and prevention of pollution;
- compliance with laws, regulations and other environmental requirements;
- communication with key stakeholders and interested parties.

Consulting guidelines and codes of practice have been developed already by a number of organisations and they can prove useful in creating an environmental policy statement. Examples are the Business Charter for Sustainable Development from the International Chamber of Commerce, the Responsible Care Programme introduced by the Chemical Industry Association, and the Coalition for Environmentally Responsible Economies, that has created its CERES Principles. The UNEP Technical Report No. 40 gives information on many of the voluntary codes and guidelines that have been developed to date (UNEP, 1998).

Before adopting an environmental policy it is worthwhile to undertake a consultation process to ensure that it has broad acceptance with outside stakeholders. It is important to realise that the environmental policy statement does not say specifically what is to be done. It is used in conjunction with the environmental review to decide on the *objectives* and *targets* that will define the actions appearing in the **Action Plan** or, as it is sometimes called, the **Environmental Management Programme**.

To give an example, if the *environmental review* of an industrial site pinpointed that emissions of certain substances were at the limit or above legal requirements then the *environmental policy* could include a commitment to reduce these emissions. One of the objectives might be to attain a specific %-reduction in these emissions by a certain date and the *action plan* would then specify what actions should be carried out in order to achieve this objective.

Example of an Environmental Policy

Rio Tinto recognises that excellence in managing health, safety and environmental [HSE] responsibilities is essential to long term success. Through effective management practices the [Rio Tinto] Group aims to ensure the health and safety of its employees, to minimise any adverse impacts its activities may have on the environment and to make a positive contribution to local community life.

To achieve these objectives the Rio Tinto Group will:

- Build from a foundation of compliance with applicable HSE laws, regulations and voluntary commitments;
- Seek continuing improvement through setting and reviewing targets, assessing and reporting HSE performance and using best available practices appropriate to the local situation;
- Contribute to the development of sound legislation and regulations; and
- Foster a better understanding of HSE issues pertinent to its activities.

The Way We Work –Our Statement

of Business Practice, Rio Tinto, 1998

Based on the final report from the environmental review, the first step in developing the action plan is to analyse the different points needing improvement and to set priorities for action. Environmental performance objectives and deadlines can then be established that are well defined and quantifiable, as well as being realistic and achievable. Once the actions have been clearly described and the targets set, the plan must specify who is responsible for carrying out the actions and what resources are available, both budgetary and human. Finally, in order to ensure that the policy is implemented properly, it is important to specify how progress will be measured and who will monitor it and start corrective action if problems arise.

A last comment regarding the action plan is that it is a "short-term" programme and actions should be completed within a relatively short but realistic period of time (ideally less than one year) in order to maintain momentum in the process.

The Action Phase

Moving on to the action phase, this is where the action plan is implemented. During the first cycle through the improvement process this is also the point where the overall **Environmental Management Structure** is put in place. In an individual company, **Environmental Management Responsibilities** follow the operational hierarchy so that it is an integral part of the overall management structure. Normally, overall responsibility for seeing that the environmental policy and action plan are carried out lies with the Senior Management or Board of Directors of the company.

The key to success is to involve all employees in the enterprise so that each person is motivated to carry out the actions assigned to them. The most important issue here is that everybody knows what he or she is responsible for, whom they report to and who reports to them. For this to occur all employees must be brought to a suitable level of understanding of the environmental issues associated with their work and how their actions affect the environmental performance of their enterprise.

This requires an effective **Training Programme** on a wide range of environmental issues. The goal of this programme might be: improving general environmental awareness of all staff, creating specialist skills needed to implement the environmental programme, or management training for implementation of the system. In this respect the *Environmental Management System Training Resource Kit*, (UNEP/ICC/FIDIC, 1997) can provide the groundwork for building such training programmes.

Communication is a crucial issue in the success of an EMS. It is important to distinguish between two types of communication. Internal communication is linked to the training that has been described above and is aimed at informing and motivating the personnel of the enterprise. External communication, which often takes the form of an environmental report, is targeted at presenting the environmental performance of the company to external stakeholders, such as the general public, regulatory authorities, or financing institutions. It is often said that the environmental report makes an important contribution to maintaining the "license to operate" of an enterprise.

In any management system it is necessary to document the individual steps. However, an environmental management system must not become swamped by a mass of documents. The enterprise must tread a fine line in order to create carefully written **Procedures** that help to define clearly - who will carry out specific actions and how, the monitoring of the results and what to do if the desired effects are not achieved. The *Environmental Management System Training Resource Kit* identifies five stages in setting and maintaining procedures: identifying hazards, assessing risks, identifying measures to control the risks, implementing procedures to maintain control, and auditing and reviewing these procedures.

An important point to introduce at this stage is that the actions carried out in this phase of the EMS do not only address the normal operating conditions of the industrial estate. The environmental management system must also address the situation of the response to take in the case of an abnormal situation, i.e. an emergency or an accident.

Evaluation

The third phase of the process is the evaluation phase in which progress is monitored in order to determine if the actions have been successful or not in achieving the objectives and targets, and to identify where corrective action is necessary. Some of the areas where **Monitoring** is required for industrial estates are:

- ambient environmental quality in and adjacent to the site,
- emissions to water and air,
- solid waste generation (including hazardous waste),
- storage of hazardous goods on site,
- accidents and spillage, and
- procedures for the control of safety and pollution.

The findings, conclusions and recommendations should be documented and **Corrective Actions** suggested with responsibility attributed for carrying out the new actions.

In order to assess how the EMS is performing it is valuable to carry out a regular internal audit of the environmental performance of the enterprise. Details of how to design and perform such an **Environmental Audit** are described in the ISO 14010 and 14011 standards (ISO, 1998), as well as in Chapter 3.7 of the *Environmental Management System Training Resource Kit.*

Audit of the Environmental Management System

The audit will cover the completeness of the EMS, whether it adequately addresses the needs of the specific nature and complexity of the organisation, whether it has been implemented well and whether it is suitable to fulfil the […] environmental policy.

UNEP/ICC/FIDIC, 1997

Corrective Action

Based on the conclusions from the EMS audit, in the fourth phase - called the corrective action phase - the Senior Management carries out a review the EMS itself. One goal of this **Management Review** is to see how well the objectives and targets have been met. Another aim is to ascertain if the EMS is responsive to new environmental concerns, for example new legislation, or changed operating conditions in the company. Depending on the results of this review, the management team may decide to recommend that the objectives and targets be modified or even that the environmental policy be changed. The effect of such decisions is to require that new, corrected actions be defined in a subsequent planning stage. Hence, the process starts again, thereby guaranteeing the objective of *continuous improvement*.

Concluding Remarks

It is important to finish our discussion of EMS's by summarising some of the benefits to an enterprise of adopting an EMS. An EMS addresses environmental issues by giving priority to prevention over remediation. It also demonstrates that there is a commitment to continual improvement, and that the organisation wants to meet, if not go beyond, compliance with regulatory requirements. While developing and implementing an EMS may appear to be time-consuming and costly at the beginning, the resulting efficiency and operational improvements from an integrated, cross-media approach will usually lead to long-term cost savings. For example, the system should assist in revealing wastage and inefficiency in operations, thereby resulting in additional savings for the enterprise.

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Further Reading

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An Industrial Ecology Approach to Environmental Management.

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An Industrial Ecology Approach to Environmental Management

Introduction

The UNEP-DTIE approach to environmental management in industrial estates is grounded in ideas that are to be found in the field of industrial ecology (Balkau, 1997). It is therefore useful to say a few words about what industrial ecology is all about.

Erkman (Erkman, 1997) has pointed out that, while the concept of industrial ecology can be traced back almost to the middle of the 20th century, the term itself only started to appear sporadically in the literature in the 1970's. We then have to wait until 1989, when the paper "Strategies for Manufacturing" by Frosch and Gallopoulos appeared in *Scientific American*, for the idea of industrial ecology to take root and start to attract a wider audience (Frosch & Gallopoulos, 1989).

The basis of the industrial ecology approach, as described initially by Frosch and Gallopoulos, is that an analogy can be drawn between the way that natural ecological systems use materials and energy and the way that the industrial system functions (Frosch, 1992). Industrial ecology then attempts to use this analogy as a framework for studying the behaviour of the industrial system and thinking about how it can be reorganised to function more efficiently.

The Natural Ecosystem

The natural ecological system can be divided into four component parts (Odum, 1975) -

(a) an ***abiotic component***, consisting of inorganic and organic compounds (nutrients) as well as the conditions - such as temperature or rainfall - that are required for existence,

(b) ***producers***, which are living species (e.g. green plants) that are able to grow using the abiotic materials and photosynthetic processes,

(c) ***consumers*** (e.g. herbivorous and carnivorous animals) that ingest either the plants or each other, and

(d) ***decomposers*** (e.g. bacteria, fungi and small invertebrates) that break down dead matter or waste products into simpler chemical compounds, which can then be used once again as nutrients by the producers.

A simplified way of representing how the four components are linked is shown in Figure 1. The first three components are linked into a *primary* food chain while the fourth component, the decomposers, constitutes what can be called the *detritus* food chain. The role of the decomposers is extremely important since they not only convert dead material and waste back into useful nutrients but also regulate its rate of conversion. In addition, the decomposers provide the link between different individual ecosystems, within the overall natural ecological system, such as for example when dead leaves from trees in a forest ecosystem fall into a stream and are broken down into nutrients that are then absorbed by the organisms in an aquatic ecosystem (Odum, 1975).

The Industrial Ecosystem

A similar approach to the description of an ***industrial ecosystem*** is shown in Figure 2. The ecosystem may again be divided into four components or *functions*. We refer to these components as *functions* because they serve certain specific purposes and do not necessarily represent different companies or sectors of the economy. In some cases one company may even fulfil several functions. The first function includes the extraction of ***raw materials*** and their refining. Examples are a mining operation or a petroleum exploration and refining activity. The function of the ***manufacturer***, similar to the producer of Figure 1, is to process the raw materials and transform them into products that can then be used by the third function, the ***consumer***. These three components are linked similarly into a *primary* production chain. The ***waste processor***, the final function, has been put in a *secondary* production chain, similar to the detritus food chain of the natural ecosystem. Here the unused materials from the supply of raw materials and the manufacturing processes, as well as the product at the end of its useful life, are converted back into the “technological nutrients”.

Figure 1: The Natural Ecological System (adapted from Odum, 1975).

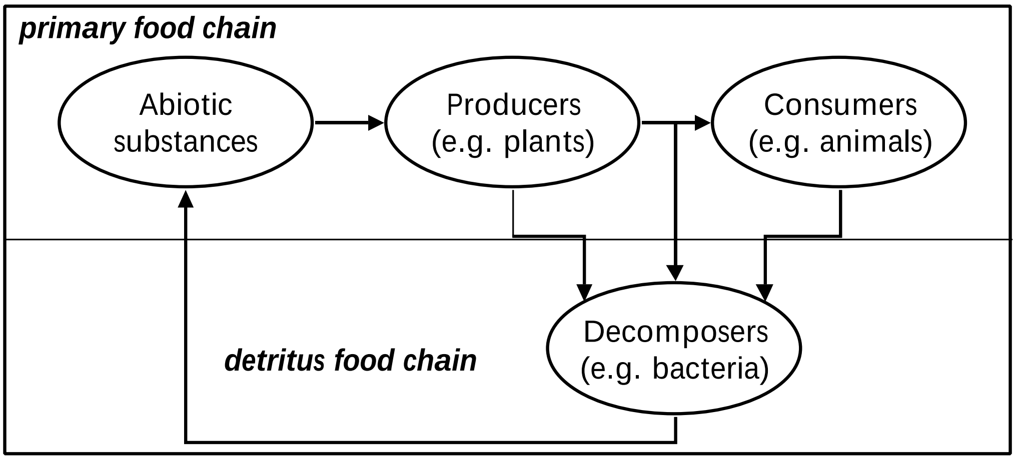
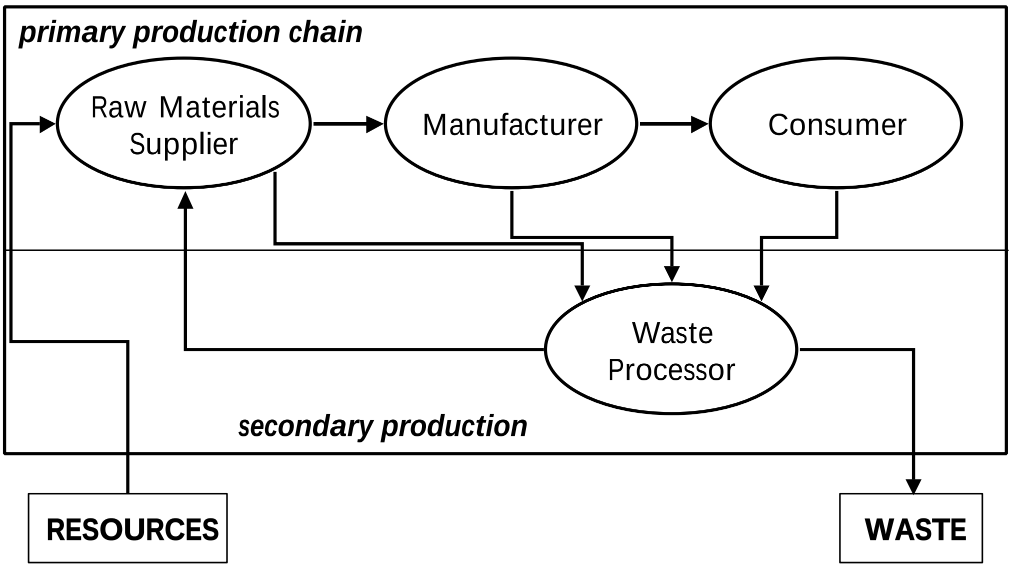


Figure 2: The Industrial Ecosystem (adapted from Jelinski, 1992).



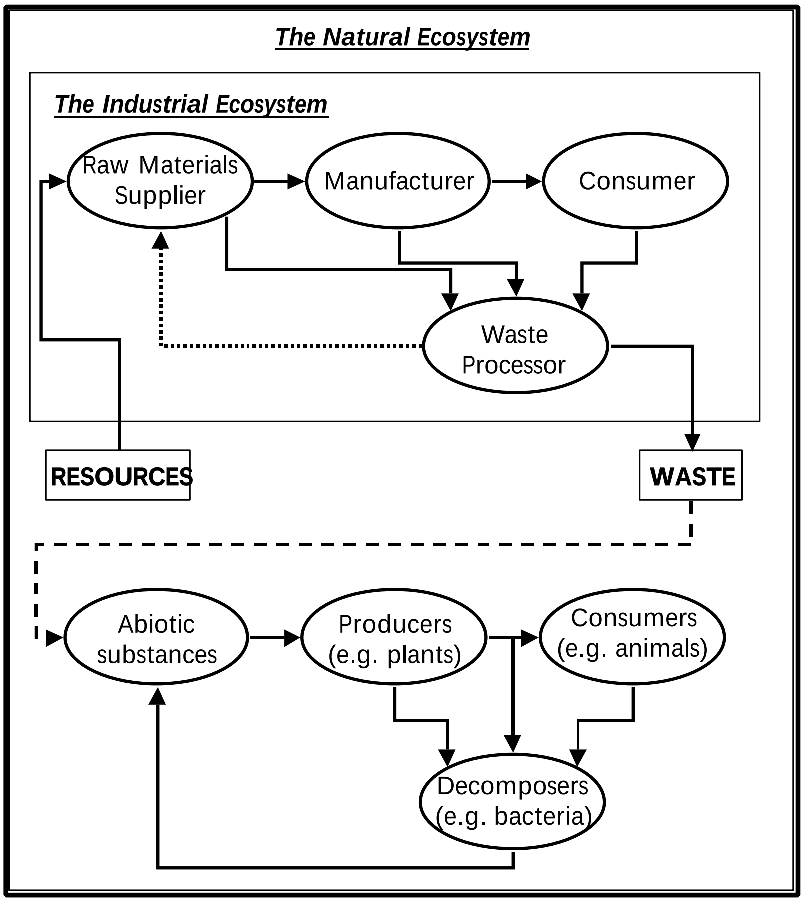
Up to this point the analogy between the natural and industrial ecosystems has worked well. However, in the natural ecosystem all materials are eventually returned to the level of simple substances or nutrients that can eventually be re-used by the plants. In Figure 1 this is shown occurring via the decomposers. However, the detritus food chain is only one of several recycling pathways. Another important path is principally physical in nature, and is referred to as the biogeochemical cycle. Probably the two most important examples of biogeochemical cycles are those involving carbon dioxide and water (Odum, 1975). The important point to retain is that materials flow *cyclically* within natural ecosystems and that overall the "loop is closed".

In contrast, the waste processor in our current industrial ecosystem is nowhere near as effective at re-generating useful materials and as a result material is lost from the industrial ecosystem as "waste" (Figure 2). Of course, although it appears that the waste is merely disappearing from the industrial ecosystem, it has to go somewhere and that "somewhere" is the natural ecosystem since the industrial ecosystem is embedded within it (Figure 3). It is therefore dispersed either to the air, to water or as solid waste for landfill and, most importantly, it is considered to have no further useful value. When the waste material is toxic for the species in the natural ecosystem and it enters into the material cycle as shown in Figure 3, the consequences can be quite disastrous. We have only to think of the situation that resulted from the discharge of mercury into the water of Minamata Bay in Japan.

Finally, the material lost from the industrial ecosystem must be compensated by the extraction and incorporation of new materials or “resources” from the natural ecosystem. In this context, and for obvious reasons, we include the lithosphere (the Earth’s mantle and crust) in the natural ecosystem.

In an "ideal" industrial ecosystem the waste processor would be able to turn everything into useful materials for re-use in the system. In reality, while materials like some metals are actively recycled (see for example Allen & Behmanesh, 1994), the flow of many other materials is essentially linear with resources being used, products being manufactured and waste being disposed of. As we have shown in Figure 3, the current situation is best represented by a very small material flow from the waste processor function back to the raw materials supplier (hence the faint dotted line) and the major flow being to the natural ecosystem.

Figure 3: Relationship between the Industrial and Natural Ecosystems.



However, as Frosch and Gallopoulos (1989) have remarked -

"An ideal industrial ecosystem may never be attained in practice, but both manufacturers and consumers must change their habits to approach it more closely if the industrialised world is to maintain its standard of living - and the developing nations are to raise theirs to a similar level - without adversely affecting the environment."

What this means for us is that we are obliged in the foreseeable future to live with the type of industrial ecosystem shown in Figure 2. But our goal must be to reduce as much as possible the quantities of "waste" generated and hence "resources" used.

Graedel and Allenby (1995) have summarised these ideas in terms that can be understood in the context of an approach to environmental management -

- Industrial ecology requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them.

- It is a systems view in which one seeks to optimise the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal.
- The factors to be optimised include resources, energy and capital.

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CASE STUDIES

The Industrial Symbiosis in Kalundborg, Denmark.

A Profile of Lingkungan Kecil (LIK) Bugangan Baru Industrial Estate, Semarang, Indonesia.

Laem Chabang Industrial Estate, Thailand.

An Eco-Industrial Networking Exercise in Naroda Industrial Estate, Ahmedabad, India.

EMS as an Opportunity for Engaging China's Economic Development Zones: The Case of Dalian.

The Evolution of an Industrial Park: The Case of Burnside, Halifax, Canada.

Developing a Programme to Accelerate Sustainability in the Humberside Region, United Kingdom.

THE INDUSTRIAL SYMBIOSIS IN KALUNDBORG, DENMARK.

1. INTRODUCTION.

It is important to point out that the example of Kalundborg in Denmark strictly speaking is an example of an *industrial network*, and not an industrial estate. However, as a case study it is an excellent illustration of the application of an Industrial Ecology approach and is certainly relevant to an industrial estate. The example of Kalundborg is often quoted in the literature, perhaps because it is simple enough to allow the idea of an industrial ecosystem to be appreciated and yet sufficiently sophisticated to give a feeling for the enormous potential of this approach.

2. BACKGROUND.

The history of Kalundborg really began in 1961 with a project to use surface water from Lake Tissø for a new oil refinery in order to save the limited supplies of ground water (Christensen, 1999). The city of Kalundborg took the responsibility for building the pipeline while the refinery financed it. Starting from this initial collaboration, a number of other collaborative projects were subsequently introduced and the number of partners gradually increased. By the end of the 1980's, the partners realised that they had effectively "self-organised" into what is probably the best-known example of a working industrial ecosystem, or to use their term - an *industrial symbiosis*.

3. PARTICIPANTS IN THE INDUSTRIAL SYMBIOSIS.

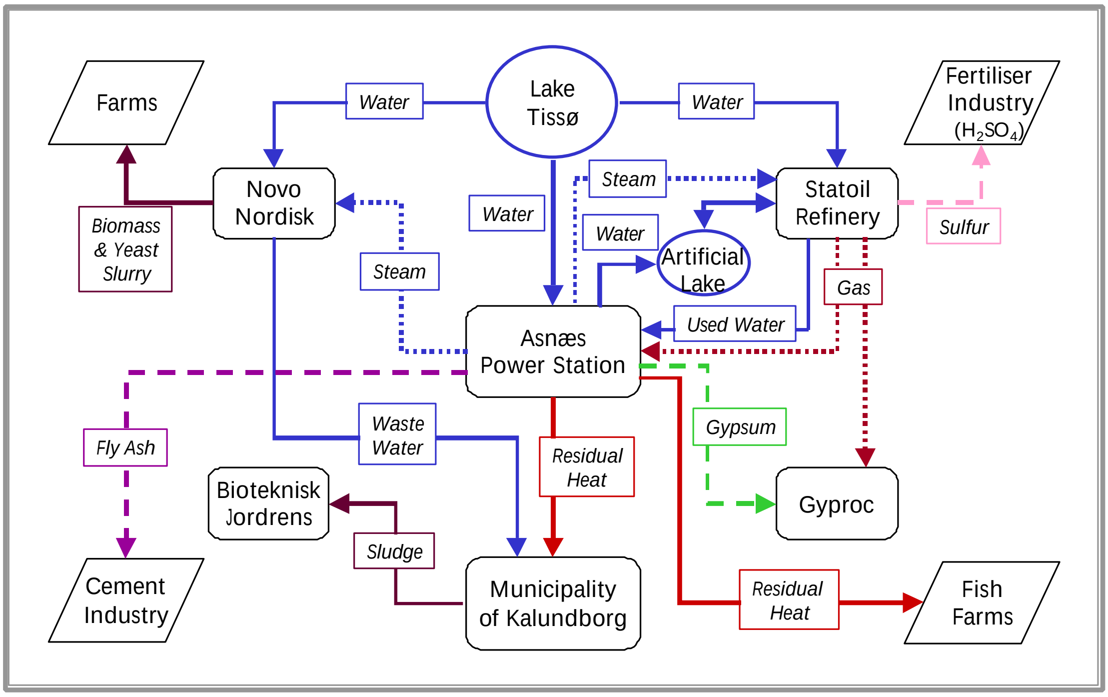
In addition to several companies that participate as recipients of materials or energy, the ecosystem today consists of six main partners -

- Asnæs power station - part of SK Power Company and the largest coal-fired plant producing electricity in Denmark.
- Statoil - an oil refinery belonging to the Norwegian State oil company.

- Novo Nordisk - a multi-national biotechnology company that is the largest producer of insulin and industrial enzymes.
- Gyproc - a Swedish company producing plasterboard for the building industry.
- The town of Kalundborg, which receives excess heat from Asnaes for its residential district heating system.
- Bioteknisk Jordrens - a soil remediation company that joined the Symbiosis in 1998.

The status of the industrial symbiosis in 1999 is shown in Figure 1 (Christensen, 1999). From this diagram we can appreciate how extensive the collaboration regarding materials and energy is. In our discussion here, however, we shall focus only on the most important flows.

Figure 1: Material Flows in the Kalundborg Industrial Ecosystem [Christensen, 1999].



4. MATERIAL & ENERGY FLOWS – A SERIES OF BY-PRODUCT SYNERGY PROJECTS.

It is important to understand initially that ***water*** is a scarce resource in this part of Denmark and is therefore systematically valorised. As we mentioned above, in order to reduce consumption of ground water, Lake Tissø has become the main source of water for the industrial partners in Kalundborg. The reduction in the use of ground water has been estimated at close to 2 million cubic metres per year (Christensen, 1999). However, in order to reduce overall water consumption by the partners, the Statoil refinery supplies its purified wastewater as well as its used cooling water to Asnæs power station, thereby allowing this water to be "used twice" and saving additionally 1 million cubic metres of water per year.

Asnæs power station supplies ***steam*** both to Statoil and Novo Nordisk for heating of their processes. By functioning in a co-generation mode, the power station is able to increase its efficiency.

Excess gas from the operations at the Statoil refinery is treated to remove ***sulfur***, which is sold as a raw material for the manufacture of sulfuric acid, and the clean ***gas*** is then supplied to Asnæs power station and to Gyproc as an energy source.

In 1993 Asnæs power station installed a desulfurisation unit to remove sulfur from its flue gases, which allows it to produce ***calcium sulfate*** (gypsum). This is the main raw material in the manufacture of plasterboard at Gyproc. By purchasing synthetic "waste" gypsum from Asnæs power station, Gyproc has been able to replace the natural gypsum that it used to buy from Spain. In 1998 approximately 190,000 tons per year of synthetic gypsum were available from the power station.

Novo Nordisk creates a large quantity of used bio-mass coming from its synthetic processes and the company has realised that this can be used as a fertiliser since it contains nitrogen, phosphorus and potassium. The local farming communities use more than 800,000 cubic metres of this liquid ***fertiliser*** each year as well as over 60,000 tons of a solid form of the fertiliser.

Finally, residual ***heat*** is also provided by Asnæs power station to the district heating system of the town. The system functions via heat exchangers so that the industrial water and the district heating water are kept separate.

5. THE EXPERIENCE OF KALUNDBORG.

What lessons can be learnt from the example of Kalundborg? Firstly, such an approach can lead to a significant reduction in the environmental impact, as is shown in Table 1 (Erkman, 1998):

Table 1: Environmental Aspects of the Symbiosis [Erkman, 1998].

Reduction in consumption of resources	
oil	45,000 tons/year
coal	15,000 tons/year
water	600,000 m^3/year
Reduction in waste emissions	
carbon dioxide	175,000 tons/year
sulfur dioxide	10,200 tons/year
Valorisation of "wastes"	
sulfur	4,500 tons/year
calcium sulfate (gypsum)	90,000 tons/year
fly ash (for cement etc)	130,000 tons/year

However, at what cost? The investment needed to put the different material and energy exchanges in place has been estimated at $75 million. This is the cost of the 18 projects established up to and including 1998. Keeping in mind that each exchange is based on a separate contract between the two partners involved, revenues can be estimated as coming from selling the waste material and from reduced costs for resources. The partners estimate that they have "saved" $160 million so far (Christensen, 1999). The payback time of a project is less than 5 years on average. Therefore a second lesson is that a more rational utilisation of resources can save money.

A third point is that the symbiosis in Kalundborg essentially "organised itself" over a relatively long period of time using sound financial criteria to decide which projects would be put in place. It is always tempting to want to re-engineer an industrial system in a "top-down" manner so that it becomes closer to a true ecosystem. As

Frosch has noted however (Frosch 1992), in such a carefully planned and integrated industrial system the individual parts would be too closely linked and dependent on each other, rendering it fragile and hence likely to collapse. He has expressed his preference for an industrial system that self-organises in order to accomplish the minimisation of waste, while recognising that there may be a need to help to "stock" the industrial ecosystem with certain types of company in order to create a better balance, either by providing information on business opportunities or supporting start-ups. Interestingly, although Kalundborg epitomises the self-organisation described by Frosch, it has in its turn been criticised by others for being fragile because it has too few partners and each is therefore too dependent on the others.

A fourth lesson is that the close proximity of the partner companies has undoubtedly helped in terms of reducing the cost of infrastructure to facilitate material exchanges, such as pipelines. However, it has also been pointed out that the proximity of the *human* partners was crucial in developing the co-operation needed to make the symbiosis work (Christensen, 1999).

These lessons from the Industrial Symbiosis can clearly be applied in an industrial estate with similar benefits. Côté and Hall (1995) have identified the following objectives for applying such an approach to industrial estates -

- Conservation of natural and financial resources
- Reduced production, material, energy, insurance and treatment costs and liabilities
- Improved operating efficiency, quality, population health and public image
- Potential income through the sale of waste materials.

6. CLOSING REMARKS.

Much of the existing literature about the Kalundborg example focuses on the Industrial Symbiosis and the By-Product Synergy projects. It is clear that such a project as the Industrial Symbiosis does not come about unless there is a basic awareness of the economic and environmental value of an effective environmental management programme.

We shall mention just one aspect of this awareness within one of the partners Novo Nordisk. Novo Nordisk is well known within the industrial community for the high quality of its environmental reporting. Its annual Environmental Report provides clear information on its resource and energy consumption as well as emissions and waste production. The data is presented for the company on a global basis and on a site basis. Comparison between different years allows the reader to assess the type of improvements that the environmental management system is bringing to the activities of the company. It is perhaps not surprising that Novo Nordisk participates in a WBCSD project on developing eco-efficiency indicators (see WBCSD, 2000 and Background Paper). It obviously has developed a great deal of expertise over the years in measuring environmental performance in its different production sites.

We see from this example that participation in the Industrial Symbiosis is not a unique experience for Novo Nordisk but is part of an overall environmental philosophy within the company.

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A Profile of LIK Bugangan Baru Industrial Estate, Indonesia

1. INTRODUCTION.

This profile of the LIK Industrial Estate in Semarang, Indonesia is taken from the case study presented by Mr Firman Istiawan at the International Conference & Workshop on Industrial Park Management held in Manila (Philippines) in April 2001. The text has undergone minor editing so that the case study responds better to the needs of the Resource & Training Kit.

This case study provides an excellent example of an industrial estate in which the estate management group has taken the lead by starting to introduce environmental management to the companies located there. Their activities include a planned effort to carry out two Eco-Industrial Networking projects as pilot studies. The goal with these two projects is to build trust between companies, as well as with the management company, in order to address environmental management at an estate-level.

2. LIK INDUSTRIAL ESTATE.

2.1 AN OVERVIEW.

In 1979 Mr. Djamin Ceha, CEO of the real estate company PT TANAH MAS GROUP, bought the land on which the industrial estate stands today in order to develop it for small scale industry. Indeed, the name of the estate, Lingkungan Industri Kecil (LIK), means "environment for small scale industries" reflecting the nature of the development.

The industrial estate is operated by a management company PT TANAH MAKMUR that belongs to the PT TANAH MAS GROUP. PT TANAH MAKMUR also owns and operates other industrial estates in Sulawesi, Kalimantan, Sumatera, and Riau and has recently acquired two new sites in Demak and Ungaran. In its role as developer of the LIK industrial estate, it took responsibility for the infrastructure on the site, building the roads, pipelines, bridges and a mosque. There is an industries association, called HIPLIK (Himpunan Pengusaha LIK), made up of businesses operating in the LIK estate. However, the association is not very active.

The complete estate (100 ha) is divided into lots of different standards and sizes to be used predominantly for warehouses. The area of LIK was originally planned to accommodate 600 lots. By 1986 almost 50% of the plots had been sold and in 1996, a year before the Asian

Table 1: General Information on LIK Semarang.

Ownership	100% private
Total size of Industrial Estate	1 km^2 (100 ha)
Number of plots	600
Number of companies	486
Total Work Force	25,000
Origin of companies	Indonesian
Size of companies	Mainly small-scale industry
Sectors	Furniture, office equipment, plastics, others
Suitability/Constraints	LIK is designed for small- and medium- sized industries; there is no preference for specific sectors
Plots	
Minimum Size of Plots	60 m^2
Maximum Size of Plots	5,000 m^2
Sale/Lease?	Plots are usually sold
Standard Factory Building	
Size	40 m^2, standard buildings can be acquired
Sale/Lease	Factory buildings are usually sold

crisis, the total area sold was close to 100%. There are only about 480 companies actually located inside the LIK industrial estate because some medium-sized companies have acquired more than one lot and have constructed their own buildings. However, the majority of companies at LIK are small-scale companies with only one lot. An overview of the LIK industrial estate is presented in Table 1 above.

Some key points regarding the LIK industrial estate are:

- The labour costs are very low.
- The estate is close to the city, the railway station, the port and the airport.
- The investor does not need to obtain any permits from the Department of Industry.
- Each warehouse comes with facilities, such as water, electricity and the land certificate.
- The estate manager (PT TAHAN MAKMUR) provides road maintenance as well as a 24-hour security service.
- The estate manager has become the mediator for the companies if they have problems, either within the industrial estate or outside.

- PT TAHAN MAKMUR provides a show room, called “Graha Pariwara” (see Figure 1), that the companies located within LIK can use (without charge) to present their products to potential customers.

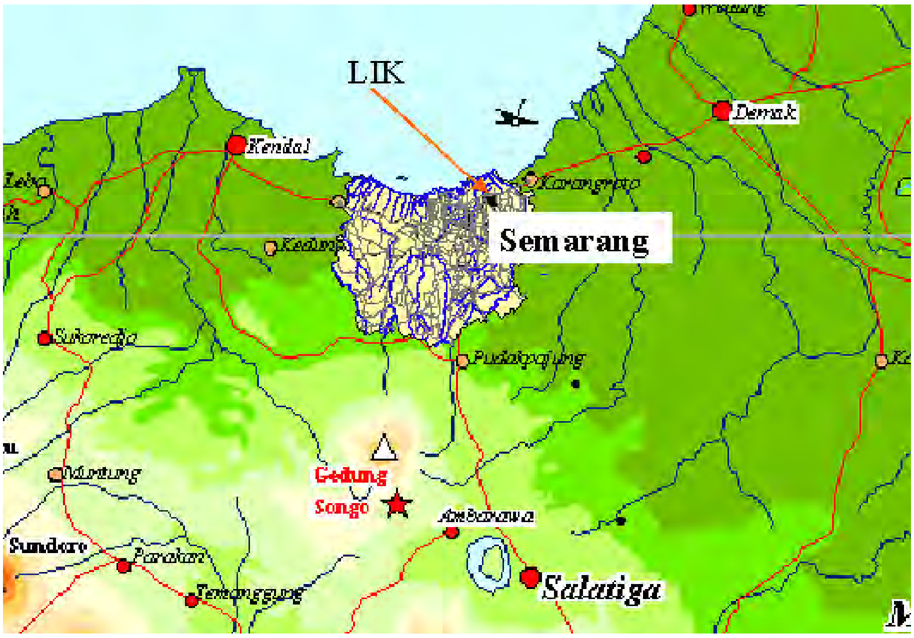
Figure 1: The LIK Showroom “Graha Pariwara”.

2.2 THE REGIONAL CONTEXT.

The LIK industrial estate is located in Semarang on the northern coast of the island of Java about 1 hour by plane east of the capital Jakarta (Figure 2).

Figure 2: Map of Indonesia

Figure 3: Location of LIK Bugangan Baru in Semarang



As can be seen in Figure 3, LIK is situated in the north-east part of Semarang. It is located on a major highway and is close to major forms of communication such as a railway, airport and port (Table 2).

The land on which LIK industrial estate is located has been reclaimed from marshland, and in parts it lies below sea level. An important factor for the estate is that, even though the entire area is now fully developed, problems do arise during heavy rains because the water cannot be discharged quickly enough. As a result the estate is easily flooded and this has a very bad effect on infrastructure and roads. Although the government has built dykes to prevent flooding, this has not made a significant improvement.

Table 2: Access to LIK Semarang

Distance to …			*Comments*
City Centre	Semarang	6 km	
Airport	Ahmad Yani	20 km	
Sea Port	Tanjung Emas	4 km	an international container terminal
Railway Station	Tawang, Semarang	4 km	freight depot

The area contains a number of environmentally-sensitive ecosystems – such as wetlands and mangroves, located only 1 km away, and an ecological reserve situated 40 km to the south. The estate is only 3 km from the coast and fisheries are a source of economic activity in the region, particularly in Pekalongan, Juwana Rembang, Pati, Jepara, and also in Semarang itself. Forestry is focussed 20 km to the south-west in Boja, where there is a rubber plantation with small amounts of java teak and pine, and there is also agriculture in the area around Semarang. Rawa Pening and Tuntang, located 40 km to the south, are tourism centres while Bandungan is popular for weekend vacations and is situated about 30 km from Semarang.

2.3 POLICIES & REGULATIONS RELATING TO INDUSTRIAL ESTATES.

a) *Industrial Development Policy.*

LIK Industrial Estate was the first private industrial estate in Indonesia and has been fully supported by the Department of Industry since the beginning. The Department of Industry in fact has a local office next to the PT TANAH MAKMUR office within LIK, which helps to facilitate an exchange of information on new policies, legislation and strategies both with the industries and the estate management.

A number of regulations apply to industrial estates, some of which are issued by the city planning department. An important example is the so-called 1:3:6 relationship regarding the size of the lots in an industrial estate. This states that for every large lot, three medium-sized lots and six small-scale lots must be erected. However, it does not indicate the absolute size of the lots. Another regulation that concerns LIK states that industries should not be located within a radius of 5-10 km from the downtown area. However, some regulations depend on the type of industry located in the industrial estate and, in fact, LIK is exempt from many of these because only small-scale industry is located there.

b) *Environmental Management Policy.*

At the time that LIK was founded, the Department of Industry supported the estate on all licensing matters. At that time no regulations governed activities of industrial estates.

By the 1990's the government had issued new environmental regulations, such as the:

- AMDAL (Environmental Impact Assessment),
- UPL/UKL (Environmental Planning and Maintenance Report).

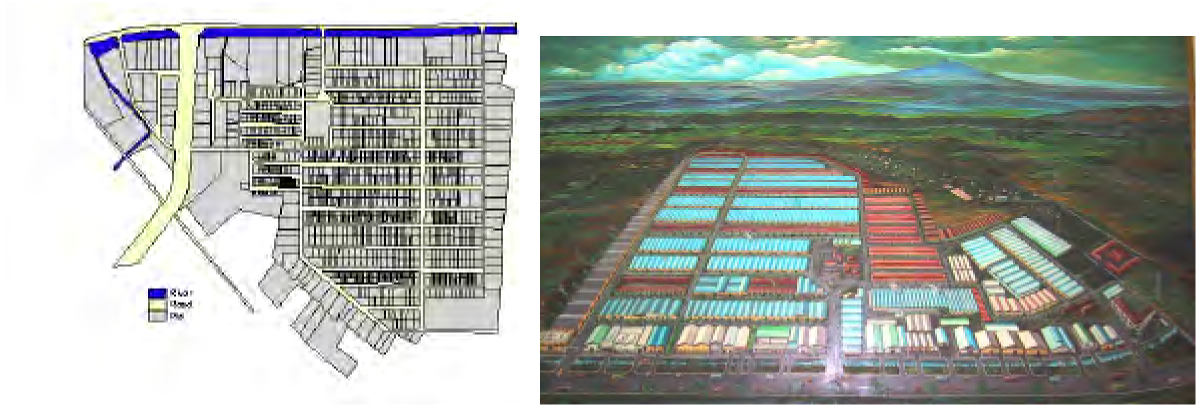
Once again, these depend on the type of activity being carried out in an estate and do not apply to LIK because the estate is host only to small-scale companies. There are other environmental regulations concerning the treatment of wastewater, the organisation of waste collection etc. However, enforcement is not very thorough and industry is frequently not well informed about environmental regulations.

2.4 PLANNING IN LIK INDUSTRIAL ESTATE.

As has already been mentioned, the industrial estate was developed originally for small-scale industries. The objective of the developer was to provide a location where small-scale and medium-size enterprises would have a better location to run their businesses. As part of the overall planning of the industrial estate, the estate management group, PT TANAH MAKMUR, tries to help the companies overcome some of the barriers that small- and medium-size enterprises encounter, such as a lack of capital, marketing, technology or workers. For example, the estate offers services in marketing, by providing "Graha Pariwara" (a show room for products of the companies, see Figure 1), and in financing, by organising a soft loan programme, called KPR/BTN, where loans can be paid back over long time periods (15-20 years).

The layout of the LIK estate, along with an aerial photograph, is shown in Figure 4 below.

Figure 4: The Site of the LIK Industrial Estate.



The estate is subdivided into -

- A general industrial zone.
- A commercial zone.
- Infrastructure, e.g. toll roads, pipelines for fresh water, electricity (in co-operation with the government), and a mosque (area: 500 m^2).
- Undeveloped zone (at the moment the area is 1.3 ha).

The types of industry located in the estate, broken down by sector, are shown in Table 3. As we can see, there are a vast number of different industries, with food & beverage and the service sector being the most important.

Table 3: Listing of companies by sector

Sector	N° of companies	%	Sector	N° of companies	%
Food and Beverage	62	13%	Car Workshop	25	5%
Services	52	11%	Paint	13	3%
Paper & stationery	41	8%	ACCU/SPIRITUS/ALCOHOL	10	2%
Printing	39	8%	Electronics/Electrical	8	2%
Ceramic/Metal	34	7%	Mechanical Engineering	7	1%
Furniture/Wood	33	7%	Footwear	5	1%
Plastics	30	6%	Textiles	4	1%
Household Equipment	30	7%	Packaging	4	1%
Chemicals	24	5%	Poultry	3	1%
Construction	24	5%	Cosmetics	2	0%

2.5 ENVIRONMENTAL MANAGEMENT.

The estate manager PT TANAH MAKMUR provides some environmental management for the collection of solid waste. It has arranged for a container to be placed in each lot to receive all types of waste. The waste is collected every day by “scavengers” and taken to a small dumpsite in the industrial estate (Figure 5). At the dumpsite the waste is separated into

Figure 5: Dumpsite at LIK

paper, plastic, carton box etc. and sold to the respective recycling factories. A waste collector from the city then collects the rest of the waste and takes it to a final dumpsite outside the city.

In addition several recycling companies are located within the LIK estate dealing with lead batteries and glass. Three battery recycling factories receive used batteries from collectors and then separate the individual parts of the battery. The plastic box is sold back to the battery manufacturer. The inside of the battery is used for energy production and this, in turn, is used to melt lead for resale. As not all of the lead can be recovered in this initial process, the parts that still contain lead particles are sold to a specialised lead recycling company in Surabay for further processing.

Although the recycling of the batteries is welcome, it creates a serious problem in the form of severe air pollution because the melting of the batteries is carried out over open fires. The environmental agencies have already intervened but they have not been able to solve the problem entirely. An important question is how the situation can be further improved, keeping in mind that the companies are unable to invest in new technology and that there is no wish to close down the companies for social reasons.

Bottles and all types of glass are also collected by the scavengers who work inside LIK. They then sell the glass on to bigger collectors (Figure 6). These recycling companies separate the glass and sell it back to the glass or bottle factory.

Figure 6: Glass collection in LIK.

3. ECO-INDUSTRIAL DEVELOPMENT OR NETWORKING.

LIK industrial estate has started to investigate the possibilities for creating eco-industrial networking amongst its tenant companies. Working with the University of Kaiserslautern (Germany) and the University Diponegoro in Semarang, they have decided on two pilot projects in the areas of:

- ⇨ Biowaste treatment, and
- ⇨ Good Housekeeping.

The general idea of the biowaste project is to make use of the biowaste that is generated in the industrial estate - and possibly also the surrounding urban settlements – and the water hyacinths to create valuable resources such as energy or fertiliser.

With respect to the Good Housekeeping project the idea is to introduce the Good Housekeeping Module of GTZ to the companies within LIK. The project will be led by the estate management group, PT TANAH MAKMUR, and will involve a group of companies in order to foster a co-operative approach. In this way companies do not have to rely on a consultant and can work with companies that they are familiar with. It is hoped that this will establish strong links and a level of trust between companies. Once the project has been shown to be successful with a few companies in LIK, the objective is to copy the approach within LIK and later possibly also at the five other industrial estates managed by PT TANAH MAKMUR.

It is important to mention here that two examples of networking activities involving the estate manager are already occurring in the estate:

- As described above, the estate management group provides a show room, or “Graha Pariwara”, for all of the tenant companies to display their goods, and
- The estate management group is also often called upon by tenant companies to supply information on manufacturers or distributors of raw materials.

The goal of the two pilot studies is to demonstrate that eco-industrial networking can be beneficial to companies that participate. Achieving success in LIK with a limited number of relatively simple projects is very important if the estate manager is going to overcome some of the typical barriers that often prevent companies from participating in such an initiative. Examples are:

- The belief that solutions to environment problems always cost money rather than being the source of potential economic benefits.
- The desire not to share or release company information because of the fear that competitors will copy their processes, or that the government will prosecute them for wrongdoing.
- A lack of awareness on environmental issues within the company.
- A lack of human resources.

However, if the first networking projects work out well, this will allow the estate manager to extend environmental management within the estate in order to reduce its environmental impact. From the viewpoint of the management group, PT TANAH MAKMUR, a profitable networking project can also be a powerful indicator of a successful and well-run industrial estate with obvious benefits for attracting new investors.

4. FURTHER READING.

F. Istiawan and M.Z. Wilderer, *Case Profile of Lingkungan Industri Kecil (LIK) Bugangan Baru Industrial Estate, Semarang, Indonesia*, presented as a Case Study at the International Conference & Workshop on Industrial Park Management, Manila (Philippines), April 2001.

Laem Chabang Industrial Estate, Thailand.

Summary

This Case Study was used during a Regional Training Workshop on Environmental Management of Industrial Estates, held at the Laem Chabang Industrial Estate in Thailand between September 1 – 4, 1997. The case profile was prepared by the Environmental Enhancement Centre of the Industrial Estate Authority of Thailand (IEAT) for the workshop, and is reproduced here from the Final Report of the workshop (UNEP/IEAT, 1997).

During the late 1980's and early 1990's Thailand enjoyed annual economic growth of more than 8% as exports changed from agricultural to industrial products. The basis for this shift to industrial manufacturing was a process of industrial decentralisation involving the development of 23 industrial estates spread throughout the country. Of these 23 estates, consisting of 1200 factories, 9 are owned by the state while the remainder are joint ventures.

These industrial estates are covered by the Industrial Estate Authority of Thailand (IEAT), which was set up in 1972 by the government of Thailand. IEAT is a state enterprise attached to the Ministry of Industry, with a mandate to promote industrial development in a systematic way through the use of zoning combined with environmental protection. One of the goals of IEAT and the government has been to decentralise industrial activities away from the heavily congested Bangkok area. On the environment side, IEAT has the responsibility for controlling industrial pollution and environmental management within all of the industrial estates. In this respect it has set up monitoring systems and enforcement mechanisms in all industrial estates (for a detailed discussion see Homchean, 1996).

One of the industrial estates covered by IEAT is the Laem Chabang Industrial Estate situated about 130 km south-east of Bangkok. It is connected to Bangkok and the other provinces by a main regional highway and a railway. In addition there is a deep sea port, owned by the Port Authority of Thailand, that was constructed as a part of the overall development plan.

Laem Chabang IE is surrounded by hills on three sides with the Gulf of Thailand making up the fourth side (essentially south/south-west). While there are two oil refineries to the north of the industrial estate, the area is not merely an industrial centre. Agriculture remains an important part of the local economy while tourism is extremely important further down the coast in Pattaya.

Laem Chabang IE is divided into a General Industrial Zone, with 45 tenant companies, and an Export Processing Zone, with 51 companies. The companies are in general concerned with light manufacturing – electronics, automotive parts, electrical appliances, metals and plastics.

A Central Wastewater Treatment Plant is provided (as is the case with all estates in Thailand), which is operated by an outside contractor under a mandate from IEAT. A consulting firm monitors the effluent and ambient environmental quality at the estate. The cost of treatment to the companies is based on the BOD and the volume of the wastewater. If companies generate wastewater that contains chemicals such as heavy metals, they are obliged to have in addition their own in-house pre-treatment facilities.

The IE has access to its own incinerator although at the time of the case study (1997) it was not functioning and each company had contracted with outside contractors to remove the non-hazardous waste. Hazardous waste on the other hand is disposed of by a company that is partly owned by the government.

An Occupational Health and Safety Centre has been established within the industrial estate as part of a programme sponsored by the government. The goal of this programme is fourfold:

- to provide information and demonstrations on industrial safety,
- to carry out training on health and safety issues for the employees within the estates,
- to provide facilities for health examinations for workers, and
- to carry out regular examination of the conditions in the workplace.

References

Homchean, 1996 – K. Homchean, *UNEP Industry & Environment Review*, 1996, 19(4), 22.

UNEP/IEAT, 1997 - UNEP/IEAT, *Final Report of the Regional Training Workshop on Environmental Management of Industrial Estates*, Laem Chabang, Thailand, September 1 – 4, 1997.

Laem Chabang Industrial Estate, Thailand

Prepared by: **Environmental Enhancement Centre, Environmental & Safety Control Division, Industrial Estate Authority of Thailand (IEAT).**

1. GENERAL PROFILE OF THAILAND.

Location:	Southeast Asia, bordering the Andaman Sea and the Gulf of Thailand; land borders with Myanmar (north and west), Lao PDR (north and east), Cambodia (east) and Malaysia (south)
Area:	total area: 514,000 sq km land area: 511, 770 sq km
Land boundaries:	total: 4,863 km; Burma 1,800 km, Cambodia 803 km, Lao PDR 1,754 km, Malaysia 506 km
Coastline:	3,219 km
Climate:	tropical; rainy, warm, cloudy southwest monsoon (mid-May to September); dry, cool northeast monsoon (November to mid-March); hottest in March and April; southern isthmus always hot and humid
Terrain:	low-lying central plain; Khorat plateau in the northeast; mountains elsewhere
Natural resources:	tin, rubber, natural gas, tungsten, tantalum, timber, lead, fish, gypsum, lignite, fluorite
Population:	60 million, 30 percent under the age of 15; growth rate of approximately 1.2- 1.4 percent per year; expected population of 64 million in 2000 and 70 million in 2010
Environment:	current issues: air pollution from vehicle emissions in Bangkok; water pollution from organic and factory wastes; deforestation; soil erosion; wildlife populations threatened by illegal hunting natural hazards: land subsidence in Bangkok area resulting from the depletion of the local water table; flooding
International agreements:	Thailand is party to international agreements on Climate Change, Endangered Species, Marine Life Conservation, Nuclear Testing, Ozone Layer Protection, Tropical Timber; it has signed, but not ratified, conventions or agreements on Biodiversity, Hazardous Wastes, and the Law of the Sea.

1.1 ECONOMY.

After a generation of intensive development, Thailand appears poised to join the ranks of the newly industrialized countries. Decades of stable economic policies based on a competitive, export-oriented, and free market philosophy paid off as Thailand registered the highest growth rate in the world from 1985 to 1994 (8.2 percent annualized growth in GDP). Although half of the Thai labor force still works in the agricultural sector, manufacturing, construction, trading and services now account for the bulk of economic activity. The economy underwent a significant cooling in 1996, however, as the growth rate fell to 6.7 percent from 1995's 8.7 percent. The slowdown has raised questions in Thailand over whether the country can continue to count on the easy gains of the past, as traditional labor-intensive industries face increasingly stiff competition from neighboring countries

On the brighter side, certain mid-tech manufacturing sectors, notably electronics and automotive parts manufacture/assembly, are showing robust gains. Most forecasters expect growth in the industrial sector in coming years to be lower than in the recent past.

1.2 INDUSTRY.

Historically, Thailand has relied on exports of agricultural products and natural resources to earn foreign exchange; exports consisted mainly of rice, timber, rubber, tin and other mineral resources. In the first five-year national Economic and Social Development Plan (1962-1966) the stress in industrial development was on import substitution sectors. By the time of the third five-year plan (1972-1976), the emphasis had shifted to export oriented industrialization. The Government has promoted industrial growth heavily so as to increase foreign investment and reduce the foreign trade deficit.

A number of Government agencies set and administer policies related to industrial development and operations, among them:

1. Industrial Works Department, Ministry of Industry (MOI)
2. Industrial Promotion Department, Ministry of Industry (MOI)
3. Industrial Estate Authority of Thailand
4. Board of Investment

The minimum wage in Thailand is currently baht 157 per day (about US$5) in Bangkok, and between baht 118-126 in the provinces. While not the lowest labor market in the region, Thailand' s workforce is considered cost efficient, and has a reputation for diligence and adaptability. A shortage of technical personnel has plagued the country recently, and the

Government is placing an increased emphasis on education, fearing that Thailand will be unable to compete in high-tech industries.

1.3 NATIONAL ENVIRONMENTAL MANAGEMENT.

The Thai Government has established a National Environmental Board, chaired by the Prime Minister, which approves national environmental policies and plans. Three departments under the Ministry of Science, Technology and Environments (MOSTE) are responsible for activities such as environmental policy and planning, pollution control, and overseeing environmental impact assessment. The departments are:

1. Office of Environmental Policy and Planning
2. Pollution Control Department
3. Environmental Quality Promotion Department

The Industrial Works Department in the Ministry of Industry is responsible for industrial pollution control, except for factories located in industrial estates established by the Industrial Estate Authority of Thailand Act. If DIW and IEAT fail to manage any cases of industrial pollution in factories under their respective jurisdiction, the Pollution Control Department is authorized to require enforcement by the two agencies or to directly intervene with the factories themselves.

Environmental Laws and Regulations

Numerous laws and regulations concerning industrial pollution control and environmental protection have been promulgated by the Government, among them:

1. The Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992, MOSTE):
   - 1.1 Notification by MOSTE regarding environmental impact assessment -principles, methods, procedure and guidance.
   - 1.2 Notification by MOSTE regarding effluent standards for industry and industrial estates.

2. The Factory Act B.E. 2535 (1992, MOI):
   - 2.1 Notification by MOI on emission standards.
   - 2.2 Notification by MOI on effluent standards.

3. The Industrial Estate Authority of Thailand Act.

4. The Public Health Act B.E. 2535 (1992).
5. The Hazardous Substance Act B.E. 2535 (1992).
6. Notifications by the Ministry of Interior regarding occupational health and safety, working conditions, and environment, etc.
7. Others - land transportation, Thailand water territory transportation, flora and fauna protection, irrigation, forestry and national park, etc.

2. INDUSTRIAL ESTATE AUTHORITY OF THAILAND (IEAT).

The Industrial Estate Authority of Thailand (IEAT) is a state enterprise attached to the Ministry of Industry and founded in 1972. It is chartered to implement the Government's industrial development policy. The objective is to promote economic development through the systematic establishment of industry.

IEAT has been working to attract foreign investment, to encourage technology transfer to Thailand, and to decentralize industrial development, which has in the past been too heavily concentrated in the metropolitan Bangkok area. Since 1972, twenty-nine industrial estates have been established in Thailand, either solely by IEAT or as joint ventures. IEAT industrial estates are recognized legally as preferential treatment areas, and investors operating factories in estates are eligible for incentives and privileges according to the IEAT Act.

IEAT has played an important role in Thailand's industrial development, stressing harmony with culture and quality of life, on the basis of 5 E ' s.

Economy –
The Industrial Estate induces investment and thus enhances the national economy. The investment in industrial estates brings about industrial production for exports and import-substitution, foreign currency, and supporting services.

Equitability –
The decentralization of industrial estates, with their provision of basic infrastructure, results in new towns, improved income distribution and other facilities in provincial areas of Thailand.

Environment –
The grouping of factories in industrial estates is done in a systematic way. Waste materials are treated and duly disposed of.

Education –

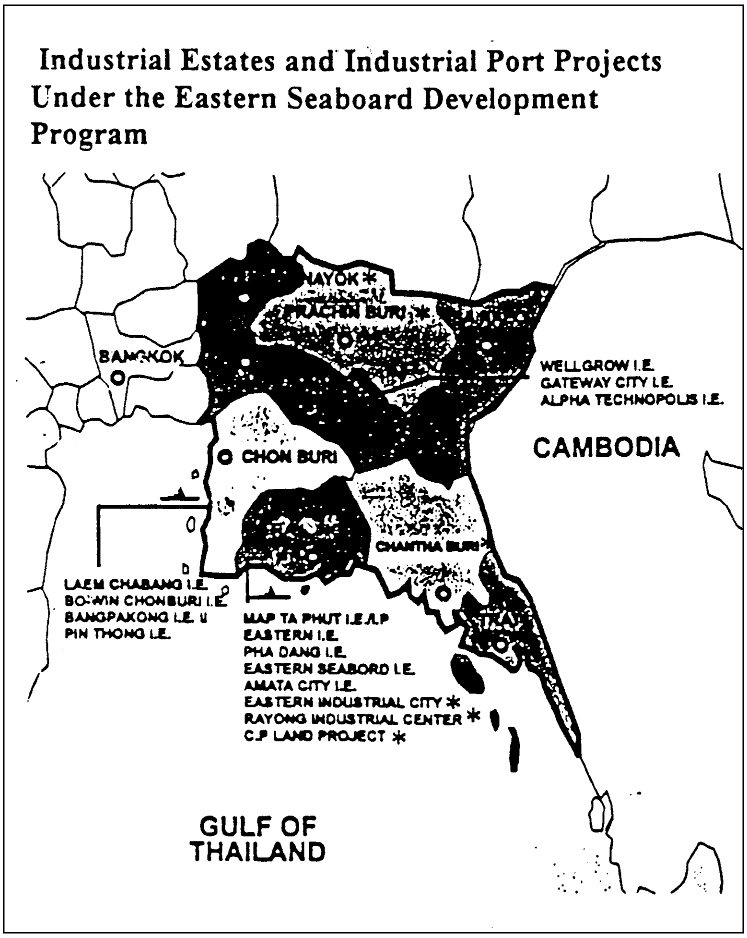
The skills of industrial workers are improved. The establishment of technological schools in some industrial estates assists technical transfer among industrialists.

Ethics –

The "Polluters Pay Principle" is the concept being realized in IEAT' s industrial estates.

IEAT has a policy to prevent pollution by separating its industrial zones away from cities and habitations, so that industrial production will not be a threat to residential communities. Special zones within each estate are allocated for a particular type of manufacturing.

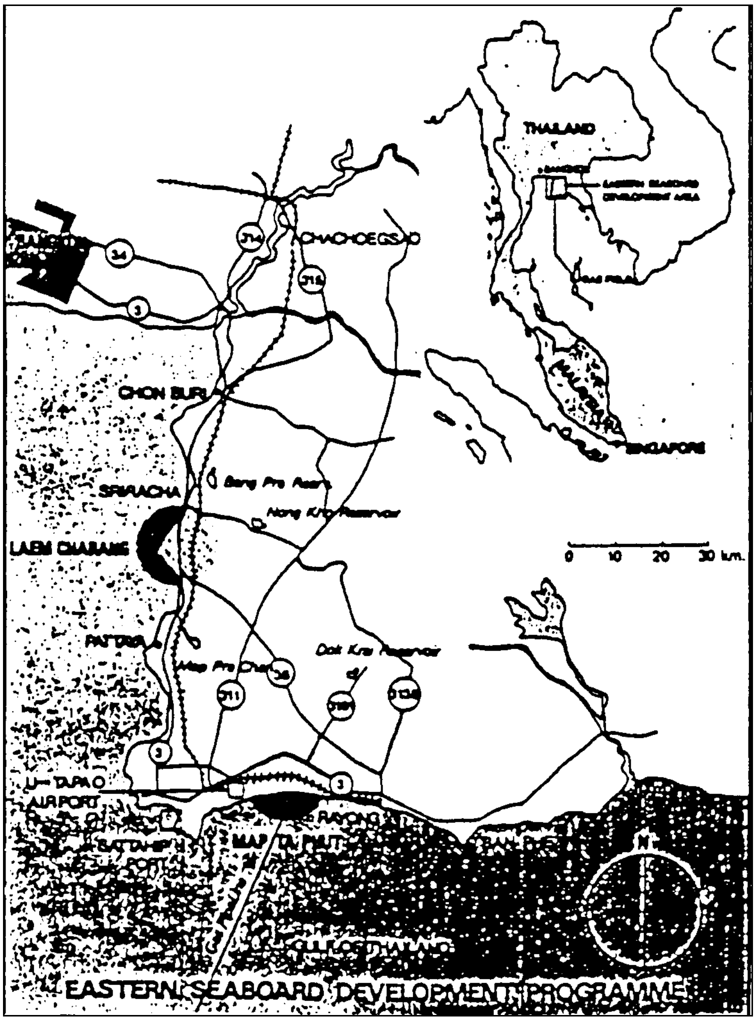
<u>Figure 1:</u>



3. LAEM CHABANG INDUSTRIAL ESTATE PROFILE.

The Laem Chabang Industrial Estate is situated on the eastern coast of Thailand in Sriracha District, Chonburi Province, about 130 km southeast of Bangkok. The Estate was established as part of the Eastern Seaboard Development Program (Figures 1 and 2), which was started in 1981 to promote industrial-led economic development in the eastern coastal region.

Figure 2:

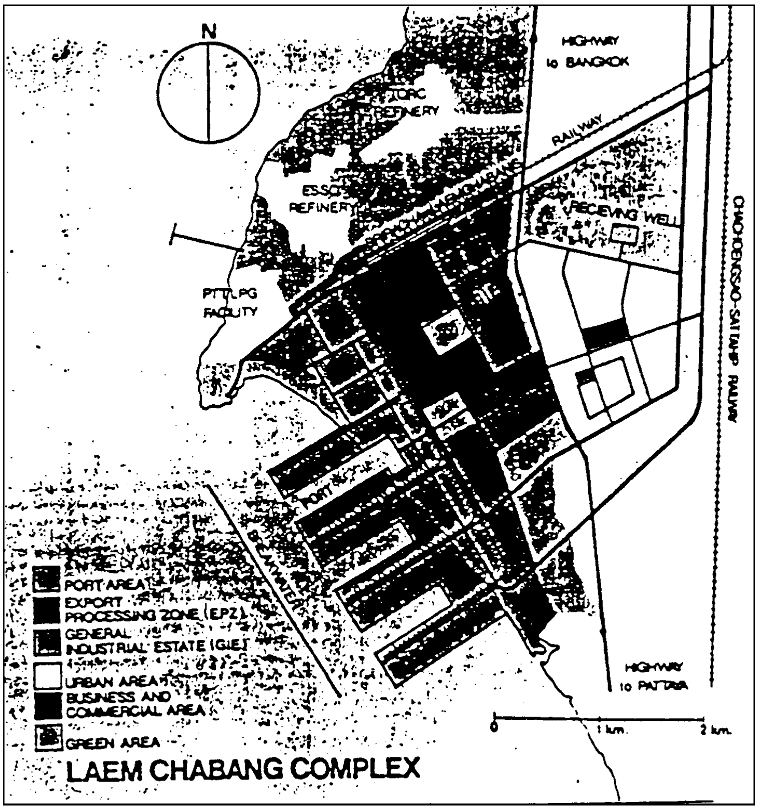


3.1 GENERAL GEOGRAPHICAL INFORMATION.

The Estate is surrounded by the hills on the west, north, and east, and by the Gulf of Thailand on the south and southwest. *[See the detailed area map in Appendix 1]* Offshore, lies a sandy continental shelf that runs from Chonburi to Trat province, and inland are mountains and forests important for watershed purposes. The Eastern Seaboard is famous for plantations and orchards, growing crops such as pineapple, cassava, rubber, rambutan, durian and mangosteen, and is rich as well in archaeological and historical terms.

