GUIDELINES FOR MUNICIPAL SOLID WASTE MANAGEMENT IN THE MEDITERRANEAN REGION

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PREFACES

The Regional Bureau for Arab States (RBAS) of the United Nations Development Programme (UNDP) has had the pleasure since January 2000 to manage the European Commission SMAP I Mediterranean Urban Waste Management Project. This initiative, managed by the RBAS Division for Regional Programme, represents a unique and innovative approach to tackling priority waste management issues in the Mediterranean region. The spirit of partnership, collaboration and knowledge exchange among the cities has been a positive force towards the success of project activities.

This booklet, the Guidelines for Municipal Solid Waste Management in the Mediterranean Region, has been produced to provide a step-by-step tool for the cities of the Mediterranean to adopt an integrated approach to solid waste management. By providing a complete overview of the waste management system and identifying alternative means for service delivery, our cities will be better equipped to implement more efficient and cost-effective waste management.

Elballa Hagona
Regional Programmes Division
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In the 12 years existence of the Medcities network, urban solid waste projects have been the most common projects undertaken.

Medcities has worked on co-operation projects for solid waste planning in the Urban Community of El Fayha (Tripoli, El Minah and El Badawi in Lebanon), Latakie (Syria) and Limassol (Cyprus); improvement of the management of the collection services in Zarqa, Limassol and Alexandria; enlargement of landfills at Tetuan and El Fayha; a materials recovery facility in Zarqa; a call centre for centralising citizens' complaints and suggestions in Alexandria; a pilot activity of selective collection from hotels and restaurants in Limassol and Yermasoia, etc.

It is no accident that urban solid waste services are one of the main problems that towns in the East and South of the Mediterranean Region have to face. The main reasons lie in the rapid growth of their urban populations and in changes in consumption and distribution patterns, which have increased the use of packaging and non-biodegradable goods. A lot of Medcities towns have asked our network to undertake co-operation projects in this field because of the considerable management problems and the health and environmental impact involved.

Promoting the skills of local politicians and staff is, in our view, the most efficient way to reach real and sustainable improvements in solid waste service management. Medcities has systematically used the exchange of experiences between our member towns, including experts from various towns getting involved in joint projects and giving practical training courses on questions such as strengthening of institutions, technical methods, accountability and organisation, and governance and public awareness.

These Guidelines are designed as a new tool in this continuous process of promoting skills. The objective is to give to political leaders in Mediterranean local government and staff dealing with solid waste services a useful document that will assist them in finding recommendations and information channels to improve their day-to-day decisions.

We hope that those with responsibility in local government will find the Guidelines useful.

Joan Parpal
General Secretary
Medcities network

The Institute for the Sustainability of Resources (ISR-cer) is a private non-profit organisation, whose main goal is to serve as a tool in rationalising the debates on waste management. Due to its international experience in waste related issues, the ISR-cer provides its scientific, economical and technical view to the *Guidelines for Municipal Solid Waste Management in the Mediterranean Region*.

The ISR-cer finds that the Guidelines are an essential tool to help solid waste management practitioners, such as local government officials and technicians. The Guidelines contain information to help these practitioners meet the daily challenges of planning, managing, and operating municipal solid waste programs and facilities.

The particularities of the Eastern and Southern Mediterranean cities are the rapid growing of population and especially the limitation of natural resources, in particular water, that have to be preserved to ensure sustainability. For these reasons, the guide's primary objective is to show the options available to establish an adequate waste management system, starting from a simple system in which basic sanitary concerns are taken into account, and introducing environmental and economic concerns.

The guidelines will also offer a few recommendations and examples to encourage the waste hierarchy of waste management (prevention of waste in the first place, recovery, recycling, energy from waste, and disposal as the last option) that is the international tendency regarding the waste management policy. These recommendations are considered an advanced step in waste management.

Readers are encouraged to carefully evaluate all of the elements in their waste handing systems, to consider the options offered in these Guidelines and to contrast information to implement waste management.

We hope that the information and references given in the Guidelines will be very helpful to all local practitioners.

Ignacio Monfort
Director of Strategy and Development
EWC / ISR-cer

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1. INTRODUCTION TO THE WASTE GUIDE

This guide has been developed within the context of the **Mediterranean Urban waste Management Project (SMAP 1998)**. Partners in this project are: United Nations Development Programme (UNDP) Regional Bureau for Arab States, MEDCITIES Network and its members (Alexandria, Limassol, Zarqa, Rome and Barcelona), CEDARE and the Institute for the Sustainability of Resources (ISR-CER).

1.1. OBJECTIVES OF THE WASTE GUIDELINES.

This chapter introduces you briefly to the waste guide, which will hopefully prove to be an easy, useful and flexible tool for better waste management in cities. The guide offers an overview of municipal waste management with specific focus on East and South Mediterranean cities.

This guide has been developed for local government officials and technicians to help them in the decision making process and implementation of a **basic solid waste management system** as well as in **solving the daily challenges of planning, managing, and operating municipal solid waste programs and facilities**. It also means to facilitate **continuity**; it intends to provide a basis for the management of urban waste throughout the years.

It is also addressed to the cities that, due to their location, number of inhabitants, infrastructure, and/or social and economic structure, will make an effort to handle their waste in an environmentally acceptable way.

The guide's primary goal is to foster the implementation of integrated solid waste management systems based on **five principal objectives**: sanitary aspects, social concerns, environmental considerations, urban structure and economic circumstances, in that order, in addition to being **cost-effective.**

Moreover, it is also the intention of this guide to **raise public awareness** of waste-related problems in cities.

Because the infrastructure and technology used in handling MSW are rapidly changing, the information presented should help decision makers consider the numerous factors associated with successful implementation of new solid waste solutions. Readers are encouraged to carefully evaluate all of the elements in their waste-handling systems and carry out source separate collection, recycling, and environmentally sound disposal.

Communities are encouraged to coordinate their goals for waste reduction and management, environmental protection, community development, and employment.

All individuals involved in MSW are encouraged to expand their professional skills and to help other practitioners and community members better understand the challenges ahead and the opportunities available. It is primarily through such co-operative enterprises that governments, communities, and businesses can make the best possible decisions for the reduction and management of municipal solid waste.

The specific targets of the waste guide are:

- To raise awareness among local, regional and national authorities by describing waste handling situations and problems;
- To provide decision-makers at the local and regional levels with knowledge of waste management planning as a practical tool to help them manage municipal and other categories of waste; and
- To incorporate good practices into the waste management system.

1.2. HOW TO USE THE WASTE GUIDE.

For the purposes of clarity and easy use, each chapter of the guide contains the following components: objective description, proposals or guidelines, examples of good practices, bibliography and web sites of interest.

The guide has been published in a paper format that allows changes and renewal of its contents. The guide has also been published on MEDCITIES web site where information will be periodically updated. Visitors and users of this guide are encouraged to send advice on changes and information to complete it, as well as examples of good practice, to the following e-mail address: desurb@amb.es

2. CITY DEVELOPMENT AND WASTE MANAGEMENT.

2.1. WHAT DOES WASTE MANAGEMENT MEAN?

Waste management is a combination of processes: collection, storage, transport, valorisation and disposal of waste, as well as the monitoring of these activities, and of the disposal sites after closure.

2.2. CONCERNS IN GROWING CITIES.

After 50 years of intense urbanisation and the transformations of lifestyle and consumption patterns, Mediterranean societies are now mostly urban.

Urban population has grown from 94 million inhabitants in 1950 to 274 million inhabitants in 2000 and a deceleration in growth is not expected until 2025.

As an example, table 2.1. shows growth rates in different cities of the Mediterranean basin.

Table 2.1. Cumulative growth 1980-1995

Metropolitan area	Thousands of inhabitants	Cumulative growth rate
Tangier	247	91.13%
Tetuan	134	67.86%
Oran	203	38.12%
Sousse	101	64.56%
Gaza	190	81.89%
Haifa	91	24.54%
Limassol	48	47.41%
Tripoli	15	7.91%
Silifke	43	192.76%
Tirana	65	33.40%

Source: Solid Waste Management Strategy for METAP Mashreq and Maghreb Countries. World Bank/METAP, 2002.

As cities and their populations grow, numerous changes occur in consumer habits. These changes make the amount of waste generated grow exponentially, and the waste composition vary radically.

One major concern for officials and government agencies is how to manage such quantities of waste in an appropriate and feasible way.

Other secondary, but still important, problems include, for example, increasing distances, the appearance of new waste producers, etc. Additionally, inadequate waste management results in dirtiness and health problems, both of which are a major cause of concern for municipalities.

Another concern for municipalities is which type of management to choose for solid waste. The management method selected has implications on many aspects: collection and storage by the producers of waste, transport suitable for collecting the waste from "cradle"; frequency of collection, the need to ensure a market for compost and recyclables, and the need to educate the public and increase awareness among residents.

Another concern is how to cover the cost of waste collection, transfer and treatment, and of limiting the weight and volume to be treated.

Avoiding these problems with a waste management system can definitely be beneficial to the municipality, by attracting tourism and industries.

New waste management systems are appearing in order to solve these concerns. An integrated sustainable waste management system can be a perfect tool to achieve this objective.

2.3. INTEGRATED SUSTAINABLE WASTE MANAGEMENT.

Integrated Sustainable Waste Management (ISWM) involves bringing together all the different stages of waste management and trying to manage waste throughout its life cycle in one efficient process, this means integrating:

- The waste producer,
- The waste treatment system, and
- The waste regulators (Administrations).

IWM implies applying a variety of schemes in an interlocking manner and supporting each other towards a common goal of dealing with the waste under consideration using the best current practices and in light of the waste management hierarchy (prevention, reuse, recycling, valorisation and disposal).

This does not imply that all authorities and contractors should work in the same manner or utilise the same systems, but that they should all apply the same criteria.

Integrated Sustainable Waste Management means managing waste today in a manner that does not leave any undue management or environmental legacies for future generations. An integrated waste management system can deliver both environmental and economic sustainability, by recognising that no single method of waste treatment or disposal can deal with all the materials in the waste stream in an environmentally sustainable way.

The ISWM system is not only a matter of technical and financial issues, but also has social, political and environmental aspects.

Main objectives

In putting together a basic ISWM system, the following five objectives should be pursued:

1. *Sanitary aspects.* The adverse health effects of solid waste are due to its inadequate storage, collection and disposal. Flies and rats breed on (uncollected) solid waste and can transmit diseases such as diarrhoea, dysentery and typhoid, if they get in contact with humans.

   Where waste is dumped in drains, the resulting stagnant water often contains mosquito larvae, which can cause malaria, dengue fever and filariasis. The inhalation of smoke from burning waste and contaminated dust is linked to respiratory problems. The health risks of inappropriately managed disposal sites are also obvious. Children playing on dumpsites and scavengers looking for materials risk being infected with, among others, the Hepatitis C and AIDS viruses, especially when healthcare waste is disposed of on the site. Waste collectors are exposed to similar risks.

2. *Social & cultural aspects.* Take into account the influence of culture on waste generation and management in the household and in businesses and institutions; the community and its involvement in waste management; the relations between groups and communities, between people of varying age, gender, and ethnicity; and the social conditions of waste workers, in order to achieve a high level of participation. Education and awareness raising should be considered at this point in the hierarchy of objectives.

3. *Environmental aspects.* Avoid or reduce effects of waste management on land, water and air; on the need for conservation of non-renewable resources and pollution control.

   The environmental effects of solid waste include air pollution from poorly operated and uncontrolled waste combustion, which is extremely serious in some cases.

   Solid waste has polluted drinking water in several areas. Plastic and paper blowing over fields or attached to trees is unsightly. Flooding occurs frequently when drains are blocked by solid waste. Land can be contaminated with hazardous industrial waste or made unusable because of careless waste disposal practices. It often results in the presence of odours and noise, as well as vectors (rats, flies, etc).

4. *Urban functionality*. Control over the waste situation in cities is necessary to be able to compete with other cities regarding economic and social development. Moreover, a controlled environmental situation in a city will attract businesses, which will not move to places with a reputation for inadequate waste management and environmental untidiness. Earlier attempts to attract businesses by offering cheap waste handling have failed with time. Another important aspect of urban functionality is how comfortable the urban structure is for the citizens. For example, when choosing a collection scheme, a system of separate collection occupies more space and presents difficulties in planning transport routes.

5. *Financial & economic aspects* pertain to budgeting and cost accounting and recovery within the waste management system and in relation to the local, regional, national and international economy. Some specific issues are: privatisation; cost recovery and cost reduction; the impact of the environmental services on economic activities; the commodities market place and how the recycling infrastructures are linked to it; efficiency of waste management systems; the macroeconomic dimensions of resource use and conservation; and income generation.

Although the primary objectives illustrated above are the main aspects on which the waste management system should be based, in a **long term system**, the EU hierarchy is quite appropriate and may be considered, if possible.

On the lowest level of the EU waste management hierarchy, there is disposal of waste at a landfill. The greatest drawback of a landfill is that it requires a land area, which could be quite restricted in the future. Besides, when waste is placed at a landfill, it can not be re-used.

The next level of the hierarchy is incineration of waste generating energy (or energy from waste). On this level of the hierarchy, there is also usage of waste as a fuel in concrete manufacture kilns or electric power plants.

Recycling is at the third level, it is a process where materials are collected, processed and remanufactured into new products or used as raw material substitutes. In other words, it is the subjection of waste to any process or treatment to make it re-usable in whole or in part. For example, melting down post-consumer glass in a furnace and making new glass containers.

The next level refers to the reuse for the same purpose, or repair of a used product or material with minimal (if any) processing, i.e., reducing the amount of waste disposed by using a material again in the same form as its prior use without any process. For example, returning bottles to be refilled or donating clothes to an organisation for someone else to wear.

At the highest level of the waste management there is prevention of waste production (quantitative prevention) and prevention of hazardous waste production (qualitative prevention). Here the following issues have to be mentioned: introduction of clean technologies, requirements for products, and influence over consumer behaviour.

The EU hierarchy of objectives scheme is described below:

Prevention of waste
Reusing of waste
Recycling of waste
Energy from waste
Disposal of waste

Table 2.2. summarises how the objectives set can be achieved with the different elements of the ISWM.

Table 2.2. Accuracy of the different elements of ISWM in achieving the objectives set

Objectives / ISWM elements	Sanitary Aspects	Social-Cultural Aspects	Environmental Aspects	Urban functionality	Economic Aspects (3)
Mixed collection	***	*	*	*** (1)	***
Selective collection	***	***	***	** (1)	**
Composting	***	***	**	** (2)	***
Biomethanisation	***	**	***	*** (2)	*
Recycling and reuse	***	***	***	*** (2)	**
Incineration	***	*	**	** (2)	*
Landfilling	***	*	*	* (2)	***

Level of achievement of the different objectives:

* minimum

** medium

*** high

(1) the main issue taken into account is how comfortable the urban structure is.

(2) treatment options do not have much influence on urban structure. Nevertheless they can attract businesses and investments.

(3) the main aspect considered is how expensive the scheme is. High level of achievement has been given to the cheapest options.

Stakeholders in solid waste management

A stakeholder is a person or an organisation that has a stake (an interest) in – in this case – waste management. Some common stakeholders involved in solid waste management are: waste producers (households, shops, clinics, etc.), municipal street sweepers, informal scavengers, the city council, the NGOs involved in recycling projects and recycling factories, and scientific groups developing new technologies. Stakeholders in solid waste management differ from one location to another, so they need to be identified in the local context.

Stakeholders have various interests and roles in their particular waste management system, but they can co-operate for a common interest. It is recommended to study the interests and attitudes of the different stakeholder groups, as they will determine whether or not a system will be successful and whether a new system will suit the local conditions.

We must keep in mind that stakeholders do not all have the same starting position. The local government should take care that weaker, underprivileged groups (low-income households, waste pickers, small-scale entrepreneurs, women, children, ethnic groups with a low social status, etc) can have a say in solid waste management too.

2.4. URBAN PLANNING.

When implementing a Waste Management System, regulations governing the use of land should be considered. Zoning divides the local territory into several sectors and regulations defining the use that land can be put to, the height and volume of buildings, the surface area authorised, and so forth.

Apart from the regulations of the local authorities, planners should consider the best places to implement the facilities, in terms of environmental, marketing or social aspects.

Land use planning aims to integrate the whole range of society's land use needs within a sustainable framework. The two main routes for assessing the sustainability of development, and involving the full range of interests, are the land use plan and the assessment of planning applications. The identification of waste management sites within local plans has been fraught with technical and political problems. Individual proposals face strong local opposition, exacerbating current and imminent shortages of acceptable processing facilities. Yet it is vital that the waste strategies currently being prepared can be implemented through the planning system. Land use planning systems that cannot deliver this key need in an integrated manner are inadequate. Therefore it is vital that local plans give full guidance for the identification of waste facilities within their areas. Targets and specifications are to be set, at a regional level, within the framework of waste strategies with adequate planning procedures.

Municipalities may initiate zoning plans within the framework of more general plans (national or regional). These set down the rules and constraints governing the use of land within city limits. Zones are allocated according to principal future use or main activities, and any urban development project within city limits must be compatible with the local zoning plan.

A zoning plan offers the following advantages:

- As the town develops and grows, the zoning plan is a management tool that helps planners manage development in a comprehensive fashion, both in space and time, rather than in a "case by case" manner.

- A zoning plan integrates environmental concerns in urban planning:

    - before the document is drawn up, when environmental constraints orient decisions regarding land use zones and the regulations to be applied in those zones; and
    - in a comprehensive, rather than a sectarian manner, taking into consideration the natural environment, natural and technological hazards, the living environment, etc.

- The document is also a regulatory tool, which gives all parties clear and precise information on their rights and obligations as regards land use.

- A zoning plan is a reference tool for the local government. It can be used to put together a coherent urban development policy and to orient daily decision making.

- It also has an educational and democratic function: local citizens, associations and government depart-

ments are all called upon to draw up the plan together in working groups

The zoning plan should include:

- A descriptive report:
  - analysis of the existing situation,
  - presentation of the municipality's urban planning orientations, and
  - the degree of compatibility of those orientations with any constraints dictated by higher authorities, with the prospects for demographic or socio-economic change and with the environment.
- Regulations. It defines principal land use by zone: uses that are prohibited, regulations concerning the location and appearance of buildings and roadway layout and characteristics.
- Graphic documents. The zoning map (including urban zones, natural zones, and reserved land) and additional maps

CASE EXAMPLES.

The integrated municipal solid waste management system in five Portuguese municipalities.
http://www.innovationbcn.net/participants/valorsul_cast.htm

Valorsul, SA, is the company responsible for the development of the integrated municipal solid waste (MSW) management system in five Portuguese municipalities, including the city of Lisbon. This system consists of several operational facilities namely a Waste to Energy Incineration Plant, a Sanitary Landfill, a Bottom-ash Processing and Recovery Plant, a Sorting Plant and a Drop-off Centre and an Organic Transformation Plant. Investments on containers and other equipments for separated collection of recyclable materials, and on sealing and landscape improvement of closed landfills and dumping areas are also considered in the global project.

Valorsul, SA, as contracted by the Portuguese Government to explore and manage a multimunicipal system, was given the mission of promoting actions that contribute to sanitation and welfare of the population assuring, the following aspects:

- the processing of MSW adjusting it to the true necessities of the municipalities, in what concerns quantitative as well qualitative features, in accordance with applicable national and European Community regulations;
- the promotion of the necessary actions to implement a proper policy of MSW management, namely regarding reduction, treatment and transformation of waste;
- cost control, efficiently and rationally using the available means in their activities.

After being conceived and consolidated, the Integrated MSW Management System is presently in a very advanced process of implementation.

Valorsul has used the Sanitary Landfill since 1998; the Waste to Energy Incineration Plant has been operating since 1999; the operation of the Bottom-ash Processing and Recovery Plant started in 2000 and the Sorting Plant in 2002. The Organic Transformation Plant will start to operate next year.

Several complementary activities are being developed with the aim of a proper implementation of the Integrated Management System, like: environmental monitoring program; use of a geographic information system to implement a separate bio-waste collection; educational program dedicated to the scholar community; and communication campaigns.

The global investment in the system is 278 Million Euro. This value includes the investment in the main treatment facilities and in containers and equipment for separated collection and sealing and landscape improvement of closed landfills and dumping areas.

The operational costs (including personnel, process and maintenance costs, transports, services, monitoring and taxes) are, for a typical year:

Waste to Energy Incineration Plant - 12,7 x 10^6 Euros ;
Bottom-ash Processing and Recovery Plant - 0,5 x 10^6 Euros;
Sanitary Landfill - 1,6 x 10^6 Euros;
Sorting Plant - 2,7 x 10^6 Euros;
Organic Transformation Plant - 3,0 x 10^6 Euros

West Bank Gaza– solid waste and environmental management project
http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000094946_00091205344549

The Solid Waste and Environmental Management Project will implement sound solid waste management systems for the Jenin District, supporting the strategic context, which calls for adequate public sector management, and institutional strengthening, to foster private sector development, while improving human resources development, and poverty reduction.

The project components will:

1) design, and construct sanitary landfills for the Jenin District, seeking to serve over two hundred thousand people. This will include earth works, lining of the site with geotextile membranes, and construction of off-site infrastructure, including access roads, service compound, leachate transfers, and treatment systems. Provision of funds for international construction management will be available to oversee the construction phase, and, rehabilitation/closure of uncontrolled dumpsites will be financed as well. Cost recovery will be phased-in during operation of the landfill;
2) supply equipment for primary collection, haulage, and disposal of solid wastes for municipalities, mostly funded through a European Union grant, possibly financing as well, incremental operations, and maintenance expenses; and,
3) build institutional capacity, providing expertise to train staff from the Ministry of Environmental Affairs; by providing solid waste management training to participating municipalities, and the Joint Services Council; by funding pilot recycling schemes at the landfill site; and by financing a public awareness campaign.

Lebanon – solid waste / environmental management project
http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000009265_3961019100907

The Solid Waste/Environmental Management Project will comprise the provision of:

(i) refuse collection facilities - containers and compactor trucks;
(ii) waste disposal facilities - sanitary landfills and compost plants;
(iii) a hospital waste collection and disposal system; and
(iv) technical assistance and preparation of a coastal zone management plan.

It will meet the country's needs in solid waste management facilities, as foreseen in the National Emergency Reconstruction Plan. It will strengthen the institutions responsible for solid waste management (SWM) and encourage private sector participation, not only in the collection services, but in the whole sector, including the investment of capital in SWM. It will also help develop a Coastal Zone Management (CZM) plan that will serve as a tool to protect the Lebanese coast from further degradation.

RELATED WEB SITES.

- **City development and waste management. General.**

  CDSI
  http://www.citydev.org/

  Database on Good Practice in Urban Management and Sustainability
  http://europa.eu.int/comm/urban/

  Environmental Strategies for Cities
  http://web.mit.edu/urbanupgrading/urbanenvironment/index.html

  Global Ecovillage Network
  http://www.gaia.org/

  Solid waste management in Egypt
  http://www.seamegypt.com/solid.htm

  Solid waste management strategy, Governorate of Dakahleya
  http://www.seamegypt.com/Manuals/DakahSolidWaste/content.html

  Solid waste management strategy, Governorate of Sohag
  http://www.seamegypt.com/Manuals/SohagSolidWaste/Vcontent.html

- **Integrated sustainable waste management**

  World Bank
  http://www.worldbank.org/

  "Local Sustainability," the European Good Practice Information Service
  http://www3.iclei.org/egpis/

- **Urban planning**

  International Centre for Sustainable Cities
  http://www.icsc.ca/

  Sustainable City Framework
  http://www.sustainabledevelopment.org/blp/learning/SC_Framework.html

  Sustainable Urbanisation
  http://www.sustainabledevelopment.org/blp/

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- United Towns Development Agency. **The Cities Environment Kit. A Training Guide in Local Environmental Policies for Technicians and Elected Officials in the Mediterranean.** May 1996.

- World Bank/METAP. **Source: Solid Waste Management Strategy for METAP Mashreq and Maghreb Countries.** 2002.

3. URBAN WASTE GENERATION AND CLASSIFICATION

3.1. DEFINITION OF WASTE.

In general, one can say that waste is useless, unwanted or discarded material resulting from agricultural, commercial, communal and industrial activities. Waste includes solids, liquids and gases.

On the other hand, one person's waste can be a source of income - a resource - for another. This potential for recycling and reuse can support people by buying, collecting, sorting, selling and recycling waste. An example of the value of waste as resource is factories that use the waste of other factories as raw material. Unfortunately, not all waste can be regarded as a resource. Many hazardous and toxic materials cannot be safely recycled or reused.

Urban waste means the waste generated by any activity in urban or peri-urban areas. This implies that urban waste is not only that generated in households, but also that from commercial establishments and services, street sweeping, green areas and industry.

For the purposes of this guide, all information given will apply to urban solid waste, except hazardous and special waste which will not be considered throughout the text.

3.2. SOURCES OF SOLID WASTE.

Waste can be classified depending on its source. The reason for using a classification by source is that it is the specific composition of each waste category that sometimes recommend a special collection or treatment system for each one. This means that classification of waste will be determined by the socio-economic sector generating the waste. Waste is usually generated by the following variety of **sources**:

- Households. Household waste or domestic waste is the waste generated by households. It must be discerned from municipal solid waste, which is the waste collected by the municipal collection systems. Household waste can be divided mainly into paper and cardboard, glass, plastics, organic fractions, hazardous waste and bulky waste.

- Commercial establishments. It includes waste from shops and other service providers (restaurants, etc) and it is essentially composed of packaging waste and organic waste from markets and restaurants.

- Institutions (schools, hospitals and government offices). This kind of waste includes wastes from public and private offices and institutions which belong to the so-called service sector. The amount of waste and the composition are often not very well known. Although similar to household waste, some extra fractions of paper, glass and plastics can be expected. Medical hazardous waste from hospitals should qualify for consideration, but it will not be considered throughout these guidelines.

- Factories. It is the waste from industrial production, including related functions like canteens, administration, etc. This category of waste can be split into various fractions depending on the main industries in the city concerned. They often contain a fraction of hazardous waste that has to be collected and treated separately.

Table 3.1. presents waste fractions of the different sources of the waste stream.

Table 3.1. Waste fractions

	Households	Commercial, institutions	Industry
Glass	X	X	
Cans	X	X	
Paper & cardboard	X	X	X
Plastics	X	X	X
Food & organic waste	X	X	X
Furniture, etc.	X		
Refrigerators, etc.	X	X	
Electronic waste	X	X	X
Scrap metal	X		X
End of life vehicles	X	X	X
Garden & park waste	X	X	
Hazardous waste	X	X	X
Tyres		X	X
Sludge			X
Medical waste		X	

Source: "Wasteguide. Framework and strategies for waste management in European cities". EPA copenhagen

3.3. SOLID WASTE CHARACTERISTICS

Quantity

There are very significant differences in quantity depending on many factors, such as:

- The size of the population living in the area,
- the type of sources of the area (commercial, residential, touristic, industrial, etc.),
- the quantity of public or private gardens,
- whether the families living in the area are predominantly poor or rich,
- the season of the year, and
- the cultural aspects of the area affecting the composition, quantity and peak-days of the solid waste produced.

Some typical waste generation rates for low-income, middle-income and high-income countries are shown in Table 3.2.:

Table 3.2. Waste Generation Rates

	Waste generation rates (in kg/capita/day)		
	Low-income country	Mid-income country	High-income country
Mixed urban waste Large city (>500000)	0.50 - 0.75	0.55 – 1.1	0.75 – 2.2
Mixed urban waste Small to medium city (<500000)	0.35 - 0.65	0.45 – 0.75	0.65 – 1.5
Residential waste only	0.25 – 0.45	0.35 – 0.65	0.55 – 1.0

Source: Cointreau-Levine, S., 1999

Table 3.3. shows waste generated waste in different South and East Mediterranean countries.

Table 3.3. Waste Generation in South and East Mediterranean countries

	LEBANON	SYRIA	JORDAN	WEST BANK GAZA	EGYPT	TUNISIA	ALGERIA	MOROCCO	REGION(1)
Estimated Solid Waste Generation 1998 (10^6 tonnes)(2)	1,4	3,4	1,3	0.9	14,5	1,8	5,2	6,0	34,5
Projected Solid Waste Generation 2010 (10^6 tonnes) (3)	1,8	5,7	2,0	1,7	20,1	2,3	7,4	8,8	49,8
Percent Increase In Waste Generation	28	69	57	83	39	26	41	47	44
Estimated Annual Per Capita Waste Generation 1998 (kg)(4)	337	203	284	321	219	193	173	206	242
Projected Annual Per Capita Waste Generation, 2010 (kg)(4)	363	243	349	362	247	211	192	246	277
Percent Increase In Per Capita Waste Generation	8	20	23	13	13	9	11	19	15

Notes: 1. Regional estimates of "Percent Increase In Waste Generation", and "Per Capita WasteGeneration" for 1998, 2010 and percent increase in per capita waste generation are calculated as the mean of the national values.

2. All data based on estimates provided by local officials, except Syria and Jordan for which data are based on independent analysis.

3. All data based on independent analysis.

3. Population estimates used to calculate these data is taken from or based on The World Factbook

Source: Solid Waste Management Strategy for METAP Mashreq and Maghreb Countries. World Bank/METAP, 2000

Evidently the best method to calculate the quantity of waste for a given zone is by simply weighing the waste trucks at the entrance of treatment and disposal sites.

Composition

Knowing the composition of waste is important for deciding the treatment systems. Numerous factors have an influence on the composition and characteristics of solid waste:

- The area: residential, commercial, etc.
- The season and weather (differences in the amount of population during the year, tourist places).
- The economic level (differences between high and low-income areas). High-income areas usually produce more inorganic materials such as plastics and paper, while low-income areas produce relatively more organic waste.
- The cultural aspects of the zone.

Urban waste is normally divided into three big groups:

- Inert waste: metals, glass, soil, slags and ashes
- Putrescibles: food waste, yard trimmings
- Combustibles: paper, cardboard, plastics, wood, tyres, leather, textiles.

As an example, table 3.4. describes the composition of the urban waste in the South and East Mediterranean area and table 3.5. shows the waste composition of five different cities in Turkey.

Table 3.4. Generalised Solid Waste Composition for South and East Mediterranean countries

	Typical of Region (%)	Countries Outside Typical range
Paper/cardboard	11 – 14	Lebanon (17%) Israel (22%)
Glass	2 – 7	Lebanon (9%)
Plastic	7 – 10	Jordan (16%) Israel (14%)
Metal	2 – 6	
Putrescible	55 - 70	Israel (43%)
Fabric/textiles	3 - 5	
Unespecified	2 – 5	Egypt (13 percent) Israel (8%)

Source: Country estimates and independent analyses

Table 3.5. Waste composition in five different cities in Turkey

	Bursa	Istambul	Izmir	Adana	Mersin
Organic matter	53	43	46	64	63
Paper & cardboard	18	8	12	15	18
Plastic	12	14	12	6	7
Glass	3	6	3	1	1
Metals	3	6	4	3	3
Other	11	23	23	11	8

Source: CEVKO. solid waste management practices and review of recovery & recycling operations in Turkey, (2000 data), (www.cevko.org.tr)

Other characteristics

There are four characteristics that are absolutely necessary when setting up the treatment/disposal system. These are:

- Density

Density varies depending on the composition of waste. It is normally higher in residential areas where organic matter makes up a large proportion of the waste, and lower in commercial districts where waste contains more paper and cardboard. It also varies with the economic level, being less dense in high income areas where there is a higher percentage of packaging waste. Table 3.6. shows the density range of municipal solid waste:

Table 3.6. Typical density range of MSW at the generation point

Country	Waste density (in kg/m3)
High-income country:	100-175
Mid-income country:	175-330
Low-income country:	330-600

Source: UNCHS, undated

The density of waste may also change during waste transportation. Therefore it is essential to indicate where density has been measured (at the point of generation, in the container, or at the disposal site). Usually the density increases by 20-25% during transport in a non-compaction truck. The density is important for the selection of waste collection equipment. For example, compactor trucks, which press the waste together, are most effective if the waste has a low density, for example, if it has a high proportion of paper, cardboard and plastics.

- Moisture content

Moisture content of solid waste is the weight loss (expressed in percent) when a sample of solid waste is dried to a constant weight at a temperature of 100 to 105 ºC. The percentage of moisture contained in a solid waste sample can be calculated on a dry or wet basis.

Moisture content has a great influence on the heat of combustion as well as in the biological processes of organic matter. It depends on:

- organic content
- weather
- source

- Heat of combustion (= heating value)

The heating value of waste is a measure of the energy released when it is burned.

A heating value of about 11.6 x 10^6 J/Kg is needed to sustain combustion. Waste with lower heating value can be burned, but it will not maintain adequate temperature without the addition of auxiliary fuel.

The heat of combustion increases when there is more paper, cardboard and plastic in waste because they have a high heating value, and decreases when there is a high content of organic matter, and therefore, of moisture.

- CN Ratio

CN ratio is the ratio of the weight of carbon to the weight of nitrogen present in compost or in materials that are being composted.

It is an important parameter in composting processes and should always be between 20 and 35. Lower ratios indicate the loss of nitrogen as ammonium gas and render composting impractical.

3.4. SOLID WASTE QUANTIFICATION AND ANALYSIS.

When implementing a solid waste management program, solid waste analysis is crucial to determine which techniques, systems and procedures are suitable to the waste stream.

There are essentially two different methods of sampling:

- Continuous sampling of a low fraction of waste
- Intensive sampling carried out over one or more relatively short periods.

Statistical reliability favours continuous sampling, but practical considerations, including cost, mean that the latter method has to be considered.

At a minimum, surveys should collect data covering a period of one week. This will allow for measurement of variation of refuse within cycles of a day or week.

To take into account the changes over monthly, seasonal and yearlong periods, it is necessary to either:

- Repeat the survey at different times , or
- Spread the survey period over a long time.

The following approach is recommended for the overall sampling regime:

- Surveys should be carried out over a minimum period of one week.

- Seasonal variation should be estimated by repeating the survey at different times of the year, which are generally best done over a week in the middle of each of the four seasons.
- Where baseline data is required, four surveys of one week each should be done in each season over a single year.
- Where monitoring of long-term trends is needed, a single-week survey should be done every year, in each season, over a four year cycle.
- If it is possible, it is very useful to carry out a survey differentiating between the different zones of the town, with special emphasis on waste composition.

The principal steps to be taken for this analysis are:

1. Weighing the vehicle loads to be analysed upon entering the site.
2. Sampling a statistically significant proportion of incoming loads in each category and sorting and weighing a sample of refuse from those loads into primary categories: paper/cardboard, glass, plastic, organic matter, wood, etc.
3. Statistical analysis and reporting

An analysis of a specific solid waste source will need a similar approach. The main difference is the sampling method and the weighing location.

CASE EXAMPLES.

Continuous process of waste characterisation in Pamplona. Spain.
Source: "Ciudades para un futuro más sostenible"
(http://habitat.aq.upm.es/bpes/na00/bpna9.html)

The objectives of the program were the following:

- Periodically characterise by products and matters the total urban waste generated in the Region of Pamplona.
- Determine the availability of the different treatments: valorisation, recycling and disposal.
- From the characterisation obtained, verify the quantity and quality of the available materials at source.
- Configure an evaluation and control tool to measure the effectiveness of urban waste collection and treatment management.

To get these objectives, the program must carry out analysis several times a year, and cover a duration of more than two years.

One of the most delicate and hardest steps in the characterisation analysis, is the manual classification of the different components of the waste into the several categories and subcategories; the Association of Scavengers of Emaus was dedicated to that task.

The pick-up points were conformed by a green container for the organic matter and the non-recyclables, and a blue container for the recyclable matter, which is processed in the recycling facility. There is also specific collection for glass, paper and bulky waste.

The average composition was obtained from the complete analysis of an entire pick-up point and that composition was corrected by the material quantities from the specific collection. The process took place every three months.

The results were integrated in a greater data base, where there were three lines of information:

- Data including the waste collection and treatment streams.
- Results of the waste analysis.
- Collection and treatment effectiveness (relationship between the real and the potential waste streams).

Development of a methodological tool to enhance the precision and the comparability of solid waste analysis data. Various Municipalities and Institutions throughout Europe, namely Austria, Germany, Italy, Spain and UK
Source: Wiener Compost (http://www.wienkompost.at/swatool/)

In the first part of the project the tool for the implementation of waste analyses will be developed. This implies four important steps. First, the sorting nomenclature of categories and sub-categories has to be standardised. Second, there are serious methodological deficits concerning stratification of the parent population. Therefore, statistical tests for the evaluation of stratification parameters will be implemented leading to recommendations for reasonable stratification criteria. Third, in a comparative discussion, already existing waste analysis methods will be evaluated. Fourth, a manual for waste analysis will be developed for several waste analysis methods. These methods can be applied depending on the different local requirements (for example the waste collection system). Their appliance should ensure a certain minimum level of accuracy for the produced data. Along with the standardised sorting nomenclature, this is an important prerequisite for the comparability of waste analysis data in the future.

In the second part the pilot implementation of the proposed methods in three cities in the EU will be carried out. The cities of Brescia (Italy), Bilbao (Spain) and Newcastle upon Tyne (United Kingdom) will carry out the analysis in their own city.

After the practical use of the methods proposed in the manual, it should be revised and optimised so that at the end of the project a user-friendly manual for the implementation of waste analysis can be presented which permits the comparability of the produced data along with a certain minimum level of data accuracy.

An important part of the project will also be the dissemination of the outcomes. It is an aim of the project partners that the final method will be spread out all over the EU and also over the borders so that it will be possible in future to make comparisons between waste analysis carried out in different countries. Maybe benchmarking between the different waste management systems in Europe will be also be possible.

RELATED WEB SITES.

"Analisi merceologica dei rifiuti urbani. Rassegna di metodologie e definizione di una metodica di riferimento". Agenzia Nationale per la Protezione dell' Ambiente, 2000.
http://www.sinanet.anpa.it/

CEVKO. Solid waste management practices and review of recovery and recycling operations in Turkey
http://www.cevko.org.tr

Characteristics and Quantity of MSW
http://msw.cecs.ucf.edu/lesson2new.html

European Topic Centre on Waste and Material Flows
http://waste.eionet.eu.int/activities/0000108.html

Solid Waste Characterisation
http://www.ciwmb.ca.gov/WasteChar/default.htm

UN-Habitat, United Nations Settlement Programme (UNCHS)
http://www.unhabitat.org/

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- Ministry for the Environment, New Zealand. **Solid waste analysis protocol (Summary procedures).** March 2002.
- World Bank/METAP. **Solid waste management strategy for METAP Mashreq and Maghreb Countries DRAFT.** 2000**.**

4. REGULATION / INSTITUTIONAL COORDINATION.

4.1. REGULATION

International regulations and recommendations.

International organisations have developed several guidelines that can be useful as a general framework for more specific regulations at the national and local levels.

The following are some guidelines proposed by the main international organisations in the fields of urban development and environmental conservation.

UNDP (United Nations Development Programme) http://www.undp.org/

- Integrating the environment into national development frameworks
- Strengthening local environmental governance
- Addressing environmental challenges

OECD (Organisation for Economic Co-operation and Development) http://www.oecd.org/l

- Maintaining the integrity of ecosystems through efficient management of natural resources.
- Decoupling environmental pressures and economic growth.
- Improving information available to decision makers. Measuring progress through indicators
- Enhancing the quality of life
- Improving governance and co-operation

UNEP (United Nations Environmental Programme) http://www.unep.org/

- Enhancing compliance with multilateral environmental agreements
- Enforcing environmental laws

UNEP/MAP (Mediterranean Action Plan, UNEP) http://www.unepmap.gr/

- Formulating and adopting guidelines for environmentally sound and economically feasible systems of solid waste collection and disposal
- Incorporating the principles of non-hazardous material recycling and reuse
- Developing programmes for the reduction and recycling of urban solid waste

WB (World Bank) http://www.worldbank.org

- Enhancing compliance with environmental policies and practices in the country
- Enhancing positive environmental effects and mitigating the negative ones

The WB requires Environmental Assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus, to improve decision making.

EIB (European Investment Bank) http://www.eib.org

- Preserving, protecting and improving the quality of the environment
- Protecting human health
- Ensuring prudent and rational utilisation of natural resources

- Promoting measures at an international level to deal with regional or world-wide environmental problems

In financing any investment, the EIB applies the core environmental management principles of "prevention", "precaution" and "the polluter pays", as called for in EU policy.

ADB (African Development Bank)
http://www.afdb.org

- Identifying major environmental issues
- Implementing environmental policies and the use of appropriate environmental assessment procedures
- Developing a national legislative framework and institutions involved with environmental and natural resource management

National political and legal framework

Nowadays, many Southern and Eastern Mediterranean Countries have started a process of legislative and institutional changes in order to improve the integrated solid waste management policy at the local level. (See Chapter 2).

This new policy framework has direct implications for municipal waste management, mainly concerning the prioritization of action (introducing the goals of waste reduction, reuse and recycling of materials, and production of energy from waste), the financing and management frameworks (improving private participation and municipal taxing capacity and applying the polluter-pay principle), and planning treatment and disposal facilities (localisation, standards, EIA, technologies, prioritisation, etc.). For these reasons, it is important that local authorities be in agreement with national policies and legislation in order to optimise solid waste management.

As the process of legal and institutional changes to the Integrated Waste Management System is already on-going in several countries, co-ordination between local and national authorities covers the crucial scope of medium and long term decisions.

National policies, regulations, plans and programmes on urban solid waste issues that will greatly affect the relevant future municipal actions will be decided through this process.

Three levels of solid waste management policy frameworks can be identified: cleaning, environmental and integrated policy frameworks. Under the "cleaning approach", priority is placed on the removal of wastes from immediate areas of human activity in order to protect human health, while the final phase of waste management is of lesser importance. Waste management services are delivered as a public sector function and are largely financed from general public sector revenues.

Although this approach is generally based on protecting citizens' health and improving their quality of life, the lack of attention to where and how waste is ultimately managed in fact results in grave health and environmental effects and this model is the least protective of human health. Thus, countries are reorienting their policy frameworks with the objective of ensuring progressive transition from the "cleaning approach" to the "environmental approach" and the "integrated approach".

Under the "environmental approach", increased focus is placed on protecting human health and the environment from the consequences of the way solid waste is managed, particularly at the point of disposal. Waste management services continue to be delivered primarily as a public sector function and are substantially financed from general public sector revenues, although elements of "user-pay" cost recovery may be introduced, for example, the private sector may be required to directly pay to use a waste disposal site. The main change is the concern for the environmental impact of waste management through the establishment of environmental standards for treatment plants and landfills, environmental impact analysis and authorisation, etc.

We have already defined the "integrated approach". To improve the goals of reduction, reusing, and recycling waste, the active participation of all public and private stakeholders is needed. Integrated waste management has to co-ordinate all actions: from the National Authorities to the Citizens, from the consumable goods producers to the private companies who can deliver more complex systems of collection, treatment and landfilling. Strong financing and cost recovery structures are needed to match the high costs of investment and operation of the waste service, and the application of the polluter-pays principle is needed to give producers of goods and waste generators an economic reason to minimise their waste.

There are several essential issues ensuring the financial sustainability of SWM which the process must take into account. In many countries, there is a lack of legal grounds to permit Municipalities to claim waste collection fees and oblige residents to pay them, which would enable the public or private waste collection service providers to secure their operational expenses and achieve cost recovery. The legal restriction also acts as a constraint to further expansion of the participation of private companies in SWM. Gaps also exist in the present laws and regulations concerning measures for source separation and the allocation of waste disposal sites. These legal issues must be addressed to provide a legal basis for integrated sustainable waste management.

What is the situation in the Southern and Eastern Mediterranean?