Along the coast are many tourism attractions ranging from white sandy beaches, islands, coral, mountains and waterfalls. About 12 km south of Laem Chabang is Pattaya, a premier beach resort which annually attracts hundreds of thousands of pleasure-seeking tourists from all over the world. These tourists are an important source of foreign exchange for Thailand, but there have been concerns about the quality of the environment in the area. Several years ago Pattaya was declared a Pollution Control Zone, an action that gives the Pollution Control Department special powers to control activities affecting the environment.

Figure 3:



Immediately to the north of the Estate are two oil refineries and a liquefied petroleum gas shipping terminal (Figure 3). The oil refineries existed before the Estate, but the gas facility is part of the same overall Eastern Seaboard Development Plan. The Estate is served by Sukhumvit Road, which connects the Estate with Bangkok and other provinces, a railway spur to Bangkok and other provinces, and the Laem Chabang Deep Sea Port, owned by the Port Authority of Thailand and located adjacent to the Industrial Estate.

3.2 ESTATE CHARACTERISTICS.

The Laem Chabang Industrial Estate is divided into a General Industrial Zone of 370 hectares and an Export Processing Zone of 176 hectares. The site also contains commercial and residential areas.

Almost 100 industries are tenants at the Estate, 45 of which are located in the GIZ and 51 in the EPZ. Tenants in the Estate are mostly light manufacturing industries, major ones being electronics, automotive parts, electrical appliances, metals and plastics. The partial list of raw materials used by enterprises at the Estate includes plastic resins, food raw materials, textile cord, natural and synthetic rubber, aluminum, stainless steel, copper and zinc ingot, sodium silicate glass, silica sand, feldspar, limestone, gypsum, and more finished intermediate goods.

3.3 INFRASTRUCTURE.

The Estate has 20 km of concrete roads servicing the industries and facilities. Electricity is provided through double 115 KV transmission lines to a 115 KV/22 KV power substation constructed at the northwest corner of the Estate, and a 85 MVA substation. Water is supplied from the nearby Nong Kho Reservoir to an on-site water treatment plant with a capacity of 27,000 m^3/day , then on to industrial users through a water transmission distribution system. Fire hydrants are provided near road crossings and along roads.

3.4 ENVIRONMENTAL SITUATION.

Wastewater

A Central Wastewater Treatment Plant, with a capacity of 20,500 m^3/day, is located near the power substation. The plant has a maximum hourly flow rate of 2,430 m^3, and is designed for the influent/effluent characteristics shown in Table 1 below.

The wastewater treatment system is operated by a contractor retained by IEAT. Treatment charges are based on BOD concentration and the volume of wastewater. In case of wastewater contaminated with chemicals or heavy metals, tenant factories are required to have onsite pre-treatment facilities. Effluent discharged to receiving waters by the Central Wastewater Treatment Plant must comply with MOSTE effluent standards.

Table 1:

Parameter	Influent	Effluent
BOD	500	20
SS	250	30
TSS	170	20
TKN	40	< 10
P	8	< 2

Air Pollution

Factories are required to install air pollution equipment and emissions must conform to MOSTE emission standards.

Solid Waste Disposal

The Estate has an incinerator with a capacity of eight tons/day for disposing of solid, non-hazardous waste.

Table 2:

Laem Chabang Industrial Estate Environmental Monitoring Program	
Area	**Parameter**
I. Ambient Air	TSP, NO_2, SO_2, CO, HC
2. Wind	speed and direction
3. Noise	level
4. Surface waters	pH, DO, Salinity, Turbidity, SS, BOD, COD, Total-N, Total-P, Oil &Grease, Cd, Hg, Pb, Zn, Coliform
5. Estuary	pH, DO, transparency, Turbidity, salinity, SS, BOD_5, Total-N, Total-P , Oil & grease, coliform, Cd, Cr, Cu, Hg, Pb
6. Silt	TOC, Oil & Grease, BOD, Cd, Cr, Cu, Hg, Pb, size distribution of silt
7. Biota	type and density of plankton, type and density of benthos, density of larvae

Monitoring Program

The Estate has contracted a reputable consulting firm to monitor environmental quality as shown in Table 2. In addition, the Estate regularly monitors the effluent discharged from the Central Wastewater Treatment Plant. Typical values of parameters measured are presented in Appendix 2.

For comparison, Appendix 3 shows values from the ambient air monitoring program taken in November 1996.

3.5 HAZARDOUS WASTE TREATMENT CENTER.

Industrial Works Department has set up a joint venture company with General Environmental Conservation Co., Ltd. (GENCO) to establish hazardous waste treatment and disposal centers in four regions. The centers will primarily service the industrial sector.

Thailand's existing hazardous waste treatment center in Bangkhuntien District, Bangkok, and the first landfill in Rajburi Province (west of Bangkok), were started by the Industrial Works Department before establishment of the GENCO operation; they are now operated by the company.

The first hazardous treatment center and landfill set up by GENCO is in IEAT's Map Ta Phut Industrial Estate, located in Rayong Province, about 60 km from Laem Chabang. It services industries primarily located in the Eastern Seaboard.

4. OCCUPATIONAL HEALTH AND SAFETY CENTER.

The Ministries of Industry, of Public Health, and of Science, Technology and Environment have signed an agreement setting up occupational health and safety centers at industrial estates. The centers provide the following services:

1. occupational health and safety training
2. health examination services for workers
3. examination of workplace quality and conditions
4. demonstration and information services on industrial safety issues.

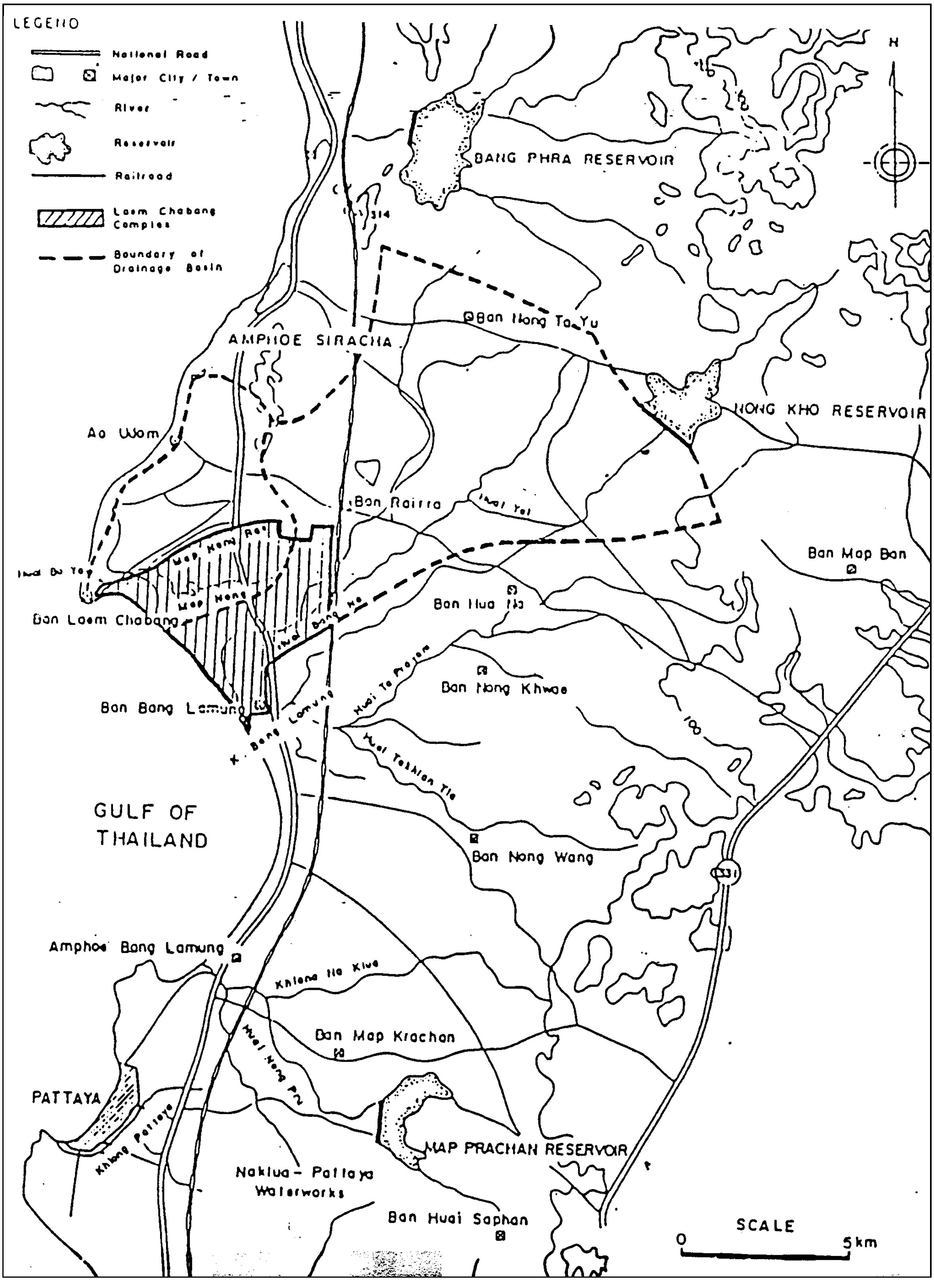
5. WASTE OIL RECOVERY PLANT IN EASTERN SEABOARD.

Waste oil has been illegal discharged from tankers and freighters polluting and damaging marine resources. The Harbor Department, the Government agency responsible for Thailand's water territory, has issued a new regulation that all vessels must discharge their waste oil into serviced barges before leaving port. The Department also contracts a company to provide such a service. Collected oil will be transported to a recovery facility on the shore, which might be in the Map Ta Phut Industrial Estate.

6. FURTHER READING.

A. Chavanich, *Thailand's Eco-Industrial Estate Development*, Proceedings of the International Conference & Workshop on Industrial Park Management, Manila, Philippines, April 3 – 6, 2001.

Appendix 1.


LEGEND
National Road
Major City / Town
River
Reservoir
Railroad
Laem Chabang Complex
Boundary of Drainage Basin
BANG PHRA RESERVOIR
Ban Nong Ta Yu
AMPHOE SIRACHA
NONG KHO RESERVOIR
Ao Wom
Ban Raiira
Ban Map Ban
Ban Loem Chabang
Ban Hua
Ban Nong Khwae
Ban Bang Lamung
GULF OF THAILAND
Ban Nong Wang
Amphoe Bang Lamung
Ban Map Krachan
PATTAYA
MAP PRACHAN RESERVOIR
Naklua - Pattaya Waterworks
Ban Huai Saphan
SCALE
0
5km
N

Appendix 2.

Laem Chabang Central Wastewater Treatment Plant Effluent Characteristics July 1997					
No.	Parameter	7. Unit	Effluent Standard	Analyzed Result	
				07/07/97	24/07/97
1.	pH	-	5.5-9.0	6.40 at 30.5°C	6.66 at 20.9°C
2.	Dissolved solids	mg/l	< 3000	971	000
3.	Suspended solids	mg/l	< 50	21	19.0
4.	Zn	mg/l	< 5.0	1.9950	1.287
5.	Cr (total) - hexavalent Cr - trivalent Cr	mg/l	- < 0.25 < 0.25	ND - -	< 0.10 - -
6.	As	mg/l	< 0.25	< 0.2	< 0.002
7.	Cu	mg/l	< 2.0	0.04	0.0310
8.	Hg	mg/l	< 0.005	ND	0.002
9.	Cd	mg/l	< 0.03	< 0.02	< 0.01
10.	Pb	mg/l	< 0.02	< 0.05	< 0.05
11.	Ni	mg/l	< 1.0	0.05	0.039
12.	Oil & Grease	mg/l	< 5.0	nil	nil
13.	Temperature	°C	< 40	30.5	32.0
14.	BOD	mg/l	20 - 60	1.8	2.60
15.	Phenols & Cresols	mg/l	< 1.0	-	-

Appendix 3.

Ambient Air Quality Laem Chabang Industrial Estate							
			Sampling Point				
Parameter	**Unit**	**Date**	**1**	**2**	**3**	**4**	**Standard**
TSP	mg/m^3	07/11/96	0.206	0.099	0.132	0.094	0.33
		08/11/96	0.368	0.194	0.335	0.174	(24hrs)
		09/11/96	0.346	0.174	0.258	0.170	
NO_2	mg/m^3	07/11/96	0.014	0.012	0.037	0.030	0.32
		08/11/96	0.046	0.178	0.064	0.009	(24hrs)
		09/11/96	0.003	0.154	0.064	0.011	
SO_2	mg/m^3	07/11/96	ND	ND	ND	0.006	0.30
		08/11/96	0.006	ND	0.006	0.007	(24 hrs)
		09/11/96	0.007	ND	0.014	0.015	
CO	mg/m^3	07/11/96	2.35	0.20	1.01	0.28	10.26
		08/11/96	2.65	1.51	0.83	0.69	(10hrs)
		09/11/96	2.54	0.73	0.98	0.78	
HC	ppm	07/11/96	0.10	0.04	0.15	0.05	
		08/11/96	0.20	0.03	0.30	0.05	
		09/11/96	0.24	0.13	0.10	0.10	

An Eco-Industrial Networking Exercise in Naroda Industrial Estate.

1. INTRODUCTION.

This case study describes efforts taken by small-scale enterprises within the Naroda Industrial Estate in India to address environmental management of their activities through an Eco-Industrial Networking approach. These activities are a continuation of earlier efforts carried out in the estate in the areas of environmental/waste auditing and Cleaner Production. The approach is similar to that described previously for Kalundborg in the sense that an "industrial symbiosis" is sought as a way to address waste management problems through resource recovery. The principle difference, however, is that the initiative in Naroda results from a ***co-operative*** effort by ***many*** enterprises within the industrial estate, and makes use of the industrial estate association (Naroda Industries Association) as a channel for co-ordinating the activities.

The text is based on a paper presented by R. Patel and B. Modi of the Naroda Industries Association at the Industrial Conference & Workshop on Industrial Park Management, held in Manila (Philippines) in April 2001. Additional information has been taken from the Masters Dissertation of R. Mohanlal, of the Centre for Environmental Planning and Technology in Ahmedabad, from a paper presented by M. Wilderer at the same meeting in Manila, and from a paper by Professor P. Pangotra, of the Indian Institute of Management in Ahmedabad, on the dyestuffs industry in Gujarat.

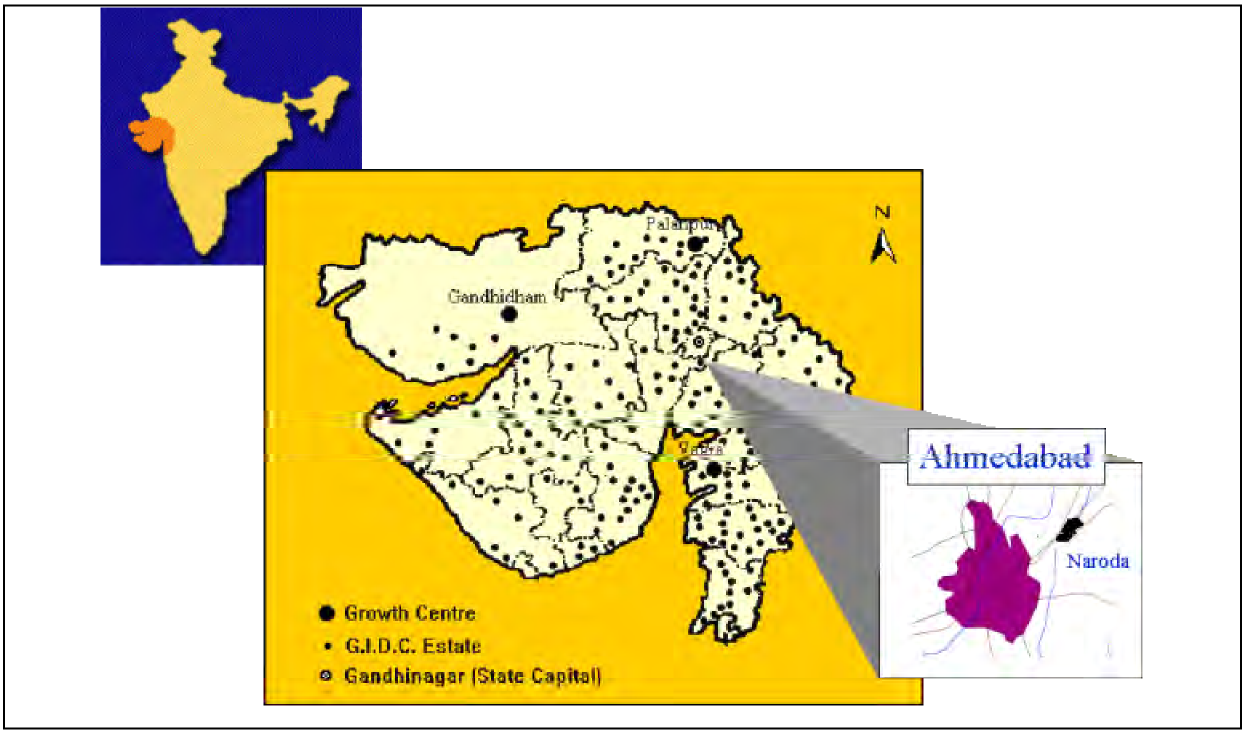
2. NARODA INDUSTRIAL ESTATE.

2.1 THE REGIONAL CONTEXT.

Naroda Industrial Estate is located in Ahmedabad in the north-west of India (Figure 1). Ahmedabad is the largest city in the state of Gujarat and has played a significant role in the industrial development of the state because of its important textile industry. However, in the early 1980's many of the textile mills in Ahmedabad closed and it became necessary for the city to diversify its industrial base.

It achieved this in part by promoting activity in the chemical industry, for example in plastics and pesticides, and in the engineering sector. Fortunately, the 1980's also witnessed a transfer of textile chemical dyestuffs manufacturing from Europe and North America to India

Figure 1: Location of Naroda Industrial Estate.



Source: Gujarat Industrial Development Corporation

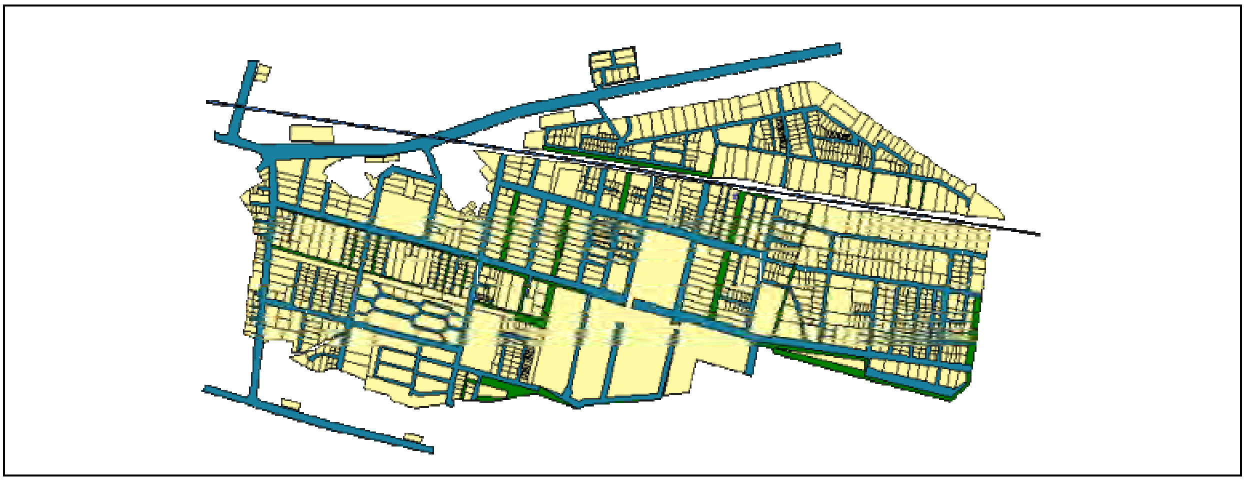
and other parts of Asia. Chemical dyestuffs for the Indian textile industry had been mainly produced in Gujarat and Maharashtra since the 1950's, and so Ahmedabad was well-placed when an export-focussed dyestuffs industry began to grow up in India in the 1980's. Today, almost 60% of total exports of dyestuffs from India are manufactured in Gujarat, with nearly half coming from three industrial estates in Ahmedabad - Vatwa, Odhav and Naroda.

2.2 ABOUT NARODA INDUSTRIAL ESTATE.

Naroda Industrial Estate was established in 1964 - the first industrial estate to be created in Gujarat by the Gujarat Industrial Development Corporation. Today there are nearly 900 industries located in the estate and they employ roughly 30,000 people. A further 40,000 people can be considered to depend indirectly on the industrial estate for their livelihood.

Approximately 26% of the industries in the Naroda Industrial Estate fall into the chemicals category, predominantly dyestuffs and dye-intermediates. Other types of chemical production are plastics (5%), pharmaceuticals (3%), and pesticides (1%). Engineering (24%), textiles (5%) and trading companies (9%) complete the picture of significant industrial sectors within the estate.

Figure 2: Naroda Industrial Estate.



Source: Naroda Industries Association

The estate provides services (water, power, and communications) and infrastructure - such as roads, a school, hospital, canteen, post office, banks and a police station. A plan of the industrial estate is shown in Figure 2 above.

2.3 NARODA INDUSTRIES ASSOCIATION.

Approximately two-thirds of the companies in the industrial estate are members of Naroda Industries Association (NIA) (see Table 1). NIA is an association, made up from owners of companies located within the estate. It has been responsible for a number of projects in the areas of infrastructure, services and environment. For example, in 1997 NIA created a co-operative bank to help small industries in the estate. Other projects include a hospital and a tree-planting initiative.

In the environmental field, NIA has set up Naroda Enviro Projects Ltd. (NEPL) as a separate company to operate a landfill site for hazardous solid waste from the estate. The landfill site became operational in 1997. NEPL has also taken responsibility for the construction and running of a Common Effluent Treatment Plant (CETP) which came online in September 1999. The CEPT now treats the wastewater from more than 200 companies, although it is important to mention that some companies are required to carry out their own primary treatment before their wastewater can be accepted at the CETP.

Table 1: Members of Naroda Industries Association.

Industrial Sector	N°	Industrial Sector	N°
Ceramics & Potteries	22	Chemical, Paint, Dyestuff	220
Electronic, Electrical	30	Electroplating	3
Eng. Fabrication, Steel	130	Gum & Guwar	5
Minerals, Pesticides	12	Oil Mills	12
Pharmaceuticals	18	Plastics	35
Rice & Pulse Mills	10	Rubber Industries	17
Stationery, Allied	8	Textile Mfg & Processing	33
Tiles, Marbles	5	Wood & Furniture	6
Food Products	9	Misc.	59

Source: Naroda Industries Association

NIA also acts as a forum for questions relating to environmental performance. It provides an opportunity for members to share information and to learn about different environmental approaches. The involvement of NIA is particularly important for promoting environmental awareness in the context of an industrial estate such as Naroda with a large number of firms. This is true whether the awareness relates to compliance with environmental legislation (either at the initial project stage or from an end-of-pipe waste mitigation perspective) or to firms needing to understand the implications for their processes of waste minimisation approaches. The activities of the NIA have already enabled the estate to set up its own CETP as well as to create sector-specific initiatives in Cleaner Production.

2.4 ENVIRONMENTAL LEGISLATION.

All companies in the Naroda Industrial Estate are subject to environmental standards or requirements set out in legislation such as:

- ⇨ Water Pollution Control Act (1974),
- ⇨ Air Pollution Control Act (1981),
- ⇨ Environment Protection Act (1986),
- ⇨ Management and Handling of Hazardous/Toxic Waste Rules (1989),
- ⇨ ?Public Liability Insurance Act (1991),
- ⇨ Environmental Impact Assessment/Environmental Clearance (1994).

3. THE ECO-INDUSTRIAL NETWORKING EXERCISE.

3.1 THE BACKGROUND TO THE EXERCISE.

Environmental management within Naroda Industrial Estate has already resulted in the estate creating its own landfill site for hazardous solid wastes and setting up a CETP to improve the efficiency of wastewater treatment within the estate. The existence of the CETP, with its more than 200 members, provides a good example of the companies in the estate working in a co-operative way to address the issue of water pollution.

The need to enhance environmental performance beyond mere compliance has led some firms in the estate to investigate more proactive approaches, such as Cleaner Production. The consideration of "preventive " rather than end-of-pipe approaches has in turn required companies to think about questions such as the following:

- ⇨ What possibilities exist to prevent the generation of waste at source?
- ⇨ Is it possible to improve production operations by focussing on resource recovery?
- ⇨ What are the opportunities for waste exchange mechanisms between firms in the estate?
- ⇨ How do institutional mechanisms within the estate need to evolve to help firms to improve their environmental performance?
- ⇨ What economic opportunities can result from improving environmental performance?

Environmental audit reporting, introduced by the State Pollution Control Board, has required firms in Naroda to improve their knowledge of their resource utilisation and the types of wastes that their activities generate. The establishment of the CEPT has also led to a better understanding of the waste material flows within the estate, thereby providing information on possible links between processes.

Finally, the combination of environmental and economic pressures has led firms in Naroda to make process improvements in order to improve their resource efficiency, and hence their profitability. They have achieved this mainly through a Cleaner Production approach that has helped them to enhance ***individual*** environmental performance. This now sets the scene for them to enlarge the scope of their activities and co-operate with different companies to look for resource recovery opportunities.

3.2 STARTING THE EXERCISE.

The Eco-Industrial Networking exercise, described in this study, was carried out by Naroda Industries Association (NIA) and Martin Wilderer, of the University of Kaiserslautern (Germany), with the support of the Confederation of Indian Industry (CII) in Gujarat. The project grew out of an ICAST-sponsored "Workshop on Industry & Environment", held at the Indian Institute of Management in Ahmedabad in 1999, at which the concept of Industrial Ecology was presented along with other environmental strategies.

The objectives of the project can be summarised as follows:

- ⇨ Map the different raw material and waste streams in the estate, with their quantities.
- ⇨ Look for potential links for resource recovery activities.
- ⇨ Investigate how to put together partnerships.
- ⇨ Try to institutionalise the process in order to make it sustainable.

The primary objective was to understand the main types of waste being generated by the firms in the industrial estate, and the quantities involved. A survey of nearly 500 companies in the estate was carried out using a combination of site visits and questionnaire. The survey attempted to identify -

- ⇨ the different categories of industries within the estate;
- ⇨ the sources of their raw materials, power and water;
- ⇨ whether they modified their processes on a regular basis;
- ⇨ what types of by-products or wastes they were producing, and the quantities;
- ⇨ the level of waste treatment carried out within the company, and if they were members of the CETP; and
- ⇨ whether there were existing resource recovery activities in place.

Based on the responses to the questionnaire (477 responses from 495 requests for information), the survey revealed that a wide variety of wastes are being generated (Table 2) with the chemical industries, in particular the manufacture of dyestuffs and dye-intermediates, important sources of waste.

The most important waste materials generated (principally) by this industrial sector are -

- ⇨ iron sludge from the Bechamp reduction process,
- ⇨ waste acids, in particular sulphuric and hydrochloric acids,
- ⇨ chemical gypsum with varying content of calcium sulphate and chlorides,

- ⇨ sludges containing sodium chloride and sodium glycolate, and
- ⇨ boiler ash.

Table 2: Overview of Wastes Generated by Naroda Industrial Estate.

By-Product or Waste		By-Product or Waste	
Mild Steel Scrap	C/V	Hulled Sesame Seeds	NC/V
Cast Iron Scrap	C/V	Natural Rubber	NC/V
Aluminium Scrap	C/V	Synthetic Rubber	NC/V
Cast Iron Powder & Dust	C/V	Raw Rubber	NC/V
Stainless Steel Scrap	C/V	Treated Wastewater	NC/V
Carbide Waste	NC/V	HCl	C/V
Rice Husk	C/V	Cotton Yarn Waste	NC/V
Food Industries Waste	NC/V	Mixed Pottery Waste	NC/V
Jute Waste	NC/V	Broken Marble Tiles	NC/V
Chemical Gypsum	NC/V	Marble Powder	NC/V
Iron Sludge	NC/V	Grey Cloth Yarn	NC/V
Spent H_2SO_4	NC/V	Polyester Waste	NC/V
Spent Earth	NC/V	Waste Paper	NC/V
Soap Stock	C/V	Mixed Cotton Waste	NC/V
Boiler Ash	NC/V		

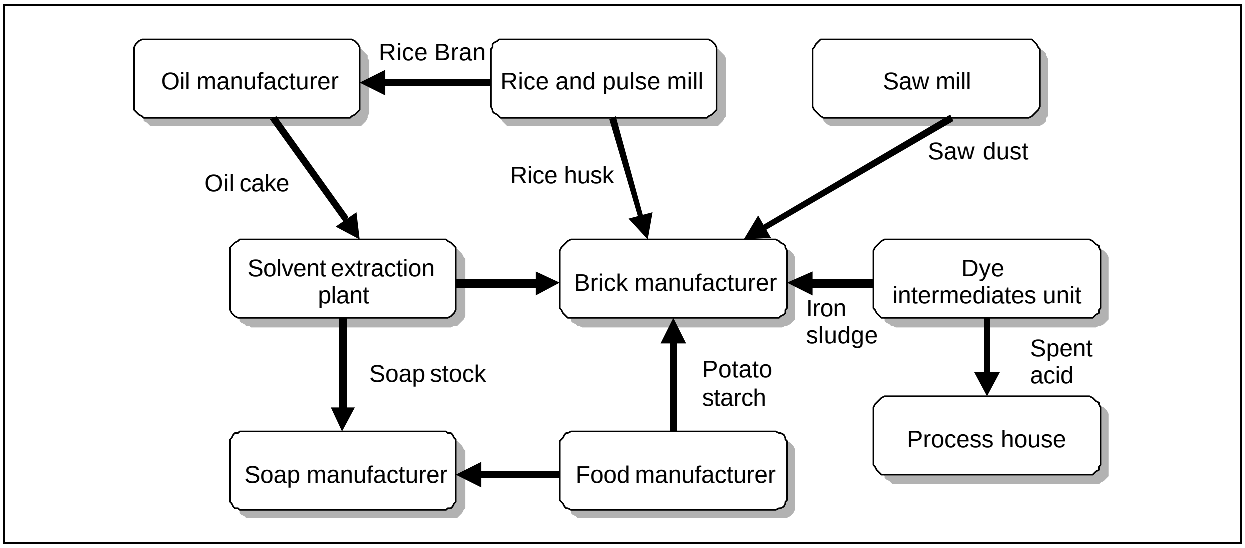
[C/V - Commercial Value ; NC/V - No Commercial Value]
Source: Eco-Industrial Baseline Survey (NIA AND UKL)

3.3 LOOKING FOR POTENTIAL NETWORKS.

Using the information on the types of waste available, it was possible to look for opportunities for Eco-Industrial Networking within the industrial estate. In fact the survey revealed that some Eco-Industrial Networking activities, or "local partnerships", were already taking place in Naroda Industrial Estate. These are shown in Figure 3.

Based on these existing cases of resource recovery and the potential for reuse of other materials, an attempt was made to classify the waste materials in Table 2 into those with commercial value (C/V) and those without ***current*** commercial value (NC/V). In order to look for further opportunities for networking, two options were chosen - (i) to seek ways of revalorising NC/V wastes, and (ii) to look for higher (environmental and economic) value recovery options for C/V by-products or waste materials.

Figure 3: Existing Local Partnerships in Naroda Industrial Estate.



Source: Eco-Industrial Baseline Survey, from Rashmi Mohanlal (CEPT)

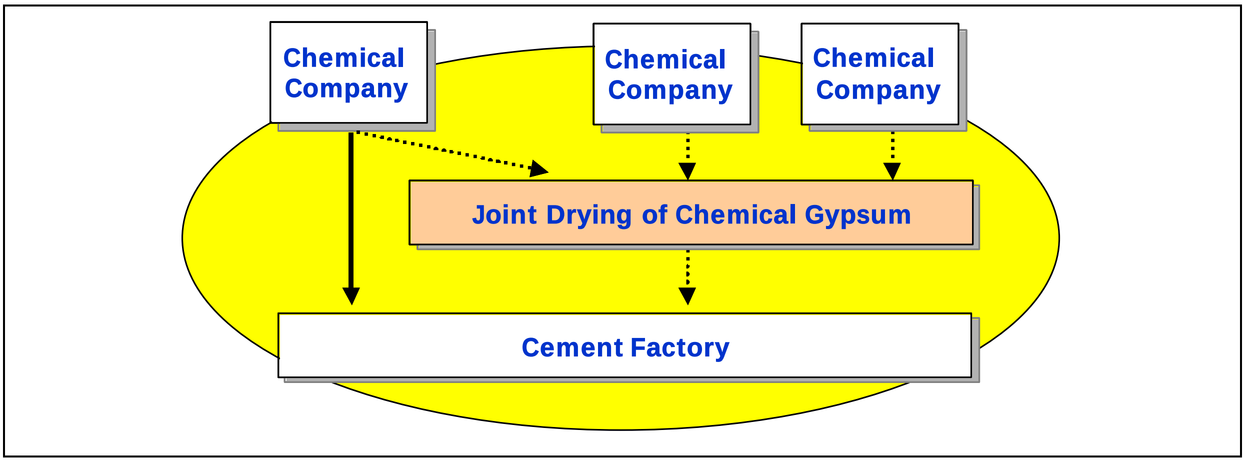
Of more than 20 possible partnerships revealed through the survey, a high potential for success was thought to exist for the following five materials:

- chemical gypsum,
- biologically-degradable wastes,
- mild steel scrap,
- spent sulphuric acid, and
- iron sludge.

Chemical gypsum is generated by 19 chemical industries in the estate as a result of neutralisation of their acidic wastewater with lime. Cement-manufacturing companies could use this gypsum provided that it meets certain specifications. An analysis of the process for recovering the gypsum as a raw material (Figure 4) confirmed that it is economically viable. A proposal has been made for a partnership to be run through the NIA or through NEPL.

Biodegradable waste is produced by 9 companies in the estate. The total amount of waste per year is approximately 10,000 kg of solid material and nearly 90,000 litres of liquid waste. Digestion of this biodegradable waste could be used to generate ***Bio-Gas*** as an energy source for either the industrial estate or a housing development located nearby. In the latter case, the Bio-Gas could replace liquefied petroleum gas (LPG) for domestic use. An economic analysis has shown this energy recovery process to be extremely favourable.

Figure 4: Recycling of Chemical Gypsum.



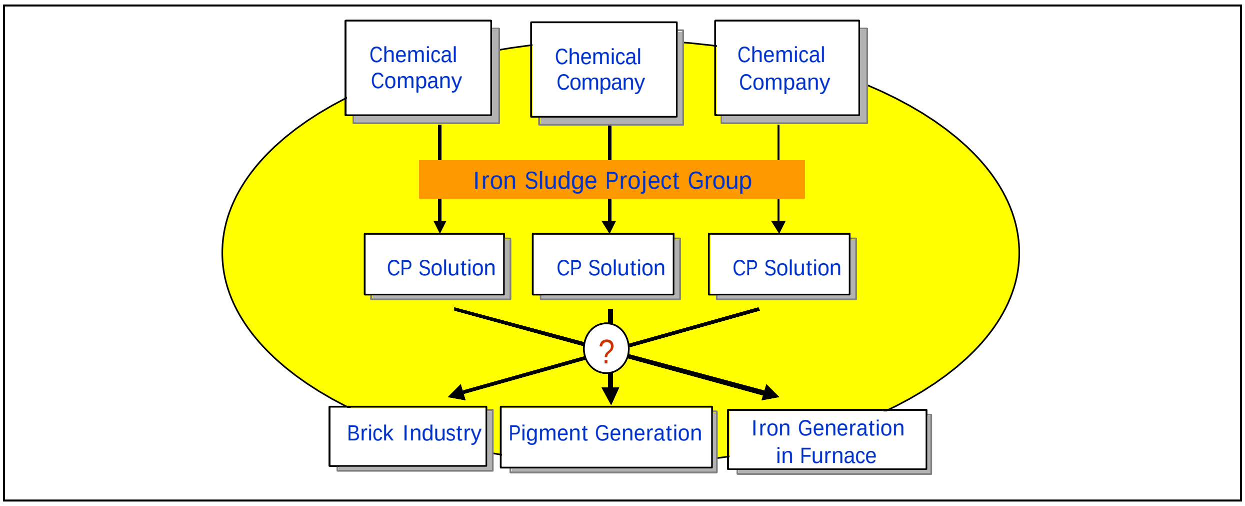
Source: M.Z. Wilderer

While sulphuric acid is produced as a waste by 17 chemical industries, 16 engineering firms generate mild steel scrap. Both waste materials can be used as raw materials to make ***ferrous sulphate***, a chemical used in primary wastewater treatment at the CETP.

Other possible partnerships that have been identified in the industrial estate include -

- ⇨ using spent sulphuric acid in the manufacture of phosphate for fertiliser,
- ⇨ the use of iron sludge to prepare synthetic red iron oxide (see Figure 5),
- ⇨ an alternative application for chemical gypsum in the production of plasterboard,
- ⇨ energy conservation, and a reduction in raw material consumption, in the ceramic sector.

Figure 5: A Possible Approach to an Iron Sludge Partnership.



Source: M.Z. Wilderer

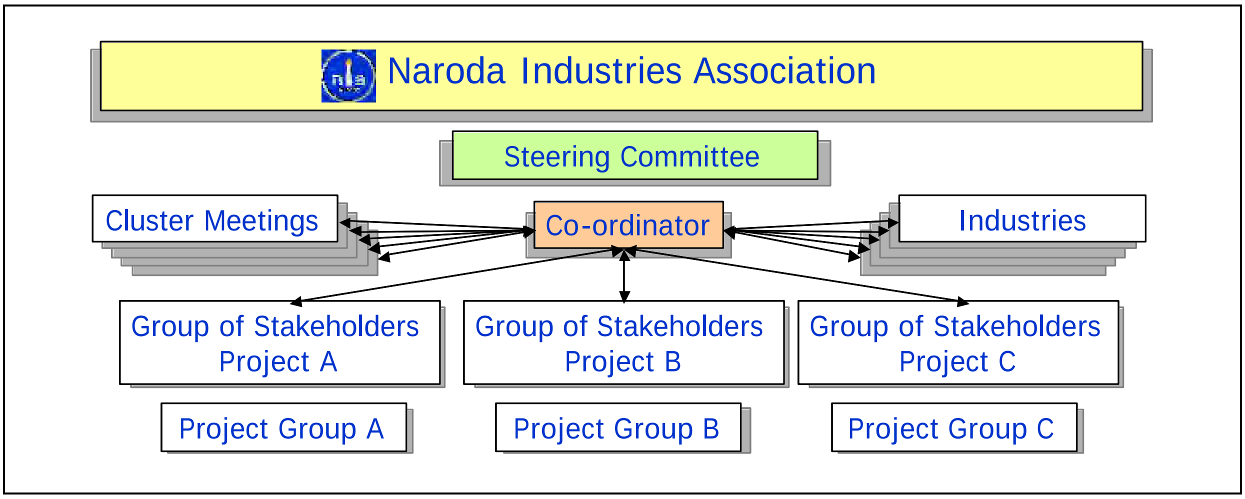
4. FUTURE DIRECTIONS.

Several of the partnerships described above are now being put into place with the support of the NIA. In the case of iron sludge for example (Figure 5), networking activities are being combined with a Cleaner Production approach to improve resource use within the process.

An important question facing the NIA, now that the initial survey is completed, is how to use the interest and momentum created by the Eco-Industrial Networking exercise to introduce preventive environmental approaches, such as Cleaner Production, and networking/ partnerships to a wider audience within the industrial estate. One approach, which has already been implemented by NIA, is to publish a newsletter describing examples of Cleaner Production and networking/partnerships that have been initiated in Naroda Industrial Estate. A second approach is to create links to institutions that can provide access to expertise from outside of NIA.

Another question is how to "institutionalise" the Eco-Industrial Networking activity within the industrial estate to ensure its sustainability. The NIA has decided to organise its activities as shown in Figure 6 with a Steering Committee, a Network Co-ordinator and Project Co-ordinators. The Steering Committee is made up of high-level representatives of companies within the estate whose role is to direct the overall development of the network. Naroda Steering Committee has decided to create a Cleaner Production Centre within the industrial estate to support Cleaner Production and Eco-Industrial Networking activities. As part of capacity building efforts in Naroda Industrial Estate, the Centre for Environment Education in

Figure 6: Support Structure for Cleaner Production and Eco-Industrial Networking.

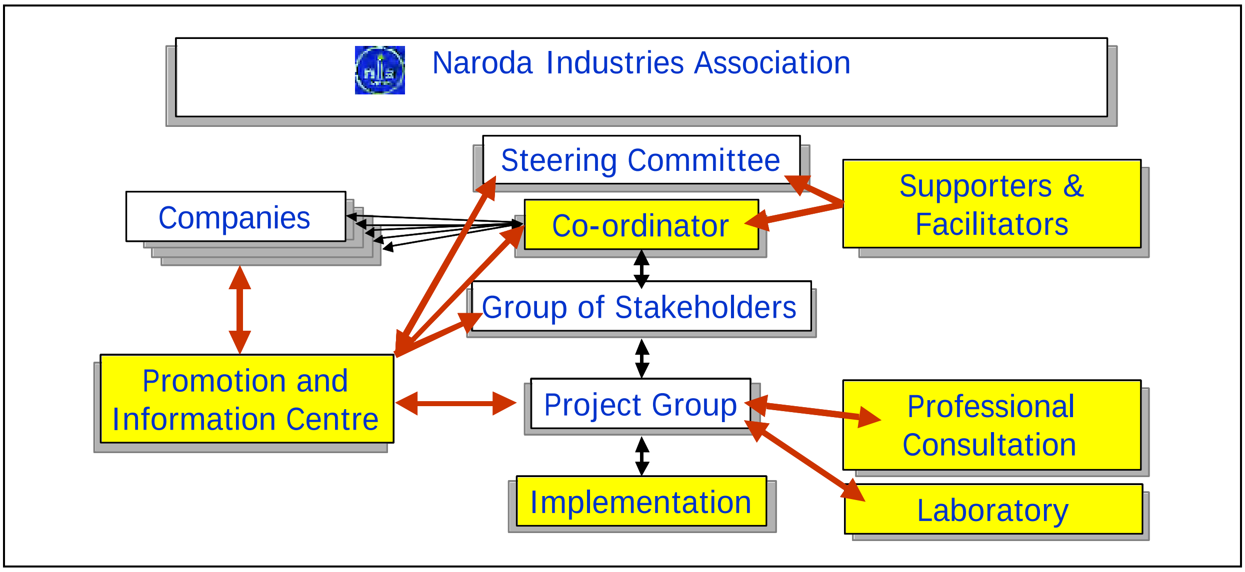


Source: M.Z. Wilderer

Ahmedabad has been given the responsibility of developing proposals for technology demonstration projects, and profiles for Cleaner Production assessments in the various sectors of the estate.

Martin Wilderer has pointed out that, in addition to the basic organisational structure shown in Figure 6, other support may be needed if an Eco-Industrial Networking activity is to function effectively within an industrial estate such as Naroda. Examples of different supporting elements that may be required are shown in Figure 7.

Figure 7: Examples of Supporting Elements for Eco-Industrial Network Development in an Industrial Estate.



Source: M.Z. Wilderer

In conclusion, the use of a resource recovery project has proven very useful in the Naroda Industrial Estate as a way to initiate an Eco-Industrial Network. It has also served to enhance interest in environmental management activities throughout the estate. The particular value of this step-wise approach is gradually to encourage the industries in the estate to focus not only on their individual environmental aspects but on the synergistic effects resulting from the large number of companies concentrated within the estate. The impacts resulting from the "system" rather than from the sum of the sub-systems. It is important to mention that a networking initiative should not be limited to environmental issues, but must also be employed for all estate-level issues – such as to put in place health and safety measures for the estate, including emergency response procedures (such as APELL) in case of major accidents.

5. FURTHER READING.

R. Patel, B. Modi, S. Patwari, R. Gopichandran, M. Wilderer, *Aspects of the Eco-Industrial Networking Exercise at the Naroda Industrial Estate, Ahmedabad, Gujarat, India: Foundations, Present Status and Future Directions*, presented as a Case Study at the International Conference & Workshop on Industrial Park Management, Manila (Philippines), April 2001.

R. Mohanlal, *Industrial Symbiosis through Reuse of Industrial Wastes: A Case of Naroda Industrial Estate, Ahmedabab*ad, Masters Dissertation, School of Planning, Centre for Environmental Planning & Technology, Ahmedabad, India, 2000.

M.Z. Wilderer, *Principals for Developing Eco-Industrial Networks*, presented at the International Conference & Workshop on Industrial Park Management, Manila (Philippines), April 2001.

P. Pangotra, *The Dyestuffs Industry in Gujarat*, Proceedings of a Workshop on Industry & Environment, Ahmedabad (India), February 1999.

Dalian Economic and Technological Development Zone, China.

Summary

This Case Study was presented by Mr Geng Yong, from Dalian University of Technology in China, at the International Conference & Workshop on Industrial Park Management, held in Manila (Philippines) in April 2001. The Background Paper for the presentation, written by Mr Geng Yong and Professor Raymond Côté, is reproduced here in its entirety.

The profile of the case is that of one of the 53 Economic & Technological Development Zones (or ETDZs) in China. ETDZs are examples of Integrated Industrial Zones (see Chapter 3 of the Background Paper), where a new industrial estate or park is developed according to an approved plan with integrated residential, commercial and public areas. The scale of the Dalian ETDZ, a surface area of 28 km^2 of which 15 km^2 is designated for industrial use, means that it is really a reasonable size town of 200,000 inhabitants, of which 98,000 are workers or managers in the associated industrial estate.

The particularly interesting feature of this Case Study is the use of an Environmental Management System or EMS (in this case ISO 14001) by the Administrative Group of the ETDZ to develop a more comprehensive approach to the wide range of environmental issues that they face in running the zone. In essence the goal is to address many of the issues at ***the level of the zone***. It is therefore an excellent, and very complex, example of the ***Infrastructure Option*** described in Chapter 6 of the Background Paper.

Some of the 1,150 companies located within the zone have followed the lead of the Administrative Group in seeking ISO 14001 certification, but the success-rate is low at the moment. This case points to some of the difficulties in evolving from the ***Infrastructure Option*** to the ***Comprehensive Option*** for an EMS at the Estate- or Zone-level. However, it provides an excellent insight into the practical aspects of using an EMS to improve overall environmental performance.

Further Reading

J. Yang et alia, *Environmental Management in Industrial Estates in China*, Report prepared for UNEP and the China State Environmental Protection Administration, 2000.

EMS AS AN OPPORTUNITY FOR ENGAGING CHINA'S ECONOMIC DEVELOPMENT ZONES: THE CASE OF DALIAN.

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Abstract:
Environmental Management Systems (EMS), such as ISO 14001, can be used as a tool by the Chinese Economic and Technological Development Zones (ETDZ) to improve their environmental performance. This article uses the case of the Dalian Economic and Technological Development Zone to show how to establish environmental management systems according to the ISO 14001 standard at a zone-level by considering the local realities. It also describes the incentives, benefits and barriers associated with implementing ISO 14001. However, implementation of an environmental management system should not be thought of as the ultimate objective for an ETDZ's environmental management. The next steps must be to encourage further public participation and to take an integrated approach leading to an industrial ecosystem, which can realize better environmental performance at the zone-level.

Key words: Environmental Management System; ISO 14001 Standard; Eco-industrial Park; Public Participation.

1. INTRODUCTION.

As the largest developing country in the world, China is increasingly under pressure to develop its economy rapidly so as to solve people's need for a better quality of life. Therefore, a pro-growth policy has been a focus. Under such a framework, whenever officials perceive a conflict between economic interests and environmental protection, they tend to accord the former a higher priority. But due to its limited natural resources, huge population and lack of advanced management methods and technologies, environmental issues have hampered China's development efforts and affected the well being of the Chinese people.

In order to harmonize economic development and environmental protection, the Chinese government has adopted "Sustainable Development" as the national strategy for long term development. As a consequence, there has also been a noticeable increase in the proportion of GNP devoted to investment for environmental protection and a series of administrative directives to compel local governments to strictly enforce pollution control. After the promulgation of the first draft of the environmental protection law in 1979 and its final version in 1989, plus corresponding institutional and legal reforms, the Chinese authorities have introduced an environmental protection structure, and provided it with a set of environmental laws and regulations. Measures for preventing pollution include incorporating environmental considerations in development and urban planning, making Environmental Impact Assessment (EIA) compulsory for development projects, and charging emission and effluent fees for pollution. Public environmental awareness has been actively promoted through green education and publicity programs organized by environmental agencies at different levels. The current environmental management system also allows local government and their environmental protection bureaus a considerable degree of autonomy. This means that local governments are given substantial freedom to formulate their own policy priorities, select policy tools, design their own arrangements for enforcement and decide the pace of implementation.

This paper illustrates the value of environmental management systems to China's economic development zones by using the case of Dalian. As a government agency, a Chinese Economic and Technological Development Zone (ETDZ) is a regulator and a provider of a number of community services. A defined management system can be used by ETDZ to help to set priorities for addressing the concerns of its community, as well as ensuring that its services are being delivered according to efficient and effective practices. An EMS can be used to help an ETDZ achieve the wider global goal of sustainability, as outlined in China's Agenda 21. In this paper we will first review the objectives, the development and the current situation of China's ETDZs. Then we will focus on the introduction of an environmental management system, namely the ISO 14001 standard, in the Dalian Economic and Technological Development Zone (DETDZ). This will cover the motivators for implementing the ISO 14001 standard, the procedures, the barriers, the benefits and the plan for the future.

2. A SHORT REVIEW OF CHINA'S ETDZs.

In order to attract more foreign investment and advanced technology and management, the Chinese government decided in late 1984 to establish economic and technological development zones (ETDZ) in fourteen coastal cities, including Dalian, Tianjing, Shanghai, and Guangzhou.

The Office for Special Economic Zones of the State Council of the People's Republic of China is the central government agency responsible for guiding and administering ETDZs. The central government has bestowed on the administrative committees of all ETDZs administrative powers for economic affairs that are similar to those of the local government of the city or prefecture where an ETDZ is situated. In support of infrastructure development in ETDZs, the central government adopts preferential policies on loans, credit, and other financial aspects [11]. Wherever there is one or more ETDZs, the Provincial People's Congress (the legislature) has introduced "Administrative Regulations on Economic and Technological Development Zones", thus providing a legal framework for the operation of the zones. All of these management procedures are characterized by efficiency, convenience and conformity with international practices, and can provide simplified and convenient services of examination and approval on investment projects.

An ETDZ is an independent industrial area near a city. The main industries located in ETDZs are generally high-technology – usually computers, telecommunication, automotive and appliances. The area of each ETDZ is usually less than 100 square kilometers. With over ten years' experience, such zones have now moved into inland provinces encompassing major municipalities across the country, all becoming unique economic districts with special vitality. ETDZs are currently one of the fastest-growing areas in China with a heavy concentration of investment from both at home and abroad. To date there are 53 ETDZs in China, most of them located in or near provincial capitals, economic centers or transport hubs. They are based in areas with an advanced economy, well-developed industrial foundation, and a comprehensive distribution of industrial sectors. They also benefit from good access to all means of transportation. While the total development acreage of ETDZs has reached 400 square kilometers, about 0.004% of China's territory, the accumulated direct foreign investment in ETDZs accounts for about 10% of the national total of realized foreign capital inflow. The 1996 per capita productivity of some manufacturing businesses in ETDZs, such as Minxing of Shanghai, Tianjing, Dalian, Beijing and Kunshan, reached as much as 200,000 RMB or more. This excellent investment environment has attracted more than 200 of the world's corporate giants, including Motorola, P&G, Pfizer, Johnson &

Johnson, Xerox, Coca-Cola and Pepsi-Cola from the United States; Mitsubishi, Toshiba, Panasonic, Sanyo and Canon from Japan; ABB and Nestle from Switzerland; Nortel from Canada; Daewoo, Samsung and Hyundai from South Korea; ELF-Atochem from France; Unilever from the United Kingdom; and Bayer, Hoechst and SEW from Germany (Office for Special Economic Zones of the State Council of the People's Republic of China, 2000).

3. A BRIEF INTRODUCTION TO THE DALIAN ECONOMIC AND TECHNOLOGICAL DEVELOPMENT ZONE.

Located in the southern part of the fertile Liaodong peninsula in the northeast of China, Dalian is one of the important port, industry, trade and tourism cities in China with over five million citizens. Since 1990, Dalian urban environmental development has pursued a strategy of "seeking the best rather than the biggest", which was set out according to the local geographical, natural and environmental conditions. In a short period of ten years, Dalian has accomplished what many developed countries have needed many decades to accomplish. Not only has environmental contamination been controlled, but environmental quality has also improved considerably at a time of a rapidly increasing economic activity, and continually increasing energy consumption [9]. It has realized harmonious development of economy, environment and society and created a new sustainable development strategy, which could serve as a model for cities in the developing countries.

Dalian Economic & Technological Development Zone (DETDZ) is located to the north of Dalian city (see Figure 1). Established as the first economic & technological zone in China in 1984, DETDZ functions as a window to Dalian city and northeast China. After 16 years development, DETDZ is now a garden-like new town with effective infrastructure, convenient transportation and telecommunication systems. The total area of the zone is 28 square kilometers, with 15 square kilometers being designated as industrial area. The total population is over 200,000, including 98,000 workers and managers.

The object of this zone is to attract foreign investment, foreign management and technology in order to realize full employment and strengthen the local economic competitiveness. There are now 1150 enterprises with over US $10 billion investment, including 39 companies that rank among the world's top 500 group. Due to its favorable geographical situation near to Japan, the zone has become a favored investment site for Japanese enterprises, such as Canon, Toshiba, Mabuchi, Sanyo and Omron. The industries include food processing, electronic appliances, furniture, pharmaceuticals, motors, machine

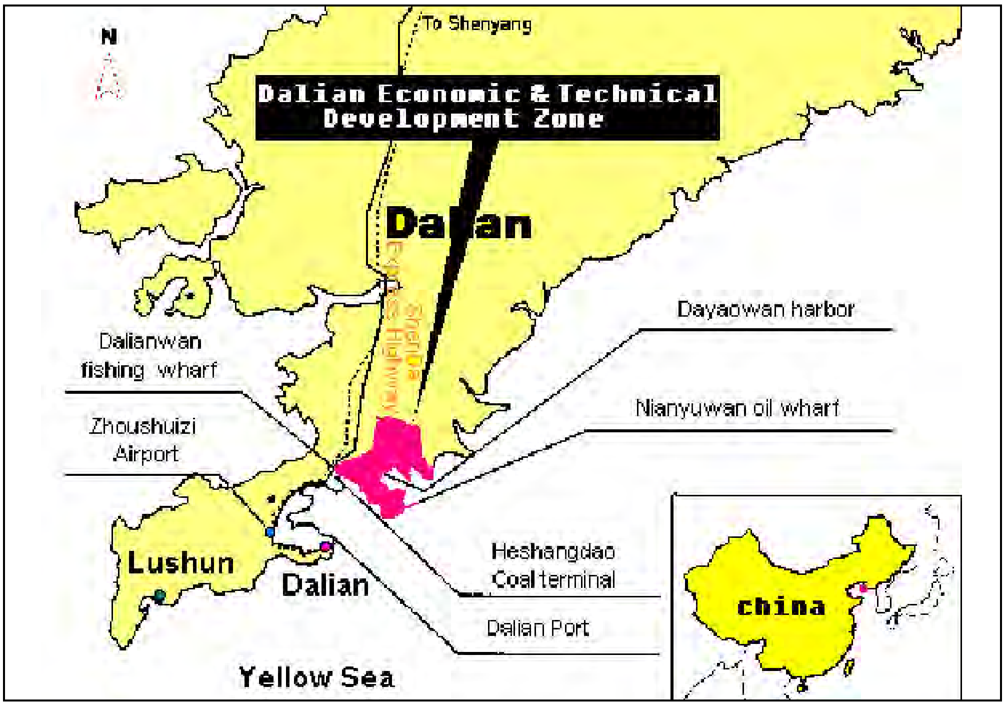

Figure 1. Location of Dalian Economic & Technological Development Zone.

manufacturing, office equipment, chemicals, plastic products and clothing. Except Dalian West Pacific Petrochemical Ltd and Dalian Huaneng power plant, most of the enterprises are small or medium sized enterprises with staff numbering from tens to hundreds.

The DETDZ Administration Commission (DETDZAC) is the official agency of Dalian Municipality in charge of the daily administration of zone functions. The Planning and Construction Bureau (PCB) of DETDZAC is in charge of environmental protection in the zone. The bureau has established an environmental protection office, environmental supervision department and some environmental monitoring stations to implement this function. Moreover, in order to enhance their performance, they also hired an environmental management agent in each part or community of the zone to help them enforce environmental protection laws and regulations. This organizational framework has ensured efficient and effective environmental protection.

4. THE DRIVERS FOR IMPLEMENTING THE ISO 14001 STANDARD.

As a new zone, DETDZ systematically planned its industrial park, commercial districts, residential communities and public areas with the goal to "firstly prevent and secondly control". The bureau designed the infrastructure in accordance with these goals. Regulatory measures – including environmental impact assessment, the three synchronizations (which requires that pollution facilities and the principal parts of a construction project should be designed, constructed and put into operation in a synchronized manner), and the system of fees for pollutant discharge – have on the whole controlled pollution and prevented the environment from further degradation [1].

However, this framework does not solve all environmental issues. With the rapid economic development and a low level of environmental awareness in the general public, some environmental issues such as solid waste treatment and water resource conservation still puzzled the local government and even affected the attraction of further foreign investment. China's exigent pressure to become a member of the World Trade Organization also required the stakeholders to address a wider range of environmental issues carefully [2]. Therefore, adopting a more comprehensive environmental management approach was crucial. Considering the widespread application of the ISO 14001 standard, its spectacular growth and its generic feasibility, in October 1998 DETDZAC decided to establish an environmental management system according to the ISO 14001 standard. They recognized that the ISO 14001 standard is the leading environmental management system (EMS). Although the value of the ISO 14001 standard to a local government agency is different to its value to a company, it can be used by the government to help set priorities for addressing the concerns of the community as well as to verify that its environmental aspects and services are being handled in an effective and efficient manner.

Establishing an EMS and seeking independent certification of the management system was the primary tool selected to achieve the mandate of DETDZAC. Having a structured decision-making process to demonstrate how and why priorities are being set helps counter the public image that decision-making is short-term and *ad hoc* as opposed to systematic. Independent certification establishes credibility with the community and provides reassurance that issues of concern are being identified and addressed in the delivery of DETDZAC's services [10]. Other drivers typically include the opportunity for cost savings, enhanced employee safety and environmental stewardship [2].

Meanwhile, at that time, the Dalian Municipality initiated a new program named "Blue Sky, Green Sea Project" [9]. The objective of this project is to protect local natural environment, promote the local residents' living conditions and increase the city's competitiveness. Implementing the ISO 14001 standard can definitely assist in achieving the objectives of the "Blue Sky, Green Sea Project".

5. IMPLEMENTING THE EMS.

Implementing an environmental management system in such a large geographical area required the DETDZAC to adopt new different approaches from those employed for companies. In order to better carry out this goal, an efficient organization is very critical. On the basis of the existing environmental management framework, as well as inviting environmental experts from local universities and institutions, the DETDZAC set up a specialized EMS guidance group [1]. This group first carried out an internal audit and identified 66 factors affecting the local environmental quality. Then, by considering the local economic and social reality and analyzing the related environmental regulations and laws, the integrated and comprehensive approach fostered by the environmental management system was stipulated. This has resulted in an enhanced identification of aspects and opportunities and the development of plans to address them. The detailed measures adopted by them include the following:

5.1 Air Emission Control.

In order to reduce the sulfur dioxide emission and dust pollution from coal burning, the plan adopted was to replace coal by liquefied petroleum gas for domestic consumption. The conversion to liquefied petroleum gas consumption in DETDZ has now reached 98%. Another element of the plan was the development of district heating in order to improve energy efficiency and reduce air emissions. Almost all the boilers below one ton have now been taken out of use. The current use of district-heating is over 90%. Moreover, in order to control emissions from vehicles, they strengthened the monitoring and enforcement of controls on vehicle exhaust. Over 400 vehicles exceeding the limits have been inspected and improved. The zone also promoted the consumption of lead free gasoline.

5.2 Water Management.

In order to better manage wastewater, the DETDZAC has invested 200 million RMB (1 US$=8.27 RMB) since 1987 to construct two sewage treatment plants. All the wastewater in their territory is treated before being discharged to the ocean. The local bureau strictly monitors the operation of all the sewage treatment facilities so as to guarantee appropriate sewage treatment and better performance. To date, the daily sewage treatment ability is 140,000 tons with the quality of the treated water reaching the national standard.