In EU pre-adhesion countries (Malta and Cyprus), governments are quickly integrating into its national legislation the EU Directives dealing with solid waste, packaging waste, landfills and hazardous waste, in order to harmonise them with EU policy.

National plans or strategies for solid waste management based on the Integrated Waste Management framework exists in some of the other Mediterranean countries (e.g. Tunisia, Egypt, Turkey, and Israel). The correspondent legislative and institutional changes are on-going. There are already very good practices of implementation, such as the privatisation process in Egypt and Morocco, the municipal waste fees in Turkey and the new institutional roles and recycling strategy of Tunisia.

There are a few countries, like Tunisia and Israel, that have more advanced environmental legislation. They have clear application of the polluter pays principle. It is stated in law that "the producer or conveyor is responsible for recovering the waste engendered by the materials or the products they produce or distribute". They have also de-

veloped a regulatory framework for hazardous waste management, including a list of hazardous materials and registration and monitoring procedures.

Setting up local regulation

Local authorities should set up regulation related to waste management regarding the protection of human health and the urban environment. The responsibility of municipalities to set up regulation is established by the national legal framework. This framework determines if the municipality is able to levy taxes for waste management services, establish public enterprises, delegate the responsibilities of service delivery to the private sector, determine the duties of waste producers, etc.

The following is a list of possible items to include in local regulation:

- Waste definition and classification
- Residents' responsibilities
- City's duties and responsibilities
- Classification and definition of collection fees for municipal waste
- Classification and definition of penalties.
- Frequency and schedule of waste collection and city cleaning.
- Regulation concerning containers: placement, types and identification
- Functions of citizen information services
- Collection procedures for special waste (bulky, hazardous, etc.)
- General restrictions in waste treatment to prevent environmental contamination
- Types of waste that cannot be disposed of

Other options.

Other options include voluntary agreements between the stakeholders of municipal waste management, and discussion forums where people can take part in developing regulation (mandatory public hearings, debates, etc). These actions provide additional popularisation of solid waste management technologies.

4.2. INSTITUTIONAL DISTRIBUTION OF ROLES.

Government.

At the national level, government authorities normally carry the responsibility of planning and organising the solid waste management system.

After implementation, the government would also be responsible for monitoring. Therefore, the role of the government would be multifunctional, including planning, enforcing, and monitoring any kind of management system.

Government authorities are also responsible for the implementation of an appropriate policy framework and for the approval of licences and permits.

The co-ordination of all the different government bodies is one of the major problems in developing an SWM system since it causes delays in the decision making progress.

Municipalities.

At the local level, the responsibility of implementing a solid waste management system frequently falls to the municipalities. Each municipality is responsible for waste collection in its own area, and the municipalities own and maintain collection equipment.

The following is a list of possible municipal responsibilities:

- Cleaning the area
- Maintaining an adequate level of hygiene
- Collecting, treating, and disposing of waste including the service provider (private or public)
- Preventing the accumulation of waste in any public or private area
- Providing public waste containers where they are needed and maintaining their cleanliness
- Preventing the illegal transport of waste
- Setting and collecting collection fees from residents

Households, shops, industries and restaurants can be charged with a special fee for having their waste collected by the municipality. This waste collection fee should be established by the board of the municipality and depends on the type of the premises served. Each municipality has to be responsible for determining the charges within the national legislation framework.

At each municipality there should be a complaint mechanism, where the public can make complaints related to SWM. Each complaint should get a response and be reviewed for possible improvements to the system.

Private sector.

The private sector has a triple-faceted role that has to be regulated. They are at once waste producers, potential service providers to the municipality, and important town stakeholders.

The first role can be regulated according to the behaviours that the municipality is interested in achieving, regarding waste minimisation and collection. It is recommended to make specific regulations for private activities with significant influence on urban waste selective collection, such as commercial centre shops, big commercial areas, restaurants, construction and demolition contractors. Hospitals and other industries whose activities potentially produce hazardous waste also need specific municipal regulation.

The second role, providers of services, is crucial and must be regulated, through concessions or other contracting methods, to facilitate their participation in many aspects of urban waste management. From an entire urban solid waste service to small contracts for awareness campaigns, the role of the private sector in providing services is very broad. The municipality must always maintain its political and managerial control of the private activity as well as the private enterprise's ability to respect its contractual commitments, including the economic ones.

The third role of the private sector, as town stakeholder, is mainly a participatory role in the consultation demands of the municipality, and in planning and operational issues.

NGO's and community institutions.

They have a main role as town stakeholders with similar functions in municipal consultation platforms. They also play an important role as representatives of population groups transmitting messages and information to and from them. Finally, they can also be service providers for the municipality in their own territories and sectors of activity. Municipal regulations should enhance those two roles.

Citizens.

As "consumers" of the municipal solid waste service, their main roles are:

- The first role implies regulations similar to those concerning other producers of waste, about service-friendly behaviours and about paying for the service.
- The municipality has to take into account the complaints, opinions and suggestions of the citizens to improve and maintain service quality. Free phone lines or offices to submit complaints and suggestions, as well as regular inquiries into citizens' opinions about the waste service are the more popular tools for these purposes. The municipality should regulate this citizen's role.

Table 4.1. summarises the roles and responsibilities of the stakeholders.

Table 4.1. Institutional Delineation Of SWM Roles And Responsibilities

LEVEL	ROLE / RESPONSIBILITY	TASKS
National Government	Policy/planning	Establish policy objectives and monitoring indicators to measure progress towards objectives Establish SWM legal framework to achieve objectives that incorporates "polluter pays" principle, encourages regionalized SWM service delivery, incorporates cost recovery and encourages private sector participation Implement national plan to achieve objectives Periodically review/amend policy objectives and plan
	Licensing/permitting	Develop standards and norms for the siting, design and operation of SWM facilities to ensure protection of human health and the environment Implement system for issuing SWM facility licenses/permits that incorporates environmental impact assessment, public input and legal obligation of operators to monitor and meet standards and norms, and report deficiencies
	Monitoring	Establish/implement framework for monitoring progress of overall SWM system, and reporting progress Establish/implement framework for verifying SWM facility compliance
	Enforcement	Undertake compliance/enforcement actions necessary to maintain established standards and norms
	Education	Create national SWM public education/awareness program in support of policy/program objectives
	Financing/Cost Recovery	Create financing mechanism whereby sub-national entities can capitalise SWM improvements Work with sub-national entities (public and private)to establish a cost recovery structure that incorporates capital depreciation/ amortisation on life cycle basis, ensures funds for future SWM capital investment and autonomy of sub-national entities to make capital investments
	Administration	Provide SWM operational mandate to municipalities and "polluter pay" entities; provide regulatory mandate to ministry responsible for environment.
Municipal/ Regional	Operations	Identify required SWM facilities/systems and schedule for implementation Identify private sector roles Implement facilities/systems, contracting with private sector as necessary
	Monitoring	Monitor facility/system performance, including private sector compliance with contract requirements
	Enforcement	Undertake compliance/enforcement actions necessary to control litter and to ensure private sector contractual obligations are maintained
	Education	Create SWM public awareness/education program in support of local operations
	Financing/Cost Recovery	Establish cost recovery mechanisms that include capital depreciation/amortisation on life cycle basis and accumulates funds for future SWM capital investments
	Administration	Consider/establish regionalised service delivery under local municipal control
Private Sector	Financing/Cost Recovery	Contribute to financing/cost-recovery in accordance with application of "polluter pays" principle
	Operations	Provide SWM services under contract or concession (applies only to SWM service providers)
	Administration	Participate in administration of entities created to implement private sector responsibilities under "polluter pay" principle
NGOs/Community Institutions		Participation in municipal consultation platforms Representatives of population groups
Citizens		Friendly behaviours and paying for the service Provide opinions and complaints

4.3. NECESSARY STEPS TO IMPROVE THE INSTITUTIONAL AND REGULATORY ENVIRONMENT

To improve the regulatory and institutional environment of the solid waste management system in the municipality, the following steps need to be taken:

- Establishing a national legislative framework that sets the conditions for a solid waste management system. This step is the responsibility of the central government. The local legislative framework should be established if municipalities have the power to do so.
- Planning and designing a solid waste management system where the role of each actor is defined clearly. This is mainly the responsibility of the central government with significant contributions from the municipalities, the private recycling sector, and non-governmental organisations. The cooperation of all actors is necessary to come up with an operational and effective system.
- Planning and designing a hazardous waste management system. This is also mainly the responsibility of the central government also with contributions from the municipalities, the industry organisations, and local recyclers.
- Providing municipalities with capacity building and incentives to go through the necessary changes to create an SWM system. Economic and financial incentives should be given to the municipalities to implement the necessary changes in the current waste management system.
- Educating the public. For a solid waste management system to operate efficiently, the cooperation of the public with the responsible authorities is essential. For this to be achieved, central government and local authorities should organise sensitization campaigns to promote the new system, having the dual purpose of informing the public about the new system and increasing environmental awareness.
- Implementation and monitoring of an SWM system by local authorities and co-ordination between stakeholders.

CASE EXAMPLES.

Lebanon - Environment and Solid Waste Management Project: Environmental impact assessment study
http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000009265_3980429110227

The purpose of the environmental assessment is to ensure the projects under consideration are environmentally sound and sustainable, and that possible negative impacts are identified, and mitigation measures to properly address these issues are incorporated into project design. In doing so, several alternatives for achieving the project objectives have been evaluated along with the risks associated with each item. The scope of the study includes an assessment of the physical environment, the biological environment and the socio-cultural environment.

The potential impacts of the project identified by the study are: settlement and relocation of population, nuisances, level of pollution, natural habitat, cultural heritage, and traffic.

Major findings of the study are:

1) the sanitary landfill was deemed to be the best technology to remedy the solid waste disposal problem of West Bekaa, since it solves an overall regional problem;
2) the landfill will cause negative impact in terms of modification of land occupation, noise pollution, odour, and dust; and
3) the effects of composting plants on the site morphology, the fauna and flora, the climate, the tourist attractions, the archaeological sites, and the presence of utilities are negligible.

Partnership for the development of environmental laws and institutions in Africa.
Source: United Nations Environment Programme
http://www.unep.org/padelia/publications/publication.htm

Partnership for Development of Environmental Law and Institutions in Africa (PADELIA) is a successor to the UNEP/UNDP/Dutch Joint Project on Environmental Law and Institutions in Africa which was implemented systematically in seven African countries with a grant of US$ 5million from The Netherlands Government from 1995 to 2000. In four of the countries, namely Burkina Faso, Malawi, Mozambique and Sao Tome and Principe, activities involving development of laws are country-specific. On the other hand, in Kenya, Tanzania and Uganda the focus is on development and harmonisation of laws on issues of a common and transboundary character within a sub-regional project.

Beside development of laws, activities include training on environmental law and its enforcement, including the role of the judiciary. Publications used in the training exercises are distributed world-wide. These include a four-volume Compendium of Judicial Decisions; a ten volume Compendium of Environmental Laws of African Countries; Handbook for Implementation of Conventions Related to Biological Diversity; Industries and Enforcement of Environmental Law; and 8-volume Reports of Development and Harmonisation of Environmental Laws in East Africa. Background reports on environmental law in Burkina Faso, Kenya, Malawi and Sao Tome & Principe have been published.

PADELIA, as a Phase II of African Law Project seeks to enhance the capacity of the countries in implementation of existing laws; develop legal instruments to fill gaps in the existing laws; and enhance the capacity for sustained development and implementation of environmental law. The duration is 2001 to 2004.

RELATED WEB SITES.

- **Regulation**

Egypt regulation
http://www.eeaa.gov.eg/English/main/law4.asp

European Investment Bank
http://www.eib.org/environment/en/index.htm

Israel regulation
http://www.israel.org/mfa/go.asp?MFAH0awv0

Libya regulation
http://www.moe.gov.lb/ind6.html

Malta regulation
http://www.environment.gov.mt/legislation/

Morocco regulation
http://www.minenv.gov.ma/juridique/polludectexte.html

The African Development Bank Group
http://www.afdb.org/projects/policies_and_procedures.htm?n1=5&n2=0&n3=0

Questionnaire for evaluating environmental policy performance
http://www.worldbank.org/nipr/work_paper/1448

The Working Page on Urban Policies and Enabling Legislation
http://www.sustainabledevelopment.org/blp/policies.html

The World Bank Operational Manual. Operational Policies.
http://wbln0018.worldbank.org/Institutional/Manuals/OpManual.nsf/

- **Public participation and discussion groups.**

Convention on Access to Information, Public Participation in Decision – Making and Access to Justice in Environmental Matters.
http://www.unece.org/env/pp/ecases/welcome.html

Man Power Planning & Organisational Back-up in Environment Policy.
http://www.mpinfo.org/english/policies/env/manpower9.0.htm

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5. URBAN WASTE PLANNING.

5.1. WHY PLANNING?

The main purposes or objectives of a planning process are:

- To consider alternatives, establish adequate siting options, and manage the implemented actions, all of which help to take long-term decisions.
- To integrate the implemented option into higher levels.
- To define options and optimise decisions
- To achieve a consensus and promote participation.

Historically, municipal solid waste management was a simple one way end-of-pipe approach to the problem: the waste was taken away and either dumped or burned somewhere in more or less controlled conditions. This guaranteed the local authorities with a permanent solution and well known and stable costs.

But, the role of local authorities is changing under the pressure of public demand, legal requirements, technological processes and the rapid growth of cities:

- Waste flows are becoming more complex, as waste is closely linked to the increasingly changing patterns of lifestyle and consumption (increasing quantity of waste, increasing distance between centres, legal framework modifications, etc), and call for adequate and technology-intensive solutions.
- There is a need for planning the collection and treatment of certain flows.
- Landfilling high energy waste makes no sense while various alternative technologies are available.
- Waste incineration is growing ever more unpopular with the public

Thus, local authorities are forced to:

- Implement complex scenarios taking the best advantage of technological possibilities.
- Work in an unstable technological environment: technologies are being constantly improved, and new waste flows call for new solutions.
- Develop partnerships with multiple industrial sectors.

Planning has special significance in Eastern and Southern Mediterranean cities. These cities are currently developing infrastructure and their population is increasing very fast. Therefore, developing a long term urban waste strategy will help them to avoid wrong decisions and make the most of the available resources, both environmental resources (which are quite limited, especially water) and financial, technical and human resources.

5.2. STRATEGIC SOLID WASTE PLANNING PROCESS.

When planning solid waste management strategically, seven steps can be undertaken in the process. At each step, developers should integrate both strategic (political, institutional...) and functional (generation, handling...) elements.

Planning for solid waste management is not primarily a technical issue, but the organisation and management of relationships between all the stakeholders, and therefore the participation and consensus of all of them, is needed. The planning process is not a one-off or linear process, but is an on-going exercise in need of regular revision and updating.

It is important that the municipal process take into account the State planning process if one exists.

The seven steps of the planning process are the following:

1. *Organising a planning study.*

- Mobilising support (political process)
    - Agree on need for a strategic planning study
    - Establish Steering Committee involving key stakeholders
    - Build political will and commitment

- Organising the work (operational level)
    - Establish Working Group to carry out study
    - Define overall terms of reference
    - Acquire resources and funding
    - Contract consultants if necessary
    - Prepare detailed work plan

2. *Defining the problem.*

Analyse current situation. Study what is currently happening with the waste stream in the community (quantity generated and how the management system works). Studying the quantity and type of material being generated and how much of that material managers can expect to prevent or capture is essential to decide the equipment and space needs, facilities, market, personnel, etc. Decision makers should also analyse the stakeholders in waste management: producer responsibility, role of scavengers, etc. The residents' complaints must be considered by the developers, as well as the current environmental concerns in the area.

Predict future capacity requirements. Make an attempt to accurately predict future trends in community waste generation. The two most important trends that should be investigated are population and public policy changes. Population trends are usually monitored carefully and public policy shifts can quickly change the quantity and type of waste materials available to support a given option. Changes in the composition of the waste stream should also be noted. While generic estimates are difficult to apply locally, such predictions should be considered during the planning of the program.

3. *Establishing planning framework.*

- Selection of planning area and planning period
- Selection of types of waste to be covered by plan
- Definition of service levels (quality and coverage) desired. In this section, a compromise between desirability and affordability must be reached
- Setting of objectives and targets for the plan

4. Identifying and evaluating options.

- Organisational framework
  - Distribution of responsibility for collection, transfer, disposal between different (levels of) municipalities.
  - Inter-municipal cooperation
  - Organisation among waste management institutions
  - Separation of functions to avoid conflict of interests (client, regulator, operator)
  - Strengthening management within autonomous departments to fulfil functions and responsibilities
  - Opportunities for private sector involvement

- Improving standards, efficiency and coverage
  - Examine operating subsystems for storage, primary collection, secondary collection transfer, and street sweeping, focusing on improving efficiency and effectiveness and identifying, evaluating and selecting a preferred option for each subsystem
  - Involve the community more in service delivery, especially as a means of expanding service coverage in poor and informal settlements

- Moving up the waste management hierarchy.
  - Give preference to waste avoidance and minimisation and materials recovery and recycling, rather than treatment and disposal, where it is practical and cost-effective to do so

- Developing waste treatment and disposal facilities.
  - Phase-out current open-dumping practices as soon as possible.
  - Focus on landfills as the most appropriate and cost-effective option for upgrading open-dumping in the short term
    - Choose appropriate landfill standards
    - Introduce practical steps to improve existing facilities
    - Begin studies for siting, design and development of future landfills

- Strengthening the financial management framework
  - Focus on financial policy framework (financial management and control, affordability, willingness to pay, revenue generation, cost recovery policies, sources of investment funds).
  - Conduct economic evaluation of technology options, service levels and targets and alternative strategies
  - Conduct financial appraisal of the strategic plan, focusing in particular on the action plan.

5. Formulating the strategy.

Integrate the results of the previous step to come up with the most appropriate strategy for developing a waste management system over the long term (15 years). This includes the systematic identification and evaluation of a small number of alternative strategies.

6. *Formulating the action plan.*

- Turn the strategic vision into practical reality:
  - What specific and detailed actions need to be taken to implement individual components in general?
  - Who should take those actions and when?

- Detailed feasibility studies, which include overall financial planning and appraisal of the action plan, and the identification and sequencing of priority investments within the action plan.

- Obtain necessary approvals for the strategic plan

- Introduce public awareness and education measures, without which the strategic plan cannot be implemented.

7. *Implementing and monitoring the plan.*

Waste management planning will vary in intensity over time, but it must be continuous. A continuous process can be organised with the help of yearly status reports on the updated situation. A yearly report will not necessarily be comprehensive if not much has changed or not a lot of new knowledge has been obtained since the preceding year.

A continuous planning process will be a good basis for revising the existing waste plan. It even has to be decided how often the plan itself should be revised, taking into consideration the intensity of the work this entails, and involving all the waste actors and decision-makers.

In principle, it may be recommended to revise the waste plan each political election period or, at least, make a review of the situation, if an interval between the elections is short. A national regulation system or an overall waste management authority may determine the period of revision.

The plan will often cover a scope of 4 or 5 years, after which it can be revised. Or it may have a prospective period of 12 to 15 years. This means that every 4 or 5 years a new plan should be prepared looking 12-15 years ahead

Updating starts with the evaluation of the results of current waste management actions. As far as the annual status reports are concerned, they can determine the necessity of revising a plan or strategy. The first step can be a special report to obtain a consensus or decision on beginning a new round of planning processes.

5.3. ANALYSIS OF INSTRUMENTS TO DEFINE ALTERNATIVES.

Waste collection systems, waste treatment methods, waste management systems, etc, should be evaluated through several analytical instruments through which the most adequate alternatives can be defined.

Budgeting and financing.

The principal financial objectives for developers implementing a solid waste management system are:

- To establish practical systems of budgeting and cost accounting for municipal solid waste management which yield transparency with regard to the real costs of waste

management and provide a basis for planning and improving operational efficiency.
- To mobilise required resources for investment in waste management facilities and equipment.
- To acquire cost-oriented revenues for waste management operations based, as far as possible, on user changes, and ensure that the collected revenues are applied to the intended purpose of waste management.
- To reduce the costs and improve the efficiency of waste management operations.

Decision makers should consider these facts concerning budgeting and financing in every stage of the planning process.

Legal and regulatory framework.

The instrumental basis for implementing the strategic plan comprises a legal and regulatory framework which is elaborated in the form of by-laws, ordinances and regulations concerning solid waste management, and includes corresponding inspection and enforcement responsibilities and procedures at national, regional, and local levels. These would also include provisions for the management of industrial and hazardous waste. Regulations should be few in number, transparent, unambiguous, easily understood and equitable. Furthermore, they should be conceived with regard to their contribution to urban physical and economic development.

Regulations and controls are not the only types of instruments available for achieving waste management goals. Other options include economic incentives and non-economic motivations based on the environmental awareness and solidarity of the population. Authorities should consider the full range of available instruments within the policy framework.

CASE EXAMPLES.

Integrated urban waste management plan for the area of Txingudi (2002 – 2016), Vasc Country, Spain.
http://www.txinzer.com/frances/pdf/plan.pdf

Since July 1997, the municipalities of Irun and Hondarribia (71.832 inhabitants) constituted an Intermunicipal Association. This Association is in charge of the solid waste management and street cleaning.

Txingudi elaborated an Integrated Waste Management Plan taking into account the EU waste management hierarchy. The Waste Management Plan includes urban and rural areas as well as industrial parks.

The Plan includes an overview of the current situation concerning population and generation of waste, and their forecasts for the duration of the plan. These data is employed to design logistics and facilities to develop the plan. The document also includes the recurrent and non-recurrent costs of the system as well as awareness raising campaigns.

The management plan includes evaluation and updating of the objectives and actions set in the plan. The following is carried out by the Intermunicipal Association and the Council of Hendaye in order to assure that the objectives and actions considered in the plan are achieved and adjust the plan when needed. Control of the integrated plan is done by the town councils in order to reinforce the following actions undertaken by the Intermunicipal Association and the council of Hendaye.

Development and implementation of a new municipal waste management strategy. West Sussex, United Kingdom.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=8566

The management of municipal waste in West Sussex has historically relied on disposal by landfill. Despite increasing emphasis on waste recovery for recycling, landfills are currently used as the method for disposing of the remaining 90% of municipal waste and there is only about ten years of landfill capacity at the current rates of filling. Landfills are also regarded as the most unsustainable option, both financially and most importantly, environmentally. New arrangements had to be planned immediately ensuring that we deal with our waste problems now and do not store them for future generations.

It became clear that delivering a sustainable municipal waste strategy that was to be robust for a 20 year period would not only require appropriate collection infrastructure, facilities and public acceptance, but would also require an increase in public awareness of the waste problem, acceptance of the problem and some behavioural changes by householders.

With this background in mind, the County Council, aided by the district and borough councils as collection authorities and the Environment Agency (the national regulatory body), embarked on the development of a new municipal waste management strategy.

It was with this in mind that West Sussex County Council made the decision to involve the public at the earliest stages of development prior to the establishment of the strategy, and consequently produced a new waste strategy that meets the needs and expectations of West Sussex residents.

West Bank and Gaza - Second Municipal Infrastructure Development Project: environmental management plan.
http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000094946_00062305363924

This Environmental Management Plan has been prepared to integrate environmental concerns into the design, and implementation of the Second Municipal Infrastructure Development Project, and will support adequate roads and site selection, and assess water network subprojects. This includes staff and contractor training during implementation, and community involvement in monitoring environmental impact as a result of construction. Mitigating measures include:

1) the establishment of guidelines, and specifications for contractors to control waste disposal, and safety hazards, and enforce environmental and traffic regulations;
2) soil erosion should be contained, through the installation of guard rails, with reflectors, and proper compaction of shoulders, and re-vegetation, particularly the replanting of trees, should take place, as road widening and improvements require uprooting of existing vegetation;
3) construction and maintenance of drainage ditches should prevent clogging caused by erosion and improper drainage; and
4) increased separation of wastewater from consumption water, to prevent health hazards resulting from inadequate sanitation, and improper sewage, and sludge disposal. Capacity building, training, and a contingency budget are included to sustain environmental protection.

RELATED WEB SITES.

Ohio Pollution Prevention and Waste Minimisation Planning Guidance Manual
http://www.epa.state.oh.us/opp/guide/p2pbgn.html

Working with others to find better Solutions
http://199.212.16.11/solutions/english/circle.html

Cities Environment Report on the Internet (CEROI)
http://www.ceroi.net/index.htm

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6. LOCAL MANAGEMENT OF WASTE SERVICES.

Local management of waste services consists of a long term organisational system set up by the local authority with the purpose of providing daily urban solid waste services of an appropriate quality at a minimum cost. It implies setting up the proceedings; administration and accountability; budgeting; financing; management of personal means, equipment and facilities; deciding between public or private management; monitoring and quality control; taking into account suggestions and complaints from the public; etc.

6.1. MUNICIPAL MANAGEMENT STRATEGIES.

Local authorities and the institutions responsible for solid waste management must pay special attention to modern management approaches based on adequate information systems, decentralised responsibility, interdisciplinary interaction and co-operation among functional levels. With regard to operational planning, appropriate management methods and skills include data collection techniques, analysis of waste composition, waste generation projection and scenario techniques, formulation of equipment specifications, procurement procedures and management information systems for effective monitoring, evaluation and planning revision.

Governments may clarify the goals and priorities of urban waste management and environmental protection and formulate appropriate legislation, by-laws, regulations and standards, and the integration of solid waste management into the general legal framework for public health and environmental protection. This framework should provide local authorities with the instruments and competence necessary to develop solid waste management system.

Development of municipal solid waste management systems implies that specific objectives are formulated and appropriate measures taken regarding a range of strategic aspects, within the national regulatory framework. The following are the strategic aims that should be considered when implementing a system:

Political Aspects.

The main political objectives are:

- To determine society's goals and priorities for waste management and mobilise public support for these goals;
- to achieve a clear definition of jurisdictional arrangements for waste management tasks among the concerned government bodies and private sector actors, as well as the roles, rights and responsibilities of service users; and
- to elaborate an appropriate legal and regulatory framework and body of instruments which enable responsible authorities to achieve and sustain their defined goals.

In pursuit of these objectives, policy makers will need to deal with numerous issues:

- Setting up trade-offs between the expansion of collection service as opposed to improved, environmentally sound disposal
- Define a minimum acceptable level of collection and/or disposal service as a practical basis for determining necessary trade-offs
- The way in which authorities deal with the service needs of irregularly settled residential areas
- How much weight is to be given to other instruments of waste management: regulations and control, economic incentives, and non-economic motivations
- Steps to be taken to incorporate financial and economic analysis into strategic planning functions
- How much emphasis is to be placed on awareness building, demonstration of effects and/or project-linked policy dialogue
- In the long term, priority is to be given to waste minimisation and resource recovery in relation to waste treatment and disposal.

Institutional aspects.

The main objectives at the institutional level are:

- To distribute functions and ensure a corresponding decentralisation of power and authority,
- To establish effective institutional arrangements for waste management at the municipal level,
- To introduce appropriate methods and procedures that enable efficient waste management services which meet the needs of the entire population,
- To organise the structure of municipal institutions and their staff so that they are able to provide the demanded waste management services,
- To introduce competition and increased efficiency to solid waste management through the involvement of private sector (formal and informal) enterprises, and
- To lower costs and improve the effectiveness of waste management through the participation of communities and service users in local waste management.

Some of the main issues to consider at the institutional level are:

- Distribution of municipal solid waste management functions, responsibilities and powers
- Possibilities for local governments to develop the responsibility and authority for planning and developing waste management when these institutions lack the necessary experience and capacity
- Institutional arrangements and approaches that will foster more demand-oriented solid waste services

- Introduction of a life-cycle approach to waste management among institutions whose mandate is usually limited to the functions of waste collection and disposal
- Decide which waste management functions should be contracted out to private sector enterprises

Social aspects.

The principal social aspects to be taken into account are:

- To orient municipal waste management towards the real service needs and demands of the population;
- To encourage patterns of waste handling and disposal which contribute to the effectiveness and efficiency of municipal waste services;
- To raise public awareness of solid waste management problems and priorities and promote an effective economic demand (willingness to pay) for waste collection and disposal service; and
- To protect the health of formal and informal waste workers, improve their socio-economic security and alleviate their social marginalisation.

Questions that arise regarding the social aspects of waste management include:

- The Possibility of adapting municipal waste management systems to the specific demands and requirements of residential populations, particularly, those of low-income households
- Determination of the potential role of the community in local waste management, and the types of input required for promoting community-based waste management
- Dealing with the problem of equity of service access in areas where the population cannot afford paying the full cost of waste management
- Forms of collaboration between informal sector waste workers and municipal authorities to improve the productivity and working conditions of informal sector workers
- And on the long term, instruments of awareness building and incentives to mobilise everyone's contribution to waste minimisation and recovery

Financial aspects.

The main financial objectives are:

- To establish practical systems of budgeting and cost accounting for municipal solid waste management which yield transparency with regard to the real costs of waste management and provide a basis for planning and improving operational efficiency;
- to mobilise the resources required for investment in waste management facilities and equipment;
- to achieve cost-oriented revenues for waste management operations which are based, as far as possible, on user charges, and to ensure that the collected revenues are applied to the intended purpose of waste management; and

- to reduce the costs and improve the efficiency of waste management operations.

Critical financial issues include:

- The use of appropriate cost accounting systems to promote transparency in spite of the possible reluctance of municipal officials
- The way in which incentives for cost reduction and increased operational efficiency will be integrated into municipal waste management operations
- Tasks areas and conditions in which private enterprises contribute most effectively to cost reduction and service effectiveness
- Choice of the system of municipal solid waste management revenue collection that will produce adequate cost recovery while, at the same time, creating real incentives for cost reduction and effectiveness

Economic aspects.

The main economic objectives are:

- To promote the productivity and development of the urban economy through the efficient provision of waste collection and disposal services
- To ensure the overall economic effectiveness of waste management services through the adequate evaluation of economic costs and benefits
- To generate jobs in the field of waste management
- And on the long run: to promote waste minimisation, material conservation, waste recovery and reuse – and the long-term efficiency of the economy – through the practical application of the "polluter (and user) pays" principle

Principal economic issues to consider are:

- The appropriate balance between a low-cost waste management service and optimal environmental protection
- The role of economic incentives in promoting material efficiency
- Practical steps to internalise the externalised costs of waste management and/or pollution
- Use of public subsidies to promote environmentally safe waste disposal in landfills
- Improvements needed in municipal solid waste management procedures, processes and capacities in order to facilitate public-private partnerships for waste management and improve the linkage between formal and informal private sector activities

Technical aspects.

The main technical objectives are:

- To introduce coherent technical systems adapted to the requirements and operations of all concerned actors including: service users, informal sector workers, private enterprises and public sector waste operations;
- to ensure the environmentally sound collection, recycling and disposal of all generated waste; and
- to achieve optimal life-cycle cost-effectiveness of solid waste management equipment and facilities, with due consideration of operation and maintenance requirements, operation costs and dependability.

Technical issues to be outlined are:

- Operational integration and coherence of technical systems to be achieved in spite of the diversity of local collection needs, actors and decision makers, and incremental development of facilities and equipment
- Estimation of reliable life-cycle costs of alternative equipment and facilities which take into account operating costs, maintenance requirements, down time, etc.
- System characteristics required to facilitate private and community involvement in waste management
- Technical equipment and procedures required for optimal separation of hazardous wastes at the source
- Determination of the appropriate landfill design

6.2. ORGANISING LOCAL MANAGEMENT.

Management of waste services includes having an economic, technical and social perspective.

Waste management needs to implement a quality control program (complaints hotlines, information systems, etc), with which system performance can be monitored. The system needs to be adapted to the city changes. It cannot be an annual monitoring system only, but must also cover a minimum of 5 years of operation.

Solid waste management is a service for which local government is normally responsible. This service is non-exclusive, meaning that once it is provided for some portion of a community it benefits overall public welfare, not only the resident that specifically receives the service. Any resident can enjoy the benefit of the service without diminishing the benefit of anyone else. Accordingly, it is not feasible to exclude from the service those who do not pay, because public cleanliness and the safe disposal of waste are essential to public health and environmental protection.

These qualities place responsibility for solid waste management squarely within the public domain as a public good. Because solid waste management is an urban issue, the level of government responsible is typically the local or metropolitan government. This does not, however, mean that local government has to accomplish the task of solid waste service delivery entirely with its own staff and equipment, this is where the role of the private sector comes into play.

6.3. PUBLIC OR PRIVATE MANAGEMENT?

There is a simplistic argument that public goods should be paid for by public funds and delivered by public agencies, while private goods should be paid for by private individuals (through users charges) and delivered by the private sector. Issues of private sector participation in solid waste management services should not be confused with those of cost recovery; therefore, there are sometimes reasons for involving the private sector in solid waste management activities, regardless of whether these activities are public or private goods.

Whether to involve the private sector in solid waste management services or not is an issue separate from cost recovery. Instead, the question of whether to involve the private sector is to be examined from the perspective of service coverage, efficiency, reliability, cost, economies of scale, equability, and accountability.

- Efficiency.

Within the local governments of developing countries, expenditure for municipal solid waste services is usually from 20 to 50 % of total municipal expenditure. Even at such high level of expenditure, the level of solid waste service is low, and only 50 to 70 % of solid waste is collected. In response to that, the main argument for private sector participation is that the private sector might be more efficient than the public one in providing services, deriving from management flexibility, freedom of action, greater financial discipline, and accountability to market forces.

However, public enterprises may have the same advantages as private ones if the legal framework regulating the system is appropriate. Moreover, even when there are many private companies, efficiency will not be optimised if they are in collusion over prices or good practices.

- Public accountability.

The municipal solid waste service normally involves labour-intensive street-sweeping and waste collection techniques. Because labour costs are relatively low, labour intensive techniques are appropriate.

Local governments have often provided patronage through jobs in the municipal solid waste agency. As a result, solid waste employment rolls are bulging with extra employees, whose productivity may be low. In addition to the problem of patronage, technological changes have led to labour redundancy. As urban areas become densely populated and travel time to disposal sites increases, local governments tend to change to labour-intensive systems, which use compaction trucks. Few cities, however, take any parallel steps towards reducing labour-redundancy in their refuse collection work force.

Turning solid waste collection over to the private sectors is a way for local governments to avoid accountability, and it also transfers civil responsibility to the private companies. However, if an appropriate legal frame has been set up, public and private management have the same advantages.

- Management context.

One of the most frequently cited advantages of the private sector over the government is its management flexibil-

ity. Private sector management can more easily in fire personnel for non-performance and provide upward mobility for workers with good performance. Also, the private sector is not constrained by government hours and overtime problems.

Studies on optimal municipal solid waste management have shown that cost is reduced in cities where the span of management between the manager or supervisor and the worker is appropriate. Ideally, to achieve low-cost services, the span of management for solid waste collection systems should be about one supervisor for every four solid waste collection vehicle crews, a much higher or much lower span would lead to unnecessary and high costs. In developing countries, most municipal solid waste agencies have a span of management of about one supervisor to every twenty to fifty solid waste collection crews and often the salaries for supervisory positions are not high, which makes it difficult to maintain qualified supervisors. If the private sector has a greater ability to implement more appropriate management practices than government, there is an opportunity for cost reduction through private sector participation.

Staffing ratios are important in maintenance as well as supervision. Maintenance and repair service is one area where the private sector has typically been able to perform very effectively. Vehicles used in private sector collection fleets are seldom down for repair service for more than half a day.

Private sector participation in solid waste services is not the only way to introduce management flexibility into the system. This goal can be effectively accomplished by commercialising the solid waste management entity.

- Financing

In developing countries, cities are hard pressed to obtain enough capital to finance their solid waste systems and are burdened with political constraints limiting their ability to generate revenues. In response, private sector participation is viewed as one way to secure investment finance from private companies for solid waste equipment and facilities in return for contracts to provide services. In many developing countries, the private sector has expressed an unwillingness to provide solid waste services under contract with local governments. The private sector questions the ability of local governments in developing countries to reliably meet their payment obligations to suppliers and contractors.

In countries where the private sector is unwilling to work with the government under contract, this sector is sometimes willing to work independently (through zone monopoly or open competition) and to collect its own user charges. Some problems are:

- How can the government deal with those generators of refuses that are not willing to enter into individual agreements with private haulers and pay for service?
- How can the government regulate the tariffs charged?
- How can the government limit collusion and price setting?

In countries in which the private sector is willing to invest in solid waste management, the apparent and hidden costs of private versus government service need to be carefully analysed. These need to be put into comparable and equitable terms, showing any hid-

den subsidies and costs that might exist in either service.

- Legislation.

Laws significantly influence the private sector's decision of whether to become involved in the provision of municipal solid waste management services. Reputable private companies want a field in which they can compete equitably, fairly and with minimal risk.

Few developing countries have domestic, private companies with expertise in municipal solid waste management. For foreign firms to take an interest in participating in municipal solid waste services in such a country, an attractive environment for foreign investment needs to be created. This would necessary include the local recognition of the value of the expertise that foreign firms can contribute.

It has to be considered that the law in many developing countries has several limitations that do not protect the foreign partner against liability due to the non-performance of the local partner.

- Institutional context.

Privatising some aspects of municipal solid waste service delivery does not in any way take away the need for local governments to be fully responsible for solid waste management services. Local government needs to have adequate autonomy to enter into multiyear agreements that achieve economies of scale, as well as efficiency.
For some of these services to be effectively privatised, local governments would need to be strengthened. Only a governmental organisation with a competent professional staff and an adequately designated authority with commensurate responsibility would be fully able to develop, negotiate, manage, monitor, and enforce a competent contract instrument.

- Cost.

At first glance, a low cost for service delivery by the private sector will be lower than the cost for local government service. After the cost for local government to monitor the performance of the private sector is added, a low cost for service delivery by the private sector would be still lower than the cost of local government service.

Sometimes there is no clear delineation between recurrent and capital expenditures. It is recommended to attempt to aggregate municipal solid waste management costs incurred by all the various agencies that participate in the system, and to track the depreciation, debt service, personnel benefits, land acquisition, and human resettlement costs within the solid waste management accounting system. The result is an accurate estimation of the municipal solid waste system costs.

6.4. CREATING AN ADMINISTRATIVE UNIT.

In a solid waste management system, it is necessary to create a municipal unit formed by experienced managers whose responsibility should be waste management and street cleansing. This management can be carried out by a private or public system.

In case a private system is chosen, the function of the administrative unit should be the preparation of the Terms of Reference and contract, the management of the tendering and contracting process, and once the enterprise has been chosen and operations have

begun, the overall direction of the waste service as a public responsibility, the monitoring of service delivery quality and the control of private contractor activities.

If a public system is the option selected, the administrative unit should be in charge of similar functions as in the private delivery case, and the service delivery should be done through a public agency. The relation between both may be regulated with a contract-programme between the municipality and the public agency.

6.5. PRIVATE MANAGEMENT METHODS.

Contracting.

Among the various options for private sector participation, contracting for solid waste services holds the greatest promise to developing countries as a way of lowering the costs. Even when only a small portion of the city is served under private contract, significant efficiencies may be achieved through the effectiveness of market principles.

In cities where there is no public monopoly, but where the public sector competes with the private, there is no evidence that contracting costs less than public service. In fact, data from several cities suggests that competition encourages the public sector to significantly improve its efficiency and lower costs, as discussed below.
In developing countries, it is difficult for the public service to implement the changes necessary to match the efficiency of the private sector. Nevertheless, it has been shown that when the public service agency is placed in competition with private contractors, and is allowed to make the necessary adjustments to become competitive, the public agency has been able to attain costs comparable to those of the contractor. For this reason, a good arrangement may be a mix of public and private service (for example, contracting for the collection of solid waste from some zones of the city, while retaining public service for the remaining zones).

Contracting is a viable means of securing service so long as it is possible to adequately describe outputs anticipated from the contract. Thus, contracting is well-suited for discreet activities within the solid waste system, such as the operation of a transfer station or a sanitary landfill.

In many countries, local governments have successfully contracted their billing and collection of solid waste user fees to regional water and electric utilities.

Contracting to lease equipment, rather than to obtain service, is one way of obtaining equipment when the opportunity to borrow money for a capital investment is limited. In developing countries, the available equipment for solid waste service leasing has typically been fully depreciated during private sector use in construction or haulage. Most leasing involves open tipper trucks or bulldozers that are readily available from construction contractors.

To foster competition, a key factor is a good tender document: one that recognises the capabilities and limitations of the local private sector and enables it to bid competitively toward providing an acceptable standard of service.

It would be a mistake to assume that in the absence of well-defined contract performance measures, enforceable contract sanctions, vigilant contract monitoring, and cost accountability, private contractors would deliver a lower cost than that of the public service. The monitoring of the performance of the private sector is very important. A good contract clearly defines measurable outputs of service required of the contractor and thus enables performance monitoring. A good contract also clearly defines the sanctions that are to be imposed in case of non-performance.

For low cost to be achieved by contracting, it is generally agreed that the contract should have a long enough duration to enable the private sector to depreciate capital expenditures for appropriate equipment. Many developing countries have limits on whether local government can contract beyond its current fiscal year and commit funds beyond its current budget allocation.

Franchise.

Local government normally has the authority to give exclusive franchise to a qualified private firm for the right and responsibility to provide service to customers within a zone. In return for such an exclusive franchise, the private firm pays a license fee to the government. The firm subsequently charges their customers appropriate fees to cover the cost of the service.

Ceilings fixed by municipal ordinance may regulate the fees charged. Local government retains the responsibility of monitoring the performance of private firms having franchise agreements, and regulating user charges. It also retains the right to renew or revoke licenses in accordance with established criteria.

For developing countries, franchise is applicable only in the areas of the city wherein all of the households and establishments can be readily educated to be concerned about public cleanliness. Only in such areas would it be possible for the private company holding the franchise to obtain full co-operation and achieve cost recovery.

Concession.

Under concession arrangements, the private sector finances and owns solid waste management facilities and equipment (for a period of time sufficient to depreciate investments and provide a reasonable return to the equity investors). In return, the government typically grants and enables access to a specific quantity and quality of solid waste and provides some form of tipping fee. In cases in which the local government is the only purchaser of the product or output service of the concession, the local government will normally be required to enter into a binding long term agreement to purchase on a “take or pay” basis. The concession agreement might specify performance standards, methods of judging performance, penalties for delay or non-performance, risk assignment, insurance requirements, dispute resolution, and standards for worker safety and health protection and for environmental protection.

Open competition.

In open competition, each household and commercial establishment hires a private collection firm and pays the solid waste removal fee that the firm charges. Generally, this form of privatising solid waste management systems leads to substantially higher costs than those incurred by local government contracting with private firms, and is often more costly than public service.

CASE EXAMPLES.

New Solid Waste Management System in Alexandria
http://www.medcities.org/docs/2Technical%20Review%202.pdf

The Governorate of Alexandria has decided to engage an international company to carry out collection, hauling, recycling and landfilling according to international standards. The company will be responsible for providing equipment, upgrading of already existing facilities, training and awareness and will build a secure landfill. The service fees will be collected from beneficiaries (residential houses, commercial and industrial activities, medical activities, hotels), based on the monthly Electrical bill. A 2% charge on street and square cleaning will still be charged.

After tendering and evaluation, it was decided that ONYX Company would carry out the job for Alexandria city.