Due to increasing concern about water supply, Dalian City needs to increase the value that it draws from the water in use. The DETDZAC transmitted the treated water from the sewage plant to the local power plant for their production, and since 1998 to the public gardens for watering the plants. At the end of 1999 they purchased another facility for purifying treated wastewater and installed a new water pipe (44.8 km) to deliver treated water for watering the local gardens. Now 1.2 million tons of water is recycled each year. Besides this, rainwater has also been collected through an independent system of pipes and treated for watering the local lawns and gardens. This practice is the first one in China and has optimized the water consumption and reduced the wastewater emissions to the Bohai sea.

In order to solve a problem with pollution of the local sea, they also stipulated a new policy to control the waste discharge from ships and mariculture. They have strictly monitored the emission of sewage and promoted the use of phosphate free detergents.

5.3 Solid Waste Management.

In order to comply with national, provincial and municipal laws and regulations on solid waste management, the DETDZAC focused on the following three aspects:

⇨ ***Industrial Solid Waste Management***

The local government planned a systematic approach to monitor, manage and treat industrial solid waste, which included the reduction of solid waste, the control of waste transportation and recycling and reuse. A modern private solid waste company, Dongtai Industrial Waste Treatment Company, was established to put a comprehensive system in place for all aspects of solid waste management. The government is in charge of monitoring the operation of this company. This company invested in the construction of a hazardous waste landfill in 1999 and constructed a liquid waste incinerator in 2000 so as to realize the entire treatment of dangerous solid waste. This new model reduced the government's financial burden and promoted efficiency and effectiveness. The regular model would have been for the government to take charge of all the environmental management issues. Under such a mechanism, the performance is often unsatisfactory due to a lack of efficient monitoring.

⇨ ***Reuse and Recycling of Fly Ash and Bottom Dust***

Fly ash and bottom dust, coming especially from the local power plants, are among the main sources of solid waste in this new zone. In order to solve this problem, a new desulfurization and filter facility was installed on the chimneys of the power plants so as to reduce the air emissions. Some of the desulfurized fly ash and bottom dust was delivered to a local construction factory as raw materials for bricks. The remainder was used to make asphalt for pavement.

⇨ ***Domestic Solid Waste Management***

All the domestic waste was treated in Maoyingzi landfill. A new regulation enacted in 2000 requires that local citizens use plastic bags to contain their domestic garbage in order to avoid non-point pollution during its transportation. By collaborating with developed countries, some new solid waste treatment technology and equipment has been adopted to further optimize the solid waste management system. In addition, non-degradable plastic packaging products have been banned in favour of paper-based and degradable plastic packaging materials.

5.4 Urban Greening.

According to national, provincial and municipal planning requirements, the DETDZAC initiated a greening project in 1990. The goal of this project is to develop at least ten green areas in DETDZ every year and more community gardens and public parks have been constructed. The greening rate of their territory had reached 40.95% by the end of 1999, which beautified the urban area and improved local air quality.

5.5 Promoting Cleaner Production and ISO 14001 Standard Certification among the Local Enterprises.

In order to improve the local enterprises' environmental performance, the local government actively promoted cleaner production and the establishment of environmental management systems consistent with the ISO 14001 standard among the local enterprises. Cleaner production is the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase overall efficiency and reduce risks to humans and the environment. The goal of cleaner production is to reduce the adverse impact of production and service activities on the environment. Therefore, cleaner production is a very useful tool for the local enterprises to eliminate waste within the process rather than at the end-of-pipe.

The local EPB collected documents and information on cleaner production and provided free consulting services with the help of external environmental experts to the local enterprises. An EMS based on cleaner production approaches and technologies can result in significant emission reductions as well as cost reduction and increased profits. In order to promote the establishment of an EMS consistent with the ISO 14001 standard, the DETDZAC provided not more than 50% of the certification fee to those enterprises that wanted to pass ISO 14001 certification. The local Planning and Construction Bureau also provided comprehensive environmental management services to those companies that had either been certified or were preparing for certification. This included providing relevant environmental laws and regulations, environmental management case studies and information on environmental technologies.

5.6 <u>Awareness and Preparedness for Emergencies at the Local Level (APELL)</u>.

The local EPB initiated the APELL program in 1995. The objective of this program is to prevent technological accidents and to reduce their impacts by assisting decision makers and technical personnel to increase community awareness of hazardous installations, and to prepare response plans in case unexpected events at these installations should endanger life, property or the environment. The relevant measures taken included the following:

- Stipulated a set of prevention measures;
- Established a demonstration software for simulating emergency situations for an earthquake;
- Perfected the organization network for tackling with typhoons and floods;
- Improved the environmental infrastructures so as to safely treat pollution;
- Increased the local enterprises' environmental awareness.

5.7 <u>Forest Management and Biodiversity Conservation</u>.

Although DETDZ is a new town, there is still some forest in their territory, including a forest park (4.662 km^2). The local forest system was composed of bushes, broadleaf, hardwoods and conifers. In order to protect forest resources, the local government banned the cutting of trees in their territory and planted more trees every year according to a scientific plan. The effective forest management improved the local air quality, absorbed carbon dioxide and avoided soil erosion and flooding.

In order to protect the local marine resources, fishing was banned from June to October every year. The efficient wastewater monitoring avoided pollution of the local sea thereby protecting the marine animals. Land animals have also been protected by discreetly enforcing the national law on protecting animals.

5.8 Environmental Education.

Carrying out environmental education among the staff and citizens is a crucial measure for implementing the ISO 14001 standard. The DETDZAC hosted many activities to increase the local people's environmental awareness, including making TV advertisements, publishing newsletters, hosting environmental knowledge competitions, installing signposts with environmental knowledge in the urban areas, "training trainers" for capacity building, hosting conferences and workshops on environmental protection, setting up an environmental column in the local daily newspaper. Such activities have increased the local people's environmental knowledge and facilitated the implementation of the ISO 14001 standard.

By implementing all of these measures, the overall environmental performance of Dalian Economic and Technological Development Zone has been improved. The zone passed the ISO 14001 certification on December 16, 1999 as assessed by the Huaxia EMS examination center, a unit of China's State Environmental Protection Agency(SEPA). Furthermore, the EMS guidance group has become a stable organization after the certification in order to continuously enforce the implementation of the ISO 14001 standard and ensure the effectiveness and efficiency of their EMS.

6. BENEFITS.

More than one year's operation of the EMS has brought many benefits to the DETDZ. In this part of the paper, we will summarize the benefits that they have obtained.

⇨ Improving the investment environment -

The implementation of the ISO 14001 standard makes the local environmental management more standardized and systematic. Foreign investors won't worry about the local infrastructure and the investment in environment as they are consistent with the international level. For example, Kaijin Chemical Company has increased their investment by 500 million RMB in order to expand their business. The Chrysler Motor Corp. also plans to invest US $150 million to manufacture engines in Dalian.

⇨ Establishing the local government's green image -

The local environmental quality is a critical factor for measuring the government's working performance. The DETDZAC first issued their environmental policies to the public and actively solicited public opinions before implementing the ISO 14001 standard. Then they carried out environmental education through the media so that the public would accept this program and match their activity. They also helped the local enterprises to carry out cleaner production programs and establish their own EMSs. All of these activities established their green image among the public and the communities.

⇨ Promoting more enterprises to establish an EMS according to the ISO 14001 standard -

ISO 14001 is a voluntary standard. Although the DETDZ has passed the certification, it doesn't mean that the local enterprises are required to do so. However, the local government's active involvement in environmental management can affect the local enterprises, especially as they provide funding, policy and an information service to those planning to establish their EMSs according to ISO 14001. These measures have inspired local entrepreneurs and thirteen enterprises passed ISO 14001 certification in the year after the zone passed the same certification. Now more enterprises are actively preparing to establish their EMSs in this zone.

⇨ Protecting natural resources -

The implementation of ISO 14001 reduced the waste of natural resources. The water-recycling program has reduced the government's burden on water supply and avoided water pollution. The energy saving program increased the energy efficiency. Other savings programs, such as reducing the consumption of office supplies in the government buildings, has decreased the operational costs and protected natural resources directly and indirectly.

⇨ Improving the local environmental quality -

The establishment of an EMS in this zone reduced the air emissions, wastewater pollution and solid waste generation. The solid waste has also been safely treated at an economic scale. Therefore, the environmental quality of the local area has been improved very evidently and quickly. The direct outcome is that in the year 2000 Total Suspended Particulates (TSP) were reduced by 46.5%, sulfur dioxide was reduced by 16.7%, COD was reduced by 13.2%, and NO_x was reduced by 9.1% using 1999 as the reference year (*Environmental Protection Office of DETDZ*). The increasing green areas also brought clean air and avoided soil erosion.

⇨ Reducing pollution accidents and environmental risks -

The APELL program is a very important part of the EMS. The implementation of APELL required the local government to prevent, evaluate and treat potential environmental accidents according to a scientific mechanism. Therefore, after the initiation of APELL, the environmental risks have been reduced and the local people's health and safety have been protected.

7. BARRIERS.

Although the DETDZ succeeded in establishing their EMS according to ISO 14001, there are still some loopholes and barriers:

⇨ A lack of public awareness and participation -

More channels have been opened for the public to register complaints concerning pollution, and the adoption of green education among citizens has increased their environmental awareness. However, the local environmental organizations, such as "Green Dalian" and "DETDZ Environmental Protection Association", have little autonomy and mainly perform the functions of promoting Dalian's green image and mobilizing popular support for the implementation of the government's green policies. They are not allowed to play an active role in the policy process. In the absence of public participation, accountability in the environmental regulatory process is almost non-existent. In any case, popular demand for a cleaner environment is not particularly strong since the environmental awareness of the citizens is still on the whole at an early stage. In such a situation it is difficult for an environmental agency to gain any powerful allies in order to counter a strong resistance to environmental protection.

⇨ Lack of collaboration among enterprises -

The current industrial system in this zone is a linear model. Due to lack of collaboration among companies, many useful resources and by-products are being wasted [8]. Additional networking and exchange of information should encourage the development of new opportunities and the creation of new services [3]. However, at the present, there are no "scavenger" and "decomposer" companies who can recover, reuse and remanufacture materials and by-products in this zone. Encouraging synergies and symbiosis among these companies will further increase the systemic energy efficiency, as well as the amount and types of process outputs that have market values, and thereby reduce the use of virgin materials and the generation of pollutants [7]. An environmental information center in the industrial park that will collect environmental information from enterprises and external sources and carry out material and energy analysis, so as to seek potential by-product exchange, is one proposed solution [5]. Fortunately, the local government has recognized the significance of developing an "eco-industrial park" and is proposing to retrofit the zone as an industrial ecosystem by collaborating with UNEP and other sources.

In addition, the local government does not regularly evaluate the enforcement of environmental laws and regulations in their territory, and they have not yet imposed a standardized requirement on environmental management to those contractors providing services to the government. Most of the enterprises that have passed ISO 14001 so far are Japanese, which means that the local government still needs to further encourage more Chinese enterprises, as well as other foreign enterprises, to become involved in the implementation of ISO 14001.

8. CONCLUSION.

In an era dominated by "green" thinking, environmental protection is seen officially as the "Key for China to sustain economic development". The adoption of a more decentralized mode of governance, necessitated by economic reform, has allowed the local environmental agencies to display a larger degree of flexibility in adopting and implementing their own policies and in shaping public opinion about such matters as pollution. The Dalian Economic and Technological Development Zone experience has shown that a more favorable context can be created by implementing an environmental management system. The key is to establish an appropriate system based on the local realities.

ISO 14001 therefore is a primary tool to achieve the local government's mandate. The implementation of the ISO 14001 standard can ensure compliance with environmental statutes and regulations, as well as strengthening Dalian's green image, reducing the local pollution and environmental risks, improving the investment environment and the efficiency of service delivery, and reducing the consumption of virgin material and resources at the zone-level.

However, due to lack of public participation, major environmental policies are often formulated and decided by non-elected officials and without public consultation. This situation can impede the local environmental agency from gaining more powerful extra-bureaucratic allies, so as to counter strong bureaucratic resistance to environmental protection and allow them to perfect their existing environmental management system.

The implementation of ISO 14001 is not the final step in environmental management. To retrofit such an industrial park as an ecosystem by applying the principles of industrial ecology will definitely improve further the overall environmental performance at the zone-level [6]. However, a lack of collaboration among enterprises may reduce the opportunities for by-product exchange and sharing of energy. But at this early stage, to establish an EMS according to the ISO 14001 standard at a zone-level is an practical tool for China's economic and technological development zones. The Dalian experience should be disseminated to other zones and more exchange on environmental management among these zones should be encouraged.

9. ACKNOWLEDGEMENTS.

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THE EVOLUTION OF AN INDUSTRIAL PARK:

THE CASE OF BURNSIDE.

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1. SUMMARY.

Burnside Industrial Park is located in the Halifax Regional Municipality, Nova Scotia, Canada (Figure 1). It encompasses an area of 1200 hectares of which three-quarters is currently developed. There are approximately 1300 companies and 17,000 employees in those businesses. The Park is one of the five largest in Canada.

Burnside Industrial Park is one of seven parks operated by the municipality, of 51 in Nova Scotia, and of approximately 1,000 in Canada. UNEP-DTIE reports that there are more than 12,000 industrial parks or estates around the world and some estimates are as high as 20,000.

Figure 1. Map of eastern Canada showing the location of Halifax.

2. INDUSTRIAL DEVELOPMENT AND ENVIRONMENTAL MANAGEMENT.

Municipalities in Canada, such as the Halifax Regional Municipality, have zoned areas for commercial and industrial development. In some cases these are advertised as industrial parks. These are a means of optimizing infrastructural costs and facilitating industrial development through specific zoning standards. In Canada, the three levels of government, namely local, provincial and national, support industrial development through a variety of policies and incentives.

Ensuring that the environment, that is air, water, land, and other species, are protected is the responsibility of the three levels of government in Canada. The primary actors are the federal and provincial governments that are assigned these responsibilities under the Constitution. Some of these responsibilities are assigned to the municipal governments by the provinces. This is the case with such issues as solid waste management, urban runoff wastewater treatment and nuisances such as noise. Recently municipalities have begun addressing issues such as pesticide use and greenhouse gas emissions. These responsibilities extend to industrial parks or zones under the control of municipalities.

On the basis of a provincial solid waste/ resource management framework, the Halifax Regional Municipality has implemented a solid waste management system, which is widely viewed as the most sophisticated in Canada. This system includes diversion of glass, some plastics, paper and cardboard and aluminum, organic and compostable wastes and construction and demolition debris from the landfill. The municipality is also a member of the Partners for Climate Protection program of the Federation of Canadian Municipalities whose goal it is to reduce greenhouse gas emissions by 20% of 1990 levels. Finally the municipality has adopted a sewer use bylaw which will limit discharges of certain materials into the sewers and a pesticide use bylaw which will, within four years, ban the use of pesticides for aesthetic purposes within the city.

There are federal and provincial requirements which also apply to industries located within the municipality, such as those in Burnside Industrial Park. In particular, relatively new legislation will require companies to adopt pollution prevention plans and restrict the use of a number of toxic chemicals. Unfortunately, small and medium sized companies in Canada do not merit the attention of regulatory agencies unless they fall into certain sectors such as metal plating and printing. The fact that 1300 companies are located in a relatively compact area, with resulting cumulative impacts, should be cause for greater concern.

3. BURNSIDE INDUSTRIAL PARK.

Burnside is designated primarily for light manufacturing, distribution, and commercial activities. One section of the Park is designated as a business park and attracts computer, health and technology companies. Although not specifically designated as such, another section has attracted many large trucking companies and their maintenance facilities. There is no "worker housing" at this time but there are two hotels in the park and a third is being considered. Housing is an option that is under consideration for park expansion. Table 1 lists some of the sectors represented in Burnside. Companies encompass the range of types from local to multinational. The scale of the businesses extends from a few employees to 250 people. The majority of the companies located in the park are small businesses.

Table 1. Sectors represented in Burnside Industrial Park

Accommodations	Distribution
Adhesives	Door & Window Manufacturing
Air Conditioning	Electrical Equipment
Automotive Repair	Environmental Services
Beverage Products	Furniture Manufacturing
Building Materials	Food Equipment
Business Centers	Industrial Equipment
Business Firms	Steel Fabrication
Carpeting and Flooring	Machine Shops
Chemicals Processing	Medical Equipment
Commercial Cleaners	Paint Recycling
Clothing Manufacturers	Paper/Cardboard Products
Communications Equipment	Printing
Computer Assembly and Repair	Metal Plating
Construction	Refrigeration
Containers and Packaging	Transportation
Dairy Products	Warehousing

Figure 2 provides additional detail on the location of the Burnside in relation to the rest of the municipality and Halifax Harbour in particular. Figure 3 is a map of the Park, showing the layout, the areas which have been developed as well as those yet to be developed, the areas designated a green or parkland, and the road network. Figure 4 is a panoramic view of Burnside Industrial Park.

Figure 2. Map of the Halifax Regional Municipality showing the location of Burnside Industrial Park.

Figure 3. Map of Burnside Industrial Park showing developed, protected and undeveloped areas.

Figure 4. A panoramic view of Burnside Industrial Park.

4. DEVELOPMENT STANDARDS.

Since the inception of the "Burnside as an Industrial Ecosystem" project, the municipality has strengthened the standards which apply to the Park. The objectives and covenants are:

- to protect property values and enhance the investment of businesses located in the Park by providing a well-planned and maintained development;
- to create an attractive and efficient business environment through sound land use, planning and environmental management standards;
- to ensure harmonious relationships among uses.

Two of the standards are worth noting here:

"…incorporating conservationist principles, preservation and upgrading of existing topography, vegetation and cover in conjunction with supplementary planting and treatment of a consistent and compatible nature. Interesting, distinctive and unique site features and relationships in the existing environment should be maintained."

and:

"…the supplementary planting of native species."

The covenants are intended "to ensure that the Park continues to be developed in a manner consistent with superior aesthetic and environmental protection standards and with the declared intention of creating a pleasant and harmonious environment for the Park's residents." The requirements apply to architecture, landscaping, signage, protection of natural areas particularly streams, lakes and wetlands, and require buffer zones of undisturbed habitat or suitable green spaces around all watercourses.

5. ENVIRONMENTAL MANAGEMENT.

Businesses in the Park must satisfy federal, provincial and municipal regulations which apply to them. These include requirements to prevent the discharge of pollutants that may be hazardous to fish, restrictions of specified toxic chemicals such as PCBs and ozone depleting substances, and separation of solid wastes that are compostable or recyclable for diversion from the landfill. These requirements are enforced through regulation or encouraged through fees such as tipping fees and sewer use fees.

Additionally, companies locating in Burnside must abide by the particular covenants and standards intended for the industrial park. All of these requirements, whether regulation or economic instruments, along with the increasing environmental awareness of people in Canada, have created an atmosphere which is conducive to enhanced networking and the application of new environmental management strategies based in industrial ecology.

6. BURNSIDE AS AN INDUSTRIAL ECOSYSTEM.

Largely because of its diversity, the park was selected a working laboratory for assessing strategies which would create inter-relationships between companies and between companies and their environment. In an initial study, a research team identified a number of strategies, guidelines, potential symbiotic relationships and support systems which would facilitate the transformation of Burnside. Table 2 lists these support systems while Table 3 lists the strategies which have been the focus of our continuing work.

Table 2. Support systems for designing, operating and transforming parks, estates or clusters into eco-industrial systems (Côté et al 1994).

Information clearinghouse
Materials exchange
Environmental audit capability
Educational and training programs
Applied research program
Enforcement of standards and regulations

Table 3. Strategies for designing, operating and transforming industrial parks into eco-industrial systems (Côté et al 1994).

1. Site selection	2. Standardization
3. Site design	4. Inventory Control
5. Building design & construction	6. Co-location of businesses
7. Conservation of energy resources	8. Material cycling & exchanges
9. Substitution of materials	10. Information collection & management
11. Using environmentally friendly products	12. Encouraging "scavengers and decomposers"
13. Environmental reviews or audits	14. Cascading materials
15. New product development	16. Feedback and communication
17. Packaging waste reuse and reduction	

6.1 Support systems.

All of the functions identified have been put into place in one way or another. The Eco-Efficiency Centre is primarily an information clearinghouse and networking mechanism. Originally we had envisaged the creation of a computer based information and decision-support system but it became clear that a "hands-on" approach was required at least in the first few years. The Centre also conducts environmental reviews and encourages companies to join an Eco-Business program adopting an environmental code or policy, setting objectives and targets and, competing for reduction or conservation awards. Recently, the Centre has begun testing the Efficient Entrepreneur calendar and assistant developed jointly by the Wuppertal Institute and UNEP-DTIE to encourage companies to track their performance.

Both Dalhousie University and the Eco-Efficiency Centre act as educators in this endeavour. For the past seven years, we have written *The Burnside Ecosystem* column in the monthly park newspaper. The Centre prepares and publishes a series of fact sheets on various generic and sector specific topics which are distributed to businesses in the park. In addition, we have just concluded an agreement with the Metropolitan Chamber of Commerce which will result in the publication of 3 or 4 articles per year in their monthly magazine. Under the supervision of their professors, students undertake projects with companies in the park. For example, during the past five years, papers on the implications of environmental management systems with a gap analysis, have been written and presented to 25 businesses in the park.

The Centre encourages materials exchange and symbiotic relationships between companies and supports Clean Nova Scotia in the province-wide waste materials exchange. There is a possibility that the Centre will be taking this function over in the next few months. Finally, the project and the Centre encourage professors and students to collaborate with companies or sectors on applied research projects. One such study involves the integration of an environmental management system and the Natural Step into a furniture manufacturer owned by a multi-national corporation. Another project is a demonstration of an engineered wetland for the treatment of landfill leachate and runoff.

6.2 Strategies.

The Centre and the university have continued to promote and investigate the strategies identified at the beginning of the project. Companies are encouraged to substitute chemicals and use environmentally appropriate cleaning products. At least one company has established, and is now expanding, a manufacturing facility in the park. The Centre conducts environmental reviews of companies and encourages formal auditing which can be undertaken by environmental consulting firms located in the park.

Packaging of various types and configurations is the largest quantity of waste materials in the park. The Centre is encouraging the reuse of as much of this packaging as possible, and the recovery and recycling of the remainder of this packaging.

Two key components of a mature natural ecosystem are scavengers and decomposers. Arguably, they are the most important groups of species in an ecosystem as they recover and cycle nutrients within the system. The educational and informational efforts of the Centre, along with the regulatory framework and the economic instruments, have resulted in a proliferation of scavengers and decomposers as might be seen in a maturing ecosystem (Table 4).

Table 4. Examples of the "scavengers" and "decomposers" species which have evolved or migrated into the park (Noronha 1999).

Recovery	Rental
Fine paper	Construction equipment
Cardboard	Tools
Glass bottles	Pallets
Metals	Communications equipment
Batteries	Photocopiers
Chemicals	Uniforms

Remanufacturing	Repair
Toner cartridges	Computers
Furniture	Electronic equipment
Printer ribbons	Trucks and cars
Tire retreading	Furniture
Computers	Buildings
Automotive parts	

Reuse	Recycling
Building materials	Paint
Tools	Waste oils
Packaging	Solvent

7. THE FUTURE.

Burnside is composed of old areas which are now being redeveloped (brownfield), sections which are relatively new and areas yet to be developed (greenfield). Companies come and go and in some years as many as 10% of the businesses in the park are undergoing some change: locating in new premises, closing, opening, and expanding. Therefore there are continuing opportunities to investigate the application of the strategies in the transformation of the park into an industrial ecosystem.

In addition, the project and the Centre will continue fostering additional networking among companies within sectors, within mall units, with common issues or materials. One issue which is currently ripe for networking is transportation. Carpooling, vanpooling and public transportation must be encouraged to improve efficiency and reduce environmental impact.

As listed in Table 5 there have been some successes in the transformation of the park but there are continuing challenges to the continuing evolution of Burnside Industrial Park: limited enforcement of current regulations, getting the economic instruments right, expanding the partnerships and maintaining the momentum of a very complex initiative.

Table 5. Examples of the application of the concept in Burnside Industrial Park.

- Environmental design of the park:
  Spectacle lake park and trails
  Use of wetlands
- Cycling of materials and cascading:
  Scotia Recycling
  Envirosystems
- Scavengers and Decomposers:
  Happy Harry's Used Building Materials
  Miller Composting Facility
- Environmentally Sensitive Products:
  Bebbington Industries
  Swish maintenance
- Information and education:
  Eco-efficiency Centre in Burnside
  Burnside news
- Economic instruments:
  Tipping fees
  Water rates
  Pollution control charges
- Regulation:
  Landfill bans
  Sewer use bylaws

8. ECO-INDUSTRIAL DEVELOPMENT.

Burnside Industrial Park has served as an eco-industrial laboratory for the past 9 years. However, while we are investigating the application of eco-industrial development strategies, we are collaborating with the municipality in attempting to transform the existing infrastructure and companies while influencing the nature of new infrastructure and industrial operations.

Collaboration and networking has occurred at different levels: 1) the university and the municipality in the study and application of industrial ecology to an industrial park; 2) the university, the private electric utility company and governments in the creation of the Eco-Efficiency Centre; 3) material exchanges between two or more companies; 4) establishment of new companies to take advantage of opportunities in reuse, rental, repair, remanufacturing and recycling. Two aspects which we want to emphasize in the future are supply chain management of materials within the park and partnerships or joint ventures in the recovery of wasted materials. We also wish to collaborate with industry groups and governments in environmental management training which will result in increasing awareness and testing of eco-efficiency analysis tools which should result in increased understanding of benefits.

While an interest in eco-industrial development and a willingness to participate are important for launching projects, the main success factor is a continuing commitment by a group of partners from government, industry, academia, and community organizations. Eco-industrial developments are not short-term initiatives. Without this commitment, projects cannot be sustained.

9. ACKNOWLEDGEMENT.

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A Sustainable Development Project in the Humberside Region, United Kingdom.

Summary

This Case Study describes an example of industrial regional networking rather than an industrial estate *per se*. However, in a similar way to the example of Kalundborg, there are many useful elements of the strategy employed here by the *Business Council for Sustainable Development – North Sea Region* that can be employed profitably within an industrial estate. This case is very much an ongoing project and the enclosed document describes the initial Pilot Phase.

Further Reading

Business Council for Sustainable Development – Gulf of Mexico, *By-product Synergy: A Strategy for Sustainable Development – A Primer*, 1997.

INITIAL PILOT STUDY

SUMARY REPORT

SEPTEMBER 2000

Developing a Programme to Accelerate Sustainability in the Humberside Region, United Kingdom

BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT NORTH SEA REGION

conoco

NORTH LINCOLNSHIRE COUNCIL

YORKSHIRE FORWARD

Yorkshire & Humber Regional Development Agency

ENVIROS
knowledge innovation solutions

1 Background, Objectives and Scope

The Regional Economic Strategy for Yorkshire and the Humber has identified the Humber estuary as an area with major growth potential. A specific initiative, the Humber Trade Zone, has been established by Yorkshire Forward to realise this potential. This addresses the sustainable development of the area including issues such as improved infrastructure and provision of serviced land, the development of collaborative business-based programmes and environmental improvements.

This pilot study, conducted by Enviros, is primarily concerned with three major initiatives which have the potential to contribute significantly towards the economic and sustainable development of the Humber area:

- **An Industrial Symbiosis or By-Product Synergy TM (BPS) programme.** This involves the creation of linkages between firms to raise the overall efficiency of material and energy flows. It is based on a systematic approach covering all the processes and activities of the participating firms. This programme is being developed by the Business Council for Sustainable Development, North Sea Region (BCSD:NSR) in conjunction with the Humber Trade Zone and other regional partners.
- **A 475 to 650 MW Combined Heat and Power (CHP) plant,** linked to the two refineries on the South Bank, which would provide energy, in a cost-effective and sustainable way, to existing and new businesses in the area. This project is being developed by Conoco Global Power Developments UK Ltd.
- **The Humber Bundle (HB),** a series of feedstock pipelines linking process plants on both sides of the Humber, that is being promoted by a consortium of major local firms including BP and Air Products. This has the potential to lead to greater integration of local plants and stimulation of new investment.

Proposed Humber Bundle Feedstocks	
Methanol	Hydrogen
Gas Codensate	Ammonia
Naphtha	Oxygen
Natural gas	Nitrogen
Propylene	Water
Ethylene	Telecoms

The objectives of this initial study have been to evaluate the added-value benefits to the area of the CHP plant and the HB in the context of the overall Regional Strategy and the specific aims of the BPS TM programme.

The work programme has involved the collation and analysis of a wide range of existing information and reports followed by discussions with the various parties involved in the Humber area and elsewhere in the UK. The focus has been on the oil, gas and chemicals sectors since they are all important in the relation to the three initiatives. However, other sectors particularly in the context of the CHP plant and the BPS programme have also been considered.

2 Industrial Symbiosis/ By-Product Synergy TM Programme

BPS TM is a prime example of a collaborative business-based programme with the potential to deliver tangible benefits to the Humber area through:

- financial savings to those involved as a result of lower raw materials costs and reduced waste disposal charges
- higher added values for by-products e.g. by developing local markets for materials such as hydrogen and propylene
- closer integration of neighbouring businesses to minimise distribution costs
- lower environmental impacts as a result of reduced waste and more efficient use of materials
- safeguarding and creating local employment by helping firms in the area to be more competitive and establishing new businesses to handle materials which are currently perceived to be waste

This study has identified a number of key links between the BPS project and the CHP plant and HB:

- the CHP plant will use hydrocarbon by-products from the refineries as fuel hence significantly decreasing gas flaring which will reduce costs and greenhouse gas emissions
- the CHP plant and the HB will help to stimulate new investment in industries which could be users of local by-products and materials currently classified as waste
- there are a number of strategically important materials available locally as by-products that are planned for transmission through the HB e.g. hydrogen and propylene. The HB would increase the flexibility of use of these by-products on either the north or south banks and stimulate greater integration of the plants involved
- the CHP plant will have a large requirement for water which could be supplied from local sources of wastewater
- the CHP plant could supply low grade heat to existing and new local users (e.g. for horticultural and fish farming applications) and carbon dioxide also for horticultural use
- the "spoil" from the HB tunnel could be used for sea defences, which are increasingly important in the context of climate change induced tide rises.

FROM THE DEPUTY PRIME MINISTER

DETR

Jonathan Hobbs
Executive Director
Business Council for Sustainable Development
North Sea Region
Kellfield House
Berkeley Business Centre
Doncaster Road
SCUNTHORPE
DN15 7DQ

21 SEP 2000

Dear Mr Hobbs

ACCLERATING SUSTAINABLE DEVELOPMENT: HUMBERSIDE REGION

I applaud your efforts to deliver a practical example of profitable sustainable development in action through the By Product Synergy Programme, Humber region.

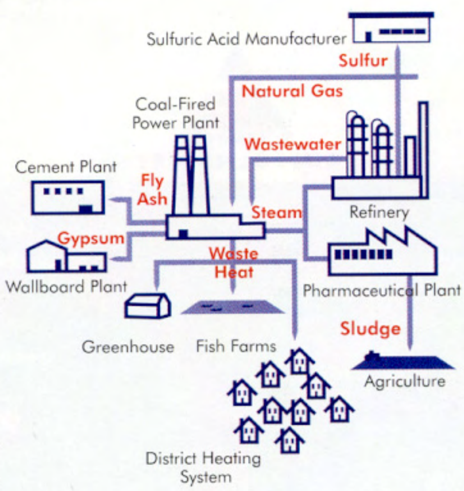
Sustainable business practice means generating more wealth in environmentally benign and socially acceptable ways. Many of your ideas represent a truly exciting way of facing up to the many challenges and opportunities now facing business. While we need individual businesses to improve their performance, this can be enhanced by concerted action through greater co-operation and joint working.

Such action has much to offer. Business itself can benefit from reduced operating costs and increased competitiveness through increased efficiency in energy and material flows. The environment can benefit from the more efficient use of resources, reduced waste production and greenhouse gas emissions. The region can benefit from its attraction to inward investors and security of employment.

I would be interested to hear in due course, what opportunities the programme identifies.

JOHN PRESCOTT

This study has also identified a number of other by-products and waste streams in the area which could form the basis of a BPS TM project e.g. sulphuric acid, polymer wastes, spent catalysts, waste solvents and sulphur. The focus has been on the chemicals sector but there are a number of other local industries which could be involved in the project including steel, food processing, the ports, storage and distribution companies and those involved in providing specialist services e.g. waste processing, design & engineering and fabrication.



Industrial Symbiosis and an Early Example of an Eco-industrial Park: Kalundborg, Denmark

3 CHP Plant

Conoco Global Power Developments UK: State of the Art CHP Plant

The CHP Plant would deliver added-value benefits to the Humber area in three main respects:

- **By providing electricity and steam in a flexible, secure and cost-effective manner to local firms.** The cost benefits to local companies could range from £1.8 to 5.8 million per annum depending on the energy use profiles and prices. This would make a significant contribution towards increasing the competitiveness of local firms. The supply of energy from the CHP plant would also enable them to avoid the costs of replacing older, low efficiency boiler plant.
- **The CHP plant would help to attract new energy intensive industries into the area based on its potential to provide electricity and steam at competitive prices.** The plan to provide an energy corridor close to the South Bank would overcome one of the key disadvantages of the area in terms of lack of sites with ready access to established utilities. The energy cost benefits based on a mix of new investors could be in the range £3 to 13.5 million per annum depending on the energy use profiles and prices.

Within the scope of this study we have identified a number of potential new investment opportunities in the chemicals industry which could be attracted into the area based on its overall strengths and the existence of the CHP plant and HB. The impacts of these on the local economy are summarised in Table 1.

- **There are significant environmental and sustainable development benefits of generating electricity and steam by CHP.** It is estimated that the 475MW plant will reduce CO_2 emissions by 3.3 million tonnes per year compared with generation by conventional means. There will also be significant reductions in SOx and NOx emissions. The conclusion from this study that there is sufficient potential demand from new investors to build a plant up to 950MW doubles these benefits. There are additional environmental benefits associated with the scope for local companies to shut down existing inefficient boiler plant thus reducing greenhouse has emissions even further.

Table 1 - Potential New Chemicals Investment in the Humber Area

Economic Effect	Factor	Units	Amount
Direct	Output	£m/year	540
	Gross Value Added	£m/year	160
	New Capital Expenditure	£m	370
	Employment	Numbers	960
	Site requirements	acres	170
Total	Output	£m/year	800
	Employment	rnumbers	2400

Note: Total effects include direct, indirect and induced activities.

4 Humber Bundle

The Humber Bundle (HB) would deliver added-value benefits to the Humber area in the following ways:

- **Benefits to existing companies.** The added value benefits of the HB are associated with distribution of the materials to existing users directly through a pipeline network rather than by ship and/or road tanker. This should lead to cost savings to the supplier and/or customer and environmental benefits in terms of the substitution of road transport. The main benefits here will accrue directly to the HB partners and the refineries and these have not been quantified in this study since the details remain confidential to the parties involved.

  The benefits to other companies in the Humber area are most significant for the utility materials in the HB since there are some large local users of gas and water and also companies with sufficient demand to justify a direct pipeline feed of nitrogen. For the chemicals feedstocks and by-products (e.g. ethylene, propylene, hydrogen etc), there are no major local users to take these materials by pipeline apart from BP and the refineries. Based on the sample of companies contacted during this study, we estimate that these cost benefits could range from £1.5 to 2.4 million per annum.
- **Attracting new investment.** The HB has the potential to attract new investment into the Humber area based on the availability of strategic feedstocks (such as ethylene and propylene) through pipelines to sites on the north or south banks depending on the source of the materials. The HB will also facilitate the integration of chemical sites in the Humber area which will help to overcome one of its key weaknesses.

  The main short term prospects for new investment are associated with chemicals derivatives from ethylene and propylene, particularly the latter since availability of chemical and polymer grade propylene is a barrier to investment in downstream derivatives elsewhere in the UK and overseas.

  The levels of chemical investment which could be attracted to the area based on the HB, in conjunction with the CHP, are summarised in Table 1.

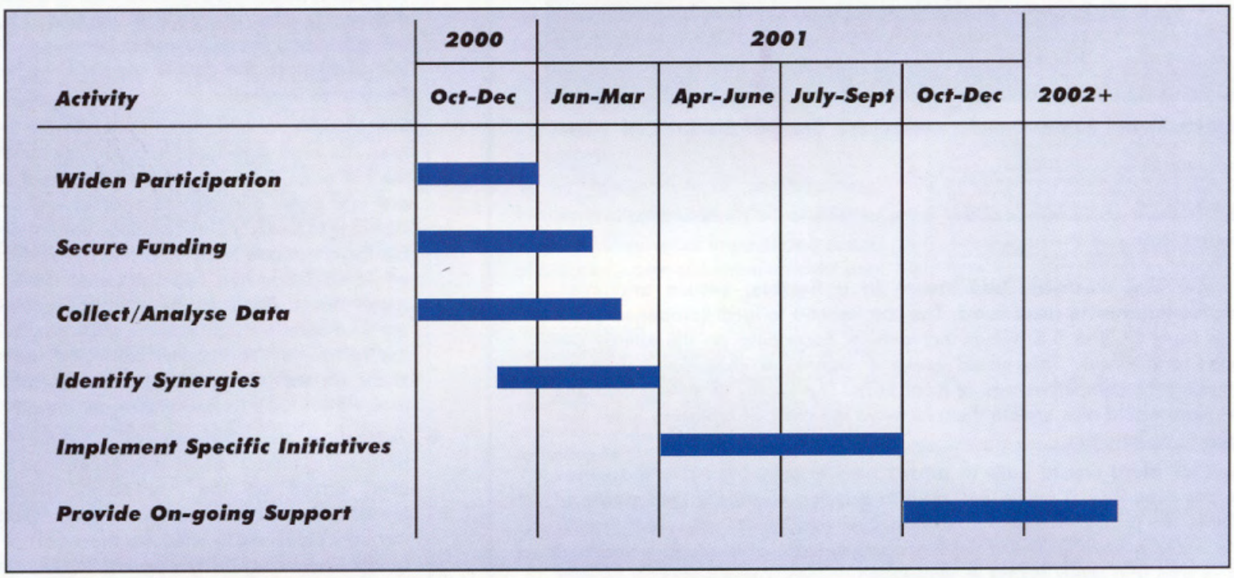
  The medium term potential to develop a hydrogen economy around the availability of by-product hydrogen and linking the banks of the Humber through the HB represents an exciting prospect. In this analysis we have only included the direct investment in additional capacity which would provide more hydrogen for the area. Further work is needed to assess the scope for development of the infrastructure and the longer term benefits to the economy and the environment. An important short term action could be to develop a proposal for the next round of ENERGIE funding in the late Autumn.
- **Environmental benefits.** There are significant environmental benefits associated with the transportation of chemicals by pipeline rather than by ship and/or road tanker. It is estimated that the project would remove 750,000 tonnes of hazardous cargo from surface transport. In the case of oxygen, nitrogen and hydrogen there are additional benefits of delivering these gases by pipeline rather than road tanker because of the lower energy required to produce them in a gaseous rather than liquid form.

5 BPS™ Forward Programme

The next steps in the development of the BPS ™ programme are as follows:

- Promotion of the programme to a wide audience followed by confirmation of the participants
- More detailed data collection and analysis to identify the main areas of synergy amongst the companies involved and to assess the resources and cost-benefits
- Implementation of specific initiatives and involvement of a wider group of organisations and companies
- Provision of on-going technical and commercial support, monitoring results and disseminating information.

BPS ™ Programme Timetable



6 Other Actions

- More detailed evaluation of the technical and commercial issues is needed to confirm the priorities for industrial development in the Humber area. This will involve discussions with the relevant local organisations, companies and potential inward investors. In the context of the chemicals sector, it will be important to involve the Humber Chemicals Focus, the DTI and Invest UK as well as those already supporting this study.
- More work is required to evaluate the impacts in selected non-chemicals sectors e.g. food & drink, paper & board, timber products.
- The results of the evaluation of the CHP benefits will be integrated into the inward investment strategy for the South Humber area to demonstrate its competitiveness in terms of energy supply. Some comparisons with energy costs in competing locations in Europe will help to complete this picture.
- The results of this pilot study will also be used to investigate the need for a larger CHP plant than the 475 to 650MW current design e.g. through a modular build-up to a plant at least twice this size.
- The results from this initial study will be combined with the benefits and costs relating to the partners in the HB and the refineries to assess the overall feasibility of the investment. A number of the key assumptions identified in the report will need to be considered. This will then form the basis of any case made for public sector support for the HB.

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SLIDES

This section of the Resource & Training Kit provides a number of slides that can be used when presenting the subject of Environmental Management for Industrial Estates either in a lecture format or for training seminars and workshops. A hardcopy of the slides is included in this section of the Kit, while the original Powerpoint files are to be found on the accompanying CD-ROM.

The slides have been grouped approximately according to the subject matter of each chapter in the Background Paper and the citations can also be found in the References section of the Background Paper. Where necessary, two Powerpoint files have been created to cover both Landscape and Portrait formats for slides. They are distinguished by a –L or –P in the name of the file.

Each group of slides can be used to present one topic from the Kit, for example during a training seminar. However, it is hoped that most users will choose individual slides from the different groups in order to create a customised presentation according to their needs. Of course, it is also expected that users of the Kit will add their own slides to suit their specific requirements.

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Environmental Management for Industrial Estates: Information & Training Resources.

UNEP Environmental Management for Industrial Estates. slide - 1.1

Environmental Management for Industrial Estates.

Why is Environmental Management Important in the Context of an Industrial Estate ?

UNEP Environmental Management for Industrial Estates. slide - 1.2

Environmental Management for Industrial Estates - *Why we need it …*

*When industrial estates began to appear a little over 100 years ago the objective was to **promote**, **plan** and **manage industrial development** in a systematic way.*

EMIE Resource & Training Kit, 2001

Environmental Management for Industrial Estates - *Facts & Figures …*

- ***Estimates of the number of industrial estates worldwide vary between 12,000 - 20,000.***
- ***Recent growth of industrial estates in the developing countries in Asia is very rapid - there are now 2,000 in China and more than 500 elsewhere in the region.***
- ***Industrial estates may cover up to 100 km^2 and contain >1500 industries (e.g. Jebel Ali Free Zone in Dubai).***
- ***Industrial estates are major employers - 60,000 in Batamindo (Indonesia), 600,000 in Suzhou (China).***
- ***32 Economic & Technological Development Zones in China received 10% of total foreign investment in 1998.***

Environmental Management for Industrial Estates - *Local impacts ...*

Relatively little attention has been paid to the environmental impact of industrial estates in most developing countries.

Moving industry out of town all too often merely means shifting pollution away from existing residential areas, and where action is taken, this rarely extends beyond end-of-pipe treatment.

UNIDO, 1997

UNEP Environmental Management for Industrial Estates. slide - 1.5

Environmental Management for Industrial Estates - *More impacts ...*

Enschede, 13 May 2000

- **18 people killed**
- **947 injured**
- **2 missing**

Destruction:

- **Entire factory**
- **400 houses**
- **> 1000 houses damaged**

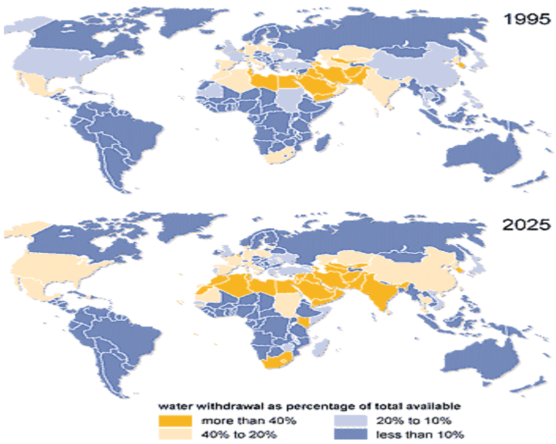
UNEP Environmental Management for Industrial Estates. slide - 1.6

Main Environmental Issues - *Agenda 21* ...

- ⇨ Protection of the atmosphere.
- ⇨ Sustainable management of land.
- ⇨ Combating deforestation.
- ⇨ Combating desertification and drought.
- ⇨ Sustainable mountain development.
- ⇨ Sustainable agriculture and rural development.
- ⇨ Conservation of biological diversity.
- ⇨ Management of biotechnology.
- ⇨ Protecting and managing the oceans.
- ⇨ Protecting and managing fresh water.
- ⇨ Safer use of toxic chemicals.
- ⇨ Managing hazardous wastes.
- ⇨ Managing solid wastes and sewage.
- ⇨ Managing radioactive wastes.

UNEP Environmental Management for Industrial Estates. slide - 1.7

Global Water Stress, 1995 and 2025
[UNEP GEO 2000]

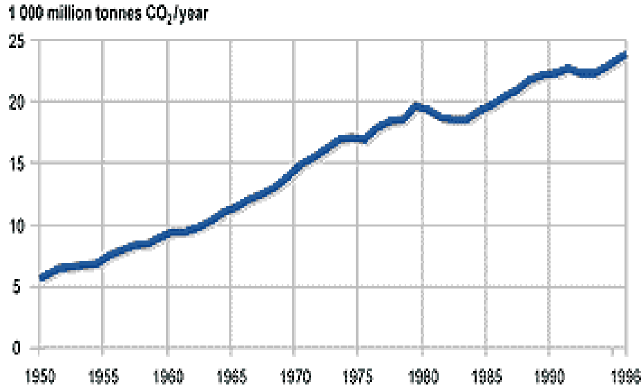


Today, one third of the world's population lives in countries with moderate to high water stress.

Lack of water is already a major constraint to industrial and socio-economic growth in many areas including China, India and Indonesia.

UNEP Environmental Management for Industrial Estates. slide - 1.8

Global Carbon Dioxide Emissions
[UNEP GEO 2000]



Only in Europe have per capita CO_2 emissions declined over the past 20 years. Emissions are much higher in North America than in any other regions.

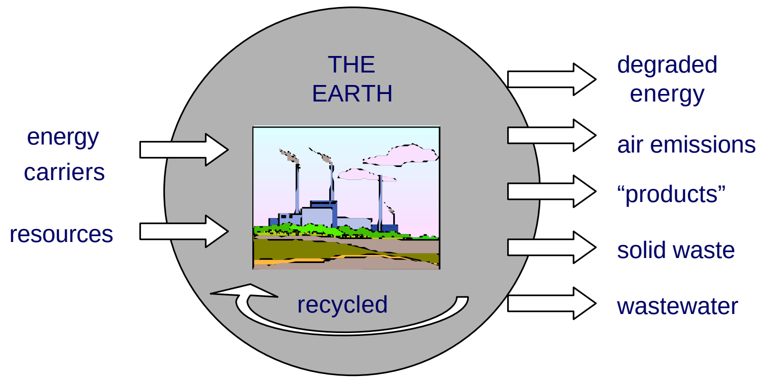
UNEP Environmental Management for Industrial Estates. slide - 1.9

Industrial Pollution
[UNEP GEO 2000]

The output of hazardous wastes worldwide was about 400 million tonnes a year in the early 1990s mainly from chemical production, energy production, pulp and paper factories, mining industries and leather and tanning processes.

UNEP Environmental Management for Industrial Estates. slide - 1.10

Environmental Management for Industrial Estates - *Inputs and Outputs …*



UNEP Environmental Management for Industrial Estates. slide - 1.11

Environmental Management for Industrial Estates - *Global issues …*

Global environmental issues in reality can be divided into:

- truly global issues
- universal practices that lead to major environmental issues
- regional environmental issues that develop into global issues

(IHDP, 1999)

UNEP Environmental Management for Industrial Estates. slide - 1.12

Environmental Management for Industrial Estates - *Why we need it …*

*In thinking about **sustainability**, we must carefully balance our human desire to live as we please with an increasing set of **political, economic, social, and environmental constraints**.*

R. Frosch, *The Bridge*, 1999

UNEP Environmental Management for Industrial Estates. slide - 1.13

Environmental Management for Industrial Estates - *Sustainability ...*

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

[…] in particular the essential needs of the world's poor, to which overriding priority should be given.

WCED, Our Common Future, 1987

UNEP Environmental Management for Industrial Estates. slide - 1.14

Environmental Management for Industrial Estates - *Sustainability ...*

Sustainable development […] mean[s] improving the quality of human life while living within the carrying capacity of supporting ecosystems.

IUCN, UNEP, WWF Caring for the Earth, 1991

Environmental Management for Industrial Estates - *Why it is important ...*

Estates can provide leadership to other sectors of industry and the economy (US-AEP, 2000) :

- ☑ ideal for introducing better environmental practices -
  - provision of common infrastructure
  - close links with government (in many developing countries)
  - broad spectrum of companies - (multi-) nationals to SME's
- ☑ position of the industrial estate in the global supply chain allows tenant companies to influence local suppliers (e.g. ISO 14000)
- ☑ estates bring together many stakeholders -
  - manufacturing companies
  - local and national government
  - local communities

Environmental Management for Industrial Estates.

The Industrial Estate Concept.

One Definition of an Industrial Estate ...

- ⇨ A defined geographical area which contains businesses of an industrial nature.
- ⇨ The essential element is that the estate is administered or managed by a single authority that has defined jurisdiction with respect to tenant companies.
- ⇨ The authority makes provision for continuing management, enforcing restrictions on tenants and detailed planning with respect to lot sizes, access and utilities.

from UNEP Industry and Environment Review, 1996

Industrial Estates - *Some characteristics ...*

- ⇨ Industrial estates cover a relatively large surface area - 40-80 ha
  - ➤ necessary to reduce the cost of infrastructure
- ⇨ All factories and buildings have access to:
  - ☑ utilities (water and electricity)
  - ☑ common services (*e.g.* central effluent treatment, waste collection, fire protection)
- ⇨ The estate is responsible for providing:
  - ☑ roads and telecommunications
  - ☑ some estates also include housing for workers.

UNEP Environmental Management for Industrial Estates. slide - 2.3

Utilities and Services Provided by Industrial Estates - *PPDC Petrochem Park, Philippines.*

UNEP Environmental Management for Industrial Estates. slide - 2.4

Industrial Estates - *More characteristics …*

⇨ Restrictions on companies within the estate exist:
- ☑ with respect to the type of construction
- ☑ concerning the size of individual sites
- ☑ there is a master plan that guides overall use of the built environment, *e.g.* energy or water efficiency.

⇨ Industrial estates are developed according to a “master plan” that guides:
- ☑ the physical planning of the estate
- ☑ the economic and social environment, depending on the role within the regional or urban development plan.

Industrial Estates - *Types and synonyms …*

- **Industrial Parks**
- **Industrial Zones**
- **Industrial Clusters**
- **Office Parks**
- **Science and Research Parks**
- **Industrial Development Zones**
- **Bio-Technology Parks**
- **Industrial Districts**
- **Export Processing Zones**
- **Business Parks**
- **High Technology Zones**
- **Industrial Processing Zones**
- **Integrated Industrial Zones**

Industrial Estates - *Players and their roles ...*

Government	Land use planning, environmental regulations
Estate developers	Proper EIA, ecological siting and environmental policy setting
Estate managers	Environmental services, EMS, facilitate collective efforts, environmental reporting
Local authorities	Emergency response plan, monitoring
Communities	Awareness, public pressure and participation
Tenants	EMS, reporting, communication for EIN

UNEP Environmental Management for Industrial Estates. slide - 2.7

An Industrial Estate - *The management team ...*

An <u>estate management group</u> typically assumes the following roles:

- A **managerial** role for -
  - enforcing restrictive covenants in leasing agreements,
  - deciding on the entry of new companies into the estate,
  - collecting rents and ensuring that taxes and charges are paid,
  - being responsible for maintenance and order on the estate.
- A **technical** role that covers -
  - responsibility for common facilities,
  - training,
  - technical services.
- A **financial** role including -
  - overseeing loans to tenant companies
  - arranging bulk purchasing agreements for materials.

UNEP Environmental Management for Industrial Estates. slide - 2.8

Industrial Estates as a Regional Development Tool - *Part 1 ...*

- Promote ***economic development***, and ***employment***, by attracting ***new investment***.
- Promote ***decentralisation*** of industrial activity from urban areas:
  - ∅ a better ***geographical balance*** within a region for ***production*** and ***employment*.**
- Introduce ***diversification*** within the industrial base of a region and improve ***quality*** and ***productivity***.

UNEP Environmental Management for Industrial Estates. slide - 2.9

Industrial Estates as a Regional Development Tool - *Part 2 ...*

- Achieve **economies** in investment in public infrastructure.
- Encourage a more efficient use of **resources** through **synergies** between companies focussed on:
  - ∅ an **anchor industry** (*eg.* power plant, oil refinery, steel mill, chemical plant)
  - ∅ a **transport centre** (*eg.* port, airport, rail or road junction).

UNEP Environmental Management for Industrial Estates. slide - 2.10

Industrial Estates -
Some locational advantages for a company ...

☑ Lower capital investment costs:
- ∅ part of the set-up has been carried out by the developer of the estate

☑ Fewer hurdles in the construction and start-up of the plant:
- ∅ eg. permits may be easier to obtain, …

☑ Access to common facilities provided by the estate:
- ∅ water and electricity,
- ∅ effluent treatment and waste collection, or
- ∅ fire protection.

UNEP Environmental Management for Industrial Estates. slide - 2.11

Industrial Estates -
More locational advantages for a company ...

☑ Housing and recreation areas for workers may be available.

☑ Co-location may provide an opportunity for co-operation between companies
- ∅ eg. purchasing, transport, …

For Small- and Medium-size Enterprises (SME's) collective access to these facilities can be important -

☒ they may not have the financial strength to access them individually

UNEP Environmental Management for Industrial Estates. slide - 2.12

Industrial Estates - *Responding to the needs of companies …*

Some factors determining a company's choice of location are:

- Ease of access
- Proximity to clients, potential markets and suppliers
- Cost of set-up (land, rent for buildings, charges)
- Geographical situation
- Quality of office space
- Proximity to other subsidiaries of the same company
- Distance to urban centres
- Opportunity costs
- Fiscal conditions (subsidies, professional taxes)
- Image of the region
- An existing industrial estate
- Qualification of the local work force

(Association Orée)

UNEP Environmental Management for Industrial Estates. slide - 2.13

Examples of Industrial Estates - *An Integrated Industrial Zone in Dalian, China*.

Dalian Economic and Technological Development Zone (DETDZ)

- established in 1984
- the first ETDZ in China
- total area 28 km^2
- industrial park - 15 km^2
- >200,000 citizens - of which 98,000 workers and managers
- >1,150 enterprises
- many industrial sectors

Source: G. Yong, 2001

UNEP Environmental Management for Industrial Estates. slide - 2.14

Examples of Industrial Estates - *Burnside Industrial Park, Halifax, Canada*.

- area ~12 km2
- ~1300 companies - mainly light manufacturing, distribution & service
- ~17,000 employees
- 75% of park is developed (yellow), there are natural areas (dark blue), available land (pale blue), and room for expansion (pink)

Source: R. Côté, 2001

UNEP Environmental Management for Industrial Estates. slide - 2.15

Environmental Management for Industrial Estates.

What are the Environmental Aspects and Impacts of an Industrial Estate ?

Environmental Management for Industrial Estates - *Environmental Impacts ...*

- ☑ Occur as a result of the **planning** of the industrial estate.
- ☑ Arise from the day-to-day **operations** of the industrial estate.

Environmental Aspects & Impacts of Industrial Estates.

Nuisances for local communities

Air Pollution

Atmospheric Emissions

Noise, transport, light

Pollution of air, water and soil

Accidental release of chemicals

Degradation of natural resources

Wastewater

Solid Waste

Hazardous Waste

Contamination of water and sediments

Contaminated Land

Pollution of water and soil

UNEP Environmental Management for Industrial Estates. slide - 3.3

Environmental Aspects and Impacts - Atmospheric emissions ...

Atmospheric emissions - SO_2, NOx, VOC's, CFC's, CO_2, metals, particulates

- ∅ poor air quality near to the industrial estate
- ∅ further away other impacts may be observed, e.g. SO_2 is deposited as "acid rain"
  - ☒ acidification of lakes
  - ☒ damage to forests

UNEP Environmental Management for Industrial Estates. slide - 3.4

Environmental Aspects and Impacts - Wastewater ...

Description of pollution from an industrial estate in India:

"At about noon, the water is flowing deep green next to a resident's home. Just a few hours later, another visit to the same stream reveals that the water has turned deep red."

"Deep red-brown water gushes into the stream from a large concrete pipe. People are living in shacks along the water, across from the effluent pipe."

[taken from C&EN, 2000]

Environmental Aspects and Impacts - Noise, transport, light ...

With large industrial estates, the impact on local communities of transport, noise and light is very important.

As anybody who has passed a large industrial complex during the night can affirm, the amount of light and noise emitted by the installations is quite impressive.

Environmental Aspects and Impacts - Hazardous Waste ...

Hazardous Waste -

- ∅ contains leachable toxic components;
- ∅ shows hazardous properties such as -
  - corrosivity,
  - high reactivity,
  - ignitability

The output of hazardous wastes worldwide was about 400 million tonnes a year in the early 1990s, mainly from chemical and energy production, pulp and paper, mining and the leather industry.

(GEO 2000)

UNEP Environmental Management for Industrial Estates. slide - 3.7

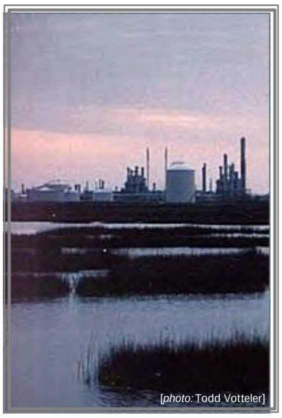
Environmental Aspects and Impacts - Accidental release of chemicals ...

The warehouse fire in November 1986 at the Sandoz chemical plant in Schweizerhalle (Switzerland).

- ∅ the people of Basel were affected by a cloud of highly unpleasant mercaptans
- ∅ 33 tons of toxic substances (including pesticides and fungicides) were washed into the Rhine river during fire-fighting
- ∅ the accident resulted in the death of ~500,000 fish and eels
- ∅ the river water could not be used for drinking water during 1 month

UNEP Environmental Management for Industrial Estates. slide - 3.8

Environmental Aspects and Impacts - Loss of ecosystems, biodiversity ...



The reclamation of wetlands for construction of an industrial estate -

- destroys animal and plant habitats
- removes natural water filtration functions
- takes away storm-management systems

Environmental Aspects and Impacts - Loss of ecosystems, biodiversity ...

Between the mid-1970s and the mid-1980s the USA lost -

- 3.3 million acres of inland freshwater wetlands, and
- 71,000 acres of coastal wetlands.

Losses were due to -

- agriculture (54%)
- industrial development (41%)
- urban development (5%)

US-EPA, 2000

Environmental Aspects and Impacts - Features of an industrial estate ...

- Industrial estates require a large amount of land, often in a remote region -
  - damage to habitats and loss of biodiversity
- The scale and diversity of the activities of the estate are very high -
  - the risks from pollution and accidents are highly concentrated
  - the environmental impacts may reach far beyond the local level, and have a regional or even global component

UNEP Environmental Management for Industrial Estates. slide - 3.11

Environmental Management for Industrial Estates - *The traditional approach.*

To investigate the environmental impacts of an industrial estate in terms of -

- Emissions to air.
- Emissions to water.
- Disposal of hazardous solid waste.
- Contamination of the soil.
- Accidental releases of chemicals resulting from an explosion or fire.

with a focus on activities of ***individual companies*** in the estate.

UNEP Environmental Management for Industrial Estates. slide - 3.12

Environmental Management for Industrial Estates - *A new strategy.*

UNEP Technical Report N° 39:

- introduces a new approach to environmental management for industrial estates -
  - consider environmental impacts and solutions at the ***industrial estate level***
  - emphasise the community of companies
- does not focus on waste management issues alone to solve environmental problems
- takes a broader perspective of the issues that is based on Agenda 21 ...

UNEP Environmental Management for Industrial Estates. slide - 3.13

Environmental Management for Industrial Estates - *What are the issues?*

1. Reducing wastes and emissions from industrial production and from product use. Managing safely and responsibly what cannot be eliminated.
2. Managing safely the production and use of chemicals.
3. Conserving energy, water and soil.
4. Reducing releases of greenhouse gases and ozone-depleting substances.
5. Protecting seas and oceans, and in particular coastal zones.
6. Protecting natural habitats and biodiversity.
7. Protecting landscape, human amenities and heritage sites.

(F. Balkau, 2000)

UNEP Environmental Management for Industrial Estates. slide - 3.14

Environmental Management for Industrial Estates - *A UNEP approach ...*

The UNEP approach asks the question:

"How do the activities of an industrial estate affect these issues?"

- ∅ This broadens the scope beyond issues of materials and energy flows (although they are still important).
- ∅ It uses a systems approach that looks at the industrial estate and how it interacts with the natural world.

The basis of this approach is - **Industrial Ecology**.

UNEP Environmental Management for Industrial Estates. slide - 3.15

Environmental Management for Industrial Estates - *A UNEP approach ...*

The environmental management strategy is defined by -

- ? What specific aspects of the industrial estate's activities give rise to environmental impacts?
- ? How can these activities be modified in order to reduce or eliminate these aspects?
- ? How can the different members of the industrial estate co-operate to achieve this in the most effective way?

UNEP Environmental Management for Industrial Estates. slide - 3.16

Environmental Management for Industrial Estates - *Co-operation ...*

- There are many companies who can participate in approaches such as by-product synergies or energy cascading.
- The industrial estate manager is involved in the planning and operation of the activities of the estate and can promote co-operative approaches to environmental management.
- Estates are often part of a regional development strategy and can benefit from the extended timetable for return on investment required by a sustainable development agenda.

Environmental Management for Industrial Estates.

The Evolution of Environmental Management.

The Evolution of Environmental Management ...

"Doing Nothing" (Dilute & Disperse)

The Evolution of Environmental Management - *"Doing Nothing" (Dilute and Disperse)*

Nature treats, recycles or makes use of her pollutants; and for a long time mankind has counted on nature to treat its pollution as well.

(E.P. Odum, 1975)

The Evolution of Environmental Management ...

End-of-Pipe Technology

"Doing Nothing" (Dilute & Disperse)

The Evolution of Environmental Management - *The End-of-Pipe Approach.*

The next phase assumes that -

- the environment has an ***assimilative capacity*** for mankind's pollutants
- we can release pollutants to the environment as long as the amounts are within the capacity of the environment to assimilate (absorb) them

UNEP Environmental Management for Industrial Estates. slide - 4.5

The Evolution of Environmental Management - *The End-of-Pipe Approach.*

This gave birth (in the 1960's) to the development of "end-of-pipe technology" -

- **wastewater treatment plants** [CETP's - Common Effluent Treatment Plants]
  ⇨ to reduce the concentration of contaminants in wastewater
- **incinerators**
  ⇨ to break down solid and liquid wastes to remove potential pollutants
- **filters and scrubbers**
  ⇨ to remove pollutants in emissions to the atmosphere

UNEP Environmental Management for Industrial Estates. slide - 4.6

The Evolution of Environmental Management - *The Environmental Industry.*

US Environmental Industry (1996):

$181 billion	- total revenues
$ 68 billion	- wastewater and water treatment
$ 45 billion	- management of solid waste & garbage
$ 16 billion	- air pollution controls
$ 14 billion	- resource recovery
$0.8 billion	- pollution prevention

Source: Environmental Business International

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The Evolution of Environmental Management - *A Global Environmental Industry.*

$640 billion

⇨ estimated value of global environmental technology and services industry in 2010

(estimate from Environmental Industries Commission)

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The Evolution of Environmental Management ...

Pollution Prevention

End-of-Pipe Technology

"Doing Nothing" (Dilute & Disperse)

UNEP Environmental Management for Industrial Estates. slide - 4.9

The Evolution of Environmental Management - *Pollution Prevention.*

In its simplest form, pollution prevention -

⇨ seeks to eliminate the *production of waste* rather than the *waste* itself

UNEP Environmental Management for Industrial Estates. slide - 4.10

The Evolution of Environmental Management -
A hierarchy for waste management ...

Source: D.T. Allen & K. Sinclair Rosselot , 1997

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The Evolution of Environmental Management -
Pollution Prevention Activities.

Source reduction refers to modifications carried out by companies to prevent the creation of by-products that may then become pollutants -

- ∅ process modification
- ∅ technology upgrading
- ∅ changing raw materials
- ∅ redesigning the product
- ∅ reducing toxic dispersion

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The Evolution of Environmental Management ...

Industrial Ecology

Pollution Prevention

End-of-Pipe Technology

"Doing Nothing" (Dilute & Disperse)

UNEP Environmental Management for Industrial Estates. slide - 4.13

Strategies for Manufacturing

R.A. Frosch & N.E. Gallopoulos, Scientific American, September 1989.

"[T]he traditional model of industrial activity - in which individual manufacturing processes take in raw materials and generate products to be sold plus waste to be disposed of - should be transformed into a more integrated model: an ***industrial ecosystem****."*

UNEP Environmental Management for Industrial Estates. slide - 4.14

Strategies for Manufacturing

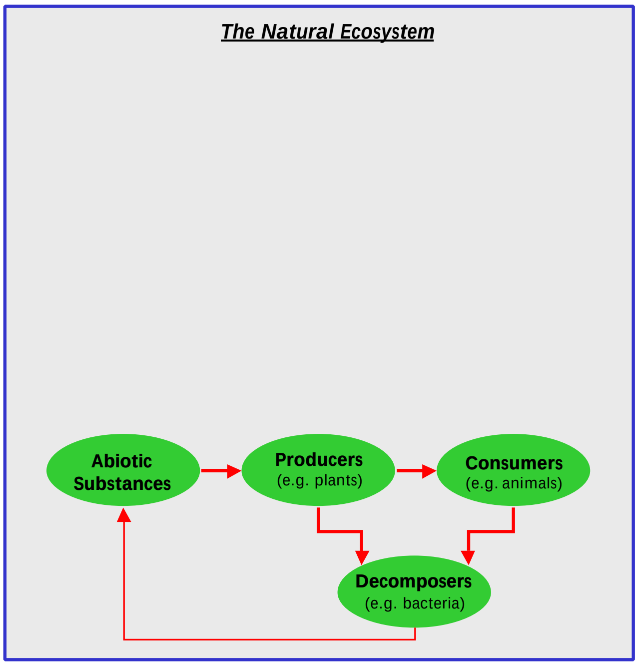
R.A. Frosch & N.E. Gallopoulos, *Scientific American*,September 1989.

"The industrial ecosystem would function as an analogue of biological ecosystems.

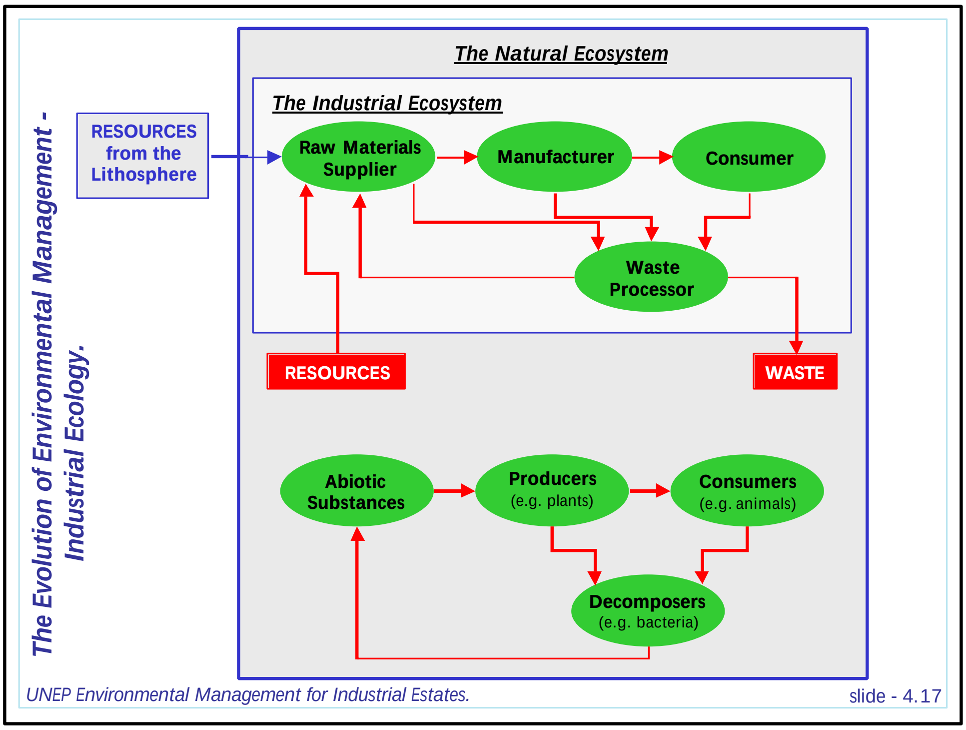
Plants synthesize nutrients that feed herbivores, which in turn feed a chain of carnivores whose wastes and bodies eventually feed further generations of plants."

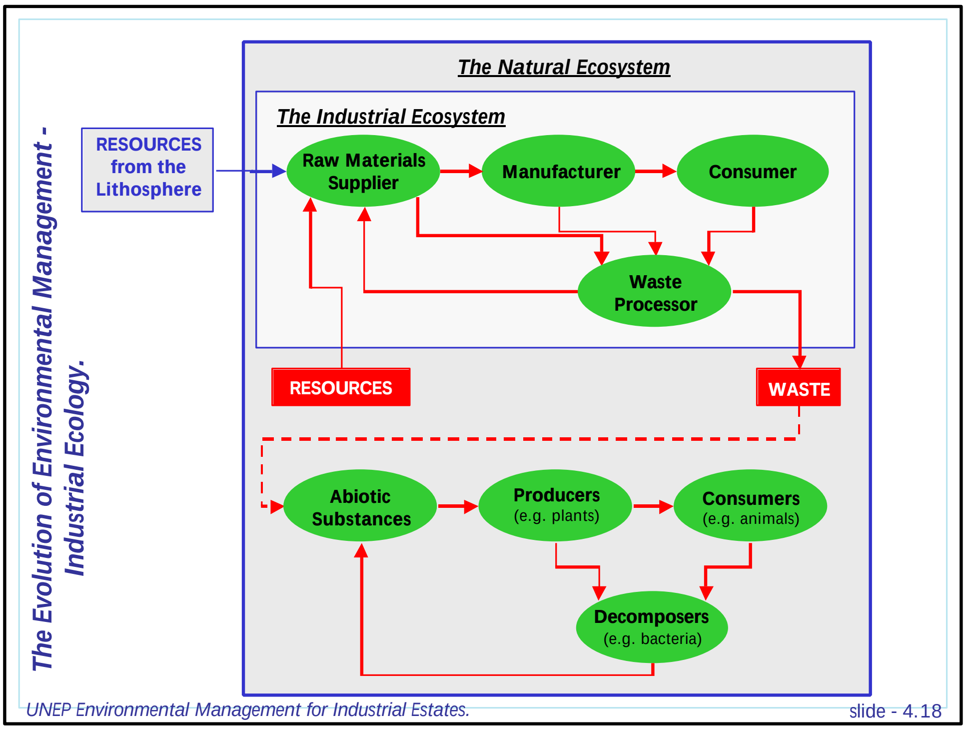
UNEP Environmental Management for Industrial Estates. slide - 4.15

The Evolution of Environmental Management - Industrial Ecology.



UNEP Environmental Management for Industrial Estates. slide - 4.16


The Evolution of Environmental Management - Industrial Ecology.
RESOURCES from the Lithosphere
The Natural Ecosystem
The Industrial Ecosystem
Raw Materials Supplier
Manufacturer
Consumer
Waste Processor
RESOURCES
WASTE
Abiotic Substances
Producers (e.g. plants)
Consumers (e.g. animals)
Decomposers (e.g. bacteria)
UNEP Environmental Management for Industrial Estates.
slide - 4.17


The Evolution of Environmental Management - Industrial Ecology.
RESOURCES from the Lithosphere
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WASTE
Abiotic Substances
Producers (e.g. plants)
Consumers (e.g. animals)
Decomposers (e.g. bacteria)
UNEP Environmental Management for Industrial Estates.
slide - 4.18

The Evolution of Environmental Management - *Industrial Ecology: How it works.*

- IE involves analysis of the flows of -
  - materials,
  - energy,
  - capital,
  - labour, and
  - information

  within production and consumption systems.

- It considers the impacts of these flows on the environment, as moderated by the influences of technological, economic, political, regulatory, and social factors.

from R. Frosch, *The Bridge*, 1999.

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The Evolution of Environmental Management - *Industrial Ecology: The objectives.*

The objectives of industrial ecology are -

- to better integrate environmental and social concerns in the design and management of industrial activities, and
- to inform public policy decision making.

from R. Frosch, *The Bridge*, 1999.

UNEP Environmental Management for Industrial Estates. slide - 4.20

The Evolution of Environmental Management - *4 steps to an "ideal" industrial ecosystem.*

The strategy is called *eco-restructuring* -

1. optimising resource use - such as by employing by-products as raw materials in new production
2. closing material loops (recycling) and minimising emissions, in particular of toxic materials

[continued]

UNEP Environmental Management for Industrial Estates. slide - 4.21

The Evolution of Environmental Management - *4 steps to an "ideal" industrial ecosystem.*

3. "dematerialisation" of products and economic activities -
   - ⇨ by reducing the mass of material used,
   - ⇨ by extending the durability of the product, or
   - ⇨ by developing a new way to provide the service
4. "decarbonising" the energy supply by -
   - ⇨ greater energy efficiency
   - ⇨ using sources of energy with higher H : C ratio [coal < oil < natural gas < hydrogen?]
   - ⇨ introducing renewable energies (e.g. wind, solar)

UNEP Environmental Management for Industrial Estates. slide - 4.22

The Evolution of Environmental Management - *Application of eco-restructuring.*

The 4 approaches can be applied at 3 different levels -

- macroscale - complete industrial ecosystem
  - ☑ to improve overall material and energy efficiency
- mesoscale - the production site
  - ☑ to modify processes and products
- microscale - the molecular level
  - ☑ to redesign synthetic routes for chemical production, combustion pathways or material fabrication procedures

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The Evolution of Environmental Management - *Defining the industrial ecosystem.*

"Industrial ecology involves designing industrial infrastructures as if they were a series of interlocking man-made ecosystems interfacing with the natural global ecosystem."

Hardin Tibbs, Industrial Ecology - An Environmental Agenda for Industry, 1993

UNEP Environmental Management for Industrial Estates. slide - 4.24

The Evolution of Environmental Management - *Defining the industrial ecosystem.*

To define these interlocking ecosystems, we can use -

- material flows of a specific material - e.g. iron/steel, plastics
- industrial sectors - e.g. chemicals, textiles, automobile industry
- geographical country or region
- industrial estates …

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The Evolution of Environmental Management - *Industrial Ecology.*

"From the beginning I imagined that Industrial Ecology was the technical engine, or technical core, of sustainability."

Hardin Tibbs, First IMM Workshop, Kalundborg, 1996

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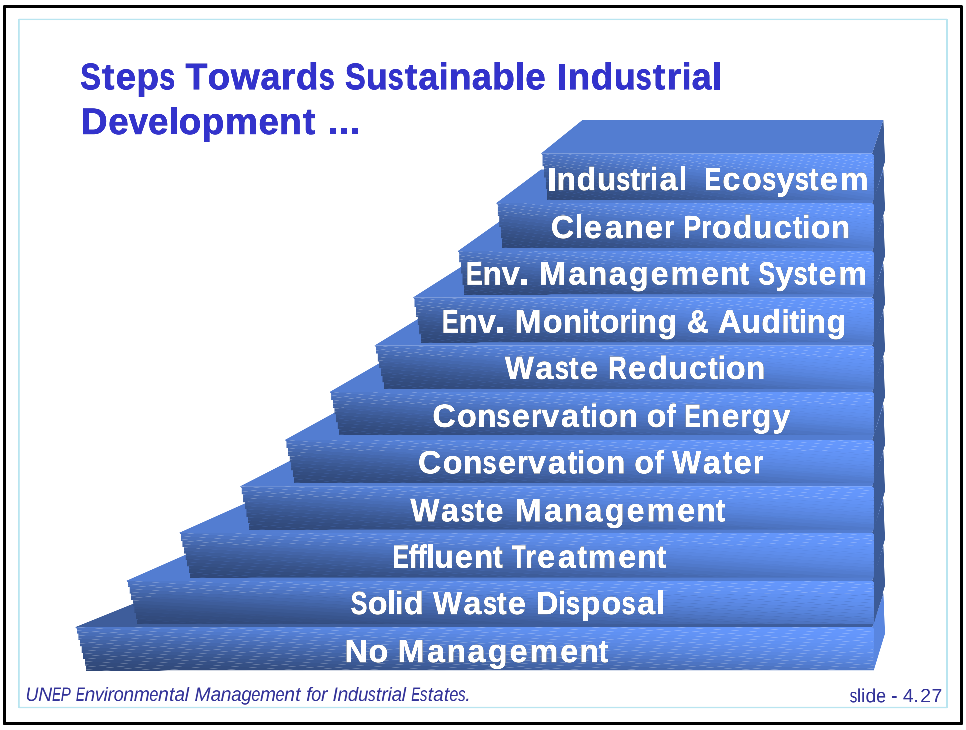

Steps Towards Sustainable Industrial Development ...
Industrial Ecosystem
Cleaner Production
Env. Management System
Env. Monitoring & Auditing
Waste Reduction
Conservation of Energy
Conservation of Water
Waste Management
Effluent Treatment
Solid Waste Disposal
No Management
UNEP Environmental Management for Industrial Estates.
slide - 4.27

Environmental Management for Industrial Estates.

Managing the Industrial Estate as an (Eco)-System

UNEP Environmental Management for Industrial Estates. slide - 5.0.1

Managing the Industrial Estate as an (Eco)-System - *The approach ...*

? How does the estate impact on environmental issues, such as:

- resource efficiency and waste generation,
- chemical safety
- water issues
- biodiversity and habitat
- landscape protection
- global climate change

UNEP Environmental Management for Industrial Estates. slide - 5.0.2

Managing the Industrial Estate as an (Eco)-System - *The approach ... (contd)*

? What specific aspects of the industrial estate's activities give rise to environmental impacts?

? How can these activities be modified in order to reduce or eliminate these aspects?

? How can the different members of the industrial estate co-operate to achieve this in the most effective way?

UNEP Environmental Management for Industrial Estates. slide - 5.0.3

Managing the Industrial Estate as an (Eco)-System - *The strategy ...*

Strategies and tools to manage the environmental aspects of the estate as a whole:

∅ activities that are implemented at the ***level of the estate***,

∅ activities that are best carried out at the ***level of individual companies***

UNEP Environmental Management for Industrial Estates. slide - 5.0.4

Managing the Industrial Estate as an (Eco)-System - *The different phases …*

In order to create a clear environmental concept, we must consider the 3 phases of the existence of an estate:

- planning and construction -
  - type of estate (heavy industry, technology, integrated)
  - choice of site
  - location of industries within the estate
- implantation of new companies -
  - environmental criteria required by the management
- the operating phase (day-to-day running) of the estate -
  - creation of a coherent environmental programme (e.g. an EMS)

UNEP Environmental Management for Industrial Estates. slide - 5.0.5

Managing the Industrial Estate as an (Eco)-System - *The Precautionary Principle …*

Underlying the UNEP approach to Environmental Management for Industrial Estates:

"Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

(*Principle 15* of the Rio Declaration, 1992)

"In the real world we have to act on the balance of the available evidence, and everyone has to do what is in his or her power to confront the issue."

(Sir John Browne, BP-Amoco, 2000)

UNEP Environmental Management for Industrial Estates. slide - 5.0.6

Environmental Management for Industrial Estates.

Managing the Industrial Estate as an (Eco)-System - The Planning & Construction Phase

UNEP Environmental Management for Industrial Estates. slide - 5.1.1

The Planning & Construction Phase - *The impetus ...*

The development may be:

- a privately-sponsored initiative
- a government-driven effort within a regional development plan
- a privately-developed and managed project carried out on behalf of a government body, such as an industrial estate authority

UNEP Environmental Management for Industrial Estates. slide - 5.1.2

The Planning & Construction Phase - *The different steps ...*

- ☑ *defining the potential clients*
- ☑ *selecting a site*
- ☑ *evaluating potential environmental impacts*
- ☑ *estimating potential socio-economic impacts*
- ☑ *designing the site*
- ☑ *choosing an environmentally-sensitive construction process*
- ☑ *deciding on the infrastructure*

UNEP Environmental Management for Industrial Estates. slide - 5.1.3

The Planning & Construction Phase - *Defining the potential clients ...*

The type of estate (e.g. heavy industry, high-technology/science, light manufacturing, service, or general purpose) will influence potential environmental issues, such as:

- ⇨ water and energy use
- ⇨ waste generation
- ⇨ transport infrastructure
- ⇨ public utilities

UNEP Environmental Management for Industrial Estates. slide - 5.1.4

The Planning & Construction Phase -
Selecting the site ...

It is important at this early stage to create a project team including:

- the ownership group / estate manager
- the financial sector (inc. economists)
- the site planner / engineer
- marketing experts
- environmental specialists

UNEP Environmental Management for Industrial Estates. slide - 5.1.5

The Planning & Construction Phase -
Economic factors in selecting the site ...

- the size of the site
  - initial size is adapted to the initial demand
  - there is room for future expansion
- the specifications of the site, e.g. a light-manufacturing estate ideally needs
  - suitable land (gentle slope, good drainage)
  - good access to cities, ports and airports
  - adequate water supplies
  - reliable electricity supply and telecommunications
  - possibility for wastewater treatment and solid waste disposal

UNEP Environmental Management for Industrial Estates. slide - 5.1.6

The Planning & Construction Phase -
Environmental guidelines for site selection ...

- ☑ select sites where environmental impacts can be minimised (with good planning and site management)
- ☑ avoid sites that will result in damage to environmentally fragile areas (*e.g.* wetlands)
- ☑ check that the natural ecosystem can support the development (*inc.* residential areas and transport infrastructure)
- ☑ avoid using valuable agricultural land
- ☑ favour disused sites ("*brownfields*") where possible - however, carry out an effective "due diligence" study to avoid future liabilities !

UNEP Environmental Management for Industrial Estates. slide - 5.1.7

The Planning & Construction Phase -
Evaluating potential environmental impacts ...

The most useful tool at this stage is an Environmental Impact Assessment:

- ? Can the industrial estate operate safely, without serious risk of dangerous accidents or long-term health effects?
- ? Can the local environment cope with the additional waste and pollution it will produce?
- ? Will the estate's proposed location conflict with nearby land uses, or preclude later developments in the surrounding area?
- ? How will the presence of the estate and its activities affect local fisheries, farms or industry?

adapted from North, 1992

UNEP Environmental Management for Industrial Estates. slide - 5.1.8

The Planning & Construction Phase -
Evaluating potential environmental impacts ...

Environmental Impact Assessment (contd):

? Is there sufficient infrastructure, such as roads and sewers, to support the estate?

? How much water, energy and other resources will the estate consume, and are these in adequate supply?

? What human resources will be required, and what will be the social effects on the local communities?

? What damage may be caused inadvertently to national assets such as forests or other valuable ecosystems, tourism areas, or historical and cultural sites?

adapted from North, 1992

UNEP Environmental Management for Industrial Estates. slide - 5.1.9

The Planning & Construction Phase -
Estimating potential socio-economic impacts ...

? Is the local infrastructure able to cope with a large influx of workers into the region (e.g. housing, transport, hospitals, schools)?

? Are the zoning laws sufficient to prevent unplanned residential areas being created too close to the estate (*i.e.* for safety reasons)?

"The continued expansion of [Thailand's Map Ta Phut industrial estate] has resulted in a substantial increase in the population in the nearby area, which has begun encroaching into the green buffer zone surrounding the complex."

Chumpol NaLamlieng, President of Siam Cement Public Co., C&EN, 1999.

UNEP Environmental Management for Industrial Estates. slide - 5.1.10

The Planning & Construction Phase -
Designing the site ...

UNEP suggests the following **6 principles** as contributing to an ecologically-sensitive design of an estate (UNEP, 1997):

1. Define the carrying capacity of the site.
2. Maintain natural areas and indigenous vegetation as much as possible.
3. Retain natural drainage systems.
4. Increase the density of development.
5. Design sites with energy efficiency in mind.
6. Create the potential for synergies by co-locating companies so as to achieve easier opportunities for industrial symbiosis.

UNEP Environmental Management for Industrial Estates. slide - 5.1.11

The Planning & Construction Phase -
Ecologically sensitive planning ...

DuPont's Complex in Asturias, Spain

1. *Habitat restoration* -
   - imported eucalyptus trees have been removed
   - indigenous plants and trees have been planted
   - wetlands and peat bogs have been restored
2. *Visual impact* -
   - excavated earth and rocks from the construction work have been used to create small artificial hills around the buildings
3. *Maintenance* -
   - cattle, horses, sheep and donkeys graze the green areas

UNEP Environmental Management for Industrial Estates. slide - 5.1.12

The Planning & Construction Phase -
Building in energy efficiency ...

Some ideas from Côté et alia, 1994 are -

- Position buildings and streets so as to optimise passive solar use for lighting and heating.
- Utilise natural vegetation and land forms to cool the site in summer and protect from the wind in the winter.
- Investigate the feasibility of using alternative energy sources, such as active solar, wind or geothermal energy.

UNEP Environmental Management for Industrial Estates. slide - 5.1.13

The Planning & Construction Phase -
Environmentally-sensitive construction ...

Some ideas from Technical Report N° 39 are -

- reducing the disruption of natural areas
- limiting the generation of waste during the construction process
- landscaping in order to reduce energy and water requirements

UNEP Environmental Management for Industrial Estates. slide - 5.1.14

The Planning & Construction Phase -
Deciding on infrastructure ...

Environmental aspects must be considered when deciding on infrastructure *[Technical Report N° 39]*

- Transportation
- Energy efficiency
- Water efficiency
- Wastewater treatment
- Materials management
- Buildings

UNEP Environmental Management for Industrial Estates. slide - 5.1.15

The Planning & Construction Phase -
Deciding on infrastructure ...

- *Transportation -*
  - location near to existing railways, ports or airports
  - creation of mass transit systems to bring workers to and from the estate
  - provide pedestrian and cycle routes, or bus routes within the estate

UNEP Environmental Management for Industrial Estates. slide - 5.1.16

The Planning & Construction Phase - *Deciding on infrastructure ...*

- *Energy -*
  - optimise energy use (*e.g.* energy cascading and co-generation)
  - reduce energy losses through construction of energy - efficient buildings
  - maximise use of renewables in non-essential applications (*e.g.* optimal use of natural lighting in buildings)

UNEP Environmental Management for Industrial Estates. slide - 5.1.17

The Planning & Construction Phase - *Deciding on infrastructure ...*

- *Water -*
  - water efficiency can be improved if the estate operates its own water utility (*e.g.* through the cost structure)
  - planning for conservation and efficient use of water
  - re-use of water through a water-management programme (e.g. matching of the need with the right water quality)

UNEP Environmental Management for Industrial Estates. slide - 5.1.18

The Planning & Construction Phase - *Deciding on infrastructure ...*

- *Wastewater treatment -*
  - use an integrated approach to the management of wastewater
  - a ***common*** effluent treatment plant (CETP) can result in a more cost- and environmentally-effective solution
  - treatment of sewage for a neighbouring community at the CETP can maintain the CETP at a higher level of efficiency
  - treated wastewater leaving a CETP may be suitable for re-use in the estate (*e.g.* for irrigation)
  - artificial wetlands are suitable for some wastewater treatment
  - natural wetlands are effective for stormwater management

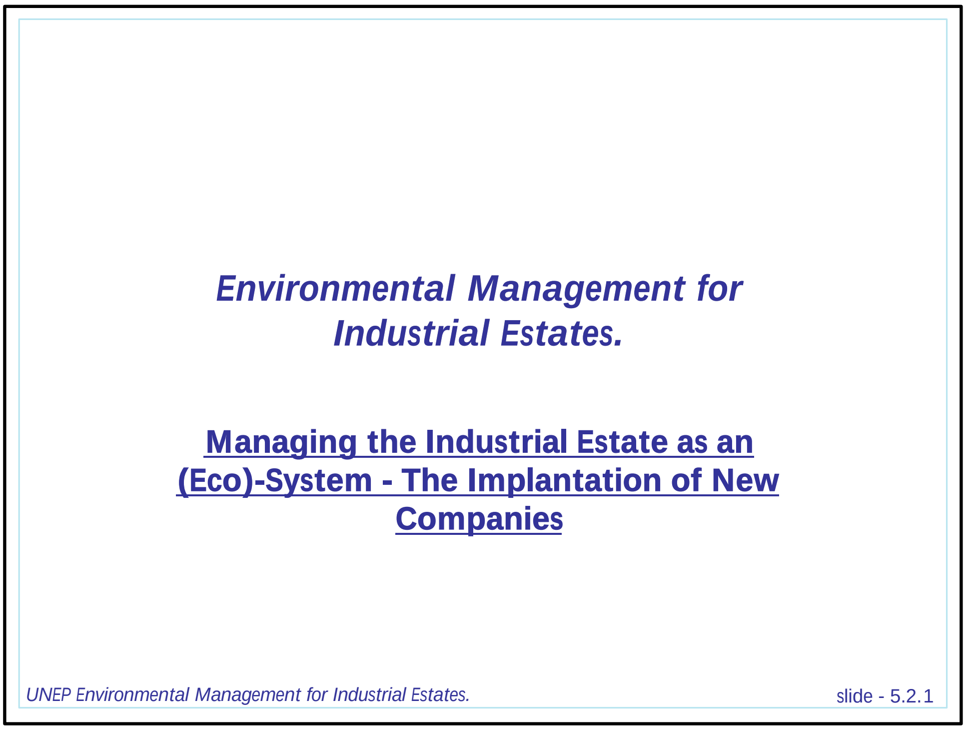
UNEP Environmental Management for Industrial Estates. slide - 5.1.19

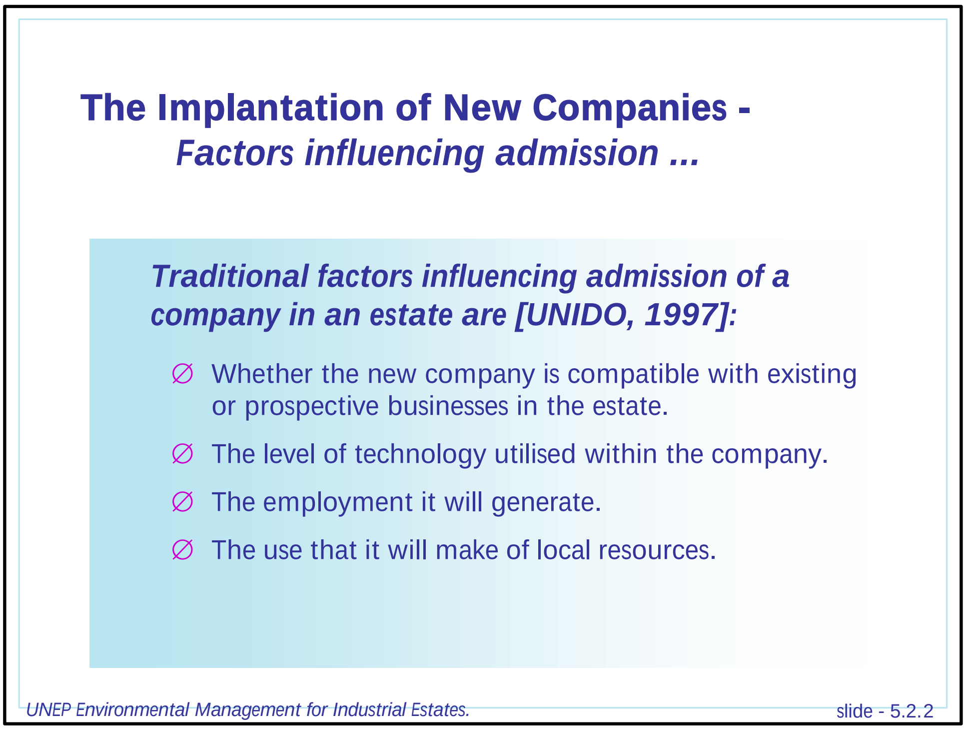
The Planning & Construction Phase - *Deciding on infrastructure ...*

- *Materials management -*
  - centralising environmental services allows for better control at the estate-level of the waste disposal activities of the companies
  - creation of a recycling centre for the estate can reduce environmental impacts
  - development of a treatment facility for larger estates will offer a way to address the problem of hazardous wastes
  - construction of an incinerator or a controlled landfill

UNEP Environmental Management for Industrial Estates. slide - 5.1.20


The Planning & Construction Phase -
Deciding on infrastructure ...
Buildings -
promote more environmentally-compatible buildings using sustainable architecture
apply Codes, Covenants & Restrictions to guarantee that buildings on estates meet official standards
UNEP Environmental Management for Industrial Estates.
slide - 5.1.21


Environmental Management for Industrial Estates.
Managing the Industrial Estate as an (Eco)-System - The Implantation of New Companies
UNEP Environmental Management for Industrial Estates.
slide - 5.2.1


The Implantation of New Companies - Factors influencing admission ...
Traditional factors influencing admission of a company in an estate are [UNIDO, 1997]:
Whether the new company is compatible with existing or prospective businesses in the estate.
The level of technology utilised within the company.
The employment it will generate.
The use that it will make of local resources.
UNEP Environmental Management for Industrial Estates.
slide - 5.2.2

The Implantation of New Companies - *Factors influencing admission ...*

Today factors influencing admission of a company in an estate are:

- Whether the new company is compatible with existing or prospective businesses in the estate.
- The level of technology utilised within the company.
- The employment it will generate.
- The use that it will make of local resources.
- The potential environmental impact of the company.

UNEP Environmental Management for Industrial Estates. slide - 5.2.3

The Implantation of New Companies - *Identifying potential environmental impacts ...*

- Operation of production or other processes.
- Supply of materials, power, water.
- Combustion of fuels.
- Storage, handling or transport of hazardous materials.
- Release of residues to air, water, soils.
- Release of light, heat, noise, vibration, other radiation.
- Generation and disposal of wastes.
- Use of hazardous materials.
- Accidents - explosions, releases, spills, fire, etc.
- Vehicle movements on and off site.
- Housing and facilities for the workforce.

Source: European Commission, 1996.

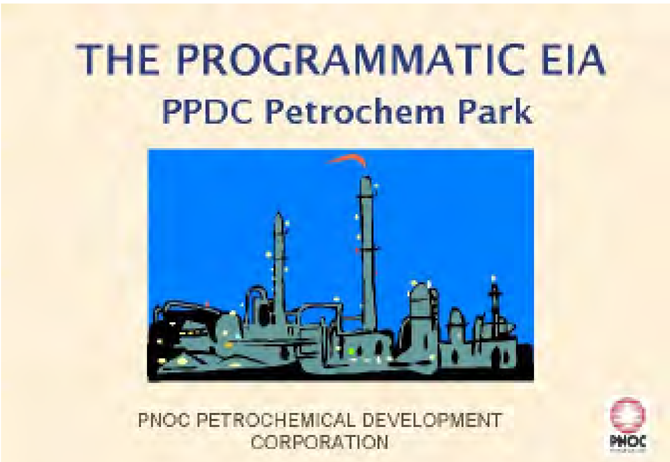
UNEP Environmental Management for Industrial Estates. slide - 5.2.4

The Implantation of New Companies -
An environmental impact assessment … ?

- ☒ *at the moment an EIA is the **exception** rather than the **rule***
- ☑ *some estates require an Environmental Impact Assessment (EIA) to be carried out for each new company, e.g. Jebel Ali Free Zone in Dubai*
- ☑ *PRIME and the PNOC Petrochemical Development Corporation in the Philippines have developed a **Programmatic EIA Approach***

UNEP Environmental Management for Industrial Estates. slide - 5.2.5

The Implantation of New Companies …



Source: E. Tanchuco [PNOC], Manila Conf. & Wkshp, 2001.

UNEP Environmental Management for Industrial Estates. slide - 5.2.6

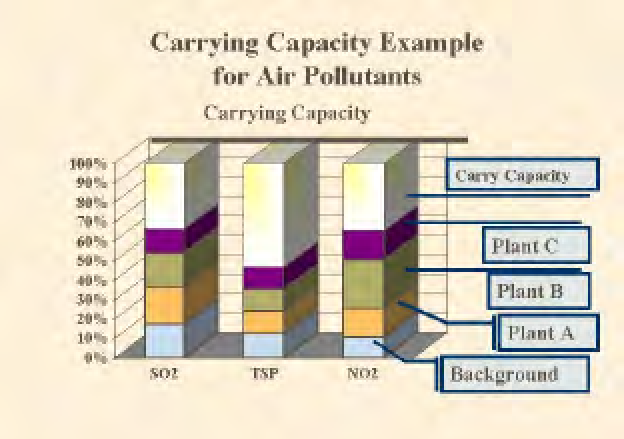
The Implantation of New Companies - *A Programmatic EIA approach …*

Stage 1: carry out a baseline study of the environmental impact of the estate -

- *study carrying capacity of the receiving environment (air, soil, water)*
- *measure actual discharges from current tenants*
- *carry out an environmental risk assessment*
- *carry out an environmental health impact assessment*

Source: *PRIME, 2001*

The Implantation of New Companies - *A Programmatic EIA approach …*



Source: E. Tanchuco [PNOC], Manila Conf. & Wkshp, 2001.

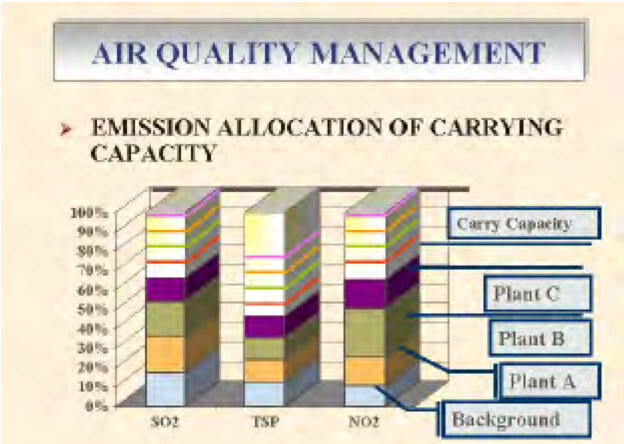
The Implantation of New Companies - *A Programmatic EIA approach …*

Stage 2: establish a single Environmental Compliance Certificate (ECC) for the estate

Stage 3: assess the environmental aspects of each new company's activities to see if the emissions profile (for example) is compatible with the overall carrying capacity (see next slide) ...

Source: *PRIME, 2001*

The Implantation of New Companies - *A Programmatic EIA approach …*



Source: E. Tanchuco [PNOC], Manila Conf. & Wkshp, 2001.

The Implantation of New Companies - *A Programmatic EIA approach …*

***Stage 4:** as a function of the environmental risk assessment, establish where new companies should be located within the estate (see next slide) ...*

***Source:** PRIME, 2001*

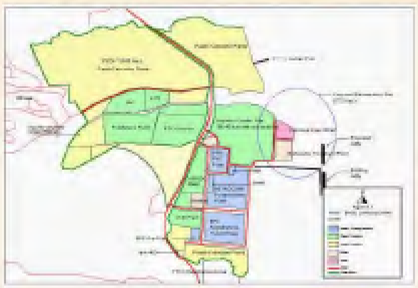
UNEP Environmental Management for Industrial Estates.

slide - 5.2.11

The Implantation of New Companies - *A Programmatic EIA approach …*

RISK MANAGEMENT

- Risk-Based Land-Use Plan



Source: E. Tanchuco [PNOC], Manila Conf. & Wkshp, 2001.

UNEP Environmental Management for Industrial Estates.

slide - 5.2.12

The Implantation of New Companies - *A Programmatic EIA approach …*

Advantages:

- ☑ *each company does not need its own ECC*
- ☑ *time for project development and start-up is reduced (by 6 months to 1 year)*

Source: *PRIME, 2001*

UNEP Environmental Management for Industrial Estates.

slide - 5.2.13

Environmental Management for Industrial Estates.

Managing the Industrial Estate as an (Eco)-System - The Operating Phase

UNEP Environmental Management for Industrial Estates. slide - 5.3.1-L

Managing the Industrial Estate as an (Eco)-System - *The Operating Phase ...*

- *The estate management and the tenant companies must work together to reduce environmental impacts.*
- *Certain activities are best addressed at the* ***level of individual companies*** *-*
  e.g. cleaner production, eco-efficiency
- *Other activities are better implemented at the* ***level of the whole estate*** *-*
  e.g. by-product synergy, integrated waste management, emergency response

UNEP Environmental Management for Industrial Estates. slide - 5.3.2-L

Managing the Industrial Estate as an (Eco)-System - *The Operating Phase ...*

The role of the estate manager is very important for -

- ☑ *promoting an environmental programme to the management of the individual companies via different strategies and tools*
- ☑ *co-ordinating companies' activities with those being carried out at the estate-level*

UNEP Environmental Management for Industrial Estates. slide - 5.3.3-L

Managing the Industrial Estate as an (Eco)-System - *Some Strategies & Tools ...*

- *Promoting an Environmental Programme*
- *Cleaner Production*
- *Eco-Efficiency*
- *By-product Synergies*
- *Integrated Pollution Prevention & Control*
- *Energy Conservation*
- *Water Conservation*
- *Industrial Health & Safety*
- *Emergency Response & APELL*

UNEP Environmental Management for Industrial Estates. slide - 5.3.4-L

Environmental Management for Industrial Estates.

1. Promoting an Environmental Programme

UNEP Environmental Management for Industrial Estates. slide - 5.3.5-L

Promoting an Environmental Programme - *An Environmental Policy for the Estate.*

Some key issues to be addressed by the policy are -

(i) the estate's vision with regard to the environment,

(ii) a commitment to adhere to principles such as continual improvement and pollution prevention,

(iii) a willingness to comply (at the minimum) with environmental laws and regulations,

(iv) the desire to maintain an open communication with all key stakeholders and interested parties.

UNEP Environmental Management for Industrial Estates. slide - 5.3.6-L

Promoting an Environmental Programme - *The Benefits of an Environmental Programme.*

For the tenant companies:

1. the environmental programme helps to locate wastage and inefficiency in operations, resulting in cost savings,

2. a total quality management system, including an environmental component such as ISO 14001, can be very important for the image of a company and its sales -

   e.g. many industries in the high-technology industrial estates in Malaysia have sought ISO 14001 acceptance of their EMS *(US-AEP, 2000)*

UNEP Environmental Management for Industrial Estates. slide - 5.3.7-L

Promoting an Environmental Programme - *The Benefits of an Environmental Programme.*

For the industrial estate -

1. It enhances the image of the estate and the tenant companies.

2. The estate becomes more attractive when recruiting prospective tenants.

3. If investors are satisfied then access to capital is facilitated.

4. Giving priority to prevention over remediation improves relations with government and local communities because the estate is going beyond compliance with environmental regulations -

   ⇨ this may facilitate the approval of permits

UNEP Environmental Management for Industrial Estates. slide - 5.3.8-L

Promoting an Environmental Programme - *A possible alternative situation …*

From "Environmental Mess in Taiwan", by J-F. Tremblay, C&EN, 1999, May 31, p. 19.

"The combination of wealth and excessive pollution leads groups of Taiwanese to oppose most industrial projects…

*Last year, protesters succeeded in their efforts to kill a project to build a toluene diisocyanate plant in Taichung, where the firm concerned had promised to **implement its cleanest and most advanced technologies** [emphasis added]."*

Promoting an Environmental Programme - *Environmental Management Systems (EMS's).*

Côté & Balkau (1999) have identified four different options for introducing an EMS **within an industrial estate**:

- The enterprise option,
- The infrastructure option,
- The comprehensive option, and
- The environmental charter option.

Promoting an Environmental Programme - *The enterprise option …*

∅ The estate manager encourages individual companies to adopt an EMS.

The encouragement may take the form of -

- ☑ *financial incentives*
- ☑ *assistance by providing seminars*
- ☑ *training or technical assistance.*

This option is relatively simple to implement but it does **not** -

- ☒ *build synergies between companies*
- ☒ *address cumulative environmental impacts of the estate*

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Promoting an Environmental Programme - *The infrastructure option …*

∅ An estate can implement an EMS for its own activities and services:

- ☑ it is important if the estate management is responsible for major environmental services (*e.g.* CETP's, solid waste collection and disposal facilities,recycling plants)
- ☑ it may inspire companies in the estate and help the creation of a comprehensive EMS for the whole estate.

∅ Some estates that have obtained ISO 14001 certification:

- ☑ Batamindo industrial estate, Indonesia
- ☑ Plaine de l'Ain, Landacres, Vesoul Technologia Park, France
- ☑ Suzhou, Dalian industrial estates, China

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Promoting an Environmental Programme - *The comprehensive option …*

- The estate manager can develop a comprehensive EMS with the estate viewed as a **total interacting system**.
  - ☑ the estate must have influence over the environmental activities of its tenants through permits or other contractual agreements
  - ☑ such an EMS would ideally be developed with the tenants as primary stakeholders
- The closest example is -
  - ☑ Programmatic EIA of the PNOC Petrochemical industrial estate in Bataan, Philippines.

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Promoting an Environmental Programme - *The environmental charter option …*

- Different stakeholders in an estate prepare and sign a **contractual charter** that specifies the environmental responsibilities of each partner.
- This approach has been promoted in France by *Association Orée*.
- It is not formally an EMS, but -
  - ☑ includes elements of an EMS
  - ☑ can be adopted with the other options or independently
- Some French estates or regions that have developed a charter -
  - ☑ Les Grands Champs de Roissy-en-Brie
  - ☑ La Chaussée-Puiseux à Cergy Pontoise *[Orée, 2000]*

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Promoting an Environmental Programme - *Practical considerations …*

- Based on the current situation, the goal is to -

  take a combination of the ***enterprise*** *and* ***infrastructure*** *options and turn them into a* ***comprehensive*** *approach.*

- This requires the industrial estate manager to play a key role in advancing the process.
- The key points in putting in place an EMS in an industrial estate are shown on the next slide …

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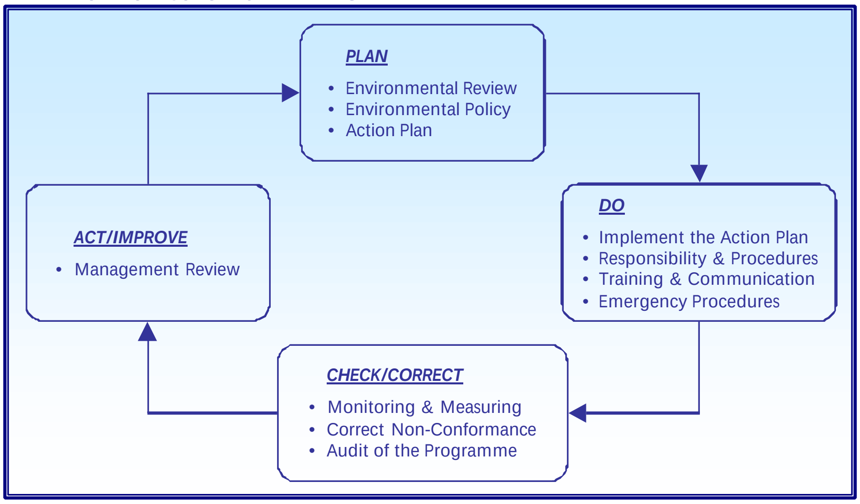
Promoting an Environmental Programme - *Elements of an EMS*



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Promoting an Environmental Programme - *Training and Communication …*

It is important to distinguish between two types of communication -

- Internal communication is aimed at informing and motivating the internal stakeholders, for example employees and owners of other tenant companies.
- External communication is targeted at presenting the environmental performance of the estate to external stakeholders, such as the general public, regulatory authorities, or financing institutions.

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Promoting an Environmental Programme - *Training and Communication …*

Some ideas of how the management of an estate can contribute in the area of communication -

- publishing on a regular basis information sheets or a newspaper,
- holding seminars and conferences,
- opening the estate to the public on certain days,
- the use of posters to describe progress being made within the estate on environmental matters,
- the creation of contact groups or advisory groups, to inform the general public about the estate’s activities.

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Promoting an Environmental Programme - *Environmental services …*

The Estate Management can provide environmental services to tenants-

- *Supply of water*
- *Centralised supply of heating and/or energy*
- *Waste recovery and valorisation (by-product synergies)*
- *Collection and treatment of wastewater*
- *Collection, treatment and disposal of hazardous waste*
- *Collection and disposal of solid waste*
- *Training on environmental issues*
- *An information service on environmental issues*
- *Environmental monitoring and auditing*

adapted from Yang et alia, 2000

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Promoting an Environmental Programme - *Codes, Covenants, Conditions & Restrictions …*

1. Design of the estate - including the use of materials, the site plan, landscaping and construction.
2. Resource use - how to minimise energy consumption, raw material use (including water), and the generation of waste.
3. Transportation and infrastructure - the type of transportation system to use for people and goods outside and inside the estate.
4. Emissions and pollution - balancing pollution prevention activities with the need for infrastructure for waste treatment, as well as efforts to provide environmental support services.
5. Social and community issues - such as the type of work environment and employment, as well as the interaction between the estate and the local communities.
6. Management - what type of management structure is best adapted to the needs of an eco-industrial development project.

(Cohen-Rosenthal, 2000)

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Environmental Management for Industrial Estates.

2. Cleaner Production

Cleaner Production - *The definition …*

Cleaner Production :

the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase eco-efficiency and reduce risks for humans and the environment [UNEP/WBCSD, 1996]

⇨ For *production processes*, this includes -

- ☑ conserving raw materials and energy
- ☑ eliminating toxic raw materials
- ☑ reducing the quantity and toxicity of all emissions and wastes

Promoting Cleaner Production -
The role of the estate manager …

The manager of an industrial estate plays an important role by motivating companies in the estate to introduce a Cleaner Production programme.

The benefits of a Cleaner Production programme can be summarised as follows …

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Promoting Cleaner Production -
The benefits …

- ***economic benefits*** -
  - ☑ reduced production costs due to improved process efficiency
  - ☑ reduced costs for end-of-pipe treatment
  - ☑ lower insurance costs due to reduced liability
- ***environmental benefits*** -
  - ☑ improved air and water quality for surrounding communities due to reduced emissions
- demonstration of ***responsible behaviour*** -
  - ☑ reduced risk for workers and communities
  - ☑ careful resource management

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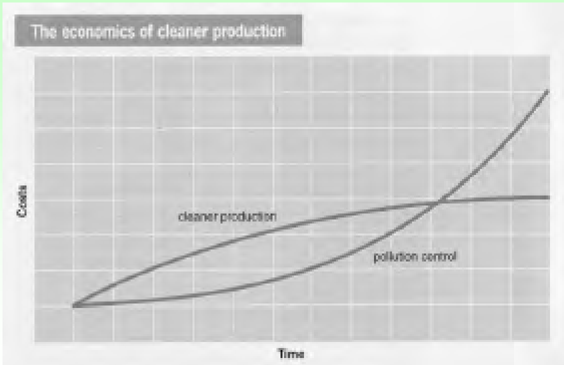
Promoting Cleaner Production -
The economics …



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Promoting Cleaner Production -
The role of the estate manager …

- Give financial incentives to companies who introduce waste reduction measures in the case where the industrial estate treats waste for the tenant companies.
- Reward financially energy conservation measures.
- Create a small team who can
  - (i) inform companies about opportunities associated with Cleaner Production, and
  - (ii) present demonstration projects from other estates as an example of what is possible. Provide training to tenant companies in Cleaner Production if there is sufficient need.

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Promoting Cleaner Production -
The role of the estate manager … (contd)

- Offer an environmental service to help with conducting Cleaner Production Assessments for small- and medium-size companies that may lack the necessary resources.
- Help in arranging loans for companies that lack financial resources for implementing Cleaner Production options.
- Promote programmes to find by-product synergies within the estate.
- Publicise successful results within the estate so as to promote the programme.
- Work with authorities to create more supportive regulations or policies for preventive measures.

Environmental Management for Industrial Estates.

3. Eco-efficiency

Eco-efficiency -
The definition …

"Eco-efficiency starts from issues of ***economic efficiency*** which have positive ***environmental benefits***, while Cleaner Production starts from issues of ***environmental efficiency*** which have positive ***economic benefits***."

(UNEP/WBCSD, 1996)

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Eco-efficiency -
The factors that contribute to Eco-efficiency …

- reducing the material and energy intensities of goods and services,
- reducing the dispersion of toxic materials,
- enhancing the recyclability of materials,
- maximising the sustainable use of renewable resources,
- increasing the useful lifetime of materials, and
- increasing the service intensity of goods and services.

(WBCSD, 1996)

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Eco-efficiency -
Promoting Eco-efficiency …

In an industrial estate the manager can promote eco-efficiency as a strategy by -

- focussing on the economic advantages to companies of more eco-efficient processes and the revalorisation of materials and energy
- the use of ***eco-efficiency indicators*** to track progress in resource efficiency at the company and estate levels …

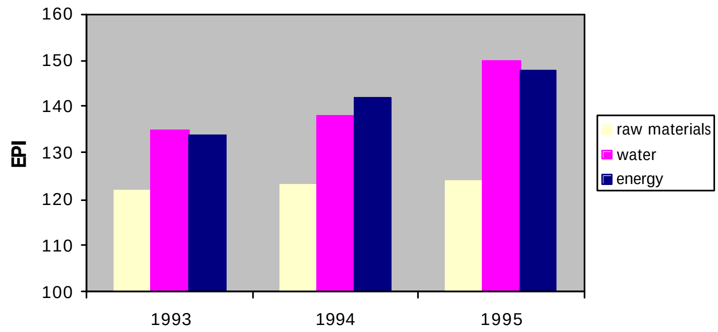
Eco-efficiency -
The Novo Nordisk Eco-productivity Index [EPI]

- The Eco-productivity Index or EPI monitors resource utilisation in production processes.
- It relates turnover (the *product value*) to *resource consumption* for raw materials, water and energy [1990 base year (= 100)]

$$\text{EPI} = \frac{\text{indexed turnover}}{\text{indexed resource consumption}} \times 100$$

- A larger EPI is equivalent to better environmental performance (Novo Nordisk, 1995; WBCSD, 2000).

Eco-efficiency - *The Novo Nordisk Eco-productivity Index [EPI]*



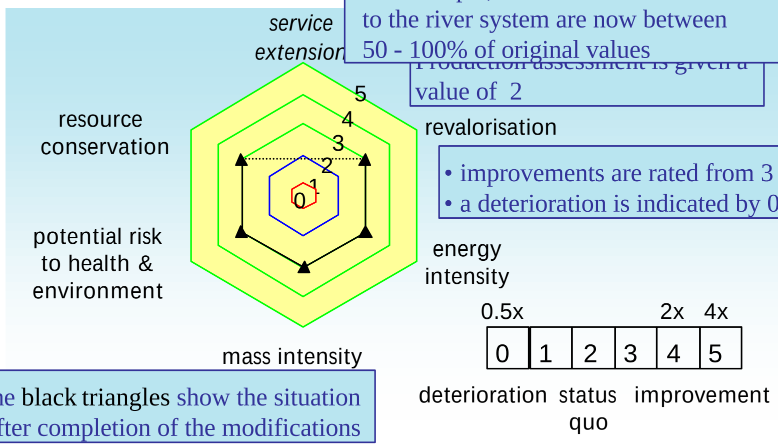
Eco-efficiency - *The Beijing Chemical Factory N° 3*

A Cleaner Production assessment was carried out.

- A mass balance study showed that ~50% of waste was from production of a single chemical - penta-erythritol.
- The Cleaner Production team found why the waste was being created and identified ways to reduce it -
  - better process control, improved maintenance and better training, and
  - on-site recovery of a by-product as a raw material.
- They then found ways to reduce the consumption of raw materials, energy and water, as well as cut water pollution, in another sector of the plant.

Eco-efficiency -
The Eco-Compa

- the improvements at the Beijing Chemical Factory rate a value of 3 on average
- for example, this shows that waste discharges to the river system are now between 50 - 100% of original values



value of 2

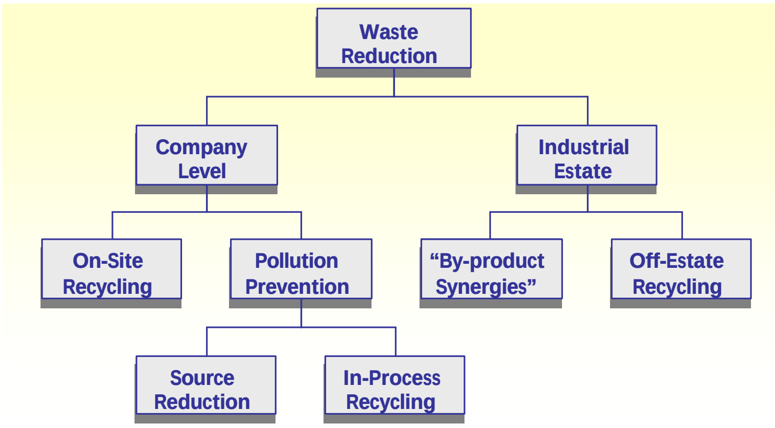
- improvements are rated from 3 - 5
- a deterioration is indicated by 0 - 1

the black triangles show the situation after completion of the modifications

Environmental Management for Industrial Estates.

4. By-product Synergies

By-product Synergies -
Waste Management in an Industrial Estate.



UNEP Environmental Management for Industrial Estates. slide - 5.3.37-L

By-product Synergies -
Providing the impulsion for a programme ...

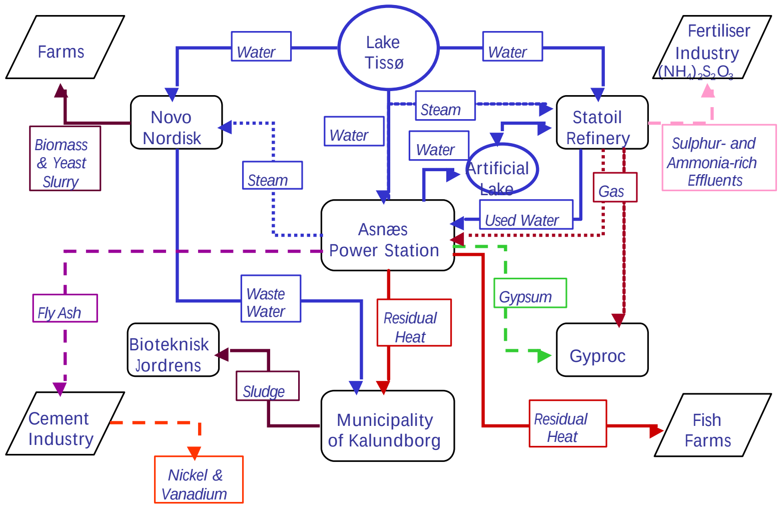
A By-product Synergy programme is an estate-level activity and the estate manager therefore plays an important role -

- ⇨ It needs a good knowledge of the material flows within the estate (the **industrial metabolism** of the estate):
  - ⇨ US EPA Tools - FaST, DIET, REaLiTy✓
- ⇨ It requires companies to be willing to share information:
  - ⇨ the BCSD-GM has put together a Primer that describes ways to tackle this problem
- ⇨ It requires companies to consider a symbiotic use of resources when they develop new processes.

UNEP Environmental Management for Industrial Estates. slide - 5.3.38-L

Kalundborg Industrial Symbiosis

[C.G. Francis - adapted from J. Christensen, 1999]



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Environmental & Economic Aspects

[S. Erkman, 1998]

Reduction in consumption of resources:

- oil - 45,000 tons/year

Reduc

With 18 projects -

- Investments: $ 75 million
- Total Revenues: $ 160 million

Valori

- sulfur - 4,500 tons/year
- calcium sulfate (gypsum) - 90,000 tons/year

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Environmental Management for Industrial Estates.

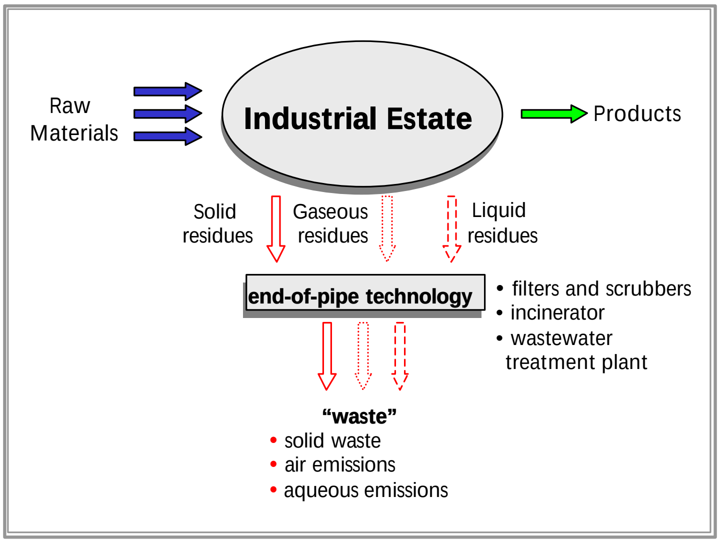
5. Integrated Pollution Prevention & Control

Integrated Pollution Prevention & Control - *The advantages …*

Many industrial estates offer a wide range of environmental services:

- this is more efficient than obliging each company to act independently
- it may provide an incentive to companies considering locating within an estate
- the estate management then has a good view of the estate's overall environmental footprint

Pollution Control in an Industrial Estate



UNEP Environmental Management for Industrial Estates. slide - 5.3.43-L

Integrated Pollution Prevention & Control - A precautionary note ...

Before making important investments in end-of-pipe technology the industrial estate management should -

- integrate pollution prevention and pollution control during the planning phase to avoid “over-capacity” later on
- build small, modular wastewater treatment plants - for example
- work with companies to help them apply pollution prevention approaches
- companies may find it cheaper to invest in pollution prevention rather than more pollution control

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Environmental Management for Industrial Estates.

6. Energy & Water Conservation

Energy Conservation.

Lowe et alia have estimated that many industrial estates could reduce energy consumption by as much as 50%.

At the company level examples are -

- The use of heat exchange networks.
- The use of effective insulation of buildings and energy-efficient lighting.

At the level of the estate -

- (Co-)generation of electricity with waste heat recovery.
- Energy cascading between companies.

Energy Conservation
Some examples …

Kalundborg:

Asnaes Power Station uses co-generation to supply -

- ∅ process steam to Novo Nordisk and Statoil
- ∅ heat for municipal district heating

Zeneca:

As a result of a simple energy audit at their Grangemouth site, Zeneca were able to locate -

- ∅ £25,000 - £30,000 of savings for each plant - through "basic housekeeping" measures [Source: Martin, 1998]

Water Conservation
Some thoughts …

- ∅ industrial estates can be very large consumers of water
- ∅ water can be reused in many applications if sufficient thought is given to the question -
  - ➢ water cascading
  - ➢ use of filtered river water as process water
  - ➢ wastewater may be suitable for irrigation purposes
- ∅ water pricing must reflect the true cost …

Environmental Management for Industrial Estates.

7. **Industrial Health & Safety**

Industrial Health & Safety

- ∅ In an industrial estate responsibility for the safety and health of workers rests with the companies themselves.
- ∅ Due to the clustering of companies within an industrial estate, the safety and health of workers is affected -
  - ∅ primarily by the activities of their own company
  - ∅ but also by activities of neighbouring companies.

Industrial Health & Safety - *The estate manager's role …*

∅ To carry out a systematic study of the hazards associated with the estate's activities (*e.g.* a HAZOP study)

∅ To work with companies to minimise risks resulting from synergies between companies.

∅ To provide common services in health and safety …

UNEP Environmental Management for Industrial Estates. slide - 5.3.51-L

Industrial Health & Safety - *Providing common services …*

1. Training for workers of companies on the estate in -
   - ∅ *awareness of hazards in the workplace*
   - ∅ *health and safety routines and procedures*
   - ∅ *emergency procedures and first-aid*
   - ∅ *reporting of incidents*
   - ∅ *accident prevention and safe conduct*
2. An Information Centre for chemical hazards -
   - ∅ *safety data on chemicals*
   - ∅ *intrinsically safe processes*
3. Provision of a Health Care Service, *e.g.* first-aid centre or small medical centre for treatment of minor accidents.
4. Provision of a fire-service.