Responsibilities of ONYX Company are:

- Daily collection, hauling and landfilling of all types of solid waste
- Daily cleaning and sweeping of streets and roads
- Beach and park cleaning
- Collection, treatment and disposal of medical waste
- Upgrading and development of compost plants
- Building and operation of a secure landfill
- Treatment and/or rehabilitation of already existing dump sites
- Employment of at least 50% of the already existing manpower according to Egyptian regulations
- Upgrading the existing fleet of trucks according to Governorate regulations
- Insurance of all installations, equipment and facilities against fire and all other risks
- Providing monthly reports and annual reports with a plan of action for the next year including suggestions for efficiency improvement
- Presenting the structure of the project management and a plan of action for the phases of the project taking into consideration population growth, summer and tourism seasons
- Presenting an action plan for rehabilitation of already existing dumpsites
- Finalising all commissioning activities in less than one year
- Preparation of a training programme for administrative staff, technicians and workers at all levels
- Establishment of a communication and 24 hour information centre for feedback and complaints
- Returning installations and facilities to the Governorate in a reasonable operating condition after the end of the contract.

The project covers the entire city including urban and rural areas, according to maps and databases of the normal operation of Alexandria Electricity Company.

The role of the Alexandria Governorate will be mainly:

- Technical follow-up and field surveys
- Follow up of the information centre to ensure 24 hour operation
- Receive reports according to the present schedule
- Study reports to allow for improvements and upgrade efficiency
- Activation of the cost system
- Monitoring and assessment of company services according to the contract

Private Sector Participation in Solid Waste Management of Aleppo, Syria
http://www.unep.or.jp/ietc/Publications/TechPublications/TechPub-17/syria1.asp

Aleppo (Halab in Arabic), is one the oldest continuously inhabited cities in the world and the second largest city in Syria. Aleppo is a major centre of agriculture, trade and industry and has a population of 1.9 million inhabitants, with a growth rate of about 3.8% per annum.
This demographic situation makes providing services, in general, and cleanliness services, in particular, a difficult problem. Other contributing factors to this problem are:

- The spread of the old city over a large area with very narrow lanes. This makes providing cleanliness services very difficult because it can be only done manually by workers.
- The mingling of residential, commercial, and small-scale and medium-scale industrial areas. This results in large quantities of mixed solid waste.
- Close social ties among Alepenes. Parties and other social activities go on until late hours at night, and the garbage generated thereby is usually left uncollected till the following day.
- High consumption of meat, fresh vegetables and fruits. Such food stuffs produce large quantities of organic waste.

Aleppo has decided to involve the private sector in solid waste management due to:

- Lack of available manpower in the Department of Cleanliness because of low pay, the availability of ready cash and improvement in the construction industry and social attitudes (in urban areas, cleanliness work has become socially unacceptable).
- Increases in the costs of running some solid waste disposal vehicles. These vehicles were owned and operated by the City Council. 1n 1993 and 1994, it was observed that their operation costs soared. Such costs and the poor degree of readiness of these vehicles resulted in the disruption of waste container emptying operations. Contracting the private sector was a practical way out.
- Unplanned city expansion and the growth of illegal settlement areas. Lacking proper and planned roads, they are very difficult to serve by the public sector considering its red tape and slow response. This makes it necessary to serve them by methods and means the private sector can provide more easily and effectively.

The Regulatory Framework of PSP in Urban Services in Aleppo includes the following measures, according to the Syrian Law of Contracts:

- The preparation of a study, which identifies the work concerned, the need for it, and the inability of the council staff to do it.
- The preparation by the relevant department of a dossier containing the study and what the private sector should do, a price analysis, and a complete book of terms.
- Making the dossier known to the private sector, through the press, on the Council notice board, or by direct contact.
- Approval of the Council Chair and then of the Executive Bureau. If the contract is worth between half a million and five million Syrian pounds, it is sent for the approval of the Council of State and to the Ministry of Local Administration. If it is worth more than five million pounds, it is sent to the Economic Committee of the Cabinet.

The Project of Waste Management in The Two Governorates of Khan Younis and Deir El Balah (Palestine): Implemented by The Solid Waste Management Council in Collaboration with The German Agency For Technical Co-operation (GTZ).
http://www.unep.or.jp/ietc/Publications/TechPublications/TechPub-17/palestine1.asp

The solid waste management project including 11 municipalities (300,000 citizens) in the two governorates of Khan Younis and Deir el Balah started in 1994. The main problem at that time was how to achieve the general aim of the project in every municipality in the governorates, taking into consideration the financial limits of the project, and the fact that some municipalities had a population below 3000 citizens while others reached 90,000 citizens.

The idea of privatising cleaning services was unknown and impractical because the standards, principles and costs of such services were unknown at that time. In effect, the regional solution was adopted, i. e. enshrining the eleven municipalities under one specialised institution (common services council). The following steps were designed to achieve the goal of the project:

- Establishing a common or regional service council specialised in solid waste management for the municipalities.
- Providing the service of waste collection regularly and efficiently for at least 90% of the population within the boundaries of the projects.
- Pursuing steps for solid waste disposal that preserved the environment, closing non-hygienic open dumps and erecting one central dumpsite with environmentally accepted standards.
- Adopting an effective administrative system to manage solid waste within an institution that functioned on the basis of cost recovery to guarantee continuity in providing the services.

The Council for Solid Waste Management in the governorates of Khan Younis and Deir el Balah was established in 1995 in collaboration with the German Agency for Technical Co-operation (GTZ), as a governmental company in charge of implementing technical projects within the German governmental external aid.

The role of GTZ was to provide the infrastructure of the project such as the garages, the waste dumps, the machinery and the technical support. The role of the Council (the Owner of the project) was to provide the working force cadre and the land, as well as implement the project and pay the full costs of operation. The heads of the eleven municipalities were members of this council.

The Palestinian ministry of local administration has approved and endorsed the council as an independent institution that works on a commercial non-profit basis with a special system unlike that of other government institutions, and endorsed its ownership by the member municipalities. The reference of the council was the Ministry of Local Administration.

The Council for Solid Waste Management carries out the secondary waste collection process (by machines), namely, emptying garbage containers and transferring garbage to the central waste dump. Those services are enjoyed by more than 240,000 citizens in 11 areas, villages and cities. As for the street sweeping and door to door garbage collection, i.e. primary collection; it is the responsibility of the local municipality.

The Council for Solid Waste Management adopts a certain system in proving its financial dealings (cost recovery) including the value of depreciation of all assets and taxes, just like any other private company, excluding the value of the dumpsite construction. Member municipalities are accounted for in accordance to their monthly quantity of collected waste. For every fiscal year, the surplus or the deficit is distributed to all the members on the basis of their quantities of waste. An independent auditor verifies the budget of the council.

The member municipalities pay their contributions for the operation of the project from their own finances through imposing cleaning fees and taxes on the citizens. They do not receive financial aid from the central government to cover any operational cost, but they have the right to attain governmental grants directly or through donor states to cover infrastructure projects only.

This was also applied to the council for solid waste management due to the fact that it is owned by member municipalities, although the system of the council is different from governmental institutions and more like the nongovernmental sector. That was one of the advantages that enabled the council to attain governmental grants through donor states. Governmental grants are classified as a regular income in a period in which certain assignments are supposed to be fulfilled.

The council is owned by the member municipalities and is considered one of the assets of those municipalities. The council took the responsibility of collecting and disposing of the wastes, relieving the municipalities from this responsibility. There is great coordination between the council and the cleanliness departments in municipalities in the primary collection processes undertaken by the municipality and the secondary collec-

tion process undertaken by the council in order to ensureintegration and harmony between the two processes. There is also coordination in financial matters with every municipality in terms of assisting the municipalities to impose the proper fees and taxes that suit the actual costs of the service in a way that guarantees enough revenues to cover the contributions of the municipalities to the council.

Among the advantages of the council is that it is the only body responsible for the final waste collection in its domain, including transferring the waste to the right dump place. Hence, the random dumping of waste in open spaces no longer exists, and this, in itself, is a target, in order to preserve the environment and public health. The council also plays an important role in setting standards for the provided services and their actual costs. It also helps in setting the suitable environmental legislation.

Community Participation in the Management of the Urban Environment. Senegal.
http://www.vcn.bc.ca/citizens-handbook/unesco/most/africa6.html

In West Africa today, the urban population is growing at a rate of about 5-6%. More than 70% of the urban areas on this continent are completely excluded from the urban public service network of drinking water distribution, liquid waste drainage or household refuse collection, as a result of a lack of means at municipality or state level. In the commune of Rufisque, nine quartiers (neighbourhoods) are involved in the programme.

These neighbourhoods have a concentration of 51,000 inhabitants, divided up among 5,225 households, i.e. 45% of the commune's population; 30% of this population is illiterate. Each inhabitant produces around 0.70 kg of waste per day; total production for the nine neighbourhoods is 35 tonnes per day, and waste water amounts to 1,800 cubic meters per day. Statistics reveal that 75% of patients treated at the Diokoul community clinic suffer from diarrhoea, dysentery or dermatosis and belong mainly to young age groups. Within the scope of our programme, some actions increasingly call for contracts between grassroots groupings, municipalities and other competent institutions which generally claim territorial rights or demand that all local initiatives be harmonised. Early collection experiences in the poorer neighbourhoods are gaining ground across the town.

It is Enda who runs the programme. It ensures practical training for all those involved in the programme, including members of community groups and associations, and cart drivers. Management committees composed of mandated community representatives (youth, women and the elderly) and municipal technical and health services have been established to ensure continuous assessment, follow-up and planning of actions.
The municipality is involved in different actions, and is represented at the meetings of each continuous assessment committee. It approves the establishment of the routes for the early collection of solid waste in the neighbourhoods involved in the programme. The committee is based in the relevant district health centre. It signs the approved contracts with those requiring private refuse collection. A contract is signed with a cart driver, who is supplied with a horse-drawn cart for which he is responsible. The cart driver ensures door-to-door refuse collection on a determined route. The

contract only requires two hours of early collection from the cart drivers and such a link between employment and environment should not distort the cart drivers' vocation as road hauliers.

Around 450 households have been provided with private sanitation infrastructure, of which nearly 200 are linked to water treatment plants through a narrow drainage system. Up to 65% of demand has been met, which represents 15% of requirements. The population co-finances this equipment at a rate of about 70%. On the long run, the costs will be entirely covered by the beneficiaries. Cost recovery is ensured by the management committee, which countersigns the contracts for the beneficiaries of the sanitation infrastructures. The costs recovered by the programme are invested into a community revolving fund (savings account), which will allow other inhabitants requesting such infrastructures to benefit from the project.

The development of private sanitation has enabled us to confirm the ability of the neighbourhood representatives on the continuous assessment committee to administer the supply of work created by the construction sites. Youths from the neighbourhood have been trained by the programme and organised into several micro-enterprises working in enhancing the value of refuse (recycling, compost and urban agriculture).

The existence of a frame of reference at a local level - Enda TM / Local Authorities / Health Committee - allows for the harmonisation of the various initiatives with the local urban management policies.

The main impacts of the PADE (Diokoul and Surroundings Sanitation Programme) are economic (job creation, increase in revenues); social (lightening womens' workload, improvement of living conditions, home economics and especially social status of participants); environmental and sanitary (fight against the spread of faecal hazards, domestic refuse and numerous illnesses); and communal (reinforcement of independence of the community and citizenship of its inhabitants).

The most visible effect on urban policy is to illustrate the feasibility of inhabitants taking direct charge of their own waste collection and recycling, and the construction of private sanitation infrastructure within their community. Also, the municipal authorities have recognised the validity of this alternative solution, which is particularly well-suited to the layout of poor neighbourhoods. They have accepted the need to provide incentives by exempting the collection carts from municipal taxes. The treatment of liquid waste allows the spread of a new waste management policy, which will promote a new enhanced value resource.

Results:

- 4000 meters of narrow sewerage system
- 450 households benefit from private sanitation
- 2 water and waste treatment plants built
- 3000 households benefit from door-to-door waste collection
- 90 cubic meters of water recycled daily
- 3 tons of refuse recycled daily
- 70 full-time jobs created over 4 years
- 50 people trained in recycling
- US$ 40000 in funds mobilised within the community
- 40 people participate in regional exchanges of experiences
- 1930 participants in the programme management out of 2316 are women
- 50 programme decision-makers out of 90 are women
- 33% reduction in illnesses related to the environment over 4 years
- 1.8% increase in household income over 4 years
- 86.2% decrease in annual facilities maintenance expenditure over 4 years
- 50% reduction in costs of private sanitation infrastructure over 4 years

RELATED WEB SITES.

El Estudio, Análisis y propuestas para el fortalecimiento de los programas de gestión público-privada en el manejo de los desechos sólidos y el saneamiento ambiental existentes en el Área Metropolitana de San Salvador. SEMA – EMS. Secretariado de Manejo del Medio . Ambiente para América Latina y el Caribe. Marzo 2001
http://www.undp.org/ppp/library/publications/salvador.pdf

Institutional Arrangements for Solid Waste Management in Metropolitan Areas.
Carl R. Bartone. Course on Urban and City Management. 2002
http://www.worldbank.org/wbi/urbancitymgt/toronto/assets/t-bartone-mod08.ppt

Pilot Project on Solid Waste. Management in Khulna City:
Community Organisation and Management
http://www.wsp.org/pdfs/sa_pilot_khulna.pdf

Private Sector Participation Municipal Solid Waste Services in Developing Countries. Sandra Cointreau-Levine. UNDP, UNCHS, World Bank. 1994
http://www.worldbank.org/html/fpd/urban/mun_fin/toolkit/private_sector_part.html

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The two following chapters include different aspects to consider when implementing a waste collection program. The first one takes into account general considerations applicable to a general waste collection system as well as collection in difficult areas. The second one focuses on specific procedures in separate collection systems.

7. WASTE COLLECTION I. GENERAL CONSIDERATIONS.

The purpose of this section is to suggest a methodology for the management of general waste storage and collection.

7.1. DEFINING COMMUNITY CONSTRAINTS AND GOALS.

Decision-makers can consider developing a waste collection program if they identify with some or most of the following problems:

- The waste collection service is struggling to keep the city clean
- Not all the city is covered by the collection service.
- Waste accumulating in the streets and around squatter settlements and blocking drains is a public health concern
- Despite the low levels of service, costs are high and represent a large share of the total municipal budget
- With population growth, the spread of the city and increases in living standards, the quantities of waste are growing faster than the city's ability to cope.

When identifying goals and objectives at the early stages, some issues must be considered:

- Level of service.
- Roles of the public and private sectors.
- Waste reduction goals.
- System funding.
- Physical configuration of the city.
- Labour contracts.
- Local culture and behaviours related to solid waste.

7.2. CHARACTERISING WASTE TYPES, VOLUMES AND THE SERVICE AREA.

It is necessary to gather data to determine the community's collection needs. The assessment usually draws from a combination of different sources:

- Historical data from the community.
- Data from similar communities.
- Published typical values.

City street and block maps should also be obtained to determine information on specific zone configurations, including number of houses, locations of one-way and dead-end streets and traffic patterns.

7.3. IDENTIFYING WASTE PREPARATION AND COLLECTION PROCEDURES.

As a general rule for developing a waste collection system, and in order to set out a basis for the collection procedures, decision-makers should consider waste collection with containers before a waste bag delivery system.

Solid waste set-out requirements.

The community should specify how residents must prepare solid waste and recyclables for collection by developing guidelines or ordinances.

- Storage container specifications.

Containers should be suitable for the amount and types of materials they are to hold as well as the vehicles used in collection; they should also be durable, easy to handle, economical and resilient.

In residential areas, where refuse is collected manually, either plastic bags or standard sized metal or plastic containers are typically required for waste storage. The municipality can limit the volume, weight and total number of containers to be collected under normal service. Single-bins are a good solution for use in blocks of flats; however, the value of single-bin use in individual dwelling situations is unclear.

When automatic or semiautomatic collection is used, solid waste containers should be specifically designed to fit the truck-mounted loading mechanisms.

A review of various types of containers follows. Advantages and disadvantages of each type are listed in table 7.1.

Table 7.1. advantages and disadvantages of different types of containers

Type	Advantages	Disadvantages
Bags	Suitable volume Easy to store when empty	Causes problems with certain materials (e.g. glass) Requires an opening system in sorting centres Wasteful when bags are not full when collected The stock of bags must be renewed Experience shows that printing sorting instructions on the bags is not effective Bags can be opened and torn apart by animals
Boxes	Provides rigidity Reusable Easily checked by waste collector	Not closed Enables only small volume collection
Single bins, with or without wheels	Rigid container Clear presentation of waste Easy to handle Available in large sizes Long service lifetime	Bulky (difficult to use more than two) Poorly suited to volume of private use
Compartment bins on wheels	It allows separation into a few batches, and simultaneous collection of the batches	Requires costly and bulky collection Poor filling efficiency of bins and trucks
Containers	Provides rigidity Reusable Easily checked by waste collector Suited to residential units with varying number of residents, commercial centres or industries	The volume is not often used optimally, and often the ratio of weight to volume is low Big containers require separate transfer to the transfer station

The containers can be arranged in the street or integrated into the building by providing a special space for them inside the structure.

- Solid waste separation requirements

Communities may require that residents separate different types of waste before collection. For example, commonly recyclable materials such as paper, glass, aluminium, plastic, etc. The separation of bulky waste, yard trimmings or domestic hazardous waste can also be required. Solid waste separate collection requirements will be discussed in the next chapter.

Frequency of collection.

The development of a collection system in a community needs to specify how often the materials will be collected. The factors to consider when deciding the frequency of collection are diverse: cost, customer specifications, storage limitations and climate (which can influence health and odour problems).

Some communities are accustomed to collection seven days a week, whilst other collection agencies are striving for just once a week. In hot climates, where odour problems and fly breeding have to be controlled, waste should be collected at least three times a week.

Other factors to consider are the odours caused by decomposition and the accumulated quantities. If residents are accustomed to daily collection it may not be politically feasible to reduce the frequency to twice a week.

Pick up points.

The most usual configuration of the pick up points for collection in urban and suburban areas is the curbside or alley service, which means collecting the waste in containers placed in alleys or on curbsides. This method is more economical but requires greater resident participation than a backyard service, in which containers are carried from backyards by collection crews to the curbs for collection.

In rural areas there are other alternatives because of the low density rate and limited budgets. The most common options are placing the waste near routes along major roads or a drop-off arrangement, which consists of a kind of small transfer station. This last option is cheaper, but also less convenient for the inhabitants.

It is highly convenient to construct a concrete base on the floor to facilitate loading the waste onto the truck. Communication with the residents in order to establish a schedule, delivery forms, and waste types to be deposited, is crucial to determining optimum pick-up points. Businesses and services may have to be provided with special pick-up points, and special regulations for their waste collection.

Collection options.

Curbside collection.

The waste is picked up at the point of generation. Curbside service is usually offered in cities and suburbs, because it is the most cost-effective and convenient method of collecting recyclables in medium to high density population areas. This system is convenient for waste generators, requiring little or no

change in their routines and it also encourages participation.

Drop-off facilities.

The use of one or more drop-off facilities consists of a centrally-located facility with covered bins, large containers, or stalls or trailers to receive and store recyclables. They are more often used in rural areas where it is convenient or prohibitively expensive to provide curbside service. One or two employees are required to discourage vandalism, maintain the site and assist and ensure safety of users. Residents may be asked to separate the various materials into different bins or be allowed to deposit them in a commingled bin.

Start-up costs for drop-off stations are relatively low because equipment, personnel and maintenance requirements are minimal.

Buy-back facilities.

They are similar to drop-off facilities because participants must transport their recyclables to the facility. The difference is that residents that use a buy-back facility are paid in cash for the items they bring to the site. Buy-back centres are usually located in urban, low-income areas in order to foster participation through direct incentives. These centres also have a litter-reducing effect.

It is not always advantageous for local government recycling, because in many cases if residents get cash from their recyclables, they prefer not to give them to the local government.

Special collection day.

Recyclables are collected on a different schedule from regular garbage, for instance, a different day of the week or time of day can be designated during which only recyclables or certain materials are collected.

Combinations between this system and the curbside and drop-off collection system can be considered, which consist of collecting or dropping-off recyclables on a designated day of the week.

The special collection day system may incur added costs for staff, equipment and publicity.

Combined collection options.

Many communities provide collection for the whole system, and in several cases some publicly provided collection is implemented along with privately provided collection systems.

In large communities, a combination of options may lead to higher participation and result in a more effective program.

7.4. DETERMINIG COLLECTION EQUIPMENT AND CREW SIZE.

Collection equipment.

Three common types of **primary collection vehicles** are:

- the handcart pushed by the operator as he walks along.
- the pedal tricycle with a tray or box in front of or behind the operator.
- animal-drawn carts, often pulled by donkeys.

Simple, motor powered vehicles, based on small motorbikes, should be considered where longer distances require larger payloads and higher speeds, or where there are slopes. Truck chassis and bodies can be combined in many different ways. When selecting them, the municipality must consider several factors, such as waste set-out requirements, waste quantities, collection routes, regulations regarding truck size and weight, the recommendations of collection crews and drivers, etc. Compactor trucks are used for residential collection services, and are classified as front-loading, side-loading or rear-loading, depending on where the containers are emptied into the truck.

Although open and closed non-compacting trucks used to collect solid waste are relatively inexpensive to purchase and maintain, they are inefficient for most collection applications because they carry a relatively small amount of waste, and workers must lift the containers high to dump the contents into the truck. This type of truck is appropriate to collecting bulky items or materials collected separately, as well as for small communities or rural areas.

Crew size.

Crew size is a crucial issue when evaluating collection costs, it can clearly affect the overall economic efficiency of the project. When determining crew size, collection methods and routes, labour and equipment costs, and labour union contracts should be considered.

Crew size in the collection system includes urban cleaning equipment and collection equipment which should be mutually complementary and optimal.

7.5. EVALUATING TRANSFER NEEDS AND OPTIONS.

Once a local government has collected the solid waste, it may need to store the waste at an interim location prior to recycling or final disposal. If such storage is necessary, it usually occurs at a transfer station. A transfer station is a facility where waste is transferred from the smaller collection vehicles to larger transport vehicles, such as tractor trailers, railroad gondola cars, or barges. These vehicles then transport the waste to the disposal site. The procedure to determine if this system is applicable in a given community is described below.

Evaluating local needs for waste transfer.

The benefits of constructing a transfer station must be compared to the costs of developing and operating the facility. Such benefits include:

- lower collection costs because crews spend less time travelling to the site
- reduced fuel and maintenance costs for the vehicles
- increased flexibility in selecting the disposal facility
- the opportunity to recover recyclables or compostables at the transfer station
- the opportunity to shred or bale materials before disposal.

Transfer station cost-effectiveness depends on the distance between the disposal site and the generation area.

Types of transfer stations.

Several factors influence the design of a transfer station, such as:

- Required capacity and amount of waste.
- Types of waste received
- Processes required
- Types of collection vehicles using the facility
- Types of transfer vehicles that can be accommodated at the disposal facilities
- Site topography and access

The different types of transfer stations can be divided into three big groups: small capacity (<100 tons/day), medium capacity (100-500 tons/day) and large capacity (>500 tons/day).

Small to medium transfer stations.

They are typically direct-discharge stations that provide no intermediate storage area. These stations usually have drop-off areas which residents can use, in addition to areas dedicated to the collection trucks. Depending on weather, site aesthetics and environmental issues, the operations can be located indoors or outdoors.

Larger transfer stations.

These are designed for heavy commercial use by private and municipal collection vehicles. The typical operational procedure for a larger station is as follows:

- When collection vehicles arrive at the site, they are checked in for billing, weighed, and directed to the appropriate dumping area.
- Collection vehicles travel to the dumping area and empty waste into a waiting trailer, pit or platform.
- The collection vehicle leaves the site.
- Transfer vehicles are weighed either during or after loading.

Depending on the transfer distance and the vehicle type, there are different types of larger transfer stations:

Direct discharge non-compaction stations.
The waste is loaded directly from the collection vehicles at the top into larger collection trailers. This system is efficient because the waste is handled only once; however, some form of storage during peak times or system interruptions should be provided.

Platform/pit non-compaction stations.
Collection vehicles dump their waste onto a floor or area where it can be temporally stored, and, if required, picked through for recyclables or unacceptable materials. The waste is then pushed into open-top trailers, often by front-end loaders. They provide temporary storage, which can result in levelling the peak inflow of waste, but construction costs for this type of facility are usually higher. They are designed to have a storage capacity of one-half to two days inflow.

Compaction stations.
These stations use mechanical equipment to increase waste density before it is transferred. The most common types have a hydraulically powered compactor to compress the materials. Compactor stations are used when waste must be baled for shipment or for delivery to a balefill, when open-top trailers cannot be used because of size restrictions or when site topography or layout does not accommodate a direct-discharge station.

Transfer station design considerations.

The objectives of a transfer station design are efficient waste handling, equipment and building durability, a simple operation scheme and allowance for future modifications.

Site location and design criteria.

When selecting a site, there are several factors that must be considered, such as:

- Proximity to the waste collection area, to minimise hauling time and distance
- Accessibility of haul routes to disposal facilities
- Visual impact
- Site zoning and design requirements
- Proximity to utility tie-ins, such as electricity and gas, water, telephone, etc.

When the site is selected, the process of obtaining permits should be started immediately, because it can be time-consuming.

Building design.

The key factors to consider when building the facility are durability of construction, adequate size for tipping and processing requirements, minimisation of obstructions to trucks and flexibility and expandability of layout.

Transfer station sizing.

The determination of the size of the transfer station should be done by considering a variety of factors:

- Capacity of collection vehicles using the facility
- Desired number of days of storage space on tipping floor
- Time required to unload collection vehicles
- Number of vehicles that will use the station and their expected days and hours of arrival
- Waste sorting or processing to be done at the facility
- Transfer trailer capacity
- Hours of station operation
- Availability of transfer trailers waiting for loading.
- Time required, if necessary, to attach and disconnect trailers from tractors, or to attach and disconnect trailers from compactors.
- Time required to load trailers

There are formulas for estimating the station capacity considering these factors. Designers should also include in their plan an adequate area for waste storage and, if necessary, waste processing. To minimise the size of the facility, collection vehicles can back into the unloading position. In addition, there must be an adequate area for offices and other employee facilities.

Additional processing requirements.

Waste shredding or baling, as well as the recovery of recyclables or compostables, may also be included in the design of a transfer station. The developer must assess early in the design process the sizing and designing requirements for these additional processing facilities.

Transfer vehicles.

Trucks and semitrailers.

The specific truck or semitrailer required for a community should be selected by considering the following aspects:

- Waste should be transported at a minimum cost
- Waste must be covered during transport
- The vehicles should be designed to operate effectively and safely in the traffic conditions founded on the hauling routes.
- Truck capacity must ensure that it never exceeds road weight limits
- Unloading methods should be simple and dependable
- Truck design should prevent leakage of liquids during hauling
- The truck should be able to withstand abusive loads.
- The number of required vehicles depends on peak inflow, storage capacity, trailer capacity, and number of hauling hours.

Rail cars.

Rail transfer should be considered when it is available for the transfer station and the disposal site. Waste can be transported using either dedicated boxcars or containerised freight systems. Railcars should be covered and kept clean, and shipments should be scheduled to minimise en-route delays.

7.6. EVALUATING COLLECTION AND TRANSFER ALTERNATIVES.

Defining system alternatives.

When the options of collection and transfer are identified, the developer should determine which combination of elements is the best for the community being studied.

Analysing crew and truck requirements.

To estimate staff and equipment needs, the designers need the average amount of waste generated for all the sectors in the area to be served. This can be calculated using the number of houses per block, along with waste density and quantity information.

Estimating time requirements.

Loading time requirements

If historical data is not available, the loading time can be determined by a time study of proposed collection procedures. However, it is always better to determine it from previous experience. The loading time is used then to calculate the average time required to fill a collection truck, which is essential in determining the collection routes.

Hauling time and other travel time requirements.

The following time requirements should be considered when determining the total travel time:

- Time of travelling from the garage to the route at the beginning of the day
- Time of travelling from the route to the disposal site

- Time spent queuing, weighing and tipping at the disposal or transfer site.
- Time of travelling from the site to the collection route
- Time of return trip to the garage at the end of the day

Overall time requirements.

Overall time can be used to estimate the number of loads that each crew can collect per day, and then calculate the number of vehicles and crew-people required to collect waste. At this point, the developer is able to estimate the annual cost of each collection alternative.

Selecting a collection and transfer alternative.

These are other important factors to be considered by the decision makers when evaluating collection and transfer alternatives:

- Costs of required new equipment and ability of community to secure financing for it.
- Costs of operating collection system and transfer facilities.
- Compatibility of total costs with budget available for solid waste services.
- Differences in levels of service provided by alternative systems.
- Ability of system to meet the public's service demands or expectations.
- Proposed methods for financing system costs and public acceptability of those methods.
- The system's effects on efforts to meet the community's waste reduction goals.
- Compatibility of proposed roles for public and private sectors with political support for them.
- The public's interest or disinterest in changing present arrangements for collecting solid waste and recyclables.

7.7. DEVELOPING COLLECTION ROUTES.

A well designed collection route system is crucial to minimise the costs of the overall collection program by reducing the labour expenses of collection.

Planning efficient routing for the area you will collect waste from is crucial to the development of an efficient and cheap waste management system; therefore, it is necessary to create an administrative unit in charge of developing the plan and considering the city's circumstances (work days, holidays, etc). Proper routing aims at:

- Collecting as much waste as possible in one collection round
- Taking the shortest possible route (in time and distance)
- Dividing workloads equitably among crews

These are the steps for designing new waste collection routes:

1. Preparation of a detailed map showing waste sources and the amount of waste generated.
2. Data analysis and preparation of data summaries.
3. Preliminary lay-out of routes.
4. Evaluation of preliminary routes and development of balanced ones through repeated trials.

Cities and towns are expanding rapidly, implying more and more waste being generated. Routing has to change to accommodate the changing situation. Changes may include introduction of

more collection points or the construction of more transfer stations or communal collection points. Routing designs must change and always focus on aiming towards minimum costs.

It should be considered that collection routes may have to be changed because of seasonal adjustments, by providing fewer and larger routes during low-generation periods. It is also important to ask the crew about their daily observations to improve the collection route and schedule systems.

7.8. DETERMINING THE SYSTEM FUNDING STRUCTURE.

The cost of collecting waste varies from one country to another, due to the following:

- Variations in the typical situation with respect to the number of passes (collection points passed) per unit of time (the higher this is, the lower the cost. This is not simply an issue of population density, since it is affected by factors such as traffic).

- The nature of the setting out of residential waste and the costs of containers used (in some systems, residents purchase bags/bins, in others, these are included in scheme costs).

- Variation in the quantity of residential waste collected per collection point (the lower the collection, the higher the per tonne cost), which is affected by:

    - The rate of source sorting
    - The nature of containers used for collection
    - What householders are allowed to put in the container for collection

- The vehicles used (and their maximum payload empty, larger vehicles can reduce costs).

- Labour costs (these vary according to the number of operatives, itself affected by the nature of the area in which collection takes place, and with unit labour costs in country). Note that labour is an important component of collection costs, but relatively much less so in the case of treatments.

- The frequency of collection, related to the nature of the housing stock, the collection mechanism, the climate, and most significantly, the presence or absence of organic waste collection.

- The level of sophistication of the collection equipment.

The money needed to pay for the collection system can be secured using different methods, as described below:

- Property taxes. It is usually enforced in communities where collection has been performed by municipal workers. Funds are derived from money received from collection of personal and corporate property taxes, ensuring administrative simplicity for the funding

method. However, funding from property taxes does not provide any incentive to residents to reduce waste through recycling and source reduction.

- Flat fees. Indicated for communities served by private haulers or a separate authority or where a special purpose fund is used for solid waste services. This method does not provide an incentive for reducing waste, either.

- Variable rate fees. Generators pay in proportion to the amount or types of wastes they set out for collection. They are sometimes calculated:

    - According to the number of residents in the house.
    - According to the wealth of the zone.
    - According to the type of producer (businesses, bars, supermarkets...)
    - According to the degree of difficulty of the collection.

  They typically require that residents purchase special bags or stickers. They may also offer generators a range of service subscription levels, which means less administrative complexity.

Communities can combine elements from different funding methods to meet their specific needs.

7.9. IMPLEMENTING THE COLLECTION AND TRANSFER SYSTEM.

Purchasing and managing equipment.

Equipment purchasing.

To purchase equipment it is necessary that the community include equipment specifications, which may either provide detailed equipment requirements or be based on more general performance criteria

Equipment maintenance.

Municipalities may either perform equipment maintenance themselves, contract with a local garage or contract with the vehicle vendor at the time of purchase. A well designed preventive maintenance program is crucial to controlling repair costs and sustaining high reliability for fleet vehicles. Each vehicle should have an individual maintenance record that includes:

- A preventive maintenance schedule
- A current list of specific engine or packer problems
- A description of repairs and a form including repair date, costs, type and manufacturer of repair parts and the length of time the truck was out of service

This information should be periodically reviewed by the management personnel to control and improve maintenance plans.

Equipment replacement

A truck replacement strategy based on the actual costs of owning and maintaining individual trucks is likely to result in an effective use of resources. When using this system, costs are tracked for each truck, and each truck is replaced as the costs of continuing to own it exceed the costs of purchasing and operating a replacement truck.

Hiring and training personnel.

Safety

Because collection work includes many hazards for the employees, safety is an issue that the developer should mainly consider. A well designed safety program would minimise insurance costs, and should include, at a minimum, the following items:

- Procedures and training in proper lifting methods, material handling, equipment operation and safe driving practices.
- A reporting and record-keeping procedure for accidents
- Requirements for protective clothing
- Frequent refresher sessions

Collection managers should closely monitor worker accident and injury reports to try to identify conditions that warrant corrective or preventive measures.

Comfort.

The program operators should provide crew employees with adequate clothing, equipment and other facilities, in order to increase work comfort; and consequently, reduce the risk of potential injuries and enhance employee morale

Training.

Haulers should develop an employee training program that helps employees improve and broaden the range of their job-related skills.

Worker incentives.

The different ways to implement worker incentives are, for example:

- Merit-based compensation
- Awards programs
- Work structure that emphasises task completion

These will recognise and reward outstanding performance and provide motivation.

Developing and managing contracts with labour unions and private collectors.

If the municipal collection department bargains collectively with labour unions, it should usually designate a labour management relations group to handle collective bargaining, and set a formal procedure for managing employee grievances.

If the municipality decides to contract for collection systems, the selection of the contractor should require the issuance of service specifications and evaluation of contractors' bids, and the municipality must ensure that it has enough resources to monitor the performance of collection contractors.

Providing public information.

The developers should perform an adequate and continuous system of communication with the public during all stages of the process, through awareness campaigns or other methods.

Collection system managers should find creative methods of using available communication methods and materials to remind customers of set-out requirements, inform them of changes to those requirements, provide them with names or telephone numbers of key contacts, and how to provide them with helpful feedback on system performance. Commonly used methods of communicating information include brochures, articles in community newsletters, newspaper articles, announcements and advertisements on radio and television, information attachments to utility belts, and school handouts. These materials should be designed not only to communicate new information, but also to remind customers of service requirements.

It is important to provide residents with a telephone number which they can call to have their queries answered.

7.10. MONITORING SYSTEM COSTS AND PERFORMANCE.

Collection and transfer system managers should develop and maintain an effective system for cost and performance monitoring. Just as the goals of a collection program is to guide its overall direction, a monitoring system provides the short-term feedback necessary to identify the corrections needed to achieve those goals.

Monitoring can be defined as the process of collecting and analysing data in order to measure changes and to improve waste collection services. It is recommended to use a mix of indicators for monitoring, including technical, social, financial, environmental, etc, according to the model of waste management.

To maintain a correct monitoring system, each collection crew should complete a daily report that includes the following information:

- Total quantity hauled
- Total distance and travel time from and to the disposal site
- Amounts delivered to each disposal, transfer or processing facility
- Waiting times at sites
- Number of loads hauled
- Vehicle or operational problems in need of attention

Vehicle and weight information should be collected at the transfer stations, and municipalities must register all the pertinent complaints concerning the collection system.

7.11. MEASURES TO IMPROVE WASTE COLLECTION.

The following are the principal measures needed when the decision-makers are deciding on how to improve the existing waste collection system:

- Promotion of communal recycling activities to reduce the quantity of solid waste collected
- Standardisation of containers to make collection operations faster and increase the amount of waste collected within the same working hours
- Use of a curbside collection or fixed station system, instead of a door-

to-door collection system, to minimise time of collection
- Rationalisation of collection frequency. For example 2-3 times a week for residential areas is usually sufficient; daily collection requires more vehicles and workers and is therefore less efficient.
- Use of communal containers at markets, schools, high rise buildings, and other areas where a large volume of solid waste is expected, to load a high quantity of waste in a short period
- Design of better collection routes to reduce idle times of vehicles and workers
- Selection of appropriate equipment
- Assignment of sufficient workers to each collection vehicle.
- Use of 2-3 shifts to increase the working hours of each vehicle
- Establishment of a preventive maintenance system to reduce vehicle down time.
- Installation of transfer stations where justifiable, in terms of the overall cost involved.
- Provision of incentives and disincentives to improve crew behaviour and efficiency
- Establishment of an operation-control system
- Use of pilot-scale projects to identify the most locally appropriate and efficient system

7.12. COLLECTION METHODS IN DIFFICULT AREAS.

Many municipalities think that it is best if the waste collection system and equipment used is the same all over the city; however, this is not always the best option. Neighbourhoods can be very different: areas can be poor or rich, hilly or flat, commercial or residential, spacious or densely populated, etc. It is therefore **better to adapt your waste collection system to the characteristics of the neighbourhood** (especially the physical conditions and the preferences of the customers). For example, a densely populated area will often be better off with a curbside collection system than with communal containers, because there is no space for such containers.

CASE EXAMPLES.

Improving Solid Waste Management and Recycling in Zarqa
http://www.medcities.org/docs/Zarka%20Technical%20Review.pdf

Over the past two years (2001-present), the Municipality of Zarqa has undertaken a gradual overhaul of its solid waste management system in order to improve service effectiveness and achieve a cleaner urban environment. The Municipality has improved its solid waste collection and street sweeping services and has implemented a pilot recycling project for inert recoverable materials.

The Municipality of Zarqa has benefited from "Mediterranean Urban Waste Management" (MUWM), a technical co-operation project funded by the European Commission's Short and Medium Action Program (SMAP) and jointly implemented by UNDP, Medcities, and the Municipality of Rome. The MUWM project provided technical support in the form of expert missions and training courses and co-financed the building of a pilot Materials Recovery Facility.

Thanks to the political commitment and support of its Mayor and Council, as well as the dedication and professionalism of the municipal project team, the Municipality of Zarqa has formulated long-term objectives and activities *to improve MSW collection and street sweeping services*, to be implemented gradually over time and space. The Municipality has started implementing a pilot test in Region 7, which combines various approaches such as:

- Management improvement: mapping of city streets, collection routes and container locations, introduction of self-certification datasheets to be filled out by truck drivers, and analysis of data collected in order to optimise collection routes/frequencies and container locations;

- physical investment: building cement/asphalt platforms to reduce wear and tear of containers and minimise stress and injury to workers, replacing old containers with new ones (lighter and more durable design, built in-house) or upgrading them (e.g., replacing wheels), and installing small bins on poles in the commercial centre to reduce litter and street sweeping costs;

- organisational development/capacity building: setting up a separate purchasing committee within the Department of Cleanliness, training key municipal staff in planning and optimising collection service (e.g., developing baseline map, filling self-certification datasheet, analysing data to optimise collection system), hiring/detaching a computer specialist (MS Access) to the Solid Waste Department to assist in developing and analysing databases; and

- awareness raising: conducting workshops, producing posters, organising drawing competitions in schools, preparing video, etc. with the objective of drawing support and cooperation from the Zarqa population (e.g., placing waste bags in containers at specified times).

The Municipality has also analysed the potential risks and opportunities of recycling materials from the MSW stream in Zarqa. Building on this analysis, the Municipality has planned, designed and started to implement *a pilot recycling project* for select inert recoverable materials. The objectives of this pilot project are to assess the technical, economic, and institutional feasibility of a full-scale recycling project and to learn about the optimal operating techniques and other economic, organisational and management parameters for designing, constructing and operating/maintaining such a recycling project in Zarqa. When completed, the pilot recycling project will include the following components:

- Separate collection of select recoverable materials: paper and cardboard from the commercial centre and from about 25 select schools; paper, cardboard, plastic, iron and aluminium from residences in the Princess Haya suburb (25 blue and yellow containers (1.1 m^3) placed for this purpose on the streets); and
- A Materials Recovery Facility (MRF), designed and built by the Municipality, to sort and bale recovered materials before shipping them to the recycling industries: 20m x 15m hangar facility housing a conveyor belt system, a compactor/baler, a cutter, and electrical and water connections and installations.

The Municipal Council of Zarqa has given its full support to the pilot recycling project by funding it above and beyond the EU grant of Euro 35,000 provided by the SMAP EC project "Mediterranean Urban Waste Management". The Council has decided that the Municipality would operate and maintain the pilot recycling project using its own human, technical and financial resources for a short while, and then eventually contract out those services to the private sector.

The Municipality has also drafted a reasonable proposal to increase solid waste service fees paid by some industrial and commercial establishments. While the proposed fee system would help the Municipality recover a greater fraction of its SWM service costs, the Council has decided not to submit it to the Government of Jordan for its approval at this stage.

Development project for Nasriya, Asuan (Egypt)
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=107&key=

The Nasriya project was established to develop infrastructures in a marginal area of 60,000 inhabitants in Asuan, Egypt. The project began in 1987 and finished in 1997 and was carried out by the Governorate of *Asuan*, the Nasriya inhabitants and the German Agency for Technical Co-operation *(GTZ)*.

Nasriya is the most populated urban district in Asuan, except for the centre of Asuan itself, that has been growing without a planned urban structure and so constitutes a difficult access area.

The project included improvement of different infrastructures among which was the implementation and organisation of a waste collection system.

There was no municipal regulation of waste collection in the area of Nasriya. Waste was stored on rooftops or dumped anywhere.

In 1988, the project started the Waste Collection Programme that considered the difficult topography, narrow streets and necessities of the inhabitants.

The German Republic financed the acquisition of 5 small tractors for waste collection. The Cleansing Committee from the Community Development Association (CDA) prepared a detailed plan in which they underlined the role of Nasriya inhabitants. All stakeholders accepted the plan.

Currently, waste management in Nasriya is an independent project that has managed to establish a waste collection system and created an urban management unit.

Integrated solid waste collection system in the City of Olongapo, Philippines.
http://www.serd.ait.ac.th/umc/bestprac/olongapo.htm

Until the late 1980s, the City of Olongapo had no specific ordinances or other legislative measures dealing with solid waste collection. Solid waste was collected in a rather crude and haphazard manner and was often left to private groups or firms; and no service fees were imposed.

In September 1989, the City of Olongapo launched the Integrated Solid Waste Collection System. New trucks equipped with public address systems were bought and paraded in the entire city to show to the population that the local government was serious about the introduction of an integrated system of solid waste collection. Simultaneously, the City established the Environmental Sanitation and Management Office (ESMO), a full-fledged municipal department that is responsible for the management of the system.

Between 1988 and 1990, the City Council enacted eight ordinances or measures dealing with the utilisation of the sanitary landfill area, the rates of solid waste collection fees, the schedules and mechanics of collection, etc. The ordinances are supplemented by directives and issuances by the Local Chief Executive. For residential areas, solid waste is collected twice a week, while in commercial areas it is collected daily.

People's participation in the programme is encouraged. They have a responsibility to follow the regulations, particularly with regard to the use of plastic bags and the payment of service fees. In return, the benefits go to the people, because the whole community benefits from the system. During a massive information campaign, the support of all members of the community was solicited in order to minimise resistance to the programme.

A social pricing system was adopted for the service fees: charges were based on one's ability to pay. Businesses, professionals and other higher-income groups pay more than the ordinary residents. Fee collection was kept simple by synchronising the pay-

ment for the fee with that of the electricity bill. Citation tickets are issued if premises are unclean.