UNEP Environmental Management for Industrial Estates. slide - 5.3.52-L

Environmental Management for
Industrial Estates.

8. Emergency Response & APELL

UNEP Environmental Management for Industrial Estates. slide - 5.3.53-L

Emergency Response & APELL

- The high density of operations in an industrial estate results in it being a relatively high-risk area.
- There is therefore a need for both ***on-site*** and ***off-site*** emergency plans to be formulated.

UNEP Environmental Management for Industrial Estates. slide - 5.3.54-L

Emergency Response & APELL - *Implementing an On-site Emergency Plan.*

- The role of the estate manager is to establish the framework for the emergency plan.
- Development of the plan is a collaboration between the manager and the companies.
- The estate should have an emergency control centre to direct operations in the event of an accident.
- The estate manager co-ordinates the emergency response programme on-site -
  - training for employees of tenant companies
  - emergency “drills”.

UNEP Environmental Management for Industrial Estates. slide - 5.3.55-L

Emergency Response & APELL - *What is APELL?*

Awareness and **P**reparedness for Emergencies at **L**ocal **L**evel -

- APELL is a programme to prepare an emergency response at a community level in the case of major accidents -
  - community awareness - the provision of information to the community
  - emergency response - the formulation of a plan to protect the public
  - training

UNEP Environmental Management for Industrial Estates. slide - 5.3.56-L

Emergency Response & APELL -
Establishing the community emergency plan

- The community should be aware of the hazards associated with the activities of the industrial estate.
- On the basis of this information, emergency response plans should be drawn up.
- Residents should be trained in how to react in the case of an emergency.

UNEP Environmental Management for Industrial Estates. slide - 5.3.57-L

Environmental Management for Industrial Estates: Information & Training Resources.

Environmental Management for Industrial Estates.

Managing the Industrial Estate as an (Eco)-System - The Operating Phase

Environmental Management for Industrial Estates.

1. Promoting an Environmental Programme

Promoting an Environmental Programme -
The Eco-Business Programme - Burnside Industrial Park.

The Code of Eco-efficiency and Environmental Excellence

1. We are committed to reducing the environmental risks associated with the manufacture, distribution or sale of our products and services.
2. We will educate our employees and customers on relevant environmental issues. We will encourage our suppliers, employees and customers to strive for environmental excellence.
3. We will periodically review our operational procedures and use appropriate opportunities to improve our environmental performance.

(contd)

Promoting an Environmental Programme -
The Eco-Business Programme - Burnside Industrial Park.

Where practicable and applicable, we will:

- Manage our affairs in ways that reduce the generation of solid waste. We will separate and divert materials from landfills;
- Reduce discharges of liquid wastes into sewers and minimise the discharge of toxic and corrosive materials;
- Promote efficiency and the conservation of energy and water, by educating our staff and applying innovative technologies and conservation practices;
- Reduce the generation of greenhouse gases associated with manufacturing, distributing and transporting our supplies and products;
- Re-use and recycle products and materials; and
- Use recyclable, reusable, and/or returnable packaging.

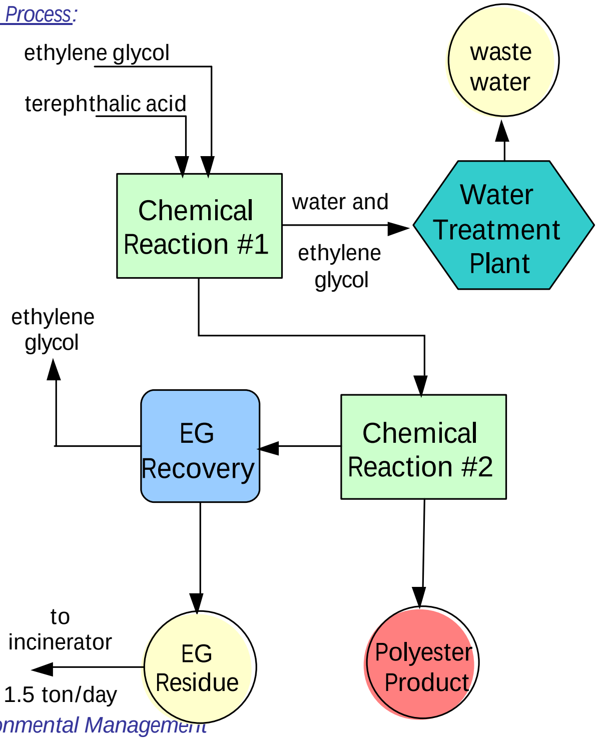
Environmental Management for Industrial Estates.

2. Cleaner Production

Cleaner Production -
Reduction of Waste in Polyester Production, Indonesia.

[Source: Cleaner Production in the Asia Pacific Region (UNEP), 1994]

Old Process:



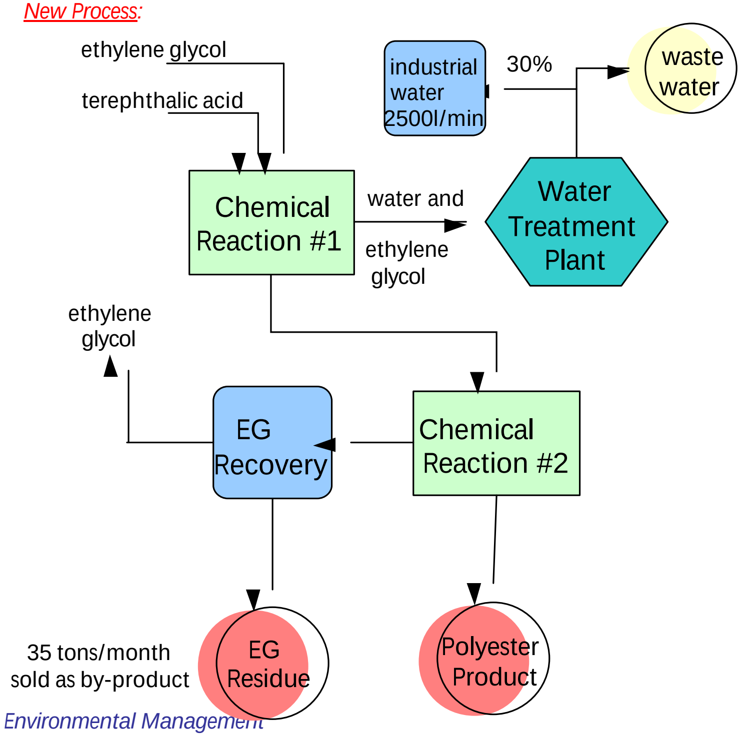
UNEP Environmental Management for Industrial Estates.

slide - 5.3.7-P

Cleaner Production -
Reduction of Waste in Polyester Production, Indonesia.

[Source: Cleaner Production in the Asia Pacific Region (UNEP), 1994]

New Process:



UNEP Environmental Management for Industrial Estates.

slide - 5.3.8-P

Cleaner Production -

Reduction of Waste in Polyester Production, Indonesia.

[Source: Cleaner Production in the Asia Pacific Region (UNEP), 1994]

P.T. Tifico Company, Indonesia.

New Process - Economic Benefits:

- *Sale of EG Residue for roofing -*
  Cost Saving = $7,000 per year
- *Recycling of Industrial Water -*
  Cost Saving = $55,000 per year
  Investment = $12,000
  Payback Time = 3 months
- *Energy Saving -*
  a) Heat recovery
  Cost Saving = $600,000 per year
  Investment = $1.1 million
  Payback Time = 1.8 years

  b) Change from diesel to natural gas
  Cost Saving = $390,000 per year
  Investment = $670,000
  Payback Time = 1.7 years

Environmental Management for Industrial Estates.

4. By-product Synergies

By-product Synergies - *Factors affecting the feasibility …*

Technical	Is the conversion of the by-product to a resource technically feasible?
Economic	Is the conversion economically feasible?
Geographical	Can the by-product be safely and economically transported from the producer to the consumer?
Regulatory	Is transportation of the by-product regulated?
	Will use of the by-product as a resource result in additional regulations, such as through the presence of trace impurities?
Legal	Could use of the by-product as a resource lead to increased liability for the consumer?
	Is transport or use of the by-product prohibited?

UNEP Environmental Management for Industrial Estates. slide - 5.3.11-P

By-product Synergies - *Factors affecting the feasibility …*

Business	Are partners willing to make a commitment to the project?
	Is funding available for the project?
	Will the market accept products made from by-products?
Social	Will the public refuse to purchase products made from by-products?
	What is the state of public trust in the organisations involved in the projects?
Time	Is by-product synergy a high- or low-priority for the organisation?
Information	Is information about the matching of by-product and resource streams available?
	Is information about potential partners available?
	Is information about technology available?

[**Source:** BCSD-GM, 1997]

UNEP Environmental Management for Industrial Estates. slide - 5.3.12-P

Environmental Management for Industrial Estates.

8. Emergency Response & APELL

UNEP Environmental Management for Industrial Estates. slide - 5.3.13-P

Emergency Response & APELL

The 10-point approach for preparing an emergency response plan -

1. Identify participants and establish their roles, resources and concerns.
2. Evaluate the risks and hazards.
3. Review existing emergency plans to assess how they fit into a co-ordinated response.
4. Identify the required tasks not covered by existing plans.
5. Match these tasks to the available resources.
6. Make any necessary changes.
7. Prepare a complete documentation.
8. Educate participating groups about the plan and carry out training if necessary.
9. Establish procedures for testing, review and updating.
10. Educate the wider community about the integrated plan. [Source: APELL, 1988]

UNEP Environmental Management for Industrial Estates. slide - 5.3.14-P

Environmental Management for Industrial Estates.

Managing an Industrial Estate as an Ecosystem - Eco-Industrial Parks.

Managing an Industrial Estate as an Ecosystem - *Eco-Industrial Parks*.

"An EIP is a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water and materials.

By working together, the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realise if it optimised its individual performance only."

Source: E.A. Lowe et alia, *Eco-Industrial Parks - A Handbook for Local Development Teams*, 1998.

Managing an Industrial Estate as an Ecosystem - *Lowe's 6 strategies ...*

Lowe's six strategies for designing an EIP:

[from: Eco-Industrial Parks - A Handbook for Local Development Teams, 1998]

1. Maximise **energy efficiency** through:
   - co-generation and energy cascading within and between firms, and
   - extensive use of renewable sources.
2. Conserve **water resources** and reduce possibilities of water pollution.

Managing an Industrial Estate as an Ecosystem - *Lowe's 6 strategies ...*

Lowe's six strategies for designing an EIP (contd.):

3. Master **material flows** and **waste management** through:
   - Pollution Prevention, in particular with respect to toxic materials,
   - maximising re-use and recycling of materials between firms,
   - reducing risk from toxic waste materials by integrated waste management, and
   - creating links between firms in the EIP and the surrounding region for exchanges of resources and recycling networks.

Managing an Industrial Estate as an Ecosystem - *Lowe's 6 strategies ...*

Lowe's six strategies for designing an EIP (contd.):

4. Entrust the management of the EIP with the following additional tasks:
   - maintaining the range of companies to allow **by-product synergies** to function,
   - supporting improvements in **environmental performance** within companies as well as for the EIP as a whole,
   - supporting efficient **communication** between companies, informing members of local environmental conditions and providing feedback on the performance of the EIP.

UNEP Environmental Management for Industrial Estates. slide - 6.5

Managing an Industrial Estate as an Ecosystem - *Lowe's 6 strategies ...*

Lowe's six strategies for designing an EIP (contd.):

5. Follow **best environmental practices** in the selection of materials and building technology when carrying out new construction or rehabilitation of existing buildings.

6. Integrate the EIP into **natural ecosystems** by:
   - incorporating the EIP into the local landscape and ecosystems, eg. the hydrological cycle, so as to minimise local environmental impacts,
   - considering the global environmental impact of the activities of the EIP, eg. the production of greenhouse gases.

UNEP Environmental Management for Industrial Estates. slide - 6.6

Managing an Industrial Estate as an Ecosystem - *Key challenges ...*

- **Finance** - obtaining private financing for new EIP developments is difficult
  - ∅ financial institutions need to be aware of the advantages of an EIP approach, i.e. lower financial risk and increased ROI
- **Adapting regulations** - some environmental regulations act as barriers to EIP development, e.g. by restricting movement of by-products

UNEP Environmental Management for Industrial Estates. slide - 6.7

Managing an Industrial Estate as an Ecosystem - *Key challenges ...*

- **Profitability** - there is a need to demonstrate that the EIP concept increases the profitability of companies through improved environmental performance
- **Recruiting** - the early success of an EIP depends on finding
  - ∅ enough new tenants
  - ∅ the "right ones", e.g. anchor companies to be the nucleus of a resource optimisation network

UNEP Environmental Management for Industrial Estates. slide - 6.8


The Industrial Symbiosis in
Kalundborg, Denmark
Asnæs Power Station [photo: Indigo Development]
UNEP Environmental Management for Industrial Estates.
slide - 6.9


The Location of Kalundborg ...
NORWAY
0 25 50 km
0 25 50 mi
Skagerrak
Skagen
SWEDEN
Ålborg
Kattegat
Århus
Kalundborg
COPENHAGEN
Jutland
Odense
Esbjerg
Sjælland
Fyn
Åbenrå
Møn
Bornholm
Lolland
Falster
Baltic
Sea
North
Sea
GERMANY
POLAND
UNEP Environmental Management for Industrial Estates.
slide - 6.10

The Partners in the Kalundborg Industrial Symbiosis (1999).

- **Asnæs** - *the largest coal-fired power station producing electricity in Denmark.*
- **Statoil** - *an oil refinery belonging to the Norwegian State oil company.*
- **Novo Nordisk** - *a multi-national biotechnology company producing insulin and industrial enzymes.*
- **Gyproc** - *a Swedish company producing plasterboard for the building industry.*
- **City of Kalundborg** - *receives excess heat from Asnaes for its residential district heating system.*
- **Bioteknisk Jordrens** - *a soil remediation company.*

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Some of the Partners in the Kalundborg Industrial Symbiosis

Photos: Symbiosis Institute, Novo Nordisk, Statoil

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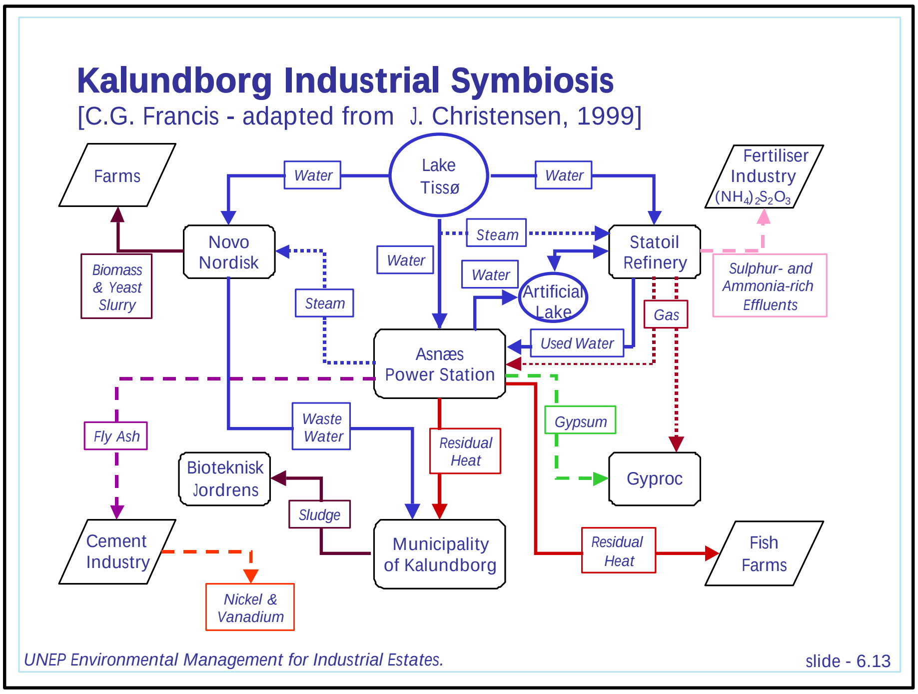
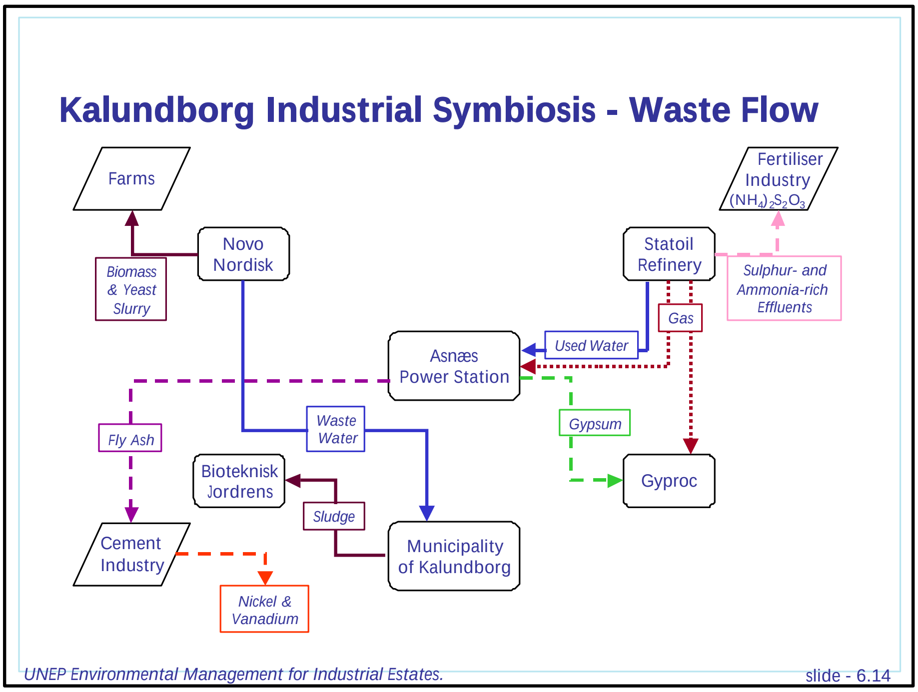
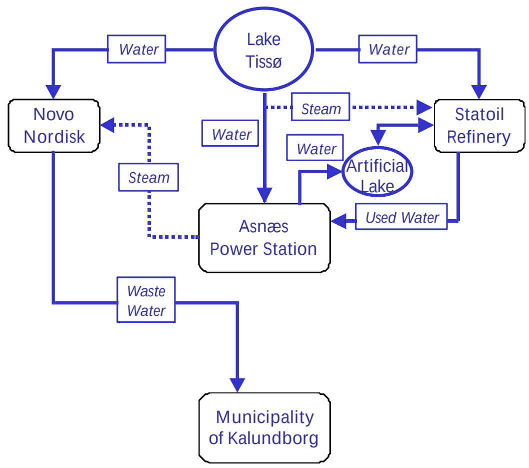

Kalundborg Industrial Symbiosis
[C.G. Francis - adapted from J. Christensen, 1999]
Farms
Water
Lake Tissø
Water
Fertiliser Industry $(NH_4)_2S_2O_3$
Novo Nordisk
Steam
Statoil Refinery
Biomass & Yeast Slurry
Water
Water
Artificial Lake
Sulphur- and Ammonia-rich Effluents
Steam
Gas
Used Water
Asnæs Power Station
Waste Water
Gypsum
Fly Ash
Residual Heat
Bioteknisk Jordrens
Gyproc
Sludge
Cement Industry
Municipality of Kalundborg
Residual Heat
Fish Farms
Nickel & Vanadium
UNEP Environmental Management for Industrial Estates.
slide - 6.13


Kalundborg Industrial Symbiosis - Waste Flow
Farms
Fertiliser Industry $(NH_4)_2S_2O_3$
Novo Nordisk
Statoil Refinery
Biomass & Yeast Slurry
Sulphur- and Ammonia-rich Effluents
Gas
Used Water
Asnæs Power Station
Waste Water
Gypsum
Fly Ash
Bioteknisk Jordrens
Gyproc
Sludge
Cement Industry
Municipality of Kalundborg
Nickel & Vanadium
UNEP Environmental Management for Industrial Estates.
slide - 6.14

Kalundborg Industrial Symbiosis - Water Flow



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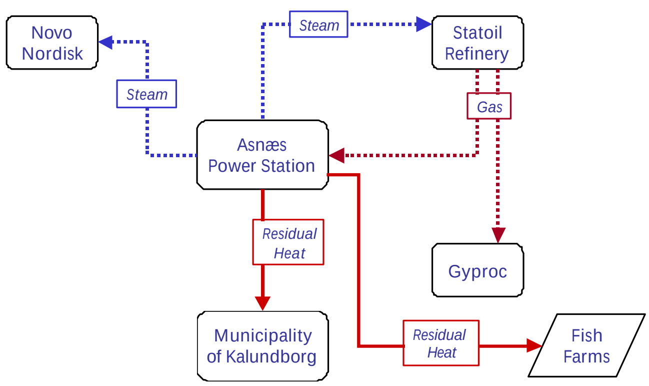
Kalundborg Industrial Symbiosis - Energy Flow



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Environmental & Economic Aspects

[S. Erkman, 1998]

Reduction in consumption of resources:

- ➔ oil - 45,000 tons/year
- ➔ coal - 15,000 tons/year

Reduc

With 18 projects -

- ☞ Investments: $ 75 million
- ☞ Total Revenues: $ 160 million

Valori

- ➔ sulfur - 4,500 tons/year
- ➔ calcium sulfate (gypsum) - 90,000 tons/year

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The Kalundborg Industrial Symbiosis - *What can we learn?*

- ☑ A co-operative approach can result in significant reductions in environmental impacts … and save money.
- ☑ The Symbiosis essentially « organised itself » over a long period of time using sound financial criteria to decide on projects.
- ☑ Confidence has been built between partners, resulting in long-term contracts to supply « wastes ».
- ☑ The close proximity of partners has helped to reduce investment costs for infrastructure (e.g. pipelines etc.)
- ☑ The proximity of the *human* partners has been crucial in developing co-operation (socio-cultural factors).
- ☑ Creation of a working group to follow the development of projects is very important (e.g. Symbiosis Institute, 1996)

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The Kalundborg Industrial Symbiosis - *And now?*

Kalundborg is not strictly an Eco-Industrial Park but … an Eco-Industrial Network of companies.

Côté & Hall (1995) have identified the following objectives for applying this approach to industrial estates -

- conserving natural and financial resources
- reducing liabilities as well as production, material, eneregy, insurance and treatment costs
- improving operating efficiency and quality
- receiving potential income through the sale of waste materials
- improving the health of the population and public image

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Managing an Industrial Estate as an Ecosystem - *Burnside Industrial Park ...*

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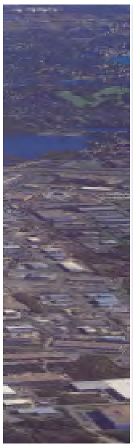
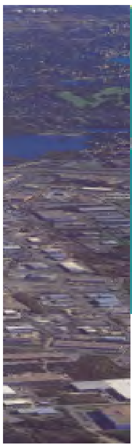
Burnside as an Industrial Ecosystem - *Some facts and figures ...*



- area of the park ~12 km^2
- ~1300 companies - mainly light manufacturing, distribution & service
- ~17,000 employees
- approximately 75% of park is already developed; other areas have been designated as natural areas (parkland or green areas); the industrial park still has room for expansion

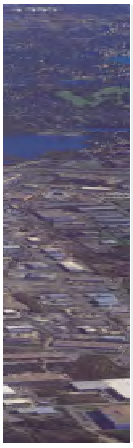
Source: R. Côté, 2001

Burnside as an Industrial Ecosystem - *The site ...*



developed area (yellow),
natural areas - green or parkland (dark blue),
available land (pale blue), for expansion (pink)

Burnside as an Industrial Ecosystem - *The beginning ...*



- A project entitled - "The Industrial Park as an Industrial Ecosystem" has been running at Burnside Industrial Park since 1992.
- The project has been led by Professor Raymond Côté from the School for Resource & Environmental Studies at Dalhousie University, Halifax, Canada.

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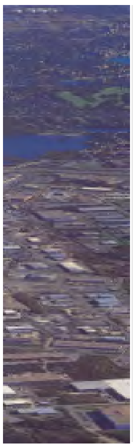
Burnside as an Industrial Ecosystem - *Supporting systems ...*



Supporting systems for managing a park as an ecosystem:

- information clearinghouse
- materials exchange
- environmental audit capability
- educational and training programmes
- applied research programme
- enforcement of standards and regulations

Source: Côté et alia, 1994

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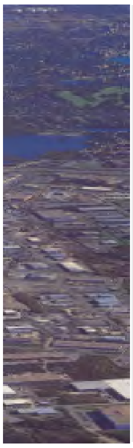
Burnside as an Industrial Ecosystem -
The Eco-Efficiency Centre ...



ECO-BUSINESS PROGRAM BURNSIDE

The Eco-Efficiency Centre carries out the following tasks:

- ☑ information clearinghouse and networking centre
- ☑ conducts environmental reviews
- ☑ supports materials exchanges
- ☑ encourages companies to join an Eco-Business Programme and adhere to a Code of Eco-Efficiency and Environmental Excellence

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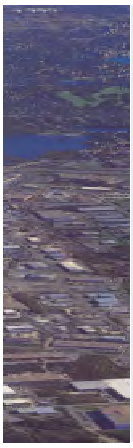
Burnside as an Industrial Ecosystem -
Strategies to foster an ecosystem ...



The presence of recovery and recycling companies within the park - "scavengers and decomposers".

Examples in Burnside -

Recovery	**Rental**
Fine paper	*Construction equipment*
Cardboard	*Tools*
Glass bottles	*Pallets*
Metals	*Communications equipment*
Batteries	*Photocopiers*
Chemicals	*Uniforms*

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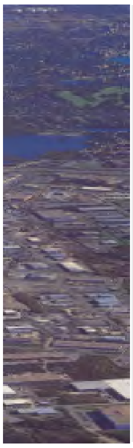
Burnside as an Industrial Ecosystem -
Strategies to foster an ecosystem … (contd)



Remanufacturing

Toner cartridges
Furniture
Printer ribbons
Tire retreading
Computers
Automotive parts

Repair

Computers
Electronic equipment
Trucks and cars
Furniture
Buildings

Reuse

Building materials
Tools
Packaging

Recycling

Paint
Waste oils
Solvent

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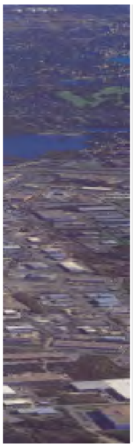
Burnside as an Industrial Ecosystem -
Successful applications of the concept ...



- Environmental design of the park:
  e.g. use of wetlands; creation of lakes and parks
- Cycling of materials and cascading
- Scavengers and Decomposers
- Environmentally Sensitive Products
- Information and education:
  e.g. the Eco-efficiency Centre; Burnside News
- Economic instruments:
  e.g. landfill fees; water rates; pollution control charges
- Regulation:
  landfill bans; sewer use bylaws

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TRAINING ACTIVITIES BASED ON THIS MANUAL

Introduction

This section has been prepared to help with the creation of training activities based on the Information & Training Resources Manual. Since it has been designed to fulfil two roles – that of a Resource Package and that of a Training Kit - the material should be used as one uses a toolkit rather than as a ready-made lecture course.

The objectives of the training activity will depend on the audience, and the programme must therefore be adapted to achieve those objectives. Examples of seminars and workshops are presented that are designed to introduce the concept of environmental management for industrial estates to these different audiences.

Objectives

The Information & Training Resources Manual can be used to develop different types of training activities. We envisage seminars and workshops being the most useful training tools for presenting to different audiences the concept of environmental management for industrial estates.

The objectives of the training activity, whether it be a seminar or a workshop, will depend on the audience. For example, primary objectives may be:

- For the different stakeholders to understand why an industrial estate will benefit from a comprehensive approach to environmental management.
- For industrial estate managers to realise that the environmental dimension of the estate is their responsibility as well as that of the tenant companies.
- For the tenant companies to recognise that a collaborative approach to environmental management in the estate can provide them with greater benefits than an independent approach.
- For the different stakeholders to appreciate that a preventive approach to environmental issues can be cost-effective.

Each of these objectives requires a different approach and the use of different training material. We shall now go on to discuss how the training activity can be adapted for these different audiences.

Adapting the Training Activity for Different Audiences

It is possible to imagine a sequence of training activities on Environmental Management for Industrial Estates based on the Information & Training Resources Manual. This sequence would follow the progressive realisation in a country or region of the need for environmental management in industrial estates. Each step in the sequence would target a different audience and therefore require a different approach. The material in the Manual will cover all of the basic requirements, although it is recommended that this information be supplemented by material, such as Case Studies, that relate to the local situation.

The first step is a seminar to present an overview of the environmental dimension of industrial estates to the different stakeholders - industrial estate managers, representatives from tenant companies, entrepreneurs and private property developers, and local and central government representatives. This type of presentation cannot go into the subject in great detail but must explain why such an approach is important to the success of an industrial estate and hence to the different stakeholders. A consultant or expert working in the field of development in the geographical region would be the likely choice to give such a seminar.

This would be followed by a workshop for industrial estate managers that presents in more detail, using Case Studies and interactive working sessions, the types of environmental issue faced by industrial estate managers and possible approaches for reducing the environmental impacts of industrial estates. The goal of such a workshop should be to sensitise the estate managers that the ***environmental impact of their estate is also their problem***, and not just the responsibility of their tenant companies. And it should motivate them to take the lead in working with their tenant companies to introduce an effective form of environmental management for the estate. A consultant, supported by suitable resource persons and experts in the field, would be required to present such a workshop.

The third step would then be a workshop focussed on a single industrial estate. Such a workshop would normally take place after the estate manager has convinced the tenant companies of the value of such an approach. It would normally be carried out by the Management Team of the industrial estate, supported by external resource persons and consultants. In this case, use of the Background Paper (Section 3) should be focussed on the specific needs of the industrial estate as should the choice of Case Studies to be presented. The workshop should be directed heavily towards practical solutions to the environmental problems of the estate.

Suggestions of formats for seminars and workshops are given in the next section "Different Types of Training Programme", with ways in which the Manual can be used to construct the activities.

Different Types of Training Programme

The material can be used to create a variety of different training activities, varying from seminars to workshops. While each situation will demand a slightly different approach depending on the audience, the geographical location etc. we have chosen to provide some general indications about ways that training can be carried out.

<u>Seminar</u>:

A seminar of 0.5 to 1 day may be the most appropriate way to introduce the subject to larger audiences drawn from the different stakeholders, e.g.

- managers of industrial estates,
- representatives from tenant companies,
- entrepreneurs and private property developers, and
- representatives of local and central government.

The seminar should probably limit itself to awareness raising and the basic principles of environmental management targeted at an industrial estate.

A useful approach is to send out a questionnaire with the registration form for the seminar asking participants to provide some background information about their profession, how it is linked to industrial estates and why they wish to attend the seminar. This allows the person giving the seminar to better target the audience.

Such a seminar should draw heavily from the Background Paper (Section 3) with appropriate use of the Case Studies in Section 5. The Overheads in Section 6 will help to reduce the workload.

<u>Workshops</u>:

UNEP has already organised several workshops on Environmental Management for Industrial Estate Managers (see for example the final report of the Regional Training Workshop held in Thailand in September 1997) and this provides an idea of "what works and what does not … ". The following suggestion for a workshop draws from these experiences – although the programme has been reduced from 4 to 3 days. Depending on the amount of time that can reasonably be devoted to the workshop by the participants, the programme can easily be extended to a fourth day thereby making it less intensive.

Running a workshop will require a good knowledge of the material in the Background Paper (Section 3) and the Briefing Papers (Section 4). In such an interactive training environment liberal use of information from the Case Studies (Section 5) will serve to give a practical flavour to the presentations and help to feed the discussions in the working groups. The selection of Overheads provided in Section 6 provides a basic support for workshop presentations, but they will probably need to be modified and supplemented depending on the situation – e.g. geographical region, type of industrial estate development, type of audience. It will also be necessary to provide Background Material to the participants and this may be drawn from either the Background Paper or the Briefing Papers.

A Three-day Workshop for Industrial Estate Managers.

DAY 1	*The Environmental Dimension of an Industrial Estate*
morning	Introduction to the Workshop – discussion of programme and objectives. Presentation – *The Environmental Dimension of an Industrial Estate.* Topics might include: • The impact of the choice of the site for a new estate on the local landscape, the natural habitat (biodiversity), the local communities. • The impact of the construction and operation of the estate with respect to: - waste production, treatment and elimination – large-scale use of energy and water – the safety and health of workers and people in the local communities – water pollution – pollutants without frontiers (greenhouse gases, CFC's, POP's …).
afternoon	Presentation of background information for a visit to an industrial estate in the area where the workshop is taking place. Field Visit: The visit to the industrial estate should be essentially a "fact-finding mission". Following a short focussed presentation of the activities of the industrial estate by the estate manager, the participants visit the site. The industrial estate then becomes the subject of the case study for the rest of the workshop. Following the Field Visit, the participants in the workshop are divided into smaller groups of 5 – 6 people. The composition of each group remains the same throughout the workshop. First Working Group Session: Each group works on evaluating the environmental issues associated with the industrial estate. This is similar to an Environmental Review in ISO 14001. A moderator and a resource person are present to guide the discussion.
evening	A *rapporteur* from each group presents a synthesis of their deliberations during the First Working Group session. This is followed by a question-and-answer session.

DAY 2	*Strategies and Tools to be used at the Company Level*
morning	Note that the industrial estate management group is assimilated to a company for this discussion. Presentation – *Strategies and Tools to be used at the Company Level.* Topics might include: • Cleaner Production and Pollution Prevention. • Mass Balance calculations. • Eco-efficiency. • Water and Energy Conservation. • Safety and Health in the Workplace. • Accident Prevention. • Management of Chemicals.
afternoon	Second Working Group Session: Each group takes one company within the industrial estate (from different industrial sectors and including the estate infrastructure group) and assesses which tools can be used to address the environmental aspects of the company's activities. They then put together an Action Plan for that company. A moderator and a resource person are present to guide the discussion. Expert Forum: This is an opportunity for participants to question a panel of resource persons about environmental management in the context of an industrial estate.
evening	A *rapporteur* from each group presents a synthesis of their deliberations during the Second Working Group session. This is followed by a question-and-answer session.

DAY 3	<u>*Strategies and Tools to be used at the Estate Level*</u>
morning	The goal of this session is to bring out the ideas of treating the industrial estate as a(n) (eco-)system. Presentation – *Strategies and Tools to be used at the Estate Level.* Topics might include: • Environmental Impact Assessment at the estate level. • Environmental Management Systems for an industrial estate. • Voluntary agreements – their role in rallying all of the actors in an estate to the same objectives (example of Responsible Care and the CERES Principles). • By-Product Synergies. • Co-generation. • Common Effluent Treatment Plants and Waste Treatment. • APELL. • Eco-Industrial Parks. • The role of the estate management group in promoting environmental initiatives.
afternoon	Third Working Group Session: Each group studies the industrial estate as a single unit and works on proposals to bring about harmonisation of approaches to reducing the overall impact of the estate. The objective is to see how attacking the problem at the level of the estate can open up new opportunities for success. This will require the participants to also work with the results from the previous two working group sessions. A *rapporteur* from each group presents a synthesis of their deliberations during the Third Working Group session. This is followed by a question-and-answer session.
evening	Policy Session: Having received an overview of what is “theoretically” possible, the participants in the workshop take part in a question and answer session with representatives of local and/or central government to see how local policies and laws would affect their ability to implement their proposals for the industrial estate. Summary & Conclusions: • Summing up by the organisers. • Feedback from the participants about the workshop (oral and written course evaluations).

Alternatively, the programme can be reduced to 2 days so that it becomes more of an introduction to the subject. In this case, the course would feature a case study presented to the participants in a paper (a Case Profile) prior to the course. The Case Profile would contain all of the necessary information for the study.

An approach to such a course is shown below:

An Introductory Workshop for Industrial Estate Managers.

DAY 1	*The Environmental Dimension of an Industrial Estate*
morning	Introduction to the Workshop – discussion of programme and objectives. Presentation – *The Environmental Dimension of an Industrial Estate.* Topics might include: • The impact of the choice of the site for a new estate on the local landscape, the natural habitat (biodiversity), the local communities. • The impact of the construction and operation of the estate with respect to: - waste production, treatment and elimination – large-scale use of energy and water – the safety and health of workers and people in the local communities – water pollution – pollutants without frontiers (greenhouse gases, CFC's, POP's …).
afternoon	Presentation of the Case Study. The participants in the workshop are divided into smaller groups of 5 – 6 people. The composition of each group remains the same throughout the workshop. First Working Group Session: Each group works on evaluating the environmental issues associated with the industrial estate. This is similar to an Environmental Review in ISO 14001. A moderator and a resource person are present to guide the discussion. A *rapporteur* from each group presents a synthesis of their deliberations during the First Working Group session. This is followed by a question-and-answer session.
evening	Expert Forum: This is an opportunity for participants to question a panel of resource persons about environmental management in the context of an industrial estate.

DAY 2	*Strategies and Tools to be used at the Estate Level*
morning	The goal of this session is to bring out the ideas of treating the industrial estate as a(n) (eco-)system. Presentation – *Strategies and Tools to be used at the Estate Level.* Topics might include: • Environmental Management Systems for an industrial estate and the role of the estate management group in promoting environmental initiatives. • Voluntary agreements – their role in rallying all of the actors in an estate to the same objectives (example of Responsible Care and the CERES Principles). • Promoting Cleaner Production and Pollution Prevention. • By-Product Synergies. • Water and Energy Conservation. • Safety and Health in the Workplace. • APELL. • The Management of Chemicals. • Eco-Industrial Parks.
afternoon	Second Working Group Session: Each group studies the industrial estate as a single unit and works on proposals to bring about harmonisation of approaches to reducing the overall impact of the estate. The objective is to see how attacking the problem at the level of the estate can open up new opportunities for success. A moderator and a resource person are present to guide the discussion. A *rapporteur* from each group presents a synthesis of their deliberations during the Second Working Group session. This is followed by a question-and-answer session.

The morning programme for Day 1 is maintained, but then the afternoon session includes work on the case study and a presentation of the results. The evening session on Day 1 features the Expert Forum. The choice of experts should allow the discussion to cover also policy and legislative aspects related to an industrial estate.

On Day 2 the morning session covers strategies and tools viewed principally from the level of the estate. The focus is more on how the estate management can promote use of different strategies and tools within the tenant companies. The afternoon session includes work on the case study, based on the morning's presentation, and a presentation of the results from the group work. The course finishes at the end of the afternoon session.

Using the Case Studies

Case Studies represent an excellent way to simulate decision-making in complex situations. Several factual case studies are presented in Section 5. They should be used during presentations to provide concrete examples to support the concept being described. In the absence of a Field Visit to an industrial estate, either a hypothetical or one of the factual case studies can be used in its place.

Trainers may also develop their own hypothetical case studies or compile new factual case studies. Case studies will be more useful if they are adapted to local circumstances and brought as close as possible to the practical experience and knowledge of the participants.

Interactive Sessions

Working group sessions are an important part of most training programmes since they provide an excellent opportunity to foster interaction between participants and ensure an exchange of ideas and information. This allows participants to contribute to the learning experience by sharing their knowledge and experience with others.

The discussions ought to permit a large number of ideas to be generated. A moderator should be present so as to keep the discussion focussed and to ensure that the participants debate and discuss relevant issues. If the discussion proves to be inconclusive, the moderator should intervene and give it the correct perspective.

However, there is one Golden Rule that applies to moderating discussions during working group sessions. This is described in Point #5 of the Table *10 Suggestions for Developing a Training Workshop from this Kit*, presented at the end of this section. The rule is that the "correct answer often depends on the context of the question". If you are the moderator, it is important to keep an open mind and listen carefully to all of the arguments before intervening. For example, what might appear at first to be a good solution could, under certain circumstances, be politically or socially unacceptable and hence unworkable.

The use of a resource person during working group sessions, in addition to the moderator, can be helpful for providing supporting information in situations where the participants' experience in a certain area is not sufficient to resolve the problem. During relatively long and difficult discussions the resource person can also serve to moderate the discussion, thereby helping the moderator.

Evaluation of the Training Programme

One way of evaluating a training programme is simply to observe the participants during the course. Their body language, enthusiasm, participation and comments are important indicators. Moreover, they allow the trainer to adjust the level or the pace of the course as he goes along.

An extremely important question, however, is what appreciation of the course the participants will take away with them. The goal of such a training programme is to initiate a process whereby the participants in the course are able to motivate their colleagues and see how they can put into practice the concepts they have learnt. This will only occur if they leave with a positive impression of the course. Their overall appreciation of the course can be assessed through an evaluation at the end of the course. It is therefore important to leave enough time at the end of the course for the participants to think about and work on their evaluation. Do not allow the participants to leave with the evaluation and the promise that they will send it back to you. You are unlikely to see it without a lot of harassment and the appreciation will not be "fresh" after the course.

All of the UNEP Training Kits include a suggested format for the course evaluation. One adapted from the publication - *Environmental Management System Training Resource Kit*, prepared by UNEP, ICC and FIDIC in 1997 – gives a good idea of the type of questions that should be asked:

<u>Part 1</u>:- <u>Overall views of the course</u>

- I think the most useful parts of the course were …
- I think the least useful parts of the course were …
- I will have difficulty applying …
- My overall feelings about the course are …
- If a friend asked me to describe this course, I would say …

<u>Part 2</u>:- <u>Views on particular elements of the course</u>

1 = Poor	*2 = Adequate*	*3 = Good*	*4 = Excellent*

- *Length of the course*
- *Content*
- *Preparatory work*
- *Talks/Lectures*
- *Group work*
- *Background material*
- *Training staff*
- *Organisation of the course*
- *Venue and logistics*
- *Overall benefit from the course*

10 SUGGESTIONS FOR DEVELOPING A TRAINING WORKSHOP FROM THIS KIT

1	The objective of the training programme is in part to inform the participants, but more importantly to develop insights or skills that will help them to address the issues associated with the environmental impact of an industrial estate. • Understand the needs of the participants, and • Define your learning objectives accordingly.
2	Prepare some background questions and preliminary exercises for the participants to complete and send to you before they start the workshop. Information on their experiences with industrial estates will help you to adapt your course to their needs.
3	Refresh your memory by reading the Background Paper and some of the Briefing Papers, and study the Overheads. Make notes to help you with your presentation. If you think that the Overheads provided do not address the particular needs of your audience, do not be afraid to adapt them to the circumstances.
4	Identify some expert resource persons who could be invited as tutors to help during the discussion sessions.
5	Examine carefully the Case Studies provided and think about possible solutions that you can explain and defend. Remember that the “correct answer” often depends on the context of the question. For example, what may appear at first to be a good solution could, under certain circumstances, be politically or socially unacceptable and hence unworkable. Case Studies represent an excellent opportunity to foster interaction between participants and a good way to simulate decision-making in complex situations.
6	Develop your own local Case Study, if possible, to replace the hypothetical Case Study provided. Prepare your own questions and exercises adapted to your audience.
7	In session, summarise the issues for the participants using the Overheads provided and others that you may have developed. Discuss the problems and difficulties that decision-makers face. Inform the participants about where they can obtain extra factual information to help them with their decision-making.
8	Working sessions should focus on small groups guided by a tutor. Discuss and compare results. Be open to ideas and experiences from the participants and discuss these.
9	Return to your learning objectives and verify that they have been achieved.
10	Think about how you can reinforce the learning process by establishing a follow-up process, e.g. periodic reunions, an Internet network, or collaborative projects.

FURTHER READING

Auditing and Monitoring

UNEP and UNIDO (1991). *Audit and Reduction Manual for Industrial Emissions and Wastes*. Technical Report No.7, Paris. France.

Environmental Protection Department, Hong Kong (1993). *Monitoring and Audit of Major Projects, in Environmental Assessment and Planning Group Operation Manual*.

UNEP and UNIDO (1996). *Monitoring Industrial Emissions and Wastes*. Technical Report No.27, Paris. France.

Cleaner Production

UNEP IE (1993). *Cleaner Production Worldwide*. Paris. France.

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THE ENVIRONMENTAL MANAGEMENT OF INDUSTRIAL ESTATES

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Cover photograph shows the Burnside Business Park in Halifax, Nova Scotia, Canada, which has 1300 businesses (photo: Sundancer Photo Communication)

THE ENVIRONMENTAL MANAGEMENT OF INDUSTRIAL ESTATES

This document aims to meet the needs of government officials, estate managers, both public and private, and industry leaders for information on the environmental management of industrial estates

UNEP IE Technical Report No. 39

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PREFACE

Since the meeting of world leaders at the Earth Summit in Rio de Janeiro, Brazil, in 1992, all sectors of society have attached increasing importance to the environmental agenda and the concept of sustainable development. Individual industries and industrial associations have taken major steps to address these issues. However, the industrial estates in which many of the world's industries are located have still to tackle environmental issues in a comprehensive way.

Environmental management at the estate level is a relatively new concept. While some initiatives have already been taken, as reported for example in the UNEP *Industry and Environment Review* (vol. 19, no. 4), they have not yet resulted in a consensus about how best to tackle the problems. Simply leaving the environmental problem to be resolved by individual enterprises is not enough as they, and the estate as a whole, are locked into a relationship of management interdependence.

Lack of environmental action by industrial estates is potentially very serious. The concentration of industries in estates often magnifies pollution and safety problems. The large area of many estates has serious implications for habitats, loss of biodiversity and coastal zone management. Despite increasing environmental constraints imposed by governments, financing institutions and even potential investors, few managers of industrial estates are yet equipped to address the issues systematically. Nor is the growing body of knowledge on industrial ecology yet sufficiently field oriented to provide practical management options for most estates.

In cooperation with Environment Canada, UNEP (United Nations Environment Programme) recently began, through a series of expert workshops, to examine ways of

The importance of industrial estates: an Asian view

'Industrial estates are the very seat of the breathtakingly-fast industrialization process taking place in Asia. There is intense competition to attract and keep investors, and the estates therefore look for original ways to differentiate themselves from their competitors while adding value to potential investors.

'In a world increasingly sensitive to environmental concerns, an environmental management system may be the magic marketing instrument.

'Essentially a set of rules and procedures established along internationally recognised practices, an environmental management plan can help attract interest and build up confidence with potential customers at marginal cost. It can also help optimize the allocation of resources to different environmental priorities.

'For investors, the existence of such a system can be a guarantee that environmental difficulties will be dealt with rationally and effectively; it provides a supporting framework that individual companies can use to master environmental constraints and opportunities.

'Finally for estate developers and service providers, it may be the best way to adding environmental services which can be sold to the captive audience of industries present in the park.'

Philippe Bergeron
Regional Institute of Environmental Technology
Singapore

helping estate planners and operators. This publication is the result of two such workshops held in April 1996 in Paris, France, and in October 1996 in Halifax, Canada.

This publication is the first stage in the process of preparing advice for estate managers, and is intended for four principal groups of users:

- estate planners and managers, who are responsible for decisions on the location, layout and functioning of industrial estates;
- financing bodies and the tenants of estates which constitute the clientele;
- government administrations which provide the regulatory framework: and
- estate associations and institutions which provide technical information and advice on management options.

This publication proposes a practical set of options for day-to-day work activities based on best current experience. However, as the environmental issues and management tools are themselves still evolving, readers are invited to contact UNEP so that practical experience can be exchanged and updated. In turn, it is important that estate associations adopt and advance the ideas of rational environmental management among their members.

Many issues remain to be worked out in more detail. Two of the more important are

- how to undertake the 'green marketing' of industrial estates as a competitive notion, based on the environmental quality and services that may be provided; and

- how the rapidly evolving environmental management systems such as ISO 14 000 can be applied at the estate level.

These are areas for further investigation which we plan to cover in subsequent publications. Readers are encouraged to participate in this development, to join UNEP and other organizations in organizing workshops, and to work with existing professional and business associations to bring the message of sustainability into the day-to-day activities of estate managers.

UNEP expects these guidelines to develop further as environmental and management issues evolve.

UNEP and Environment Canada would like to thank all those who contributed to this publication. We hope that they will form the nucleus of a growing number of environmentally-conscious estate managers and planners.

Jacqueline Aloisi de Larderel
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PART I:

THE BACKGROUND

INTRODUCTION

Industrial estates have become common features of the global landscape.
Since 1970, the number of estates has increased dramatically in the more developed countries and especially in rapidly industrialising countries of Asia. A report on industrial estates in Asia documents that in 1992 there were 147 in the Republic of Korea, 28 in Singapore, 23 in Thailand, 63 in the Philippines, 117 in Indonesia, 166 in Malaysia and 95 in Japan. The US-based International Development Research Council has documented more than 12 000 estates around the world (Site Selection 1996). More than 500 estates worldwide are categorised as export processing zones. The World Export Processing Zones Association represents 34 such zones operating in 31 countries with a total employment of 650 000 workers.

Parks range in size from a hectare or two to more than 10 000 hectares (the Jebel Ali Free Zone in Dubai is 10 125 hectares). Employment ranges from less than 100 to 65 000 (in Las Colmas in Texas, United States). The number of industries also varies; one of the estates with the most is the Burnside Industrial Park in Nova Scotia, Canada, which has 1300 businesses.

Industrial estates play a significant role in the production and use of goods and services, however many of them also pose a substantial threat to the environment. Their size and number are expanding at a time when the world's remaining natural ecosystems are rapidly shrinking, particularly in countries undergoing fast industrialization. The pollution of living space and of natural resources, especially water, is already threatening development efforts. Global issues of climate change, reduction in biodiversity and transboundary pollution are challenging the abilities of many countries to take remedial action.

It is not inevitable that industrial estates pose environmental problems. Indeed, it is UNEP's view that, as in the case of individual companies, systematic and continuous environmental improvement could raise the performance of industrial estates, providing benefits to companies, industrial estate management, surrounding communities and the wider environment.

DEFINITIONS AND CHARACTERISTICS

The concept of clustering industries into estates was first described as a planning tool early this century. The development of industrial estates was later adopted as an economic development strategy after 1945.

An industrial estate, in its simplest definition, can be described as 'a large tract of land, sub-divided, and developed for the use of several firms simultaneously, distinguished by its shareable infrastructure and close proximity of firms' (Peddle 1993). Industrial estates are designed to meet the often compatible demands of different industries within one location. Estates add a management dimension to the simple idea of providing a special zone where industry can locate. This usually occurs through the provision of supervision and servicing, enforceable restrictions on tenants and detailed planning with respect to such things as lot sizes, access and utilities.

'Industrial estates play a significant role in the production and use of goods and services, however many of them also pose a substantial threat to the environment. Their size and number are expanding at a time when the world's remaining natural ecosystems are rapidly shrinking, particularly in countries undergoing fast industrialization.'

Types and synonyms of industrial estates

Industrial Parks
Industrial Districts
Industrial Zones
Export Processing Zones
Industrial Clusters
Industrial Processing Zones
Industrial Development Zones
Business Parks
Office Parks
Science and Research Parks
High-tech Centres
Bio-technology Parks
Eco-Industrial Parks

Source: Peddle 1993

'Industrial estates differ according to a country's stage of economic development, the priority they are given in the country's national development strategy, attitudes towards master planning and the availability of investment capital.'

Industrial estates are distinguished from other types of business and industrial locations by the following characteristics:

- development of a relatively large tract of land, normally more than 40 hectares;
- a tract of land that includes buildings and factories as well as services such as utilities, streets, telecommunications, landscaping, access to transportation networks (including road, rail and maritime cargo and passenger services) and sometimes amenities such as recreation and child care;
- enforceable restrictions on resident companies in relation to such matters as minimum lot sizes, land use ratios and types of construction;
- detailed master planning that prescribes performance standards and specifications for all aspects of the built environment; and
- provision for management to enforce covenants and restrictions, to approve and accommodate the entry of new companies into the estate, and to provide for policies and forward planning to promote the long-term development of the estate and thus protect the investments of resident companies.

Not all industrial estates include all these characteristics. Industrial estates differ according to a country's stage of economic development, the priority they are given in the country's national development strategy, attitudes towards master planning and the availability of investment capital. Industrial estates also depend on who develops them and their priorities and motivations. Industrial estates are usually developed by national or local government or private sector management companies.

Industrial estates are usually developed on land peripheral to a city centre, or in its suburbs. The high price of land, the lack of space for industrial expansion and traffic congestion in urban centres are major incentives to develop industrial and business districts elsewhere. However, in some industrialised countries 'brownfield' sites—industrial areas that have been abandoned and perhaps contaminated by previous users—are now being redeveloped.

According to UNIDO (1978a), estates contribute to a more balanced distribution of production and employment, and can achieve economies in investment in public infrastructure They can also promote rapid industrialization by attracting private investment, reducing capital costs and eliminating delays in developing facilities.

THE NEED FOR ENVIRONMENTAL MANAGEMENT

Industrial development policies that encourage the concentration of industries can have major impacts on the environment, and human health and safety. These can lead to serious financial consequences as a result of increased health care costs, damage to coastal fisheries, water treatment costs resulting from water pollution, rapid depletion of groundwater supplies, restrictions in land use capability due to contaminated soil, traffic congestion and reduced worker productivity.

However, there is increasing recognition that:

- development and land preservation are not necessarily conflicting goals;
- development need not affect adjacent natural areas;
- land can be developed in such a way that the resulting landscape is a functional combination of the natural and built environment; and
- responsible and sustainable methods can be applied to utilise resources without exhausting them.

These notions are consistent with the vision of sustainable development proposed by the World Commission on Environment and Development and with the concept of eco-efficiency as promoted by the World Business Council for Sustainable Development (see box). Sustainable industrial development aims to provide projects that have beneficial long-term effects on the economy, the environment and society.

Industrial estates have a significant advantage over individual enterprises trying to adopt sustainable business practices. Industrial estates can provide cost-effective environmental management services for a number of industries. The management of water and sewage services, the provision of environmental training, and efficient treatment of effluent and hazardous wastes can, for example, reduce the cost per unit of treatment and benefit the environmental management practices of individual companies.

THE BENEFITS OF ENVIRONMENTAL MANAGEMENT

Many benefits result from a sensible environmental approach to the design and operation of industrial estates. These include economic benefits to industrial estate management and to the companies on the estate, and environmental benefits for natural systems and society. These benefits can be used as the basis for a marketing strategy to prospective tenants, financial institutions and surrounding communities.

In some countries, national environmental laws do not apply within export processing zones. In these instances, estate or zone management authorities have an opportunity to develop their own regulations aimed at integrating the environment and the economy.

Sound environmental estate management can:

- enhance the competitive advantage of the estate;
- increase land-use efficiency;
- increase land values in and around the estate;
- reduce infrastructure and servicing costs;
- encourage tenants not to move; and
- reduce overall risk and environmental liability.

Benefits to companies

Good environmental estate management can help companies reduce their operational and liability costs. It can also lead to higher productivity as a result of

The concept of eco-efficiency

The World Business Council for Sustainable Development (WBCSD) first developed the term eco-efficiency. 'Eco-efficiency', it claims 'is reached by the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity.'

The WBCSD has identified the following strategies for implementing eco-efficiency:

- reduce the material intensity of goods and services;
- reduce the energy intensity of goods and services;
- reduce the dispersion of toxic wastes and by-products;
- maximize sustainable use of renewable resources;
- extend product durability; and
- increase the service intensity of goods and services.

'While estate managers can never dictate environmental solutions to their tenant companies, they can play a highly important facilitative role by, for example, setting standards, ensuring that companies are provided with the information they need to take environmental action, and providing access to appropriate training.'

cleaner production initiatives such as adoption of low-waste technologies, more efficient use of resources, and substitution of toxic and persistent chemicals. While estate managers can never dictate environmental solutions to their tenant companies, they can play a highly important facilitative role by, for example, setting standards, ensuring that companies are provided with the information they need to take environmental action, and providing access to appropriate training.

Benefits to companies from estates having environmental management policies and plans include:

- reduction in operating costs especially in materials, water and energy;
- reduction in pre-treatment, transport and off-site disposal costs for liquid, solid and hazardous wastes;
- potential income from the sale of by-products;
- reduction in environmental liability and insurance costs;
- improvement in public image; and
- increase in employee productivity (recent studies suggest that environmentally-sound buildings can increase worker productivity by as much as 15 percent).

Benefits to society

There are also benefits to the outside community, such as

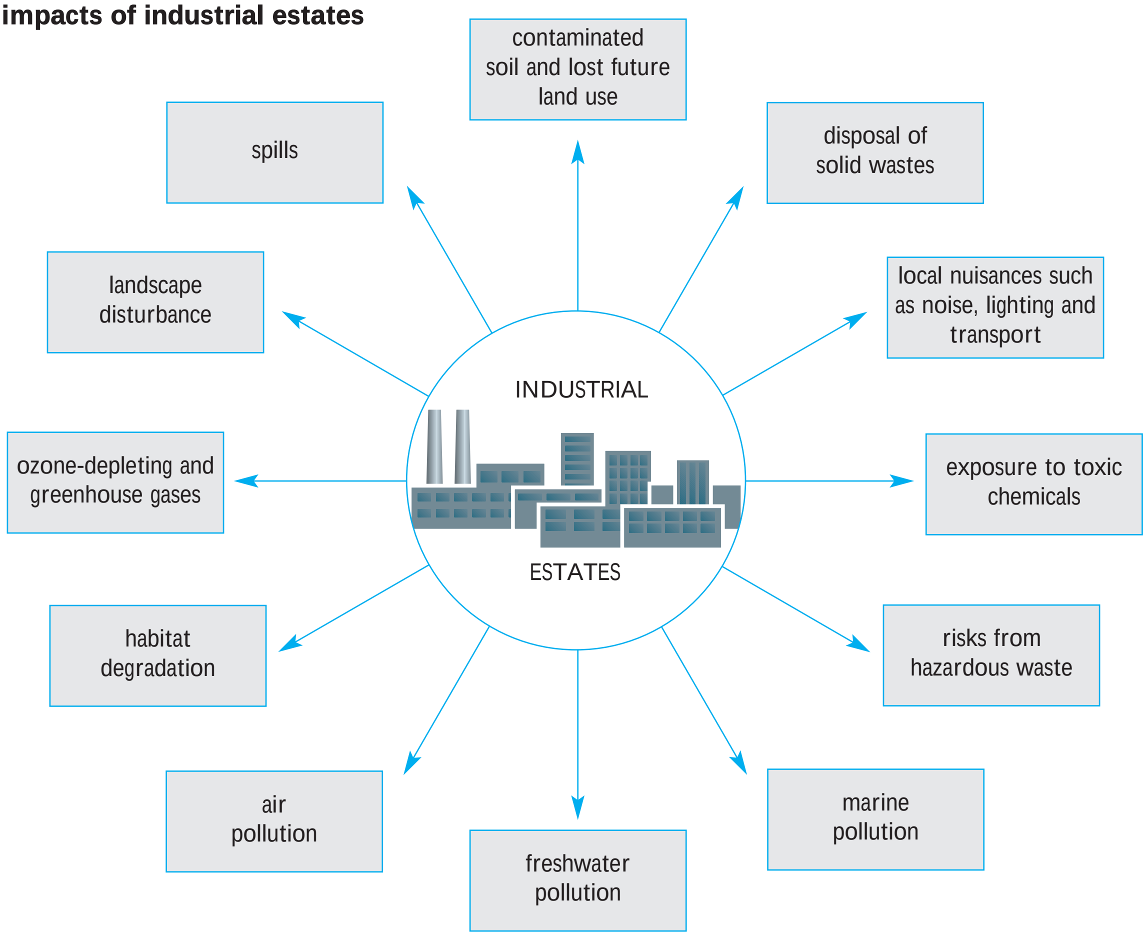
- enhanced protection of natural ecosystems, habitats and landscapes;
- more efficient use of resources such as land, water, energy and other natural resources;
- the protection of cultural and archaeological resources;
- reduced risks to human health and safety from industrial accidents and emissions; and
- improved health for employees and human communities.

WHAT ARE THE ENVIRONMENTAL IMPACTS?

Although some estates have always had stringent aesthetic and landscaping requirements, few addressed other environmental issues. In fact, waste disposal and other environmental standards were regarded in at least one survey as 'of questionable value in promoting quality developments' (Conway, Liston and Saul 1975). Since then, water supply, sewage treatment, solid waste disposal, air and water quality have become serious concerns in many countries and numerous regulations have been introduced to deal with them.

Some environmental issues, such as ozone depletion and global climate change, are common to all estates. In some parts of the world, acid precipitation and deposition of persistent chemicals are also priorities. The severity of these issues varies; in some estates, water supply is a major concern while in others hazards associated with industrial chemicals dominate the agenda. Poorly managed industry can, for example, significantly degrade environmental resources by contaminating soil, water and air. Health and safety risks escalate in areas where housing or other land uses are allowed to locate in dense industrial zones.

Possible environmental impacts of industrial estates



Furthermore, some industries are incompatible with one another, and if they are located on the same estate the risk and potential consequences of industrial accidents increase.

Some of the possible environmental and human health and safety problems that can result from concentrating industries in one location are illustrated above. While individual industries must abide by laws and regulations, the cumulative emissions from industries and transportation may nevertheless be detrimental to the work force and surrounding communities. For example, potable water is becoming an increasingly scarce resource and many industries use large volumes of water. In some cases, rapid development of industrial estates has led to unplanned environmental and socio-economic impacts involving communities of workers and families.

In the planning phase, conventional industrial estates design roads, lots, buildings and other infrastructure services. Traditionally, an estate developer approaches land utilization and

'In and around many industrial zones, the natural resources of air, water and land as well as the actual purification capacity of the environment itself, have been seriously reduced. Associated with this exploitation there has been significant and widespread disruption to social and community life. Possible consequences include the introduction of disease, the destruction of fisheries, forests and soil resources, the loss of employment, the imposition of heavy financial burdens to remedy pollution damage, and even loss of life.'