The Environmental Sanitation and Management Office currently has an annual budget of P. 4.0 million. This includes personnel costs, operating expenses and capital outlay. Prior to the implementation of the System, the city had to subsidise the solid waste collection and disposal services, because no revenue was generated. Now, the ESMO raises P. 6.0 million per year in collection fees.

Because of terrain constraints, the solid waste collection system can serve only 85 per cent of the current city population of 250,000 inhabitants. Some areas are difficult to access for the collection trucks and the municipality has designated collection points.

RELATED WEB SITES.

A Community Based Solid Waste Collection Service, Village of Gedelah, East Mansoura
http://www.seamegypt.com/CaseStudies/Egedelah1-4.htm

Developing a District-Community Partnership for Solid Waste Collection in Kolongeel Village
http://www.seamegypt.com/CaseStudies/Ekolon1-4.htm

National waste management strategies and action plans south africa. Action plan for General Waste collection
http://www.environment.gov.za/ProjProg/WasteMgmt/collection/

Solid Waste Collection
http://msw.cecs.ucf.edu/lesson3-general.html

Solid Waste Collection, Bardees Village
http://www.seamegypt.com/CaseStudies/Ebardes1-4.htm

Waste Transfer
http://www.recycle.net/Waste/transfer/

Westminster City Council. Waste collection.
http://www.westminster.gov.uk/environment/wastecollection/index.cfm

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8. WASTE COLLECTION II. MIXED/SOURCE SEPARATE COLLECTION.

8.1. ASSESSMENT OF ALTERNATIVES ON SOURCE SEPARATE COLLECTION.

Choosing appropriate technologies requires making three preliminary decisions:

- Which method to use for collecting specific materials
- How the collection system will operate
- What type of facility is needed for processing materials

When the decision-makers consider to implement a source separate collection system, they should focus on the following aspects:

- It is usually an expensive program, overall costs are higher than mixed collection system costs.
- It requires remarkable participation by the residents, which in turn needs several education and communication programs.
- The separation obtained is not unlimited.

However, the reasons for implementing a source separate collection system are clear:

- Benefiting from selling recyclables.
- Reducing disposal facilities dimensions.
- Producing a higher quality compost with the remaining organic matter.
- Preserving natural resources, in terms of raw materials and energy.
- Adapting to local and national regulations.
- Attaining social cohesion and community commitment

8.2. PREVIOUS CONDITIONS.

A community planning to implement a source separate collection program should have some pre-existing conditions without which the program will not be successful. The two most important conditions are:

- A recycling culture among the residents, to ensure high participation.
- An established and adequate market for recyclables.

8.3. OBJECTIVES.

Before the implementation of the source separate collection system, it is crucial that the developer clearly define what the goals or objectives of that system are. Some examples of objectives are:

- Satisfying an existing recyclables or compostables market.
- Reaching the regulatory standards of recycling and reuse.
- Reducing disposal site space.

8.4. HOUSEHOLD WASTE.

Source separation of materials.

Many communities have chosen a source separation of materials system, which has several options, including selective collection of paper, glass, metal, plastics or the organic fraction as well as their multiple combinations. These options focus on the convenience of collecting recyclables separately in order to reduce recycling costs.

The different ways of separately collecting these types of materials, in terms of pick-up points, are described in the previous chapter.

Paper.

The following categories of paper are of interest to a separate collection program:

- Newspaper. The recycling of newspapers is a basic element of all paper recycling programs, but requires additional involvement by the resident.
- Cardboard. The waste producers of cardboard are supermarkets, product warehouses, industries, etc
- High quality paper. Mainly rejected by offices.
- Mixed paper. It is the paper fraction with the lowest market value.

Glass.

Glass collection for recycling concerns glass bottles, glass containers and jars, as well as other glass materials, such as windowpanes, crystals, etc. The main sources of glass are industries dealing with the bottling of beverages, refreshments and water, hotels, restaurants, households and stores.

Glass is subdivided into three categories: white, green and brown, and the market value of the separated glass is higher than the value of the mixed; however, this material is usually collected mixed.

Metal.

Separate collection of metal can be divided into two materials: steel/tin collection and aluminium collection. The separation of these materials from the waste stream can be accomplished at the source by a selective collection method, or, more commonly, at the Material Recovery Facility with special equipment (magnetic separator for ferrous waste and eddy current separators for aluminium).

Plastics.

The major concern when collecting plastics is the high ratio of their volume to their mass (in many cases it reaches 3:1). Plastic recycling mainly deals with PVC (polyvinyl chloride), PET (polyethylene terephtalate) and HDPE (high density polyethylene). Numerous problems are faced concerning the recycling potential of plastic materials, the most important of which are:

- There are many types and levels of quality for plastic materials, each with different physical properties and chemical composition.
- Several types of plastics are difficult to identify.
- There are a lot of admixtures in recycled plastics, due to residues of the packaging systems.

Organic fraction.

Some communities have an organic fraction separate collection, mainly focused on the production of compost from the waste collected. Nevertheless, it is quite difficult to obtain high quality separate organic waste. A strong and continuos awareness campaign would be needed to change consumer behaviour. For some applications of organic matter, such as land regen-

eration, the compost could be obtained without selective collection of the organic fraction.

Combinations.

Depending on the type of waste generated and the marketability of the different materials, there are several options when implementing a separate collection system collecting the different combinations of them. The preferable materials to collect separately are paper and glass.

There is also the possibility of collecting packages separately. This waste stream includes different materials which are segregated in a materials recovery facility. It is commonly implemented through a contract between the product manufacturer and the authorities.

Wet/dry collection.

In this variation of separate collection, wet materials (yard trimmings, food scraps, disposable diapers, soiled paper and animal waste) are separated from other materials for collection. The wet stream is usually composted. Other materials, including recyclables, form the dry portion. Some communities collect all of their dry waste mixed and separate recyclables during processing. Others require further separation of dry materials into recyclable and nonrecyclable fractions. Some programs require generators to bundle newsprint or take glass bottles to a drop-off site to reduce contamination and breakage. In this approach, a separate collection vehicle is normally used for each container type.

8.5. BUSINESS AND BULKY WASTE.

When developing a collection program, the decision-maker should take into consideration business and bulky waste.

The drop-off facility system and all its combinations are often a cost-effective method of collecting bulky items or special materials such as batteries.

Institutional and business waste. There is a high generation rate of used paper in government offices and businesses (tab cards, computer printout paper, ledger paper, etc). To successfully create a program to collect such paper, a system must be developed for bringing wastepaper normally generated individually to a central location where the paper could be collected. Some systems make use of individual desk collecting bins, while others have central boxes or collection points.

Employee education is a key: workers must be told which types of office paper can or cannot be mixed together. Also, some effort must be made towards predicting office paper volumes. Overflowing waste bins or boxes will create a potential for fire or accident, as well as difficulties for those being asked to co-operate.

In addition to recycling office paper, many businesses want to shred corporate documents before disposal and will pay a premium to have documents rendered unreadable. Shredding requires an investment in processing equipment, but could prove economically attractive for recyclers working with proprietary businesses. The shredded material, properly segregated, can be recycled.

Waste from restaurants and bars. Bars and restaurants produce large quantities of glass and aluminium. Glass can become a storage and safety problem and its marketability can be affected by contamination; it could also be separated by colour. There is also in some cases an interesting fraction of organic matter that can be transformed to compost. In this case, it is recommended to collect only the uncooked fraction. Some big restaurants have a regular flow of used cooking oil, grease and animal fat. These materials can be rendered into a variety of useful products, including animal feed, soap, lard and cosmetics.

Waste from consumer goods shops, food selling, supermarkets, etc. Consumer goods shops produce a large quantity of packaging waste, mainly cartons and plastic. It is important to encourage selective collection not only to increase recycling but also to facilitate the collection in that zone by considerably reducing the volume of waste delivered to household containers. This situation is usually found in downtown commercial areas. In the case of large food shops or supermarkets, one could consider the selective collection of the organic fraction.

Waste from hotels. In towns where there is a significant tourism sector, it could be worthwhile to promote selective collection in hotels of paper, plastics, aluminium and uncooked food. This campaign is sometimes supported by the hotel's desire to be internationally recognized for its friendly attitude towards the environment.

Waste from retail businesses. In this type of business, large quantities of corrugated cardboard can be easily and economically recycled, if this material is kept separate from other waste streams. However, cardboard must be sorted carefully because it can easily be contaminated with food waste. Weather can also damage the quality of corrugated cardboard. Retail businesses also frequently produce large volumes of office paper, wood, glass and plastic.

Wood and construction/demolition materials. Building and infrastructure construction or demolition projects can also be a source of quality materials for recycling. Care must be taken to ensure that hazardous materials, such as asbestos and PCB's are not mixed with recovered items.

8.6. SEPARATE COLLECTION VS. MIXED COLLECTION.

Table 8.1. Separate / mixed collection

Separate collection	Mixed collection
▪ Extends landfill life. Removes potential recyclables from the waste stream. Lowers net disposal costs. ▪ Done by the household. No extra cost for the community. ▪ Highly applicable to residential waste. ▪ Industrial waste may be recycled through industrial waste exchanges. ▪ An effective and reliable tool for recycling. ▪ Can be implemented on small-scale, then expanded. ▪ Recyclables are usually uncontaminated by garbage and other debris.	▪ It is not time or space consuming for the residents. ▪ The facility does not need additional space to handle recyclables. ▪ Basic technology is needed ▪ The effectiveness of the collection system does not depend on how people prepare recyclables. ▪ There is no need for established secondary markets.

CASE EXAMPLES.

Door to door selective collection system for organic matter and refuse in the municipality of Tiana (Spain)
http://www.innovationbcn.net/participants/Tiana_cast.htm

The municipality of Tiana (Barcelona, Spain) implemented, for the first time in Catabnia, in the year 2000, and following Italian models, a door to door selective waste collection system for organic matter and refuse. The municipality of Tiana has a low population density.

The door to door collection facilitates maximum household separation and avoids low participation behaviours, because greater control is exercised. Therefore, in practice, it is almost impossible not to collaborate in household separation. This is due to the complete container removal from the streets. Furthermore, public space and cleaning is achieved.

As a result, door-to-door collection in Tiana obtains very high levels of participation (80%). Besides, very relevant qualitative and quantitative results are obtained: the results achieved are 79% of selective waste collection and 63% of recuperation. In the organic matter phase, the results achieved are: ratios near 300 grams by inhabitant per day of OM collected and improper levels below 5%.

In economic terms, it is also shown that door to door collection has the same economic cost of a container waste collection system. Furthermore, it may become cheaper according to the refuse treatments prices. Costs are estimated at € 180.000 per year.

Separation at source and separate collection of waste for recycling. Calvià, Spain.
http://www.innovationbcn.net/participants/finalistes/f_Calvia_eng.htm

The project started on July 1998 and will end on 2007.

The Ajuntament de Calvià (Calvià Town Council) through its strategic plan, Calvià Local Agenda 21, headed by Calvià 2000, promoted the project along with the municipality's business and hotel associations and the collaboration of local people.

The project aims to incorporate all the municipality's hotels and businesses and its 17 towns and villages. At present, 62% of Calvià's hotel capacity and 90% of its businesses are taking part in the project; by 2003, all the municipality's towns and villages will be involved.

Initiative 34 of Local Agenda 21 proposed implementing a Separate Waste Collection Plan which differentiated between the various waste producers (residents, businessmen and hotels) and put forward a specific model to be followed in each case. The Initiative marked a significant qualitative step forward in waste collection systems and ensured the involvement of all participants, in line with the Agenda's philosophy.

In residential areas, local residents can now deposit waste in containers located within 100 metres of their houses. Local businesses use the 'personalised' service at previously agreed upon times and collection points. Finally, many hotels in the area have bought cardboard compactors and waste is collected from each establishment.

Various voluntary agreements, effective until 2003, have been signed with businessmen and hoteliers. These agreements are founded on the following key points:

- integrating waste from the tourism sector through separate waste collection.
- providing the investment necessary to collect different materials.
- guaranteeing the quantity and quality of the resources provided.
- compensation by the Town Hall to project participants for investments made through a 15% rebate of the annual waste collection rates.

In addition to this programme, a number of other initiatives have been developed to help achieve the objectives of Initiative 34, namely the provision of basic infrastructure such as the Deixalleria or Punto Limpio (Clean Zone) and encouraging families to produce their own compost. The first initiative is aimed at collecting all types of waste, including hazardous household waste, whereas the second represents a step forward in raising public awareness about reducing waste and producing natural compost for their gardens.

Based on potential recovery, the total percent of material collected was as follows: paper -31%, glass - 41%, packaging waste - 6% and organic matter - 11%. These figures reflect a significant increase compared to previous years and confirm the degree of acceptance of those involved in the project. This year has also seen the opening of the Deixalleria, a waste collection facility where people can separate and deposit all types of materials, ranging from municipal waste to hazardous household waste, including special and bulky materials.

Each of the hotels taking part in the project has invested a total € 8,400 in purchasing the paper and card compactors described in the agreements. On the other hand, depending on the type of establishment, between € 3.88 and 6.66 per hotel bed of revenue has been saved, as hotels receive a 15% rebate off waste collection rates.

There are also a number of indirect costs arising from the system itself that affect both parties. These essentially derive from prior internal waste collection and Calvià's separate waste collection system. Since the start of the project, Calvià 2000 has invested a total of 1,658,793 €, or 15 € per inhabitant.

The key to the programme's success is the participation of Calvià's residents, visitors and businesses, and their appreciation of the importance and benefits of selective waste collection in safeguarding the environment. It is for this reason that Calvià 2000 has launched a series of information campaigns encouraging the collaboration of all those involved.

Selective solid waste collection and recycling in Recife, Brazil
http://www.undp.org/ppp/library/files/caval01.doc

Recife (population 1,300,000) is plagued by poor infrastructure that has resulted in the limited collection and treatment of domestic sewage and solid waste. The contamination of water and the incidence of water-related diseases are high. Facing serious financial problems, the municipal institutions have turned to social structures and community approaches as alternatives to public service provision.

The Programme of Selective Collection and Recycling of Solid Waste, initiated in June 1993, is a basic instrument for city cleaning.

The programme implements a low cost solid waste collection and recycling programme. It supports the informal collection and commercialisation of recyclable products. Specific objectives are the upgrading of the dumping area and improving the treatment of urban solid waste in the Recife Metropolitan area, the reduction of waste production and the promotion of solid waste recycling through commercialisation in partnership with the private sector. Participants are scientific researchers, central local and regional government, NGOs, CBOs, the formal and informal private sector, professional associations and women and men in the neighbourhoods.

The programme involves cooperation between the following institutional partners: Ministry of Environment, Ministry of Education, State Secretary of Planning, Municipality of JaboatAo dos Guararapes, the Glass Industry Company-CIV, Fra Francisco Works Foundation, and the Josue de Castro Centre for Studies and Research.

Through environmental and hygiene education, people learn to separate recyclable materials at the source and donate them to groups which collect, sort and sell them for a living. People work in co-operatives or other community based organisations, generating income by collecting, sorting, selling and recycling recyclable wastes.

The Municipality of Recife promotes training in recycling. The Urban Cleaning Municipal Company (EMLURB) has a workshop which recycles municipal waste paper and offers training courses to community groups interested in recycling for the paper and package industry.

Subprojects of the programme are a project for selective collection of waste paper in public departments, with the motto 'Our role/paper is to recycle' (in Portuguese 'paper' and 'role' are the same word); a similar project in schools, a project for collecting glass called 'New glass again', and a project for housewives to separate and hand in recyclable materials at the neighbourhood level, entitled ‘Selective Collection in Condominia’.

These projects operate independently, while other projects operate in an integrated fashion and work interdependently, such as: 'Voluntary Delivery Spots', 'Communal Selective Collection' and 'Support to Selective Collection by the Informal Sector'.

Under the 'Voluntary Delivery Spots' project 26 special containers for the segregated collection of recyclables have been placed mainly in high income neighbourhoods. The target is 40 more spots.

The 'Communal Selective Collection' project is implemented in middle-low and low income neighbourhoods. To stimulate the separation of materials by the households, they are given the possibility to exchange the separated materials for food, meal tickets or construction material for a group's building. This exchange is made by each household individually or by collective households.

Concrete results of the various projects are:

- 73% increase in recycled materials in two years
- 62% annual increase in volume of material for recycling
- 482 ton/month reduction in solid waste
- 56.5% reduction of special operations for waste collection and 285 dumpsites reduced to 124 (43.5%)
- 5,796 tons/month less garbage collected
- 5 - 20 years expansion of the life of the dump site. Upgrading of the dumping area and waste treatment
- food supply for approximately 2,040 recycling families

RELATED WEB SITES.

SDC Strategic planning guide for MSW. Overview for decision makers.
http://wbln0018.worldbank.org/External/Urban/UrbanDev.nsf/Attachments/UW_SPG+OVERVIEW/$File/Overview.pdf

Solid waste separation, collection and recovery system implementation for tourist areas in Turkey
http://www.cevko.org.tr/yayinlar/solid.html

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9. WASTE GENERATION PREVENTION.

9.1. DEFINITIONS.

Quantitative/qualitative reduction.

Waste generation prevention can be defined as the policies and actions related to the design, manufacture, purchase or use of goods in order to reduce the quantity or toxicity of waste produced during the whole process. Base on this definition, two types of waste prevention can be identified:

- Quantitative waste prevention (amount reduction)
- Qualitative waste prevention (toxicity and hazard reduction)

Waste audits.

An effective tool for establishing a successful source reduction policy or program for a specific product is the waste audit, which is an assessment of the material flow taking into account the amount of materials purchased, used, recycled and disposed of. A waste audit includes the following steps:

- Quantifying the material flow and costs for the activities of the whole life cycle of the product.
- Identifying and quantifying materials that are unnecessary, reusable and recyclable.
- Pre-designing alternatives
- Analysing the barriers facing change.
- Estimating cost, including savings, in environmental impact reduction.
- Defining an action plan and program

9.2. QUANTITATIVE PREVENTION.

Understanding and fostering source quantitative prevention.

At the manufacturing level, waste quantitative prevention or waste reduction means redesigning products and packaging, whilst at the consumer level, it means changing purchasing and disposal habits and attitudes.

Quantitative prevention reduces the amount of materials produced and the harmful environmental effects associated with producing and disposing of them. Adequate source reduction conserves resources, reduces disposal costs and pollution, and teaches conservation and prevention; therefore, it should be given first consideration. It also results in substantial and measurable cost savings, such as avoided collection, transportation and disposal costs.
Monitoring should be an integral part of quantitative prevention programs. Tracking the costs associated with them and integrating those costs into the decision-making process is essential to developing accountability. It is difficult to measure what has not been produced, and to discern which reductions are due to prevention and which are due to other factors. However, on a company-by-company and product-by-product basis, measurements such as the savings achieved by substituting one product with another are acceptable.

Assessment of alternatives.

Quantitative waste prevention by residents.

A source reduction program for the residential sector involves using a variety of approaches, in addition to the regulatory establishments.

Economic incentives.

The usual way to give economic incentives to the residents is requiring that users pay for the amount of refuse they generate (for each bag or can of waste); therefore individual residents can reduce refuse collection costs by producing less refuse. This provides an economic incentive for source reuse, recycling and composting.

There are a variety of mechanisms for charging fees to the residents. These include residents purchasing special trash bags, buying tags or stickers to affix to their own bags and containers, signing up for a specific size and number of cans, or being charged according to the weight of their garbage.

Deposit programs are also a way to encourage residents towards waste reduction; the purpose of deposit programs is to give consumers an incentive to return packaging materials and thereby remove these materials from the waste stream.

Yard material reduction

Decision-makers can encourage residents to promote quantitative prevention by managing yard material at home. Using the material where it is produced rather than adding it to the waste stream is a form of source reduction. Backyard composting, leaving grass clippings on the lawn, and mulching are some forms of yard material waste reduction.

Pre-cycling or eco-shopping

In this method, consumers judge the purchase of a product based on the product's waste implications, not only with regards to its environmental attributes and cost, but also its packaging and alternatives of disposal.

A local pre-cycling or eco-shopping program is usually promoted by developing a strong awareness raising campaign. Implementation strategies include:

- Reusing shopping bags.
- Buying concentrates.
- Buying in bulk.
- Purchasing reusable products.
- Purchasing durable and repairable products.
- Buying second hand items.
- Borrowing or renting items when possible.
- Avoiding over-packaged products.
- Being aware of products containing hazardous products.

Commercial quantitative waste prevention.

Implementation guidelines for industries.

- *Manufacturing redesign.* Making changes in the manufacturing process itself is an important strategy for achieving source reduction, which industry representatives should be encouraged to consider.

- *Product redesign.* Benefits to industry from product redesign include additional cost savings to reduce shipping weight or space, less water usage, and reduced packaging materials and shelf space. It is important to be aware of and carefully evaluate the frequent trade-offs resulting from the ultimate waste produced by the product.

- *Other strategies.* Some industrial quantitative prevention strategies are designing products for their durability, their reuse or to facilitate their repair.

Implementation guidelines for businesses.

To help businesses implement these programs, representatives can adopt various source reduction strategies, including the following:

- Making double sided photocopies
- Using electronic mail
- Establishing central document and file areas
- Selling items in reusable containers
- Providing items in bulk and encouraging shoppers to buy in bulk.
- Establishing a material exchange program with surrounding businesses
- Ordering supplies in bulk with other businesses.

Government quantitative waste prevention.

Government procurement policies that make waste prevention a priority can achieve a significant impact on the waste stream. As a result, the purchasing power of government can influence manufacturing practices towards implementing source reduction goals. Also, by implementing source reduction practices, government sets an example for business, industry and residents.

Evaluation of alternatives.

Applicability/capacity

.

Waste quantitative prevention can be applied to most elements of the waste stream. A cooperative effort between the government and the private sector would enhance implementation of new waste reduction laws. However, local actions such as consumer education or user incentives may be more effective.

System cost.

Administrative costs of developing and implementing packaging standards and fees, and mandatory industrial/commercial waste reduction programs are prohibitively high. In the long-run, a grade school education plan may be the most cost-effective tool.

9.3. QUALITATIVE PREVENTION.

Prevention can occur when the amount of waste is reduced, and also when there is less hazardous and toxic materials in the refuse. Common household purchases containing hazardous materials include some types of cleaners, disinfectants, polishes, motor oil, solvents and garden pesticides and herbicides.

For householders as consumers, the choice is determined by two factors:

- What is available, which is in turn influenced by what industry has provided for the market. In marketing terms, such a choice is often

summarised in terms of product, place, promotion and price.

- Lifestyle, attitude and awareness of members of the household as consumers. In behavioural terms, this is influenced by socio-demographic factors (including age and family life cycle) together with income levels.

There are several strategies to accomplish qualitative waste prevention, most of them centred around education measures:

- teaching consumers to purchase only the amount necessary so none or minimal hazardous waste materials are left over,
- how to substitute alternative products, and
- how to identify and use fewer hazardous materials.

9.4. GENERAL RECOMMENDATIONS.

- Elaborate waste prevention as an internal council-wide policy. Integrate the policy into staff training and widely publicise it within the whole council and in council run services (schools, leisure centres, libraries, etc). This alone would have significant impact on waste generation.
- Conduct a waste audit throughout the municipality offices. This will make staff think about how much is being wasted, how it could be better used, and provide source information for developing and implementing your waste prevention policy.
- Include waste-avoiding activities in all awareness campaigns on waste management.
- Measure changes in consumer behaviour produced by awareness campaigns.
- Promote the participation of all stakeholders (citizens, NGOs, etc) in prevention activities.

CASE EXAMPLES.

Waste prevention in Geneva, Switzerland
http://www.geneve.ch/inf-eau-dechets/dechets/plan_de_gestion/index.asp

The Government of Geneva has undertaken several measures to promote waste prevention. These measures aim to reduce the quantity of waste produced and the polluting potential of products and waste.

Prevention measures address producers, consumers and municipalities, providing guidelines for the role of each.

- Role of producers
  - Maximum reduction of packaging
  - Appointment of an employee responsible for waste management in SME in order to assure the accomplishment of waste management objectives
  - When possible, local producers shall develop an Environmental Management system

- Role of consumers (households and persons responsible for company's purchases)
  - Take into account environmental criteria of products when purchasing (e.g. choosing ecolabelled products)
  - Purchase long-life, non-pollutant and repairable products, with minimum packaging
  - Adopt environmentally friendly behaviour regarding paper (e.g. reuse of printed paper)

- Role of Municipalities
  - Develop exemplary behaviour towards waste prevention in their purchases and when awarding contracts
  - Training school and college teachers in waste management

Migros Prevention campaign in Switzerland
http://www.miosphere.ch/f/newsapp/index.php3?id=76

The supermarket chain Migros has developed several campaigns to encourage waste prevention and recycling. One of these campaigns aiming to prevent waste production focuses on devices.

Experience has shown that devices in general are normally replaced by new ones when broken, instead of being repaired. This behaviour increases the amount of waste produced.

Migros has established a two-year guarantee that has proven to delay the disposal of these devices in one year. Migros offers the free repair or replacement of devices under guarantee, thus encouraging consumers to keep devices instead of throwing them.

Variable charge for waste collection in Comuni dei Navigli, Italy
"Financing and Incentive Schemes for Municipal Waste Management. Case Studies." European Commission, Eunomia, Ecotec. 2002

The Comuni dei Navigli in Milan Province effectively covers ten municipalities including 24,200 inhabitants. In 1999, the source separation rate for this area was 70.3%.

According to the principles set out by the National Waste Management Act and subsequent Technical Regulations on financing of MSW collection, overall running costs should be partitioned between householders and other users on the basis of some parameters related to the specific potential waste production and to the quality of the service.

Comuni dei Navigli has adopted, since 1997, a source separation scheme for biowaste, based on doorstep collection. The system is based on the "polluter pays" principle. The charge to be paid for the cleaning service is composed of two parts, a fixed part and a variable one. The structure is as follows:

- The fixed quota for householders is assessed on the basis of the area of the house, the number of people per household and the type of dwelling (flat, single-family house, etc).
- The variable quota is assessed based on the number of bags used to deliver the residual waste to the cleaning service. Each householder has a magnetic card whereby the household is identified through a numeric code. This is automatically linked to a personal set of bags, with a printed bar code , for the collection of residual waste

This variable quota encourages waste prevention because reducing the amount of waste implies a lower charge.

It should be noted that because the variable quota is only linked to the amount of residual waste delivered, and does not therefore take into account the possible lower delivery of biowaste where home composting is practised, households doing composting in the backyard are allowed a 20% reduction of this quota. This serves to promote participation in home composting, thereby encouraging waste minimisation. In addition, credits for a further reduction in the variable quota are given in proportion to the quantity of recyclables delivered in a separate manner at Civic Amenity sites.

With the introduction of this system, a reduction of an 18% of the amount of residual waste was achieved.

Effective waste reduction in Inchon metropolis. South Korea.
http://habitat.aq.upm.es/bpn/bp198.html

The coastal city of Inchon has experienced rapid development, therefore waste production has become a serious issue. The Metropolitan Government of Inchon implemented a solid waste control program which consisted of paying per volume produced (volume based collection fee system, VCFS).

Objectives:

Year	Waste production (kg) per day and person
1994	1.04
1995	1.03
1997	1.00
2000	Less than 0.9

Procedures for volume base collection fee system implementing.

- Pilot program: 23704 families in 6 administrative units in 6 metropolitan districts. 78386 people participated (April 1st to December 31st , 1994)
- Creation of a Study Team for the development of a street-cleaning system (July 8th, 1994).
- General implementation of VCFS (from January 1st 1995) in all metropolitan areas.
- Distribution of the VCFS reviews and corrections along 6 months (September 1995).
- VCFS general review (October 13th to 17th, 1995).
- Auto-evaluation of 10 metropolitan districts.

Before its implementation, the total amount of solid waste produced was 2,272 tonnes per day; however, when the system stabilized, the quantity became 1,598, which is a 30% reduction. In 1995, the benefits from waste recovery had increased by 195%, going from 4 to 11.6 million US dollars.

RELATED WEB SITES.

Ohio Pollution Prevention and Waste Minimisation Planning Guidance Manual
http://www.epa.state.oh.us/opp/guide/p2pbgn.html

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10. NON ORGANIC MATERIALS RECYCLING AND REUSE.

Recycling of materials is an important way to reduce waste streams and consequently to decrease environmental pollution; however, it can also be a remarkable way to benefit from urban waste.

The municipal role in non organic materials recycling is usually the selective collection and delivery to the local or national recyclers or the national authorities. In some cases, it will be necessary to implement a material recovery facility (MRF).

10.1. ASSESSMENT OF ALTERNATIVES.

A well designed recycling program is quite difficult to implement, and the possibility of developing one must be carefully studied. Problems such as obtaining adequate recyclable materials from the producers of waste and the existence of stable and reliable markets must be studied.

There have been several cases where the recycling program offers only minimal services because of inadequate planning, resulting in uncontrolled collection and scavenging. The developer must avoid these problems by conducting an exhaustive study of the reliable options in each case.

10.2. USING EXISTING RESOURCES.

Before implementing the recycling plan, the different services that the community, including the public and private sectors, may offer, should be evaluated. This could save time and money. Also, cooperation among different communities can benefit a recycling program, and should be studied.

10.3. DESIGNING AND IMPLEMENTING.

When deciding to implement a recycling program, the developers should carefully analyse the current situation of the community, each one is unique and should have its own program. The development program should at least carry out the following 12 steps:

- Identify goals.
- Assess the quantity, composition and accessibility of recyclables in for each of the main categories of waste producers.
- Assess and generate political support.
- Assess markets and market development strategies for recyclables
- Assess and choose the methods and technologies of collection and processing
- Develop budget and organisation.
- Address legal and siting issues.
- Develop start-up approach.
- Implement education and publicity program
- Begin program operation
- Supervise ongoing program and continue publicity and education
- Review and adjust the program

The ultimate success of recycling depends on stable, reliable markets for recyclables. It may be adequate to start by collecting only reliable marketable materials.

10.4. STRUCTURE OF THE RECYCLABLES MARKET.

Private sector.

In many Southern and Eastern Mediterranean Countries the situation of private sector recycling is the following: Many small private companies collect recyclable paper, plastic, glass, iron, aluminium, and other metals themselves or through scavengers. Only some of these establishments produce raw materials or secondary products. Mostly, this activity is limited to the collection and initial treatment of materials before they are sold to other companies for further recycling or for exporting.

As a whole, the main sources of material for the final recyclers are these collecting companies, other industries and large establishments producing waste. They do not normally have contracts to get separate collected municipal waste material from the municipalities. Private recycling companies operate completely on their own with no support from the government or recognition of their role in the existing solid waste management system. In spite of this general situation, there are some interesting cases of integration from collecting door-to-door to recycling as in the case of the “Zabbaleen” in Cairo and in other Egyptian towns.

The private sector plays an important role in solid waste management even when there is no solid waste management system established. The private sector is responsible for the existing recycling efforts. The role of the private sector has a positive effect on the state in financial and ecological terms. The role of the private sector will be much bigger in the future when the government uses these recycling companies as a starting point in implementing a solid waste management system with selective collection. The private sector considers the lack of government support and of a legislative framework the biggest difficulties it faces.

Informal recycling sector.

Individuals and families collect recyclable waste from the streets and landfills and deliver it to private collectors, and in a few cases, to recycling companies. Door-to-door collection by the informal sector is usually not conducted because the SWM system normally does not encourage the public to sort their recyclable material. They mainly collect cardboard and waste aluminium.

The integration of this sector in a modern integrated waste system (with selective collection) is a difficult task, but in many countries there are initiatives aiming to do so, not only for social reasons but also to benefit from their experience. The Tunisian government has a very interesting on-going initiative to integrate them as regular and paid providers of a public network of points for collecting recyclable materials.

Another interesting initiative for integration is nowadays being carried out by the Egyptian government within its process of privatising the municipal waste services of the main towns.

Market structure.

The market infrastructure includes two sectors: intermediate markets (collectors, processors, brokers and converters) and end-use markets (the recovered material is the feedstock to manufacture new products). Companies can carry out one or more of these roles simultaneously:

- Collectors. Companies that collect recyclables from residents or business. Most of them accept unprocessed materials, either source-separated or mixed.
- Processors. They accept and modify recyclables by sorting, baling, crushing or granulating.
- Brokers. Brokers buy and sell recyclable materials, receiving a fee for this service. They can switch materials from one market to another, depending on demand and other factors.
- Scavengers. They collect recyclables directly from the disposal site to sell them, and provide a separation process that should be considered.
- Converters. Companies that take recyclable materials and modify them so they are readily usable by a manufacturer.
- End-use markets. They purchase recovered materials and use them as feedstock to manufacture new products. With direct marketing to end uses, communities can avoid market price swings and benefit local manufacturers.
- Transportation companies.

Material-specific market structure.

- Paper and cardboard. Recovered paper and cardboard are sometimes bought and sold through well-established local processors and brokers who sell them to domestic paper mills and export brokers. It is recommended to sort the cardboard and some kinds of purer paper from the rest in order to optimise the economy of the process.
- Glass. Normally, recovered glass markets are already established for empty bottles. Sorting by colour is usually not recommended for economic reasons.
- Plastic. The market structure for plastics is the least developed among recyclables because recycling capabilities are very recent. Sorting some families of plastics is sometimes a good practice in order to facilitate end-use market acceptance and preserve the economic balance of the process.
- Metals. Ferrous and non-ferrous metals are different markets. Normally, aluminium tins have a clear-cut market allowing a specific collection method. Ferrous recyclables normally have a low-price market.

10.5. MARKETING RECICLABLES.

The process to determine the best market situation for a given material requires following these four steps:

a. Identifying buyers. In this first and crucial step, the developer must find out which buyers may purchase or accept his recyclables. To that end, recycling market directories or other recycling programs should be consulted.

b. Contacting buyers. When contacting each buyer identified in the previous step, in addition to asking what price the marketer is willing to pay for the recyclable, the specifications for how the material must be presented to the buyer and what grade of contamination they accept for each price level should be identified. Transportation costs are extremely important, so the buyer should be asked whether they will provide transportation or whether the materials would be delivered to them. It is also important to determine if the buyer will pay higher prices for higher volumes of material and for a long term compromise regarding delivery. Market representatives should also be asked to provide references for other programs they have serviced.

c. Selecting buyers. When all the information is collected, the developer must start an evaluation, the objective of which is to select buyers whose abilities most closely resemble the needs of the recycling program. A call for offers of purchasing for each kind of recyclable material is recommended.

d. Contracting with buyers. A written agreement between buyer and seller is necessary to protect the relationship. It should include tonnage, volume and quality specifications, the pricing basis and its evolution, length of commitment, etc.

10.6. MARKET DEVELOPMENT INITIATIVES.

Initiatives for residents.

Education strategies.

Education is vital to fostering market development between the public and private sectors. The public must be educated to understand the importance of participating in recycling programs and following local requirements regarding contaminants and acceptable materials. Efforts must be made to increase public awareness of recycled products sold at retail outlets. Individuals must understand and assess the “environmental” and “recycled” labels used by manufacturers.

Sectarian campaigns

It might be useful to organise sectarian campaigns for specific groups of producers such as shops in commercial centres, public offices, supermarkets, general stores, hotels, etc. It is also recommended to promote specific recycling campaigns with social sectors that are sensitive to recycling behaviours, such as schools, environmental NGOs, neighbourhood associations, etc.

Green purchasing.

Green purchasing is the process of selecting products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose, in order to focus on purchasing recyclables rather than other materials. It is an opportunity to reduce harm by adding environmental considerations to purchasing decisions along with the traditional factors of price, performance and availability.

Co-operative marketing.

To maintain more reliable markets and to improve bargaining power, communities can form regional marketing co-operatives. Benefits include the ability to amass greater recyclable volumes and economies of scale for processing and program administration, but the challenges include maintaining quality control of recyclables collected by members, adopting an appropriate legal structure and developing equitable means for sharing program costs and revenues.

Governmental initiatives.

Legislative options.

The activities considered by specific governments to encourage market development are a combination of supply-driven and demand-driven initiatives.

Legislative actions conducted to guarantee private-sector processors and manufacturers reliable supplies of quality recyclables will promote market development.

Regulatory initiatives to increase demand for recyclable materials include recycled content mandates (such as a mandate on recycling packages to the producers or distributors of consumable goods), introduction of the polluter-pay principle, environmental standards, recycled product labelling laws and requirements to procure recycled products. One important economic tool to improve the recycling market, is the landfilling tax, to help the economic feasibility of recycling as compared to waste disposal.

Economic incentives.

The advantages given to virgin materials may be altered through economic incentives, such as tax incentives, rebate programs, grants and loans that local and national governments give to improve recycling market economics. This type of economic support should be especially helpful for large and small recycling companies.

Technology development and improvement.

Technology development is encouraging additional demand for different recyclables, it is often orientated to one specific material, and depends on effective public or private partnerships that provide funding opportunities and guarantee supply for recyclables.

Business development.

Most businesses want to know that sufficient demand for their products exists to make their operation financially viable. Encouraging large companies to locate in a region by providing incentives is a traditional approach to recycling market development. Local officials, economic

development staff, and recycling program planners should co-operate to determine optimum local opportunities.

10.7. DESIGNING MATERIAL RECOVERY FACILITIES.

To manage large urban recycling programs, many communities consider implementing Material recovery facilities, which are designed to process large volumes of recyclable material in the most efficient and cost-effective manner. The objective of these facilities is to receive, sort, process, and store recyclable materials efficiently and safely.

Although final product quality is poorer, it is possible to put the waste from a mixed collection system through a sorting process at the beginning of the facility, to separate the organic matter. Another possibility is to operate an MRF at the landfill, transfer station or compost plant.

Site location.

The perfect location of a material recovery facility is a large piece of clear, uncontaminated land in an industrial area close to the source of material production. If the site has been previously used for an industrial process, ensure that no hazardous materials are still on the site.

Area.

The site must be large enough to accommodate the recycling building as well as safe and efficient traffic flow for the different types of vehicles. The developer should also evaluate local and national land use regulations.

Sorting system.

Sorting divides recyclables into different categories, this system can be:

- A bag opener to get rid of the container and make sorting possible. This equipment can be integrated into the trommel, but this is not always as efficient.
- Trommel screens to pass bigger recyclables such as paper and plastics, and to drop out metals, glass and ceramics, which are assumed to be smaller.
- Hand sorting for small appliances, glass, metals, different types of plastics, and various grades of paper.
- Magnetic separators to remove ferrous metal recyclables from commingled recyclables.
- Foucault currents to separate aluminium.
- Air classifiers and ballistic separators to sort light recyclables from heavier materials.
- Optical sorters to sort glass by colour.

Manual sorting is the best way to get high-quality, low-contamination loads of recyclables and experience less downtime. It is the only proven feasible alternative for some special treatments, such as mixed coloured glass, but it can be dirty, dangerous and expensive. Mechanised sorting equipment is becoming available and may provide improved handling efficiency at an acceptable quality. It is a cleaner system than the manual one, and can be cheaper on the long-run. Several aspects affect the selection of one system or another: volume and types of materials, market requirements and economics of purchasing, operating and maintaining the equipment and hiring employees.

Personnel.

The employer should pay special attention to the health and safety conditions in the facility, the equipment and environmental conditions may be dangerous if the personnel are not adequately protected and trained.

Addressing legal siting issues.

Zoning and land use considerations in siting. It is best to use a site already zoned to allow recycling processes; when the elected site needs a land use change, the procedure to obtain the approvals should be started immediately. It might be necessary to show that the recycling facility is not a glorified junk or scrap yard.

Permits. All necessary permits should be obtained before beginning the recycling program operation, such as permits for air and water quality, solid and hazardous waste storage or transportation.

Ordinances. If mandatory recycling is chosen, some programs may require local government enforcement. To ensure that people understand what is required of them, many communities use recycling ordinances. In general, each recycling ordinance should have the following components:

1. Statement of purpose
2. Applicability of the ordinance
3. Items that must be separated
4. Material processing
5. Collection procedure
6. Penalties

If program revenue is important, efforts at discouraging scavenging should probably be undertaken.

10.8. DEVELOPING START-UP APPROACH.

When implementing a recycling program in a community, the way that residents handle waste is expected to change. The first period usually portrays a great response from citizens and large amounts of recyclables are collected. If this is not anticipated, transportation and treatment facility equipment may collapse. To avoid these problems, the developer may require residents to set out recyclables over a number of collection days.

In any case, a careful starting plan should be devised. Using a pilot program can allow the community to try several ideas. Without the pilot program, it may be difficult to make changes in the full-scale one.

Pilot programs.

Recyclables are collected through different methods over a specific period, and the developer is able to evaluate the efficiency of each one. If coupled with an education and publicity program, the pilot program can begin public discussion and understanding of the recycling problem. The structure may be altered to fit the specific needs of the community.

Voluntary recycling.

This can be used to educate people concerning the requirements and benefits of recycling without any coercion. The voluntary program may precede the implementation of a mandatory program, and the shift from one to another will not seem such a large effort.

Mandatory recycling.

There are different ways to implement a mandatory recycling program. In some of them, a resident who has not set recyclables out separately will not have his or her trash picked up. In others, fines for non compliance are imposed. In rural areas, ordinancec require residents to take materials to drop-off centres, for example, at their landfill.

10.9. IMPLEMENTING AN EDUCATION AND FACILITY PROGRAM.

The success of a recycling program will be achieved only if the reasons for participating are understood and accepted by the public. The public and local officials must be regularly reminded of the environmental, economic and social reasons for implementing the recycling system, and to do so, a continuous publicity and promotion plan should be developed.

Although the publicity plan is needed, the crucial aspect in a recycling program is the education plan. If children are adequately and continuously educated, the long-term success of the program will be guaranteed.

10.10. CONTINUING SUPERVISION, LONG-TERM PUBLICITY AND EDUCATION.

Programs should be carefully supervised to maintain citizen and local government support. An operational plan should provide for timely maintenance and replacement of equipment and for continuing publicity. Program expansion, new technology, and variable markets must all be expected and planned for. Both management and operating personnel must be willing to change and improve skills to keep ahead of new developments in the field. Also, changes in the processing technology that will affect the collection program must be communicated to the public. A program to inform local officials about program benefits and costs should be implemented. All program progress should be constantly reviewed and adjustments made when necessary.

10.11. ENVIRONMENTAL IMPACT OF RECYCLING FACILITIES.

Most of the impact associated with recycling is beneficial because this activity removes a significant amount of waste from the environment, extends landfill life and conserves valuable natural resources such as raw materials and open space. Overall, the benefits should greatly outweigh any negative impact. However, any negative impact must be considered and properly mitigated.

The impact will vary depending on the collection system employed and the mix of facilities that comprise the overall recycling program. However, the potential impact from construction and operation of drop-off stations, recycling centres, transfer and storage facilities and yard waste composting centres is expected to be substantially less than the potential impact associated with a materials recovery facility or mixed municipal waste composting facility.

Collection of recyclables.

If separate collection routes are utilised for the collection of recyclables there will be an increase in traffic and in fuel consumption. An increase in noise may occur and the visual impact of additional traffic may become apparent to local residents along the collection routes. This impact can be mitigated through proper route design and utilising appropriate collection vehicles and equipment.

Drop-off stations and facilities for storage and transfer of unprocessed recyclables.

Such facilities are small and the predominant potential effects associated with them are traffic, noise and visual impact. When properly operated, these facilities receive only non-putrescible, source-separated recyclables. As such, odours and vectors should not be a concern. Construction impact should be minimal if proper procedures are practised. In addition, when these facilities are located near existing solid waste or other municipal public works operations, mitigation of potential impact can be incorporated into the operations of the existing facilities.