Environmental Management Development in Indonesia and the Indonesian Department of Industry, 1992

development primarily from a marketing and engineering point of view, using the most cost-efficient approach to land development and infrastructure servicing. With such an approach, environmental resources such as wetlands, wildlife habitats or other significant environmental features are often ignored or are seen as detracting from the commercial value of the site.

In the operational phase, estate managers can have some influence on how individual companies conduct their operations. If these industries operate without any environmental management controls, they may cause air and water pollution, traffic congestion, noise and industrial accidents. There may also be cumulative environmental impacts resulting from many emissions into air, water and land. If companies in an industrial zone use hazardous chemicals, this creates an accident risk that may affect property, human life and the environment. Furthermore, hazardous chemicals may interact or mix with one another, producing synergistic effects on the local environment and human communities. These impacts may affect other people—particularly those living downwind or downstream—than those benefiting from the industrial estates.

ENVIRONMENTAL, HEALTH AND SAFETY CONCERNS

This section summarises the types of environmental, health and safety concerns associated with industrial estate development and operation. The range of possible negative impacts demonstrates why industrial estates need to pursue and adopt more sustainable practices.

The following key issues are examined:

- land use;
- water use;
- energy use;
- pollution and wastes; and
- health risks and social impacts.

Land use

There are two aspects to land use that deserve consideration in the planning phase. The first is the *size* of estates relative to the ecological, social and economic capacity of the area. The second is that poorly *located* industrial activity may limit other potential land uses and interfere with urban activity or important natural ecosystems and biodiversity. Industrial estates sited and developed with little or no concern for landscapes and ecosystems can lead to:

- loss of wetlands and other valuable ecosystems;
- loss of agricultural land; and
- pollution of adjacent areas.

Loss of wetlands and other valuable ecosystems

In earlier decades, developers of industrial estates drained wetlands and mangrove swamps and filled them with engineered structures: wetlands were considered to be wasteland. Today, however, the importance of maintaining wetlands is widely recognised: they provide habitats for many plant and animal species, filter the water passing through them and provide a natural form of stormwater management.

Many natural landscape features disappear as developers prepare a site for development. The site plan often resembles a rectangular grid layout, and developers often grade the contours of the existing land to a standard 1–2 percent gradient. In addition, they often clear more land than is strictly necessary. As a result, the habitats of many plant and animal species—sometimes even endangered ones—are lost.

Loss of agricultural land

Good agricultural land is already scarce in many countries. Flat farming land near urban centres is a magnet for developers intent on attracting industry. In addition to the land required for the estate itself, large areas are cleared for roads and parking. Often little thought is given to land quality when sites are cleared, and the role of agriculture in the development process is frequently neglected.

Pollution of adjacent areas

Pollution from industrial estates close to sensitive habitats, such as coastal areas and human settlements, can cause a greater impact than if the estate were located in a more robust environment with a greater assimilative capacity.

Coastal areas are generally quite sensitive to water pollution and suspended sediment in run-off. Adjacent human settlements may be affected by air pollution from heavy industry in an estate. There is also a potential problem of interference with local water resources when a large estate is built.

Pollution from transport can also be a major issue. Industrial estates rely on airports, railways, ports and highways to move workers, raw materials and finished goods to and from the site, often leading to noise and air pollution. Additional human health and environment risks result from the movement of hazardous cargoes by ship, road and railway. Pollution of the ports and harbours associated with industrial estates can become a serious environmental issue.

Water use

Industrial estates can affect water resources in two ways:

- water-intensive industries may deplete local water resources, especially groundwater, leading to lowered water tables and even the intrusion of salt water into groundwater resources at coastal sites (World Bank 1991); and
- the large areas of land used for parking, roads and other transport infrastructure can lead to the pollution of both surface water and groundwater, and may cause stormwater flooding (Fields and Ruitenbeck 1992).

Energy use

Energy has become closely linked to the environmental agenda. Potential problems range from air pollution from power stations (leading to smog and acid rain) to global climate change caused by the emission of carbon dioxide and the depletion of non-renewable resources such as oil and coal. Fuel substitution and energy conservation, without reducing industrial production, are now major environmental objectives.

Industrial estates consume large quantities of energy for heating, cooling, lighting, manufacture and transport. Their

Trinidad: loss of wetlands and land-use conflicts

The Point Lisas Industrial Estate of the west coast of the island of Trinidad comprises an area of 878 hectares. The site was formed from 137 hectares of reclaimed mangrove wetlands with a water depth of up to four metres and the conversion of 640 hectares of sugar cane fields.

When the estate was planned in the 1970s, the mangroves were viewed as wasteland. The consequences of the actions taken to create the industrial estate have included elimination of breeding and nursery areas for economically and ecologically important shellfish and finfish in the neighbouring Gulf of Paria and loss of habitat for birds.

Taiwan: protesters block an industrial estate

Local environmental groups have stalled a major industrial development plan in Taiwan. The Environmental Protection Agency there recently announced that it would not approve an industrial estate for machinery producers in Hsinchu county because the investors failed to resolve the doubts raised by environmental groups. Some 240 machinery companies invested in the estate, the construction of which would have involved the levelling of several hilltops. The investors have retained an independent consulting firm to assess the plans, which are likely to remain stalled until local groups drop their opposition.

Cost of soil contamination

When a fuel supply and service company moved from Burnside Park in Canada, it left behind land contaminated with hydrocarbons. The seepage of pollutants would have contributed to groundwater contamination, and therefore a remediation programme was required. The cost of clean-up to the estate was $50/m^2, compared to the actual land value of the site of $20m^2.

construction also entails substantial energy consumption.

Buildings are now a key element in most energy conservation programmes. In the United States, 40 percent of energy consumption is used to process the raw materials need for construction, for construction itself and for heating, cooling and lighting buildings (Van der Ryn, Sim and Cowan 1996).

Energy management programmes for estates must include any energy produced on the estate, energy consumed by services and infrastructures, and the energy consumed directly by tenant companies.

When power is generated on an industrial estate, the discharge of warm water that has been used for cooling purposes can cause ecological impacts on downstream rivers and lakes.

Pollution and wastes

Pollution and wastes are unwanted by-products from the processing of raw materials into finished goods. Gaseous wastes include a range of pollutants causing smog, acid rain, ozone depletion and global warming; liquid wastes can pollute groundwater and surface water; and hazardous and solid wastes can lead to soil contamination and the pollution of surface and underground water supplies.

Pollutants discharged to air, water and land are potentially harmful to living resources and ecological systems. For example, wastewater may contain hydrocarbons, metals, acids, bases, organic compounds and nutrients. If discharged untreated, wastewater can cause eutrophication and water pollution, with serious effects on aquatic resources. Even when treated, conventional sewage treatment plants do not remove all the constituents of industrial effluents. In some instances, these constituents can damage the treatment system itself.

One of the major results of the improper disposal of wastes is the creation of contaminated sites. These sites result from landfilling and spills of toxic and hazardous materials. The cost of remediation of such sites often exceeds their sales value (see box left).

Some scientists and industrialists have concluded that the scale of industrial pollution is now so great that even normally non-toxic emissions, such as carbon dioxide, have become a serious threat to the global ecosystem. The outputs from our industrial system are reaching levels that are damaging because of their sheer volume.

The presence of pollution really represents an economic cost caused by an inefficient use of resources. The World Business Council for Sustainable Development suggests that even profitable companies are losing money from their inefficient use of raw materials.

Health risks

Within the crowded confines of an industrial estate, the health risks posed by exposure to chemicals can be substantial. When misused or released into the environment, these chemicals pose risks to employees and neighbouring communities. These risks are associated with manufacture transport, storage and disposal.

Complex mixtures of industrial air pollutants can degrade air quality and lead to respiratory diseases. Many materials used in the manufacture of chemicals are toxic and some are carcinogenic. Hazardous materials can cause immediate injury to workers and toxic materials have long-term ecological and health effects, even in low concentrations.

Recent disasters illustrate the hazards of chemical handling and manufacture. In Bhopal, India, in 1984, lack of management, maintenance, monitoring and training systems at a chemical plant led to the release of a cloud of toxic methyl isocyanate which killed thousands of local residents. Poor city zoning controls were a contributing factor as many squatters lived close to the plant. In Basel, Switzerland, in 1987 the volume of water used to fight a fire at a chemical facility exceeded the capacity of the plants' retention ponds. Millions of litres of highly polluted water were released into the Rhine River, killing fish in downstream countries.

While neither of these disasters actually occurred on an industrial estate, they illustrate the kinds of problem that have to be addressed by estate managers.

Vector and pest proliferation

Poorly developed industrial estates can attract vectors that carry diseases or become nuisances. Estates with poor drainage or standing waters can become breeding grounds for insects. Storage of grain and other food materials and improperly managed waste dumps also attract insects, rodents and birds. If these vectors carry diseases, human health problems can arise.

Impacts from human settlements

The development of industrial estates may encourage the unplanned development of residential communities of workers or those looking for work. Unplanned residential communities frequently pose health and environmental risks. They also put additional environmental pressure on adjacent habitats, natural areas and communities.

KEY ISSUES

The key issues that emerge from this chapter are that:

- industrial estates and their tenants have to address a complete environmental agenda that is partly dictated by outside influences;
- the major issues include questions of land use, pollution, safety and health;
- where problems originate in individual enterprises, the role of estate management is to facilitate, rather than dictate, a solution;
- estate managers also have an important role to play in setting standards;
- particular attention should be paid to the cumulative environmental impact of the estate as a whole;
- most of the issues involved, particularly those related to resource management, energy and human settlements, have been high on the environmental agenda

'Within the crowded confines of an industrial estate, the health risks posed by exposure to chemicals can be substantial. When misused or released into the environment, these chemicals pose risks to employees and to neighbouring communities.'

for some time; environmental management systems and regulations already exist to deal with them.

Environmental estate management, however, is not just an extra chore for the estate manager; it can provide many benefits for the estate, its tenants and their employees. With proper planning and preventative strategies, environmental impacts can either be avoided or at least reduced. International environmental and business organizations are increasingly encouraging countries and industries to address the causes of these impacts rather than rely on costly remedial action.

GUIDING PRINCIPLES AND APPROACHES

Following the lead given by Agenda 21 and the Rio Declaration, many organizations have developed environmental principles, codes and guidelines to assist their constituencies in the pursuit of sustainable industrial development. It has also become increasingly common for industry associations to adopt policies of environmental conduct and to propose environmental charters for their members to sign.

These principles address the sustainable use of natural resources, reduction of waste, wise use of energy, and marketing of safe products and services with an overarching principle of protecting the biosphere for future generations. Some of these principles also acknowledge that protecting the environment can lead to significant economic benefits, such as enhancing business competitiveness and stability. Many industry policies stress public communication or even participation, transparency in information handling and formal systems of environmental management.

The organizations concerned with industrial estates have not so far produced environmental policies or codes for individual estates. This chapter therefore draws on models used by individual companies and trade associations. Many of these environmental charters, guiding principles and codes of conduct suggest elements that could be used as environmental management principles for industrial estates. These include the Business Charter for Sustainable Development (see Appendix 1) of the International Chamber of Commerce, and the Responsible Care Principles (see box below) of the International Council of

‘The organizations concerned with industrial estates have not so far produced environmental policies or codes for individual estates.’

Responsible Care® guiding principles

- to recognise and respond to community concerns about chemicals and operations
- to develop and produce chemicals that can be manufactured, transported, used, and disposed of safely
- to make health, safety, and environment considerations a priority in planning for all existing and new products and processes
- to report promptly to officials, employees, customers, and the public, information on chemical-related health or environmental hazards and to recommend protective measures
- to counsel customers on the safe use, transportation, and disposal of chemical products
- to operate plants and facilities in a manner that protects the environment and the health and safety of employees and the public
- to extend knowledge by conducting or supporting research on the health, safety, and environmental effects of products, processes, and waste materials
- to work with others to resolve problems created by past handling and disposal of hazardous substances.
- to participate with government and others in creating responsible laws, regulations, and standards to safeguard the community, work place, and environment
- to promote the principles and practices of Responsible Care by sharing experiences and offering assistance to others who produce, handle, use, transport, or dispose of chemicals.

'The precautionary principle advocates a 'no-regrets' or 'better-safe-than-sorry' approach to environmental management. This approach encourages decision makers to take anticipatory action even in the absence of complete scientific proof that a specific emission, waste or activities causes health or environmental damage. '

Chemicals Association. Many of these charters and principles require individual companies to commit themselves to operate according to the principles, and sign a statement to that effect. The Environmental Management System standards of the International Standards Organization have recently defined a management framework (1S0 14000) which can help implement such charters and practices.

This chapter does not review these charters or codes in detail because they will be the subject of a forthcoming UNEP publication. Instead, to help industrial estates define their own policies, it summarises several of the key principles and approaches which underlie any environmental initiatives that an industrial estate may take. They include:

- the precautionary principle;
- integration;
- environmental planning;
- ecological design;
- total quality management;
- cleaner production and resource recovery; and
- industrial ecology.

THE PRECAUTIONARY PRINCIPLE

The high cost of rectifying damage compared to the cost of preventive action suggests that a precautionary approach makes both long-term economic and environmental sense. The precautionary principle advocates a 'no-regrets' or 'better-safe-than-sorry' approach to environmental management. This approach encourages decision makers to take anticipatory action even in the absence of complete scientific proof that a specific emission, waste or activities causes health or environmental damage. For example, even though uncertainties arise regarding the severity of global warming, scientists and other environmental managers call for governments to reduce carbon dioxide emissions. This is reflected in the 1992 Framework Convention on Climate Change.

The precautionary principle evolved from the London Declaration of the Second North Sea Conference in 1990 where ministers stated that 'in order to protect the North Sea from possible damaging effects of the most dangerous substances, a precautionary approach is necessary which may require action to control inputs of such substances even before a causal link has been established by absolutely clear scientific evidence' (Ayres and Simonis 1994).

The precautionary principle involves:

- preventing future damage;
- avoiding conflict that would arise if stressful conditions were knowingly allowed to continue;
- minimising risk where causes and consequences are unknown or where valued environmental resources are in potential danger;
- protecting the assimilative capacity of natural systems; and
- adopting best practice integrated management to create least-cost environmental outcomes (Ayres and Simonis 1994).

A precautionary approach will ensure that the estate and its constituent companies are better equipped for the environmental and economic challenges of the future by reducing the possibility of surprises.

INTEGRATION

Calls for an integrated approach have become the hallmark of environmental management since the mid-1980s. At the international level, the World Commission on Environment and Development first drew attention to the interdependence between environmental and economic processes. At the level of the individual enterprise, there is increasing evidence that waste reduction and cleaner production result in both economic and environmental benefits.

For managers, an important focus for integration is the cross-media approach to pollution control and prevention. An integrated approach is required to ensure that the solution to one problem, for example, a water pollution problem, is not simply converted into a hazardous waste disposal problem because of the toxic sludge generated by the wastewater treatment system. More and more environmental agencies are now adopting an integrated approach to pollution and waste control. The same principle is relevant to managers of industrial estates.

There is also a need for integration across environmental management responsibilities, ensuring that limited human and financial resources are focused on priority problems. This integration involves regulatory agencies, the estate management authority, and individual companies in the estate cooperating in solving key problems in which they all have a stake.

A final need is integration across industry sectors. By linking different companies, estate management can create opportunities for waste exchanges within the estate and target new industries which can take advantage of wasted materials and energy. An integrated approach will benefit estate owners and individual companies by facilitating a more efficient use of financial, human and natural resources.

ENVIRONMENTAL PLANNING

Environmental planning supported by environmental impact assessment, evolved in the 1970s as a preferred approach to the ‘react and cure’ formula which had been applied in many industrialised countries. The call for prevention signalled an important change in environmental management philosophy. Environmental planning aims to optimize a community’s use of energy and materials without exceeding a region’s carrying capacity. The natural environment has a limited ability to withstand uses such as harvesting, extraction and waste disposal; that limit is called the carrying capacity.

Conventional planning for an industrial estate incorporates land use, transportation, waste treatment and infrastructure demands in one master plan. This master plan tries to provide a balanced approach to development, carefully considering the long-term implications of all the major elements in the development process.

Most importantly, environmental planning recognises that development and land preservation are not necessarily conflicting goals. Impact on the landscape is an

Contents of the EIA for Hi-tech Industrial Estate, Thailand

Chapter I: Introduction
- General
- Purpose of EIA
- Report layout
- Study team

Chapter II: Project description
- Necessity of the project
- Project schedule
- Project location
- Industrial estate layout
- Acceptance of industry in the estate
- Water supply system
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- Landfill
- Drainage system
- Power supply

Chapter III: Existing environmental setting
- Physical environmental resources
- Ecological environmental resources
- Human use values
- Quality of life values

Chapter IV: Environmental impact assessment
- Introduction
- Physical environmental resources
- Ecological environmental resources
- Human use values
- Quality of life values

Chapter V: Recommendation and monitoring program
- Introduction
- Physical environmental resources
- Ecological environmental resources
- Human use values
- Quality of life values

Objectives for an environmental impact assessment

- identify adverse environmental problems expected to occur
- examine and select the best alternative from the available options
- identify critical environmental problems that require further study
- incorporate mitigation measures into the development plan
- identify the project's environmental benefits and disadvantages, and its economic and environmental acceptability to the community
- involve the public in decision making related to the environment.

increasingly important issue, and early planning studies make it possible to develop the land in such a way that the resultant landscape is a functional combination of the natural and built environment. The figures below provide examples of how estates have been planned in Japan, Korea, Thailand and Malaysia.

The planning process has to be based on reliable information about likely environmental impacts. A variety of assessment tools are available to planners, and in some countries there is a legislative requirement to use them.

Environmental impact assessment

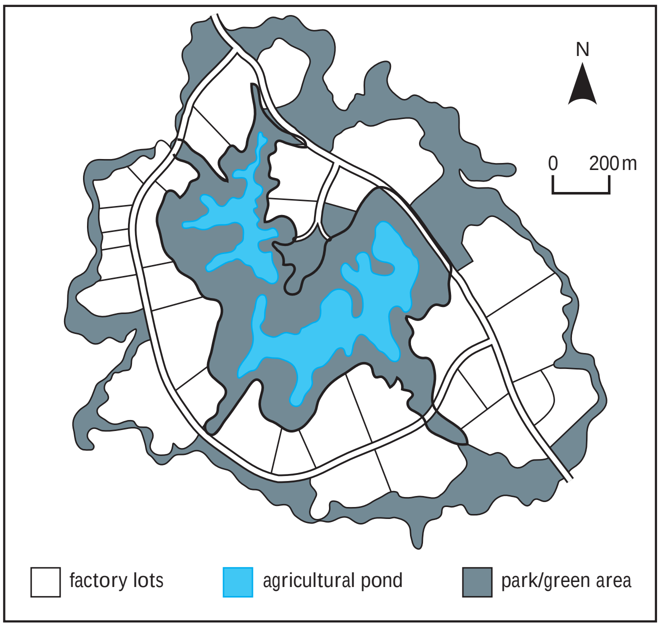
Environmental impact assessment (EIA), an important tool in environmental planning, is used to predict the potential environmental, social and economic impacts of a proposed development project. Few governments or development banks now support, finance or approve a major project without first taking into account its environmental and socio-economic consequences, and many have made an EIA a formal condition of financing approval. Similarly, some estates now require EIAs to be made by prospective tenants.

Appendix 3 provides a technical guideline for setting out the form and content of an EIA for industrial estates in Indonesia. In many countries the details of how to carry out an EIA are described in legislation.

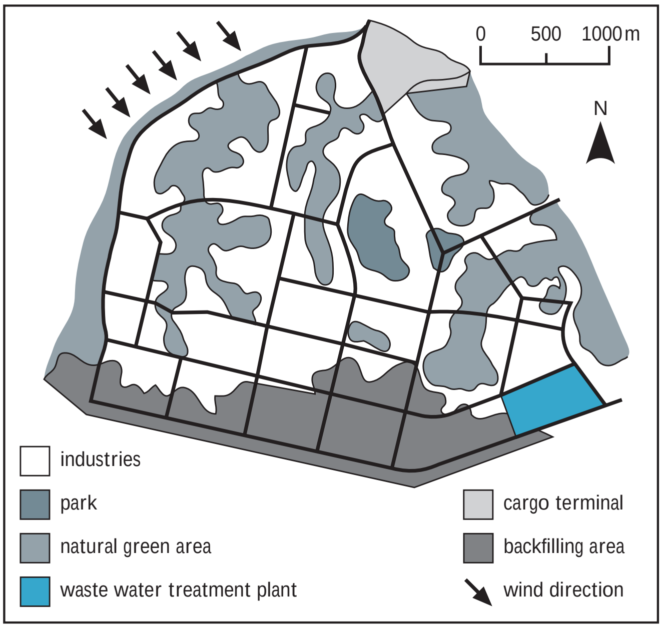
By identifying potential problems, project planners and engineers can influence the

Layouts of industrial estates in Japan, the Republic of Korea, Thailand and Malaysia

Japan



Republic of Korea



project so that its benefits can be enjoyed and sustained without causing inadvertent problems. In some cases, projects do not go ahead if the EIA identifies too many adverse impacts which cannot be mitigated. For an industrial estate, it is often the cumulative impacts that are the more significant concerns. For example, each of the individual facilities may satisfy national emission requirements set out in regulations but the air quality of the area could still be seriously degraded by the total pollution load emitted.

It is also helpful to examine the individual causes of environmental impacts. The pollution potential of individual technologies likely to be used on an estate will help predict the potential point sources of concern. This prediction can be made through the personal knowledge of industrial engineers or through formal techniques such as *Environmental Technology Assessments* (EnTA) which can be used by planners to identify the likely impacts of new technologies on human health, ecological systems and resources (see box right).

ECOLOGICAL DESIGN

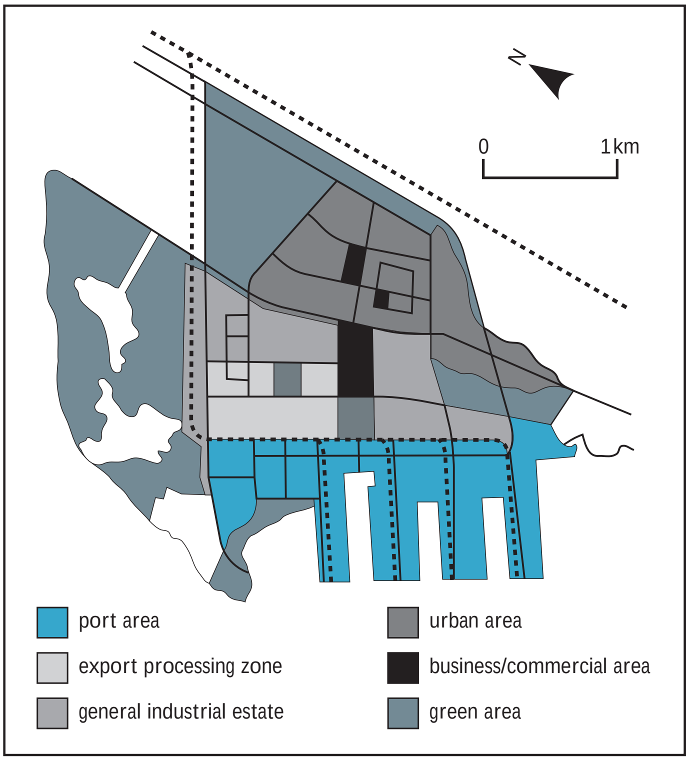
Ecological design offers exciting and innovative approaches for redesigning buildings, businesses and communities based on ecological concepts identified in natural systems. Ecological design minimizes the environmental impacts of the built environment as well as the goods and services in the market place. It can greatly

10 steps for an Environmental Technology Assessment

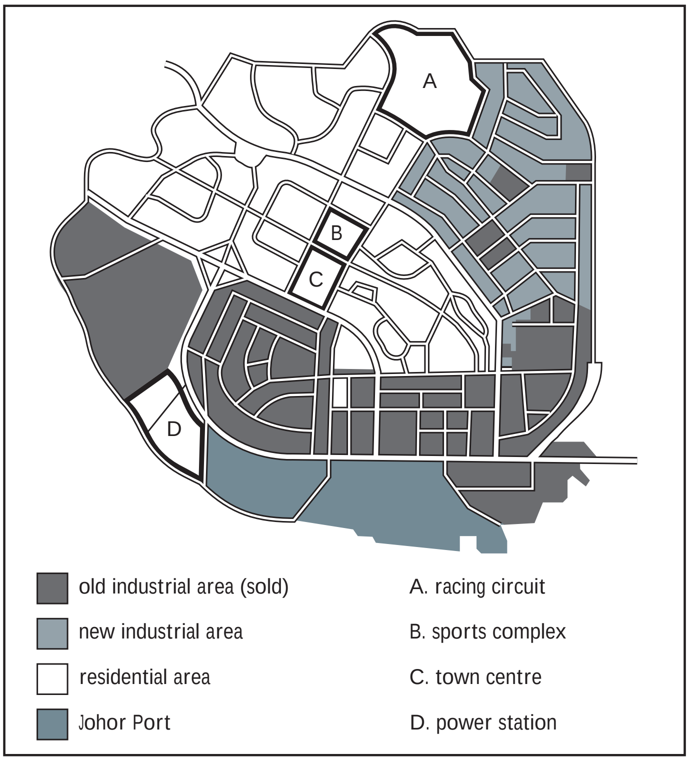
1. Examine the reason for introducing the technology
2. Describe the technology
3. Specify the systems alternatives
4. Trends affecting the system
5. Identify stakeholders
6. Identify possible impacts
7. Evaluate impacts
8. Identify the decision process
9. Identify action options for decisions
10. Conclusions and recommendations

Source: UNEP IE

Thailand



Malaysia



Defining a sustainable property

A sustainable property

- Enhances the health and well being of its occupants by adopting human compatibility principles and contributing positively to its community and to society.
- Meets the needs for stewardship of the local and global environments by adopting environmental compatibility principles.

Human compatibility is the extent to which a building meets the physiological and psychological needs of its occupants; environmental compatibility is the extent to which the direct and indirect loadings imposed on both the local and global environments by a building can be absorbed by their carrying capacity without irreversible damage.

Robson Dunk, a well-known property developer, believes that 'the long-term economic viability of developments can be viewed only in the context of the future well being, healthfulness and productivity of the people who will work in them, the contribution these buildings make to the competitiveness of their corporate owners and occupiers, and their ability to enhance the environment.'

Robson Dunk believes that well designed buildings increase the productivity of the average occupant by 5–10 percent and reduce utility expenses by at least 50 percent per year.

Robson Dunk Inc.
Property Development.

improve the environmental and resource efficiency of an estate once its location has been decided, and so is a subsequent step to environmental planning.

At the enterprise level, the notion of environmental design can also apply to the products being manufactured. However, the estate manager usually has little influence over products, and it rarely forms a part of estate management.

A number of different disciplines have adopted the basic principles of ecological design. Design for environment (DFE) considers all potential environmental implications of product or building design and construction: energy and materials used, its manufacture and packaging, transportation, consumer use, reuse or recycling and disposal. Designers balance these impacts and sometime make trade-offs to try and find a solution with the least negative environmental impact. Buildings and products can often be designed and built in such a manner as to facilitate the recycling of the materials from which they are constructed.

For industrial estates some examples of the application of ecological design include:

- constructed wetlands that purify industrial or residential wastewater;
- buildings that can be disassembled into reusable or recyclable materials.

Life cycle analysis (LCA) is a tool which permits the developer or manufacturer to assess the total environmental impacts of a product, building or process from cradle to the grave. It examines the inputs to the production process from raw material extraction and processing through to manufacturing, distributing, retailing, consuming and discarding the material or product. A recent UNEP IE publication *Life Cycle Assessment: what is it and how to do it* gives further details about the procedure.

Estate owners and managers who encourage ecological design of the estate and its buildings should find that their financial and environmental costs are reduced over the long term.

TOTAL QUALITY ENVIRONMENTAL MANAGEMENT

Total Quality Environmental Management (TQEM) is an emerging concept linking total quality management and environmental management. It has evolved from Japanese initiatives and the International Standards Organization's 9000 series of standards. In some sense, pollution can be regarded as an efficiency and quality issue. An industrial estate aiming for higher efficiency and quality will also be a cleaner estate.

With the increasing attention given to environmental issues by governments and industry, a new ISO set of standards is evolving. The ISO 14000 series will include environmental policies, life cycle analysis, environmental auditing, waste management, emergency planning and prevention. ISO 14001 and other environmental management systems were developed for use by individual enterprises or manufacturing installations. Some adaptation is required before they can be easily applied by an entire estate; however, the concept of an EMS is just as valid as for companies.

Estates receiving 1SO 14001 certification (see page 25) should in principle be attractive to companies which are also committed to an environmentally sound approach to the manufacture of goods and provision of services. Other options for recognition of environmental performance, in addition to ISO 14001 certification, are being tested. An organization in France is developing an eco-labelling scheme for industrial estates, similar to the approach taken in many countries with environmentally-appropriate products.

CLEANER PRODUCTION AND RESOURCE RECOVERY

Over the past ten years, countries and institutions have increasingly adopted strategies to improve both environmental and economic performance of industries and businesses. Some of these concepts are: eco-efficiency, waste reduction, waste minimization, pollution prevention and cleaner production. Most of these concepts share a common philosophy: to reduce the generation of polluting substances to avoid the cost of clean-ups and disposal, protect human health, and minimize impacts on the environment and resources. The term cleaner production is used in this publication.

The goal of cleaner production is to minimize environmental impacts by changing either the way goods and services are produced (process technology) or the products themselves (product design). Improving the efficiency of processing operations and the product life cycle is a key concept in cleaner production. Cleaner production technologies:

- conserve energy ;
- reduce raw materials consumption;
- reduce or eliminate toxic and hazardous chemical use; and
- reduce waste generation

The aim is fewer, and where possible zero, emissions to air, land and water.

At the level of individual companies, cleaner production can be implemented by:

- adopting new technologies;
- good housekeeping;
- changing products;
- changing input materials; and
- reusing materials on site.

This is consistent with eco-efficiency, as promoted by the World Business Council on Sustainable Development.

There is, however, also an important role for the authorities (and by implication industrial estates) to support company initiatives by adopting cleaner production policies and strategies, and associated support measures. Many of the concepts outlined in *Government Policies and Strategies for Cleaner Production* (UNEP IE 1995) are relevant to estate managers in their role as providers of infrastructure and local bye-laws. Concerted action between estates and individual companies benefits both.

More information on cleaner production is available from UNEP IE, and from the National Cleaner Production Centres that have been established in Brazil, China, the Czech Republic, India, Mexico, the Slovak Republic, Tanzania, Tunisia and Zimbabwe.

Eco-labelling of industrial estates

DEMAIN, a French consulting organization, has developed PALME (Programme d'Activités Labellisées pour la Maîtrise de l'Environnement, see Appendix 2) to facilitate environmental management of industrial areas and, specifically, estates. The organization encourages the formation of local PALME teams which provide technical assistance and advice on pollution prevention, eco-auditing, life cycle analysis and energy conservation. The team also provides assistance in arranging permits and contracts with government authorities, in developing shared water, energy and waste management facilities, and in improving social conditions through commercial cafeterias, kindergartens and bicycle parking lots.

The concept is evolving into a set of criteria and procedures for a PALME label, essentially an environmental management label specifically designed for parks. At the heart of the system is a formal charter of environmental commitments to which partners agree. An example of a PALME charter adopted by a new estate at Chalon-sur-Saône is included as Appendix 2. The charter provides specific objectives and goals, and is thus complementary to ISO 14 001.

An EMS in an estate in the Philippines

Fil-Estate Land Inc. in the Philippines has employed a consultant to develop a company-wide EMS. As well as being able to anticipate national environmental performance requirements, Fil-Estates expects to achieve cost savings in operations and to reduce environmental risks. Regular evaluations will ensure that each employee understands the importance of the company's policies.

Cleaner production

Cleaner production is 'the continuous application of an integrated preventative environmental strategy to processes and products so as to reduce the risks to humans and the environment.'

UNEP IE

Many studies have shown that cleaner production provides economic benefits for companies. These benefits include:

- reduction in waste disposal costs
- reduction in raw material costs
- improved worker safety
- improved public image
- reduction in property damage risks and attendant liabilities.

Information on cleaner production technologies, policies and networks can be found in the International Cleaner Production Information Clearinghouse (ICPIC) managed by UNEP IE.

Resource recovery

While it is important to encourage cleaner production through changes in processes and materials as well as in the design of products, it is unlikely that the generation of wastes will be entirely eliminated. Recycling and reusing wastes within companies or by exchanging wastes between companies is another option that has both environmental and economic benefits. This can involve recycling, the recovery of energy from waste facilities, or pyrolytic destruction with recovery of heat and materials. Some jurisdictions have gone so far as to design and develop waste management estates, or zones within estates, as a means of taking advantage of the opportunities presented by the recovery and reuse of materials and energy.

An estate which provides these services can expect to attract new industry and reduce government oversight.

INDUSTRIAL ECOLOGY

Industrial ecology advocates a new direction for industrial development. Frosch and Gallopoulos (1989) envisioned the following transformation:

> *The traditional model of industrial activity, in which individual manufacturing processes take in raw materials and generate products to be sold, plus waste to be disposed of, should be transformed into a more integrated model; an industrial ecosystem. In such a system, the consumption of energy and materials is optimized and the effluents of one process … serve as the raw material for another process.*

At about the same time, Ayres introduced the concept of industrial metabolism. This concept suggests that businesses must improve material efficiency, as unbalanced inputs (raw materials) and outputs (waste and consumer products) have negative impacts on the natural world. Ayres (1995) also suggests that industrial systems must begin to use alternative energy sources and improve the efficiency of current energy sources. At present, the use of virgin resources for raw materials and fossil fuels for energy to feed the process-product cycles still creates major pollution emissions.

Both these ideas have now gained considerable currency. Industrial ecology, as defined by Tibbs (1992), involves 'designing industrial infrastructures as if they were a series of interlocking ecosystems interfacing with the natural global ecosystem'. Industrial ecology goes even further than this definition because it is an attempt to model the industrial system on natural ecosystems that demonstrate resource-efficient operations.

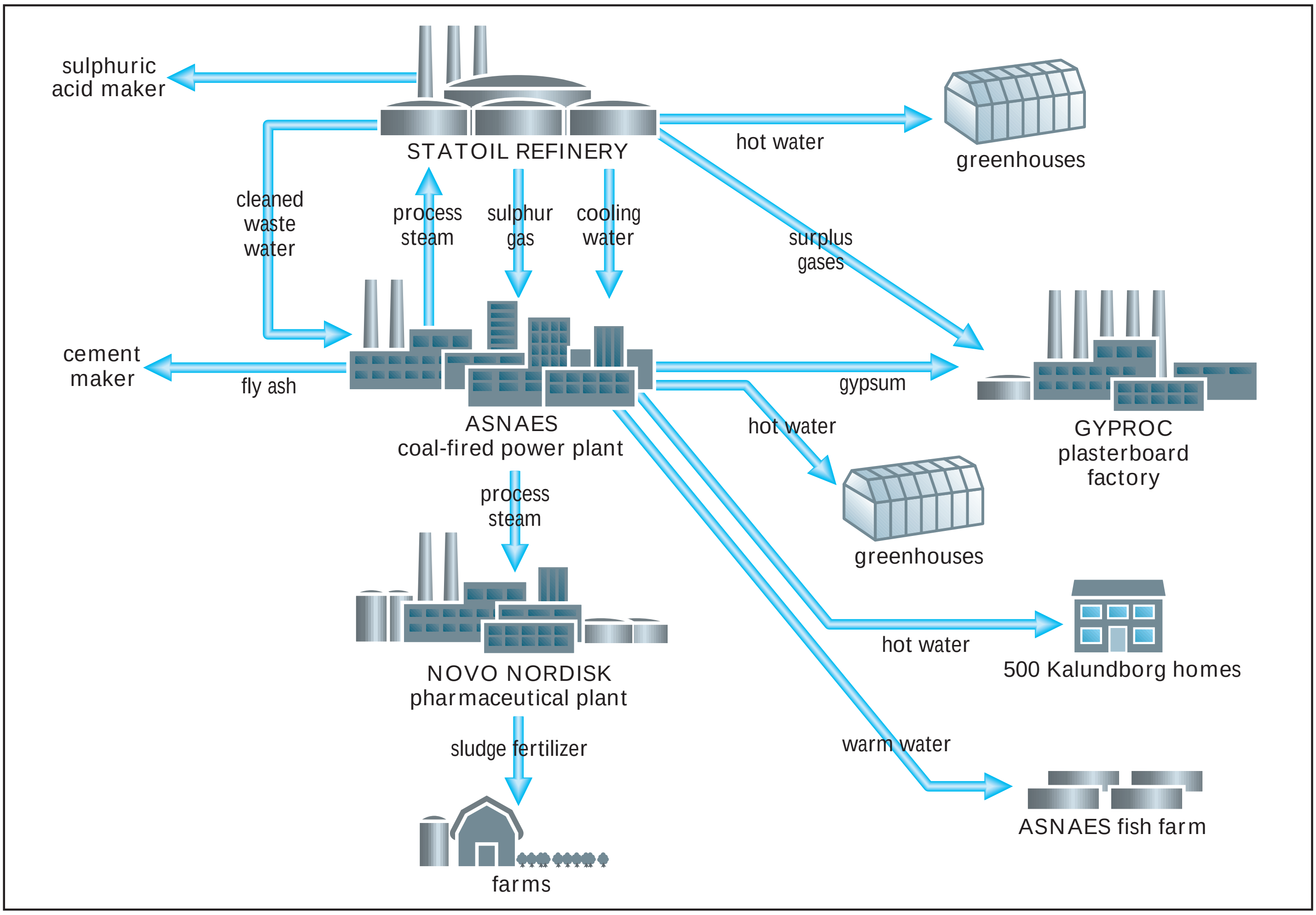
The exchange of by-products between companies is one way of creating industrial ecosystems or industrial symbiosis. Wastes or residues generated in industrial operations can be used as raw materials for other industrial operations. The paper and oil refining industries, for example, have been successfully practising industrial symbiosis for several decades.

The industrial district of Kalundborg, Denmark, is the most famous example of industrial symbiosis. For 15 years, industries have exchanged by-products such as surplus energy, waste heat and other materials. In one example, waste heat (in the form of cooling water) from the Asnaes Power Plant provides district heating to houses and buildings in the municipality of Kalundborg. The figure below illustrates the many by-product exchanges.

This pattern of inter-company reuse and recycling has reduced air, water and ground pollution and reduced levels of resource (raw materials and energy) consumption. From an investment of US$60M over a period of time in infrastructure to transport materials and energy, participating companies have generated US$120 million in revenues from by-product exchanges and additional cost savings from business efficiency improvements.

While the situation in Kalundborg evolved gradually, its success suggests the possibility of forming this sort of exchange deliberately. Industrial estates are excellent places to apply this because they contain diverse industries, and economies of scale can be achieved. Efforts are underway in

Industrial symbiosis in Kalundborg, Denmark



several countries to establish eco-industrial estates. For example, many small to medium-sized companies in industrial estates cannot afford the cost or time needed to implement their own environmental management systems but they would benefit (economically and environmentally) from the provision of common environmental services. Gunter Pauli (1995) of the Zero Emissions Research Initiative at the United Nations University in Tokyo makes a strong case for industrial symbiosis and points to the opportunities to create spin-off businesses that use the wastes of other industries as their basic inputs (see box for an example from the Philippines). Estates that foster such clusters can reduce waste outputs and diminish demand for treatment facilities.

Similar possibilities exist in relation to pulp and paper mills, sugar manufacturing plants, breweries, cement plants, oil refineries and petrochemical complexes.

Industrial ecology encourages a form of development which is economically and environmentally sustainable. Industrial ecosystems can be developed at the estate and the regional level. In the latter case, a network of industrial estates could be linked to improve of the metabolism of materials in the region. A network of industrial estates functioning as ecosystems is seen as the ultimate transformation of industrial development.

KEY ISSUES

The principles in this chapter provide a solid foundation for the development of planning and operational strategies in industrial estates. They are based mainly on a preventative approach that tries to sidestep future problems (and the costs of

Industrial clustering in the Philippines

Peter Paul Philippines Corporation, a food processing plant producing desiccated coconut, used to generate a large volume of highly organic wastewater that posed pollution problems in a local water resource. Today, however, Peter Paul collects and sends the coconut water to Chia Meei, a company from Taiwan. The Chia Meei plant, located next door, concentrates, freezes and ships the coconut water to Taiwan, where another company turns it into a commercial juice drink. This initiative has lowered the Biochemical Oxygen Demand (BOD) of Peter Paul's wastewater by an estimated 50 percent and reduced the annual operating costs for use of a wastewater treatment plant by 10 percent. In this example, both Peter Paul and Chia Meei profit from a raw material once considered a waste.

Cleaner Production in the Asia Pacific Economic Cooperation Region
UNEP IE, 1994

solving them) rather than using the older method of waiting for problems to appear before taking action.

What is now needed is to convert the principles and approaches into concrete action. This is the role of the following chapters which outline some specific proposals for action and the ways in which these actions can be coordinated through a formal environmental management system.

Locations of some eco-industrial estates

Canada

- Burnside Industrial Park, Nova Scotia
- Bruce Energy Centre, Ontario
- Port Industrial District, Ontario

United States

- Brownsville, Texas
- Baltimore, Maryland
- Cape Charles, Virginia
- Chattanooga, Tennessee
- Plattsburgh, New York
- Burlington, Vermont

Denmark

- Kalundborg

Sweden

- Linköping

France

- Sophie Esterel
- Chalon-sur-Saône
- Réseau Haute Saône

ENVIRONMENTAL MANAGEMENT: ESTABLISHING A FRAMEWORK

International agencies, governments and progressive companies are all beginning to adopt a new approach to environmental management: one that is integrated, systematic and preventative. These environmental management initiatives are becoming increasingly formalized. The European Union's Eco-Management and Audit Scheme (EMAS), for example, is supported by a regulation. Many require certification, such as the International Organization for Standardization's new 14001 standards.

The environmental management framework for an estate should include an explicit policy statement, environmental goals and objectives, mechanisms for ensuring achievements of these goals and objectives such as bye-laws and economic instruments, supporting services, an audit function and enforcement mechanisms. Using this manual, both estates and companies can begin this process now.

A key aspect of any management framework is that the roles and responsibilities for various functions be clearly defined. For industrial estates where other stakeholders (such as regulatory agencies and individual companies) are found outside and inside the estate, it is important that their roles are also identified.

ISO 14001
Environmental management system specifications

- ❖ Scope
- ❖ Definitions
- ❖ General requirement
- ❖ Environmental policy
- ❖ Planning
  - environmental aspects
  - legal and other requirements
  - objectives and targets
  - communication
  - documentation
  - control
  - emergency preparedness and response
- ❖ Checking and corrective action
  - monitoring and measurement
  - corrective and preventive action
  - records
  - audit
- ❖ Management review

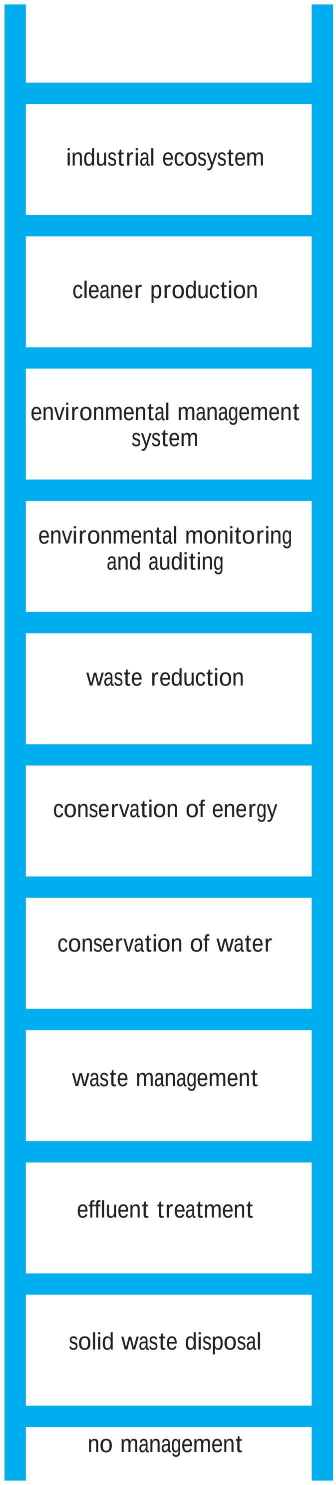
DEVELOPING AN ENVIRONMENTAL POLICY

Policy, and the subsequent detailed objectives which follow them, are usually developed through an interactive consultative process within an organization, driven by directives or instructions at the highest levels. The organization's policy options must be responsive to the context of the surrounding society, and be sensitive to trade and market factors.

A number of principles that were originally developed for individual companies can also help in developing the environmental policy for an estate. One of the most important is the International Chamber of Commerce's Business Charter for Sustainable Development (see Appendix 1).

Possible environmental management strategies for industrial estates (see the 'Ladder of Environmental Management', right) range from providing a minimum of services

The ladder of environmental management



such as solid waste disposal and sewage treatment to more comprehensive approaches in which the estate authority plays an active role in encouraging resource conservation and waste reduction. At the top of the ladder are those industrial estates that have been designed as industrial ecosystems, in which waste materials and energy from some industries are used as inputs by others.

DEVELOPING ENVIRONMENTAL PERFORMANCE OBJECTIVES

Estate developers traditionally establish economic performance goals at the beginning of the project to demonstrate the financial viability of the development to its investors and ensure economic success. Similarly, environmental performance objectives, established early in the development, can help reduce the estate's impact on the environment. This section examines the types of environmental performance objectives an estate might adopt.

Environmental performance objectives are increasingly common for companies. They can also be set for the estate's own facilities and services, for contractors providing services within the estate, and for the estate as a whole.

Ports Corporation of Queensland, Australia Environment Programme

Objective

To ensure that all PCQ ports continue to operate where required, expand to provide the facilities and services required by port users with minimum impacts on the natural and social environment, consistent with; the PCQ Mission Statement, all relevant environmental legislation, government policies and the concept of Ecologically Sustainable Development.

Goals

- ❖ To seek to achieve ecologically sustainable operation and development of all PCQ ports.
- ❖ To continue to reduce the environmental impacts of port operations and developments.
- ❖ To ensure that all port operations and developments comply with all relevant environmental legislation and government policies.

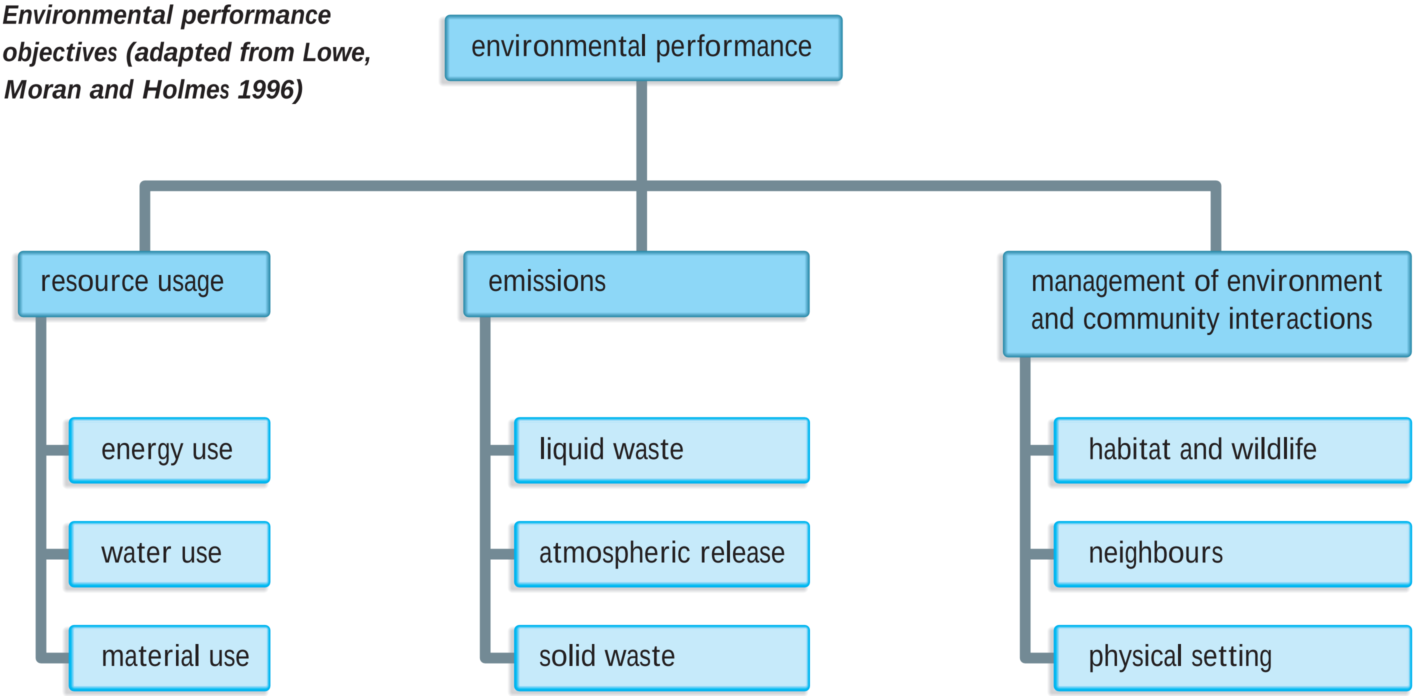
Performance indicators and outcomes

- ❖ Progress is made towards ecologically sustainable operation and development of all PCQ ports.
- ❖ No unacceptable environmental impacts are caused by PCQ activities, as measured by scientifically rigorous monitoring programs, while port operations and developments continue to proceed efficiently and cost effectively.
- ❖ All relevant environmental legislation and government policies are adhered to in the conduct of all of PCQ activities.
- ❖ PCQ is and is perceived to be an environmentally responsible organization.
- ❖ PCQ's success as a business and port authority is enhanced by its environmental performance and reputation.

Environmental management initiatives for ports

Environmental Audit (EP Act)
Environmental Management Plan for each port
Integrated Catchment Management (ICM)
Ballast Water Risk Assessment
Port Specific Oil Spill Contingency Plans
Ships' Waste Reception Review
R&D of Ballast Water Treatment Technology—CRC Reef Research Centre.

Environmental performance objectives (adapted from Lowe, Moran and Holmes 1996)



These objectives normally include overall pollution loads, resource efficiency and industrial safety. However, they can also be applied to factors such as habitat, landscape, biodiversity and species protection. While each estate must set its own objectives, guidance can be found in national policy objectives reinterpreted for the local level. Ideally, performance objectives should include quantifiable goals against which performance can be measured over a realistic time frame. Sometimes, however, as in the case of the Ports Corporation of Queensland (see box left), the aim is simply to reduce environmental impacts to the greatest extent possible.

Setting environmental objectives is a very site-specific affair, and the estate management team needs to determine the environmental issues which are important to it. In some areas, air quality may be a serious problem; in others, river or coastal water quality is a threat to health; in a few cases, the history of accidents involving hazardous chemicals may warrant more attention. Estate environmental objectives also need to pay regard to existing national policy statements, international agreements, policies of financing bodies and any environmental policies already adopted by tenant companies.

Setting objectives for the estate's own operations is easier than agreeing on objectives for the estate as a whole, especially for existing estates. However, the latter will need to be addressed in most cases where regulatory, public or investor pressure is strong.

Environmental policy for estates: Thailand

The Industrial Estate Authority of Thailand (22 estates, 9000 ha, 173 000 employees) has adopted an environmental policy that includes:

- implementation of a 'clean and green programme
- joint implementation with other community and business partners
- the adoption of advanced environmental technologies
- support for waste minimization and auditing
- environmental training of staff.

Development goals and objectives: Burnside Industrial Park, Canada

Halifax Regional Municipality has established goals and objectives for the development of land in the Burnside Industrial Park. These are:

'to ensure that the Park is developed in a manner consistent with superior aesthetic and environmental protection standards and with the declared intention of creating a pleasant and harmonious environment for the Park's residents by:

- providing a well planned and maintained development;
- protecting property values and enhancing the investment of businesses located in the Park;
- creating an attractive and efficient business environment through sound land-use planning and environmental management standards; and
- ensuring harmonious relationships among users.'

The following categories of environmental performance objectives were adapted from Lowe, Moran and Holmes (1996) as a contribution toward the development of a handbook on eco-industrial estates in the United States. The categories are:

- efficient resource utilization;
- reduction of environmental emissions; and
- management of environmental and community interactions.

The examples of performances objectives below are for the moment stated in non-quantitative form such as 'optimize', 'minimize' etc., but wherever possible estates should try to introduce targets and objectives.

Efficient resource utilization

Setting environmental performance goals for the efficient use of energy, water and materials will benefit individual industries and the estate as a whole. Some examples in this category are:

Energy and water use

- optimize total use for estate infrastructure and companies involved
- maximize use of renewable energy

Material use

- optimize total use within estate infrastructure and companies involved
- maximize use of recycled materials
- maximize recovery and recycling of solvents

Reduction of environmental emissions

This category could include reducing liquid, solid and gaseous emissions from industrial processes and estate activities, by setting absolute standards or targets, by percentage reductions, or by simply encouraging continuous improvement. It is important to include all the pollution parameters that are considered significant in national environmental policy. Some examples are:

Atmospheric

- minimize emissions of greenhouse gases
- eliminate use of ozone-depleting substances
- minimize release of SO_x, NO_x, particulates, VOCs, noxious odours

Solid waste emissions

- minimize solid waste generation and disposal
- maximize re-use of solid residues

Liquid waste discharges

- minimize amount of liquid residue requiring treatment
- minimize treatment burden of water effluent leaving an estate
- minimize or eliminate use of persistent hazardous materials

The reduction goal must reduce overall emissions without transferring wastes from one medium to another.

Management of environmental and community interactions

This is a broad set of objectives that aims to minimize impacts on both the natural environment and on neighbouring communities. Some possibilities are:

Habitat/wildlife

- ensure estate and its facilities protect or even enhance natural ecosystems and preserve wildlife
- maximize use of native plants in landscaping
- create artificial habitats on unused land.

Interactions with neighbours

- minimize negative impacts on neighbouring facilities
- ensure estate enhances the environment of people living in the area
- avoid negative impact between tenant companies

Interactions with the physical environment

- ensure estate and its operations do not result in the deterioration of physical landscape, surface water, groundwater, geology or the atmosphere
- reduce hazards involved with transport of hazardous materials

In existing estates, the management team can set quantifiable targets for these objectives through a consultative process with companies in the estate and preferably with government agencies and surrounding communities.

Operationalizing environmental performance objectives

Mechanisms to implement the objectives generally involve the following components: regulations or bye-laws, provision of estate infrastructure and services, information dissemination and training for site operators and companies. Estate management may decide to:

- establish covenants with industries and implement them according to a schedule;
- target selected industries to implement specific projects to serve as models for other industries; and
- build common wastewater effluent treatment or solid waste management facilities.

When new industries are attracted to the estate or submit proposals to build facilities in the estate, management must ensure that overall performance objectives are met. For example, where reducing emissions to the environment is an objective, estate management should establish specific targets or standards, provide a mechanism for monitoring performance and, where necessary, address the problem of companies that continuously fail to meet the standards.

The next section discusses the nature of the regulatory framework needed to meet the environmental performance objectives and assist companies in the estate.

A REGULATORY FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT

A balanced framework of sound and enforceable regulations will help define some of the management objectives. This framework can include national or local regulations, as well as bye-laws or covenants established by the estate itself. The question of enforcement (practicability,

'… where reducing emissions to the environment is an objective, estate management should establish specific targets or standards, provide a mechanism for monitoring performance and, where necessary, address the problem of companies that continuously fail to meet the standards.'

'A clearly defined framework provides an impetus for companies to meet the environmental performance goals.'

International conventions and recycling

A knowledge of the implications of international environmental conventions can be important to estate managers. For example, in banning the export from OECD to non-OECD countries of hazardous waste for recycling and recovery, the Basel Convention affects the ability of recycling companies in some estates to source their raw materials in industrialised countries. A company recycling lead/tin/antimony residues in the Jebel Ali Free Zone in Dubai was recently denied approval to import these wastes for processing. Sri Lanka has also refused permission for recycling companies to import wastes from India due to the difficulty of monitoring and controlling this trade.

transparency, effectiveness) is as important as the regulations themselves.

A clearly defined legal framework provides an impetus for companies to meet the agreed environmental performance goals. The next section describes some of the regulations and economic instruments that can be used in the environmental management of industrial estates.

Environmental law increasingly emphasizes goal setting and time frames for achieving specific performance measures, greater autonomy, and voluntary or self-regulation of industry within targets set through public/private collaboration. The core assumption is that industry personnel know the best means of achieving the goals. Their solutions are often more creative and cost effective. Estate managers should employ similar approaches in developing new requirements or revising existing bye-laws or covenants, rather than simply copying national 'command-and-control' legislation into estate bye-laws.

External regulations

As a rule, national environmental requirements apply to companies within an estate, either directly or because estates have copied them into their bye-laws. In some countries, the regulatory framework can be quite complex. For example, Japan has a number of statutes dealing with environmental issues to which industrial estates are subject. These statutes include:

- Town Planning and Zoning Act
- Town Greenbelt Conservation Act
- Port and Harbour Act
- Atmospheric Pollution Prevention Act
- Water Pollution Prevention Act
- Water for Industrial Use Act
- Noise Pollution Reduction Act
- Offensive Odour Prevention Act
- Agricultural Land Act
- Forest Act
- Natural Environment Conservation Act
- River Act

In some countries, similar legislation is complemented by statutes on environmental impact assessment, hazardous waste disposal and work place health and safety. This legislation is being increasingly amended or developed to implement international conventions and protocols such as those on the transport of hazardous wastes, ozone-depleting chemicals, climate change, marine pollution, endangered species and biodiversity.

In some jurisdictions, environmental agencies retain authority to apply laws and regulations to industries within the boundaries of an estate. Elsewhere a specific agency may be assigned this job. In Thailand, for example, the Industrial Estate Authority of Thailand (IEAT), a semi-public government agency under the jurisdiction of the Ministry of Industry, is responsible for environmental conduct within estates.

Within existing environmental regulatory frameworks, site-wide or umbrella permitting could ease the burdens of environmental management for companies as well as regulators. If such permitting came into more widespread use, significant benefits could accrue to estates and tenant companies through reduced government oversight and associated transaction costs.

Internal regulations

Even where environmental agencies implement national or local regulations and guidelines, owners or operators of industrial estates frequently establish additional bye-laws and rules sometimes referred to as 'covenants, controls and restrictions' (CC&Rs). CC&Rs are internal land-use controls and standards that are legally enforceable and applicable only to a specified property.

CC&Rs can include specific guidelines about site planning, landscaping and architectural design for industrial estates as well as efficient releases and emissions. They can be applied to virtually every aspect of business and industrial estate development (see box right).

Investors and lenders are becoming more cautious about projects that may pose liabilities from environmental contamination. CC&Rs illustrate to lending institutions that the owners have a long-term concern for the project. Tenants increasingly see CC&Rs not as a regulatory burden but as an assurance of the continuing quality of their industrial estate. In the United States, the Urban Land Institute predicts that the number of business estates with strict, detailed guidelines will climb swiftly. Quality standards codified in an estate's CC&Rs are viewed as a competitive advantage (ULI 1988).

A developer should not adopt CC&Rs designed for another estate without examining their suitability. Each estate is unique and requires a well thought-out set of CC&Rs that build on existing zoning controls and the natural environment of the site. If the site is sub-divided into special development areas (offices, retail etc.), separate covenants for each area could be considered. CC&Rs can be applied to the estate as a whole or can be applied to each deed.

CC&Rs and design guidelines should be based on the environmental performance objectives for the estate. For example design guidelines could stipulate that buildings must meet certain energy efficiency standards; and CC&Rs could stipulate that all companies send their wastewater to a common effluent treatment plant on-site.

Economic instruments

In some jurisdictions, user fees for services cover management costs incurred by the estate. Indirectly, such fees encourage waste reduction.

In some situations, economic instruments (market-based approaches) offer significant advantages over 'command-and-control' regulations. Economic instruments are flexible; companies can decide on the best methods to protect the environment, provided these methods meet established standards. Economic instruments recognise that companies can change their own behaviour—employees know how to improve their facilities, technologies, management and operating systems more effectively than any outside regulator.

Economic instruments for environmental control have not yet been widely used by estates; indeed, they have yet to become common in national environmental agencies. However, their potential should be considered by estate managers.

CC&Rs: the range of action

- ❖ declarations of intent, and statement of purpose of businesses;
- ❖ legal description of the property;
- ❖ permitted and/or prohibited land uses;
- ❖ nuisance restrictions;
- ❖ building design guidelines such as
  - setback requirements for buildings
  - type and size of buildings
  - maximum building height
  - building colour and material
  - building usage signs
  - storage requirements (exterior and interior)
  - parking (location and space);
- ❖ design or architectural review procedures;
- ❖ regulations for odour, smoke emissions and noise;
- ❖ landscaping and maintenance requirements;
- ❖ safety regulations;
- ❖ requirements for pre-treatment of wastewater where estates provide common effluent treatment services;
- ❖ operational requirements and zoning; and
- ❖ percentage of site covered by structures or parking lots.

Slough Estates PLC

This private industrial property investment and development company operates estates in the United Kingdom and Canada. At least one of its estates has its own water supply, and generates electricity and steam for use by tenant companies. Slough Estates conducts environmental assessments of all development projects and continually assesses the environmental impact of the activities and processes of its tenants.

The company ensures that all buildings comply as far as possible with the latest standards of good environmental practice for building materials, energy and water conservation, ventilation, etc. It encourages tenants to operate with continuous environmental, health and safety improvement in mind. At a minimum, all tenants must commit themselves through the lease to observe all environmental regulations and the stipulations of estate's covenants.