CASE EXAMPLES.

Bursa recycling project. Turkey.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=107&key=

In regard to environmental responsibility and developing environmental conscious proclaimed by dd. November 2nd 1994 issue of the Official Journal which amended the Regulations about the Control of Solid Waste Materials, Separation Collection of Waste at Source and Recycling Projects have been launched with the incorporation of ÇEVKO Foundation , whose main office is located in Istanbul , and co-ordination of Metropolitan Municipality for Central District Municipalities. The aim of the project is to collect the packaging waste in houses before they are put into garbage . Therefore , natural resources will be protected by recycling these materials and the life of City's Sanitary Landfill will be extended. Owing to above mentioned reasons , economically developed neighbourhoods of city were chosen as pilot areas and the project was launched in these areas.

Amount of the packaging waste had been scrutinised in pilot areas before the project , and it was determined that the amount of such recyclable household waste is 10 % per cent in these areas . Then doorkeepers of the apartments were informed about the project and garbage collection days and methods. Besides , posters about the project were tacked in the entrances of each apartment and brochures were delivered.

Special plastic bags for garbage collection were also delivered and people were told to collect the packaging materials into these bags by separating them from other bins . These recyclable bins are collected by the lorries allotted by district Municipalities on previously determined days and utilised by selling related places . For this project each District Municipality has a lorry.

Experiment for sorting out garbage and recycling in Metropolitan Amman.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=20247

Jordan is a small Arab country with a total population of 5.2 million covering an area of 92,300 square kilometres. Solid waste is one of the critical environmental problems facing urban areas in Jordan. The Al Rusaifa Dump, the biggest dumpsite in the kingdom, occupying an area of 700,000 square metres, serves around 2.25 million people. The dump receives around 2,300 tonnes of garbage daily. The pilot project in waste management was initiated by a group of young men and women under the umbrella of the Jordanian Environment Society. On April 15, 1998 the Recycling Coalition was established as a partnership between the Jordanian Environment Society, the Royal society for protecting nature and the Arab Women's Organisation.

A study was conducted to assess the existing waste collection, sorting, transporting and recycling practices. Greater Amman Municipality held a meeting where a plan of action was adopted to implement the methodology and establish a mechanism to involve citizens, and to define the role of each partner (the Municipal Authority, the Private Sector and the coalition).

Easy-to-handle cloth bags and containers were designed for use by each family. An awareness raising campaign was launched in Amman. As a result of the pilot project, collection time has been reduced while households undertake separating waste at source. The private sector collects and transports the recyclable garbage. More companies were encouraged to compete resulting in more jobs being created and a large number of women being employed in the waste management business.

The initiative has since expanded to cover than 250 neighbourhoods. Full collaboration is achieved between municipal authorities, the coalition and the private sector. UNDP, Canadian funds and the World Environment Utility are also supporting the initiative and providing technical guidance. The experiment has proven to be highly cost-effective.

The pilot project illustrates the complementary roles of government, non-governmental organisations and community members in seeking sustainable solutions to the problems they faced. As a result of the project, investors were encouraged to set up private companies to collect and recycle used materials. This helped create new job opportunities for both men and women in the kingdom and improved their social and economic conditions. Industries have since embarked on utilising environment friendly materials in their production endeavours.

The initiative fully meets the three basic criteria of impact, partnership and sustainability as well as the additional considerations of leadership and community empowerment, gender equality and social inclusion, and innovation within local context and transferability.

Improving the Management of Waste Produced by the Tourism Industry in the Greater Limassol Area
http://www.medcities.org/docs/Limassol%20Tech%20Rev%20.pdf

The Municipality of Limassol has benefited from "Mediterranean Urban Waste Management" (MUWM), a technical cooperation project funded by the Short and Medium-Term Priority Environmental Action Program (SMAP) and jointly implemented by UNDP, Medcities, and the Municipality of Rome. MUWM provided technical support and co-financed a pilot project on waste segregation in one hotel and three restaurants and a public awareness campaign to improve solid waste management in the Greater Limassol Area (260 Km^2 and more than 165,000 inhabitants).

MUWM conducted a pilot project with the Miramare hotel and three restaurants in Yermasoyia, the municipality in the Greater Limassol Area with the largest number of hotels and restaurants. The pilot project had two major goals: show that segregation was easy; and ensure that there were outlays for collected recyclables.

MUWM started by training the staff from the hotel and restaurants on how to segregate waste. Then, for a period of six months, two recycling companies picked up the segregated waste.

The collected material is used as follows: glass, plastic and aluminium is recycled in Cyprus and paper is exported for recycling; cartons and garden waste are used as green coal in the Vasiliko cement factory; and cartridges are segregated and collected separately but there is no possibility for recycling for the moment

In parallel, MUWM conducted a public awareness campaign to stress the importance of good solid waste management to protect the environment and ensure the sustainability of tourism. In particular, the campaign aimed at informing the people involved in the pilot project (staff and clients of hotel and restaurants) and the public (Cypriots and tourists) of the benefits resulting from the proper disposal of refuse, and the minimization of refuse. The campaign produced slogans that were placed for two weeks on large billboards near the hotel and the restaurants participating in the pilot project and various tourist areas in the municipalities of Limassol and Yermasoyia. To maximize media coverage, the campaign issued press releases, organized a press conference, and invited the local and national press (newspapers, radio, and TV stations).

As a result of the project, different remarks and conclusions can be outlined:

- Due to the late start of the project, the period October – December was rather towards the end of the tourist period with low occupancy in the hotel and not a very busy period for the restaurants. This had a positive effect as the staff was not extremely busy and could adapt to the segregation procedure. At the same time, it had negative effect as the expected quantities were not collected.
- The restaurants cooperated with the project but they didn't show the enthusiasm and professionalism shown by Miramare Hotel
- The segregation was done very satisfactorily especially in the Miramare stations
- Positive comments and reactions from local people working in the area and from tourists as well
- This pilot project has considerable potential for replication; lessons learned from this project can be used to improve the tourist waste management system in Cyprus.

French Integrated System for packaging waste (ECOEMBALLAGES / ADELPHE)
http://www.ecoemballages.fr
http://www.adelphe-recyclage.com/
http://www.pro-e.org

The adventure began in 1992 with a target set by the Government to recover 75% of household packaging by the year 2002. The decree of 1 April 1992 stipulates that any person responsible for first placing on the market packaged products used by households must contribute to or provide for the disposal of their used packaging. This decree has been in force since 1 January 1993. Eco-Emballages has developed the French answer prior to the packaging directive adopted on 20 December 1994.

Companies came to an agreement with the authorities to take responsibility for recovering their product packaging. The programme was an ambitious one that could only work with the support of local authorities, consumers, recyclers and ordinary citizens. One main principle was that of sharing responsibility and cost of selective collection.

Eco-Emballages offers the local authorities responsible for household waste management, a pragmatic solution to the question of how to valorise household packaging waste: Eco-Emballages provides financial and technical support to the local authorities which undertake the selective collection and valorisation of household packaging waste. Eco-Emballages provides also a take-back guarantee for all the secondary materials in conformity with the contractual quality standards.

On the same conditions, a second compliance scheme has been set up with the agreement of the French ministries named Adelphe, approved on February 1993, coming from the wine and spirits sector .

36,600 (60 Million people, means fully covered) local authorities participate in selective collection and 11.6 Million tonnes of packaging were collected in 1999 (2.65 Million tonnes for Ecoemballages and 0.25 for Adelphe). In 2000, household packaging recovery and recycling rates were 53% and 40% respectively.

9,600 licensees have now joined Eco-Emballages. The green dot on the packs means that the company contributes to finance the selective collection programmes set up by Eco-Emballages. More than 12,000 licencees have joined Adelphe and are using the green dot as a financial symbol by an agreement of sub-licence from Eco-Emballages. Adelphe is covering 2 Million inhabitants for all materials and 5 Million for the glass in contract with local authorities common to Eco-Emballages and supporting the other four materials.

Thanks to the fee contributions collected from participating licensees, Eco-Emballages and Adelphe help local authorities set up selective waste collection programmes by providing finance for the extra cost incurred by this type of collection and in operating sorting centres (the amount is based on the weight of separated material). Except for the very first pilot-sites, set up by Eco-Emballages, the schemes never invest in selective collection but support the performance of this collection by financing sorted materials.

Since 1993, most packs participating in Eco-Emballages have been paying 1 centime irrespective of the material or weight. From year 2000, the principles of the new fee structure provide for a fee by weight of each material + a fee per pack, taking into account packaging waste prevention which is a priority of European Directive 94/62/EC.

RELATED WEB SITES.

Africa's Recycling Marketplace.
http://africa.recycle.net/

Alameda County Recycling Guide 2002
http://www.stopwaste.org/info.html

Asia's Recycling Marketplace
http://asia.recycle.net/

Community Recycling Network (CRN)
http://www.crn.org.uk/indexjs.html

Europe's Recycling Marketplace.
http://euro.recycle.net/

Global Recycling Network (GRN)
http://www.grn.com/grn/

Packaging Recovery Organisation Europe (Pro- Europe)
http://www.pro-e.org

Recycle Talk
http://www.grn.com/chat/talk.htm

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- EPA Copenhagen with European Commission Environment Directorate-General. **Wasteguide. Framework and strategies for waste management in European cities.** November 1999.
- New York State/Department of Environmental Conservation. **Generic Technology Assessment: Solid Waste Management.** June 1990.

11. ORGANIC MATERIAL RECYCLING AND REUSE.

11.1. COMPOSTING.

What is composting?

Composting involves the aerobic biological decomposition of organic materials to produce a stable humus-like product. To derive the most benefit from this natural, but typically slow, decomposition process, it is necessary to control the environmental conditions during the composting process. This determines the rate of decomposition and the quality of the resulting compost.

On average, over 50 percent of the municipal solid waste stream from Mediterranean developing country cities can be composted.

The benefits and constraints of composting.

- Composting is a component of integrated solid waste management. Source reduction tops the hierarchy of management options. In grasscycling and backyard composting, the materials are completely diverted from the disposal facilities and require no management or transportation, consequently they are forms of source reduction or waste minimisation.
- Because of its organic matter content, compost makes a valuable soil amendment and is used to provide nutrients for plants. It also promotes proper balance between air and water, increases soil water retention and helps reduce soil erosion.
- The benefits of reducing disposal needs through composting may be adequate to justify choosing this option even if the compost can not be marketed easily for agriculture and is used mainly for soil remediation, forestry or landfill covering.
- Composting is flexible, it can be implemented at different levels, from households to large-scale centralised facilities.
- Composting can be implemented with very little capital and operating costs.
- Composting addresses the significant health effects resulting from organic waste, such as Dengue Fever.
- Composting can integrate existing informal sectors involved in the collection, separation and recycling of waste.

Composting is not more wide-spread for a number of reasons. These include:

- Sensible preoccupation by municipal authorities to first concentrate on providing adequate waste collection and final disposal;
- Poor marketing experiences and poor integration with the agricultural community which supposes a degree of risk reagarding the prospects of compost delivery;
- Inadequate attention to the composting process;
- Technical requirements such as pathogen and weed seed suppression, poor feed stock and final compost cleaning which yields poor quality finished compost;

- Lack of support from governmental urban waste policies which do not establish as a priority the economic externalities of composting, such as reduced soil erosion, water contamination, climate change emissions, and land occupation by landfills.

Composting challenges.

Communities face several challenges in developing and operating successful composting programs which include the following:

- Developing markets and new end uses.
- Good design of the composting facility, including prevention of potential environmental impact such as water pollution, odours, rats and flies and ensuring high quality finished compost.
- Training of management and technical staff or securing a sound agreement with a private partner to run the compost facility.
- Adequate financial planning and cost recovery.

Inadequate or nonexistent separation of materials before composting can adversely affect compost quality, and directly impact its marketability.

Which materials can be composted?

All organic matter will eventually decompose; however, some materials are more suitable for composting than others. The raw materials which are most appropriate for composting include:

- vegetable and fruit waste from public food markets or food industries;
- yard waste;
- sawdust;
- bark;
- household or restaurant kitchen waste (uncooked is preferable);
- sewage plant slugs (in a small percentage);
- human excreta and animal manure;
- farm waste;
- and crop residues such as banana skins, corn stalks and husks.

Many of these organic materials are easily found in municipal solid waste generated in the Southern and Eastern Mediterranean. Animal waste, such as carcasses and fish scraps, can be used as well, but they are more likely to attract unwanted vermin and generate a bad odour. Other organic matter such as wood, bones, green coconut shells, paper and leather decompose very slowly and hinder the composting process. Non-compostable materials in the solid waste stream include plastics, glass, ceramics, metals, textiles, and rubber products.

It is important for composting to use previously diverted organic wastes, in order to obtain good quality compost, without heavy metals. If the source materials for the process have not been separated, crushing is not recommended because it may release some hazardous materials.

An overview of composting methods.

Depending on the quality of the organic materials to be composted, there are two different methods:

- Mixed MSW composting. Some composting programs use as a raw material a commingled stream of municipal solid waste. Mixed MSW must be sorted to remove, as much as possible, recyclable, hazardous, and non-compostable materials, from the organic portion to be composted. This separation is

made partially before, and partially, after the composting process. Mixed MSW composting should certainly be considered when there are difficulties in implementing a source separated MSW program, and it can be reliable in several cases, mainly for its lower cost and its easier implementation as it does not need the selective collection of organic waste. However, this system can have some disadvantages, such as a higher potential for contamination from heavy metals in the soil and agriculture products, which can result in a lower-quality compost product.

- Source separated organic composting programmes. They rely on residents, businesses, and public and private institutions to separate one or more types of organic materials and set them out separately from other recyclables and trash for collection. Source separation of organics offers several advantages, for example, it requires less handling time, tipping space and preprocessing equipment than mixed MSW composting. This can result in a higher-quality compost product (without heavy metals), provide an educational benefit to residents and might encourage waste reduction. On the other hand, it might be less convenient to residents and might require new equipment or containers.

Three methods of composting, ordered according to the required management level of organisation from low to high, might be worth considering:

Residential Composting.

Household composting can be a simple way to manage kitchen and garden wastes. This type of composting effectively reduces waste quantities for collection, thereby improving efficiency and reducing operating costs. Residential composting should be promoted when a significant number of homes have individual or collective yards or gardens and there is sufficient space (UNEP, 1996).

Composting units can be made out of locally available materials such as wood, bamboo, clay bricks, wire mesh, etc. The design and operation of the composters should not attract rodents, insects, or other scavenging animals. Making sure that no large quantities of meat, fish and fatty foods are kept in the composter is the best way to keep pests away from the unit.

Public health officials may discourage household composting because of perceived health risks; however, local governments can overcome this concern through public awareness programs, providing subsidies for basic composting units, and promoting education on compost processes, e.g., how to minimise the presence of rodents and flies.

Decentralised Community Composting.

Decentralised composting at a neighbourhood or community scale provides small groups with a way to compost at a relatively low cost. Households, commercial establishments (e.g., small markets or shops), and institutions (e.g., government buildings, schools) in an area generating between 5 and 50 tonnes of organic waste per day can compost on vacant land, beside community gardens, or in public parks. Local governments can support the proj-

the project through public education, providing land for the facility, assisting with start-up costs, transporting and disposing of rejects to local landfills, and using the final compost in public parks. To ensure that the composting operation is environmentally and socially acceptable, UNEP (1996) recommends that the site must be:

- accessible to all individuals who want to use it,
- clearly designated with signs which all users and non-users can understand,
- be approved by all surrounding land users,
- have adequate controls to prevent it from becoming an area for local dumping, and
- have the appropriate soil and drainage facilities to accommodate the leachate.

Centralised large-scale Composting.

Centralised composting can range from 10 tonnes per day to more than 500 tonnes per day. Since centralised composting is on a significantly larger scale, environmental, social and technical considerations should be approached in a more formal manner and address the following requirements (UNEP, 1996):

- Technical assessment of the area, soil, and geographic characteristics of potential sites.
- Inclusion of engineering and design professionals in site selection and facility design.
- Environmental assessment of the site.
- Formal evaluation and site selection processes that involve all relevant stakeholders.
- Management of the facility by a private company or a public agency (local or national) with management autonomy and resources.
- Program to minimise and/or compensate for the annoying effects of traffic, odour, leachate, and noise produced by the composting operations.
- Separate collection and/or preprocessing systems to ensure that unwanted materials do not enter the composting system,paying special attention to the informal sector in pre-processing the waste and recovery of non-compostable materials.
- Establishment of a marketing strategy for the compost.
- Enforceable protocols for the quality and composition of the compostable materials delivered to the facility.
- Formal agreements made between all municipalities within the jurisdiction for siting, design, financing, operations, maintenance, environmental compliance, billing for services, and waste delivery routes for the delivery of organic materials to the facility.

Developing a composting program.

Evaluating Waste Management alternatives.

Communities faced with the task of selecting any solid waste management alternative should consider both monetary and environmental factors in evaluating the various alternatives available to them. According to the principles of integrated waste management, no single solid waste management option can solve all of a community's waste problems.

Selecting the best solid waste management option should be based on the goals and evaluation criteria that the community adopts early in the planning process.

Lack of co-ordination between composting facilities and solid waste management authorities, inadequate financial resources, absence of technical guidance, and poor marketing plans are common problems experienced by composting operations in many Mediterranean developing countries. Technical problems and poor management invariably lead to higher production costs and ultimately financial losses.

Planning the program.

If a community decides that composting is a viable and desirable alternative, there are several steps for developing a successful composting program:

- Identify the goals of the composting project. Goals must be clearly identified during the earliest planning stages of the project and must be determined based on the community's short- and long-term solid waste management needs. The project may have multiple objectives:

    - Achieving waste reduction goals by increasing the amount of materials recycled.
    - Diverting specific materials.
    - Using compost as a replacement for daily cover in a landfill.
    - Using compost for erosion control.

Clearly defined goals help focus activities and resources.

1. Identify the scope of the project (backyard, source-separate, combination...).

2. Gather political support for changing the community's waste management approach. To gain political support, it is crucial to inform elected officials and government agencies of the project's goals and the developer's plans for the implementation. It is also important to solicit input during the early stages of project development from government officials and agencies, especially those responsible for solid waste management. To elicit support, it may be helpful to arrange for decision makers to visit successful composting facilities.

3. Identify relevant facts and environmental factors.

4. Identify potential compost uses and markets. A useful purpose must be found for the materials recovered from the composting process. Marketing compost is discussed in detail in the Marketing section of this chapter.

5. Initiate public information programs. The education program should provide objective, factual information about the composting process and potential problems that may be associated with composting facilities. Often, residents equate a composting facility with a waste disposal facility, providing information about the nature of composting may help dispel such opposition.

6. Inventory materials available for composting. The planning process should include an accurate assessment of the quantities of materials available for processing and their composition and sources. Such data can help determine the size and type of equipment the planned facility will need and also the facility's space requirements.

7. Composition data should be obtained for each source separately. Data should be collected for at least one year, so as to represent seasonal fluctuations in composition. This will help identify the need for any modifications to the collection system, such as the implementation of a household hazardous collection program.

8. When planning a program or facility, it is also crucial to consider the major long-term trends and changes in management strategies, regulations and programs already underway.

9. Visit successful compost programs.

10. Evaluate alternative composting and associated collection techniques. The selected composting approach should be compatible with the existing programs for the other three parts of the system: collection, treatment and disposal.

11. Analyse the financial needs and possibilities of the alternatives, including the cost recovery of the capital and running costs, in order to determine the most adequate financing system.

12. Once a specific approach has been selected, program developers must decide wether the facility is to be completely built and operated by a private contractor or a public agency. An extensive study into the pros and cons of each option should be made before the council makes a decision.

13. Develop the Terms of Reference for the tendering and contracting (private management) or for the contract programme with the Public Agency.

14. Launch a call for proposals and select and contract the most convenient private company or create and/or develop a contract programme with the public management agency.

The composting process.

Aspects of the composting process.

- Biological aspects. Micro-organisms that decompose the organic materials are the key to the composting process. They convert organic carbon to by-products like carbon dioxide and a humic end product (compost). This carbon is used to form new microbial cells, as well. Heat is released during the decomposition. If the biological, chemical and physical conditions of the microbial population are maintained at optimum levels through all stages, they will achieve maximum production, and composting will occur rapidly.

- Chemical aspects. An adequate chemical environment is essential to achieve the appropriate composting results, and it is determined by these factors:
    - Carbon/energy source. The amount of carbon present in the organic materials is not typically a limiting factor in the composting process, because most of the waste used in this process contains adequate quantities of biodegradable compounds.
    - Nutrients. An initial ratio of 30:1 carbon:nitrogen is considered ideal, higher ratios hinder the process, while ratios below 25:1 may result in odour problems.
    - Moisture. A moisture content of 50 to 60 percent of total weight is considered ideal; less water may slow down the process, and an excessive quantity can create liquid management and odour problems. The amount of moisture can be controlled by irrigation systems or an adequate design for the piles.
    - Oxygen. The compost pile should have enough void space to allow free air movement. A 10 to 15 percent oxygen concentration is considered adequate. Too much air can dissipate heat and cool the pile, promote water evaporation and increase production costs.
    - pH. A neutral rate, between 6 and 8 is considered optimum. The pH affects the amount of nutrients available, the solubility of heavy metals and the metabolic activity of the micro-organisms.
- Physical aspects.
    - Particle size. The optimum particle size of the material has enough surface area for rapid microbial activity, but also enough void space to allow air to circulate for microbial respiration.
    - Temperature. The optimum temperature range in between micro-organisms is 32 to 60ºC. Pathogen destruction is achieved when compost is at a temperature greater than 55ºC for at least three days in an in-vessel composting system. For a windrow system, this time period reaches at least 15 days, during which time the windrows must be turned a minimum of five times.
    - Mixing. Mixing and agitation distribute moisture and air evenly and promote the breakdown of compost clumps.

<u>Composting technologies. System descriptions.</u>

- Windrow systems.

A windrow is a pile, triangular in cross section, whose length exceeds its width and height. For most materials, the ideal height is between 1,5 and 2,5 meters with a width of 4 to 5 meters. Machines equipped with augers, paddles or tines are used for turning and oxygenating the piles, some of them have an incorporated irrigation system. The control of the composting conditions is done by the frequency of turning, the irrigation and/or nitrogen adding. Any leachate or runoff created because of the precipitation when placing the piles out-of-doors must be collected and treated or added to a batch of incoming feedstock. To avoid this prob-

lem, piles can be created under a roof, but that increases the cost of the operation.

The porosity of the raw material affects the air flow within the windrow. Dense materials, such as manure, require smaller windrows to minimise anaerobic zones, whereas more porous and lighter materials, such as leaves, can be built into larger windrows. A balance needs to be achieved between proper aeration and temperature requirements since small windrows tend to dissipate heat quickly and may not reach adequate temperatures to kill pathogens and weed seeds.

- Aerated static pile composting.

In this system the piles are placed over a network of pipes connected to a blower, which supplies the air for composting. The air can be either forced into the pile or drawn out of it. This system has been successful with MSW, yard trimmings and industrial composting.

Aerated static pile composting can be done under a roof or in the open. It requires less land than the windrow system, but has the inconvenience of the air blowing costs.

- In-vessel composting.

In-vessel composting systems enclose the feedstock in a chamber or vessel that provides adequate mixing, aeration and moisture, providing the perfect environmental conditions for the process. Obviously this excellent control in composting is quite more expensive than the first two ones.

- Co–composting.

This system consists of the simultaneous composting of two or more diverse waste streams, typically MSW and sewage sludge mixed with chipped yard wastes. This combination is best handled in an enclosed system because of the odour and the leachate collection problems. Co-composting requires more specific conditions than other alternatives, and subsequently very careful design and management.

- Backyard composting.

The householder attempting to compost must have adequate outdoor space for the bin or pile. Grass clippings, leaves, tree trimmings and some kitchen wastes are a very valuable product for mulching and mixing with soil.

Design Precautions.

Precautions to mitigate environmental and public health effects can be implemented in the design and siting phases of the composting project. The following criteria can be applied to Mediterranean developing countries:

- locate away from wetlands or flood plains.
- meet quality standards, such as using waste sources low in toxic compounds and heavy metals, and not extremely saline.
- avoid densely populated neighbourhoods and areas where adjacent land users may find the operations inappropriate, such as hospitals, religious facilities, schools.
- locate in accordance with urban plans and zoning regulations.

- avoid locating on top of sites which have waste beneath them, or where toxic waste has been previously disposed of.
- choose sites with buffer zones separating the facility from the surroundings, such as hills, trees, fences.
- distance from the surface of the facility to groundwater/clay layers/bedrock should be a minimum of 1 to 1.5 meters.
- avoid impermeable or overly permeable soils.
- locate downwind from residential areas to avoid possible odour complaints.

Facility Operation Precautions

There are several ways to reduce worker exposure and minimise health hazards from the composting process. Education is one of the best ways to prevent problems, workers and facility managers should receive ongoing training and education about health and safety issues. Children, the elderly, pregnant women, and immunosuppressed individuals should not work in composting facilities since they are the most susceptible to infection by pathogenic diseases. The compostable materials should also be source separated to eliminate hazardous waste, metals, and glass which can cause worker injury. Additional precautions to be implemented in all composting facilities are the following:

- workers should be encouraged to maintain high standards of personal hygiene.
- during hot, dry weather the composting area should be periodically sprinkled with water to reduce dust.
- workers should protect themselves by wearing gloves, masks and boots during processes such as sieving or turning, when the spores can be dispersed.
- during adverse weather conditions, workers should be encouraged to wear masks, respirators or some other material to cover the mouth and nose in order to avoid dust inhalation.

Composting health & safety.

Pathogens, toxic chemicals, dust and heavy metals are the main health and safety concerns for both waste workers and the general public. Compost workers tend to be more exposed since they directly handle the waste for an extended period of time. Health risks are influenced by the composting technology itself and the raw organic materials used as feed stock.

Most compostable wastes contain low levels of toxic organics. MSW may have higher levels due to disposal of household hazardous waste, pesticides, and other chemicals.

Once again, household source separation of the waste before it is brought to the composting facility is recommended to reduce worker injury and compost contamination.

Human excreta and animal manure contain pathogens which are found in MSW from the disposal of sludge, diapers, and yard trimmings containing domestic animal waste. Table D2 shows that MSW can contain the same or even higher orders of magnitude of indicator pathogenic organisms as sludge and hospital waste. Open dumping of municipal waste in urban areas attracts rats, flies, and other insects which can transmit these pathogens to humans.

Avoiding heavy metals.

Heavy metals, such as cadmium, lead, and mercury, are found in MSW because of discarded objects like batteries, lighting fixtures, paints, and inks. Heavy metals in compost pose very little health threats to workers. However, a public health hazard exists when poor quality compost is used for agricultural purposes because heavy metals can accumulate in the soil and enter the food chain through plant uptake. Source separation of municipal waste into compostable and non-compostable fractions is an effective way of reducing compost heavy metal concentrations.

Establishing and enforcing heavy metal standards is an effective way to ensure appropriate compost use. Most industrialised countries that consider composting to be part of an integrated solid waste management plan have developed regulations and guidelines concerned with its ultimate use. It should be realised that these regulations and guidelines were established after several years of research and that the application of different scientific approaches results in a wide range of standards among industrialised countries.

Composting technologies. Technology evaluation.

- Applicability.

Mixed municipal solid waste. This waste stream will typically require processing before composting; furthermore, household hazardous waste must be removed prior to processing. This compost will contain types of residue that must be properly disposed of.

Yard waste. Leaves and yard waste are generated seasonally, so the collection should take place during certain periods of the year. They are usually composted by the windrow method.
Sewage sludge. Sludge is typically composted by either the aerated static pile or in-vessel composting methods. Good quality sludge and proper operational control are essential to the success of a sludge composting program.

- Reliability / Experience.

Mixed municipal solid waste. There are several factors to consider before adopting the alternative of municipal waste composting:

- Composting product is sensitive to the incoming waste, and must be effectively marketed.
- Compost must be monitored carefully to ensure that it meets regulatory requirements.
- Excessive amounts of refuse treated affect the sizing and type of facility components.
- A municipal solid waste composting system does not eliminate the need for a sanitary landfill.

Yard waste. It is relatively easy to compost and can be effective, it is also a good way for the community to begin composting and significantly decrease the waste stream destined for the landfill.

Sewage sludge. Sludge composting is a proven technology. Its main problems are: marketing the sludge compost, less of a problem now than it used to be, and effective odour control.

- System costs.

Composting rarely generates profits on its own. However, when viewed as a component of an integrated solid waste management program, composting can provide economic benefits on a much larger scale. The cost of composting includes raw materials, production, marketing, and hidden environmental costs; whereas the benefits include the market value of the compost, savings from avoided waste disposal costs, as well as various positive environmental effects.

Plants typically consist of a few buildings, mobile machinery, and the composting area covered by a roof or uncovered and having some kind of pavement. The cost of the compost plant is typically affected by:

- Cost of land acquisition
- The requirements for land per unit of capacity (which are determined by the retention and maturation times, and linked to end product quality). Vertical units also reduce land requirements.
- Scale.
- Plant utilisation rate.
- The choice of technology, especially the degree (and technological sophistication) of the process control. This may be linked to the input materials and location.
- The purity of source separation (which will determine the need for screening)
- The nature and length of contracts and the materials received.
- Revenues for sale of product, related to the quality of input material and the maturity of the end product.

Marketing compost.

A well planned marketing approach ensures that all the compost is distributed. Accomplishing this goal, however, requires consistent production of high quality compost in order to satisfy the needs of most markets.

Marketing strategies.

The quality and the composition required for a compost product must meet the needs of the specific market.

Marketing efforts should be continuous: before, during and after the composting process. Two major objectives should guide marketing plans: selling or distributing all of the compost that is produced, and optimising revenues and minimising costs. Market developers should also be aware of potential large-scale users of compost and consider targeting those users in their areas or regions. Compost should be viewed as a usable product, not a form of waste requiring disposal.

Education, research and public relations.

It is crucial that the marketers thoroughly understand the compost's advantages and limitations, based on which, the value of the product should be a focus of the marketing strategy. Marketers could design an education program in order to convince potential customers that there is a compost product that meets their specific needs.

Potential compost uses.

Knowing the many potential uses of a compost is necessary in order to be able to target appropriate markets, but marketers should also consider the practical limitations of some applications. The following potential uses can be distinguished:

- To improve water drainage.
- To increase water holding capacity.
- To improve nutrient holding capacity.
- To act as a pH buffering agent.
- To help regulate temperature.
- To aid in erosion control.
- To improve air circulation by increasing the void space.
- To improve the soil's organic matter content.
- To aid in disease suppression.
- To slowly release nutrients into the soil.
- To reduce bulk density.
- To increase cation exchange capacity for sandy soils.

Compost quality – impact on uses and markets.

The quality of a particular compost product and the consistency with which that quality is maintained directly impact the product's marketability. Many markets should also look at the uniformity of the product from batch to batch and of the raw materials, e.g. the percentages of plastic and glass. Concentrations of hazardous materials such as heavy metals and PCB's can make marketing the compost very difficult.

The high organic content in the MSW stream of Mediterranean developing countries is ideal for composting. However, the municipal waste stream also contains increasing quantities of glass, plastics, metals and hazardous materials which can contaminate the finished compost. Separating contaminants from the raw material at the compost site is inefficient since it requires additional effort, space, and time, and it is likely that much of the contamination has already affected the organic fraction.

To increase the quality of the compost, and with that its marketability, composting facility operators should selectively accept feedstock materials. Compost quality is also affected by the ageing process and storage conditions. Source separating the waste before collection is usually an environmentally and technically preferable way to improve the quality of the final compost.

In addition to ensuring a safe product, compost standards provide a valuable marketing tool. The consumer can be satisfied with the knowledge that the product quality is consistent and suitable for the desired application. This is important for commercial and agricultural operations where a relationship exists between predictable results and repeated sales. The supply of compost must also be reliable since inability to meet market commitments affects customer relations and reflects poorly upon the credibility of the program.

Manufacturing multiple products.

A successful marketing strategy should include the ability to offer more than one grade or product. This should increase revenues, alleviate some of the peak demand periods, improve distribution and require less storage capacity.

Inventorying potential markets.

Marketers should determine if there are potential users who could benefit from their product, specially those who have not considered using compost in the past. The objective is to develop target markets and focus on them.

Pricing.

The goal of marketing should be to sell all the compost that has been produced. The price of the compost should facilitate this goal. Revenues alone should not be expected to offset the cost of producing the compost, but prices should be set to offset as much of the production costs as possible. Price the product modestly at first, then increase the price based on demand. Large volume buyers should get a significant discount. Transportation costs must be carefully assessed while the facility is being planned, and the distance between potential markets and the production centre should be minimised.

Finalising marketing arrangements.

A technical evaluation conducted during the planning stages should provide quantity and quality data, which can be used to finalise marketing arrangements. Contracts between compost facility operators and product buyers will state product specifications and other arrangements such as delivery or payment. The arrangement must at least specify the minimum quantity and how the compost will be used.

Operational considerations and concerns.

- Housekeeping. The appearance of the compost facility should be appealing from the outside. Indoors, the floors and equipment should be cleaned periodically and maintained free of dust and mud.

- Leachate. Poor water management management at a compost site can lead to water pollution and odour problems. It may be transported and treated at a wastewater treatment plant or mixed with the incoming material. It should not be returned to material that has been through the pathogen destruction stage. Attempts must be made to minimise leachate production by diverting any surface water runoff from the up-slope side of the piles.

- Odour and dust control. Processed air should be routed through filters, deodorisers or scrubbers before it is returned to the atmosphere. The degree of odour control needed depends in part on the facility's proximity to residences, businesses, schools, etc. The use of biofilters in composting to treat odorous compounds and potential air pollutants is a widening trend.
- Monitoring. At a minimum, the following should be monitored: compost mass temperatures, oxygen concentrations in the compost mass, moisture content, particle size, maturity of the compost, pH, soluble salts, ammonia, organic and volatile materials content.

- Record keeping. Good record keeping can result in better decision making in the long run. Records are the basis for quality control, safety, and minimising down time in any operation.

- Public information. Objective, factual information should be continuously distributed to the public. The community needs to be periodically reminded that composting is an effective management tool and that having such a facility is evidence that the community is progressive and environmentally conscious.

- Complaint response. The most common complaint is about odours. These complaints are normally made by those most exposed, and should be promptly responded to, following an adequate response procedure.

Facility sitting.

It is best to avoid sites that may be located close to populated or potentially populated areas of a community. If the compost facility is constructed in an existing landfill, the transportation cost for the non-compostable and non-recyclable wastes would be minimised. If composting biosolids is a project objective, locating the facility at the wastewater treatment plan should be considered. Other considerations for siting a composting facility include the following:

- Potential for release of contaminants to surface and ground waters
- Potential for airborne dissemination of contaminants.
- Distance from where feedstock materials are generated to the compost facility.
- Distance from compost markets and landfills.
- Traffic patterns/roads to and from the facility.
- Buffer zones for visual/noise screening and odour dilution.
- Appropriate soil types and geotechnical conditions.
- Drainage patterns.
- Flood hazard.
- Past ownership and usage.
- Zoning limitations.
- Room for future expansion of the facility.
- Anticipated growth and development near the facility.

Environmental issues.

Composting is one of the simplest ways to prevent emissions of methane because the organic fraction of the waste stream is diverted from the landfill. While composting does release carbon dioxide, it is currently considered to be a neutral process when the removal of carbon dioxide from the atmosphere by photosynthesis to produce organic matter is taken into consideration.

The major environmental concerns associated with composting facilities are vectors, odours, noise and surface/groundwater impact. Odours are produced when conditions inside the compost pile become anaerobic through a lack of oxygen, but a well operated composting facility should produce minimal objectionable odours. Vectors can be controlled by operations that minimise waste storage and promote rapid aerobic decomposition. Selection of a suitable site at an ample distance from nearby residents, commercial areas and other areas likely to be affected, would also mitigate effects associated with odours and noise. In addition, topography and soil characteristics should be selected to

istics should be selected to avoid creating stagnant pools of water to minimise surface water run-off onto adjacent properties and to avoid leachate problems.

The refuse delivery and pre-processing aspects of a refuse composting facility would generate similar impacts to those associated with a materials recovering facility, such as traffic, noise, litter and visual impact. Furthermore, if the composting process is from mixed MSW, odours and explosions can be a significant problem.

11.2. BIOMETHANISATION.

What is biomethanisation?

Biomethanisation is a biological process in which organic matter is decomposed by anaerobic organisms (organisms that grow in the absence of air), producing methane gas as a major by-product. The three basic steps of the process are:

- Pre-processing: organic material is separated from the waste stream, shredded and mixed into a slurry.
- Decomposition: the slurry is placed in anaerobic digesters for a 5 to 30 day period for generation of methane gas.
- Treatment: methane gas is refined to meet market specifications

Which organic materials can be methanised?

In general, any organic matter can be methanised.

It is essential that toxic substances are minimised in feedstock, and certain materials should never be fed to digesters because they will arrest or kill the process These include:

- Toxic materials that inhibit digestion
- Bioagents
- Disinfectants

Long straw and non-biodegradable materials should be avoided as they can cause blockages in the system. So it is highly recommended to use only organic waste as raw material for biomethanisation, and not mixed urban waste. The sorting of the organic matter inside the facility is always incomplete and the risk of mechanical blockage is high.

Biomethanization and energy. Production and utilisation of gas.

Putrescible material mechanically sorted has been shown to produce 130 to 160 cubic metres of biogas per tonne of waste.

The more complex two-stage process of digestion converts more organic material to biogas (around 65-70% of dry weight) than single stage processes (around 45% of dry weight) giving typical production rates of 115 and 75 cubic metres of biogas respectively. If it is assumed that 100m3 of biogas are produced per tonne of input to the digester, with a methane content of 55%, this will give a gross energy potential of 2076MJ of thermal energy per tonne digested. If this is burned in a gas engine to produce electricity with an efficiency of around 30%, this will give a gross electricity production of 173kW-h per tonne digested.

Considerations when establishing a biomethanization program.

Any decision to establish a biomethanisation facility will be based on an assessment by the farmer or developer of the marginal increased costs (if any) as compared to the additional benefits and opportunities created. Biomethanisation will generally be a more expensive capital option than alternative waste management solutions. If the developer cannot show a surplus from this process, a stand-alone plant would not be appropriate and he may then consider other options (co-operate in other biomethanisation facilities or other waste management alternatives).

11.3. COMPOSTING OR BIOMETHANISATION?

When selecting one treatment or another, the advantages and disadvantages of each one should be considered:

- The production of carbon dioxide in both processes is equivalent to the natural cycle.
- Potential vector problems in the composting process (seagulls, rats, flies).
- Biomethanisation and its energy recovery may substitute carbon fossil fuel energy.
- In both processes, deodorization is required; however, a smaller quantity of air has to be treated in biomethanisation.
- Composting requires the treatment of a smaller volume of water.
- The economic needs of biomethanisation are higher than those of composting.
- There is quite a lot more experience in composting technology.
- Biomethanisation facilities are more compacted and require less area.
- A market for compost products must be developed and maintained, as well as for the liquid fertiliser resulting from biomethanisation, unless the liquid has a very low nutrient content and can therefore be discharged in the public sewer system.
- Composting eliminates weeds and pathogens in waste materials.

CASE EXAMPLES.

150 tons per day Compost Plant, Mansoura, Egypt
http://www.seamegypt.com/CaseStudies/SW_Compost.PDF

A 150 ton per day (45,000 tons per annum) municipal solid waste composting plant has been constructed at Mansoura to treat waste from the city and surrounding environs. The Support for Environmental Assessment and Management (SEAM) Project is a major environmental programme implemented by the Egyptian Environmental Affairs Agency, Entec UK Ltd and ERM with support from the UK Department for International Development. SEAM and the Governorate of Dakahleya jointly financed the plant, designed by SEAM. Total cost for plant, equipment and construction was LE 2.4 million. The quality of the compost is good and is presently sold as a conditioner for land reclamation schemes. The plant is now operated by a private contractor, under a management contract with the Dakahleya Governorate.

Waste generation in the urban areas of Mansoura and adjoining Talkha is estimated to be 305 tons per day. Typically, the organic content of urban waste is 60-70% and for rural waste, 50%. All waste had been previously disposed of at the municipal dumpsite.
Since Dakahleya is mostly prime agricultural land, the availability of sites suitable for landfilling is severely limited. This problem can be partially addressed through composting, which will reduce the amount of material to be landfilled by 40%. In addition the demand for compost in Egypt has been rising.

The purpose of constructing this plant was not only to take advantage of the economic benefits but also to demonstrate:

- Low cost technology
- Commercial viability through the introduction of a Gate Fee of LE 5 per ton, which may in turn encourage the private sector to enter the market.

The recovered organic content of the waste was estimated at 70% of the organic component.

Household source separation. Egypt.
http://www.scri.salford.ac.uk/bf2002/pdf/El-Hawi.pdf

Efforts are underway to convince Cairo residents of the benefits of separating their wastes into organic and non-organic fractions. In an experimental project, 600 households are separating their residential wastes into two streams before collection. The health and efficiency of the waste collectors and the quality of the compost are being monitored. The collectors and processors realise numerous benefits from source separation: reduced incidence of worker injuries and waste related diseases, higher selling price of cleaner recyclable materials, less time required to sort the incoming waste materials, and improved compost quality. Municipal waste management authorities also benefit from household source separation because less waste has to be collected resulting in lower transportation and disposal costs (Lardinois and van der Klundert, 1993).

Community composting. Brazil.
http://www.scri.salford.ac.uk/bf2002/pdf/El-Hawi.pdf

In Olinda, two neighbourhoods have set up composting units on plots of land of about 250 m^2. Incoming waste is dumped into a shallow, lined pit and lifted onto a sloped sorting table where rejects and recyclable materials are removed. A team of six individuals can sort one trailer load of waste, weighing approximately 600 kg, in about 45 minutes. The remaining organic matter is weighed and formed into windrows. The composting process is controlled by measuring the temperature on a daily basis and the windrows are turned when the temperature drops or when it rises above 65°C. Pieces of plastic and other reject material that were missed during pre-sorting are removed when the windrows are turned.

Stabilised compost is sieved before it is transferred to stockpiles for future use. Regular supervision of the composting process is necessary to ensure proper control (Lardinois and van der Klundert, 1993).

Sanitary Composting. Sri Lanka.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=17820&key=

The purpose/aim of this initiative was the development and demonstration of an improved composting method for typical mixed urban solid waste in Sri Lanka, enabling efficient production of high quality, marketable compost at any scale, while not entailing excessive expenditure on high-cost technologies such as large silos using forced aeration, rotating drums and sophisticated sorting equipment; and involving neither unhygienic manual sorting before composting nor manual windrowing.

It had to be a method which would minimise land extent needed, negate odour problems, facilitate use of sites within local authority areas as much as possible so as to avoid the NIMBY attitude widely prevalent in the country and involve private sector participation.

Following construction and testing of a small engineering model, the University of Peradeniya developed a "Sanitary Composting" process using an inclined step-grate aerobic digester involving thermophilic composting (no forced aeration) and back-end sorting, with bag-ripping and very minimal sorting before composting. The pilot vessel at the university farm was designed and constructed for a capacity of 4 metric tons per day, compost being obtained after 25-30 days.

Under the second stage of the project, research continues while pilot units are being constructed in 4 different localities in Sri Lanka. The unit in Kalutara (wet zone coast) is nearing completion, while work is well under way in Mawanella (hills) and Dambulla (dry-zone plains). The Kataragama (semi-arid zone plains) site development has started.

Biotechnical use of the fraction organic of urban residuals in San Luis. Argentina.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=4881

Part one. This project aims at satisfying a growing demand: to solve the problem of the final disposition of the urban solid waste, by means of the recycling of the inerts that have some value in the market, and the transformation of the biodegradable organic matter into ORGANIC BIOLOGICAL FERTILIZER, thus eliminating the complex problem of environmental pollution and allowing the clean inert materials to be recycled.
The main purpose is to solve the final disposition of the urban solid garbage in San Luis' Municipality , Argentina and the surrounding areas.

Part two. This project complements the previous project called "Biotechnical use of the Organic Fraction of Urban Residuals" using the same theoretical support described in 1998 (Dubai prize 98). This new experience was developed at the Municipality of Las Heras, district of Las Heras, Mendoza, Argentine, according to an agreement between this Municipality and our science group, and the financial support of Sobius S.A., a private company interested in finding a real solution for the final disposal of urban solid waste and to whom the Fundación Luis transferred its rights as associate. The Government of Mendoza declared our pilot plant an initiative of "environmental interest". At this new stage, we designed a project that increased the scale of the first pilot plant by 45 times in order to process the equivalent of the treatment required for the biodegradable organic fraction of one day in a city of 180,000 inhabitants.

Moreover, this initiative allowed us to schedule experiences for the design of different kinds of treatment for various kinds of agricultural waste and, mainly, for pathological waste, whose results were highly promising. The experience had also as a purpose to evaluate the mechanisation of some steps and the contribution of human resources, basically during the selection and separation of materials received from the rubbish collection. We worked together with workers that enthusiastically co-operated in the process because they were naturally specialised, although they live in extreme poverty, since they foresaw the chance to have a more dignified job and purpose for their lives.

RELATED WEB SITES.

AD – NETT (Anaerobic Digestion Network)
http://www.ad-nett.org/

Alameda County Recycling Guide 2002

http://www.stopwaste.org/info.html

Anaerobic Digestion
http://www.ciwmb.ca.gov/Organics/Conversion/Anaerobic/

Biogas Forum.
http://www.biogas.ch

Composting list.
http://www.jiscmail.ac.uk/lists/composting.html

ORBIT Association
http://www.orbit-online.net/

The Composting Association
http://www.compost.org.uk/dsp_home.cfm

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12. WASTE-TO-ENERGY.

The main waste-to-energy form of treatment is incineration, which will be discussed in detail in this chapter. Other waste-to-energy treatment methods (Refuse derived fuel systems, Gasification, Pyrolysis) will be briefly introduced.

Incineration is a treatment technology involving destruction of waste by controlled burning at high temperatures. It is accompanied by the release of heat. This heat from combustion can be converted into energy (steam or electricity).

Incineration is a high-quality treatment for MSW, very useful in big or crowded cities, because it reduces the quantity and volume of waste to be landfilled, it can be localised in an urbanised zone, and offers the opportunity of recovering energy. However, it should be taken into account that the economic investment needed is high.

The environmental conditions of the incineration process must be very precise to make it environmentally safe. The larger portion of the investment required is due to environmental measures such as emissions control.

When choosing incineration as an alternative, the following issues should be considered: volume/quantity of waste produced, heat of combustion of waste, site location, dimensions of the facility, operation and maintenance costs and investment.

12.1. PROJECT DEFINITION: IDENTIFYING GOALS.

When defining the goals early on, managers can plan the project and avoid unnecessary complexities in the process.

Goals may include waste diversion from landfills, energy production for central heating or electricity, and reduction of transport requirements of collected waste.

12.2. ENERGY AND MATERIAL MARKETS.

Incineration has high capital and operating costs; consequently, most facilities need to produce significant income from energy sales to be economically acceptable for an urban waste service that has a politically limited tax level. The sale of recyclable materials before combustion and of the waste after combustion are not a substantial source of additional revenue for an incineration project.

Energy market options.

The kind of energy produced depends directly on the needs of the buyer, and there are three different forms:

(a) Electricity only. This is the most common form of energy produced in facilities constructed today. The process is relatively simple: directing the incineration steam through a turbine generator.
(b) Steam. Producing and selling steam requires the existence of available industrial customers, and matching the supply with their needs. It is also possible to use steam at institutional or ob-

mestic complexes, but the principal disadvantage of this option is that heating needs in the Mediterranean are normally very low and for a very short period of the year.

(c) Refuse derived fuel. RDF is the product of processing municipal solid waste to separate the non-combustible from the combustible portion, and preparing the combustible portion into a form that can effectively be sold for use as fuel. The quality of the RDF will determine the target market, as it can be used pure or as a supplemental fuel in existing coal-fired boilers.

Energy contract issues.

The buyers must be assured that using waste-produced energy is equal to or better than using energy from other sources (coal, oil, gas, etc.). The factors that the developer should consider to achieve this objective are three: price, service and reliability.

- Price. It must be very competitive, usually cheaper than the customer's current energy costs.
- Service. The form of energy that the facility is selling must be available when the customer needs it. The price varies according to the type of service - daily and seasonal fluctuations must be estimated and taken into account when preparing the agreement.
- Reliability. The customer must be assured that the facility can meet its commitments, especially for uninterrupted service.

Material markets.

In some cases, more than one market may be available for the combustion waste produced by the facility, mainly as raw material for road construction. This avoids the cost of hauling and disposing them but can provide only small additions to plant revenue.

12.3. THE COMBUSTION PROCESS AND TECHNOLOGIES

- **Modular combustion.** Modular combustion systems are usually factory assembled units consisting of a refractory-lined furnace and a waste heat boiler. This type of system can be more cost-effective for smaller–sized facilities, but the relative energy production will likely be lower than alternative combustion technologies. It is the most flexible option, but pollution control equipment must always be considered, in addition to facility size.

- **Mass burning systems.** It typically consists of a reciprocating grate or a fluidised-bed furnace, a special steam generator, and a turbine. It also includes a very strong and expensive system for controlling air pollution from combustion smokes. They are much more efficient than modular ones in combustion, energy and pollution control outputs.

- **Refuse derived fuel systems**
  - Shred-and-burn systems. They are the simplest form of RDF production, and require minimal removal of non-combustible material. They shred mixed municipal solid waste to the desired particle size and magnetically remove ferrous materials.
  - Simplified process systems. They remove a significant portion of the non-combustible material (85 % of ferrous metals and a considerable percentage of the remaining non-combustibles), and then shred the material to a nominal particle size.

- **Gasification.** The gasification process means treating a carbon-based material with oxygen or steam to produce a gaseous fuel. The gas can either be cleaned and burned in a gas engine, or transformed chemically into methanol, that can be used as a synthesis compound. Nowadays, this technology is not used for mass waste but for somewhat homogeneous waste.

- **Pyrolysis.** Pyrolysis is the application of heat in an atmosphere of zero or limited oxygen to a substance in order to induce chemical decomposition and avoid combustion. Organic material is processed within an enclosed chamber where heating releases valuable gas, leaving residual solids and coke, and in some cases, oil. The gas is afterwards combusted to obtain energy. The residual solids can be landfilled or vitrified. Like gasification, pyrolysis is a technology sufficiently developed only for homogeneous waste.

12.4. ENVIRONMENTAL ISSUES.

Environmental impact.

The major environmental concerns associated with waste-to-energy facilities are their potential impact on air quality and the disposal of ash.

- Air emissions. Air emissions aspects include particulate matter, acid gases (hydrochloric acid and sulphur oxides), organic compounds (including dioxins and furans), inorganic compounds (trace metals) and nitrogen and carbon oxides. Release pathways for air emissions for humans or for the environment can be direct (through inhalation) or indirect (through the food chain). Air emissions can also have an impact on global atmospheric problems such as ozone layer depletion and the greenhouse effect. Proper design and operation, taking into consideration emission standards and regulations, control these effects.

- Residue from combustion. It consists mainly of the following products:

  - Slag. Medium to large sized, completely or partially combusted material that passes through, or is discharged from, the combustion grate.
  - Ash. Small sized, inorganic, particulate residue of combustion. Ash is usually polluted by small quantities of organic material resulting from incomplete combustion.
  - Filter dust. Particulate matter captured from gas cleansing systems.

All permit applications for construction and operation of solid waste incineration must include a residue management plan, which should describe methods, equipment and structures that will be used to prevent the uncontrolled dispersion of residue and its impact on the environment.

If the combustion process is well developed, the slag can be recycled after the appropriate testing and sorting of ferrous components, such as road sub-bases. In contrast to slag, the other residue products must be considered hazardous waste. They can contain high to very high contents of mobilizable heavy metals, such as lead, cadmium, mercury, arsenic, copper, and zinc, which originate from plastics, coloured printing inks, batteries, certain rubber products, and hazardous waste from households and small industrial generators. Harmful organic compounds such as dioxins and furans and other harmful compounds such as chlorides and sulphates have also been detected. They can create disposal problems.

Incinerator ash is usually disposed of in an MSW landfill (ideally in a special section) or an ash-only landfill known as an ash monolandfill, specially designed to reduce the ability of heavy metals to migrate from the ash into the environment.

Moreover, different processing procedures have been developed, such as consolidation, siltering, melting and vitrification processes. The melting and vitrification processes are safe but expensive alternatives. Through special moulding, the vitrified material can be used in building and cement industries or in road building.

Other environmental effects that should be considered during the implementation and operation of the waste-to-energy facility are wastewater disposal, noise, landscape, etc.

Obtaining permits.

The following are some potentially required permits. Permits needed will vary depending on legislation in each country:

- Air regulation permits. Requires adhering to the pertinent source emission standards. The parameters to control are basically: particulate size, dioxins and furanes, volatile organics, nitrous oxides, acid gas and heavy metals (mainly mercury). It is important to carefully prepare the necessary documents to ensure that the facility successfully obtains its permits.

  Table 12.1. shows the emission limits of the EU Directive (in a base of 11% O2 and 0%water).

Table 12.1. Maximum emission values (daily average) of the EU Directive

Pollutant	(mg/Nm³)
Total dust	10
HCl	10
HF	1
SOx (as SO_2)	50
NOx (as NO_2)	200
Hg	0.05
Cd	0.05
Other heavy metals	0.5
CO (hourly average)	50
Organic (CmHn)	10
Dioxines	0,1 ng TEQ/Nm³

- Residual disposal. After testing the residue, hazardous waste standards may apply to its disposal. The developer should check with the state environmental program to determine the regulatory status of municipal waste combustion residue.
- Water discharge. Some facilities also produce wastewater as a residue. Usually this effluent can be discharged to a local sewer system, but in some cases prior treatment is necessary.
- Other. The developer may also need to include controls on the following parameters: land-retained pollutants, noise pollution, aesthetic impact and land use compatibility.

Monitoring.

To assist the operator of the combustion process and the emission control equipment, continuous emission monitoring equipment has become a requirement for any new or existing waste combustor.

12.5. SITE SELECTION.

Potential facility sites should be determined focusing principally on territorial factors (neighbourhood impact, urban planning requirements, traffic access, landscape integration, atmospheric dispersion capacity of the zone, etc); economic factors (cost of transporting waste to and from the incinerator, refrigeration water availability, land prices, etc.) and socio-political factors (citizens' acceptance, consensus among the relevant national and local authorities, etc.).

The site selection process is very sensitive to citizens' acceptance. A reaction of non-acceptance of the facility is usual due to the well-known "not in my backyard effect" (NIMBY effect). We recommend carrying out a participatory site selection process with a transparent awareness campaign aimed at citizens and stakeholders. The responsible authority should communicate clear information about the reasons for building the facility, the pros and cons of site alternatives and the planned measures for reducing and controlling the possible negative effects.

12.6. RESPONSIBILITY FOR FACILITY OPERATION.

How the facility should be managed and by whom it should be operated (public or private system), are important concerns for developers. To make this decision, the following should be considered:

- Financing capacity of the investment and of long term cost recovery.
- Guaranteeing good operation according to design requirements.
- Attracting and adequately compensating trained and qualified staff members.
- Procuring emergency outage repair services quickly
- Maintaining sufficient budgetary reserves to make unexpected repairs.
- Assuring bondholders that their investment will be well maintained and that the facility will operate for the term of the bonds.
- Availability of qualified experts to meet day-to-day operating demands.

Private operations reduce the community's obligations and responsibilities, but also require relinquishing control. However, the municipality will gain financial security because the operator will be obliged to pay for the costs of specific contract obligations.

12.7. COSTS.

The costs of an incineration plant are typically affected by the following factors:

- Cost of land acquisition.
- Scale (there are significant diseconomies of small scale).
- Plant utilisation rate.
- The requirements for treatment of flue gas.
- The treatment and disposal or recovery of ash residues.
- The efficiency of energy recovery, and the revenue from energy delivered.
- The recovery of metals, and the revenues received from this.
- Taxes on incineration.

12.8. METHOD OF FINANCING

The following are some different ways to finance an incineration facility:

- **General obligation bonds.** The bonds are backed by the full faith and credit of the municipality based on its ability to levy taxes as necessary to pay the principal and interest on the bonds. This may affect the municipal debt capacity for future projects and its credit rating for those projects; however, it allows the municipality full flexibility to use traditional municipal project execution methods and allow public operation of the project. To secure funding, this method also requires the funding of the least direct technical or economical analysis of the project's details.

- **Municipal revenue bonds.** They are based on the credit worthiness of the project and the parties involved, the technological feasibility, and the project's revenue forecast. Either the contractor or the municipality must take the financial risk for any deficiencies in the project.

- **Leverage leasing.** It is a method that allows private investment in the project in combination with public debt. The municipality does not own the facility and leases it back for the term of the debt service payments.

- **Private financing. P**rivate developers attempt to use some form of tax exempt debt to make the project financially feasible. The municipality would likely be committing to a long-term contract to deliver waste to the facility at a specified tipping fee to financially support the project.

12.9. IMPLEMENTATION METHOD.

- **The architect/engineer approach.** This method involves the municipality retaining a qualified firm to design and procure the facility employing procurement methods used traditionally by municipalities for public facilities. The architect/engineer approach can be used if the municipality will own and operate the plant.

- **The turnkey approach.** A qualified company designs, builds and demonstrates the performance of the facility, without an operational compromise after it is handed over to the Municipality.

- **The full service approach.** This approach involves selecting a company willing to accept a full service obligation with the municipality to take the waste and process it to produce energy at an agreed upon fee in return for ensuring plant operational performance. This approach enables the municipality to minimise the risk, and gives added security by providing the municipality with a known operating fee for the length of the contract.

CASE EXAMPLES.

Municipal solid waste processing plant in Son Reus, Majorca. Spain.
http://www.tirme.com

The waste produced in Majorca is collected in each municipality and taken to the transfer stations. These plants concentrate the household waste of one area, unloading it straight from the rubbish lorries into hermetic containers where it is compacted.

The transfer stations are designed according to the strictest environmental standards: waste never comes into contact with the outside, there is no manual handling, they are equipped with a waste water purifier and they are built to fit into their surroundings. At the transfer stations, lorries unload directly into the feed opening and the gravity pulls the waste into the compactor, which puts it into high-capacity (40m³) hermetic containers by means of a hydraulic press. Once full, they are placed in a parking area, where they are collected and transported by lorry to the Son Reus plant.
The facility technical file is as follows:

Technical Facts:	
Type of waste	Solid urban waste
Thermal Capacity	45'15 MW/furnace
Incinerating Capacity	18'75 t/h/furnace
Calorific Power Range	1.530-2.070 kcal/kg
Energy Generation:	
Maximun Power	42'625 MVA (11kV,50Hz)
Intermediate extraction N.	3
Condenser type	Air Condenser
Gas Cleaning:	
Type	Semi-dry absorber with bag hose filter
Reagent	Raw lime (CaO)
Active Carbon Injection	Yes
Gas Flow	100.000 Nm³/h/line
Ash Treatment	Stabilization / solidification with cement

MSW incineration plant in Tarragona, Spain (SIRUSA)
http://www.aceversu.com/sirusa.html

This facility burns SWM and recovers energy from the process. Also, slags from the process are recovered as secondary material in civil works.

As a result of the process, from 1000 Kg of waste (plastic, organic matter, glass, metals, etc) the following elements are obtained:

- 43 KW/h electricity power are produced
- 230 Kg of slags potentially reused in civil works
- 25 Kg of metals
- 30 Kg of ash

The facility technical file is as follows:

Technical facts:	
Type of waste	Solid urban waste
Number of furnaces:	2
Incinerating Capacity	9,6 t/h/furnace
Calorific Power Range	1.500-2.000 kcal/kg
Tonnes incinerated:	145.000 t/year
Energy Generation:	
Maximum Power	7,4 MW/h
Condenser type	Air Condenser
Gas Cleaning:	
Type	Semi-dry absorber with bag hose filter
Reagent	Raw lime (CaO)
Active Carbon Injection	Yes

All emission values are within the limits of Regional and European legislation.

The Spittelau Waste Incineration Plant in Vienna. Austria.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=18740

The plant is part of the Viennese waste management concept. The annual amount of waste which thermally treated is about 265,000 tons. Besides heat for the district heating system, it also produces electricity for its own purposes.

In 1995, over 150,000 flats and over 3,000 public buildings wereconnected to the district heating system of Vienna..

- The Spittelau incineration plant has state-of-the-art installations for environmental technology: electrostatic precipitators plus wet scrubbers for elimination of heavy metals, hydrochloric acid and sulphur dioxides.
- a catalytic flue gas scrubbing system reducing NOx, Dioxins and furan at a high degree of efficiency.

Another indicator for environmental compatibility of Spittelau waste incineration plant is the fact that the architectural design was carried out by the internationally renowned artist Friedensreich Hundertwasser who is a committed environmentalist and who only agreed to undertake this project in an honorary capacity after long discussions of its environmental aspects .

RELATED WEB SITES.

IET Energy
http://www.ietenergy.com/

Cardiff University Waste Research Station
http://www.wasteresearch.co.uk/ade/Currentprojects.htm

WASTE TO ENERGY GENERATION FOR CYPRUS
http://www.geocities.com/ResearchTriangle/5671/wte.htm

Green Pages
http://www.eco-web.com/cgi-local/sfc?a=index/index.html&b=index/category/5.6.html

Hydrolysis
http://www.ciwmb.ca.gov/Organics/Conversion/Hydrolysis/

Gasification
http://www.ciwmb.ca.gov/Organics/Conversion/Gasification/

Réseau de controle pour l'étude et la caractérisation des émissions atmosphériques des installations de valorisation de déchets en region wallonne
http://environnement.wallonie.be/data/air/valorisation/

Réseau de contrôle des émissions de dioxines des incinérateurs de déchets ménagers
http://environnement.wallonie.be/data/air/dioxines/

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13. DISPOSAL IN LANDFILLS

13.1. LANDFILLING: AN OVERVIEW.

MSW landfills provide environmentally sound disposal of waste that cannot be otherwise managed. A landfill is needed for disposing of residues from recycling, composting, incineration, or other processing facilities, and can be used if the facilities break down. A properly designed landfill includes provision for leachate management and the possible collection of landfill gas and its potential use as an energy source.

The goal of an MSW landfill is to place residuals in the land according to a coordinate plan designed to minimise environmental impact, maximise benefits, conserve resources and optimise operational and financial costs. The authority responsible for solid waste must carefully plan the development of new facilities and the landfill operator has to improve the performance of existing ones.

Waste disposal improvement or implementation may be needed if some of the following problems are identified:

- Current disposal is by dumping
- Existing dumpsites are a cause for concern because of political, environmental or public health reasons.

Landfill costs can typically be divided into the following components:

- Acquisition costs.
- Capital expenditure and development costs.
- Operating costs.
- Restoration costs.
- Post-closure costs.
- Landfilling charges from National policies.

13.2. EXISTING OR CLOSED LANDFILLS.

Owners and operators of existing landfills must carry out the following frequently overlooked actions, in order to ensure adequate environmental and health conditions:

1. Instituting ground water quality monitoring and preventing any impact on aquifers, if needed.
2. Establishing a leachate management plan
3. Setting up a gas management plan
4. Preparing landfill final cover specifications and obtaining closure plan approval
5. Planning post-closure care and its financing.
6. Establishing financial assurance for closure and post-closure care

The developers should also consider the suitability of creating different zones in the landfill for different types of residues that need different environmental contamination prevention requirements or management, a process called co-disposal.

13.3. NEW LANDFILLS.

Site selection.

Proper siting of a landfill is a powerful tool to reduce potential environmental impact. The siting process can eliminate sites that would not have visual, air quality, traffic and other adverse effects and, most importantly, can reduce the possibility of ground water quality degradation from accidental or long-term containment failure. Ideal sites should be located far away from valuable groundwater or surface water resources. It is also recommended to choose a location with abundant impermeable soil types.

Estimate landfill volume requirements.

It is necessary to estimate the quantity of waste to be received at the site, such estimates can range from simple methods to detailed programs. The next step is to calculate any anticipated increase or decrease in the diversion of material to waste-to-energy facilities, composting, recycling, reuse or waste minimisation efforts.

To estimate the capacity of the landfill, the waste density is needed.

The amount of soil necessary for waste covering must be added to the refuse quantity to obtain the final landfill capacity. The refuse-to-covering soil ratio usually ranges from 2:1 to 5:1 on a volumetric basis.

Conduct initial investigation and select potential sites.

When establishing a new facility, developers must determine if the new facility can economically compete with existing landfills.

Potential sites must be in areas that are suitable for landfill development. The following considerations should be key factors in locating and operating a landfill.

- The landfill must be consistent to overall land-use planning in the area.
- The site must be located in an area where the landfill's operations will not detrimentally affect environmentally sensitive resources, mainly ground water.
- The site must be accessible from an adequate road.
- The site must be chosen taking into consideration the feelings of community residents.
- The site should be large enough to accommodate the community's waste for a reasonable time (10 to 30 years).
- The site chosen should facilitate developing a landfill that will satisfy budgetary constraints.
- It is recommended that the site have a sufficient quantity of earth cover material easily handled and compacted.
- Operating plans must include provisions for co-ordination with recycling and resource recovery projects.

When available, soil maps may provide useful preliminary information about potential landfill sites.

Determine applicable national, regional and local requirements.

When siting the disposal facility, the developer should determine not only the applicable legislation, but also consider global trends in legal requirements of waste disposal site selection.

Assess landfill options for energy and material recovery.

The gas produced in a landfill may be used, after some cleaning, as fuel for a boiler or gas engine for generating electricity, or as a natural gas supplement. In the first case, gas with as low as 20 to 30 percent methane can be used in boilers. To drive a generator, the gas must be at least 30 percent methane or have a minimum heat value of 373 MJ per cubic meter. The use of landfill gas as a supplement for natural gas requires more diligent removal of some trace gases.

Consider final site use.

The final use of the landfill site should be considered during the initial site decision phase. The best strategy is to define the after-closure use of the site before the landfill is constructed and operated. After closure monitoring requirements, ground water protection, gas migration control, and uneven settlement should be carefully considered in the initial landfill design according to the future land use. This approach may reduce possible opposition to a new landfill. Potential uses for closed MSW landfills are, for example: nature park, recreation park, wilderness area, animal refuge, etc. Final uses under consideration must be compatible with the post-closure care plan, with other nearby land uses, and with the limited ability of the landfill to support structures.

Determine suitability of sites.

The next step in the site selection process is to conduct a more detailed investigation of those most suitable sites. Thorough site characterisations are conducted in two phases. The first one involves collecting and reviewing as much information as can be found about the site. The second phase involves field investigation activities.

Developing the facility design.

Selecting the type of MSW landfill.

The major types of MSW landfills are area and canyon landfills. An area landfill is generally used in a rolling terrain where cover soil can be obtained from an area adjacent to the landfill itself. A canyon landfill is used in mountainous areas and it tends to be deep (total refuse depths of over 60 meters are common). The main difficulty is determining how to rout the traffic to the landfill.

They can also be defined by the types of waste disposed of and the type of pre-processing zone. Each project requires a unique combination of timing, site restrictions and waste characteristics, along with different regulatory, political and social aspects.

Public participation in the site selection process.

Projects lacking public review or input until the design is completed may face several delays in the approval process. It is recommended to involve the community's residents in the project from the earliest phases.

Meeting regulatory standards and requirements.

In the implementation phase, the site operator must consider the correspondent regulatory aspects applicable in each case.

Developing the site layout.

Landfill layout will be strongly influenced by the site's geology. Of particular concern is the potential for gas and leachate migration and the suitability of the soil for landfill base and cover material. Data describing subsurface formations and groundwater conditions are diagrammed to present an interpretation of subsurface conditions at the planned landfill site.

Operating plans.

The operating plan should describe all of the activities that will occur at the facility, determining all kinds of needs: working face, phase dimensions, personnel, funding, etc. It should also illustrate the chronological order for developing each feature in the phase diagrams.

Leachate management.

Leachate is a liquid that has passed through or emerged from the waste in a landfill. It contains soluble, suspended or miscible materials removed from the waste.

- Factors affecting leachate generation. Leachate generation depends on the amount of liquid originally contained in the waste (primary) and the quantity of liquid that enters the landfill (secondary). The factors that influence the generation are: climate, topography, landfill cover, vegetation and type of waste.

- Predicting leachate production rates. It requires water balance calculation. Several models exist, the simplest version states: the leachate production is equal to the volume of precipitation minus the volume of actual evapotranspiration.

- Leachate management.

    - Liner systems. Landfill liner systems consist of controlling leachate movement off site through several layers of natural or artificial components. It is usually required that the total soil liner has a permeability of less than 10^{-7} centimetres per second. Flexible membrane and high density plastic liners are the more effective artificial components, due to their duration and small permeability and lasting ability. Natural liners can have a large capacity for the attenuation of materials, but they are considerably more permeable than artificial ones.

    - Collection systems. The effectiveness of a leachate collection system depends on the design of the liner and collection pipes. The slope of the liner should be at least 2 percent, and preferably 4 percent or more, to promote lateral flow of leachate to collection pipes, and pipes should be sloped at 1 percent minimum to ensure leachate flow and prevent accumulation at low spots along the pipeline.

- Treatment processes. It includes on-site treatment, discharging to a municipal sewage treatment plant or a combination of these approaches. It is also possible to consider leachate recirculation as a treatment process; it increases the rate of waste stabilisation, improves leachate quality and increases the production and quality of methane gas.

Groundwater quality assessment.

- Monitoring wells. The monitoring is necessary to determine groundwater quality at a facility and to determine whether there has been a release of contaminants through the base of the landfill. Monitoring wells must be cased in a manner that maintains the integrity of the borehole, and constructed to facilitate the collection of ground water samples.

- Groundwater pollution corrective actions. When contamination is detected, more extensive monitoring, and possibly corrective action, may be necessary if the leachate infiltration affects important water resources. The correction is usually very difficult and expensive.

Gas management.

- Why is gas control needed? Uncontrolled landfill gas migration can be a major problem at a municipal solid waste landfill. Methane can quickly asphyxiate a person, and concentrations as low as 5 percent are explosive. Landfill operators must receive adequate safety training, and gas monitoring equipment and other safety devices must be properly calibrated and maintained.

- The gas that is generated will either vent to the atmosphere or migrate underground. In either case, monitoring and control equipment must be used to detect and control gas pollution or damage structures or vegetation.

- Methane is also one of the main gases causing the global greenhouse effect. At least, it must be collected and burned, because the gas produced by methane combustion (carbon dioxide) is a lot less active as a greenhouse effect gas.

- Gas control systems. Controlling gas movement at a landfill begins with a study of the local soils, geology, and nearby area, and continues with the implementation of the gas control systems. There are two types of gas control systems: passive and active.

  - Passive gas control systems. They rely on natural pressure and convection mechanisms to vent the landfill gas trough wells or trenches. They can be confined to the perimeter of the site or extend to all the surface. Passive systems offer limited protection, and they may not be reliable enough where there is a significant risk of methane accumulating in buildings.
  - Active gas collection systems. They remove landfill gas using vacuum pumps connected to a network of venting wells from the landfill perimeter, whole surface, and surrounding soils. These systems may provide only migration control or may also recover methane for use as energy.

- Collecting gas for energy recovery. At some landfills, it is cost-effective to install gas recovery wells or trenches throughout the landfill and recover the gas for its energy value. Depending on gas quality and user requirements, gas collected along the perimeter may be flared so as not to dilute the higher-quality gas typically collected from an interior surface well network .

  Depending on the waste to be disposed of, the amount of gas generated varies; greater composition in organic matter will generate greater amounts of gas. As waste keeps producing gas 10-15 years after closure, existing disposal sites may implement a gas recovery facility.

  Before constructing an energy recovery system, it is important to conduct tests to predict the quantity and quality of gas available. If a factory or large building is near the landfill, it may be practical to pipe the gas directly into a boiler at the facility. If the boiler is not available, landfill gas can be directed to an engine/generator system for producing energy. The cost-effectiveness of generating electricity from landfill gas is limited by the price paid for the electricity and varies depending on local power costs and generating capacity.

Final cover system.

The final cover system may be composed of an infiltration layer and overlain by an erosion layer. Over the long term, the infiltration layer should minimise liquid infiltration into the waste. Under no circumstance can the infiltration layer have hydraulic conductivity greater than 10^{-5} centimetres per second regardless of the permeability of underlying liners or natural subsoils.

- Design considerations. The cover system should be designed to provide the desired level of long-term performance with minimal maintenance. Surface water runoff should be properly controlled to prevent excessive erosion and soil loss. A system for gas emissions control after closure must also be designed.
- Erosion control. To minimise major erosion and post-closure care problems, the maximum slope is typically 4:1; however, 5:1 is better.
- Vegetation. Good vegetation will improve erosion control through rapid growth and the formation of a complex root system. It is common to use vetches and fescues.
- Landscape. To minimise the visual impact, the cover system must ensure general harmony with the landscape of the zone.

Post-closure care assurance.

The owner and operator in private landfill facilities must provide financial assurance for closure and a long period of post-closure care (30 years) before opening a landfill.

Other design considerations.

- Entrance control. It is very important to control the landfill entrance by maintaining perimeter closure and establishing qualitative and quantitative input controls. It is recommended to install a scale for weighing the incoming loads.

- Storm water drainage. Runoff water should be directed into channels that are capable of carrying most storm loads without flooding or overflowing into adjacent areas. To minimise siltation problems downstream, a detention basin should be considered. This also provides an opportunity to test the runoff water.

- Roads. On-site routing of trucks to the working face should be planned to minimise waiting times at the site. A permanent road extending from the public road system should be constructed

Regulatory approvals.

The final task in developing the plan is to obtain approval from regulatory agencies. The designer should maintain a close liaison with regulators throughout the design process to ensure compliance with legal standards.

Economic investment.

The total economic investment that has to be made in the implementation of a landfill is considerable, and it is common to gain economic support using different methods. However, it is possible to invest the money gradually as the facility is being developed.

Operating the landfill.

The landfill operational plan should serve as the primary resource document for operating the site. It shows the technical details of the landfill and the procedures for constructing the various engineered elements.

Access control.

Public access to landfills must be controlled through artificial or natural barriers in order to prevent unauthorised vehicular traffic and illegal dumping of waste.

There must be a program to exclude regulated hazardous waste or other non-desired materials from disposal in the landfill. This program is not only technical, but also has management specifications, such as who is disposing the materials, or other aspects.

- Inspections. Typically, it is the visual observation of incoming waste loads by a specialist who is adequately trained and qualified. They are usually random and their frequency depends on the type and quantity of waste received daily, and the accuracy and confidence desired in conclusions drawn from inspection observations.
- Alternative methods for detection and prevention. These methods may include waste screening for the presence of hazardous wastes before processing.

Cover material requirements.

The regulatory standards may require the landfill operator to cover solid waste with a determined height of an earthen material at the end of each operating day.

Run-on and run-off water control systems.

As much water as possible should be diverted off the landfill to minimise operational problems and leachate. The goal of the run-on system is to collect and redirect surface water entering the landfill boundaries. The run-off system should be designed to collect and control any water that may have contacted any waste materials.

Additional controls.

Good housekeeping procedures are necessary for landfill operations. A well-planned and maintained landfill effectively controls the following: aesthetics, wind-blown paper, insects, rodents and wildlife, birds, odours and fires, noise, dust and trackings, scavenging, gas and leachate.

Landfill equipment.

Equipment at sanitary landfills falls into three functional categories: waste movement and compaction, earth cover transport, and compaction and support functions. Selection of the machinery for those categories depends on the following aspects:

- Amount and type of waste to be handled
- Amount and type of soil cover to be handled
- The distance the cover material must be transported
- Weather conditions
- Compaction requirements
- Site and soil conditions.
- Economic constraints

Waste handling and compaction.

Shredding and baling are options for processing waste before it is landfilled.

- Waste shredding. Incoming refuse is mechanically processed into small, uniformly sized pieces. It can take place in the landfill or in the transfer station prior to transport. After compaction, shredded refuse has a greater density than compacted which preserves landfill space and reduces the amount of required cover material. Also, landfill settlement and stabilisation may be more uniform. Nevertheless, this type of process has significant capital and operating costs.
- Baling solid waste. Involves the compaction of refuse into high density blocks that are stacked and covered in the transfer station or in the landfill. In many cases, baling may result in landfill space savings and blowing litter reduction.

Landfill handling and compaction equipment.

- Four main functions have to be covered when selecting mobile equipment: waste spreading, compaction of waste after placement on site, transportation and deposition of cover material, and earth excavation to prepare the site of deposition or to obtain cover material. There are heavy and expensive bulldozers that usually have special rubber tires or iron chains, which are very effective in carrying out the first two functions. Normal shovel loaders, rubber-tired or with chains, can substitute them with less efficiency but they can also be used for excavating cover material. For moving earth, rubber-tired loaders are more effective than track-type units, but also more ex-

pensive. Dump trucks can also be used for this function.

- Adverse weather. Rain can do significant harm to soils with a high silt or clay content and to the surfaces of waste already deposited. Procedures to minimise and clean mud tracking on roads are important during wet weather. Windy conditions can require the use of extra or specially placed fencing and use of a lower or more protected working face

Personnel and safety.

To maintain an efficient landfill operation, employees must be carefully selected, trained and supervised. Solid waste personnel work in all types of weather, with many types of heavy equipment, with a variety of materials presenting diverse hazards, and in many different types of settings. Good employee training and supervision must include safety precautions.

Quality control and record keeping.

A quality control program should be followed to ensure the landfill conforms to design and operating plans, and all the main aspects in the landfill operation should be kept on record.

Community relations.

The landfill manager should have good relationships with administration representatives, neighbours, community associations, and other stakeholders in an effort to build trust through honest communication. A communication programme with them and with the media is recommended.

Closing the landfill and providing postclosure care.

The landfill must be closed in accordance with an approved and adequate closure plan.

Financial assurance for closure and postclosure care.

Owners and operators must have financial assurance covering the costs of closure and post-closure, and also when corrective action is necessary to clean up the impact of pollution on groundwater. Several mechanisms are possible: trust funds, surety bonds, letters of credit, insurance, etc. The trend is to purchase a concession (linked normally with an MSW collection program).

Procedures for site closure.

The procedures are usually defined during site design, and the following scheme can be adequate:

- Preplanning.
  - Identify the final site topography plan.
  - Prepare site drainage plan.
  - Prepare vegetative cover and landscaping plan.
  - Identify closing sequence for phased considerations.
  - Specify engineering procedures for the development of on-site structures.

- Three months before closing.
  - Review closure plan for completeness.
  - Schedule closing date.
  - Prepare final timetable for closing procedures.
  - Notify appropriate regulatory agencies.

  - Notify site users (by letter or by published announcements).

- At closure.
  - Erect fences or appropriate structures to limit access.
  - Post signs indicating site closure and alternative disposal sites.
  - Collect any litter or debris and place in final cell for covering.
  - Place cover over any exposed waste.

- Three months after closure.
  - Complete needed drainage control features or structures.
  - Complete gas collection or venting systems, leachate containment facilities, and gas and groundwater monitoring devices.
  - Install settlement plates or other devices for detecting subsidence.
  - Place required thickness of earth cover over the landfill.
  - Establish vegetative cover.

Post closure care.

- General upkeep. After closure, the landfill cover continues to settle as the waste continues to consolidate. Settlement will cause depressions in the cover and stresses on the cover, and they must be filled with cover soil to limit infiltration and other problems. The vegetation must also be maintained, in order to prevent excessive erosion and damage to the cover.
- Road and drainage structure repairs. Settlement may also affect access roads, which should be monitored and repaired in order to maintain their long-term usefulness.
- Leachate treatment. Leachate will continue to be generated after the landfill is closed, the quantity should diminish if a good cover was placed over the landfill. The leachate collection and treatment equipment must be adequately operating throughout the entire post-closure care period.
- Groundwater and gas monitoring. These two systems must also continue to operate after a landfill is closed, and plans must be prepared and approved for the pertinent corrective actions.

CASE EXAMPLES.

Surprises in Gaza Landfill

http://www.skat-foundation.org/resources/downloads/pdf/ws/infopage_6.pdf

Collection and disposal of solid waste in the central part of the Gaza Strip are the responsibility of the Solid Waste Management Council – an autonomous public body that is governed by a Board comprising the mayors of the eleven towns and villages that it serves.

At the start of the project, soon after the creation of the Palestinian Authority, there were a number of uncontrolled open dumpsites in the area under consideration. The first step in improving the situation was to assess the soil and groundwater conditions at several locations. Based on this information, and other factors, the existing dumpsite east of Deir El-Balah was chosen as the most suitable site for a central landfill, to serve the eleven communities in this area.

No standards or regulations with regard to MSW landfill sites were in place and no experience was available for private guidance about leachate quantities in the region. Some experts believed that no significant leachate should be expected under the climatic conditions in Gaza.

However, since groundwater is the main water source in the Gaza Strip, it was considered desirable to avoid any risk of further groundwater contamination. It was therefore decided to line the landfill site (experience later showed how wrong conventional wisdom was concerning leachate quantities, and how important it was to provide such a lining).

The design of the site was carried out by international specialists according to the following concepts:

- Lining of the site with two asphalt liners with a bitumen mastic layer between the liners.
- Installation of a coarse aggregates and drainage pipes to convey leachate to a storage pond
- Installation of pumps and a sprinkling system for recirculation of the leachate.
- The collection and treatment of landfill gas were not regarded to be a priority for the time being. Reasons for this included the fact that the landfill is relatively small and that the utilisation of gas would be uneconomical.

It was further agreed to delay decisions regarding capping, final cover and post-closure care until reliable estimates of the quantity of leachate had been established.

Basic planning parameters were the following:

- The site serves communities with a total population of about 370,000 inhabitants (11 towns and villages and 5 refugee camps).
- About 240 tonnes of MSW are disposed of at the site daily (the total quantity disposed of in 1999 was 87,9000 tonnes).
- The lined area is about 60,100 square metres
- The total capacity is about 772,500 cubic metres
- Rehabilitation of the existing dumpsite included moving some 152,000 cubic metres of old waste to the lined area of the partially completed landfill site, so that all of the site could be lined.
- The remaining life span after construction and rehabilitation works was 13 years.

Rehabilitation of the Old Disposal Site in Marka as a Green Park. Jordan.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=16660

The project intended to rehabilitate the old disposal site in Marka and establish a local community development centre in a poor, polluted suburb of Amman, providing an example of what can be done in similar situations.

Work started in July 1998. The local community was involved at the outset of the project and participated in its planning. In the first stage, 50,000 m^2 out of the total surface area of 173,000 m^2 were rehabilitated. The land was levelled; the soil tested and topographical maps prepared. Retaining walls were constructed, the site fenced, topsoil brought to the site and 6,000 forest trees of varieties that tolerate the conditions in the area planted, in addition to 500 olive trees to be used for soap production later, were planted. All this was achieved through the combined efforts of the NGO members, members of the local community, school children, the local authority and government institutions facilitated initially by seed money from the Global Environment Facility/ Small Grants Programme in Jordan.

Infrastructure on site includes streets, flowerbeds, 64 m^3 water reservoir, a 100m^2 cistern, a football playground and a centre to manage the project and facilitate its activities. A secondary sorting centre was established on site by the Recycling Project providing job opportunities for the local community.

The European Union provided funding for establishing a nursery for in-door plants as an income generating activity employing 5 women. Several awareness activities were organised targeting youth and local community members, especially women. The Mayor of Amman inaugurated the park in October 1999.

Technical Orientations on the Sites of Final Disposal of Urban Solid Waste In Morocco
http://www.unep.or.jp/ietc/Publications/TechPublications/TechPub-17/morocco.asp

The growth of urban population in Morocco during recent decades has been accompanied by a disturbing production of solid wastes both in quantity and quality. From one region to the other, the quantity of municipal waste generated per inhabitant per day ranges between 0.4 and 0.9 Kg/inhabitant/day. The rate of waste collection is relatively satisfactory, and could range between 70 and 90%.

Collected wastes are disposed of in open dumps or through burial. However, waste disposal is generally not satisfactory in terms of hygiene and environmental protection.

The current conditions of waste dumpsites have been dealt with and evaluated in a national study on solid waste management (SWM). This study, which focuses on all aspects of SWM in Morocco, was undertaken in 1997 by the State Secretariat for the Environment in collaboration with the Japanese Agency for International Co-operation. Two cities situated on the Atlantic coast, namely Safi and Al Jadida were selected in order to put the plan of action and guidelines for municipalities into concrete form, and adjust them according to results obtained. Being a pilot project, the waste management plan for the city of Al Jadida could serve as a prototype for other Moroccan cities.

However, while awaiting the promulgation of the law on solid waste, drafting technical guidelines for managing the sites of final disposal and their usage by local authorities would greatly improve conditions of final disposal in terms of hygiene, public health and environmental protection against all harmful effects.

Each commune would ensure the services of waste management within its perimeters.

In order to resolve these problems, it is necessary to improve the final disposal sites and introduce controlled sanitary landfill sites. It is important that installation of final dumpsites be well planned starting from the selection of the sites until the ultimate utilisation of territory after the closure of these sites.

Plans for the development and conversion of final disposal sites consists of the process of selection of territory adopted for the disposal of wastes produced by local collection zones. The impact of disposal sites on the environment, the fundamental orientations and executive planning concerning installations and necessary equipment must be well studied.

While laying down plans for the development of final disposal sites, it is indispensable to consider its impact on the surrounding environment. Moreover, within the framework of the assessment of the impact of final disposal sites on the environment, factors estimated to have an impact on the environment are extracted according to points of investigation before and during the construction as well as the stage of site exploitation. Finally, changes befalling the environment as a result of these factors should be estimated and evaluated, and measures should be established.

In order to put into effect technical orientations at the national level, the State Secretariat for the Environment has organised 5 workshops on solid waste management in 1998 in different regions of the Kingdom as well as a national workshop in Rabat. On the other hand, survey studies on dangerous wastes at the national level are currently being undertaken within the department of environment.

At the local level, a practical manual project for the improvement of solid waste management within municipalities is also being realised. This manual would serve as a technical guide to municipal engineers and would allow a popularisation of concepts and technical guidelines, hence making them more easy to use by local decision-makers.

Municipal Solid Waste Disposal & Energy Recovery Initiative in Hangzhou. China.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=13940

Hangzhou is located in the Yangtze River delta in the Southeast part of China, a coastal region relatively developed for its economy. The city attaches great importance to the improvement of its environment, always emphasising the idea that development of its urban economy must coexist with the improvement of its living environment and that economic restructuring must be in harmony with the process of human life and existence. Over the past ten years, the city invested RMB 110 million, both in a sanitary landfill, which is in compliance with the state standards with a daily capacity of 2,300 to 5,000 tons of solid waste and in a landfill-gas-to-energy power plant with an output of 46.5 thousand kWh per day. The initiative has solved the thorny problem of solid waste in an environmentally sound way, a problem which previously plagued the 1.7 million inhabitants of Hangzhou City and 150,000 residents of its satellite city Yuhang. The landfill boasts 6,000,000 cubic meters of receiving capacity and a 13 year life span according to its design specifications. About 0.5 hectare of the fulfilled elevations at the landfill are ecologically recovered annually. The power plant of phase 1 makes an annual profit of RMB 7.2 million and reduces landfill gas pollution by about 12 million cubic meters (including 9 million cubic meters of methane, 3 million cubic meters of carbon dioxide and 4,000 cubic meters of hydrogen sulfide).