Economic instruments can include incentives (+) and penalties (-). Some of the instruments potentially applicable to industrial estates are:

- development impact fees (-)
- depletion charges on resource use (-)
- user charges for use of sewers and disposal of solid waste (-)
- deposit-refund system to encourage reuse and recycling of containers
- lower rental fees for conservation and efficiency (+)

Other economic instruments that can be developed in cooperation with national government include:

- loans to assist with lengthy pay-back periods for some new technologies (+)
- accelerated depreciation allowances (+)
- emission charges applied to discharges to air or water (-)
- differential taxes applied to environmentally-damaging products (+, -)
- charges applied to polluting activities or products (-)
- tradeable or marketable permits based on the total permitted pollution load (+)
- administrative or judicial fines (-)

The instruments which are most likely to be applied in the near future are user charges or fees. These can be applied to water services, disposal of wastewater into sewers, collection and disposal of solid waste, storage and treatment of hazardous waste, etc. User charges can be collected on a weight or volume basis to develop and maintain specific environmental services.

PROVIDING ENVIRONMENTAL SERVICES

A 1978 UNIDO report on industrial estates listed some of the services that were provided either directly or through contracted companies to increase productivity. These included centralized workshops and production services, extension services for advice and training, and inter-firm cooperation in contracting, purchasing and marketing. The report did not specifically address environmental services but experience shows that many environmental services can be usefully provided by estates.

The provision of environmental services will help an industrial estate meet its environmental performance objectives, earn the estate new revenues and enhance the marketability of the estate itself. The nature and extent of the environmental services is determined partly by the values and principles adopted by the estate, the nature of state legislation on environmental performance, and the availability of financial and human resources.

The environmental services that can be offered by estates range from the simplistic and traditional to the complex and innovative. They include the following areas, each of which is discussed in more detail in the text that follows.

- water services
- access to waste heat (from energy source)
- sewage collection
- sewage treatment

- industrial liquid waste collection and treatment
- hazardous waste storage and destruction
- solid waste collection
- landfilling
- energy from waste
- environmental monitoring
- environmental auditing
- waste material exchange
- multi-material resource recovery
- environmental training
- environmental operations and information centre
- emergency preparedness and response capability

Water services

Water is a resource that must be carefully managed with a fee schedule that encourages conservation. Where there are water shortages, estates can harvest water from roofs and paved areas, and make it available to users. Buildings can be designed to incorporate collector systems for rainwater and gray water. Rainwater can be used to flush toilets and wash floors. Gray water can be used for the irrigation of gardens and lawns. Estate management can encourage conservation by providing tenants with water-saving devices. This can extend the life span of existing water supplies, and eliminate or postpone the need to search for new supplies.

Use of charges in Thailand

Charges for water used by hotels along Thailand's eastern seaboard are so high that the hotels treat and recycle their water for garden irrigation. Although these charges are applied to hotels rather than companies on an estate, a similar approach could be taken in industrial estates facing water shortages.

Bartone et al. 1994

Energy

Most energy-generating facilities use non-renewable resources and emit significant quantities of greenhouse gases. Cogeneration and energy-storing arrangements can be used to reduce the need for primary generating capacity. The estate can also provide an energy-saving audit service or encourage a private firm to provide this service.

Industrial waste collection and treatment

Most countries apply the 'polluter pays' principle, and on an estate this implies that each industry should construct its own treatment facilities. However, the responsibility for treatment can be wholly or partly transferred through contractual arrangements to a public or private industrial waste treatment entity. In many instances, economies of scale produce greater efficiency (see box on Jeedimetla Effluent Treatment Limited in Hyderabad, India).

Prior to discharge into sewers or tank trucks operated by the estate or an effluent treatment company, pre-treatment of one or more waste streams may be required by law or contract to protect sewers and the integrity of the treatment system.

Jeedimetla Effluent Treatment Ltd., India

Jeedimetla Effluent Treatment Ltd. was established in 1987 by a number of chemical and pharmaceutical firms in and around the Jeedimetla Industrial Estate on the outskirts of Hyderabad, India, to treat their wastewater efficiently. The company has a staff of 47 including a manager, environmental engineers and chemists. It is equipped with tank trucks, an equalization tank, an aerated lagoon, an intermediate clariflocculator, an aeration tank, a secondary clarifier and a laboratory.

A firm enters into an agreement in which it purchases shares in Jeedimetla Effluent Treatment Ltd. and agrees to send its industrial effluents to the treatment company. The latter agrees to use its tankers to collect the member firm's wastes which have been held in storage tanks. A collection schedule is arranged and the fees are based on the Chemical Oxygen Demand (COD) of the waste.

To reduce the cost of treating increasingly complex effluents from some firms, the estate has been offering waste-reduction services to its customers. Implementation of these measures has benefits to both parties.

Sewage collection and treatment

The estate should be designed with either sewers or septic holding systems for sewage. Sewage must be treated to a level that allows it to be discharged without breaching the water quality standards of the area. If the discharges are free of toxic compounds, sewage sludge can be composted and used as fertilizer.

Solid waste collection and disposal

Estate management may have to organise a solid waste collection system. In some countries, the public sector manages such services which may then be contracted to waste management companies. In others, the services are arranged directly between the generator of the waste and the collector. Fees can be set at a level which covers the costs of the system while encouraging waste reduction. Waste materials can be separated and collected for reuse, recycling and composting. Disposal facilities need not be sited within the estate although a multi-material resource and recovery facility may create a new business opportunity.

Hazardous waste collection, storage and destruction

Because of the risk to human health and the environment, highly toxic, corrosive, flammable and explosive wastes require special collection equipment and storage facilities. Although there are legal and economic liabilities associated with hazardous waste storage and destruction facilities, the existence of such services may attract new industries to the estate as in the case of Penang (see box).

Hazardous waste facilities, Penang

The Penang Development Corporation in Malaysia provides incentives to encourage the setting up of proper facilities for storage, treatment and disposal of toxic hazardous wastes.

Those companies which are themselves waste generators and wish to establish facilities to store, treat and dispose of their wastes are eligible for a special allowance at an initial rate of 40 percent and an annual rate of 20 percent for all capital expenditure.

As a further incentive, both categories of companies will enjoy import duty and sales tax exemption for machinery, equipment, raw materials and components for storage, treatment and disposal of toxic and hazardous wastes.

Environmental protection equipment is given an initial allowance of 40 percent and an annual allowance of 20 percent to enable the full amount to be written off within 3 years.

Environmental monitoring

Government regulations and estate covenants may require reporting of waste emissions on a regular basis. Unless cluster permitting has been established between the estate and the government regulatory agency, each company will have to monitor its discharges. The estate can help set up a monitoring service on a contract basis. The estate itself may also want to monitor air and water quality as well as odour and noise in order to assure companies, the work force and surrounding communities that environmental objectives are being met.

Analytical services

Laboratories are an essential support mechanism to assure quality of raw materials, assess product quality, measure emissions and assess the quality of the receiving environment. Large estates can establish common laboratories as a profit-making venture or encourage private laboratory companies to set up within the estate.

Waste exchange clearing house

Waste materials and energy can be valuable by-products to other firms. A passive waste exchange can be operated strictly as a ‘match-making’ service between two or more companies. The opportunity also exists for an active waste exchange and clearing house. This type of service requires a willingness on the part of companies to list inputs and outputs. Where no exchanges are initiated but wasted material or energy is available, estate managers can use the availability of these by-products to attract industries that need them.

Estate management can develop a waste transfer station in the estate to provide a place for materials that can be recovered, reused or recycled. Industrial estates can profit from the sale of these materials once a market is found. One idea is a facility that accepts reusable construction and demolition materials or reusable packaging.

Environmental audit services

Audits are being increasingly required by lending institutions and regulatory agencies for compliance purposes. Energy, health and safety, and environmental audits have in the past shown that there are many opportunities for improving efficiency, reducing waste and protecting the environment at the same time. An audit service provided by the estate is another means of helping businesses and improving the environment. An innovative approach for paying for audits is a contractual arrangement between the auditor and the company in which the former receives a percentage of the savings resulting from improvements in efficiency.

Multi-material resource recovery

Recovery of materials from solid waste is an increasingly common practice, sometimes called scavenging. Estates can construct multi-material resource recovery and sorting facilities to ensure reuse and recycling of materials. At least some of the cost of the operation can be recovered by sales of the materials to companies in the estate. Vegetable waste, soil and sludge can be composted and sold as fertilizer within the estate.

Training and education

Estates can offer training courses on a wide range of health, safety and environmental topics. Courses can include general environmental training awareness, cleaner production technologies and processes, occupational health and safety, environmental auditing, housekeeping techniques for specific types of industries, and general environmental management techniques including ISO 14000. Specialized courses, seminars and workshops for management and employees are more effective if employers organizations, industrial federations and unions are involved.

A need may also exist to offer decentralized training within individual facilities. A 'train the trainers' programme in which people from each company are trained in selected topics aimed at improving efficiency and reducing waste is worth considering. This approach can benefit the entire estate. Such services can:

- improve the operating efficiency of individual companies through the promotion of cleaner production;
- reduce risks from handling hazardous materials;
- reduce risks to the environment in and outside the estate; and
- make waste treatment more reliable.

It may be possible for the estate to subsidize such a programme but it would generally be paid for with fees from the users.

A waste audit

- defines sources, quantities, and types of wastes being generated
- highlights process inefficiencies and areas of poor housekeeping
- helps to set targets for cleaner production
- permits the development of cost-effective waste management strategies
- raises awareness of the benefits of cleaner production and
- helps to improve process efficiencies.

UNEP IE 1996a

Waste management options in the Dominican Republic

Under legislation in the Dominican Republic, industries in 'free zones' can accept raw material deliveries but cannot send wastes out. However, disposal options in the zones are limited. In one of the zones, employees at the Fenwal Facility, collaborating with the US Environmental Training Institute, organised a series of workshops on waste management and pollution prevention. The zone is now developing a waste management plan for itself, which will also serve as a model for other zones in the country.

Environmental operations and information centre

Environmental performance requires on-going management. An industrial estate can establish an operations and information centre to coordinate the management of environmental services. This centre can:

- disseminate information to new clients on the estate's environmental performance objectives and services;
- gather up-to-date information on industrial environmental management strategies and technologies;
- network with organizations such as UNEP's International Cleaner Production Information Clearinghouse (ICPIC) and the International Environmental Technology Centre (UNEP IETC) and national environmental agencies;
- provide environmental management training services for tenant companies;
- provide a newsletter on environmental management activities in the estate;
- develop information systems to support the environmental management of industrial estates, such as geographic information systems (GIS) which incorporate data on landscape, land use, climate and infrastructure;
- provide technical assistance for companies; and
- coordinate a waste materials exchange.

Emergency preparedness and response

Even with the best planning and management, some industrial accidents and environmental emergencies will continue to occur in the transport, handling, manufacture, storage and disposal of industrial chemicals. The high density of operations within an industrial estate makes this a high risk area.

Preventing the occurrence of industrial accidents for the protection of workers, the public and the environment is a first priority, and many estates have established programmes for this. The second step is emergency planning. The following strategies can reduce both the risk and the consequences of industrial accidents:

- reduce or minimize company and estate use of hazardous materials;
- ensure dangerous industrial operations are at safe distances from one another;
- undertake risk assessment of facilities and activities;
- operate safe hazardous waste disposal and treatment facilities;
- provide occupational health and safety training;
- introduce emergency procedures and regular drills to deal with accidents such as spills, explosions and fires; and
- ensure cooperation with local governments and communities.

UNEP IE's APELL (Awareness and Preparedness for Emergencies at the Local Level) programme is designed to prevent technological accidents and to reduce their impact when they do occur. This is done by helping decision makers and technical managers to increase community awareness of hazardous installations, and to prepare response plans in the event that accidents at these installations endanger life, property or the environment. A guidebook is available from UNEP IE to help local authorities,

Paint plant fire empties homes

'Fire in a paint plant on Thursday sent exploding canisters flying and nearby residents fleeing as thick smoke spiralled over an industrial estate near Montreal.

'Firefighters struggled for several hours with flames shooting through the UPC-Solignum paint manufacturer. The intense heat set off explosions in cans of paint and other chemicals stored at the plant.'

The Chronicle Herald,
Halifax, Nova Scotia
24 May 1996

industrial managers and community groups to develop emergency response plans cooperatively through a 10-step plan (see box and UNEP IE 1988).

The International Labour Office (ILO 1991) code of practice also provides guidance in setting up an administrative, legal and technical system for the prevention and control of hazards. It emphasizes employee training and education, the hazards of the work place, and emergency response (International Labour Organization 1994).

The general framework for such prevention and emergency preparedness needs to be set out by the estate. Concrete measures for risk reduction are, however, taken by individual companies. It is important that employees are made aware of:

- the chemical names and composition of hazardous substances;
- the hazardous properties of such substances;
- the hazards of the installation and precautions to be taken;
- full details of the emergency plan for handling a major accident on site; and
- full details of their emergency duties in the event of a major accident.

In many large industries, jurisdictional occupational health and safety committees must be established. These committees facilitate information transfer between company management and its employees.

FINANCING ENVIRONMENTAL MANAGEMENT SERVICES

Industrial estate management can finance its environmental services by charging appropriate fees to its tenant companies. Charges can be applied for effluent treatment, solid and hazardous waste recovery, audits, training and technical advisory services.

APELL's 10-step approach to emergency planning

1) identify possible participants and their roles and resources
2) evaluate potential hazards
3) have participants review their existing emergency plans
4) identify responses not covered by existing plans
5) match the resources needed to cover these omissions with those of the participants
6) change existing plans as necessary and integrate them into an overall community plan
7) commit the plan to writing and obtain local governmental approval
8) educate and train participants in the plan
9) establish procedures for testing, review and updating
10) educate the general community about hazardous materials and preparedness.

UNEP IE 1988

Environmental Enhancement Centre, Thailand

The Environmental Enhancement Centre of the Industrial Estate Authority of Thailand is a technology transfer and information centre. Its focus is on pollution control, clean technology, environmental management and industrial safety to encourage awareness and sustainable development of industry. The Centre provides information to entrepreneurs, consultants and technocrats on such topics as wastewater treatment, waste management, waste minimization, recycling, air pollution control, energy conservation and industrial safety technology. The Centre also has an annual seminar programme providing opportunities for firms and consultants to present information on technologies to industrial operators, consultants, entrepreneurs, government agencies and academic groups. Finally, the Centre provides exhibition space for display and demonstration of environmental technologies.

The Board of Investment of Sri Lanka

The Board of Investment of Sri Lanka was established to encourage foreign investment and enter into joint ventures with local industries to establish export processing zones. Each proposal requires an initial environmental assessment and adherence to the environmental, fire and safety guidelines developed for these zones by the Board of Investment based on national standards. The Board supplies infrastructure and services including road access, electrical power, a treated water supply, telecommunications, sewage collection and treatment, and solid waste disposal.

An Environment Department has been created by the Board to plan and arrange environmental aspects arising from estate development and operation. The Department has been assigned responsibility for implementing the guidelines, rules and regulations established by the Board and the National Environment Authority.

The Environment Department provides advice on the siting of industries, control of air, water and noise pollution, and disposal of solid waste; monitors wastewater treatment plants and other pollution control equipment; and operates a laboratory.

These services need not be implemented by industrial estate management itself; companies can be hired to operate them. Universities and other training institutions can also provide education and laboratory services to the estate and its constituent companies. Estate management needs to recruit and coordinate these services and charge fees to its tenants. A major advantage of providing these environmental services is that the improved environment of the estate and the performance of its tenants should translate into higher sales prices and rents as well as savings in operating costs.

Development and investment banks prefer to support estates that are committed to reducing environmental liabilities and improving efficiency of resource use. Some insurance companies also require firms and industries to commit themselves to a certain level of environmental management. In November 1995, 14 international insurance companies signed a Statement of Environmental Commitment with UNEP, agreeing to include environmental management performance as a core insurance requirement.

MANAGING THE ENVIRONMENTAL RESPONSIBILITIES

Managing an industrial estate has always differed from the management of commercial and residential buildings because it is, in essence, a community of individual buildings and interests. Estate managers must find a way to balance individual and community interests because there may be conflicts between competing responsibilities (ULI 1988). This section explores how environmental management systems, economic instruments and regulatory measures can help an estate manage its environmental performance.

Management responsibilities for industrial environmental affairs may be divided among the following:

- tenant companies
- building owners
- managers of infrastructure and environmental services
- private owners of the estate
- government or contract managers of the estate
- a government-owned estate management authority
- government regulatory authorities.

Responsibilities are often distributed among a number of government bodies. For example, in Japan, the agencies involved include national bodies concerned with location policies, land utilization plans, economic instruments and environmental regulations; the regional development corporation involved with promotion, development surveys, land preparation plans and financing; regional and local government bodies involved with land acquisition and preparation, local incentives, and industrial estate operation and management. Other related agencies are involved in enterprise placement and training for specialists.

In North America, municipal and county governments as well as private developers are responsible for the management and promotion of estates. They are subject to normal industrial and environmental regulations. Estate managers sometimes impose additional bye-laws or covenants.

In some countries, estate managers are simultaneously developers, promoters, regulators and providers of essential services. These responsibilities can conflict with one another; for example, when the manager is expected to maximize industrial activity while protecting the quality of the community and environment—an activity which may impose costs on tenant companies.

Some countries, such as Thailand, have created specialized agencies to develop and manage industrial estates. Established in 1972, the Industrial Estate Authority of Thailand (IEAT) carries out government policy to promote systematic and orderly industrial development that avoids problems of pollution, inadequate infrastructure and social disruption such as that experienced following rapid industrial growth in the late 1950s. IEAT sets out to solve these problems by grouping factories into industrial estates to enable effective environmental management. The objectives and responsibilities of the Industrial Estate Authority of Thailand are:

- procurement of suitable land for establishment or expansion of industrial estates;
- provision of services such as roads, drainage systems, wastewater plants and buildings;
- surveying, planning, designing, construction and maintenance of facilities;
- determination of industrial activities, including their categories and sizes;
- control of estate operations in accordance with rules and regulations relating to public health and environmental quality;
- provision of investment, including arrangements for loans and issuance of bonds or other instruments to finance IEAT activities; and
- supervision of living conditions of workers.

The estate management authority is usually concerned with one or more of the following functions:

Planning
- identifying possible sites
- conducting environmental impact assessment
- selecting sites
- undertaking pre-planning
- transport of goods, materials and people
- designing layout

Operating
- constructing infrastructure and services
- operating infrastructure and services
- designing individual facility sites
- constructing facilities
- landscaping sites

Control
- monitoring emissions and media quality
- enforcing regulations or covenants
- auditing environment
- reporting on environmental performance of companies and estate.

The establishment of a coherent and integrated environmental programme within an estate is best achieved through the

'Development and investment banks prefer to support estates that are committed to reducing environmental liabilities and improving efficiency of resource use.'

Environmental bye-laws: Sri Lanka

The Sri Lankan Board of Investment supervises the export processing zones in Sri Lanka and administers the environmental licensing procedures established under national law. The BOI assessment, permitting and annual licensing procedures cover the following points:

- classification of industries, and buffer zones applicable
- limits for effluents discharged into common treatment systems
- limits for effluents discharged from common treatment plants
- drinking water standards
- air emission standards
- noise level criteria
- information on chemicals used within the estate.

An EIA is required prior to the establishment of any new zone.

EMS principles

An environmental management system (EMS) defines the organizational structure, responsibilities, procedures and resources for implementing environmental actions systematically. An EMS is driven by high-level, explicit decisions on environmental objectives and targets. Many systems are now being built around international standards such as ISO 14 001 (see box on p. 25). ISO 14 001 does not itself set standards or provide objectives—it is a management tool, not a regulation. To introduce an EMS effectively, an initial environmental review needs to identify all relevant issues, the current level of emissions and wastes, and any environmental liabilities. Periodic audits are carried out to ensure the system is functioning properly. ISO 14 010 will eventually provide an auditing standard for internal and external auditors of EMS.

Further details about building an environmental programme in the framework of an EMS can be found in Appendix 4.

development of a formal environmental management system (EMS). Such a system describes the management framework for the estate's action programme and defines the responsibilities of companies within the estate, while acknowledging also the jurisdiction of other agencies concerned with the environment (see box left). The EMS process can be initiated by a senior staff member with top management support.

Some industrial estates establish a tenant association that plays a valuable consultation and communication role as well as assisting in the maintenance of the estate and enforcement of bye-laws or covenants.

MEASURING PERFORMANCE AND REVIEWING THE MANAGEMENT SYSTEM

The value of regulations, covenants, controls and restrictions, or economic instruments, are only as good as their enforcement. Monitoring, auditing and reporting are necessary elements and may be undertaken by any of the stakeholders in an estate. Monitoring by regulatory agencies is especially important.

Monitoring needs within an estate include:

- ambient environmental quality on and adjacent to the site;
- concentrations and qualities of pollutants discharged to sewers and receiving aquatic environments;
- concentrations and qualities of pollutants discharged to the atmosphere;
- quantities and types of solid waste discarded;
- quantities and types of hazardous waste produced;
- spillages;
- quantities of dangerous goods stored on site; and
- adequacy of safety and pollution control procedures.

Reports on environmental performance may be used by an estate to differentiate itself from competitors, to demonstrate regulatory compliance and to demonstrate an overall commitment to the environment. Industrial estate managers should also encourage companies to report on their own environmental improvements.

If the estate and its tenant companies are committed to continuous improvement, updating and adjusting the objectives and possibly the management system itself will be necessary. In addition, environmental issues and priorities are evolving as new knowledge and information is gained. In some circumstances, the performance review may require corrective response measures such as dissemination of information, technical assistance as well as levying fines, revoking permits or other services, and banning certain substances.

Environmental audits have become an important management tool. As the *Environmental Management System Training Resource Kit* (UNEP, ICC and FIDIC 1996) states: 'A periodic audit of the enterprise's environmental performance will indicate how well the EMS is performing and what modifications are needed'. Audits are systematic and documented verification processes designed to determine conformity with policies, objectives and procedures. They should be seen as an integral part of the system.

MOTIVATING COMPANIES' ENVIRONMENTAL ACHIEVEMENT

Incentive and recognition programmes can help motivate companies and their workers. They can give firms and employees in an industrial estate encouragement to implement pollution prevention, energy efficiency and other environmental management programmes. Within the close community of an estate, many opportunities exist to use the recognition factor to good effect.

An annual Environmental Award can help establish the importance of environmental performance. Many corporations recognise economic performance and some countries and industrial associations have established environmental awards for progressive businesses. This also occurs in the health and safety area. Many companies in Canada display signs listing the number of days operated without injuries or accidents. A similar approach by estates can generate support for environmental programmes.

MARKETING ENVIRONMENTAL QUALITY

Environmental services within an industrial estate can be marketed as economic benefits and amenities. Companies are increasingly interested in locating in an industrial estate that places a high priority on environmental performance and attractive surroundings.

Estate management often develops technical service packages to attract clients. These packages include information on transportation, utilities, design, taxes, labour

Jebel Ali Free Zone, Dubai

The Jebel Ali Free Zone in Dubai is the largest engineered port and industrial estate in the world. In 1995, 793 companies were located there. Land in the area is zoned by industrial types such as oil-related industries, chemical industries, heavier industries, light industries, servicing workshops and warehousing.

The Authority responsible for the estate established the Free Zone Industrial Operations Control Department. This Department developed manuals for health and safety standards and for environmental control requirements. In addition, the Department conducts environmental reviews and provides additional guidance on health, safety and environment as required. The Zone applies its own environmental standards within its jurisdiction although it tries to ensure compatibility with general regulations in force in the surrounding municipality. The Department monitors air quality within the zone as well as quality of effluents from sewage treatment plants operated by the Department using its own laboratory service. Treatment of industrial effluents must be undertaken by the companies themselves but the Department does advise companies on cleaner production and recycling opportunities. Finally the Department conducts inspections of companies to assure compliance with regulations.

This assessment, compliance and monitoring system has spawned a private environmental service industry within the Free Zone.

'An industrial estate that protects its environmental assets and has been planned and managed to ensure flexibility and adaptability is likely to maintain its economic advantage in the face of changing markets.'

Biodiversity and habitat: Boulogne-sur-Mer, France

The latest industrial estate for Boulogne-sur-Mer in northern France included a contract between the land developer and relevant stakeholders to compensate for clearing 14 hectares of the site. Twenty-one hectares of new forest have been created to provide animal habitats and recreation areas for people. The plantation was completed along with other basic infrastructure before companies arrived on site.

pool, parking and landscaping. The environmental performance objectives and available services should also be included.

Many countries now have methods of eco-labelling superior environmental products. An estate can promote similar schemes to improve the marketability of products manufactured within the estate and exported to countries with high environmental performance standards.

ATTRACTING INDUSTRY

Estate managers can attract businesses that produce environment-friendly goods, that are efficient in their consumption of energy and natural resources, and whose products and by-products can be recycled, reused or disposed of safely. Some estates have encouraged waste treatment companies to locate there (see box on Penang, page 34).

Some estates restrict heavily polluting industries. However, others attract these types of industries to act as central business hubs. If large industries such as oil refineries and power stations locate in the estate, these industries must agree to meet the estate's environmental performance objectives and find ways of using waste materials, heat and energy.

An industrial database and information network can help industrial estate management attract companies that use each other's wastes as feedstock and enable companies to discover the added benefits of co-location in an estate.

KEY ISSUES

The primary focus of an environmental management system in an industrial estate is the prevention of risk and negative environmental impact. While prevention and action may appear costly, remediation is generally still more expensive in economic, political and social terms. In some cases, environments degraded by industrial activity can be lost for further economic opportunities because they cannot be repaired. On-going planning involves keeping options open for the future. Assessing present performance and changing market demands provides estate managers with the information they need to redevelop industrial estates as necessary. An industrial estate that protects its environmental assets and has been planned and managed to ensure flexibility and adaptability is likely to maintain its economic advantage in the face of changing markets.

The key steps involved in the environmental management of an industrial estate are:

- developing an environmental policy and performance objectives for the estate;
- setting up a regulatory framework;
- providing environmental services and financing the environmental management programme;
- monitoring performance; and
- marketing the environmental quality of the estate.

PART II:
THE GUIDELINES

ENVIRONMENTAL GUIDELINES FOR NEW INDUSTRIAL ESTATES

The guidelines that follow do not include all the technical, economic and environmental requirements needed for planning a new industrial estate. Instead, they augment other industrial estate guidelines by emphasizing the key provisions for sustainable industrial planning and development (for other types of guidelines see Urban Land Institute 1988; Meehan 1986; National Association of Industrial and Office Parks 1988; and UNIDO 1978b).

Environmental management options are provided for the following operations:

- defining potential clients
- selecting the site
- evaluating potential environmental impacts
- evaluating potential socio-economic impacts
- designing the site
- increasing density of development
- using environmentally-sensitive construction methods
- developing environmentally-appropriate infrastructure
- planning for operations.

Estate managers will have to interpret the guidelines according to the environmental role and responsibilities assigned to them. A larger role in planning, provision of services and measurement of performance will influence the success of the environmental management framework established for the estate.

These guidelines may also be useful to individual lots within an estate, and should *be used in conjunction with* other environmental guidelines prepared for industry.

DEFINING THE POTENTIAL CLIENTS

It is important to define the potential businesses to be included on a new estate—for example, heavy industry, light manufacturing or service industries—because this will determine the environmental performance of the site, the regulations or bye-laws that will be needed, and the amenity level and services that will need to be offered.

These factors will also influence site selection, along with others such as whether the estate will sell land, lease buildings or construct tailor-made buildings, whether there will be access to rail, port or flight facilities or airport, whether large volumes of water will be needed and whether there will be large emissions and wastes. Answers to these questions will rule out many potential sites.

A useful strategy is to attract businesses that are either clean or green industries, and those that have a high potential for energy or waste exchange with existing businesses (see box).

Attracting green businesses

The profile for future businesses that locate on estates where the environment is highly valued may include some or all of the following attributes:

- existence of a corporate environmental policy
- ISO 14001 or EMAS certification
- an effective environmental programme
- use of clean technology
- energy/water efficiency
- production of ‘green’ products
- potential for industrial symbiosis involving materials and energy
- environmental service company.

SELECTING THE SITE

Selecting appropriate sites for industrial estates involves a comprehensive planning process in which a management agency examines all of the relevant variables, identifies locations that meet key criteria, considers the environmental and socio-economic impacts, and then acquires the site. A multidisciplinary planning team should be set up at the beginning of the planning process. The team will include the ownership group (estate manager), the financial advisor, the site planner/engineer, the marketing specialist, economists and environmental specialists. Some estates establish partnerships with local economic development agencies, community groups and universities to acquire additional expertise during the planning phase. Hiring experts who are not normally involved with industrial estate planning can also be an asset. For example, ecologists can identify natural features on the site that provide environmental and economic benefits to the estate, and hydrogeologists can identify effective means of supplying water for the site.

There are several useful rules that will help in making sound environmental decisions about site selection.

- Stay clear of environmentally-sensitive areas such as wetlands and high quality agricultural land. Poorly-placed industrial activity may limit other potential land uses and may interfere with natural processes, significant indigenous habitat or endangered species. Successful site selection thus involves identifying sites where environmental impacts can be minimized by good site planning and management.
- Develop on gently sloping land with poor soils and limited vegetative regrowth. Areas prone to floods, mud slides and earthquakes are generally neither cost-effective nor environmentally-appropriate and will always require additional safeguards.
- Re-use previously developed sites to help contain urban sprawl and avoid consuming agricultural land, mangroves, wetlands or other significant habitats outside the city. In many cases, such sites already have transportation facilities and other infrastructure in place. Improvements and/or expansion of these services cost less than on virgin tracts (National Council for Urban Economic Development 1995). Prior to choosing a previously developed site, investigate the land to ensure the absence of toxic waste, underground storage tanks, asbestos, and other forms of on-site ground, air and water pollution. Without careful assessment of the previous site conditions, the developer could be held liable, economically and legally, for remediation and environmental impacts. In the United States, urban industrial estates (UIPs) are increasingly located in the central areas of major cities. Give careful consideration to the types or sectors of industries that will be permitted to locate in urban areas.

EVALUATING POTENTIAL ENVIRONMENTAL IMPACTS

Possible environmental impacts will depend partly on the nature of the industries that wish to locate in an estate. Information can be requested from the companies themselves (as for example in Dubai where an EIA is undertaken for each company), or existing literature sources can be used to find the information independently. UNEP, WHO, the World Bank and other organizations publish digests of common industrial processes and their likely impacts. This company-specific evaluation is normally undertaken in the operational phase, although estates may also decide to prohibit certain polluting industries in order to ease

Advantages and disadvantages of site conditions

Condition at site	*Advantages*	*Disadvantages*
High wind exposure	Opportunity for wind generation; minimum potential for atmospheric inversions	Increased heating needed in winter
High sun exposure	Opportunity for solar generation; less heating needed in winter	Increased cooling needed in summer
Location near surface water; natural drainage and depressions	Potential for cost-effective integration of landscape into water management system	Higher potential for contamination of surface water
High rainfall	More water available	Greater water management challenges
Farm land	Relatively low potential for site contamination;	Loss of productive farm land
Valleys	Aesthetically pleasing	Potential for inversion and build up of air pollutants
Undisturbed land	No site contamination; no loss of productive farm land	High potential to disturb natural habitat
Industrial land	No loss of productive farm land; low potential for loss of natural habitat	High potential for site contamination
Proximity to residential areas	Potential to substantially reduce vehicle emissions from commuting	Potential limitation to types of industrial tenants
Proximity to railway	Potential to substantially reduce emissions from trucks	May restrict siting options
Proximity to industrial infrastructure	Minimizes truck traffic within community, resulting in lower emissions and other benefits	Possible additive or synergistic effects of emissions
Proximity to industry	Potential to form material or energy exchange transactions that result in reductions in wastes and demand on resources	Increased loading on local and regional environment
Location over major aquifer	May increase (or decrease potential for heating with stored solar energy	Increased potential for contamination of groundwater

Devised by Lowe, Moran and Holmes, 1996

Site development and building standards for Burnside Industrial Park, Canada

The Halifax Regional Municipality has established standards in many areas for the development of sites and construction of buildings in Burnside Industrial Park. These areas include:

- soils examination
- site excavation
- sanitary services
- storm water services
- fire insurance
- site coverage
- setback requirements
- permitted construction material
- building-to-parking ratios
- lighting
- standards for parking
- vehicular movement
- pedestrian safety
- loading areas
- fencing
- natural water courses
- landscaping
- erosion
- signage

the burden on the treatment plants to be provided by the estate. In this sense, industries that release effluents that are difficult to treat in common treatment plants (such as textile mills and pharmaceutical manufacturers) may need to be excluded or subject to special conditions.

As well as the expected impact from individual plants, an estimate must be made of the total environmental load that could occur when the estate is fully developed.

The impact that will finally occur depends greatly on the nature of the surrounding environment, and its animal and plant inhabitants (including humans). At the planning stage it is therefore necessary to study the sensitivity of the local environment to pollution by examining baseline environmental data for the area. If this is not already provided, it will have to be generated by special surveys that are completed before planning decisions are taken. This process is normally part of an EIA (see box on page 15).

For complex situations it may be necessary to model the environmental interactions that are likely to arise from a hypothetical set of industries. This applies particularly to air pollution and perhaps to wastewater discharges to coastal or inland water bodies.

Obtaining the necessary environmental or pollution information, either from industries or from local communities, often requires a certain amount of tact and skill, and the quality of the information obtained should be carefully checked.

The large amount of complex data that are inevitably collected means that the estate must have an assessment team trained to carry out this task. Skills needed include at least monitoring, data evaluation, risk assessment, and communication. Decision-support systems such as modelling are also often required.

EVALUATING POTENTIAL SOCIO-ECONOMIC IMPACTS

The first step is to locate social and economic information on the area, or conduct a baseline survey to determine the nature of this information in the area.

The possible negative and positive social and economic impacts on the area must then be evaluated. Unless there is strict enactment and enforcement of zoning laws in the vicinity of the industrial estate, unplanned residential areas (squatters) may develop. These residential settlements will be at risk if industrial accidents occur. The Bhopal accident in India caused many countries to review their controls but the possibility still exists. In Canada, three levels of government and industry have collaborated in a Major Industrial Accident Coordinating Committee to assess risk factors and develop strategies for reducing them. When population migration can be expected, estate planners need to make provisions for establishing local heath and sanitation infrastructure.

The site selected should not require established residential communities to migrate when the site is developed. Involuntary resettlement disrupts communities socially and economically because of lost income sources from previous land uses such as farming and forestry (World Bank 1991). If resettlement is really unavoidable, develop a resettlement plan to ensure that displaced people have a chance to improve or restore their standards of living.

DESIGNING THE SITE

It is important to design the internal layout of the estate bearing in mind key planning principles: land use and efficiency, health and safety protection, and environmental protection. This will enable estate owners to realize the maximum market value for properties within the estate (Shepherd 1979).

Six basic principles of ecologically-sensitive site planning are suggested to enable industry to co-exist better with natural systems.

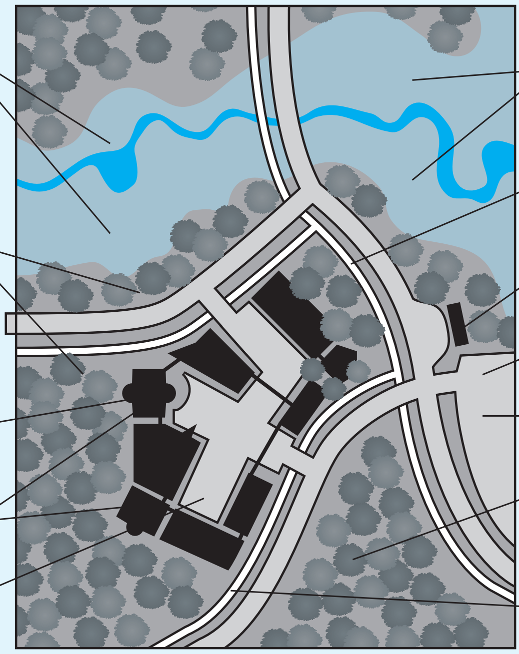
- define the carrying capacity of the site;
- maintain natural areas and indigenous vegetation as far as possible;
- retain natural drainage systems;
- increase density of development;
- design sites with energy efficiency in mind;
- create the potential for environmental synergies through location of companies to achieve easier servicing and industrial symbiosis.

Define the carrying capacity of the site

Carrying capacity is generally defined as the

'Unless there is strict enactment and enforcement of zoning laws in the vicinity of the industrial estate, unplanned residential areas (squatters) may develop. These residential settlements will be at risk if industrial accidents occur.'

Applying the guidelines:
environmental design possibilities for site development



Preserving natural habitat

The Fairlakes Business Park in Fairfax, Virginia, United States, incorporated natural wetlands on the site as part of its storm water management system. The wetlands, with their rich wildlife diversity, are a strong marketing feature of the estate. Business clients see the natural environment as conducive to productive employees and quality facilities.

number or biomass of organisms that a given habitat can support. In industrial terms, it is the number of industries that can be maintained at current levels of production on a given resource and energy base and the ability of the surrounding environment to assimilate waste materials. If the density of industry increases, the carrying capacity of the affected area will be exceeded unless production becomes more efficient, waste generation is reduced, and consumption rates and patterns are modified. The carrying capacity of an area must be assessed for air, water, land, and human health and safety. There is also a need to preserve some capacity for the development of future generations.

Maintain natural areas and indigenous vegetation

Industrial estates that maintain natural systems increase both their biological and their economic productivity. Preserving natural spaces, wetlands and woodlands can result in better property sales, occupancy rates and worker productivity (ULI 1988). Preserving natural areas also reduces the costs of grading and site development if care is taken to minimize damage from major earthworks. Protecting natural areas and species will contribute to national and global biodiversity goals.

- Wherever possible, allow natural spaces, wildlife corridors and patches to remain. These areas will be seed sources for revegetating adjacent land. Retaining as many stands of trees as possible provides many benefits. These include:
  - windbreaks for buildings
  - cooling
  - carbon dioxide absorption
  - minimum erosion
  - recreational benefits for employees
  - buffer zones to neighbouring communities, reducing noise, light and visual pollution.

- Restore developed areas with indigenous vegetation (flowers, shrubs and trees). Areas with steep slopes or around waterways should receive the highest priority for preservation. Other areas include plantings along building foundations, adjacent to roads, trails and parking areas.

- Plan to utilise developed lands fully before clearing new areas by designing building clusters and common parking and receiving and shipping areas.

Retain natural drainage systems

Wetlands, lakes and other natural features serve valuable ecological functions which in turn also have economic benefits. Wetlands and waterways provide a natural system of flood control, stormwater drainage and filtration, and habitat for wildlife (see Appendix 5 for information on erosion control and waterway protection).

The following practices should be followed:

- Designate wetlands and waterways for conservation. Protect waterways by maintaining vegetated buffers around them.
- Avoid filling in wetlands and mangrove areas, or altering the contours on floodplains.
- Limit road or utility crossings of

Applying the guidelines: the advantages of clustering suitable businesses and industries

business can reuse and recycle other companies wastes (solid waste, energy, heat water, etc.)

reduces the amount of land disrupted for development

reduces the need to extend utility services (water mains, sewers, communication cables, etc.)

waterways. Prevent large volumes of stormwater running directly into streams, rivers or marine waters by installing retention ponds or funnelling the water through wetlands.

- Protect water bodies as part of the estate's runoff control system.

Increase density of development

Intensifying the use of land saves development costs for grading, paving, utilities, and makes better use of available land. Increasing development intensity allows for the retention of more natural areas for the same carrying capacity. Some approaches that can be used are listed below.

- Designate areas of the estate for particular types of uses. Industries with similar characteristics can form separate clusters in the estate (Meehan 1986). Other clusters might encompass energy or water-intensive industries.
- Cluster businesses closer together. A compact arrangement makes better use of available land and could provide opportunities for businesses to share transport or exchange waste heat, water or materials in a symbiotic relationship.
- Develop shared infrastructure such as loading areas, parking spaces and storage facilities among small businesses. This can reduce estate management and business costs for the development and maintenance of this infrastructure.

Design energy-efficient sites

- Orient lots to optimize passive solar gain, either to 'harvest' solar energy for heating or to avoid unwanted heat loads. Natural daylight in buildings can significantly reduce the need for electrical lighting, and the secondary heat this generates. Passive solar heating and cooling can service office areas, cafeterias, warehouses and other spaces. Passive solar requires appropriate

‘ … temperature variations and prevailing wind conditions in an area affect the heating and cooling needs of buildings which in turn influence energy requirements.’

spacing between structures to prevent buildings from shading other units. Streets should also be aligned with regard to the solar effect on buildings. In the northern hemisphere, for example, optimal orientation for buildings is 10–20° east of south. Where possible, maintain vegetation to shield buildings from the Sun in tropical climates and winter winds in temperate and subarctic climates. If natural vegetation cannot be maintained, plant rapid-growing endemic vegetation.

- Determine the local climatic conditions of the area on a seasonal basis. Understanding how to work with the microclimate can lead to substantial gains in the energy efficiency of buildings. For example, temperature variations and prevailing wind conditions in an area affect the heating and cooling needs for buildings which in turn influence energy requirements.

USING ENVIRONMENTALLY-SENSITIVE CONSTRUCTION METHODS

Traditional approaches to land preparation, where sites were fully cleared, graded and left awaiting development, are no longer appropriate. This traditional approach has proven costly in the long run; developers eventually pay for negative impacts caused by erosion and siltation. Construction and development costs associated with industrial land development can be lowered by using environmentally-sensitive techniques (*Industry and Environment*, Vol. 19, No. 2, 1996). This section outlines some environmental management options for site development and construction, including:

- minimizing disruption of natural areas
- reducing waste outputs
- reducing energy and water requirements for landscaping

Minimizing disruption of natural areas

Minimal disruption of natural fauna, flora, the water regimen, topography and other natural systems implies:

- developing the land in blocks rather than focusing on individual lots
- erosion control and sedimentation plans for earthmoving activities such as topsoil removal, excavation and grading, waterway construction or enlargement, channel clearing, ditching, drain tile laying, dredging and lagooning (Simonds 1978); methods include excavation with the land contour, avoiding natural drainage areas and leaving stream channels undisturbed.

Reducing waste outputs

Significant gains can be achieved by measures implemented by the estate’s agents or contractors, such as a construction waste management plan that includes:

- the reuse of building materials
- reducing the use of toxic and hazardous materials where alternatives exist
- separating construction wastes generated on-site for possible recycling and re-use
- developing an estate-wide demolition debris site to stimulate future re-use.

Reducing energy and water requirements for landscaping

Industrial estates vary in their aesthetic appeal. Suburban research estates may include manicured landscape gardens with jogging trails that wind through forests while estates in declining central industrial areas may be dominated by storage yards bounded by rusty chain-link fencing. The trend is towards improved landscaping standards.

High landscaping standards can be good for the environment if they are based on both the practical and the aesthetic value of indigenous habitats. Options for environmental improvement include the following.

- Use of selected species and varieties in landscaping. By considering local climates, site conditions and the needs of industry, designers can develop landscape plans to reduce the costs of heating/cooling, to limit the need for on-going maintenance or irrigation, and to conserve habitat resources.
- Compatibility with local conditions and environments in preparing guidelines for landscaping. In dry areas, for example, xeriscaping will be essential to reduce demands for water. In tropical areas, on-going maintenance cannot be easily avoided as a result of the rapid growth of flora. For each set of circumstances, site planners and managers need to develop landscaping standards appropriate for the goals set for the estate and the means available to implement them.

DEVELOPING ENVIRONMENTALLY-APPROPRIATE INFRASTRUCTURE

Infrastructure to support company and estate operations includes some or all of the following: production and supply of energy, transportation, water supply, sewers, lighting, buildings and communications.

Savings can be realized if the above infrastructure is appropriately designed and sized according to environmental criteria. Pauli (1995) claims that industrial estates could save up to 80 percent of the traditional cost for developing infrastructure if industries and the estate as a whole used services more efficiently. This would involve reducing water consumption, reusing industrial wastewater and solid wastes, and improving energy efficiency. Options for designing environmentally-appropriate infrastructure exist particularly in the following areas:

- transportation
- energy supply
- water supply
- wastewater management
- materials management
- buildings.

Transportation

Through careful planning, industrial estates can minimize the need for expensive transportation systems, and thus reduce their environmental impact. The following suggestions addressing roads and parking, transportation of materials and transportation of people apply to most industrial estates:

A transportation management plan: Hacienda Business Park, San Francisco

The owners of the Hacienda Business Park have established a Transportation System Management Ordinance (TSM) to regulate commuter traffic in the estate.

The Ordinance requires each company to submit a TSM plan explaining how it can reduce peak period traffic and emissions. Businesses in industrial mall units submit only one plan but must demonstrate how they can achieve a 45 percent reduction in peak period vehicle trips. A TSM coordinator is elected for the mall unit and is responsible for implementing the transportation management programme.

The TSM task force monitors compliance with the ordinance and offers a computerised ride service that matches car users and van poolers with shuttle bus services to the estate. To help meet the costs of the TSM services, businesses pay a fee related to the area of their building. The TSM plan in Hacienda is one of the United States' most successful traffic reduction programmes.

Yang 1994

'As well as achieving economic savings for companies and the estate, energy efficiency leads to environmental benefits and contributes to national and global climate change goals.'

Roads and parking

- Limit impervious parking spaces and paved areas. For solid paving, select materials for durability. For example, crumb rubber added to asphalt extends asphalt life significantly (Lowe, Moran and Holmes 1996).
- Use porous paving wherever possible. This allows water to percolate through the surface, rather than run off in concentrated flows. Porous paving products may use recycled plastics, wire mesh or concrete pavement.

Transportation of materials

- Locate close to existing transportation systems (railways, ports, airports). These systems are more environmentally-efficient than road transport.
- Place companies that rely heavily on transportation services (warehouse and distribution companies) in the area of the park closest to feeder highways or rail services (ULI 1988).

Transportation of people

- Where the work force is large, plan and develop mass transit (buses, commuter trains). This could include a shuttle service to the estate as well as car pool and van pool services.
- Where individuals travel frequently within the estate, provide cycle lanes or trails. Pedestrian walkways may also be appropriate if business clusters are developed or retail businesses are included.
- In dense estates, encourage tenants to stagger work hours to reduce rush hour traffic. This has reduced peak period traffic in some industrial estates by 10–15 percent (ULI 1988).
- Develop a transportation management plan. In some industrial estates, transportation management associations (TMAs) address the problems created by transportation. Members include owners, developers, planners and companies operating in the estate.

Energy

As well as achieving economic savings for companies and the estate, energy efficiency leads to environmental benefits and contributes to national and global climate change goals. An integrated environmental management plan should:

- optimize total energy use; and
- maximize use of renewable energy sources.

The plan should focus both on energy consumed by the estate infrastructure as well as offering a service to the tenant companies.

Optimize energy use

Lowe, Moran and Homes (1996) estimate that the estate's total energy usage, including that used by infrastructure and tenant companies, could be reduced by 50 percent. Where the estate is the generator and provider of electrical energy and heat, this is an important consideration as energy-related activities account for a major proportion of carbon dioxide and other emissions into the atmosphere. In a number of instances, the option may provide as much or more benefit to individual companies as to the estate. Some options include the following:

- The most fuel-efficient technology should be used in power generation. Explore the potential of using by-products from some industrial processes such as energy-from-waste facilities.

- Explore cascading and cogeneration opportunities. Cogeneration captures and uses otherwise wasted heat from the electrical generating process. For example, steam from a power plant can be used for process energy or in a district heating system.
- Cascading can be used within a single facility or between separate plants. Energy cascading requires conduits for the steam or hot water moving between plants. Pipelines can be built by the companies on a cooperative basis.
- Encourage the use of heat exchangers for heating and cooling in industrial operations. Waste heat from boilers can be captured by a heat exchanger to provide heat for other industrial processes. At Kalundborg, in Denmark, the power plant's waste heat dries wallboard at a neighbouring plant.
- Insulate buildings to reduce heat loss in cold conditions and heat gain in hot conditions. Trees can be planted to provide shelter from the wind and shade from the Sun.
- The estate can encourage energy-efficient lighting for its own infrastructure as well as in buildings constructed on the estate. Such lighting will save a considerable amount of money during its operation.

Maximize use of renewable energy

Renewable energy sources are feasible for plant lighting and air conditioning although technology constraints prevent many industries from using alternative energy sources for processing. However, solar panels on roof-tops can be used to heat domestic and industrial water.

Water supply

Water usage by infrastructure and resident companies can be easily reduced with proper planning and design. If an industrial estate operates a private water utility, conservation will also lower operation and maintenance costs. In many cases, the costs of conservation remain lower than implementing another water development project to expand the water supply.

An integrated environmental management plan should aim to conserve and efficiently use water, and also re-use water.

Conservation and efficient use

- Carefully install and regularly check water supply lines to minimize leakage.
- Encourage resident companies to install water-conserving technologies. Many technologies exist to reduce industrial water use just as low-flush toilets and other devices can reduce domestic consumption.
- Landscape with hardy and water-saving plants. Indigenous plants suited to the climate of the estate are often most appropriate.

Re-use

There are many applications where water can be used and re-used in an industrial estate. Managing the complete water cycle on an estate means using water of different qualities for different purposes. Lowe, Moran and Holmes (1996) identify the following water quality levels:

'In many cases, the costs of conservation remain lower than implementing another water development project to expand the water supply.'

Industrial Development Zone, Beihai, China

Comprehensive planning enables the managers of the Beihai Industrial Development Zone to arrange the zone's industrial, raw material, energy and product structure in a way which reduces the emission of toxic by-products, conserves energy and water, improves the efficiency of material use, reduces waste, and recycles and reuses water and wastewater.

The Beihai Environmental Protection Bureau also has an extensive education programme aimed at industrial and investment decision makers. This programme includes newspaper articles, bulletins, speeches, workshops, public forums and a consultation service.

Water cascading

Singapore has been practising the principle of water cascading since the 1960s. In Singapore, treated wastewater is principally used for industrial cooling, floor cleaning and toilet flushing. It is also increasingly used as process water in paper, textile, plastic, chemical, rubber, steel and concrete factories.
Manufacturers pay 48 cents less per cubic metre for the reclaimed water than for virgin supplies.

Lowe, Moran and Holmes, 1996

Cisterns: an alternative water supply system

Compared to many modern technologies, cistern systems are a simple, age-old technology for collecting and using water. Rainwater is gathered from the roof, stored in a tank, and drained or pumped to the landscape or buildings for re-use. Good roof surfaces for collecting rain include: terra-cotta tiles, stucco, painted metal roofing (avoid coated metal with zinc), untreated wooden shingles, and composite shingles. Flat roofs sealed with various tars and petroleum products are often inappropriate for rain harvesting. The average roof can capture considerable water, even in arid climates. Five centimetres of rain falling on a 250 square metre roof results in about 125 000 litres of runoff.

Kourik 1992

- hyper or ultra-pure water (for use in making semi-conductor chips);
- Process water for manufacturing and cooling.
- drinking water (for use in kitchens, cafeterias, water fountains);
- wash water (to clean delivery trucks, floors and buildings); and
- irrigation water (for use on lawns and plants).

Some options for reusing water within industrial estates are listed below.

- Practise water cascading. Wastewater from one manufacturer might be suitable for less demanding operations within the same plant or next door for scrubbing floors or washing vehicles.
- Spray water onto roofs in hot climates to cool buildings and reduce air-conditioning costs.
- Irrigate with wastewater, rainwater or snow melt if it is free of major industrial pollutants.
- In dry climates, explore the option of collecting rainwater from roof-tops and impervious ground surfaces (where air pollution and insect vectors are not a serious problem).

To implement these approaches to water re-use and conservation, the design team will need to consider implementing pipe systems for different qualities of water. Many of these options need to be designed into the estate from its inception.

Wastewater treatment

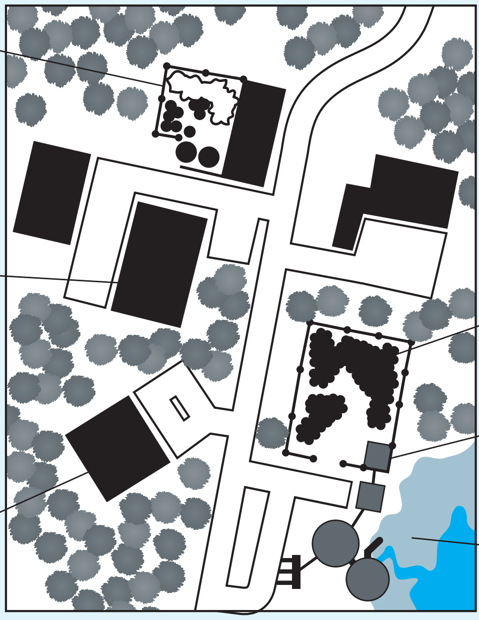
Wastewater treatment represents an opportunity to apply innovative ways of recycling. Not only can wastewater usually be made suitable for use in other processes, but the treatment facilities may be able to purchase by-product materials from tenants, or supply dried sludge for fertilizer. An integrated environmental management plan should conserve and re-use wastewater, set up common wastewater effluent treatment plants and establish stormwater management systems.

Re-using wastewater

- Wastewater can be used for irrigation, and heated water from a power plant can be re-used for fish farming or in greenhouses. Studies may be needed to see if pre-treatment is required to meet health, safety and environmental protection guidelines.
- Consider zoning a specific section of the industrial estate exclusively for water-using clients (as distinct from warehousing, office activities or dry types of industry). This could facilitate wastewater re-use or recycling among companies.

Establish a common wastewater effluent treatment plant

- This service is a cost-effective option for wastewater treatment on large estates. A treatment facility constructed to handle a larger volume of similar wastes can bring potential savings in construction, operation and maintenance of the facility. Where a number of industries generate a similar type of wastewater, their co-location makes it easier to treat specific effluents.
- A growing number of industries and communities use constructed wetlands, lagoons and solar aquatic systems to



treat wastewaters. Constructed wetlands are able to remove vast quantities of nutrients, detoxify compounds, neutralize pathogens and produce exceptionally clean water (AIA 1992–94). They have relatively low capital and operating costs and can be aesthetically pleasing. Constructed wetlands must be carefully engineered to the level and type of wastewater they will receive. General considerations for optimal design include:

- identification of pollutants to be removed from water
- the detention time necessary for thorough treatment
- the area necessary for treatment
- habitat requirements of the desired vegetation
- aquatic life survival requirements
- aesthetics
- maintenance and monitoring (AIA 1992–94).

Constructed wetlands can be designed to treat sewage, runoff and other liquid wastes from many different types of industries and estates. Individual companies may, however, have to install pre-treatment technology to protect the integrity of the common system.

Establish stormwater management systems

Stormwater management is as important as any other environmental function on an industrial estate. Stormwater from pavement surfaces can be contaminated with industrial wastewater and may require treatment prior to reuse or discharge outside the estate.

Effective and less expensive alternatives to artificial storm-drainage installations include:

- preservation of wetlands and stream corridors; and
- constructed or natural retention ponds.

Natural wetlands and constructed retention

Applying the guidelines: environmental services and infrastructure

A constructed wetland in Wuxi, China

A photo-processing facility in Wuxi, China, produced large quantities of silver-contaminated wastewater that could not be treated with a conventional chemical treatment and silver recovery system because the silver concentrations were less than one part per million. As an alternative, an artificial wetland was constructed to treat the wastewater. In two or three days, the wastewater is treated by water hyacinths and other species of aquatic plants. The root systems of the water hyacinths actually act as a silver filter and concentrate silver up to 35 000 times its level in the wastewater. After several water treatments, the roots of the plant are subsequently burned and the silver remains trapped in the ash. Silver, present at concentrations of up to 4 percent, is extracted from the ash using conventional extraction methods. An overall retrieval rate of 95 to 99 percent is achieved. This type of wastewater treatment system has been cost effective for the company because the wastewater treatment system produces clean water and saves the company money from purchasing silver from external sources.

Van Der Ryn, Sim and Cowan 1996

'… the company Compaq estimates it saves nearly US$1 million a year through efficient lighting and the systematic integration of lighting with high volume air circulation (HVAC) and building design.'

ponds can play important functions in absorbing large peak flows from storms.

Detergents and oily water from water run-off should be trapped and filtered. Water from retention ponds can be re-used in nearby buildings for heating and cooling systems. The sub-surface outflow from the retention ponds provides filtration and groundwater recharge to the area.

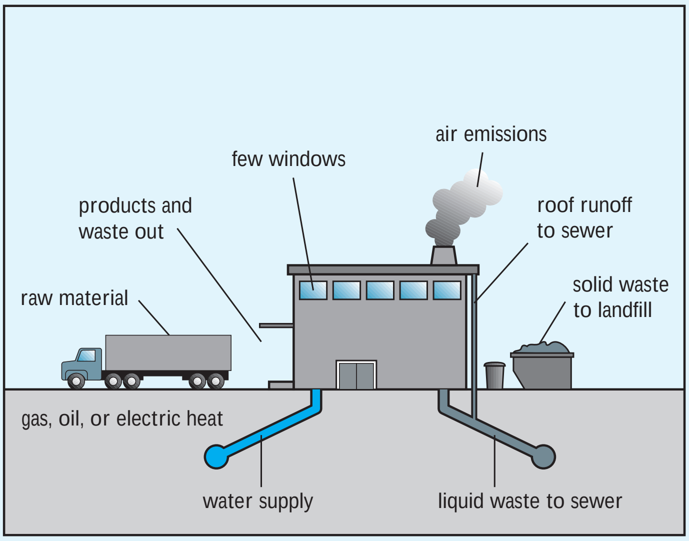
Used materials management

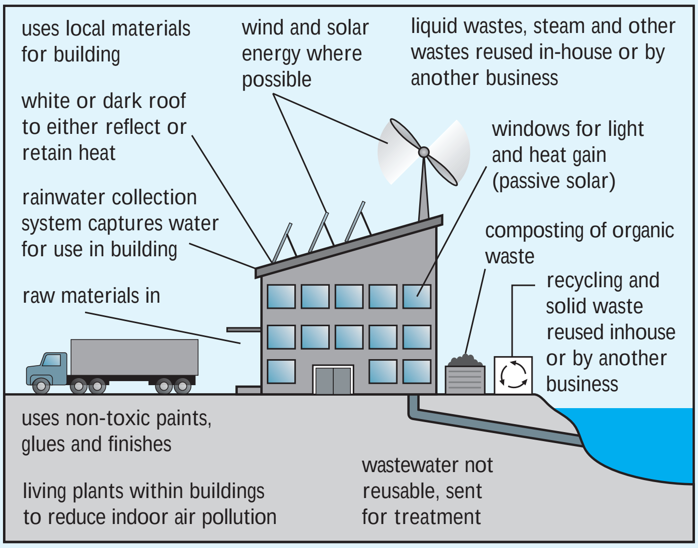
Traditionally, companies dispose of their used materials as waste. Estate management should consider providing a service and facility to manage these used materials. This facility could also handle materials from other plants outside the estate, making them profit centres. Options include the following:

- establishing storage areas for useful by-products that could be used at a later date or for a multi-materials recycling centre;
- composting organic wastes to produce fertilizer or energy in the form of biogas;
- developing a hazardous waste treatment facility on large estates; and
- building and operating a dry landfill or incinerator (though both will pose secondary problems such as local air emissions, release of greenhouse gases, and ground and surface water contamination).

Buildings

Many opportunities exist to take advantage of recent innovations in sustainable architecture or 'green building design'. Sites can adopt building construction codes that foster the use of design and material innovations. Industrial estates and companies that opt for these choices can realize significant savings through energy efficiency and pollution prevention. The benefits of green design include lower operating costs over the building life cycle. For example, the company Compaq estimates that it saves nearly US£1 million a year through efficient lighting and the





Environmental building design: traditional (left) and environmental (right)

Some principles of sustainable design and construction

Minimize resource consumption (conserve)
- ❖ design for energy efficiency in building design, HVAC systems and lighting
- ❖ use passive solar and daylight features

Select materials and design for durability.

Maximize resource reuse (reuse)
- ❖ redevelop existing sites rather than breaking new ground
- ❖ re-use construction materials, assemblies, and products
- ❖ include greywater systems to reuse water

Use renewable or recyclable resources
- ❖ use building materials with recycled content, such as tiles containing recycled glass
- ❖ specify timber from sustainable forests

Protect the natural environment
- ❖ minimize disruption of the natural environment in site preparation and construction
- ❖ provide fresh air for all occupants

Create a healthy, non-toxic environment
- ❖ select non-toxic materials and equipment
- ❖ provide fresh air for all occupants

Integrate building and infrastructure design into the natural and human environments
- ❖ landscape the site using native plants of the region and ponds or wetlands to capture stormwater runoff
- ❖ incorporate features to reduce impact of development on community transportation systems

Integrate design teams across professional, business, and agency boundaries in applying these principles.

See also *Industry and Environment*, The Construction Industry and the Environment, Vol. 19, No. 2, 1996. The first five principles are based on Kibert 1994.

systematic integration of lighting with high-volume air circulation (HVAC) and building design (Lowe, Moran and Holmes 1996).

Other benefits include healthier and productive working spaces. Some worker illnesses can be directly related to poor lighting, inadequate fresh air and dark work areas. In several studies, when a company moved into a 'green' building, absenteeism dropped by 15–25 percent and sick leave was significantly reduced (Rocky Mountain Institute 1995). Firms need a clear understanding of these benefits since design and construction costs are likely to be higher initially.

Individual industrial facilities can also adopt a more integrated design approach. For instance, operating costs can be lowered significantly by an approach that links different sections of the building. The office's lighting and heating needs could be linked to heating and cooling systems in the industrial processing area.

Many of the benefits accrue to individual companies but the estate can encourage this approach and thus generate an estate image of environmental efficiency. Furthermore, many industrial estates could specifically select suitable architects and builders to pre-construct industrial facilities for their tenants. Industrial estates often invoke codes, covenants and restrictions (CC&Rs) to ensure that buildings meet certain standards. CC&Rs could encourage building contractors to construct energy-efficient buildings.

The box on page 61, based on Lowe, Moran and Holmes 1996 and Kibert 1994, summarises some of the principles for the sustainable design and construction of buildings to reduce energy, water, materials and land consumption.

PLANNING FOR OPERATIONS

Many of the provisions mentioned above require on-going operation and maintenance during the estate's lifetime. This, together with the environmental control needed for day-to-day activities, suggests that an environmental management system (EMS) should be created during the planning stage. An EMS based on ISO 14001 or similar approaches will facilitate operation when the estate begins to function. Estates may also want to encourage the formation of a tenant's association to play a role in implementing the environmental management framework discussed in the previous chapter.

The EMS will need to encompass two different levels:

- the environmental impact of the infrastructure, services and common areas under the direct control of the estate management; and
- cooperative links with individual companies to encourage application of EMS by tenant companies.

ENVIRONMENTAL GUIDELINES FOR EXISTING INDUSTRIAL ESTATES

This chapter is aimed at some of the more than 12 000 currently operating industrial estates to help them improve improve their environmental management performance. It includes a discussion of the key action areas and is followed by a series of worksheets to use in existing estates. The worksheets draw extensively on earlier chapters of this publication.

Currently operating industrial estates can implement many of the environmental management concepts and strategies described in the preceding guidelines (pages 47 to 62), realizing both economic and environmental benefits. An extensive consultation process may be required and the guidelines may have to be implemented over a period of time. Four phases are involved:

- assessing existing environmental conditions and issues;
- developing environmental management performance objectives;
- planning environmental management systems and projects; and
- implementing environmental management projects.

ASSESSING EXISTING ENVIRONMENTAL CONDITIONS

Estate managers should begin by assessing the existing environmental conditions and issues. On the basis of this information, they can then determine the priorities for action for the estate. The main issues involved are described in the first chapter of this publication. The worksheets at the end of this chapter allow these conditions, and other key influential factors, to be identified.

This assessment process can be initiated through consultation with companies in the estate, environmental regulatory agencies, neighbouring communities and local environmental groups. It is also useful to measure environmental conditions on and around the site.

Surveys and audits of company and estate operations may be the best way to uncover this information. Surveys and audits can be coordinated by the estate staff or the environmental management planning team in cooperation with university researchers, consulting teams or employees from the companies on-site (see ‘Environmental audit services’, page 35).

If consulting teams are hired to carry out the site audits, estate management will have to finance the audits. The estate may consider charging companies a fee to recover costs. Companies may want to ensure the collected information remains confidential.

For company audits, the surveys need to assess:

- the products/services being produced
- process technologies used
- material, water, and energy inputs
- water, waste and energy outputs
- current level of environmental management.

For the estate operations, audits and surveys need to assess:

‘Estate managers should begin by assessing the existing environmental conditions and issues, essentially a situation analysis, followed by determining the priorities for action for the estate.’

- air and water quality in general and at the boundaries of the estate
- adequacy of existing environmental services
- integrity of natural features on-site
- extent of areas of contamination
- current condition of infrastructure services including water, energy and transportation.

DEVELOPING ENVIRONMENTAL MANAGEMENT PERFORMANCE OBJECTIVES

A planning team can help identify the environmental management needs for the estate. Its members can include industrial estate managers, company managers and employees, local government leaders, members of the community and environmental consultants. Collaboration with business, engineering, environmental sciences, architecture and other disciplines at local universities may be useful to support the planning team.

The team should first address adverse environmental conditions and then aim for continuous environmental improvement of the estate. The team may also develop the environmental performance objectives for the estate as a whole (see 'Developing environmental performance objectives', page 26). As already mentioned, no two estates are likely to develop the same objectives. Identifying those objectives that can improve environmental conditions while reducing costs in the short and long term will influence the decision making.

To ensure that tenant companies and estate investors agree with the objectives, as many people as possible should be involved in developing them. Workshops and networking can help build commitment and foster participation among companies.

IMPLEMENTING ENVIRONMENTAL MANAGEMENT SYSTEMS AND PROJECTS

Estate initiatives

- Estates often need to upgrade the infrastructure and services they provide (see 'Providing environmental services, page 32). For example, estates can:

  - establishing a traffic management plan to improve movement of materials and people and reduce emissions
  - capturing rainwater for use in irrigation
  - exploring cogeneration opportunities with power plants
  - retrofitting buildings to improve energy and water efficiency
  - developing emergency planning procedures.

Such actions are especially valuable where the estate is responsible for supplying inputs to companies such as water and energy.

- Develop new environmental services which will generate income for the estate and be useful in marketing for attracting new businesses. Such services could include:

  - developing a common effluent treatment plant

- developing waste recovery facilities
- establishing an environmental monitoring and auditing capability
- establishing an analytical service
- establishing training programmes in environmental management.

❖ Restore the natural features of the site where possible (see previous chapter for details). Projects could include:

- recreating or restoring wetlands
- planting trees and shrubs
- setting aside remaining natural areas
- creating habitats for birds and other animals

Such projects can protect water quality, enhance biodiversity and improve local amenity. They can also enhance the aesthetic appeal of the estate.

Company initiatives

Companies will have to identify which environmental management strategies they can implement. Estate managers can facilitate implementation of options such as:

❖ Retrofitting facilities to conserve energy and water, for example:

- re-use heat or process water (energy or water cascading)
- identify opportunities for passive solar use (such as heating warehouses)
- install energy-efficient windows and doors
- upgrade to energy-efficient motors in building and production systems
- install energy-efficient lighting.

❖ Improving the material and energy efficiency of manufacturing operations. For example:

- source reduction
- internal use and reuse of materials
- exchange of used materials with other businesses
- product changes
- technology changes
- good operating practices.

WORKSHEETS FOR ASSISTING MANAGERS

In order to allow the recommendations and suggestions of the preceding discussion to be put into practice, the next section presents a series of worksheets that can be used in actual situations.

Several of the worksheets are designed to make data collection simpler and more methodical. They include a site report (for existing sites), identification of the main stakeholders (in all cases), description of management and regulatory aspects that apply, and a checklist of key environmental issues likely to affect the estate.

The worksheets can be used by both existing estates or planners working on future projects. In both cases the sheets provide a model to which the users must add also their own questions, or delete those that are not applicable, depending on the local conditions that prevail.

Several worksheets go into considerable detail, and are intended mainly for existing estates where problems are already known to exist.

These relate especially to an estate-wide survey of emissions and wastes on a company-by-company basis. The model worksheets can be used as a convenient way of recording the information collected.

The worksheets that follow are derived from a number of manuals and guides including the Canadian Manufacturer Association's *Environmental Coordinator's Handbook*; the UNEP, International Chambers of Commerce and International Federation of Consulting Engineers' *Environmental Management System Training Resource Kit*; and UNEP and UNIDO's *Audit and Reduction Manual for Industrial Emissions and Wastes.* The UNEP training manual on Hazardous Waste Policies contains a comprehensive model questionnaire on industrial waste generation and disposal.

The UNEP documents are available for purchase, and several of them exist in multiple language versions.

WORKSHEET 1

INDUSTRIAL ESTATE SITE REPORT

This information provides a first profile of the estate that will assist in identifying possible environmental issues .

Industrial estate

Name: . . . .

Address: . . . .

. . . .

Year operation started: . . . .

Contact person for environmental affairs

Name: . . . .

Function: . . . .

Phone: . . . .

Fax: . . . .

E-mail: . . . .

Ownership

Public: . . . .

Private: . . . .

Public/private partnership: . . . .

Scale of the estate

Total surface area (km^2): . . . .

Total number of companies: . . . .

Total number of employees: . . . .

Type of land uses	*Percentage of area*
• Export processing zone	. . . .
• General industrial zone	. . . .
• Commercial zone	. . . .
• Residential zone	. . . .
• Natural areas, e.g. lakes, rivers, forests	. . . .
• Landscaped green areas	. . . .
• Undeveloped areas	. . . .
• Infrastructure, e.g. transportation	. . . .
• Other? (. . . . .)	. . . .

Nature of the industries in the estate

	Number of plants	*Number of employees*	*Production volume*
• Petrochemical processing	. . . .	. . . .	. . . .
• Iron and steel processing	. . . .	. . . .	. . . .
• Non-ferrous metal industries	. . . .	. . . .	. . . .
• Chemical manufacturing	. . . .	. . . .	. . . .
• Energy generation	. . . .	. . . .	. . . .
• Construction industry	. . . .	. . . .	. . . .
• Transportation sector	. . . .	. . . .	. . . .
• Communication technology	. . . .	. . . .	. . . .
• Food processing	. . . .	. . . .	. . . .
• Drinks manufacture	. . . .	. . . .	. . . .
• Textile manufacturing	. . . .	. . . .	. . . .
• Leather processing	. . . .	. . . .	. . . .
• Electronic manufacturing	. . . .	. . . .	. . . .
• Pharmaceutical production	. . . .	. . . .	. . . .
• Plastics formulation/processing	. . . .	. . . .	. . . .
• Paint manufacture	. . . .	. . . .	. . . .
• Ceramics/glass manufacture	. . . .	. . . .	. . . .
• Pulp and paper production	. . . .	. . . .	. . . .
• Packaging manufacture	. . . .	. . . .	. . . .

Nature of the industries in the estate (continued

	Number of plants	Number of employees	Production volume
• Metal plating	. . . .	. . . .	. . . .
• Other (. . . .)	. . . .	. . . .	. . . .

Service industries on the estate

• Transport	. . . .	. . . .	. . . .
• Warehousing	. . . .	. . . .	. . . .
• Chemical storage	. . . .	. . . .	. . . .
• Recycling	. . . .	. . . .	. . . .
• Waste treatment/disposal	. . . .	. . . .	. . . .
• Laboratories	. . . .	. . . .	. . . .
• Information technology	. . . .	. . . .	. . . .
• Banking, finance and insurance	. . . .	. . . .	. . . .

Environmental features	*on-site*	*nearby*
• Forest	❑	❑
• Wetlands, swamps, mangroves	❑	❑
• Lakes	❑	❑
• Rivers and creeks	❑	❑
• Sea coast	❑	❑
• Ecological reserves	❑	❑
• Endangered species	❑	❑
• Other? (. . . . .)	❑	❑

Nearby socio-economic features

Urban area:	. . . .
Number of inhabitants:	. . . .
Distance (km):	. . . .
Port(s):	. . . .

Other economic activities on-site or nearby?	*on-site*	*nearby*
• Forestry	❑	❑
• Agriculture	❑	❑
• Recreation	❑	❑
• Tourism	❑	❑
• Other? Please specify:	. . . .	

Transport: number of people commuting over	*<1 km*	*1–3 km*	*4–10 km*	*>10 km*
• Private or company vehicle	. . . . . .	. . . . . .	. . . .	. . . .
• Bus	. . . . . .	. . . . . .	. . . .	. . . .
• Train	. . . . . .	. . . . . .	. . . .	. . . .
• Other	. . . . . .	. . . . . .	. . . .	. . . .

WORKSHEET 2

1. Available features in the estate

This worksheet identifies a number of services and features that may be linked to environmental performance.

Who provides or is responsible for the following services, tools or actions?

	industrial estate authority	operational units	government authority	private sector	other
Energy					
Centralized energy supply	❑	❑	❑	❑	❑
Individual energy supply	❑	❑	❑	❑	❑
Supply and recovery of waste heat (cogeneration)	❑	❑	❑	❑	❑
District heating system	❑	❑	❑	❑	❑
Energy from waste facility	❑	❑	❑	❑	❑
Energy from renewable resources facility	❑	❑	❑	❑	❑
Water/waste					
Solid waste disposal*	❑	❑	❑	❑	❑
Composting of biological waste*	❑	❑	❑	❑	❑
Sewage disposal*	❑	❑	❑	❑	❑
Industrial liquid waste disposal*	❑	❑	❑	❑	❑
Hazardous waste disposal*	❑	❑	❑	❑	❑
Waste exchange clearing house	❑	❑	❑	❑	❑
Waste transfer station	❑	❑	❑	❑	❑
Multi-material resource recovery	❑	❑	❑	❑	❑

	industrial estate authority	operational units	government authority	private sector	other
Transport					
Traffic and transport management plan	❑	❑	❑	❑	❑
Management					
Environmental monitoring	❑	❑	❑	❑	❑
Effluent monitoring	❑	❑	❑	❑	❑
Air emission monitoring	❑	❑	❑	❑	❑
Environmental auditing	❑	❑	❑	❑	❑
Environmental impact assessment	❑	❑	❑	❑	❑
Environmental risk assessment	❑	❑	❑	❑	❑
Environmental technology assessment	❑	❑	❑	❑	❑
ISO 14001 certification	❑	❑	❑	❑	❑
Environmental training and education	❑	❑	❑	❑	❑
Environmental operations and information centre	❑	❑	❑	❑	❑
Emergency preparedness and response capability	❑	❑	❑	❑	❑
Register of legislation	❑	❑	❑	❑	❑
Self-regulation and operational standards	❑	❑	❑	❑	❑
Finance and insurance services	❑	❑	❑	❑	❑
Miscellaneous					
Restoring natural features of the site	❑	❑	❑	❑	❑
Landscaping and gardening	❑	❑	❑	❑	❑
Analytical and laboratory services	❑	❑	❑	❑	❑
Protection and security system	❑	❑	❑	❑	❑

* including collection, storage and treatment

2. Financing

For all available features, how are they financed and what are the costs?

3. Rationale

For all available features, how is the success, economic viability and efficiency measured?

4. REMARKS

For all available features, what are the specific achievements and problems?

5. Regulations

Regulations applicable to the estate as a whole

For which of the following items does the estate have responsibility by law?

• Making environmental impact assessments	❑ Yes	❑ No
• Meeting emission/discharge standards	❑ Yes	❑ No
• Protecting habitats and wildlife	❑ Yes	❑ No
• Preventing marine pollution	❑ Yes	❑ No
• Avoiding negative visual impact	❑ Yes	❑ No
• Undertaking waste disposal	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No

Regulations applicable to tenant companies

What regulations exist in the following areas?

	Estate bye-law	*National regulation*
• EIA	❑	❑
• Site or operating permit	❑	❑
• Emissions/discharges	❑	❑
• Noise	❑	❑
• Waste treatment and disposal	❑	❑
• Occupational safety	❑	❑
• Chemical storage	❑	❑
• Fire protection	❑	❑
• Building standards	❑	❑
• Landscaping	❑	❑
• Other (. . . . .)	❑	❑

please give details on separate sheet

Which national laws are administrated by the estate?

....

....

....

....

WORKSHEET 3

MAIN STAKEHOLDERS

This worksheet aims to identify stakeholders who, within their range of responsibility, play or could play a role in improving environmental performance or limiting undesired environmental impacts of estate activities. Four main stakeholders—the estate authority, the operating companies, government authorities, and the private and regional service sectors—will obviously be involved, but others could be important in particular estates.

If the environmental debate is not yet highly developed, it would be useful to complete this worksheet once for *actual* involvement, and once for *potential* involvement.

Other estate stakeholders important to environmental debate in your estate

Politicians:	❑ Yes	❑ No
Other government agencies:	❑ Yes	❑ No
If yes, in which areas?		
• Land-use planning	❑ Yes	❑ No
• Environmental protection	❑ Yes	❑ No
• Public health protection	❑ Yes	❑ No
• Occupational health and safety	❑ Yes	❑ No
• Natural resource protection	❑ Yes	❑ No
• Emergency response	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No
Tenant company associations:	❑ Yes	❑ No
If yes, what is their role?		
• Lobbying	❑ Yes	❑ No
• Information and communication	❑ Yes	❑ No
• Shared services	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No

Local financial institutions and banks:	❑ Yes	❑ No
If yes, what influence do they have?		
• Owners	❑ Yes	❑ No
• Conditionalities on investments and credits	❑ Yes	❑ No
• Pressure on tenant companies	❑ Yes	❑ No
• Pressure on estate authority	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No
Insurance companies and associations:	❑ Yes	❑ No
If yes, what influence have they exerted?		
• Liability for environmental damage	❑ Yes	❑ No
• Conditionalities for insurance	❑ Yes	❑ No
• Fees depending on environmental risks	❑ Yes	❑ No
• Pressure on tenant companies	❑ Yes	❑ No
• Pressure on estate authority	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No
Trade unions:	❑ Yes	❑ No
If yes, what environmental issues concern them?		
• Working environment	❑ Yes	❑ No
• Outside environment	❑ Yes	❑ No
• Social services	❑ Yes	❑ No
• Transport	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No
Public and neighbourhood:	❑ Yes	❑ No
If yes, what environmental issues concern them?		
• Pollution	❑ Yes	❑ No
• Landscaping	❑ Yes	❑ No
• Traffic	❑ Yes	❑ No
• Land use and habitat	❑ Yes	❑ No
• Landscaping	❑ Yes	❑ No
• Loss of amenities	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No

Research organizations:	❑ Yes	❑ No
If yes, in which areas have they been active?		
• Environmental training and education	❑ Yes	❑ No
• Environmental audits	❑ Yes	❑ No
• Technology assessment	❑ Yes	❑ No
• Environmental monitoring	❑ Yes	❑ No
• R and D on pollution options	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No
Service providers and suppliers:	❑ Yes	❑ No
If yes, in which areas have they been active?		
• Chemical suppliers	❑ Yes	❑ No
• Energy	❑ Yes	❑ No
• Waste management	❑ Yes	❑ No
• Laboratories	❑ Yes	❑ No
• Environmental consultants	❑ Yes	❑ No
• Environmental assessments and audits	❑ Yes	❑ No
• Environmental equipment	❑ Yes	❑ No
• Clean technology supplies	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No
The media:	❑ Yes	❑ No
If yes, which media?		
• The printed press	❑ Yes	❑ No
• Radio and TV	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No

FINAL QUESTIONS

1. *Do you belong to an industrial estate association?*	❑ Yes	❑ No
If yes, what is its function?		
• Lobbying	❑ Yes	❑ No
• Standards	❑ Yes	❑ No
• Information and communication	❑ Yes	❑ No
• Advice	❑ Yes	❑ No
• Research	❑ Yes	❑ No
• Other (. . . . .)	❑ Yes	❑ No

2. *How many individual companies interact with you on environmental issues?* . . . .

On which issues? . . . .

What do they request? . . . .

WORKSHEET 4

ENVIRONMENTAL ISSUES ASSESSMENT

Have environmental concerns or complaints relating to the estate been expressed by:

Politicians	❑ Yes	❑ No
Local government	❑ Yes	❑ No
National government	❑ Yes	❑ No
Environmental organizations	❑ Yes	❑ No
Neighbouring communities	❑ Yes	❑ No
Investors/finance bodies	❑ Yes	❑ No
Tenant companies	❑ Yes	❑ No
Employees	❑ Yes	❑ No

If you answered yes to any of the above, please provide details on a separate sheet

Have concerns or complaints been expressed about the following issues?

	Seldom	*Often*	*Source of complaint**
Air pollution	❑	❑	. . . .
Water pollution	❑	❑	. . . .
Waste treatment	❑	❑	. . . .
Solid waste disposal	❑	❑	. . . .
Hazardous chemicals	❑	❑	. . . .
Disposal of sludge	❑	❑	. . . .
Noise	❑	❑	. . . .
Dust	❑	❑	. . . .
Radiation	❑	❑	. . . .
Toxic chemicals	❑	❑	. . . .
Industrial accidents	❑	❑	. . . .
Chemical or fuel spills	❑	❑	. . . .

Have concerns been expressed? (continued)

	Seldom	*Often*	*Source of complaint**
Soil contamination	❑	❑	....
Water supply	❑	❑	....
Disease vectors	❑	❑	....
Smog	❑	❑	....
Acid precipitation	❑	❑	....
Ozone depletion	❑	❑	....
Global warming	❑	❑	....
Loss of biodiversity	❑	❑	....
Animal deaths	❑	❑	....
Aesthetic/visual impact	❑	❑	....
Landscaping	❑	❑	....

** Source of complaints is the person or organization bringing the information forward.*

Which environmental parameters are regularly monitored?

Parameter	*Monitored by*
....	....
....	....
....	....
....	....
....	....
....	....
....	....

What environmental studies have been carried out, and by whom?

Study	*Originator*
....	....
....	....
....	....
....	....
....	....
....	....

What environmental issues do you believe to be important for the estate?

WORKSHEET 5

PRELIMINARY ASSESSMENT OF POTENTIAL ENVIRONMENTAL THREATS

The previous worksheets provided a general picture of the environmental issues and options important to the estate. This worksheet provides a preliminary assessment that can be used for discussions with management and other stakeholders. It will also provide ideas for a more detailed study. Bear in mind that this assessment is for the entire estate, not for individual companies.

Area of concern

1. ‘Imminent threats’ to human health and/or the environment
   (‘imminent’ means high-risk threats that require immediate action to reduce risks and liabilities)

Threat	*Action that needs to be taken*
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .

2. Environmental ‘trouble spots’
   (issues not in compliance with regulations and sources of potentially harmful environmental effects)

Trouble spot	*Action that needs to be taken*
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .

3. Major sources of wastes (solid, air, liquid) generated in the estate

Source of waste	*Action that needs to be taken*

4. Inefficient energy uses and waste of surplus heat

Source	*Action that needs to be taken*

5. Inefficient water uses

Source	*Action that needs to be taken*

6. Environmentally-harmful employee practices and procedures

Practice	*Action that needs to be taken*

7. Habitat/wildlife issues of concern

Practice	*Action that needs to be taken*
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .

8. Potential sources of industrial accidents, explosions and fires

Source	*Action that needs to be taken*
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .

9. Sources of environmental threats in adjacent areas

Source	*Action that needs to be taken*
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .

10. International issues to address

. . . .	. . . .
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .

WORKSHEET 6

ADDITIONAL ELEMENTS TO LOCATE ON YOUR ESTATE'S ENVIRONMENTAL SITE PLAN

This list identifies some typical environmental items that may be important in a detailed action plan. To customize it to your estate's circumstances, start with this list, then carry out a thorough assessment of your estate as well as adjacent properties outside the estate to identify other possible items.

You will need additional paper to provide details of any items that you check. Checked items can often be usefully marked on a large site plan.

Air

- ❑ gas cylinders (bulk)
- ❑ exhaust vent locations
- ❑ sampling points for both stack and fugitive emissions
- ❑ stack locations
- ❑ use or storage of ozone-depleting substances such as CFCs or HCFCs

Water

- ❑ direct discharges to adjacent streams and other surface waters
- ❑ cooling towers
- ❑ municipal sewers
- ❑ septic tanks and fields
- ❑ storm water drains
- ❑ sump pumps
- ❑ manholes
- ❑ collective treatment facilities
- ❑ private treatment facilities
- ❑ water wells on site and on adjacent properties

Waste

- abandoned waste disposal areas
- on-site waste disposal areas
- contaminated sites on other land
- spill and sludge containments
- transfer points for hazardous material/wastes
- on-site waste treatment facilities at companies
- waste storage areas at companies, and by the estate
- emergency equipment
- equipment containing material posing potential health and/or environmental hazards, such as PCB-containing equipment (transformers, etc.)
- fire equipment
- storage areas for flammable or hazardous materials
- above-ground chemical or fuel storage locations
- underground storage tanks

Habitat

- wildlife refuge
- rare or endangered species
- migratory species
- coastal environment—corals, fish-breeding grounds, mangroves
- rare and threatened habitats
- commercial use of habitats and species on or near the estate
- gardens and recreation areas
- forest
- agricultural land

A GUIDE TO WORKSHEETS 7 AND 8

AN INVENTORY OF THE ESTATE'S DISCHARGES AND EMISSIONS

If it is intended to prepare a total inventory of emissions and discharges to the environment, the task can be approached in two stages.

First, a desk study is undertaken. Here a knowledge of the types, number and size of enterprises (see Worksheet 1) can be used with known pollution load factors to calculate approximate total releases. Pollution load factors can be found in published reference works and in various UNEP, World Bank and WHO technical reports dealing with specific industry sectors. The WHO publication *Assessment of Sources of Air, Water, and Land Pollution* (WHO 1993) gives load factors for many common processes. This gives an approximate result only, but is useful in identifying some of the industries to study in more detail.

The second stage focuses on the major potential polluters by compiling information on a company-by-company basis and aggregating the result. The worksheet below can be used to start such a survey, preferably after the sheet been adapted to the specific estate situation. Separate worksheets should be used for air and water releases. A different worksheet (No. 8) is used for solid waste. In using these sheets, a high degree of cooperation from the relevant companies will be required, and it is recommended that the study be carried out as a cooperative project in which the companies are also involved in developing the responses to the outcome.

WORKSHEET 7

AN INVENTORY OF POLLUTANT RELEASES

The grid below can be used as a model to prepare a worksheet for each estate. It is preferable to prepare separate sheets for air and water. The information required can be found from regulatory monitoring data from the authorities or by a survey of tenant companies. One sheet should be completed for each company or site.

Company: Site location:

Release to: air/water (indicate as appropriate)

Release (location)	Process	Pollutant	Concentration at release point	Annual release	Annual per unit production volume	Release per unit production volume

WORKSHEET 8

AN INVENTORY OF GENERATION WASTE

The information collected in a waste inventory will identify opportunities for reduction of volume, recycling or more efficient disposal. The information must be obtained from individual companies, and this worksheet is intended for estates that already have an estate-wide waste management programme. It should be used as a model from which to develop worksheets customized for individual estates. One sheet should be completed for each company or site.

An alternative to using this worksheet is to carry out a comprehensive survey of hazardous waste generation within the estate (see *Hazardous Waste Policies and Strategies*, UNEP IE Technical Report No. 10).

Company: Site location:

Waste stream (and volume or weight)	Major waste constituent	Process source	Disposition (reuse, recycle, disposal)	Where disposed	Disposition annual cost
Liquid hazardous					
Liquid non-hazardous					
Solid hazardous					
Solid non-hazardous					

WORKSHEET 9

ELEMENTS FOR A BASIC WATER AUDIT

Both the estate management and individual tenant companies can play a significant role in water conservation. This worksheet aims to identify specific water uses and water conservation opportunities in the companies. In the first instance, simply identify the major water users by company name and note approximate volumes of water use. Information can come from administrative information (water supply data) or via a company survey.

A similar sheet can be developed for energy audits if required.

Process users:

Major material transport agent, rinse baths and lubrication systems

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Cooling/heating systems:

Major cooling and heating systems that consume water such as boilers, humidifiers, evaporative coolers

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Once-through cooling systems:

Large air compressors, air conditioners, vacuum pumps, hydraulic equipment, degreasers, rectifiers

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Industrial washing:

Container washing, process equipment cleaning, vehicle cleaning, plant and building cleaning, street cleaning

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Domestic uses (sanitation):

Water used in toilets, sinks and showers

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Landscape irrigation:

Types of irrigation systems, irrigation practices, amounts of turf to be irrigated

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Leaks in distribution system:

Piping, equipment, valves, drinking fountains, taps, toilets, other locations

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WORKSHEET 10

THE ESTATE'S 'EMERGENCY POINTS'

Date:

Emergency points (identify these on a plan of the estate)

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Potential source of emergencies

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Foreseeable consequences

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Associated risks (such as fires in adjacent factories)

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Factors contributing to risk (such as congested roads or lack of escape routes)

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CONCLUSION

THE ROLE OF ENVIRONMENTAL MANAGEMENT

Managers have the dual role of operating their own activities and encouraging and assisting individual companies to improve their environmental performance. This second function, that of environmental facilitator, is a relatively new concept for estates but one that is in tune with their increasingly important economic role of stimulating sustainable industrial development.

REALIZING THE FINANCIAL BENEFITS

Improvements in the environmental management of currently operating industrial estates requires considerable effort on the part of managers, and perhaps financial investments by both estate management and tenant companies. Many environmental investments and services also have a positive net economic effect because they make manufacturing more efficient (reducing waste and loss of materials) and because they decrease the cost of environmental compliance. These economic benefits can be shared between the estate and its tenant companies. For example, estate managers can recover some of their investment in environmental management services by charging fees to tenant companies. Energy saving, water saving, material efficiency and exchange services can also be operated directly or through private contractors, which can charge a fee that is less than the savings potential to the operator. In North America, energy saving companies enter into contracts with clients in which the payment for their services is derived directly from the savings accrued.

As the number of operations run by the estate is small, the biggest potential for cost savings from cleaner production is within individual companies, and the role of the estate is to provide encouragement for continuous improvement. For companies interested in implementing environmental management programmes, the payback period can sometimes be quite short, especially for older plant that is inefficiently run. A small company in the Burnside Industrial Park in Dartmouth, Nova Scotia, Canada, calculated that it spent $12 000 (Cdn) per year purchasing solvents and arranging for the disposal of used solvents as hazardous waste. The company then purchased a solvent recovery unit which reduced the volume of new solvent purchased and the volume of waste solvent treated. The unit, costing $500 (Cdn), had a payback period of two weeks. The company now saves in excess of $10 000 (Cdn) a year. Some other examples are shown in the box on page 104. These benefits flow on to the estate as a whole in terms of economic sustainability of companies themselves, and also in reduced infrastructure costs to the estate.

For the estate, there is also a strong marketing potential for an environmentally-efficient industrial location. Surprisingly, this is rarely promoted in publicity brochures and other information, but it is undeniable that low environment cost is just as attractive to entrepreneurs as low labour or energy costs.

The economics of symbiosis: Kalundborg, Denmark

Kalundborg, Denmark, is one of the few industrial areas where the costs and benefits of symbiotic relationships among companies have been measured. The costs have been calculated at US$60 million but the savings in water, energy and waste management have been estimated at US$120 million over 15 years.

Saving money on water: Prince Edward Island, Canada

An industrial estate on Prince Edward Island, Canada, found it could save a substantial amount of money on water infrastructure services if it provided water conservation retrofits for showers, sinks and toilets (CBCL Ltd 1995).

Financial benefits of environmental management

1. **Aire and Calder Project, UK**
   542 waste reduction and process efficiencies opportunities were identified in 11 companies for a saving of £12 million per year with benefits to water supply and receiving waters.

2. **Project Catalyst, UK**
   Waste reduction and process efficiency opportunities were found in 14 companies for a saving of £8.9 million per year, with benefits in water supply and receiving waters.

3. **PRISMA Project, The Netherlands**
   164 waste reduction measures were identified among 10 companies, of which 40 percent were cost neutral and 25 percent had a payback period of less than one year.

4. **Landskrona Project, Sweden**
   A number of waste reduction and process efficiency opportunities were identified in six companies. Hazardous waste, air and water emissions were reduced in six companies with cost savings of more than 50 percent and paybacks of less than one year in many instances.

5. **ECOPROFIT Project, Austria**
   54 waste reduction opportunities were identified in five companies of which 24 percent had payback periods of less than one year and an additional 30 percent had payback periods of less than two years, with 15 percent having no cost implications.

All these projects have benefited the environment by reducing waste and enhancing the local economy by improving efficiency and reducing turnover of companies.

REALIZING THE ENVIRONMENTAL BENEFITS

The environmental benefits are significant as well. In Kalundborg, the total load on the environment has been substantially reduced. Oil consumption has been reduced by 45 000 tonnes per year, coal use by 15 000 tonnes and water consumption by 600 000 cubic metres. Emissions of carbon dioxide have been reduced by 175 000 tonnes while sulphur dioxide emissions have been reduced by 10 200 tonnes per year.

The possibility of energy savings through synergy among companies gives estates a unique opportunity to contribute to the current global campaign to address climate change.

Reduced emissions and waste loads, and the easier environmental compliance that comes with them, are relatively easy to document if an appropriate monitoring and auditing system is in place. There are also obvious benefits in a cleaner, safer workplace environment, through increased worker productivity and a lower burden on community health services.

The potential benefits to the natural environment can also be significant, and very visible. The creation or maintenance of natural areas and wildlife habitat in or around an industrial estate can make a major contribution to maintaining the natural heritage of a country (and of the planet). Such a contribution to protection of global biodiversity is much easier for an estate to achieve than for an individual company, and suggests an important new role for industrial estates as agents for sustainable development.

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APPENDIX 1

THE BUSINESS CHARTER FOR SUSTAINABLE DEVELOPMENT

The International Chamber of Commerce's Business Charter for Sustainable Development, announced in April 1991, encourages companies to improve their environmental performance in accordance with the following 16 principles. By 1997 these principles had been adopted by approximately 2000 business firms worldwide.

1. Corporate priority: To recognise environmental management as among the highest corporate priorities and as a key determinant to sustainable development; to establish policies, programs, and practices for conducting operations in an environmentally sound manner.

2. Integrated management: To integrate these policies, programs, and practices fully into each business as an essential element of management in all its functions.

3. Process of improvement: To continue to improve corporate policies, programs, and environmental performance, taking into account technical developments, scientific understanding, consumer needs, and community expectations, with legal regulations as a starting point; and to apply the same environmental criteria internationally.

4. Employee education: To educate, train, and motivate employees to conduct their activities in an environmentally responsible manner.

5. Prior assessment: To assess environmental impacts before starting a new activity or project and before decommissioning a facility or leaving a new site.

6. Products and services: To develop and provide products or services that have no undue environmental impact and are safe in their intended use, that are efficient in their consumption of energy and natural resources and that can be recycled, reused, or disposed of safely.

7. Customer advice: To advise, and where relevant, educate customers, distributors, and the public in the safe use, transportation, storage, and disposal of products provided; and to apply similar considerations to the provision of services.

8. Facilities and operations: To develop, design, and operate facilities and conduct activities taking into consideration the efficient use of energy and materials, the sustainable use of renewable resources, the minimization of adverse environmental impact and waste generation, and the safe and responsible disposal of residual wastes.

9. Research: To conduct or support research on the environmental impacts

of raw materials, products, processes, emissions, and wastes associated with the enterprise and on the means of minimising such adverse impacts.

10. Precautionary approach: To modify the manufacture, marketing, or use of products or services or the conduct of activities, consistent with scientific and technical understanding, to prevent serious or irreversible environmental degradation.

11. Contractors and suppliers: To promote the adoption of these principles by contractors acting on behalf of the enterprise, encouraging and, where appropriate, requiring improvements in their practices to make them consistent with those of the enterprise; and to encourage the wider adoption of these principles by suppliers.

12. Emergency preparedness: To develop and maintain, where significant hazards exist, emergency preparedness plans in conjunction with the emergency services, relevant authorities, and the local community, recognising potential transboundary impacts.

13. Transfer of technology: To contribute to the transfer of environmentally sound technology and management methods throughout the industrial and public sectors.

14. Contributing to the common effort: To contribute to the development of public policy and to business, governmental, and intergovernmental programs and educational initiatives that will enhance environmental awareness and protection.

15. Openness to concerns: To foster openness and dialogue with employees and the public, anticipating and responding to their concerns about the potential hazards and impacts of operations, products, wastes, or services, including those of transboundary or global significance.

16. Compliance and reporting: To measure environmental performance; to conduct regular environmental audits and assessments of compliance with company requirements, legal requirements, and these principles; and periodically, to provide appropriate information to the board of directors, shareholders, employees, the authorities, and the public.

APPENDIX 2

EXTRACT FROM PALME LABEL FOR INDUSTRIAL PARKS

Below are the key elements of the PALME label created by a French association of industry and public groups. The label is intended to ensure a more environmentally responsible planning and management of industrial parks. It is a voluntary arrangement between the various partners and stakeholders in each park, with each partner signing an operational document that lists individual actions to take.

For each specific park, the elements below need to be further evaluated for relevance, and perhaps elaborated to take into account site-specific factors.

Thus in France where this label was developed, most new industrial zones will develop on agricultural land, close to human settlements and to major transport arteries. It is less common for remote sites of high ecological value to be selected.

Implementation of the planning and management elements listed will ensure a high standard of amenity for the park itself, and improved environmental and safety performance of the individual enterprises. In France, industrial sites at Boulogne-sur-Mer and at Chalon-sur-Saône have already signed the PALME charter.

Key PALME elements

1. Prepare a site development plan, and have available the relevant regulations and guidelines.

2. Establish a landscaping plan, and architectural requirements for buildings.

3. Ensure compliance with (environmental) regulations and by-laws, and adherence to operational guidelines.

4. Ensure a preliminary pre-development ‘greening’ of the site as applicable.

5. Define and operationalize a management plan for various landscape and green areas of the site.

6. Establish and implement a plan for the transformation of any agricultural activities on the site.

7. Establish and implement a plan for natural flora and fauna to maintain or re-establish the ecological balance of the site.

8. Implement a public awareness and information programme concerning natural environment and conservation.

9. Prepare an initial baseline ‘State of Environment’ report for the site.

10. Establish a network of environmental, health and safety specialists and services available to estate management and individual enterprises.

11. Establish an advisory service for clean technologies.

12. Establish a programme to offer environmental pre-diagnostics for enterprises.

13. Establish a unit to coordinate estate-wide environmental and health services.

14. Develop and implement a ‘clean construction site ‘ programme.

15. As required, coordinate surveys and monitor the extent of soil contamination on an on-going basis.

16. Establish a plan for solid waste management

17. Establish a plan for industrial waster and effluents

18. Establish a plan for management of rainwater and surface runoff, and construction of any necessary installations.

19. Use road surfaces that reduce transport noise

20. Advise enterprises on noise reduction measures and materials for buildings and machinery.

21. List noisy industries and activities on the site plan.

22. Evaluate the applicability, and encourage use of, less polluting vehicles.

23. Monitor site air quality and noise.

24. Establish an energy management plan for the site.

25. Investigate alternative energy sources.

26. Request electricity supply to be underground.

27. Link the site with existing rail transport where possible.

28. Create a convenient road access and safe turn-off from major roads.

29. Link the site with local bus transport, or taxi-bus arrangements.

30. Develop separate cycle paths

31. Establish a liaison mechanism with relevant local authorities.

32. Link the site with the economic situation and needs of the surrounding area.

33. Establish a monitoring and coordination unit for the above.

APPENDIX 3

INDONESIAN DEPARTMENT OF INDUSTRY TECHNICAL GUIDELINES FOR AN ENVIRONMENTAL IMPACT ANALYSIS OF AN INDUSTRIAL ESTATE

The Department of Industry in Indonesia developed a set of draft technical guidelines to set out format and content requirements for an Environmental Impact Analysis Report (ANDAL) on an Industrial Estate. Readers are advised that interpretation of these guidelines requires both flexibility and discretion, as they were devised for the Indonesian situation. Depending on the nature and circumstances surrounding a particular project, it may be necessary to add to, combine, or delete one or more of the suggested topics.

Source: Environmental Management Development in Indonesia (EMDI 1992).

SUMMARY

The summary should highlight the key findings and conclusions of the report. It should be concise and clearly written and should parallel the main document in terms of headings.

INTRODUCTION

This chapter provides an introduction to the Environmental Impact Analysis Report.

Nature and purpose of report
This subsection describes in general terms what the report is about, why it has been produced and whether there are previous reports or documents on which it is directly dependent.

Study teams
In this subsection the principal members of the investor's study teams should be identified and their fields of expertise and responsibility noted.

Study area
The intent of this subsection is to define the study area. It should contain both text and maps. With respect to the latter these should depict:

- the regional setting
- the local study area boundaries.

A brief explanation should be provided on how the extent of the local study area was determined.

NEED AND RATIONALE

The thrust of this chapter is to explain the justification for the project.

Purpose of project
The subsection provides an explanation as to why the project is needed and what will be accomplished by constructing it. Reasons might be included but are not limited to benefits such as: stimulating regional development; taking advantage of local resources, or alleviating a local deficiency or problem.

Background of project
In this subsection the project events are placed in chronological order. If there are events related to the project that have

occurred over a number of years these should be set out. In addition, if there have been previous applications and submissions made on the project to the Department of Industry or other government authorities at national, provincial, or district levels these should also be listed.

Project alternatives

The purpose of this subsection is to briefly describe whether there were other alternatives to the project (for example, a form of development other than an industrial area). If so, the advantages and disadvantages of each alternative should be discussed and the principal reasons for their being rejected should be specified. For some projects the null alternative may deserve inclusion in these discussions.

Alternative sites

This subsection applies if other sites were investigated before selection of the one to which this document applies. A brief description should be given of the alternative sites ,where they were located, and why they were rejected. If a formal site selection document was prepared, the reader should be referred to it for additional detail.

Related projects

If there are other related projects which this project is the result of or a catalyst for, they should be briefly described here. For example, an industrial estate could be a necessary component of a major harbour development; on the other hand it could provide the impetus for developing a new airport or residential sub-division.

PROJECT DESCRIPTION

A detailed description of the project is provided in this chapter.

General site characteristics

This subsection briefly describes the character of the site in terms of significant on-site features and proximity to nearby features such as roads, towns, rivers, etc. A site area map should be provided and its scale should be sufficient to clearly show site boundaries and elevation contours.

Plan of subdivision

In this subsection, the plan of subdivision is depicted and generally described. Information provided in written and mapped form should address the following:

- the size and location of lots
- the size and distribution of transportation and utility networks
- the proposed land use pattern
- the distribution of major buildings and facilities such as administrative offices, waste handling facilities, settling ponds, etc.
- the location of other facilities of note such as major berms, fences, utility corridors, etc.
- a description of development phases.

Major components

This subsection provides detailed information on the component facilities that will be installed in the estate to meet the needs of tenant industries. Such facilities might include but are not limited to:

- roads
- rail lines

- docking facilities
- electric transmission lines
- water supply lines and pumping stations
- sewage lines and treatment facilities
- solid and hazardous waste disposal facilities
- administration buildings and laboratories
- fire-fighting facilities
- ponds
- commercial area and recreation facilities
- permanent housing
- construction camps
- material laydown and storage areas
- maintenance yards
- dikes, berms, and ditches.

Text, maps, drawings and cross sections should be used as appropriate to convey the following types of facility information:

- dimensions (area, height, depth)
- production capacities (number, volume)
- waste handling capabilities (treatment levels, suitability for handling different materials and fluids, etc.)
- construction methods (cut and fill, excavation, piling, etc.)
- construction materials (types, quantities, sources, storage areas, etc.).

Construction management plan

The construction management plan should consist of three parts. The first part should set out the proposed construction schedule for the overall project and each of the major project stages.

Part Two should discuss general construction practices and procedures that are being proposed either to expedite the building of project or to control negative effects arising from construction activities.

Such measures might include:

- hours of activity
- noise and dust control practices
- procedures for controlling debris
- procedures for the disposal of oils and grease from construction equipment
- building temporary service roads around communities
- regulating traffic flows on local roads, etc.

The third part of this subsection should set out labour force projections for each of the major construction phases. A labour force curve showing men per month is a useful graphic.

In addition to labour force this subsection might also indicated the number of construction vehicles that will travel to and from the site on a daily basis during the different construction stages.

Operations and maintenance

A number of subjects should be addressed in this subsection. It ought to cover the overall operation of the estate and generally touch on the construction and operation of generic types of potential tenant industry. Matters that should be addressed include:

- a description of the type and scale of industries that will be encouraged to locate in the estate
- a description of the land use regulations and construction and operating covenants that will be applied to industries locating in the estate
- a description of the general estate services that will be provided to tenants and an indication of how these services

will be paid for, operated, and maintained
- a description of how industries in the estate will be monitored to determine whether they comply with prescribed construction and operating plans
- a description of emergency planning measures, such as spill containment, fire protection, and evacuation.

In discussing the various services in this section particular care should be taken to address in comprehensive detail the operating procedures and practices that apply to:

- water supply, sewage, and effluent treatment
- solid and hazardous waste handling and disposal
- air emission controls.

KEY ISSUES AND CONCERNS

The purpose of this chapter is to scope environmental issues to determine which are most significant. Scoping helps to ensure that the ensuing environmental studies, analyses, and mitigative measures will be focused on environmental matters which are judged to be important. In turn it helps to ensure that effort and money are not wasted in dealing with issues that are of little importance or that are not relevant.

Method of scoping

This subsection describes the various methods used by the study team to scope environmental issues relevant to the subject undertaking. Such methods could include:

- site visits and preliminary field work
- discussions with local officials and community leaders
- review of available literature dealing with: projects of similar nature and environmental conditions in the local area.
- experience of the proponent and study team.

Identification and description

Based on the activities set out in the previous subsection the key issues and potential impacts should now be identified and described. Discussions should detail:

- identification of the environmental components that may be affected
- an indication of the extent to which existing conditions will be altered
- a determination of the location and area of potential impacts
- an indication of whether the impacts are short or long term
- an assessment to whether the impacts are reversible
- a determination of the ease with which potential impacts can be mitigated.

ENVIRONMENTAL CONDITIONS

This chapter describes in both qualitative and quantitative terms the existing conditions for those environmental factors determined in the preceding chapter to be important.

For each of the factors addressed, information should be provided with one or more of the following purposes in mind:
- assist in determining the environmental changes that will occur because of the project.

- assist with project design so that potential negative project effects are minimized
- assist with project design so that potential positive project effects are optimized.

Natural environment

This subsection describes the natural environmental setting of the study area. It includes both living and nonliving attributes. Factors and subjects that could be discussed include the following:

Topography

- general characteristic landforms
- slope
- grade of site.

Soils

- general characteristics
- load bearing capacity
- existing and potential erosion
- permeability
- shrink-swell characteristics.

Geology

- geologic characteristics
- geologic faults
- seismic conditions.

Ground water conditions

- nature and extent of aquifer and recharge areas
- water quality (physical and chemical characteristics).

Surface water conditions

- location and size of watershed and catchment areas
- pattern and nature of surface water flows (i.e. streams, rivers, lakes and seasonal variations in rates and patterns of flow)
- water quality (physical and chemical characteristics).

Marine conditions (if relevant)

- depth of near-shore coastal waters
- tide and current conditions
- water quality (physical and chemical characteristics).

Climate

- annual rainfall and seasonal distributions
- annual temperature and temperature ranges
- local and regional air quality
- wind speeds, directions, frequencies and seasonal variations
- potential for floods, hurricanes, other natural hazards
- frequency of inversions.

Noise levels

- ambient noise levels.

Vegetation and wildlife

- terrestrial and aquatic vegetation (species composition, abundance, and habitat significance)
- terrestrial and aquatic animal life (species composition, abundance)
- rare or endangered species
- unique natural systems (stream systems, wildlife breeding areas, etc.)
- resource areas (fisheries, plantations, forests, etc.)
- the degree of susceptibility any of the above have to pollutants that could be discharged from the project area.

For all of the preceding, maps should be used whenever practical to show the location and distribution of the phenomena in the study area. Where sampling and monitoring were carried out to generate information, such as might be the case for water and air quality data, the sampling location should be mapped and the frequency or duration of sampling described.

Socio-economic and cultural environment

The socio-economic and cultural environment within the study area are described in this subsection. It encompasses those aspects of the environment which relate to man, his activities, his perceptions, and his beliefs. Factors and subjects that could be discussed include:

Social and community conditions

- population characteristics (size, demographics, distribution, etc.)
- community characteristics (attitudes, behaviour, cohesion, lifestyles, health, etc.)
- community facilities and services (schools, hospitals, recreation, etc.)
- housing characteristics (types of housing, occupancy levels, age, conditions etc.).

Land use and resource areas

- land use and resource areas (types, patterns, density, intensity of usage, areas, and lot sizes)
- infrastructure (water, sewer, solid waste, energy and transportation facilities)
- zoning controls and regulations in effect
- regional plans or resource strategies in effect.

Aesthetic and cultural resources

- history, archaeological or architectural sites
- scenic areas, views, and natural landscapes
- other areas or features of unique cultural importance.

Economic conditions

- employment and unemployment patterns, including occupation distribution and availability of workforce
- income levels and trends
- economic base of area
- land ownership patterns
- land value.

It is strongly recommended that maps be used wherever possible to show the location and distribution of socio-economic and cultural features within the study area.

ENVIRONMENTAL IMPACTS AND MITIGATIVE ACTIONS

This chapter clearly sets out the possible positive and negative impacts that the project could impose on the environment. For each factor the possible impacts and subsequent mitigative actions for the construction and operation phases should be addressed separately. A format similar to the following is suggested for each component:

Environmental effects

- the potential direct and indirect effects associated with the project
- the description should include the benefits and adverse environmental effects
- location, area, importance, duration, and

reversibility should be discussed for each impact.

Mitigation/corrective measures

- ways of mitigating environmental effects should be described
- commitments to mitigation should be specified
- if the level of information available at this stage is insufficient to permit a determination of mitigation measures, an indication should be made of what further work is required
- any commitments to undertaking further investigations should be specified, and the schedule and manner in which this work will be undertaken should be described.
- special contingency plans on procedures to be used in case of emergencies should be described
- procedures to optimize positive impacts should be set out.

CONCLUSIONS

This final chapter briefly reviews findings of the study across the various environmental factors. It notes the potential impacts and indicates whether mitigation measures can alleviate all concerns, and if they cannot, it identifies the residual impacts. This chapter follows the sequence of environmental factors presented in the last two chapters. In essence, it is an overall summation of the environmental soundness of the proposed project.

APPENDIX 4

ENVIRONMENTAL MANAGEMENT PROGRAMMES

One of the important first steps in establishing an environmental management system is to understand the range and diversity of environmental issues to be addressed. The list of issues is longer than many managers at first believe. The relationship between issues is also an important factor, for action on one issue can easily affect the estate's performance on another. The preparation of a comprehensive environmental assessment report is thus an important first step.

Some of the specific management elements which contribute to improving environmental performance are described below.

Elements of an environmental programme

- Sound policies and clear objectives which define environmental issues and identify the estate's approach, such as emphasis on prevention rather than treatment
- Well-defined operating standards and realistic targets for discharges and site safety
- Visible and effective management commitment to environmental protection
- Clearly defined line management responsibility and accountability
- Adequate resources for the programme
- Regular review of environmental performance, e.g. audits
- Programmes on training and awareness on environmental risks
- Effective incident reporting and investigation
- Effective contingency planning for accidents, spills and fires
- Reporting systems within the estate, and with the public.

While the precise content of a programme has to be determined by each estate itself, a number of international organizations, such as the International Chamber of Commerce, have prepared environmental guidelines for their members to follow. The individual management elements may already be by included in formal standards for environmental management systems such as ISO 14001, and are explained in the UNEP/ICL/FIDEC trainers kit on Environmental Management Systems.

A clear statement of overall environmental policy greatly helps the various initiatives to function in a coherent manner. Such policy is often framed in a simple way to allow easy communication to employees and the public. A more comprehensive implementation document should be available to provide detailed guidance for operational managers.

A policy statement may include principles, objectives, definition of responsibilities, and an outline of the means to accomplish the goals. In addition to reaffirming regulatory compliance, quantitative environmental targets should be given wherever possible.

Open reporting and communication is also often included as a policy component. The policy and systems will not function without a sound corporate structure that facilitates environmental action on the site, provides feedback to top management, and responds to issues as they develop. Every estate has a different structure and no one reporting and responsibility model is universally applicable. Nevertheless some of the common elements are:

- Responsibility for environmental performance at a high level, preferably the chief executive;
- Review of environmental performance by the Board;
- A director with responsibility for environmental co-ordination;
- An environmental committee to enable input from all levels to be considered;
- Independence at the working level to see that the most appropriate environmental action is taken;
- Good communication up and down;
- Use of environmental specialists for certain tasks; and
- Technical back-up for environmental services.

APPENDIX 5

SITE GRADING AND EROSION AND SEDIMENTATION STANDARDS BURNSIDE INDUSTRIAL PARK, CANADA

1. Undertakings involving land disturbance that could result in siltation of watercourses may require environmental assessment and be subject to the provisions of other environmental legislation. Industrial Parks Development are capable of causing gross sediment pollution if not properly planned and constructed. As such, they require an Erosion and Sedimentation Control Plan.

2. An acceptable plan usually consists of two parts:

   a) A narrative report describing the Development (including the scheduling or phasing of major construction activities), and explaining the methods, techniques, and procedures (including maintenance of control measures) to be followed.

   b) A map (or several maps of the same scale) or a base map with overlays, depicting the topography and natural features of the area, the limits for clearing and grading, existing and anticipated erosion problems, and the location of suitable control measures. The map should be an integral part of any site plan, grading plan or construction drawings.

3. Conservation practices for erosion and sediment control should meet or exceed guidelines and specifications established for the estate by government.

4. Even within an industrial estate, the conservation practices needed to control accelerated erosion and sedimentation vary from site to site. The degree of slope, nature and types of soil, drainage characteristics, proximity to property boundaries and watercourses, area disturbed, amount of cut and fill, and other factors all have a direct bearing on what combination of conservation practices will result in an adequate erosion and sedimentation control plan.

5. Great care must be taking in selecting the right control measure for each erosion site. Although erosion problems often share similar symptoms, their causes may differ significantly. For this reason, it is wise to undertake a thorough site investigation. This will help to determine the exact nature of the problem and how to correct it. For example, erosion along a drainage ditch may be the result of high stream flow velocity, unstable bank conditions, concentrated overland runoff, or any combination of these. Unless the actual causes of a problem are adequately determined, the applied remedial measure may fail to correct it, and may even aggravate it.

6. The selection, design and implementation of effective erosion and sediment control measures requires a clear identification of efforts. It is important to avoid an indiscriminate choice of measures, but rather to select those that appropriately meet the

Problem Type	Erosion Problem	Sediment Problem
I	X	-
II	X	X
III	-	X

specific objectives required in correcting the specific problems for financial as well as ecological reasons.

7. A broad classification of erosion and sediment problems such as those presented below provides a basis for considering categories of problems and control strategies.

    a) An erosion problem exists where damage attributable to erosion involves the direct loss of soil, which in turn can mean the loss of roadways, the undermining of structures, and other damage necessitating costly repair.

    b) A sediment problem exists where there is damage associated with the deposition of eroded materials at a downstream location; for example, clogging of culverts, filling of drainage ditches and stream channels, silting of ponds and reservoirs, and contamination of downstream waters by sediment-borne pollutants.

    c) Problem Type I involves an erosion problem but no sediment problems. Such a situation may occur where locally-eroded sediments, even in substantial quantities, are transported and deposited relatively short distances downslope or within the construction boundaries but do not move into a waterway system.

    d) Problem Type II involves both an erosion problem and a sediment problem. This type of situation can result from substantial material being eroded and transported into downstream ditches and stream channels.

    e) Problem Type III involves a sediment problem only. This type of situation may occur when the direct loss of soil is insufficient to create local damage at the erosion sources, but the accumulated sediment transported downstream creates depositional or water quality problems.

8. Recognising the wide variations from one site to another, the following elements are to be considered in the development of the Site Grading and Erosion and Sedimentation Control Plan.

    a) A general statement of the Development must be included in the narrative section of the Plan including:

    - Description of the overall Development.
    - Date that the Development is to begin and expected date that final stabilization will be completed.
    - Description of erosion control program.
    - Description of sediment control program.
    - Description of stormwater management program.

    b) The Plan is to include cross sections showing approximate elevational relationships between buildings, parking, yards, streets, and adjacent properties at key locations. Elevations, slopes, and gradients of major installations are to be identified, and the proposed alterations to the existing topography illustrated.

c) The topographic features are to be shown on a topographical map, which is also to include map scale and north arrow. Also, the map is to show:

- The location of the Development relative to highways, property boundaries, buildings, water supplies, and other identifiable landmarks or significant features.
- Contours at an interval and scale that will adequately describe the area prior to, and following construction.
- Critical environmental areas located within, or in proximity of, the Development areas, such as streams, lakes, ponds, wetland areas, drainage ditches, flood plains and wells.
- Nature and extent of existing vegetation.

d) Information on the soils presented in the narrative and shown on the map is to be provided. This information should include:

- Adequate description of each soil, including type, texture, slope, depth, drainage and structure.

- Surface area of each soil. (Soils data is readily available in those areas for which modern soil surveys are either completed or in progress. In the absence of a soil survey, a mechanical analysis of the soil should be made to the depth of the planned disturbance. Alternatively, an on-site evaluation should be made by a qualified soil scientist.)

e) The Stormwater Management Program is to be described in the narrative and the location of facilities shown on the map. The description of the Stormwater Management Program is to include:

- The anticipated amount of runoff from the area and the upstream watershed; runoff-producing factors and methods of calculation.
- Analysis of problems posed by storm runoff on downstream areas.
- Analysis of local drainage factors which may contribute to on-site or off-site problems.
- Description of the permanent measures and facilities designed to cope with the problem(s).

f) The proposed alterations of the area are to be shown on the map and are to include:

- Boundary limits and acreage of the Development.
- Limits of clearing and grading.
- Areas of cuts and fills and proposed side slopes.
- Location for roads (including stream crossings), buildings, storm sewers, and other structures.
- Location and protection of stockpiles of excess fill or topsoil.

g) The temporary erosion and sedimentation control measures (vegetative and mechanical) to be used during active construction are to be included in the narrative and shown on the map and are to include:

- Purpose of control measures.
- Types of measures and facilities and expected length of service.
- Location of measures and facilities.
- Dimensional details of the facilities.
- Design considerations and calculations (if applicable).

h) The permanent erosion and sedimentation control measures for long-term protection are to be included in the narrative and shown on the map including:

- Purpose of control measures.
- Types of measure and facilities.
- Location of measures and facilities.
- Dimensional details of facilities.
- Design considerations and calculations.
- Landscaping or vegetative details such as seeding, sodding or mulching.

i) The maintenance program for the control facilities is to be described in the narrative and is to include:

- Inspection program, including frequency and schedule.
- Resodding or reseeding of vegetated areas.
- Repair or reconstruction measures
- Method and frequency of removal and disposal of sediment from the control facilities or the Development area.
- Method for disposing of temporary structural measures after they have served their purpose.

APPENDIX 6

ADDRESSES OF KEY ORGANIZATIONS

American Association of Port Authorities
1010 Duke Street
Alexandria, Virginia 22314
United States
Attn: Eric Stromberg

Dalhousie University
School for Resource
and Environmental Studies
1312 Robie St.
Halifax
Nova Scotia B3H 3E2
Canada
Attn. Raymond Côté

Eco-Industrial Development Programme Center for the Environment
Cornell University
Ithaca, New York
United States

International Association of Cities and Ports
45 rue Lord Kitchener
76600 Le Havre
France
Attn: Antoine Rufenacht

International Association of Ports and Harbours
Kotohira-Kaikan Building
2-8 Toranomon
1-chome, Minato-ku
Tokyo 105, Japan
Attn: Hiroshi Kusaka

Industrial Development Research Council
c/o Conway Data Inc.
35 Technology Park Suite 150
Norcross, Georgia 30092
United States

OREE
42 rue du Faubourg Poissonière
75010 Paris
France Attn: Philippe Marzolf

Regional Institute of Environmental Technology
3, Science Drive
SISR Annex 04-08
Singapore 118223
Attn: Philippe Bergeron

United Nations Centre for Regional Development (UNCRD)
Nagono 1-47-1
Nakamura-ku
Nagoya 450, Japan

UNEP Industry and Environment
39-43 quai André Citroën
75739 Paris Cedex 15
France
Director: Jacqueline Aloisi de Larderel

United Nations Industrial Development Organization (UNIDO)
Vienna International Centre
PO Box 300
A-1400
Vienna, Austria

World Bank
Environment Department
1818 H Street NW
Washington, DC, 20433
United States

World Export
Processing Zones Association
c/o Box 986
Flagstaff, Arizona
USA 86002
Attn: Richard Bolin, Director

ABOUT UNEP
INDUSTRY AND ENVIRONMENT
CENTRE

The Industry and Environment centre was established by UNEP in 1975 to bring industry and government together to promote environmentally sound industrial development. UNEP IE is located in Paris and its goals are to:

1. encourage the incorporation of environmental criteria in industrial development plans;
2. facilitate the implementation of procedures and principles for the protection of the environment'
3. promote the use of safe and clean technologies; and
4. stimulate the exchange of information and experience throughout the world.

UNEP IE provides access to practical information and develops cooperative on-site action and information exchange backed by regular follow-up and assessment. To promote the transfer of information and the sharing of knowledge and experience, UNEP IE has developed three complementary tools: technical reviews and guidelines; *Industry and Environment*—a quarterly review, and a technical query-response service. In keeping with its emphasis on technical cooperation, UNEP IE facilitates technology transfer and the implementation of practices to safeguard the environment through promoting awareness, training and diagnostic studies.

Some recent UNEP IE Publications

Audit and Reduction Manual for Industrial Emissions and Wastes (Technical Report Series No. 7), UNEP/UNIDO, ISBN 92-807-1303-5, 124 p., 1991

Awareness and Preparedness for Emergencies at Local Level: a Process for Responding to Technological Accidents, ISBN 92-807-1183-0, 63 p., 1988.

Cleaner Production in the Asia Pacific Economic Cooperation Region, ISBN 92-807-1443-0, 41 p., 1994.

Companies Organization and Public Communication on Environmental Issues (Technical Report Series No. 6), ISBN 92-807-1304-3, 130 p., 1991.

Company Environmental Reporting (Technical Report Series No. 24), ISBN 92-807-1413-9, 118 p., 1994.

Environmental Management in the Electronics Industry—Semiconductor Manufacture and Assembly (Technical Report Series No.27), UNEP/UNIDO, ISBN 92-807-1403-3, 161 p., 1994.

Environmental Management systems—training resource kit, UNEP/ICC/FIDIC, 400 p., 1995.

From Regulations to Industry Compliance: Building Institutional Capabilities (Technical Report Series No.11), ISBN 92-807-1342-X, 62 p., 1992.

Government Strategies and Policies for Cleaner Production, ISBN 92-807 1442-2, 32 p., 1994.

Hazard Identification and Evaluation in a Local Community (Technical Report Series No.12), ISBN 92-807-1331-0, 86 p., 1992.

Health Aspects of Chemical Accidents. Guidance on Chemical Accident Awareness, Preparedness and Response for Health Professionals and Emergency Responders (Technical Report Series No.19)—a joint IPCS/OECD/UNEP/WHO publication: OECD Environment Monograph No. 81), 147 p., 1994.

Industry Environmental Compliance—training manual (Technical Report Series No. 36), ISBN 92-807-1568-8, 1996.

International Directory of Emergency Response Centres (Technical Report Series No. 8, OECD Environment Monograph No. 43), 77 p., 1991.

Life Cycle Assessment: what it is and how to do it, ISBN 92-807-1546-1, 91 p., 1996.

*Monitoring of Industrial Emissions and Wastes (*Technical Report Series No.27), UNEP/UNIDO, ISBN 92-807-1434-1, 131 p., 1996

The Textile Industry and the Environment (Technical Report Series No. 16), ISBN 92-807-1367-1, 120 p., 1994.

Industry and Environment (quarterly) deals with issues relevant to industrial development, such as auditing, waste management industry-specific problems, environmental news.

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