The initiative has received several national awards including 'the best project of environmental protection" by the Ministry of Construction and "the best use of technology for environmental protection" by the State Science and Technology Commission and The State Environmental Protection Bureau. It serves as a show-case for the country's big- and medium-sized cities in municipal solid waste management and in sanitary disposal, in improving the urban environment, in waste recovery, and in the implementation of sustainable development.

Bioremediation of Sanitary Landfill in Aura, Belem. Brazil.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=14560

In practices where Caixa Economica Federal acts as the funding or resource transfer agent, Executing Agents are informed of the importance of ensuring the participation of families as partners in order to achieve successful social investments and sustainable results, thus contributing to the improvement of living standards of communities.

In line with those guidelines, this practice contemplates an integrated project for the physical recovery of a degraded sanitary landfill located in Aurá and the construction of new cells to meet the needs of the Metropolitan region of Belém up to 2020. This will ensure thorough environmental sanitation through the monitoring of all domestic, public, commercial and special waste, as well as of produced liquid and gaseous effluents. It further contemplates an alternative solution to scavenging families and the social rehabilitation and integration of children, by contributing to the elimination of child labour and to the improvement of socio-economic conditions of a population that is extremely vulnerable to environmental risks.

The project is implemented through the social development and organisation of scavengers in co-operatives and the insertion of children and adolescents in socio-educational activities, thus contributing to the development of their creativity, self-esteem, solidarity, ethical and moral values, family relations and their will to transform their lives. By providing professional education to the adolescent children of scavengers and ensuring the access of their small children to school, the inclusion of those individuals and their families in public health, social, cultural and other policies will be ensured.

RELATED WEB SITES.

Citizen's Guide to Municipal Landfills
http://www.foe.org/site1/ptp/manual.html

Emission Estimation Technique Manual *for* Municipal Solid Waste Landfills *Version 1.1*
http://www.npi.gov.au/handbooks/approved_handbooks/flandfil.html

Green Pages
http://www.eco-web.com/index/category/5.7.html

Landfill design
http://www.landfilldesign.com/

Sustainable Solid Waste Landfill Management in Asia.
http://203.159.8.151/sidaSWM/index.htm

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14. FINANCING.

Cities in South and East Mediterranean countries face difficult problems in financing solid waste management systems. Such cities face the huge and growing task of delivering services to expanding populations while the resources available to them are usually inadequate and often uncertain in amount and timing. The fundamental imbalance between expenditure needs and revenue possibilities makes it critically important that cities spend what they have as effectively and efficiently as possible. Waste management usually takes up a significant percentage of the municipality's budget.

The principal financial objectives of the municipalities' waste services are:

- To establish practical systems of budgeting and cost accounting for all waste management actions, a matter which yields transparency with regard to the real costs of waste management and provide a basis for planning and improving operational economic efficiency.
- To mobilise the required resources for investment in waste management facilities and equipment and for the operation of the service, including capital cost and technical depreciation.
- To achieve cost oriented revenues for waste management operations, which should be based on user (or polluter) charges, and to ensure that the collected revenues are applied to the intended purposes of waste management.
- To reduce the costs and improve the efficiency of waste management operations.

14.1. PATTERNS AND PROBLEMS OF LOCAL FINANCE.

The structure and operation of local government finance in any country is invariably unique, reflecting the complex historical and political factors that define governmental institutions in that country. Nonetheless, certain broad patterns recur in many countries.

- **Local governments don't have enough money.** Local governments almost invariably have inadequate "own resources" to finance the expenditure items with which they are charged. They are therefore dependent upon transfers from higher levels of government to carry out many of their activities.

- **Not all local governments are equal.** In even the smallest and most homogeneous countries, there are big cities and small cities, heavily urbanised municipalities and rural municipalities, rich areas and poor ones. The resulting unevenness in access to local public resources can be marked.

- **local governments have limited taxation powers.** Despite generally greater revenues in larger cities, few countries permit local governments to levy charges capable of yielding sufficient revenue to meet expanding local needs. The revenues under direct local control are invariably less than the spending responsibilities.

These facts reflect conscious choices made by central governments. Countries can and do exercise considerable discretion in deciding the responsibilities of local governments, the extent to which local activities are financed from local revenues, and the types of charges levied by local governments.

Governments have now established a system of financial transference to the municipalities from the national budget for general activities, but almost always there is not a specific transference for financing waste management municipal services.

14.2. FINANCING INFRASTRUCTURE.

Implementing waste management infrastructure or significant equipment replacement programmes are substantial funding for long term capital investments. The resources available to most local governments, especially in developing countries, make it difficult for them to finance costly projects from their own current revenues, so three other approaches to long-term infrastructure finance are often considered: debt instruments; grants and subsidies and; financing the infrastructure through service providers.

Debt instruments.

A loan is money provided by a lending institution or individual that must be repaid in an agreed upon amount of time at a negotiated interest rate. Loans can be granted by state or national governments to local governments or they can be provided by commercial financial institutions.

Interest rates imposed on borrowers from infrastructure banks should be set at market levels for both financial and economic reasons. Financially, interest rates set below the market result in a subsidy to the borrower, and the subsidies eventually drain the bond bank's resources. Economically, market rates ensure that local borrowers make proper infrastructure decisions.

In all cases, when applying for a loan, municipalities have to prove they are able to meet their payments to lending institutions.

As an example of financial institution, the EU has instruments of loans in privileged conditions. Municipal waste management projects can be financed by the European Investment Bank (EIB). The EIB created in 1992 the Facility for Euro-Mediterranean Investment and Partnership (FEMIP) whose aim is to promote economic development and political and social stability in the Mediterranean Partner Countries (MPC) by supporting the expansion of the private sector and the emergence of projects fostering regional integration. FEMIP has established long-term loans for this purpose. Among the objectives set, are sustained action to promote environmental protection and develop infrastructure.

Grants and subsidies.

Intergovernmental revenues have been a primary financing source for local government infrastructure investment in many countries.

A grant is a sum of money generally awarded by a government or non-profit organisation. Typically, grants are awarded by the national government to the local governments, for the purpose

of financing a particular activity or facility.

A subsidy is a sum of money given to a public body or private company needing help, or to keep down the price at which commodities are sold. As a general rule, subsidies come from the central government and are not in conformity with the polluter pays principle.

Several international organisations have established grants for environment and development purposes, available directly or indirectly to local municipalities. As an example, the EU has a programme for Mediterranean Countries. The "MEDA" Programme, is a financing instrument for countries on the Mediterranean basin that applies to States, their local and regional authorities as well as actors of their civil society. MEDA includes national and regional programmes that take into account the priorities determined with the Mediterranean partners. The financing plans are generally adopted annually. Projects involving interest rebates are included in the national financing plan and those involving risk capital in the regional financing plans.

Private equity financing.

Private equity financing occurs when the private sector has ownership or a partnership interest in the infrastructure. This can involve some form of build-operate-transfer (BOT) arrangement, in which the private sector builds and then operates the facility for some period, after which the facility is transferred to the government. A carefully specialised agreement between the private firm and the government must be negotiated.

Very few entirely new infrastructure projects have been developed trough BOT mechanisms. Major reasons for this include the lack of a proper regulatory framework and the unwillingness of private firms to share the risks of investments. Authority to set the necessary rates and fees is another problem.

Alternatives to a BOT arrangement include concessions, where a private firm contracts with the government to operate or expand an existing component of the infrastructure.

Private financing offers access to resources that otherwise would be unavailable. Also, private capital from domestic sources may be helpful when the public sector has a weak financial system. Private financing can serve as a funding substitute when the public sector is unable to generate adequate resources.

In addition, private financing is also sought because it can lower the public sector's risks of making the wrong infrastructure investments. However, in most circumstances, the private sector demands some type of guarantee or public equity financing so public risks are not eliminated. Furthermore, some reduction in construction costs and gains in infrastructure efficiency could result from practices and innovations of the private sector as the service delivery agency. But very careful regulation of firms or strict bidding procedures must exist for firms to have incentives for transferring these potential benefits to consumers. Contracting and negotiation costs that arise when the government hires the private sector often offset efficiency benefits during the design and construction phases. Experience with BOT arrangements indicates that

the negotiation process is often extended and difficult.

Disadvantages of private equity finance may result in some cases in which the private sector rather than the public sector select projects. For example, a firm may approach the government with a proposed project that would require the government to engage in cost sharing or to build infrastructure to support the new facility. The ability to leverage private resources may be diverted from more productive uses.

14.3. FINANCING OPERATION AND MAINTENANCE.

Operation and maintenance (O&M) are normally financed through user charges, general fund contributions from the government, or intergovernmental transfer from the central to local governments. General fund contributions (described in 14.2), have proved to be an unpredictable financing source for O&M expenditures in many countries. Transfers from the national government's general fund are almost always inadequate to meet needs. O&M, and particularly maintenance, may compete poorly for available general fund resources because the benefits often are not readily apparent. National governments may object to financing O&M because decisions to deliver services may have been made locally rather than nationally. Furthermore, general fund financing is likely to exacerbate government deficits, thereby increasing the negative macroeconomic consequences of deficits.

User charges.

Charge means payment for the cost of a service (e,g, waste management) and is mostly levied by municipalities.

User charges are the preferred financing method whenever viable. User charges can finance the full cost of infrastructure services that are private goods but probably cannot be the sole source for infrastructure services that have significant externalities. To achieve efficiency, charges should be levied on the direct recipients of benefits, whether residents, businesses, or "things" (real property). The appropriate policy is clearly to charge the correct price, and only thus will the correct amounts and types of service be provided to the right people, that is, those willing to pay for them.

User charges can be imposed in a variety of ways. The traditional means is a price levied per unit of purchased services. The fee should be equal to the long run marginal cost of delivery.

However, to date, experience with such charges in most countries, developed or developing, has shown several difficulties, and the prices charged are seldom those needed for efficiency.

Collection charges are user charges levied on waste collection service and can either be fixed (normally based on a flat rate for households) or variable (based on the quantity or quality of the collected waste or simply based on user categories).

Variable charges are used by local authorities as an incentive for household waste minimisation and recycling by using a progressive or differentiated charging system, consisting of a fixed fee and a variable one, the latter established according to the volume and/or weight collected. Firms are often charged on a waste volume basis.

Ability to impose collection charges depends on the user's willingness to pay, which is enhanced through good service delivery. Willingness to pay is greater when the service delivery is reliable and consistent with users' demands. Allowing users a voice in initial project design is an important means of increasing their willingness to pay. Clear communication with users, from the initial stages of project design onward, as to how much they will be expected to pay, is another important means of encouraging willingness to pay.

Financial and economic gains result from financing services with user charges. First, financial sustainability requires sufficient resources to provide adequate O&M for the infrastructure.

Difficulties in applying user charges are:

- User charges may not raise enough revenues to fully fund O&M if they are not properly enforced. Also, political officials may be unwilling to impose charges or to cut off the service delivery to non-paying consumers.

- Insufficient revenues can result when demand for services is lower than what is necessary to obtain all available economies of scale.

- User charges may raise insufficient revenues when the service has positive externalities. The price direct recipients pay should reflect their share of total benefits; normally this price is lower than the marginal costs. Indirect recipients value others' consumption of solid waste services, but cannot be easily charged for their benefits. Thus, the government probably needs to subsidise the services. There may be hesitation about pricing solid waste disposal, because consumers could be discouraged from purchasing the service. But the benefits of low-zero price must be weighed against the lost revenue necessary to finance provision of the service.

- User charges can raise at least a perceived equity problem because certain consumers or entire communities may be unable to purchase improved services. Minimal consumption of merit services may be regarded as part of subsistence living, and the government may seek means to allow each person access to these services regardless of their ability to pay. Unfortunately, the economic efficiency gains from imposing user charges and the equity goals are often in conflict. Reducing the price for all consumers is a very ineffective means of achieving equity because the benefits are not targeted to low-income consumers. Several means can be found for bringing equity to the pricing system without completely violating economic efficiency.

One possibility is to tie the user charge to income. Certain very low income consumers can be charged a minimal "lifeline" fee for the service while the vast majority of consumers pay the marginal cost fee. Of course, this requires an ability to measure income. An alternative for measuring income is a rising block pricing scheme. A rising block scheme is one in which the fee for additional units of consumption rises with usage. A rising block system will probably violate marginal cost pricing principles, but the problem will be minimal if the system is designed so that most consumers pay marginal costs. But, rising block schemes may also actually penalise low-income households. This occurs in cases where low-income households are not individually metered or where water, for example, is resold to other households. Many low income families may be jointly priced, which results in their paying higher rates than separately metered high income households.

Another approach is to offer better service at a higher fee. Everyone could be offered access to some level of service in this way.

When establishing the price of user fees, several issues should be taken into account:

- Setting the correct price requires knowledge of demand and marginal cost. Price should be set equal to the long run marginal cost of service delivery, which includes the capital and O&M costs. Costs arising from externalities in the consumption or production of services should be included in the marginal cost. Frequently, costs can be separated into those associated with connecting households to the system and those associated with production of the service. In these cases, a one time connection fee can be charged in addition to a regular fee.

- Initial user charges should be set at a sufficiently high level to cover costs. A price that is too low is particularly troublesome because it may be politically and practically difficult to dramatically raise rates soon after service delivery begins. Dissatisfaction or even riots can result from significant increases in prices for necessities. Therefore, this must be prevented, with prices increased regularly to avoid the difficulties, and users should be fully informed of the need to pay for services, of the charge structure, and of the likely need for charges to rise on a regular basis with increase in service delivery costs. of infrequent, large rate hikes.

- A careful plan must be developed to introduce user charges for services that have been delivered in the past at a nominal charge or none at all. Opposition to imposing user charges can be lessened by combining the price with a plan to improve services. In many cases, service delivery has been inadequate, and consumers will pay for improvements. An alternative is to continue giving away (or pricing very cheaply) the inferior service and to provide a higher level of service to those who are willing to pay. With either approach, the resources generated from the fees should be used to finance service delivery improvements. However, using new revenues for better service delivery means that user fees

should not be viewed as a quick means for reducing government budget benefits. Over time, revenues raised with users fees can replace subsidies and improve the budget position.

Designing Intergovernmental Transfers.

Regardless of what revenue sources are made available to local governments, transfers from central to local governments will undoubtedly continue to constitute an important feature of the public finances of many countries. A well-designed system of intergovernmental transfers is thus essential to any decentralisation strategy.

Transfer from central government should be done prior to the beginning of the management period, when the budget is set up. If the transfer is done once the period is over, it may serve to compensate the deficit obtained, though it would not encourage good management, since even if management is inefficient, losses would still be compensated by the transfer from the central government.

14.4. OTHER FINANCING METHODS.

Two options are discussed: deposit refund systems and integrated systems. Although these systems do not seem to be related to municipal financing, they offer the possibility of an adequate management of specific flows like packaging or batteries.

According to the "polluter pays" principle, these flows should be the responsibility of the producer and not of the municipality, but if no system is developed, municipalities will have to take charge of these flows in order to avoid health and environmental problems, thus increasing municipal costs.

Deposit refund systems.

A surcharge is placed on the sale of potentially polluting products. The surcharge is refunded when certain conditions are satisfied. Policies favouring refundable deposits help to ensure that products, at the end of their useful life, are effectively taken back and directed towards the appropriate recovery, treatment or final disposal facilities. This tool is normally developed by central governments.

Deposit refund systems usually target beverage containers, but they have also been effectively used for batteries, oil, tires, pesticide containers and cars. As such however, deposit refund systems can be applied only to a limited fraction on the waste stream. A difficulty with the design of levies on packaging is the fact that the different materials have different impacts "in use".

Integrated systems.

Producers in many countries have created organisations to take the necessary measures to set up take-back, collection and recovery or recycling systems for used packaging. In some countries, responsibility for the different fractions is given over completely to specific organisations so that municipalities are not paying for this collection. In other countries, the local authority receives a payment covering the over-cost of source separate collection. In others, there is no direct funding for the collection of the packaging fractions.

14.5. FACTORS TO CONSIDER IN FINANCING A MANAGEMENT SYSTEM.

- **Establishing the proper institutional framework.** Central governments must provide an appropriate institutional framework for effective local government. The two main conditions necessary for successful decentralisation are:

    - The local decision process should be democratic, in the sense that the costs and benefits of decisions are transparent and that everyone affected has an equal opportunity to influence the decision; and
    - The costs of local decisions should be fully borne by those who make the decisions, i.e., there should be no "tax exporting" and no funding at the margin from transfers from other levels of government, and of course the benefits (like the costs) should ideally not "spill over" jurisdictional boundaries.

- **Overcoming adversity.** Even when local governments are plagued by inappropriate central policies, there is usually some room for local initiative that makes a real difference in the lives of local inhabitants.

- **The need for data recording.** Regular and detailed financial data on local governments must be maintained.

- **Information and accountability.** Those charged with providing local infrastructure and services must thus be accountable both to those who pay for the services and to those who benefit from them. Ensuring accountability at the local level is not always easy. It requires not only clear incentives from central government, but also the provision of adequate information to local constituents as well as the opportunity for them to exercise some real influence or control over the service delivery system. If accountability is the key to improved public sector performance, information is the key to accountability. The systematic collection, analysis, and reporting of information that can be used to verify compliance with goals and to assist future decisions is thus a critical element in any decentralisation program. Such information is essential for informed public participation through the political process. Unless citizens are made aware of what is done, how well it is done, how much it cost, and who paid for it, no local constituency for effective government can be created.

- **Managing Public Expenditures.** No matter where local governments get their funds, they are unlikely ever to have "enough" to do all they, or their citizens, want and expect. A critical element in successful local government is, therefore, to ensure that the scarce public funds available are managed as efficiently and used as effectively as possible. It is of course critical for financial honesty and political accountability to ensure that budgeting and financial procedures are properly established and implemented -- that budgeting, financial reporting, and auditing are comprehensive, comprehensible, comparable, verifiable, and a matter of public record. But it is equally important to ensure that budgeted resources are applied as efficiently and effectively as possi-

ble to achieve the desired public outcomes. Adequate and appropriate procedural norms are important to any financial system.

- **Improving cost recovery.**
    - Introduce residential user charges based on affordability and willingness to pay
    - Apply the “polluter pays principle” for Industrial, Commercial and Institutional (IC&I) waste, and the “user pays” principle for residential waste
    - Find more robust collection mechanisms
    - Protect the poor through carefully designed cross-subsidies in user charges or taxes

CASE EXAMPLES.

Municipality of Torre Boldone pay-per-bag system, Bergamo, Italy.
Financing and incentive schemes for municipal waste management. EC, Eunomia. 2002.

The population of Bergamo Province is around 1,000,000 inhabitants. The province-wide rate of source separation of municipal waste was 42.5% in 1998. Torre Boldone is a small municipality of 8,000 inhabitants with a source separation rate of 77.4%.

A variable collection charge was established in 1998, aimed at volumetric quantification of MSW, identifying the producer, and Introducing the "polluter pays" principle.

When the system was implemented, a door-to-door collection was already in place for the main waste streams produced by the households.

The scheme implies the variation of the variable quota of the collection charge by means of the sale of bags for the collection of residual waste. Each household is supplied with a card ("chip card") whereby it can collect the bags at many locations or from vending machines.

The computerised system automatically detects the identity of the household and records it in order to determine the overall yearly amount of the charge.

The charge is split into:

- A fixed quota, intended to cover fixed costs of collection and transportation, the road cleaning service, and the service for the collection of recyclables
- A variable quota, calculated by means of the sale of bags for residual waste to households; such income in principle should cover the costs for the collection, transportation and disposal of residual waste.

The charge is collected by means of an invoice sent to the household; the invoice sums up the costs, split into fixed and variable, and costs related to collection and disposal of residual waste and to treatment and recycling of recyclable waste streams.

The Ecocharge in the Uusimaa Region, Finland
http://www.iclei.org/egpis/egpc-155.html

One of the initial ideas was to provide the public with a broad range of options for using recycling services free of charge. Households should be encouraged to recycle as much as possible, and minimise the amount of waste that they will be charged for. But the money necessary for providing these services can no longer be taken from the usual landfill charges. The Ecocharge is an additional charge, which was established to partly finance the recycling services.

The Ecocharge is based on public law as prescribed by the Waste Act and has to be approved by each municipality. It is the same in all municipalities and is paid once a year by each household together with the normal waste charge. In contrast to the waste charge which is based on volume or weight, the Ecocharge is based on the type of the building and the number of residents in a household. This is an easy system which does not cause additional work.

In fact, the Ecocharge represents only a very small part of the total waste charge (see above). The Ecocharge, including 22% value added tax, is listed below:

- residential buildings: 14 *Euro* per residence per year
- buildings with one residence and one resident: 6 *Euro* per residence per year
- leisure-time residences: 6 *Euro* per residence per year

The charge is not applied to institutions providing 24-hour care, such as hospitals or homes for the aged.

The waste charge in Western Uusimaa now consists of three components:

- charge for waste collection, for the contractor, on agreement with each household
- charge for landfilling price and treatment, for private service provider, Rosk'n Roll Ltd.
- Ecocharge for recycling surcharge based on agreement with each service, etc. of the region's 12 municipalities

All charges are generally invoiced at the same time. Invoicing is done by Rosk'n Roll Ltd. in collaboration with the different contractors for waste collection service in the municipalities.

The waste management of Rosk'n Roll Ltd. comprises of activities in the following three areas. The company is in charge of the arrangement of recycling; the management of hazardous waste; and landfill operations.

According to the regulations set by Rosk'n Roll, recycling material must be delivered to collection stations maintained by the company, or to some other collection point, in case the residential building is without such collection services. Hazardous waste must be delivered to fixed collection sites maintained by the company or the hazardous waste truck known by the name of Joonas or places like pharmacies with which the company has made an agreement.

For the collection of scrap material another truck was developed, known as scrap collection truck Romulus ("Romu" means metallic scrap in Finnish). It has been run by Rosk'n Roll since 1995. Rosk'n Roll also provides guidance and information. Two waste advisors are employed to inform clients about the different services and the options for recycling. The company also publishes waste guides for distribution to every household.

At the beginning of its work, Rosk'n Roll did finance all these services through the waste charge for landfilling and treatment. This is still the case in most of Finland's municipalities. The maintenance of these services is, however, being impeded by rapid rises in service costs.

The Ecocharge was only introduced in 1997, therefore it is still too early to produce figures on the amount of recycled material or waste disposed. An important change was the setting-up of recycling and information activities by the company.
Good results have already been achieved for toxic waste. The amount collected has been increased by about 30% every year. And it is frightening to think where all the toxic waste went before.

The Green Inchon 21 Programme: Making Inchon clean. Korea.
http://www.serd.ait.ac.th/umc/bestprac/inchon.htm

In 1995, the Metropolitan Government launched the Green Inchon 21 programme. The overall objective of the programme is to make the city greener, cleaner and healthier. The programme consists of three stages: a ground-pitting stage (1995-1997), a development stage (1998-2000) and a maturing stage (2001 onwards). On 5 April 1995, the Green Inchon Declaration was adopted. The objectives of the Declaration are to generate citizens' concern for and participation in the Green Inchon 21 programme and to remind people from all walks of life of the importance of environmental protection.

One component of the programme was the introduction of a volume-based collection fee system. The objective of this programme component is to reduce the total quantity of solid waste generated in the city and to increase the recycling and re-use of solid waste in accordance with the objectives of the Government of South Korea on solid waste control. According to the plans, solid waste generated in Inchon is to be reduced from 1.04 kgs per capita per day in 1994, to 1.03 kgs in 1995, to 1.0 kgs in 1997 and 0.9 kgs or less in the year 2000.

Apart from the introduction of a collection fee system based on volume, these targets are expected to be reached through supportive measures, such as an improved collection system for reusable waste, an improvement in the solid waste collection management system and a strict enforcement of regulations regarding the illegal discharge of waste.

The authorities are expected to strictly enforce the regulations for the usage of disposable goods and for excessive packaging. In order to reduce organic waste, 16 high-speed fermentation processors were installed and 2,065 portable fermentation processors were distributed for household use. 7 centres for the treatment of re-usable waste were established.

A pilot project involving a total of 78,386 persons in 23,704 households in 6 administrative units in 6 metropolitan districts was undertaken from 1 April until 31 December 1994. On 1 January 1995, the programme was extended to all metropolitan areas.

RELATED WEB SITES.

Community Framework for Co-operation to Promote Sustainable Urban Development
http://europa.eu.int/comm/environment/funding/urban_en.htm

LIFE - Local Initiative Facility For Urban Environment
http://www.sdnp.org.lb/life/index.html

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15. ENVIRONMENTAL EDUCATION AND AWARENESS RAISING.

15.1. OVERVIEW OF ENVIRONMENTAL EDUCATION AND AWARENESS.

A city has to be sure that individuals are at the level of environmental knowledge that enables them to communicate and receive information. This demands a certain level of education and engagement in environmental problems. Raising awareness is an important function of waste management.

The first contact between the city authorities and the public is quite complicated if there is no knowledge among the latter about the whole problem. The proactive process of communication can be carried out through:

- raising awareness of waste problems, especially in the environmental context
- regularly informing the public
- promoting an environmentally friendly behaviour among citizens towards urban solid waste issues, from consumption of products, to delivery of waste to collection services

Environmental education is an essential component of environmental programs. Its foremost goal is to prepare both the individual and society for the task of protecting the environment by raising their level of environmental knowledge, understanding, responsibility and ethics. The challenge of environmental education is to close the gap between knowledge and ethics, to internalise environmental knowledge so that it will be reflected in new behavioural norms.

To foster people's interest and involvement and to promote the development of new patterns of behaviour. Environmental education is based on three elements, it is a study of the environment, about the environment and for the environment.

Objectives.

The main objectives in environmental education and awareness raising are the following:

- **Participation** - to provide individuals, groups and societies with opportunities to be actively involved in exercising their skills of environmental citizenship and be actively involved, on all levels, in working towards sustainable development.
- **Knowledge -** to help individuals, groups and societies gain a variety of experiences in, and a basic understanding of, the knowledge and action competencies required for sustainable development
- **Values -** to help individuals, groups and societies acquire feelings of concern for issues of sustainability as well as a set of values upon which they can make judgements about appropriate ways of acting individually and with others to promote sustainable development
- **Skills -** to help individuals, groups and societies acquire the action competencies or skills of environmental citizenship - in order to be able to identify and anticipate environmental problems and work with others to resolve, minimise and prevent them

- **Awareness -** to create an overall understanding of the impact and effects of behaviours and lifestyles - on both the local and global environment, and on the short-term and long-term.

Stakeholders in Environmental Education.

A whole range of organisations in the public, private and 'popular' sectors are involved, using different messages *to target different audiences.*

Examples include: local and national governments, private sector, academia, NGOs, professional bodies, research organisations, donor agencies, UN and international organisations, community and citizens groups, media etc.

The target is usually the man-on-the-street, the ordinary citizen, but has also included policy and decision makers, business and industry, etc. (depending on the scale of Environmental Education).

15.2. A PUBLIC EDUCATION PLAN.

Developing integrated solutions for waste management problems requires public involvement. To economically and efficiently operate a waste management program requires significant co-operation from generators, regardless of the strategy chosen. To maintain long term program support, **the public needs to know clearly what behaviours are desired and why**. Involving people in the hows and whys of waste management requires a significant educational effort by the community.

Ineffective or half hearted education programs may confuse the public, reduce public confidence, or elicit hostility towards the program. Successful education programs must be consistent and ongoing.

Public education stimulates interest in how waste management decisions are made. And when citizens become interested in their community's waste management programs, they frequently demand to be involved in the decision making process. Communities should anticipate such interest and develop procedures for involving the public. When the public is involved in program design, it helps ensure that programs run smoothly

A successful waste management program requires **wide-spread public participation**. Such participation can best be obtained through early and effective public education programs, which must continue even after the program is in full swing.

Communities are made up of different mixes of home owners, apartment dwellers, business people, students (from college level to pre-school), age groups, income levels and cultures. **Planners must first know their own communities well enough to design programs that meet their specific needs**.

The city has to be aware of the behaviour of each citizen regarding waste. Each individual in the city can be seen as a resource person for successful implementation of waste management. All individuals are, with varying degrees, in touch with waste during the day. Everyone can be a resources in more than one of the following contexts:

- at home (in domestic areas);
- at work (with the responsibility of the individuals or the company);
- at institutions or organisations, both public and private (for instance in non-profit organisations with contacts outside the working market or in educational institutions).

An effective education program leads people through several stages. The **stages of a successful education program** include the following:

- **Information**: at this stage, people are learning about something new. The goal is to let people know that a different way of handling waste may be preferable.

- **Interest**: after people have been made aware of waste management issues, they will seek more information about waste management decisions, such as technical and economic solutions, rules and regulations, the implementation of which will directly affect the daily life of the citizens. Program planners must use a variety of methods to inform people. Voluntary programs require strong emphasis on promotion, while mandatory programs should make clear what is required. A variety of initiatives are needed, such as:

  - publishing all rules and regulations with a binding legislative effect on all actors;
  - publishing codes of good practice or other information summaries;
  - demonstrating exemplary actions (e.g. demonstration plants);
  - offering special conferences, seminars and training courses;
  - initialling pilot projects; and
  - offering audiovisual and other types of projects to produce documentaries for local, national and European audiences

- **Evaluation**: at this stage, individuals decide whether to participate or not. For even the most well-promoted programs, initial participation is about 50%. Making program requirements clear and easy to comply with increases participation.

- **Trial**: individuals try the program at this stage. If they encounter difficulty, they may opt not to continue participating. Well-publicised hot lines and clearinghouses provide additional instruction and information.

- **Adoption**: participation should continue to grow. Ongoing education programs solicit constructive feedback and provide new program information when necessary.

- **Maintenance**: ongoing incentives and education keep participation rates high.

Effective waste management is a continuing process of public education, discussion, implementation and evaluation. All options should be continually investigated and actively debated, moving the community toward a consensus on the proper mix of source reduction and waste management programs.
Following this stage plan facilitates public involvement:

1. Concern: waste management is put on the public agenda.

2. Involvement: representatives of various interest groups (regulatory officials, individuals from neighbouring communities, local waste management experts, representatives from environmental and business groups) are encouraged to participate.
3. Issue resolution: interest groups make their points of agreement and disagreement clear to each other and to program planners.
4. Alternatives: groups should make a list of available alternatives, including "no action".
5. Consequences: economic and environmental consequences of each alternative are discussed.
6. Choice: alternatives are decided upon.
7. Implementation: the steps necessary to carry out the program are described and potential adverse impacts are mitigated, if possible.
8. Evaluation: the community should continually evaluate the program and solicit input.

Environmental education initiatives.

Environmental education centres.

The integration of environmental education concepts into the school curriculum is a major challenge, requiring new criteria, teaching methods and innovations in the learning process. Environmental education centres assist the formal education system in planning and preparing environmental curricula (in conjunction with local teachers), conduct in-service teacher training programs, and support the introduction of innovative educational approaches. They provide educational material for both teachers and interested citizens, promote informal environmental education by stimulating public involvement, initiate and co-ordinate lectures, seminars, environmental tours and training courses, and promote environmental events

Adopt a site project.

To ensure that both the educational system and the community take part in environmental commitment programs, an "Adopt a Site" project can be launched. Within this framework, educational institutes, youth movements and community centres adopt sites in their immediate surroundings and clean, maintain and care for them. Sites may include national monuments, open spaces, public gardens, or river sections. Schools or organisations that are interested in joining the program are required to prepare an environmental program and to commit to taking responsibility for the site for at least three years.

Evaluating environmental education initiatives.

Prior to planning environmental education initiatives and throughout their implementation, to aid relevance and sustained effectiveness and efficiencies, it is helpful to consider a range of mutually supportive "testing questions". The twelve groups of questions listed below are designed to broaden and deepen the processes involved, particularly by encouraging curriculum and experiment designers to reflect on a range of hoped for outcomes in the personal, socio-political and environmental domains.

Personal.

1. Does it support: empowerment, awareness, creative visioning, value clarification, acquisition of essential literacies and competencies, responsibility, wellbeing and health maintenance, vitality and spontaneity (building & maintaining personal capital - personal sustainability)?
2. Does it support: caring, loving, responsible, mutualistic, negentropic relationships with diverse others (valuing equity & social justice), other species, places and planets (home & ecosystem maintenance)?
3. Does it support: positive total life-cycle personal development and change?

Socio-political.

4. Does it support: accessible, collaborative, responsible, creative, celebrational, life- promoting community and political structures and functions (building & maintaining social capital - cultural [including economic] sustainability)?
5. Does it support: the valuing of `functional' high cultural diversity and mutualistic relationships?
6. Does it support: positive cultural development and co-evolutionary change?

Environmental.

7. Does it support: effective ecosystem functioning (building & maintaining natural capital -- ecological sustainability)?
8. Does it support: `functional' high biodiversity, and prioritised use and conservation of resources?
9. Does it support: positive ecosystem development and co-evolutionary change?

General.

10. Does it support: proactive (vs reactive), design/redesign (vs. efficiency & substitution) and small meaningful collaborative initiatives that together you can guarantee to carry through to completion (Vs heroic, Olympic-scale, exclusive, high risk ones) and their public celebration at each stage -- to facilitate their spread -- thereby making well-being and environmental caring `contagious'?
11. Does it focus on: key opportunities and windows for change (pre-existing change moments')?
12. Does it explain: how it will effectively monitor and evaluate its progress (broad, long-term, as well as specific & short-term) by identifying and using integrator indicators and by being attentive to all feedback and outcomes (and redesigning future actions & initiatives accordingly)?

15.3. PUBLIC CAMPAIGNS FOR SPECIFIC PROJECTS.

Before starting a successful campaign, the following questions must be answered:

- What is the **aim** of this campaign? (building a new incineration plant, raising awareness, etc.)
- Who is the **addressee** or target group? (households, commercial enterprises, etc.)
- What is the **addressee's level of knowledge**? (knowledge about the planning stage, awareness of waste problems, of costs, etc.)
- What is the **addressee's interest and** what are his **incentives**? (cost minimisation, environmental protection, getting a good reputation, etc.)

Secondly, methods of publicity must be selected according to the characteristics of the population. Some possibilities are:

- low cost: news releases, public service announcements, community calendar announcements, letters to the editor, news articles, speeches, poster contests, church bulletin notices.
- medium cost: flyers, posters, fact sheets, media events, slide shows.
- high cost: commercials, TV, radio, media events, calendars, advertisements.

The type of information and the method of its distribution depend on the target groups of waste producers, such as households or production companies, or waste handlers, such as waste transport companies or waste treatment plants.

If the waste producer is a household, information about the sorting and delivery of solid waste, hazardous waste, etc., must be given directly to the household. This can be an expensive method, for which reason general information media may be preferred. Providing special municipal waste consultants, an information stand exhibited at different locations and fairs in town, a telephone hot line for quick answers, and several brochures available at many places in the city are some reliable methods of informing citizens.

If the waste producer is a company, a more specific method for providing information may be needed because of the eventual control and possibility of legal punishment for failures. A special industrial waste consultant for companies, a special waste hot line and a special brochure for different branches of industry would be good ways to inform the commercial sector. It may be necessary for the waste consultants to visit a plant or enterprise in order to develop a special waste management plan for the company together with the employees and management.

As a waste handler, a transport company will often play a key role in the system of waste control. For this reason, the information provided to them has to be more detailed. Training drivers and workers (providing detailed legal information about the methods of approval and punishment, and conflict management) may be a possible solution.

Direct information about waste treatment plants can be accessible due to the close connection between the city and treatment plants. Frequent and close communication is necessary for effective co-operation.

In certain cases (planning incineration plants, landfills, sorting plants, etc), it is necessary to have closer communication between cities and waste actors. A decision support system for waste management planning can be set up with a high degree of public participation in all phases from the very beginning to the end of the planning process, as well as in the controlling phase of environmental inspection. Maybe it is more important to speak about public interest in such issues as, for example, waste incineration. The public should be involved from the first planning steps to the final construction and operation phases of this type of plant. Communication at every milestone of the planning process may appear to be time consuming and expensive, but it is the only way to avoid interruptions during the building or running period of the plant due to lawsuits.

CASE EXAMPLES.

Project to verify and compare measurement methods of urban waste, through adequate and capillary interventions informing and sensitising citizens, aiming to support the change in financing from tax to tariff, Bolzano, Italy.
http://www.innovationbcn.net/participants/finalistes/f_seab_eng.htm

The project originated in a Legislative Decree on February 5, 1997, n. 22, art. 49, that states: "... all costs for services related to the management of urban waste, and of the waste of any nature or provenance, lying in the streets and public areas, and subject to public use, are covered by municipalities through the institution of a tariff."

From this set of rules, the Autonomous Province of Bolzano, among other things and through the Decree of the President of the Provincial council, n. 50/2000 and following modifications and integrations, began to impose a waste tariff.

The project was articulated in four phases:

Phase A) Consisting of:

- software for the management of domestic and non domestic users for the calculation of the urban solid collection (usc) tariff (data base management, category of users, emptying, and so on);
- onboard computer with data unit and system of dumpster identification and emptying;
- microchip and microchip stand to be fixed on containers from 120-240l to 1,100l.
  The device is to be applied on the lids of containers, in order to allow for opening through a personalised key or debit card, the disposal of predetermined volumes of garbage (15-20 litres).

Phase B) Delimitation of the territory:

- Depiction of the interested areas for the experiment; typology of service; users, container utilised, forms to enhance public sensitivity, related to programs and efficient means.

Phase C) Experiment;

- preventive sensitisation and information, carried out also during the experiment, of citizens;
- monitoring of the two realities;
- direct contact with citizens for the alteration of behaviours, and in order to communicate concerning development of the experiment;
- periodical product analysis of waste.

Phase D) Conclusion:

- arrangement of a detailed report of the results obtained;
- presentation of a qualitative and quantitative analysis of urban solid and differentiated collection;
- arrangement of an analysis of costs for the service;
- presentation of a virtual waste tariff;
- indication of possible ameliorations to introduce to the collections in order to apply a progressively more equal application of tariffs.

The experiment involved 4,800 citizens, and 792 businesses. The cost of the experiment, which took place, beginning in September 1999, and ending in June 2002, is equal to 327,633 Euro. Today it is possible for the Municipality of Bolzano to make its own choices on the topic of waste disposal through dedicated, but no longer anonymously owned, containers.

Castellbisbal taking care of our environment, Barcelona, Spain.
http://www.innovationbcn.net/participants/castellbisbal_cast.htm

"Castellbisbal, let's take care of our environment" is a project that seeks to radically transform the concept that the citizen has of waste and the value given to it. It seeks, therefore, to serve as catalyst from which to start a process of change and of environmental implication of both the citizens and the administration.

Based on the analysis of the municipality's environmental situation, the project is structured at two different levels:

1) INFORMATION: first hand information is given through the politicians directly involved, in meetings with no more than 80 citizens at a time, which allows two-directional information, and there is also audio-visual support and the participation of a local environmental entity and another prestigious regional one.

   Information flow is also kept constant and personalised by periodic visits of environmental educators to citizens' homes. It is transmitted by computer and graphic material, by a folder with collectable files, environmental signs and other materials like card albums, etc.

2) INFRASTRUCTURE: All the material necessary for citizens' active and effective participation is handed out.

   a) Buckets and compostible bags.
   b) Containers for the different types of waste placed at ecology islands.
   c) Containers for selective collection at shops, schools, etc.
   d) Green Point: an environmental point located in the centre of the town, where selective collection is concentrated.
   e) Other materials.

The keys to the success of the project are, on the one hand, recognition of the importance of citizens' participation in any process of environmental and ecological change. In this respect, emphasis is placed on the participation of citizens and the different sectors of the community. The campaign stresses the importance of changing the concept of the citizen regarding waste, in order to achieve a permanent change of habits, a basic goal to be reached in order to promote management based on re-use, recycling and minimising the production of waste.

On the other hand, the use of technologies to carry out the project, which goes from audio-visual to computer systems without forgetting the installation of a system pioneer in Catalonia for waste collection: buried containers which require the active spirit of the citizen's free and conscious participation.

Between the results achieved, it must be noted that the percentage of waste recovery obtained in 2001, was 54%, with a remaining 46% of inorganic waste which was sent to the Shredding Plant,(plant for selection and treatment of waste) from which a high percentage is also recovered. Another important figure is the 211.25 g/inhabitant/day of organic fragment collected during 2001, an amount in excess of that deemed optimum (200 g/inhabitant/day) by the Metropolitan Environmental Office of Barcelona.

Basic Environmental Education program. Macarena, Colombia.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=14797

The Association for the Defence of the Macarena is a non-profit NGO, which has worked in the Municipality of the Macarena for eleven years. It is located in the biological system of the Macarena Mountains where the three most important Neotropical ecosystems converge. This biological system is vitally important for the planet, since it has been considered biological patrimony since 1933 for being the oldest in the Andes and because flora and fauna representing a genetic bank of irreplaceable ecological value from all the Amazon come from there.
The biological system of the Macarena Mountains has suffered from strong human influence since 1953. They were populated by country people that had been displaced by the violent internal and social conflict, from which the country suffers. It is considered a reserve zone and a National Natural Park, where state services cannot legally reach. It is impossible for the Macarena Municipality to supply the basic needs of the country people, which live in distant hamlets. Among these services is education, a right from which a great part of the children living in the region are deprived.

These children face a hard social reality marked by illicit cocaine cultivation and the presence of a strong subversive force, led by the Marxist guerillas of the FARC-EP. The future of these children is directed to working in agricultural production without the possibility of living a full childhood, to work in the cultivation of coca, the only source of income for the country people, or join the guerrilla. Without efficient state policies, the preservation of the mountain is gravely threatened. Therefore, there is grave social deterioration, reflected in the biological system.

In 1995, the Association for the Defence of the Macarena, worried about this serious situation and in reSponse to the pleas of Macarena community representatives to supply teachers, university students from all fields were chosen to work a semester as school teachers in the communities which requested them.

In order to fulfil their objective, the Association found this to be the proper field so that through educational and cultural development programs, the perspective of a dignified life was offered to the children, reflected directly in the conservation of their environment. They work with an educational plan with an environmental emphasis, for peace and democracy, which is directed to developing all the children's mental and physical capacities, showing them other perspectives of work and life, along with the communities, for a better future for these Colombians. Children who have the right to live their childhood and dedicate it to building peace which necessarily guarantees the permanent union of the nation.

Environmental Education. Penápolis, Brazil.
http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=712

In general, the goal of the C.E.A is to develop a community conscious of the importance and necessity of preservation and conservation of nature, and especially of the Lajeado creek Hydric Manancial responsible for the maintenance of water for Penápolis city. It aims to create conditions for the community and especially for students of all ages, from primary school to university, so they can be able to:

- understand nature as a dynamic totality and its interdependence with humans ;
- appropriation and uses of nature by humans;
- know the ecological problems, the struggle for the preservation of the environment and the consequences regarding the planet's life from predatory practices and the polluters of environment;
- understand the importance of recycled garbage as a way to conservenature and as an example of supportable development;
- "cultivate" the respect and love of nature among children, youth and adults;
- know the works made in Penápolis County concerning Basic Sanitation and Environment developed by DAEP and preservations of local Hydric Manancial, creek Lajeado, developed by Creek Lajeado Inter-municipal Partnership.

The achieved results are: better quality of life, popular participation and awareness of it.

Global Village of Beijing. China.
http://www.gvbchina.org/English/english.htm

Global Village of Beijing(GVB) is an environmental non-profit and non-governmental organisation, boasting more than 4,000 volunteers nation-wide. Sheri Xiaoyi Liao, President of GVB, earned a Masters Degree of Philosophy from Zhongshan University in 1986.

Founded in 1996, GVB's mission is to help China achieve sustainable development by increasing public awareness and enhancing public participation.

Strategies:

1. Theory and practice of sustainable consumption.
2. Green community development.
3. Remediation of Desertification & biodiversity protection.
4. Environmental education of youth.

Its main functions include producing an environmental television program, publishing an environmental book series, developing an environmental training centre, initiating green communities, organising public activities such as Earth Day China, Green Olympics & Green Life.

GVB uses its international status to fulfil its mission to promote public environmental movements and civil society development in China. GVB has actively participated in international environmental activities. From 1998 to 2000, GVB was appointed the Global Environmental Facility (GEF) NGO Regional Focal Point and became the Environmental Country Portal, UNEP, in 2001. GVB is also a member of the Education Committee of IUCN and of the Asia-Pacific Environmental Journalist League.

GVB has been developing an international network promoting partnership and communication between NGOs, companies and officials by providing forums, newsletters and consultations. GVB also organises an environmental tour in China that includes briefing on the situation of environmental NGOs in China, a visit to local green communities, and a day-trip to GVB's Environmental Training Centre in Yanqing. The tour enables visitors to better understand China's environmental conditions and public environmental protection activities.

GVB's effort has been internationally recognised and reported widely by international media such as CNN, NHK, Star TV, News Week, and Reuters.

RELATED WEB SITES.

Alameda County Recycling Guide 2002
http://www.stopwaste.org/info.html

Environmental education
http://www.gdrc.org/uem/ee/6.html

Environmental Education. The Global Development Research Centre.
http://www.gdrc.org/

Environmental Education Resources on the Internet
http://eelink.net/

GLOBE
http://www.globe.gov/globe_flash.html

Learning for a Sustainable Environment
A Professional Development Guide for Teacher Educators
http://www.ens.gu.edu.au/ciree/LSE/

LEDO:
http://www.moe.gov.lb/ledo/index.html

Projet Education V. L'education relative à l'environnement dans l'enseignement fondamental et secondaire au Maroc. Rapport de Synthèse - OCTOBRE 1999
http://www.minenv.gov.ma/forum/login.htm

Recycled City
http://www.epa.gov/recyclecity/

US EPA for teachers & students
http://www.epa.gov/epaoswer/osw/students.htm

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16. EVALUATION AND UPDATING.

16.1. PLANNING CONTINUOUS EVALUATION AND UPDATING OF MEDIUM AND LONG TERM OBJECTIVES AND ACTIONS

Waste management planning has to be regarded as a continuous process. This means that it should go on for a long period without being stopped or interrupted. Waste management planning will of course be more or less intensive over time, but it is important that it continue at the hands of the staff responsible for planning.

The continuous planing function can be organised with the help of yearly evaluation reports on the situation in relation to the existing plan and the continuous analysis of the service management situation from a planning point of view.
This continuous function of planning will be a good basis for deciding whether revision of the existing waste plan is needed. It must even be decided how often the plan itself is to be revised, taking into consideration the intensive and difficult political and technical work this will mean, involving all the waste actors and decision makers.

It is recommended to revise the waste plan every five or six years if there has not been any reason to revise it before. Reasons for revising the plan may be as substantial as changes in the national planning or regulation body that seriously affects municipal services, unplanned phenomena such as the collapse of a landfill or treatment facility, municipal willingness for a big change in service delivery quality or in management methods and institutions, etc.

The plan revision has to focus on the goals, objectives and actions planned including economic, institutional, management and awareness issues. A political process of consultation and co-ordination with stakeholders and national authorities would be needed, as illustrated in point 16.2.

During the year, planning will consist of monitoring management actions and of external events that can influence the existing planning. Each year, the authority responsible for planning has to make a report on the planning process, and if needed, the corrective actions needed for plan accomplishment. Those actions will usually be within the existing plan framework and advancing the plan revision will not be needed.

Reviewing and revising programs to meet changing needs.

Even managers of successful programs must constantly review their programs' progress and make necessary adjustments. Integrated waste management is a fast-paced field with new technology, fluctuating market conditions, changing consumer waste generation patterns, and changing regulations such as federal and state environmental legislation. An effective program must be flexible enough to adapt to changes. All programs should be constantly reviewed and adjustments made when necessary. Program revisions are the basis for the continuos planning process.

Several municipalities use a "management group" for the survey and revision of the programme, led by the municipality responsible for the service with the presence of representatives of the main operational private or public institutions, (contractors, public agencies or companies). This group meets every week to share information about service delivery, co-ordinating ac-

tions, and advising the municipality about the program follow-up and revision needs.

For the purposes of the management functions of follow-up, co-ordination and program reviewing, recording and handling information is indispensable. For example, for the purposes of good program follow-up and revision, a minimum level of record keeping may be obtained through:

- Weekly reports (with indicators) on programme objectives and main actions. The actions should include all aspects of waste management such as: normal operation (collection system, landfill, other treatment facilities, collection and sale of recyclables, etc.); investments; special campaigns (e.g.: a new separate paper collection campaign, an awareness campaign, etc.); management tools (e.g.: contracting a private company for any service, creating a new internal service for monitoring service quality, etc.); etc.
- Weekly reports on citizen complains.
- Weekly management reports from private contractors.
- Weekly monitoring reports on incidents of operator and private contract breaches (Mainly from municipal inspectors and private company reports).
- Monthly budgeting report.
- Monthly personnel report
- Yearly public enquiries about behaviours and satisfaction with the system.
- Daily forms from the landfill, treatment facilities and those responsible for selling recyclables, about the inputs and outputs in quantity for each category, incidents and comments.

The planner should be aware of the reports of the persons responsible for management on programme changes and incidents

16.2. EVALUATING AND UPDATING THE PLAN.

Waste management planning evaluation and updating.

As we have already said, updating depends on the monitoring and evaluation of the results of the current waste management actions and of the annual report on plan implementation.

A table of contents for the yearly evaluation report could include the following subtitles:

- Introduction and background
- Presentation of the existing waste plan or strategy
- Evolution of national policies, planning and regulations, and global policy trends
- Assessment of the achievement of objectives and actions planned in waste reduction, reuse, collection, recycling, treatment and disposal.
- Other planned objectives achieved
- General environmental effects
- Data and results for different components of the waste stream
- Specific effects of the plan on waste producers and waste handlers regarding good hygiene and environmental preservation, as well as further improvement of waste handling
- Evaluation of the efficiency of awareness raising, communication and information
- Gaps and proposed corrective actions.

The main objective is the analysis of the achievement of planned objectives and main actions a well as the corrective actions needed and the assessment of the external facts, initiatives or trends that can seriously affect the actual plan framework.

So the information system for the planners must not only be about the main internal happenings but also about some select external items: national regulations, plans, programmes, etc, and relevant international facts or trends such as new aid for development policies and programmes, regulations from zones that can influence national regulations (such as the European Union), new technologies on municipal waste management, other towns' planning initiatives, etc.

New realities and unforeseen events may have an impact on the plan's implementation. These events, being difficult to control, illustrate the need for an uninterrupted and updated monitoring process.

To illustrate the difficulties of waste planning evaluation, here are some examples of situations that are difficult to predict:

- New framework regulations, for instance, forbidding deposition of organic waste or ordering companies to take back certain fractions, such as Ni-Cd batteries, tyres, packaging waste, electronics, freezers, construction elements, cars or parts of cars;
- New technology, such as solutions for treatment of hazardous fractions, mobile sewage systems, etc., or new practical possibilities for installations, for example, treatment facilities for freezers from which freon has been taken out;
- Falling prices for iron and other metals, paper, glass, packaging, cars or oil which could make it difficult to sell waste products for recovery;
- Public pressure to recycle certain types of products, these could be the ones composed of more than one fraction such as computers or cars which could not be easily split up into treatable fractions.

A holistic evaluation of the environmental effect of the plan is recommended as a tool to evaluate plan advancement in a very sensitive global approach such as global environment problems. Public opinion and municipal politicians would understand more the need for waste planning if they knew the positive effects of planned actions on the environmental problems of our world. The evaluation may include, for instance, the positive effect of collection and treatment of landfill gasses on the global greenhouse effect problem, or the quantity of trees, petrol and other materials that the selective collection and recycling of urban waste saves.

Determining the corrective action needed is not the responsibility of the planners but of those responsible for management. The planners need only identify and assess the gaps for those responsible for the sector with problems, who then have to propose the proper corrective actions to management.

Finally, if the evaluation report proposes a plan revision, the authority responsible should start a process of decision making and consultation, which will be followed up throughout the process.

Comparison with other cities.

During the evaluation process, it may be useful to compare the plan to similar ones in other cities. When planning and improving a waste management system, it is of vital importance to learn from each other.

As a condition, all cities have to be prepared to share not only their successes but also failures and problems. And it is of equal importance to remember while carrying out the comparison that all systems must adapt to the local circumstances.

Considering all the different factors and levers in the system: public/private ownership, incineration and recycling facilities, just to mention a few, it might seem difficult to compare the actual performance of the systems.

A benchmarking system must at least consist of two elements: comparable indicators, and evaluation of the best waste management practices in the cities.

It would be beneficial if a benchmarking system could be developed. Clear evidence of possible ways to achieve significant results, as obtained from some cities, would be invaluable.

Benchmarking at the level of a waste department provides insight into the performance of the cities in the field of waste management, and stimulates this performance. Participation of the cities' waste departments in these activities improves the benchmarking process and strengthens their individual market position.

16.3. EVALUATING AND UPDATING SPECIFIC INITITATIVES.

The evaluation and updating of specific initiatives must be focused on identifying changes in the service needs, and on evaluating the effectiveness of the system in meeting its goals and objectives. The following are the main aspects to consider in different initiatives:

Prevention

- Track the cost associated with source reduction and integrate it into the decision-making process.
- Quantify source reduction program results

Education

- Help monitor and evaluate policies.
- Inform people about formal evaluations and results
- Help stakeholders participate in formal evaluations

Collection and transport

- Effective systems for cost and performance reporting (quantity, distance, waiting times, etc)
- Collect vehicle and weight information on the transfer station

Waste treatment

- Every form of waste treatment (organic recycling, non-organic recycling, waste to energy and land disposal) must have an effective evaluation and monitoring system, specific for each treatment, with which problems and non-performances can be detected.
- Periodically obtain information about product marketing, public participation, environmental concerns, etc.

CASE EXAMPLES.

First biannual revision 1998-1999 of the Metropolitan Plan for Urban Waste Management (PMGRM), Area Metropolitana de Barcelona, Catalonia, Spain.
http://www.ema-amb.com/english/index.html#3
http://www.ema-amb.com/pdf/memoria_2001_amr.pdf

The PMGRM is committed to the principles of sustainable development. It therefore fosters joint actions by governments and non-governmental organisations with the goal of broad citizen involvement both in its implementation and monitoring and in the promotion of new initiatives. An annual report is published as a summary of the activities undertaken.

The PMGRM sets its objectives for two-year periods, the first of which finished in 2000. The plan itself, originally conceived as a dynamic process, calls for a process of revision at the end of each two year period to adapt it to the developments occurring during that period and to technological advances, both with respect to the facilities and the deployment of the different types of collection planned for the whole metropolitan area.

The first biannual revision includes updated legislation that came into force after the implementation of the plan; results obtained from separate collection; accomplishment of the construction of facilities design; performance of facilities operating; and revision of financing and awareness raising campaigns. Based on the results of this revision, proposals are established for the updating of the plan.

Mukuru Recycling Centre - A Gender Evaluation. January 2001. Nairobi, Kenya.
http://www.sustainabledevelopment.org/blp/learning/casestudies/mukuru.html

Dandora waste dumping ground is the main dumpsite for the city of Nairobi. Some 2000 people, including men, women and children, are living and working at the dumping ground. In 1991, two priests of the Kariobangi Catholic Church, Father John Nobilo and Father Alex Zanotelli, established the Mukuru Project. Mukuru Recycling Centre was created to organise the inhabitants of the Korogocho slums whose lives are linked to the neighbouring Nairobi City Council (NCC) dumpsite in Dandora. The main aim of this project was to rehabilitate its members who were originally operating and living in the Dandora dumpsite, to improve their waste scavenging activities by introducing better methods that are economically viable and to cut down exploitation by waste dealers (middlemen). UNCHS (Habitat) joined the project in 1995, providing technical support and knowledge about waste management technologies and by now has been involved in collaboration with MRC for the past five years.

The project consists of four groups. The first group started in 1991 with the main objective to organise scavengers from Dandora. The main activities of this group are the collection, sorting and sales of recyclable waste. The second group, started its operation in 1993 and collects waste from several commercial business buildings in Narobi. In 1996 the Mukurucomposting and urban agricultural group was formed, dealing with the recycling of organic waste into compost and agricultural gardening. The fourth group, created in 1997, recycles waste paper and sawdust into briquettes, to be used as a source of fuel.

An evaluation was carried out with tools such as the use of secondary data, interviews with the project implementers and a survey of the representatives of the project beneficiaries. These different tools of inquiry were combined with direct observations during field visits.As a result of the evaluation, some improvements and changes due to the implementation of Mukuru Recycling Centre can be outlined. The Centre creates job opportunities for women and men and provides its members with financial income. The salary is still relatively low but the work within MRC is easier and on better conditions compared to the work in the dump-site.

Within Mukuru Recycling Centre, the members work collectively together, they share their ideas, support and learn from each other. Regular meetings are set up to discuss the work-ing schedule or any problems faced. Kamati Kuu, the Central Management Committee is a unifying and regulatory organ within Mukuru Recycling Centre that constitutes representa-tives from each of the four groups. Things have improved for most of the members because of the solidarity and support within the group.

The evaluation also shows the problems and difficulties of the Project. For example, the pro-ject does not guarantee sufficient work for all members as well as regular income. Members of Mukuru A, Mukuru B and Mbolea complain about this issue. Due to the fact that there is not enough work for all within the Centre many of them return to the dumpsite to earn their living.

The evaluation makes some important conclusions to be taken into account when updating the project. The results of Mukuru Recycling Centre are quite satisfying but nevertheless for MRC to become sustainable and efficient, there is a need for training its members in basic numeracy and literacy, as well as leadership.

RELATED WEB SITES.

CDSI
http://www.citydev.org/

Le projet Système d'Information et Données sur l'Environnement (SIDE)
http://www.minenv.gov.ma/projets/side.htm

Working with others to find better Solutions
http://199.212.16.11/solutions/english/circle.html

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- EPA Copenhagen with European Commission Environment Directorate-General. **Wasteguide. Framework and strategies for waste management in European cities.** November 1999.

ANNEX A. GLOSSARY OF TERMS

The terms included in this Annex are the terms employed by the World Bank.

A

Aerobic Treatment: The process by which microbes decompose complex organic compounds in the presence of oxygen and use the liberated energy for reproduction and growth (such processes include composting, secondary wastewater treatment, extended aeration, trickling filtration, and rotating biological contractors) .

Anaerobic Decomposition: The second phase of decomposition that typically occurs in landfilled wastes. Refers to decomposition in the absence of oxygen with (when complete) results in the formation of mainly methane (CH4) and carbon dioxide (CO2) gases.

Ash: Inorganic, particulate residue of combustion. Ash is usually polluted by small quantities of organic material resulting from incomplete combustion.

B

Bacteria: (Singular: bacterium): Microscopic living organisms that can aid in pollution control by metabolising organic matter in municipal wastewater (sewage), oil spills or other pollutants. However bacteria in soil, waterbody or air can also cause human, animal and plant health problems.

Best Practice: The planning and/or operational practice that is the most technically and politically feasible, cost-effective, sustainable, environmentally beneficial and socially sensitive, to a particular locality.

Biodegradable: Capable of decomposing rapidly by microorganisms under natural conditions (aerobic and/or anaerobic). Most organic materials, such as food scraps and paper are biodegradable.

Biogas: Gas formed by digestion of organic materials. Typically dominated by CH4 and CO2 in a landfill.

Biological Treatment: A treatment technology that uses bacteria to consume organic fraction of municipal solid waste/wastewater.

Bring System: Collective term for methods of household waste separation at the point of generation involving the consumer taking separated materials to recycling centres (e.g., to take bottle to bottle banks).

Bulky Waste: Large items of municipal solid waste including but not limited to appliances, furniture, large auto parts, tree stumps etc., which cannot be handled by normal municipal solid waste management methods.

C

Calorific Value: The quantity of heat generated when unit mass of a material undergoes complete combustion under certain specified conditions. It is expressed in terms of kilo Joules (kJ) per kilogramme for solid or liquid fuels and kilo Joules per cubic metre for gases (kJ/m3). Gross (or 'higher') calorific value includes the enthalpy of vaporisation; net (or 'lower') calorific value excludes it.

Capital cost: Investment cost. Includes items such as land, site development, infrastructure, plant and equipment and licence costs.

Chemical Treatment: Any one of a variety of technologies that use chemicals or a variety of chemical processes to treat municipal solid waste.

Closure: The procedure a landfill operator must follow when a landfill reaches its legal capacity for municipal solid waste disposal which includes ceasing acceptance of municipal solid waste and placing a cap on the landfill site.

Collection: The process of picking up wastes from residences, businesses, or a collection point, loading them into a vehicle, and transporting them to a processing site, transfer station or landfill.

Combustion: Refers to controlled burning of municipal solid waste, in which heat chemically alters organic compounds, converting into stable inorganics such as carbon dioxide and water.

Commercial Waste: All municipal solid waste emanating from business establishments such as stores, markets, office buildings, restaurants, shopping centres, and entertainment centres.

Compaction: Reduction of the bulk of municipal solid waste and increasing its density through a physical process such as rolling or tamping or as a result of waste compacting under its own weight.

Compost: The relatively stable humus material that is produced from a composting process of putrescible fraction of MSW in which bacteria in soil mixed with it break down the mixture into organic fertiliser.

Composting: 1. The controlled biological decomposition of putrescible fraction of MSW in the presence of air to form a humus-like material. Controlled methods of composting include mechanical mixing and aerating, ventilating the materials by dropping them through a vertical series of aerated chambers, or placing the compost in piles out in the open air and mixing it or turning it periodically (windrow composting). 2. The controlled degradation of putrescible fraction of MSW following some form of pre-processing to remove non-compostible MSW.

Construction and Demolition Waste: MSW originated from or use of building materials, dredging materials, tree stumps, and rubble resulting from construction, re-modelling, repair, and demolition of homes, commercial buildings and other structures and pavements. The nature of this MSW depends upon the resources used in a given region or country for the purposes of construction. In the absence of adequate local ordinance, responsibility for the management of these wastes is invariably assumed to lie with the municipality.

Contaminant: Any physical, chemical, biological, or radiological substance or matter that has an adverse affect on air, water, or soil.

Corrugated Paper: Paper or cardboard manufactured in a series of wrinkles or folds, or into alternating ridges and grooves.

Cost Recovery: Recovering the cost of MSWM or other municipal services from the users. Cost recovery may be by direct or indirect charges.

Cover Material: Material used to cover municipal solid wastes disposed in landfills. Covering materials can be gravel, topsoil, excavation residues, or slag. Daily cover for a landfill might be important to reduce odours, nuisance, vectors, fires, landfill gas migration, and vegetation growth. Fifteen centimetres of compacted soil cover will generally achieve these desired functions. Soil texture determines the suitability of that soil for use as cover. Some areas allow the use of 'artificial cover' in lieu of compacted dirt. Examples are foam, geotextiles and plastic sheets.

Curb-side Collection (kerbside collection): Method of collecting recyclable materials at homes, community districts or businesses.

D

Decomposition: The breakdown of matter by bacteria and fungi changing the chemical makeup and physical appearance of MSW in landfills, composting and/or fermentation processes.

Digestion: The biochemical decomposition of organic matter of MSW, resulting in its partial gasification, liquefaction, and mineralisation.

Direct charges: The user of the service is charged for the use of the service, related directly to the extent of use. For MSWM, used widely for commercial and industrial wastes, less so for household wastes. See also Indirect Charges.

Disposal: 1. The final placement of MSW that is not salvaged or recycled. 2. The process of finally disposing MSW in a landfill. 3 MSW disposal is an ultimate action by which MSW is disposed on land in acceptable engineering manner with and/or without previous treatment/processing and/or recycling.

Domestic Waste: See Household Waste.

Drop-off: Recyclable materials collection method in which individuals bring them to a designated collection site.

Dump: A site used to dispose of municipal solid waste without management and/or environmental controls.

E

Effluent: The fluid discharged to the external environment.

Emission: A material which is expelled or released to the environment. Usually applied to gaseous or odorous releases to atmosphere.

Energy Recovery: Obtaining energy from MSW through a variety of processes (eg combustion.)

Environment: The sum of all external conditions affecting the life, development and survival of an organism.

Erosion: The wearing away and removal of weathered land surfaces by natural agents such as rain, running water, wind, temperature changes and bacteria.

F

Fermentation: Chemical reactions carried out by living microbes that are supplied with nutrients in the presence of heat, pressure, and light. The result of these reaction is usually methane, carbon dioxide and water.

Final Cover: Also known as secondary cover. The purpose is to make the landfill area suitable for the intended after use. Must be compacted (except the top soil), uniformly applied, and sloped to drain. Final cover must be designed to reduce infiltration, encourage run-off, while discouraging erosion, retain moisture for plant root growth and development, and reduce or enhance landfill gas migration. Depth and design requirements differ.

Fly Ash: Non-combustible residual particles of MSW expelled by flue gas.

G

Garbage: An American term for municipal solid waste arisings which include the putrescible fraction of MSW such as animal and vegetable waste resulting from the handling, storage, sale, preparation, cooking, and serving of foods.

Gas Control and Recovery System: A series of vertical wells or horizontal trenches containing permeable materials and perforated piping. The systems are designed to collect landfill gases for treatment or for use as an energy source.

Gas Migration: Is the movement of gas, either above or underground, from one area to another e.g., from within a landfill to the outside of the boundaries of the fill area. Gas is driven by two primary mechanisms, pressure and diffusion. Landfill gas exits from a landfill by vertical migration, lateral migration and migration along paths of least resistance until openings permit the release to the atmosphere. Landfill gas is heavier than air and therefore it can settle in low spots including sewers, basements, etc., and cause explosion and fires.

Generation: 1. MSW generation is a process of creating heterogeneous mixture of materials which are considered to be of no further use to the MSW generator. MSW is usually discarded from households, residential areas, commercial activities, educational establishments, hospital and clinics, business, shops, industries, etc. 2. Non-hazardous industrial waste, acceptable quantities of non-hazardous agricultural wastes, municipal wastewater (sewage) sludge and acceptable quantities of non-hazardous industrial sludges are also included in municipal solid waste generation.

Groundwater. The supply of fresh water found beneath the Earth's surface, usually in aquifers, which supply wells and springs. Because groundwater is a major source of drinking water, there is growing concern over contamination from leaching pollutants out of dumping and/or badly managed landfill sites.

H

Handling, Collection and Transportation: The process of picking up MSW from residences, businesses, or a collection point, loading them into a vehicle, and transporting them to a processing site, transfer station or landfill.

Hazardous Waste: Waste generated during production or other activities by society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity).

Heavy Metals: Metallic elements with high atomic weights, e.g., mercury, chromium, cadmium, arsenic, and lead. It can damage living things at low concentrations and tend to accumulate in the food chain through build up of concentrations in plant and animal tissue.

High-income country. A country having an annual gross national product (GNP) per capita equivalent to $9,361 or greater in 1998. Most high-income countries have an industrial economy. There are currently about 28 high-income countries in the world with populations of one million people or more. Their combined population is about 0.9 billion, less than one-sixth of the world's population.

Household Waste (Domestic Waste): MSW composed of garbage and rubbish, which is generated as the consequence of household activities. In developing countries, up to two thirds of this category consists of putrescible fraction of MSW. In poor neighbourhoods traditional cooking can also produce ash and where sanitation facilities are limited, the waste might also include faecal matter. Domestic waste may contain a significant amount of hazardous waste.

I

Incineration: 1. A treatment technology involving destruction of MSW by controlled burning at high temperatures, eg, burning sludge to reduce the remaining residues to a safe, non-combustible ash which can be disposed of safely on land. 2. The thermal process aimed in MSW destruction. It is applied in countries where high content of combustible fraction (paper and plastics/synthetics) is present in the MSW and where land for disposal is very limited and scarce. The main objective of this process is in reducing volume of MSW so that landfill life span could be extended. It requires high technological level in the country which is supported by adequate equipment, infrastructure facility and trained personnel.

Indirect Charges: Payment for a service (in this case MSWM) is linked either to the general municipal charge (e.g., property tax), or to another service for which charges are paid on the extent of use, and where the sanction of disconnection exists for non-payment (e.g., drinking water, sewage or electricity).

Industrial Waste: A heterogeneous mixture of different materials generated during an industrial operation. It may be gaseous, liquid, sludge, and/or solid. The composition is site specific and depends upon the natural resources, raw materials and markets which provide the base for a given city's industrial activity.

Inert Material: The term is commonly used to describe material which is unaffected by chemical and/or biological processes. Generally indicating that the presence of such material has no relevant influence on the process under study, e.g., glass does not contribute to methane formation and can be regarded as inert in that aspect.

Informal Sector: The part of an economy that is characterised by private, usually small-scale, labour-intensive, largely unregulated, and unregistered manufacturing or provision of services. In MSWM it refers to recycling activities (see: waste picking, scavenging).

Institutional Waste: Waste originating in schools, hospitals, prisons, research organisations and other public buildings. Where the institution involves residents, the waste composition is similar to those from households.

Integrated Waste Management: 1. A frame of reference for designing and implementing new waste management systems and for analysing and optimising existing systems Based on the concept that all the strategic aspects of the MSWM system should be analysed together since they are interrelated and development in one component frequently affects other areas of the system. 2. A practise using several alternative waste management techniques to manage and dispose of specific components of the municipal solid waste stream. Waste management alternatives include source reduction, recycling, composting, energy recovery and landfilling.

K

Key Stakeholders: Those persons, groups or institutions who can significantly influence, or are important to the success of a project/programme.

L

Landfill Gases: Gases arising from the decomposition of the organic (putrescible) fraction of MSW; principally methane, carbon dioxide, and hydrogen sulphide. Such gases may cause explosions at landfills if not properly managed.

Landfills: Designed, controlled and managed disposal sites for MSW spread in layers, compacted to the smallest practical volume, and covered by material applied at the end of each operating day (see also sanitary landfill).

Law: Generally used for primary national legislation, often at generic or 'enabling' level, requiring detailed regulations for its implementations.

Leachate: Wastewater that collects contaminants as it trickles through MSW disposed in a landfill. Leaching may result in hazardous substances entering surface water, ground water, or soil.

License: see Permit

Liner: A relatively impermeable barrier designed to contain leachate within a landfill. Liner materials include plastic and dense clay.

Litter: Wind blown municipal solid wastes (predominantly plastics and paper) at a waste handling, treatment or landfill facility.

Low-income countries: In the context of this Planning Guide, low-income refers to cities in low-income and lower-middle income countries as defined by the World Bank. The term "low-income country" is used to replace the term "developing country". According to the World Bank Atlas classification system, low-income countries, are those with a GNP per capita of equal or less than $695 (in 1993 dollars). In comparison, Lower-middle income countries have GNP per capita between $696 - $2,785, Upper-middle income countries: $2,786 - $8,625, and High-income countries have a GNP per capita of equal to or more then $8,626.

M

Manual Separation: Hand separation of compostable or recyclable material from MSW.

Manufactured products. Goods--for example, shoes, trucks, paper, radios, electric motors, and canned fruit-that are produced from raw materials by hand or by machine.

Materials Recovery Facility (MRF): Facility that processes residentially collected mixed recyclables into new products.

Mechanical Separation: Using mechanical means to separate MSW into various components.

Methane: A colourless, non-poisonous, flammable gas (CH4) created by anaerobic decomposition of organic compounds. It is explosive and should be handled with care (see also "anaerobic decomposition", "biogas").

Micro-organism: Living organisms so small that individually they can only be seen through a microscope.

Middle-income country. A country having an annual gross national product (GNP) per capita equivalent to more than $760 but less than $9,360 in 1998. The standard of living is higher than in low-income countries, and people have access to more goods and services, but many people still cannot meet their basic needs. There are currently about 65 middle-income countries with populations of one million or more. Their combined population is more than 1.5 billion.

Minimisation: A comprehensive program to minimise or eliminate wastes, usually applied to wastes at their point of generation. (See: waste minimisation.)

Moisture Content: The fraction or percentage of a substance or soil that is water.

Monitoring: 1. Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements. 2. A process including physical examination, measurements by portable instruments and analysis of sample to provide information for assessment of conditions.

Municipal Solid Waste (MSW): Includes non-hazardous waste generated in households, commercial and business establishments, institutions, and non-hazardous industrial process wastes, agricultural wastes and sewage sludge. In practice, specific definitions vary across jurisdictions.

MSW Management (MSWM): Supervised municipal solid waste management from their source of generation through collection or street sweeping, recovery and/or treatment/ processes to disposal.

N

NIMBY: Acronym for "Not In My Back Yard"; an expression of resident opposition to the siting of a municipal solid waste management facility based on the particular location proposed.

O

Odour Control: The use of equipment such as activated carbon filters, odour- attenuating cover materials, and gas flaring to reduce or eliminate odorous gases emanating from decomposing wastes.

Open Dump: A site used for disposal of waste without any management and/or environmental controls (see also dump).

Operating cost: They are the day to day expenses of an operation. They include items such as labour, fuel, materials, chemicals, utilities, repairs and maintenance, and insurance.

Organic Chemicals/Compounds: Animal or plant-produced substances containing mainly carbon, hydrogen, nitrogen, and oxygen.

Organic Matter: Carbonaceous material contained in plant or animal matter and originating from domestic or industrial sources.

Oxidation: The reaction with oxygen which breaks down organic waste or chemicals such as cyanides, phenols, and organic sulphur compounds in municipal wastewater (sewage) by bacterial and chemical means.

P

Packaging: The assembly of one or more containers and any other components necessary to assure minimum compliance with a programme's storage and shipment packaging requirements. In industrial countries it represents the largest fraction of MSW.

Packaging Waste: Material discarded after the product in the packaged materials has been removed for use. Such a waste is discarded by both residential, commercial and industrial sectors.

Pathogens: Micro-organisms that can cause disease in other organisms or in humans, animals and plants (eg bacteria, viruses, or parasites) found in municipal solid waste, sewage, in runoff from farms or rural areas populated with domestic and wild animals, and in water used for swimming.

Permeability: A measure of how well a liquid moves through the pores of a solid. Expressed as a number applied to landfills in terms of how quickly water moves through compacted MSW disposed; it is typically expressed as centimetres per second.

Permit: An authorisation, license, or equivalent control document issued by governmental body or an approved state agency to implement the requirements of an environmental regulation; eg a permit to operate a landfill site or to operate a facility that may generate harmful emissions.

Pest: An insect, rodent, nematode, fungus, weed or other form of terrestrial or aquatic plant or animal life that is injurious to health or the environment.

Physical and Chemical Treatment: Processes generally used in large-scale waste-water treatment facilities. Physical processes may include air-stripping or filtration. Chemical treatment includes coagulation, chlorination, or ozonisation.

Plastics: Non-metallic chemically reactive compounds (polymers) moulded into rigid or pliable construction materials, fabrics, etc. It represents considerable fraction of MSW in industrial countries.

Policy: A series of broad statements setting out the overall policy framework for either environmental management and/or MSWM at the national or regional level. For MSWM, policy is often termed a "national sector strategy".

Pollution: Generally, the presence of matter or energy whose nature, location, or quantity generates undesired environmental effects.

Post-Closure: The time period following the shutdown of a MSWM or manufacturing facility; for monitoring purposes, often considered to be 30 years (also used terms are after care and/or restoration).

Post-Consumer Materials: Materials that a consumer has finished using, which the consumer may sell, give away, or discarded as municipal solid wastes.

Pre-treatment: Process used to reduce, eliminate, or alter the nature of wastewater pollutants from non-domestic sources before they are discharged into wastewater treatment facility.

Primary Stakeholders: Those persons, groups or institutions directly affected, either positively (beneficiaries) or negatively (for example, those involuntarily resettled) by a proposed action or plan.

Private Sector: The part of economy in which economic activity is carried out by private enterprise as distinct from the public sector.

Producer Responsibility: In order to reduce generation of packaging and other commercial waste, many governments have introduced the legislation requiring certain type of 'producers' to minimise their packaging and/or accept back their own products which have no more value for consumers. In effect, the responsibility e.g., for packaging waste is transferred for the municipality to the 'producer'.

Public Awareness and Education: Public Awareness and Education campaigns can take many shapes and forms. Just a few examples are information leaflets, public hearings, radio programs, advertisements, lectures and school curriculum interventions.

Public Cleansing Services: A variety of services related to waste collection, which may include street sweeping, gully emptying, drain cleaning, night soil removal, septic tanks/cess pit emptying, beach and foreshore cleaning, snow and mud cleaning, grass cutting, waste backlog clearance, clean up after natural disasters, letter prevention, graffiti removal, cleaning of public toilets and/or other cleaning tasks.

Public Consultation - The process of engaging affected people and other interested parties in open dialogue through which a range of views and concerns can be expressed in order to inform decision-making and help build consensus. To be meaningful, consultation should be carried out in a culturally appropriate manner, with information in local languages distributed in advance.

Public Disclosure - The process of making information available to affected people and other interested parties, particularly with regard to the environmental and social aspects of projects. Disclosure of information should be done in a timely manner, in publicly accessible locations and in a language and format readily understood by affected groups.

Putrescible: A fraction of MSW which can decompose under aerobic or anaerobic conditions, used as a feedstock for composting or anaerobic digestion processes.

Pyrolysis: Decomposition of an organic substance (by heating, in the absence of oxygen) to degrade solid wastes to oils and gas.

Q

Quality Assurance/Quality Control: A system of procedures, checks, audits, and corrective actions to ensure that all research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.

R

Recovery: Chemical/biological processes such as biogas (methane) generation carrying out at the landfill to recover gas (energy/heat). Municipal wastewater sludge generated at the municipal wastewater treatment facility are usually added to enhance process of gas generation. Putrescible fraction of the MSW is also used to produce compost and/or methane by fermentation (anaerobic digestion). 2. The process by which MSW otherwise destined for disposal are collected, re-processed or re-manufactured, and reused.

Recurrent Costs: The costs incurred in operating MSWM services. They can include: direct operational expenditures, such as expenditure on wages, fuel and maintenance; provisions (accrued expenses) for liabilities such as employee pension obligations and insurance payments; regular recurrent cash outlays, such as debt repayment and service charges (capital and interest); and a provision (depreciation) for recovering the value of the capital assets progressively used up in delivering the service;

Recyclables: MSW fractions that still have useful physical and/or chemical properties after serving their original purpose and that can therefore, be reused or re-manufactured into additional products.

Recycling: Separation physical/mechanical process by which secondary raw materials (paper, metals, glass, plastics/synthetics) are obtained from MSW. The process could be accomplished manually, by simple and/or sophisticated mechanical equipment.

Refuse: Another term for municipal solid waste.

Refuse-Derived Fuels (RDF): Product of a mixed MSW processing system in which certain recyclable and not combustible materials are removed and the remaining combustible material is converted for use as a fuel to generate energy.

Regulation: Generally used for secondary national legislation; i.e. detailed regulations to implement a more general law.

Remediation: Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a site.

Renewable. Able to be replaced or replenished, either by the earth's natural processes or by human action. Air, water, and forests are often considered to be example of renewable resources. However, due to local geographic conditions and costs involved, strong arguments can be made that water may not be a completely renewable resource in some parts of the world, especially in developing countries or in areas with limited groundwater supplies. Minerals and fossil fuels are examples of non-renewable resources.

Residual: Amount of a pollutant remaining in the environment after a natural or technological process has taken place, eg the sludge remaining after initial wastewater treatment, or particulates remaining in air after it passes through a scrubbing or other process.

Residue: The materials remaining after processing, incineration, composting or recycling of MSW. Residues are usually disposed of in landfills.

Resources. The machines, workers, money, land, raw materials, and other things that a country can use to produce goods and services and to make its economy grow. Resources may be renewable or nonrenewable. Countries must use their resources wisely to ensure long term prosperity.

Restoration: Completion of a landfill site to allow planned after-use.

Reuse: Using a component of MSW in its original form more than once, eg refilling a glass bottle that has been returned or using a coffee can to hold nuts and bolts.

Revenue: Income, especially of large amount from any source.

Rubbish: The US EPA defines rubbish as municipal solid waste, excluding food waste and ashes, from homes, institutions, and work-places.

Run-off: That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface-water. It can carry pollutants from the air and land into receiving waterbody.

S

Sanitary Landfill: A US term for land MSW disposal site that is located to minimise water pollution from runoff and leaching. MSW is spread in thin layers, compacted, and covered with a fresh layer of soil each day to minimise pest, aesthetic, disease, air pollution, and water pollution problems (see also: landfill).

Sanitation. Maintaining clean, hygienic conditions that help prevent disease through services such as garbage collection and wastewater disposal.

Scavenging: informal removal of materials at any point in the solid waste management system.

Scrap: Materials (principally metallic) discarded from manufacturing operations that may be suitable for reprocessing.

Secondary Raw Materials (SRM): 1. Materials that have been manufactured and used at least once and are to be used again. 2. Secondary materials (eg paper, glass, metals, etc) obtained from municipal solid waste by the processes of reuse, recycling and/or recovery carried out at the municipal solid waste treatment/process facilities.

Separated Waste Collection, Transfer and/or Transport: The process of collecting and removing MSW which have been separated in order to facilitate their re-use, recycling, processing or disposal.

Shredder: A mechanical device used to break MSW materials into smaller pieces by tearing and impact action. Shredding MSW is done to minimise its volume or make it more readily combustible.

Soil Conditioner (Soil Improver) : An organic material like humus or compost that helps soil absorb water, build a bacterial community, and take up mineral nutrients.

Source Reduction: Reducing the amount of waste entering the MSW stream by redesigning products or patterns of production or consumption (eg using returnable beverage containers). Synonymous with waste reduction.

Source Separation: Segregating various wastes at the point of generation (eg separation of paper, metal and glass from other wastes to make recycling simpler and more efficient).

Stakeholders - Stakeholders are persons or groups who are affected by or can affect the outcome of a project. These can include affected communities, local organizations, NGOs and government authorities. Stakeholders can also include politicians, commercial and industrial enterprises, labor unions, academics, religious groups, national social and environmental public sector agencies and the media.

Storage: Temporary holding of MWS pending collection, transportation, treatment or disposal as in containers, tanks, waste piles (see temporary storage).

Street Sweeping: Handling, collecting and removing dust/sand, dirt and litter. In low-income countries streets may also contain appreciable quantities of household waste, drain cleanings, human and animal faecal matter. See also Public Cleansing.

Surveillance System: A series of monitoring devices designed to check on environmental conditions.

Sustainable development. Development that meets the needs of the people today without compromising the ability of future generations to meet their own needs.

T

Temporary Storage: Temporary holding of MWS pending collection, transportation, treatment or disposal as in containers, tanks, waste piles (see storage).

Thermal Treatment: Use of elevated temperatures to treat MSW. (See incineration).

Tipping Fee: A fee for unloading MSW at a landfill, transfer station or recycling facility.

Tonnage: The amount of waste that a landfill accepts, usually expressed in tons per month. The rate at which a landfill accepts waste is limited by the landfill's permit.

Toxic: Harmful to living organisms.

Toxic Pollutants: Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Transfer: The movement of MSW between different stages in the handling, collection and transportation process.

Transfer Station: 1. A facility at which municipal solid waste from collection vehicles is consolidated into loads that are transported by larger trucks or other means to more distant landfill sites. 2. A transfer stations can be adapted to serve also as a materials recovery facility.

Transportation: The physical process of moving waste.

Treatment: Any method, technique, or process designed to remove solids and/or pollutants from MSW streams, effluents, and air emissions.

U

User Charges: Payment for a service by the users of that service. Are a preferred means of raising new revenue because they can be presented and justified to the public on the grounds that they are required for and will be used in the provision of an important public service such as MSWM. See also Direct Charges and Indirect Charges.

V

Virgin Materials: Resources extracted from nature in their raw form, such as timber or metal ore.

Virus: The smallest form of micro-organisms capable of causing disease.

Volume-Based Fees: A fee paid to dispose of MSW at a facility such as a landfill, based on the volume of the MSW being disposed of.

W

Waste: 1. Unwanted materials left over from any human activity. 2. Refuse from places of human or animal habitation. Waste may be generically defined as heterogeneous mixture of material which is discarded as superfluous and has no further use or value to its owner. The EC Framework Directive on Waste defines waste as "any substance or object which the holder discards or intends or is required to discard". In waste planning there are various categorisations of waste (*eg* municipal solid waste, controlled waste, hazardous waste *etc*), and the terms relevant to this guide have been defined elsewhere in this glossary.

Waste Management Hierarchy: The waste management hierarchy is a symbol for the strategic options available for dealing with MSW and their desirability. An adapted version of the hierarchy presents the more `desirable' waste management practices at the top of the hierarchy (avoid, minimise and/or recover material) and the least `desirable' practices at the bottom (treatment and/or disposal in landfill), with dumping "floating" around the bottom, not even recognised by the MSWM concepts as an option in industrialised countries of the West.

Waste Minimisation: Measures or techniques that reduce the amount of wastes generated during industrial production processes; the term is also applied to recycling and other efforts to reduce the amount of waste going into the waste management system (also waste reduction).

Waste Picking: A process of extraction of recyclables and reusables materials from a mixed MSW for further use and/or processing.

Waste Stream: The total flow of MSW from homes, businesses, institutions, and manufacturing plants that are recycled, burned, or disposed of in landfills, or segments thereof such as the "residential waste stream" or the "recyclable waste stream".

Waste-to-Energy Plant: Combustion of MSW to generate electrical energy or heat

Wet/Dry Collection Systems: A collection system that allows wet organic materials to be separated by generators from dry MSW. Wet organic materials are suitable for composting, while dry materials are non-organics that may include recyclables.

XYZ

Yard Waste (Yard Trimmings): The part of MSW composed of grass clippings, leaves, twigs, branches, and garden refuse.

ANNEX B. RELATED WEB SITES

- CDSI (http://www.citydev.org/)
- Database on good Practice in urban waste management and sustainability http://europa.eu.int/comm/urban
- European Investment Bank (http://www.eib.org)
- European topic centre on waste and material flows http://waste.eionet.eu.int/activities/0000108.html
- Global Ecovillage Network (http://www.gaia.org/)
- Global Recycling Network (GRN) (http://www.grn.com/grn/)
- International Centre for Sustainable Cities (http://www.icsc.ca/)
- International Council for Local Environmental Initiatives (ICLEI) http://www.iclei.org/
- Local sustainability (http://www3.iclei.org/egpis/)
- ORBIT Association (http://www.orbit-online.net/)
- Organisation for Economic Cooperation and Development (OECD) http://www.oecd.org/l
- Sustainable urbanisation (http://www.sustainabledevelopment.org/blp)
- The Global Development Research Centre (http://www.gdrc.org)
- UNESCO (http://www.unesco.org)
- UNITED NATIONS (http://www.un.org/)
- UN HABITAT sustainable development (http://www.sustainabledevelopment.org/)
- United Nations Development Programme (UNDP) (http://www.undp.org)
- United Nations Environmental Programme (UNEP) (http://www.unep.org/)
- WORLD BANK (http://www.worldbank.org/)

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